PCSIR
Research & Development
Programme
2024 - 2025

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PAKISTAN COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

PCSIR
Research & Development Programme

2024-2025

Pakistan Council of Scientific and Industrial Research
Head Office, 1-Constitution Avenue, Sector G-5/2, Islamabad

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Foreword

Research and Development (R&D) form the backbone of technological progress and scientific discovery. They drive the creation of transformative products, breakthrough processes, and innovative solutions that redefine industries and uplift societies. R&D is a critical force behind economic growth, job creation, and sustainability, strengthening national resilience and global competitiveness. By strategically investing in R&D, nations unlock opportunities, address pressing challenges, and pave the way for a prosperous and sustainable future. For entrepreneurs, R&D is not just a tool but a strategic necessity—one that unlocks innovation, sustains competitive advantages, and secures success in rapidly evolving global markets.

R&D thrives on collaboration, bringing together scientists, engineers, policymakers, and entrepreneurs to explore new horizons. As Pakistan's premier research and development organization, PCSIR is committed to bridging the gap between academia and industry by harnessing collective scientific expertise to achieve significant milestones and accelerate national progress. This commitment is reflected in PCSIR's current R&D program, which encompasses a diverse portfolio of projects aimed at addressing the country's most pressing technological and economic priorities.

The program comprises 117 in-house R&D projects conducted across PCSIR's laboratories and research units, focusing on developing advanced processes and technologies. Strategic emphasis is placed on import substitution, export value addition, and fostering economic self-reliance. These initiatives include 13 PSDP schemes, 14 projects funded under the Research for Development and Innovation (RDI) initiative, 03 financed through PCSIR's Self-Generated Income (SGI), and three externally sponsored projects. Key focus areas include the halal sector, industrial and medicinal applications of cannabis cultivation, and cutting-edge advancements in gene manipulation to enhance agricultural productivity.

Aligned with the Ministry of Science & Technology's Science, Technology & Innovation (STI) Policy, PCSIR's R&D initiatives aim to modernize STI governance practices, strengthen regulatory frameworks, and build a highly skilled workforce to drive innovation. The policy also emphasizes the integration of emerging technologies across critical economic sectors and the use of science diplomacy to transition Pakistan into a technology-driven, globally competitive economy.

To amplify impact, PCSIR's initiatives extend beyond research, focusing on the commercialization of innovative products and technologies. The establishment of Technology Transfer Centers, Business Incubators, and Science and Technology Parks ensures a supportive ecosystem where local industries can flourish, contributing to economic growth, self-reliance, and global competitiveness. Furthermore, PCSIR is committed to expanding its international collaborations, fostering knowledge exchange, and building partnerships that leverage global expertise to address Pakistan's unique challenges.

This R&D program is not only advancing technologies but also addressing critical socio-economic challenges. Through rigorous research, strategic collaborations, and unwavering commitment to excellence, PCSIR is empowering industries, fostering entrepreneurship, and strengthening Pakistan's position as a global player in science and technology.

(Dr. Syed Hussain Abidi)
Chairman

CONTENT LIST

List of Public Sector Development Program (PSDP) Projects

Sub Projects Sponsored through PSDP Projects Titled Research Development & Innovation (RD&I)

Sponsored Projects

Projects to be Funded from Self-Generated Income (SGI) of PCSIR

In-House R&D Projects

PCSIR Labs. Complex, Karachi (KLC)

New Projects

(On-Going)

PCSIR Labs. Complex, Lahore (LLC)

New Projects

(On-Going)

PCSIR Labs. Complex, Peshawar (PLC)

New Projects

(On-Going)

PCSIR Lab. Islamabad (IL)

New Projects

(On-Going)

PCSIR Labs. Complex, Quetta (QL)

New Projects

(On-Going)

PCSIR – Fuel Research Center (FRC)

New Projects

(On-Going)

PCSIR – Leather Research Center (LRC)

New Projects

(On-Going)

PCSIR Laboratory, Hyderabad (HL)

New Project

PCSIR Labs. Skardu (SL)

New Project

Completed Projects

PCSIR Labs. Complex, Karachi

SGI Project

PCSIR Labs. Complex, Lahore

PCSIR Labs. Complex, Peshawar

PCSIR Laboratories Islamabad

Leather Research Center (LRC)

Fuel Research Center (FRC)

Public Sector Development Program (PSDP) Projects

PSPD No. 1141

Name of Laboratory / Centre / Unit:
PCSIR Head Office Islamabad

Title of Project: Digital Transformation, Strengthening and Automation of PCSIR

Name & Designation of Project Leader:
Engr. Fida ullah Khan, Project Director
Engr. Muhammad Ibraheem, Co-Project Director

Area(s) of Research:
IT Infrastructure

Duration:
03 Years

Date of Initiation:
2021

Project Brief:

- Leverage new digital and information technology and systems, such as enterprise-wide information systems, data analytics, knowledge repository, to enhance efficiency and effectiveness of PCSIR.
- To implement a modern digital organizational network through replacing existing/ obsolete IT equipment with modern I.T. equipment including servers, routers, switches, computers etc. at PCSIR.
- To make PCSIR hardware and network infrastructure ready for implementation of e-Office services to be acquired from NITB.
- To develop Key software/ applications with data driven management dashboards to make a digital automated system for PCSIR to increase transparency, productivity, efficiency and revenue generation.
- To strengthen technical manpower in managing, operating and delivering improved IT services in MoST and PCSIR.
- To train end-users on operating various systems to be developed under this project

Funding Source (PSDP/SGI/RD&I/etc.):
PSDP

Cost:
Rs. 960.71 Million

Tangible Outcome:
This project aims to transform PCSIR into a digital-enabled organization by implementing infrastructure and systems comprising of smart & modern technologies, implementing advanced IT solutions and upgrading existing IT equipment to achieve better productivity. This will automate business processes to enable a holistic picture of the activities for improved decision making by the top management. The project will include provision of latest computers, servers, printers, scanners, allied digital hardware, complete network infrastructure and automation of business processes for day-to-day activities as well as management decision making.

Achievements:

1. Printers, Scanner, Cable, and server Racks has been delivered to HO and other units etc.
2. Access Points and IP cameras delivered to HO and other units as well.
3. Documentation work is completed.
4. Requirements gathering, Submission of inception report, etc.
5. Staff Hiring as per revised PC-1
6. Training has been given to hired staff Almost Completed.
7. Partition of Offices in PCSIR Head Office and Peshawar.
8. Committee Room Renovation Completed.
9. Data Center Establishment Completed.
10. Data Center Establishment in PLC In progress.
11. Fiber Work In progress at Karachi and Lahore Unit.

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PSDP No. 1047

Name of Laboratory/ Center/ Unit:
PCSIR Head Office, Islamabad

Title of Project: Data Repository of Scientific Instrumentation

Name and Designation of Project Leader:
Dr. (Mrs.) Naseem Rauf, Project Director/CSO

Name and Designation of Project Associate:

Area(s) of Research:
- Financial Support to Students for Sample Analysis
- Development of Online Database of Scientific Equipment

Duration:
03 Years

Date of Initiation:
2021

Project Brief:
Pakistan is lacking behind in research and development due to unavailability of scientific facilities. Economic condition of this country does not permit providing position funding to all universities for acquiring instruments. Therefore, using the available instrumental facility of well-equipped research centers and universities from all over the country is a go-to choose to facilitate the researchers.

Keeping in view the above situation, a project was approved to design a nationwide mechanism in which anyone can get easy access to instruments present in different R & D, and academic institutions of the country. Major objective of the project is to facilitate the researchers/ scholars of research institutions, universities and R&D organizations to access instruments for carrying out sample analysis.

Funding Source (PSDP/ SGI/ RD&I, etc.):
PSDP

Cost:
Rs. 300.00 Million

Tangible outcome:
- Supporting research activities at national level and improving the productivity of research institutions.
- Enhancing the image of universities, and research centers as significant players in high-end research and innovation.
- Supporting a national culture of innovation and development of scientific knowledge.
- Producing skilled human resource to fulfill national requirement.
- Effective use of available equipment and resources.
- Saving in purchasing of new equipment.

Achievements:
- Award letters have been issued to 392 students for instrument access against an amount of Rs. 86.582443 million.
- Applications amounting to Rs. 20.00 million are under evaluation process.
- Work order was issued to a firm through tender for the development of online database. The firm has refused to take the job excusing that cost has increased. Work order has been cancelled and PPRA has been notified accordingly.
- Re-tender is pending due to insufficient release of funds and austerity measures.

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PSDP No. 1069

Name of Laboratory/Central Unit:
PCSIR Laboratories, Islamabad

Title of Project: Research, Development and Technology Transfer of Selected Active Pharmaceutical Ingredients (APIs) for Import Substitution

Name & Designation of Project Leader:
Dr. Aneela Fatima, Project Director/Director (R&D)

Name & Designation of Project Associates:
Dr. Ahmed Bilal, PSO
Mrs. Razia Kalsoom, SSO
Ms. Maliha Nishan Iqbal, SO

Area (s) of Research:
Pharmaceutical/Biotechnology

Duration:
02 Years

Date of Initiation:
2023

Project Brief:
- Establish capability of research and development of APIs for selected high value pharmaceutical products.
- Reduce the risk of supply chain disruption and thus contribute towards the national security aspect related to this important sector.
- Establish a capability by introducing new technologies, such as biotechnology, that provides a local/ domestic production base of APIs for fast-track supply to pharmaceutical industry.
- Reduce imports of raw materials (APIs) for selected APIs through the policy of import substitution. Also, increase opportunity of export of high-value pharmaceutical products and APIs.

Funding Source: (PSDP/SGI/RD&I/etc)
PSDP

Cost:
Rs. 1067.639 Million

Tangible Outcome:
- Indigenous APIs production
- In-country capability of downstream processing of biocatalysts for APIs.
- Foreign exchange will be saved.
- Creation of job opportunities in the local industries and agriculture sector

Achievements:
- Existing staff on additional charge basis hired
- Hiring of staff on daily wages basis
- Civil work completed
- Tender process for purchase of equipment and microbial strains in progress
- Hiring of project staff in progress

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PSDP No. 1048

Name of Laboratory/ Centre/ Unit:
Industrial Biotechnology Lab (IBL) & Biomolecules Purification and Testing Laboratory (BPTL)/ Food and Biotechnology Research Center/ PCSIR LLC

Title of Project: Development of Computer Controlled Fermenters and Production of Biochemicals and Bioproducts

Name & Designation of Project Leader:
Dr. Rubina Nelofer, Project Director/PSO

Name & Designation of Project Associate(s):
Dr. Quratulain Syed, Director General/CSO
Dr. Naaz Abbas, CSO,
Dr. Muhammad Nadeem, PSO
Dr. Farzana Bashir, PSO
Engr. Abad A. Nadeem, JE
Dr. Yasar Saleem, PSO
Dr. Sania Mazhar, SSO
Dr. Shaista Nawaz, SSO
Dr. Salman Saeed, PSO
Dr. Ammara Hassan, SSO
Mrs. Shagufta Naz, SO
Dr. Khurum Shahzad, CSO

Area(s) of Research:
Industrial Biotechnology/ Fermentation Technology

Duration:
02 Years

Date of Initiation:
2021

Project Brief:
Aims to establish a robust infrastructure for the indigenous design, manufacturing, and utilization of computer-controlled fermenters in Pakistan. Spearheaded by the Pakistan Council of Scientific and Industrial Research (PCSIR) and supported by the Pakistan Atomic Energy Commission (PAEC), the project is a pivotal step towards enhancing the country's capabilities in the burgeoning field of biotechnology. By leveraging advanced technologies and fostering collaborations between public and private sectors, the

project endeavors to propel Pakistan towards a knowledge-based economy, particularly in sectors crucial for national development such as food security, healthcare, agriculture, and industry.

Pakistan currently lacks an end-to-end infrastructure for the development and production of high-value biochemicals and bioproducts. The dependence on international sources for bioreactors, fermenters, and related technologies not only drains valuable foreign exchange but also hampers the country's capacity for innovation and self-sufficiency. Moreover, the absence of a robust industrial biotech ecosystem restrains the translation of academic research into commercial ventures, impeding economic growth and job creation.

The objectives are:

- Establish a design and manufacturing facility for computerized automated fermenters and associated equipment and systems for a variety of volume sizes that could be used by a wide range of facilities from lab pilot scale to commercial/industrial manufacturing.
- Develop indigenous capability in terms of R&D, design, development and subsequent commercial production of biochemicals, biopharmaceuticals and bioproteins etc.
- Leveraging existing commercial activities, this endeavor could create and open up new vistas of biotechnology related businesses for the country, thus moving towards knowledge-based economic growth.
- Develop and upgrade the existing essentially required acilities and infrastructure at PCSIR and ICC/ PAEC. Thus, providing establishment of national level integrated bio-processing infrastructure.
- Build capacity by conducting trainings, workshops, seminars and research capability in advanced techniques in development of large sized computer-controlled fermenters/ bioreactors and biochemical production. Thus, providing technical services by utilizing indigenous resources and saving precious foreign exchange in future.
- Produce local biotechnology industry needs for socio-economic growth of the country and associated spin-off technologies thereof.

Schematic Diagram for Scientific Project:

IMPLEMENTATION PLAN								
Activity	**YEAR 1**				**YEAR 2**			
Recruitment of man power								
Renovation/ Repair/up gradation								
Equipment tendering and purchasing								
Lab and Pilot equipment fabrication/Installation & automation								
Fermenters Dev. Activities								
Production of products Purification/down streaming of products Testing and validation of products and process								
Scale-up of bio Processing Commercial Products Capacity building of stakeholders								

Funding Source (PSDP/SGI/RD&I/etc):

PSDP

Cost:

Rs. 1981.607 Million

Tangible Outcome:

- Establishment of manufacturing facility for fermenters and associated equipment and systems for a variety of volume sizes that could be used by a wide range of facilities from lab pilot scale to commercial/industrial manufacturing.
- Development of indigenous capability in terms of R&D, design, development and subsequent commercial production of biochemicals, biopharmaceuticals, biofertilizers, biopesticides, etc.
- Leveraging existing commercial activities, this endeavor could create and open up new vistas of biotechnology related businesses for the country, thus creating employment in the emerging biotechnology industry.

Achievements:

- Two labs and fermentation pilot plant were renovated
- Equipments were purchased for Lab. scale production and purification of biomolecules.
- Equipments for pilot plant are in process of purchasing.
- Process Developed: 2
- Publications: 3
- Patents Filed: 2

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PSDP No. 1050

Name of Laboratory/Center/Unit

PCSIR Labs Complex Peshawar and Karachi

Title of Project: Establishment of Materials Resource Center and Development of Additive Manufacturing & Reverse Engineering Center at PCSIR

Name and Designation of Project Leader:

Engr. Sohail Ameer Marwat, Member (Technology)

Name and Designation of Project Associates:

- Engr. Haris Ikram, SE
- Engr. Muhammad Younis, PE- PCSIR Labs. Complex, Peshawar
- Mr. Shah Kamal Uddin, SSO-PCSIR Labs. Complex, Karachi

Area(s) of Research:

- Materials Science/ Engineering
- Advanced Manufacturing (3-D Printing & Reverse Engineering)

Duration:

03 Years

Date of Initiation

2021

Project Brief:

Part A: Establishment of "Material Resource Center" at PCSIR Labs Complex Karachi

1. Establishment of **Material Resources Center** at PCSIR Labs Complex, Karachi
2. The project aims at establishment/enhancement of facilities for Research and development, materials characterization, Analytical Testing and Quality assurance of materials in the following areas:
   - Advanced Engineering Materials
   - Electrical / Electronic Materials
   - Magnetic Materials
   - Optical / Spectroscopic Materials
   - Nano technology
   - Building Materials
3. Reverse Engineering and Material Identification for development of indigenous materials/ processes/ techniques for import substitution and to assist industrial and academic sector to improve / innovate their products and R&D facilities.
4. To establish a strong nexus between researchers, manufacturers and end users.
5. To help industries in exporting valuable/ finished product by providing quality evaluation of import/export products/materials.
6. To enhance earning through facilitation of commercials and technical institutes.
7. Indirect growth of material industries will generate new employment opportunities and aiding economy by producing more standard products.

Part B: Development of Additive Manufacturing & Reverse Engineering Facility. PCSIR Labs Complex Peshawar.

1. Establishment of Additive Manufacturing Units in PCSIR PLC.
2. Connecting private and public sector industries, with development of prototypes and end products.
3. Establishment of value chains and end-to-end customer support network for industrial goods and parts.
4. Enhancing the PCSIR's technical capability by developing high end prototyping labs for Advanced Thermal Design and High-Power Electronics.
5. Replacement of high-end equipment/part imports with locally produced 3D printed parts.

Funding Source (PSDP/SGI/RD&I/etc.):

PSDP

Cost:

Rs. 1951.683 Million

Tangible Outcome:

- This project mainly deals with the emerging Advance Materials, Additive Manufacturing & Reverse Engineering and the financial outcome will be both research & development products in addition to provide advance materials testing laboratory. It will pave way for the exporters to certify their consignments of locally manufactured products prior to their export and thus compete and find their place in the world market. It will become an easy source of income generation, which

could be utilized for enhancement of R&D activities of PCSIR.
- Indigenously developed products will help save huge amount of foreign exchange to import such technologies through ToT or otherwise finished product form.
- The establishment of this project is directly related to general uplift of the socio economic development of the country and indirectly towards the poverty alleviation of the growers.
- Moreover, the establishment of the project infrastructure in PCSIR Laboratories Complex will create a nucleus for the creation of jobs and employment of manpower in various categories

Achievements
- Project employees hired
- Civil work at Peshawar is near completion
- Civil work at Karachi has been started
- 7 No. of 3-D printers/ Scanners installed
- P.O for purchase of remaining 03 No. of 3-D printers has been issued.
- 20 No. of analytical testing and material processing equipment installed

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PSDP NO. 1059

Name of Laboratory / Center / Unit:
MBC/ PCSIR Labs. Complex, Peshawar

Title of Project: Up gradation of Medicinal Botanic Center as National Center for Herbal Medicine (UMBC-NCHM)

Name and Designation of Project Leader:
Engr. Sohail Ameer Marwat, Member (Technology)

Area(s) of Research:
Microbiology, Botany etc.

Duration:
04 Years

Date of Initiation:
2018

Project Brief:
- The main objective of the project is to establish National Center for Herbal Medicine (NCHM) at PCSIR Laboratories Complex Peshawar.
- To upgrade research facilities according to WHO guidelines in the areas of:
  - o Pharmacology & Animal House
  - o Phyto-chemical Standardization
  - o Process Development
  - o Herbal Analysis
  - o Microbiology
  - o Biochemical Assays
  - o Plant Tissue Culture
  - o Botany
- To have qualified/expert manpower in high technology fields related to health/medical sciences.

Funding Source (PSDP/SGI/RD&I/etc.):
PSDP

Cost:
Original: Rs.110.893 million,
Revised: Rs.286.00 million

Tangible Outcome:
The outcome of this project will be great importance in establishing the new industry by developing need-based herbal products and incorporating the prospective measures indicated from medicinal properties, dose level specification and analytical aspects of the product.

Achievements:
- Quality of Herbal products will be improved
- Value addition of herbal raw material will enhance their exports value
- Employment will be generated throughout the country

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PSDP No. 1073

Name of Laboratory/ Centre/ Unit:
Institute of Industrial Electronics Engineering (IIEE) & Pak Swiss Training Centre (PSTC)

Title of Project: Up gradation of Machinery, Equipment and Buildings of IIEE and PSTC Karachi

Name & Designation of Project Leader:
Engr. Dr. Farah Haroon, Project Director

Name & Designation of Project Associate(s):
Engr. Farhan Hamid, Co- Project Director

Area(s) of Research/ Development:
Up Gradation of Technical, Allied Facilities and Infrastructure of PCSIR Technical Centers, IIEE and PSTC

Duration:
02 Years; Completion of physical and financial targets are delayed due to ban impose on purchase of Machinery, Equipment and Transport under austerity measures 2022-23 of Finance Division of Pakistan. Expected completion 30-06-2024 as (Extension has been applied)

Date of Initiation:
2020

Project Brief:
Project is related with the Human resource development of IIEE & PSTC students. The up gradation of technical and allied facilities of IIEE and PSTC would address the skills gap and play a critical role to cope up with the rapid developments in the field of Engineering & Technology. The scope of the project includes

- Addition of Lab Trainers, General Lab Equipment, Machinery, Modernization of Labs and Library to enhance the engineering insight and technical expertise of students through updated standard of teaching and training facilities at IIEE and PSTC.
- Repair & renovation of the present infrastructure, buildings, workshops, labs of IIEE & PSTC and PSTC Hostel to provide safe and conducive environment of teaching and learning at IIEE and PSTC, Karachi. Modernization of Labs and transformation of Library into Digital Library is also an important aspect.
- Procurement of Furniture and Fixtures at Class rooms, Labs and Library is required and would be utilized for Students of IIEE and PSTC.
- Purchase of Vehicles at IIEE and PSTC is required for Students in lieu of participation in Exhibitions, Seminars and Project competitions. It would broaden their vision and promote their outreach in industries and professional community.
- ISO certification/accreditation of PSTC on recommendations of DDWP forum

Funding Source (PSDP/SGI/RD&I/etc):
PSDP

Cost:
Rs. 125 Millions

Tangible Outcome:

- Training on upgraded machines & equipment would enhance the technical expertise of the students to contribute towards worldwide Industry 4.0 revolution.
- Upgradation of allied facilities and infrastructure would be a step forward to provide conducive teaching and learning environment for students and faculty.
- Fulfillment of requirements of accrediting body Pakistan Engineering Council (PEC) and affiliating university NED, UET.
- ISO certification and accreditation of PSTC would improve its recognition.

Achievements:

Financial Progress (%age):
65 %

Physical Progress (%age):
Up gradation of Machines & Equipment: 91.81%
Modernization of Practical Lab & Library: 68.81%
Furniture & Fixtures: 70.845%
Establishment Charges & Opl. Expenses (Posts): 91.66%
ISO 9001-2015 Certification of PSTC: 49.09%
Infrastructure Development: 98.72%
Transport: 0%
Contingencies: 32.633%

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PSDP No. 1167

Name of Laboratory/ Center/ Unit:
Dukki Baluchistan

Title of Project: Establishment of Mineral Resource Center in District, Dukki Baluchistan for Product Design, Development and Value Addition to Enhance Export

Area(s) of Research:
Mineral Research & Development, Processing, Analytical Services

Duration:
02 Years

Date of Initiation:
Admin approval awaited

Project Brief:
- To establish the Mineral Processing and Extraction facilities to fulfill the industrial sector needs.
- To provide assistance to the local units to develop value added products.
- To develop the new techniques on the modern processing equipment as per international requirements.
- To improve the treatment methods of waste materials and extraction of novel ingredients from these materials.
- To start the Human Resource Development Programs in the light of modern methods and to compete with the international requirements for Mineral processing.
- To provide complete technical and management assistance to the local processors in order to overcome the national and international requirements of value added mineral products.
- To fill the gap for mineral extraction and processing research and product development.
- To develop national platform for mineral processing and extraction in the country.

Funding Source (PSDP/SGI/RD&I/ETC):
PSDP

Cost:
Rs. 700.00 Million

Tangible Outcome:
- Facility developed will be used for R&D, product design and development, value addition by using local mine and resources resulting socio-economic development of the region.
- Provision of trained staff/ manpower in the field of mineral processing
- Human Resource Development, of the region, Employment creation, contribution in sustainable growth; poverty alleviation etc.

Achievements:
- Site visit for selection of Land for the project
- Assignment account in process

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PSDP No. 1070

Name of Laboratory/ Center/ Unit:
- Ministry of Science & Technology, Islamabad (for National Industrial Hemp& Medicinal Cannabis Authority)
- PCSIR Laboratory Complex, H-9, Islamabad (National Hemp & Medicinal Cannabis Analytical Lab)
- PCSIR Laboratories Complex, Karachi (greenhouse, extraction/ distillation, testing)
- PCSIR Laboratories Complex, Lahore (greenhouse, extraction/ distillation, testing)
- PCSIR Laboratories Complex, Peshawar (greenhouse, extraction/ distillation, testing)
- PSCIR Laboratories, Skardu (greenhouse, extraction/ distillation and testing)

Title of Project: Establishment of Medical Cannabis Greenhouses For Biotechnology Derived Bio-products, National Hemp & Cannabis Analytical Laboratory and National Industrial Hemp & Medicinal Cannabis Authority

Name and Designation of Project Leader:
Engr. Sohail Ameer Marwat, Member (Technology)

Area(s) of Research:

Hemp cultivation, processing, analysis for medicinal and industrial use

Duration:

03 Years

Date of Initiation:

2023

Project Brief:

- Establishment of state of the art green house facilities each at PCSIR Labs Complexes Karachi, Lahore, Peshawar and Skardu to cultivate medicinal cannabis under controlled conditions for herbal and medicinal use.
- Biotechnology based fermentation technology to produce multiple cannabinoids (CBD, THC, CBG, CBC etc.) under good manufacturing practices (GMP).
- Indigenize production of industrial hemp and medicinal cannabis seeds in collaboration with private sector.
- Establishment of a National industrial hemp and medicinal cannabis analytical laboratory in PCSIR Laboratories Complex, Islamabad.
- Seed capital for the establishment and operation of Industrial Hemp and Medicinal Cannabis Authority in the existing premises of Ministry of Science and Technology.
- To provide state-of-the-art analytical services to the exporters and industry of cannabis products.

Funding Source (PSDP/SGI/RD&I/etc.):

PSDP

Cost:

Rs. 1946.014 Million

Tangible Outcome:

- Creation of job opportunitiesin the local industries and agriculture sector
- Industrial Hemp & medicinal cannabis based high value products
- In-country analysis/ testing facility.
- Foreign exchange will be saved.
- Regulated business for industrial hemp & medicinal cannabis based products.

Achievements

- Assignment account opened
- Tender for procurement of equipment finalized
- Tender for Services / TOT finalized

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PSDP No. 1156

Name of Laboratory/ Center/ Unit:

PCSIR Head Office, Islamabad

Title of Project: Research, Development and Innovation (RD&I) in PCSIR

Name and Designation of Project Leader:

Dr. Sarwat Ismail, Member (Science)/Project Director

Area(s) of Research:

- Food production and processing technologies
- Agriculture and irrigation technologies
- Metabolic engineering, synthetic biology, biotechnology
- Minerals, metals, chemicals materials technologies
- Any other S&T area of national importance

Duration:

02 Years (extended to 03 years)

Date of Initiation:

2021

Project Brief:

This project aims to ensure that continuous steam of funding is available for research, development and innovation of S&T pilot projects for industrial upstream and downstream initiatives. The programme provides a platform and service message to the private sector to utilize lab space/ facilities and technical expertise of PCSIR through collaborative research projects. The objectives of the programme also include the development of linkages to facilitate cooperation between research and development facilities at PCSIR, industrial businesses, technology producers and investment platforms.

Funding Source (PSDP/ SGI/ RD&I, etc.):
PSDP

Cost:
Rs. 1500.00 Million

Tangible Outcome:
- Sustainable capability in industrial research and development
- Technology Research Partnerships/ collaborations/ linkages established.
- A fundamental framework for spill over of mature technologies to civilian sector.

Achievements:
- 12 R&D projects worth Rs. 208.864 million have been approved in Phase-I and Phase-II, as given are under execution and running successfully, being executed in different labs/ units of PCSIR.
- One seminar on "Adaptation of Innovation Techniques for Agro-Food Production and Value Addition at PLC" was held in November, 2023
- Details of sub Projects sponsored through RD&I:
  - Development of a Model Urban Forest for Mitigation of Climate Change and to Restore Biodiversity
  - Establishment of Testing Facility for Electric Motors
  - Extraction, Purification, Characterization of Eugenol and Synthesis of Methyl Eugenol (ME)
  - Up-gradation of Pharmaceutical Microbiology Lab for ISO-17025 scope extension and Lab accreditation referring to international Standard to facilitate National export of pharmaceutical and surgical Products
  - Development of facility and ISO 17025 Accreditation of Method: Test for systematic toxicity
  - Production of Natural Fruits Vinegar
  - Installation of Vertical Hydroponics Growing System for Fruits, vegetables and medicinal Herbs
  - Production of Biological Based Fatliquor on Semi-Pilot Scale Level for Pakistan Leather Industry from Indigenous Sources.
  - Laboratory-scale Mineral Processing of Lithium Ore for Battery Applications

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Name of Laboratory/ Centre/ Unit:
Pakistan Council of Scientific & Industrial Research Laboratory Complex Ferozepur Road Lahore

Title of Project: Cultivation & Processing of Medicinal & Industrial Cannabis on Experimental Fields and Establishment of Testing and Product Development Facilities (PCSIR & Arid Agriculture University)

Name & Designation of Project Leader:
Dr. Qurat ul Ain Syed, Director General-LLC

Name & Designation of Co-PD(s):
Mr. Jehangir Shah, DG PLC
Dr. Hafiz Rab Nawaz, DG KLC

Area(s) of Research:
Bioresource Utilization
Industrial Chemistry

Duration:
03 Years

Date of Initiation:
2021

Project Brief:
Cannabis is a variety of the hemp plant species that is grown specifically for the industrial uses of its derived products. It is one of the fastest growing plants and was one of the first plants to be spun into usable fiber 50,000 years ago. It can be refined into a variety of commercial items, including pharmaceuticals, food items, cosmetics, paper, textiles, biodegradable plastics, building materials, bio fuel and animal feed. Through efficient cultivation, processing and product development, raw cannabis can be converted in to highly valuable products owing to its huge hidden potential.

Currently, cannabis is only known as an abusive plant due to its narcotic use in Pakistan. However, it contains a lot of natural constituents including cannabinoid like CBD, CBDA, THC, THCA, CBG, CBGA, CBN along with terpenes, flavonoids etc. Besides, its seeds, fiber and other biomass can also be utilized in the products of different fields. By effective use of this commodity through research and innovation, it can be converted to valuable products.

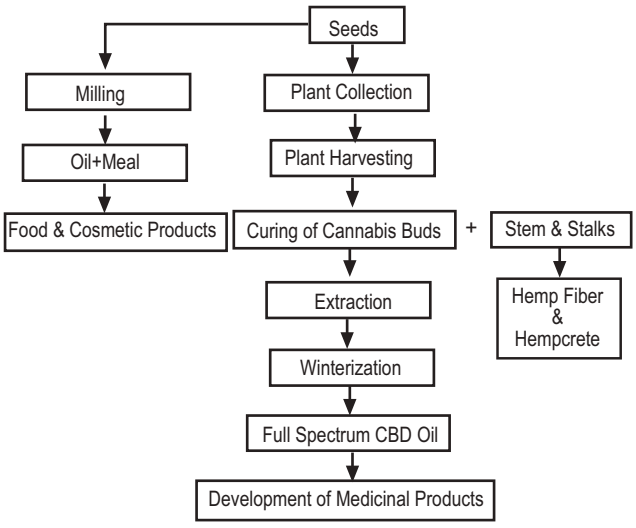
Cannabis is considered as a multipurpose crop and almost all of its parts can be utilized in different type of products. Its flowers and buds are rich source of cannabinoids which are used in pharmaceutical industry. CBD oil/ extract is considered to have many pharmacological activities like anti-depressant, anti-rheumatic, anti-spasmatic, muscle relaxant and anti-oxidant activities. Similarly, tetrahydrocannabinol (THC) possesses enormous potential as a material of legalized export to earn huge foreign exchange.

Its seeds are a rich source of proteins, carbohydrates in the form of fibers and fats. Due to abundance of beneficial fatty acids and essential omega-3 fatty acids, it can be used in a variety of food products. Besides flowers and seeds, its stalk and shoots are fibrous and may be utilized to develop hemp fiber for textiles and hempcrete as building material.

Objectives

- To develop experimental fields/ land for cultivation of industrial cannabis.
- To cultivate industrial cannabis on experimental fields and it's processing.
- To develop extraction techniques for cannabinoids from cannabis flowers
- To develop and validate analytical methods for testing of industrial cannabis.
- To conduct research for product development from cannabis.
- To provide state-of-the-art analytical services to the exporters and industry of cannabis products.

Schematic Diagram:



Work Plan:

- Field trial studies of cannabis cultivation and optimization of associated parameters
- Curing of cannabis flowers
- Development of methodologies for extraction of cannabinoids from cannabis flowers and their optimization
- Product development in the fields of pharmaceuticals, cosmetics, food, agriculture and building materials

Funding Source:

PSDP

Cost:

Rs.1896.820 Million

Tangible Outcome:

- Technology development for cultivation of high-quality cannabis crop
- Technology development for the extraction of cannabinoids
- Establishment of modern laboratory facilities for cannabis testing and product development
- Collection of baseline data for cultivation and processing of cannabis for replication in other parts of the country
- Human resource development
- Development of cannabis-based products

Achievements:

i. Development of ANF Approved Green Houses for Hemp Cultivation at LLC, KLC & PLC, which are equipped with temperature, humidity, air circulation, light control systems and RO plant for irrigation water and drip irrigation system for fertigation.

ii. An ISO 17025 analytical laboratory accredited from PNAC for testing of CBD as Pakistan first accredited laboratory is developed at Lahore while accreditation of Karachi & Peshawar laboratories for the same is in process.

iii. Cannabis processing methodology is developed including different unit operations e.g., Drying, Grinding, Decarboxylation and Extraction (with Solvent Extraction and SCFE methods).

iv. 36 Cannabis products have been developed.

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Name of Laboratory/ Centre/ Unit:
PCSIR LLC

Title of Project: Gene Editing of Biological Agents for Nutritional, Bio-chemicals and Therapeutic Purposes

Name & Designation of Project Leader:
Dr. Quratulain Syed, Director General PCSIR LLC

Name & Designation of Project Associate(s):
Dr. Naaz Abbas, CSO
Dr. Yasar Saleem PSO
Dr. Sania Mazhar, SSO
Dr. Shaista Nawaz, SSO
Dr. Ammara Hassan,
Mrs. Shagufta Naz, SO
Engr. Abad Ali Nadeem

Area(s) of Research:
Biotechnology, Gene Editing, Bioproducts development, Gene Edited Crops development (UAF)

Duration:
03 years (extension for 1 year, in process)

Date of Initiation:
2021

Project Brief :

The emergence of highly versatile gene-editing technologies has provided researchers and scientists with the ability to rapidly and economically introduce sequence-specific modifications into the genomes of a broad spectrum of cell types and organisms. The core technologies includeCRISPR, CRISPR/Cas9, TALENs, ZFNs, etc.

The proposed pilot project envisages to establish a research, design and development base for advanced gene editing that could then be used to demonstrate its functionality in later stage metabolic engineering endeavours. This advanced gene editing capability in PCSIR could lead into later stage development of industrial fermentation and production techniques in biorefineries of various types. In the initial stage, technology partnerships with reputed international entities willhelp in establishing a quick knowledge base and an expertise in this emerging field. In this respect, University of Agriculture, Faisalabad, will be made the prime partner. A Contract Agreement will be signed between PCSIR and UAF to carry out specific work as outlined in this PC-I under the sub-section 6.3.4. With the help of acquired technologies, indigenous efforts in this area would enable to establish a base for design and development of advanced gene-editing technologies. Thus, this project is an essential link for creating a complete ecosystem for bioprocessing and bioproduction. This project was developed to meet following objectives:

- Establish an advanced gene editing facility at PCSIR along with associated equipment and systems that could be used for a wide range of purposes such as nutritional and therapeutic purposes, leading to indigenous commercial/ industrial manufacturing.
- Develop indigenous strain development/ genetic engineering capability in terms of R&D, design, development and subsequent commercial production of biofoods, biochemicals, biopharmaceuticals, biofertilizers, biopesticides, etc. including biomolecules of industrial importance including vitamins, omega-3, Bioethanol, bio-butanol, industrial enzymes, single cell proteins, poultry feed additives.
- Develop testing facilities for the quality assurance of developed bio-products and thereafter their subsequent commercialization.
- Leveraging existing commercial activities, this endeavour could provide new vistas of biotechnology related businesses for the country, thus moving towards knowledge-based economic growth.
- Build capacity by conducting trainings, workshops, seminars and research capability in advanced techniques of gene editing. Thus, providing technical services by utilizing indigenous resources and saving precious foreign exchange in future.

Work Plan:

- Establishment of labs with commissioning of lab equipment
- Microbial host selection for production of bio-products
- Gene editing of metabolic pathways for precursor

target Bioproducts
- Industrial strain engineering for desired quality
- Optimization of best performing strains at lab scale
- Bioprocessing services for metabolite extraction and purification.
- Technology Transfer of IP and microbial strains for scale up studies

Funding Source (PSDP/SGI/RD&I/etc):
PSDP

Cost:
Rs. 1799.598 Million

Tangible Outcome:
- Technical facilities have been developed for biproducts at state of the art genome editing labs.
- Capacity building for pprobiotic products and spray formulations including lysine, DHA, beta carotene, has been developed, while n-butanol, albumin, biofertilizers and biopesticides are under development phase.
- Four labs meant for Bioinformatics, Genomics, Culturing labs, Growth rooms, BSL-3 facility were developed at UAF
- Technology for gene edited heat and lodging resistant wheat, stress tolerant citrus, GE Cotton, heat tolerant soybean, heat tolerant tomato, late blight resistant tomato - completed at UAF.
- Soybean crop developed for Pakistani climate applied on 100 acres of land and will be further propagated to 1000 acres followed by mass scale cultivation across the country. That will reduce soybean imports bill and major cost reduction of poultry feed.
- Improved awareness was created through five workshops and seminars, participant from NARC, NIAB, NIBGE, AARI, domestic universities and from Iran, Malaysia, Sri Lanka, Siera Leone, Nigeria got hand-on training.
- PCSIR will act as resource centre for local bioproducts industry that will lead to an approx. 10 % reduction in import of these bioproducts.

Achievements:
- Gene editing lab for carrying out DNA level targeted changes
- Molecular biology lab for carrying out cloning, expression and purification of bioproducts
- Bioanalytical lab for carrying of testing and QC of developed bioproducts
- Advanced computing and data processing lab for genome analysis and data annotations
- Production technologies for following bioproducts has been developed: Lysine, DHA (Omega-3), Beta-Carotene, Egg Albumin, n-Butanol

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Name of Laboratory/Central Unit:
PCSIR Laboratories Complex, Peshawar/Islamabad

Title of Project: Medical Equipment & Devices Innovation Center (MEDICen)

Name & Designation of Project Leader:
Engr. Ghulam Shabbir, Project Director/ Director Technology PCSIR Head Office, Islamabad

Name & Designation of Project Associates:

Area(s) of Research:
Establish a biotechnological platform for antibody production and the development of medical and surgical equipment's

Duration:
04 Years

Date of Initiation:
2021

Introduction:
The MEDICen will aim to:
- Assist Pakistani Medical and Surgical Manufacturers in research and development of Medical equipment not only to cater for local market demand but also for export.
- Understand and synthesize the local medical device industry support requirement, skill development, ecosystem, viability of manufacturing in Pakistan.
- Increase the efficiency, quality and capacity of existing industry to become a major participant in

the global supply chain of medical devices.
- Innovate and develop technologies for medical equipment, keeping in view local and global demand to assist manufacturers to move up the technology ladder.
- To augment the role of Immunology in clinical diagnostics.

Key objectives of MEDICEN are as follows:
- Knowledge Economy and Made in Pakistan Brand:
- Expedite the Digitalization Process of Health Care Sector:
- Open-Source Strategy:
- Entrepreneurship culture development in IoTs.
- Academia/ R&D organization -industry Linkage
- Training workshops and Seminars
- First Mover Advantage:
- Boosting usage of AI
- Data sharing.

Funding Source(PSDP/SGI/RD&I/etc):
PSDP

Cost:
Rs.1,989.52 Million

Tangible Outcome:
Indigenous production of medical devices in Pakistan targeting local market as well as exports
- Economic improvement
- Increased GDP
- Balance of Payment improvement
- Increase adoption of local medical devices in Pakistan
- Improvement in Forex Reserves
- A fully functional state-of-the-art antibody library, production and kit assembly facility exists in PCSIR
- Indigenized ability to produce antibody libraries, kit assemblies for infectious diseases in Pakistan.

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- Indigenized ability to produce antibody libraries, kit assemblies for infectious diseases in Pakistan.
- A fully functional state-of-the-art antibody library, production and kit assembly facility will be established in PCSIR
- Develop foot prints for Indigenized capability to produce antibody libraries, kit assemblies for infectious diseases in Pakistan.
- 20-25 projects should be funded related to research, design and development of medical devices, the projects through tipple Helix should result in either:
  i. A functional prototype of a medical device
  ii. Development of a process aiding in manufacture of a medical device
  iii. Improvement in design of a medical device
  iv. Provision of software or a service for medicinal field.
- To make Pakistani products (Medical Devices /Surgical) competitive in the international markets through a robust system of research, product design & development, quality control, testing and certification.
- Help Indigenous production of surgical/medical devices in Pakistan targeting local market as well as exports
- Increase adoption of local medical devices in Pakistan
- Availability of trained manpower both for local medical device industry as well as foreign industry
- Export enhancement & Balance of Payment improvement
- Increase adoption of local medical devices in Pakistan
- Improvement in Forex Reserves
- To increase IoT awareness in respective discipline
- To train contributors on the importance of quality control and assurance
- To improve product quality and bring it to international standards
- Transfer of knowledge & Technology & its spin off & spillover to industrial side.

The Project tangible outcomes include but not limited to:

i. Surgical and Dental Instrument & Technologies
ii. Orthopedics Devices and Implants
iii. Diagnostic Equipment & Devices
iv. Medical IT and Decision Support Systems
v. Immunodiagnostics (Exclusively performed by PCSIR)

Achievements:

Brief of the likely achievements of MEDICen project is as under:

- Development of new medical technologies: The MEDICen project will support the development of new medical technologies and devices that will improve the quality of patient care in Pakistan. This will include the development of new diagnostic tools, medical devices, and treatment options.
- Strengthening of the healthcare industry: The project will help to strengthen the healthcare industry in Pakistan by supporting local manufacturing capabilities. This will allow the country to become a leading provider of high-quality medical products, leading to increased exports and a boost to the economy.
- Faster adoption of digital technologies: The MEDICen project will expedite the adoption of digital technologies in the healthcare sector. This will improve access to healthcare services and enhance patient care, leading to better health outcomes for the population.
- Promotion of an entrepreneurship culture: The project will foster an entrepreneurship culture in the field of IoT for healthcare applications. This will provide individuals and startups with the support and resources needed to develop and commercialize IoT-based healthcare solutions, leading to innovation and economic growth in the healthcare sector.
- Strengthening of academia-industry linkages: The MEDICen project will establish linkages between academia, research and development organizations, and the industry. This will facilitate knowledge exchange, capacity building, and collaborations between these sectors, creating a robust ecosystem for medical technology innovation and development.
- Use of AI in healthcare: The project will harness the power of AI in the healthcare sector. By integrating AI technologies into medical devices, decision support systems, and diagnostics, the project will enhance the accuracy, efficiency, and effectiveness of healthcare services, leading to better patient outcomes.

Overall, the MEDICen project is expected to deliver significant achievements in terms of developing new medical technologies, strengthening the healthcare industry, promoting an entrepreneurship culture, faster adoption of digital technologies, strengthening linkages between academia and the industry, and promoting the use of AI in healthcare in Pakistan. These achievements will contribute to improved healthcare outcomes for the population and economic growth in the country

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Sub Projects Sponsored through Research Development & Innovation (RD&I)

Name of Laboratory/Centre/Unit:
ACRC/PCSIR/Labs. Complex, Karachi

Tile of Project: Development of a Model Urban Forest for Mitigation of Climate Change and to Restore Biodiversity

Name & Designation of Project Leader:
Dr. Sofia K. Alvi, PSO

Name & Designation of CoPI:
Dr. Tahir Rafique, PSO

Name & Designation Project Associate(s):
Dr. Saima Imad, PSO
Dr. Beena Naqvi, PSO
Mr. Khalil Ahmed, SSO
Mr. Sheraz Shafiq, SSO

Area (s) of Research:
Agriculture & Irrigation Technologies, Climate Change

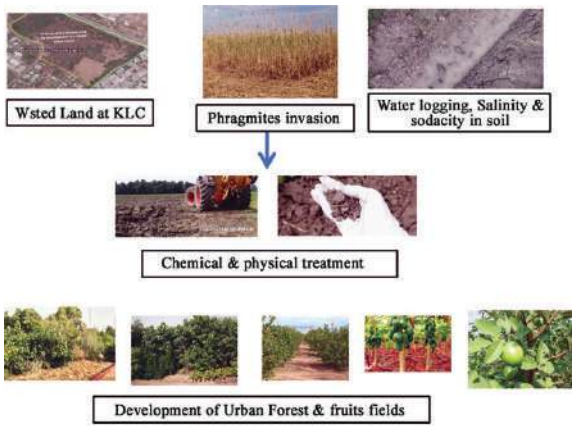
Duration:
02 Years

Date of Initiation:
2024 (Subject to allocation of Funds)

Project Brief:
Karachi is a metropolis with extensive vertical construction which has transformed the city into a concrete jungle. The extreme weather especially the heat waves have hit the city many times in past few year. To cope with this problem, a concept of urban forest is introduced. These forests are not only providing ecological balance, but also play an important role in conditioning the environment of the city. They moderate the local climate, filter air and sunlight and are critical in cooling the urban heat island effect.

PCSIR Laboratories Complex Karachi, has large area of wasted land due to multiple problems like water logging, salinity, sodicity and invasion with phragmites (*Phragmites karka*) making it inappropriate for cultivation. Management of such soil requires diversified reclamation techniques. This study aims to preserve the flora and fauna of the area in a sustainable and manageable manner and convert that area into an urban forest. Moreover, this wasted land has a great potential to be utilized for agricultural activities and to generate revenue for the KLC Laboratories.

Initially, an area of around 5 acre has been selected for development of urban forest and also start plantation to initiate a sustainable agriculture activity. Some vacant plots can be transformed into sustainable parks and gardens to provide aesthetic environment for the Laboratory. This model can be replicated further so that sustainable urban forests would be developed, and KLC PCSIR will provide consultancies and technical advisories to different institutions, NGOs working for conservation of nature.



Funding Source (PSDP/SGI/RD&I etc.):
RD&I

Cost:
Rs. 15.00 Million

Tangible Outcomes:
- Reclamation of waste land around KLC
- Establishment of Model Urban Forest for agri investors
- Improved aesthetic environment for the Laboratory
- Income generation from fruit and vegetable fields and gardens.

Achievements:
The funds could not be released for Phase II of

RD&I Project; the project will now be initiated in July 2024 after availability of funds.

Status:
New Project

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Name of Laboratory/ Centre/ Unit:
ACRC/PCSIR/Labs. Complex, Karachi

Title of Project: Establishment of Testing Facility for Electric Motors

Name & Designation of Project Leader:
Mr. Arif Karim, PSO

Name & Designation of Project Associate(s):
Mr. Faisal Ghazanfar, SSO
Mr. Naseem Ahmed, SEO
Dr. Abid Karim, SSO
Mr. Kashif Husain, TO
Mr. Noman Saeed, TO

Area(s) of Research:
Testing & Analysis in the Field of Electric Motors Performance Evaluation, Instrumentation

Duration:
02 Years

Date of Initiation:
2022

Project Brief:
Electric motors play a vital role in industry and home appliances. About 60~70 percent of electricity consumption in industry is due to electric motors. An efficient motor will therefore reduce electricity consumption many folds, in addition the pay-back period of motors will also be reduced. The testing of efficiency of motors is therefore a pressing need of our industry. In this connection PSQCA placed motors in their mandatory list for compliance of IEC standards IEC 60034(x). Similarly, Karachi Shipyard and Engineering Works (KS&EW) contacted PCSIR for developing testing facility especially for high power motors. In addition, the domestic motors used in fans, pumps, refrigerators (Compressors), air conditioners (Compressors) washing machines, exhaust etc are low power having range up to 8HP. Furthermore, there is another need of mobile-testing lab for onsite (In-Situ) motor testing under load and in process, however, this project is aimed at developing in-house testing facility for the range of 0.5~30KW electric motors.

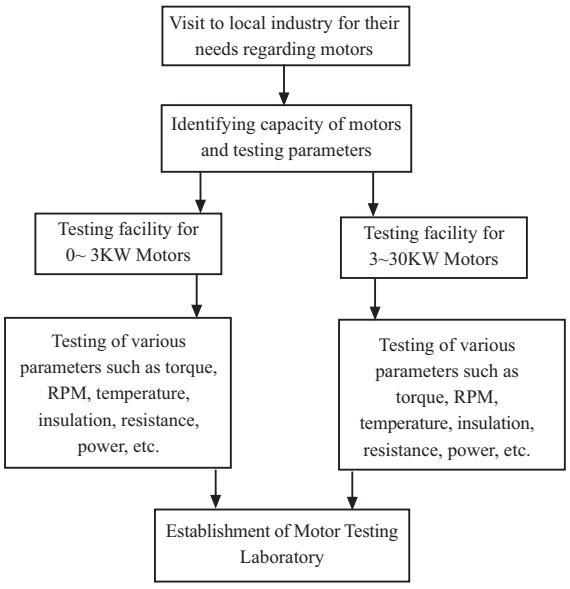
Funding Source (PSDP/SGI/RD&I etc.):
RD&I

Cost:
Rs. 45.64 Millions

Tangible Outcome:
- It will help in regulation and control of under rated motors for its local production as well as its import, thus, leading to energy conservation.
- It will help in energy conservation by identifying under efficient motors in process plants which will eventually lead to low cost products in the market.

Achievements:
- Tender Process has been completed.
- Due to the restriction on import the purchase of equipment/instrument from China and its delivery in Pakistan is suffered a lot and delayed. We are still waiting for the supply of equipment/instrument.

Graphical Abstract:



Status:
On-going

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Name of Laboratory / Centre / Unit:
CES/PCSIR Labs. Complex, Karachi

Title of Project: Extraction, Purification, Characterization of Eugenol and Synthesis of Methyl Eugenol (ME)

Name & Designation of Project Leader:
Dr. Sohail Shaukat, SSO

Name & Designation of Project Associate(s):
Engr. Nazir Ahmed Tunio, PE

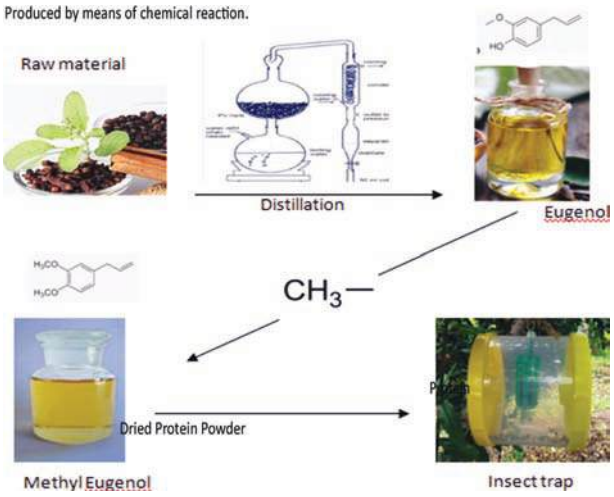
Area(s) of Research:
Agriculture & Irrigation Technologies/Environment

Duration:
02 Years

Date of Initiation:
2022

Project Brief:

- Methyl eugenol (ME) is a molecule which shows insect pheromone activity for fruit flies (especially for mango farming and generally for other fruits and vegetables), although it is believed not to be the natural pheromone itself. If present in sufficiently high concentration, it will immediately deter the herbivore from further feeding on the affected part. ME acts as a deterrent or repellant. No harm is expected from use of this substance as pesticide products. It is one of many compounds that are attractive to males of various species of orchid bees, which apparently gather the chemical to synthesize pheromones; it is commonly used as bait to attract and collect these bees for study or disruption. It also attracts female cucumber beetle. Its derivative form, Methyl Eugenol (ME), was found to be the most active attractant for the oriental fruit fly, *Bactrocera dorsalis*.
- In Pakistan, ME is used extensively especially in mango farming and being imported from abroad. Up to the best of our knowledge, it is not produced in Pakistan; therefore, the growers have to purchase it from importers / distributors. This creates a burden over them in terms of finances and in time supply. Thereby, the grower community is seeking for the local production.
- This project is designed to explore some economically feasible options indigenously for ME production.
- The pilot plant for Eugenol extraction and ME synthesis will result in value addition of indigenous sources (non-hazardous) of pest control.
- It will help to optimize the process of Eugenol extraction and derivitization of Eugenol.



Funding Sources (PSDP/SGI/RD&I etc.):
RD&I

Cost:
Rs. 11.5 Million

Tangible Outcome:

- Product Development (Methyl Eugenol)
- Pilot Scale Process Development for ME production
- Development of a unique research cum production facility on the subject matter at PCSIR KLC.

Achievements:

- Optimization of Eugenol Extraction time and conditions.
- Process development of Methyl Eugenol synthesis
- Design of Eugenol to Methyl Eugenol reaction vessel.

Status:
On-going

★ ★ ★ ★

Name of Lab/Centre/Unit:
PRC/ PCSIR Labs. Complex, Karachi

Title of Project:Up-gradation of Pharmaceutical Microbiology Lab for ISO-17025 Scope Extension and Lab Accreditation Referring to International Standard to Facilitate National Export of Pharma--ceutical and Surgical Products

Name & Designation of Project Leader:
Dr. Kauser Siddiqui, PSO
Dr. Samina Iqbal, SSO

Name & Designation of Project Associate(s):
Dr. Saeeda Bano, PSO
Dr. Shagufta Ambreen Shaikh, SSO
Dr. Kanwal Abbasi, SSO

Area of Research:
Biotechnology & Biochemistry

Duration:
02 Years

Date of Initiation:
2023

Project Brief:

This research proposal is designed for ISO 17025 scope extension and up gradation of Pharmaceutical Microbiology lab. British Pharmacopeia (BP) and United State Pharmacopeia (USP) recommend specified sterile lab area for the testing of sterile. Under this project sterile area will be designated by upgrading the lab facilities and design according to ISO-17025 standard for testing of sterile products. Non sterile product testing and Endo toxin test methods will be optimized and separate area will be specified and data will be recorded for the compliance of ISO 17025.

Regarding surgical goods and items, International standards are available and worldwide labs are accredited for their testing. Products require CE marking before they can be sold in the European countries. CE marking indicates that a product has been assessed by the manufacturer and deemed to meet EU safety, health and environmental protection requirements. It is required for products manufactured anywhere in the world. In this scenario, Pakistani exporters are compelled to get their products tested from Thailand, Philippines and China at very high cost because there are no such high tech labs in Pakistan that can fulfil the international testing and certification standards. They can be attracted and be our loyal clients if PCSIR Karachi Labs will accomplish the ISO 17025 accreditation and therefore, complies International export requirements in this under discussion field to boost up Pakistan Export with Confidence. Currently our lab is performing several Microbiological analysis of Pharmaceutical and surgical products although the lab is not accredited due to which many pharmaceutical companies refused to get their products tested. Same is the case in surgical products (instruments/devices and implants), the expertise are available but the facilities are not updated.

The objectives are given below: ISO-17025 Accreditation of Pharmaceutical Microbiology lab at PCSIR Laboratories, Karachi to enhance business opportunities and to provide Authentic Internationally required analytical services to Pharmaceutical and Surgical Instrument manufacturing industries to uplift the National Export.

Funding Source (PSDP/SGI/RD&I etc.):
RD & I

Cost:
Rs. 20.0 Million

Tangible Outcome:
- Accredited lab facility developed at Government Organization
- Frequency of samples increased/capture more Business
- Export enhancement by producing international standard products by local industry and their certification by Government body
- Revenue generation at multiple levels and saving foreign exchange

Achievements:
- Project will be initiated after availability of funds (Phase-II of sub project sponsored RD&I)

Status:
On-going

★ ★ ★ ★

Name of Laboratory/ Centre/ Unit:
FBRC/ PCSIR Labs. Complex, Lahore

Title of Project: Development of Facility and ISO 17025 Accreditation of Method: Test for Systematic Toxicity

Name & Designation of Project Leader:
Mrs. Shamma Firdous, PSO

Name & Designation of Project Associate(s):
Dr. Quratul Ain Syed, Director General/CSO
Dr. Asma Saeed, CSO Dr. Muafia Shafiq, SSO
Dr. Sajila Hina, SO

Area(s) of Research:
Biological Evaluation of Medical Devices According to ISO Standard

Duration:
02 Years

Date of Initiation:
2023

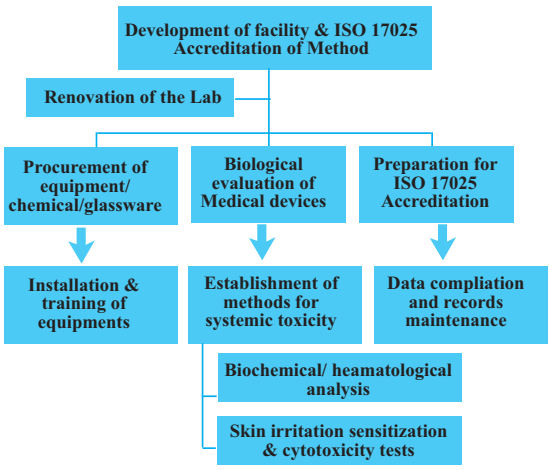
Project Brief:
All medical devices that contact the human body undergo biocompatibility safety assessment prior to market release. Today, this industry is suffering badly in international market. In spite of the fact that this industry has the potential to earn sizeable foreign exchange. One of the major issue is Biological evaluation. Surgical instrument requires Biological evaluation before they can be sold in the EU. Tests for systematic toxicity (ISO10993-11) also part of biological evaluation of medical devices and required for the medical devices categorized as external communicating device and implant devices. These testing facilities are not available in Pakistan. Establishing such facilities at toxicology laboratory will be a big initiative to combat the problems of future. The sector of medical devices has shown growth of about 34 % as compared to preceding year's growth of US $ 191 million. The total capital investment in the surgical industry is estimated at Rs. 18 billion. There are about 2000-2500 active small and medium surgical units.

Problems related to medical devices can have serious consequences for consumers. Relatively recent examples in the media that have caused severe patient injuries and deaths include metalon-metal hip implants; pacemakers, defibrillators, and associated leads; stents; endoscopes; surgical mesh; and, power morcellators. The metal-on-metal hip has been implanted in millions of patients, many of whom suffered serious harm and, as a result, needed additional procedures to replace the device.

Acute systemic toxicity tests identify short-term toxic effects that appear soon after a substance is swallowed (oral toxicity tests), absorbed through the skin (dermal toxicity tests), or inhaled (inhalation toxicity tests). The aim of toxicity studies is to ensure safety of the chemical compounds and medical devices before they can be used, as well as to determine the toxic effects of test substances. An important role of toxicology is to identify the important effect or sets of effects in order to prevent irreversible or debilitating disease. One important part of this task is the identification of the organ first or most affected by a toxic agent; this organ is defined as the "target organ. The toxic effects of chemicals, food substances, pharmaceuticals and medical devices etc., have attained great significance in the 21st century. To provide testing facility to surgical industry and exporters of the medical devices.

- Systemic Toxicity Studies
- Procurement of the equipment
  i. Hematology /chemistry analyzer
  ii. Urine analyzer
  iii. Embedding station/microscope
  iv. UV-Visible Spectrophotometer
- Renovation of the lab.
- Validation/Verification of method ISO 17025 Accreditation

Graphical Abstract:



Funding Source (PSDP/SGI/RD&I/etc):
RD&I

Cost:
Rs. 6.0 Million

Tangible Outcome:
- Availability of facility for systemic toxicity studies at Toxicology Lab LLC
- Accredited test facility regarding systemic toxicity will be available
- Development of the facility will open the new door for surgical industry of Pakistan to export their medical devices to the European countries
- Economic development

Achievements:
Renovation of animal house was carried out.

★ ★ ★ ★

Name of Laboratory/ Centre/ Unit:
FMS/PCSIR Labs. Complex, Peshawar

Title of Project: Production of Natural Fruits Vinegar

Name & Designation of Project Leader:
Dr. Arshad Hussain, PSO

Name & Designation of Project Associate(s):
Mr. Zia Ur Rehman, ST
Ms. Hina Tariq, JSO

Area of Research:
Food Microbiology/Biotechnology

Duration:
01 Year

Year of Initiation:
2022

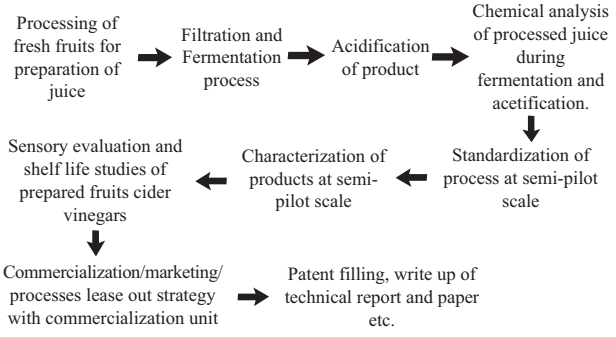
Project Brief:

Vinegar, from the French vin aigre, meaning "sour wine," can be made from almost any fermentable carbohydrate source, including wine, molasses, dates, sorghum, apples, pears, grapes, berries, melons, coconut, honey, beer, maple syrup, potatoes, beets, malt, grains, and whey. Initially, yeasts ferment the natural food sugars to alcohol. Next, acetic acid bacteria (Acetobacter) convert the alcohol to acetic acid. The wide variety of vinegars available today is nothing new. Vinegar is commonly used as food ingredient but also for its medicinal properties and for its physiological effects such as invigorating, regulator of blood pressure, diabetes mellitus regulator, appetite stimulator, digestion and absorption of calcium. Natural vinegar is a superior food additive over synthetic vinegar as it carries essential amino acids from its fruit source and is reported to act as a medicine for aches and gastric troubles. Consequently, acetic acid bacteria cause an important industrial interest as well as lactic acid bacteria and yeast.

The National priority area of this project is production process for value added natural fruits cider vinegars by utilizing indigenous raw material. This will in turn replace synthetic vinegars based on chemical additives. This research work is needed to develop natural fruit cider vinegars for local consumers. PCSIR will also provide consultancy in this regard. The developed products will be the substitute for costly imported branded natural vinegars available in local market.

The Objectives are:
- Effective utilization of apple, dates, raisins and apricot by preparation of natural cider vinegars; it will in turn will reduce to some extend the wastage of the selected fresh fruits from our Northern and Chitral areas.
- Utilization of low grade cheap fruits for production of good quality valuable product.
- Based on nutritive values of these fruits, development of value added, nutritive and cost effective process for production of cider vinegars at semi pilot scale level.
- Standardization and characterization of the products for semi pilot scale in bulk quantity.

Graphical Abstract:



Funding Source (PSDP, SGI, RD&I, etc):
RD&I

Cost:
Rs. 9.40 Million

Tangible Outcomes:
- This will substantially contribute towards enhancement of the competency of potential commodities for their utilization into valuable products
- Replacement or substitute of low quality, costly and imported branded natural vinegars available in local market.
- Production in bulk quantity in less time as compared to lab/bench scale production
- Based on semi pilot scale products development, will ease the commercialization of natural fruits cider vinegar. It will fulfill the satisfaction of the customers for lease out of the product.

Achievements:
- Procurement of Machinery/Equipment.
- Autoclave purchased under equipment head of project.
- Installation and commissioning of autoclave has been finalized.
- Purchased raw material.
- Purchased miscellaneous items.
- Purchased some chemicals, media and standards.
- Packing material purchasing.
- Commercialization/propagation of product.

Processes Developed:
1. Process for the production of **Apple Cider Vinegar** at lab and pilot scale.
2. Process for the production of **Grapes Cider Vinegar** at Lab and Pilot scale.
3. Process for the production of **Apricot Cider Vinegar** at Lab scale.
4. Process for the production of **Dates Cider Vinegar** at Lab.

Process Leased Out:
Process for the Development of Grapes Cider Vinegar @ **Rs.90000/- to M/S Hunter Orchards Syed Farms, Hazro Attock** (June 2023)

Patent File:
Patent " Method for the Preparation of Grapes Vinegar"
Patent Application No. (666/2023 dated: 18.10.2023

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Name of Laboratory/Centre/ Unit:
MBC/ PCSIR Labs. Complex, Peshawar

Title of Project: Installation of Vertical Hydroponics Growing System for Fruits, Vegetables and Medicinal Herbs

Name and Designation of the Project Leader:
Dr. Hina Fazal, SSO

Name and Designation of the Project Associate (s):
Mrs. Farina Kanwal, PSO

Area (s) Research:
Cultivation/ Hydroponics

Duration:
02 Years

Date of Initiation:
2022

Project Brief:
Agricultural reforms play a central role in the government economic reform package. Unfortunately, outdated irrigation practices have led to inefficient water usage in Pakistan. Almost, 25% of water withdrawn for use in the agricultural sector is lost through leakages, and line losses in the canals. Only a limited amount of the remaining water is actually absorbed and used by the crops due to poor soil texture, and unleveled fields.

Vertical farming includes the method of growing crops in stacked layers. It incorporates controlled-environment agriculture, optimizes plant growth, and utilizes soilless farming techniques like hydroponics, aquaponics, or aeroponics. Hydroponic farming is growing soil free plants that use mineral nutrient solutions in water to regulate the plant growth in the available atmosphere. Herein, the installation of vertical hydroponics growing system is carried out to increase the yield of fruits, vegetables and medicinal herbs (Mint, Rosemary, Sage, Oregano, Basil Stevia, Lemon

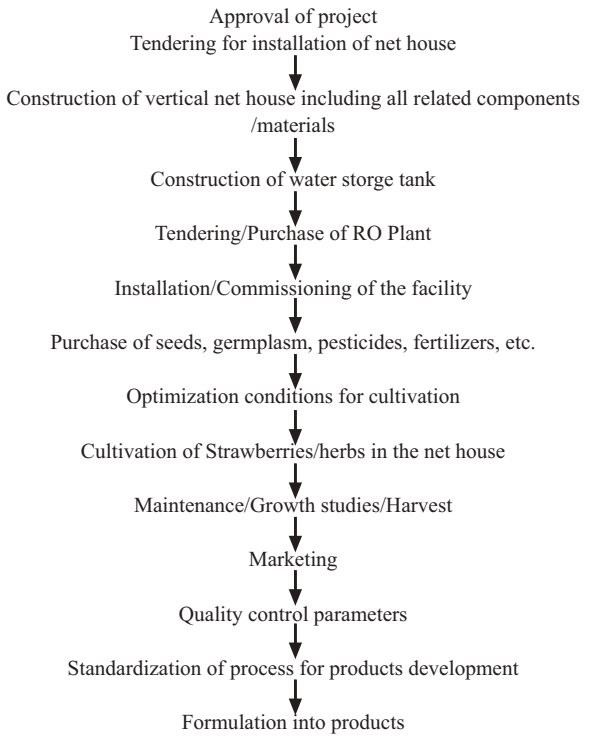
balm, Withania, Achillea etc.) that are resistant to severe environmental conditions of Pakistan. In line with this, the herbal extracts of the grown plants will be subjected to analytical techniques, process development and Phytochemical standardization to exploit the plants for use in food, therapeutic herbal and cosmaceutical products.

In developed countries many people are switching towards alternative therapies, resulting in many folds increase in the demand of medicinal plants and their products. As majority of these plants are unsustainably collected from their natural habitat, leading the existence of these plants towards extinction. To conserve the natural flora and for sustainable & uninterrupted supply of raw material, and by using advanced farming techniques including hydroponic farming, domestic cultivation of medicinal plants is the best option to overcome these threats.

Funding Source (PSDP/ SGI/RD&I/etc.):
RD&I

Cost:
Rs. 35.994 Million

Graphical Abstract:



Tangible Outcome:

- The successful cultivation possibly enhances the fresh fruits and medicinal herbs production at low cost, environmental friendly and recyclable manner.
- Successful execution of the proposed will open up new horizons for the researchers of PCSIR, and other organizations to pursue their research (of choice) in growing targeted crops, efficiently fruits and herbs.
- The developed raw material/ product/ processes will provide opportunities to pharmaceutical, food and cosmaceutical industries/ entrepreneurs for establishment of fruit and herbal based products.

Achievements:

- Site selection, uprooting, clearing, leveling of the site was completed.
- Successful Installation and Commissioning of the net-house at an area of 2200m2was carried out.
- Water channels diversion & fabrication was completed
- Electricity and water arrangement was carried out.
- Construction of water reservoir/ storage tank completed at site.
- Tendering, installation commission and operating of RO water plant completed.
- Work on fabrication of entrance of hydroponics net-house was completed.
- Purchase of fertilizers/chemicals and a miscellaneous item was carried out.
- Strawberry cultivation was carried out on trial basis to run the system.
- R&D on cultivation of medicinal herbs including Stevia, Peppermint and Geranium is in progress at hydroponic growing system.

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Name of Laboratory/ Centre/ Unit:
Leather Research Centre, PCSIR, Karachi

Title of Project: Production of Biological Based Fatliquor on Semi-Pilot Scale Level for Pakistan Leather Industry from Indigenous Sources

Name & Designation of Project Leader:
Dr. M. Kashif Pervez, CSO

Name of Designation of Project Associate(s):

Mrs. Tahir Ayaz, SSO
Mr. Barkat Ali Solangi, PSO
Mrs. Sarwat J. Mahboob, SSO
Dr. Rajkumar Dewani, SSO
Mr. Adeel Ahmed Khan, Director, M/s. Hostachem (Pvt), Ltd., Karachi
M. Imran, QAM, M/s. Hostachem (Pvt), Ltd.

Area(s) of Research:

Leather Auxiliaries

Duration:

02 Years

Date of Initiation

2022

Project Brief:

Leather Industry of Pakistan, including leather based manufactured goods, is ranked among Pakistan's top 5 export earners, contributing significantly to the national exchequer. International demand for Pakistan's leather products, low investment as compared to other sectors, easy availability of quality hides and skins, high quality craftsmanship, and cheap availability of skilled labor are some of the encouraging factors that provide a potent opportunity for a new entrant to venture into leather industry business.

All types of leather require fat-liquor to a greater or lesser degree. It affects the physical properties of leather and creates softness. Most of the fat-liquors are imported from all over the world especially from china for the fulfillment of the requirement and need of the leather industries. Our country invests a lot of money on import. This project is the import substitution of leather auxiliaries and for fat-liquors. Therefore, it is comparatively preferable to synthesis fatliquor locally to save the expenditure on import.

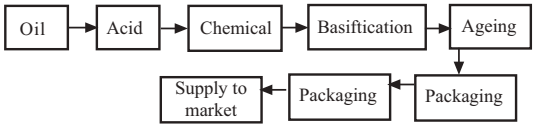
The proposed fatliquors processing involves a total investment of about Rs. 10.00 million. This project will generate direct employment opportunity for 2 persons. Higher return on investment and a steady growth of business is expected with the industrialist having some prior experience or education in the related field of business.

Basically, this technology is based on two types of products used in leather and textile industries. Both of the products are the basic requirement for the local industries. In first step, we are focusing on the synthesis of Vegetable Oil based fat-liquor from indigenous source. Fat liquors have an important role in the leather processing. Leather treated with fatliquor become more flexible and softer. Fatliquors are prepared by the pure available vegetable oil or blending canola, castor, sunflower & coconut oil at different ratio mix together thoroughly. LRC scientists have capability to make Fat liquor containing natural oil for universal applications. And some types of products already supplied to local industry had a good response.

The objectives are as follows;

- To synthesize the fatliquor on semi-pilot scale from local available fats and oil
- To utilize the indigenous sources of Pakistan.
- To provide the leather and allied industries import substituted product.
- To provide the assistance to the Pakistani Chemical Manufacturing Industries in the manufacturing of leather chemicals locally.
- To check the hazardous substances in leather after the application of fatliquor in the processing/making of leather and finished leather products by qualitative and quantitative analysis as the guideline of international standards.
- To check the toxicity of the effluent and hazardous substances of the tanneries.
- To monitor COD, BOD5, TS, TDS, SS, P, N, Chloride, Alkalinity etc.
- To check the chemical properties of synthesized fatliquor.
- To check the physical and chemical properties of fatliquor applied leather

Graphical Abstract:



Funding Source (PSDP, SGI, RD&I/etc):

RD & I

Cost:

Rs. 10.00 Million

Tangible Outcome:

- To Manufacture Fatliquor Locally
- Import Substitution
- To Save the Foreign Exchange of Pakistan
- Making Strong Relation between Tanners and LRC
- Eco-friendly Towards Greener Approach

Achievement:

Process Developed: (10)

- Making of Fat liquor from Hemp Oil.
- Application of Hemp Oil Fatliquor on Wet Blue Leather.
- Preparation of Fatliquor from Soybean Oil.
- Application of Fatliquor from Soybean Oil on Wet Blue Leather.
- Making of Fat liquor from Soybean:Canola Oil (3:1 ratio).
- Application of Fat liquor from Soybean:Canola Oil (3:1 ratio) on wet blue leather.
- Synthesis of fatliquor from a blend of Castor oil and Cotton seed oil in 4:1 ratio for use in leather industry
- Application of fatliquor made from a blend of Castor and Cotton seed oil in 4:1 ratio on goat wet blue leather.
- A Process is developed for synthesis of Soybean: Castor Oil (4:1), Fatliquor to make soft leather.
- A Process is developed for application of Soybean: Castor Oil (4:1), Fatliquor on wet blue leather to make soft leather.

Paper Published: (01)

"Fatliquor Development from Hemp Oil to Produce High Quality Natural Finished Leather", *Indonesian Journal of Chemistry and Environment*, 5(1), 9-16, 2022.e-ISSN: 25993186, August, 2022. DOI:

Patent Filed: (01)

A patents has been filed vide Patent Registration No. 122/22, "Development of Sulphated Fatliquor from Hemp Oil and its Application on Natural Wet Blue Leather, on 28th February 2022.

Poster Presentation: (01)

A poster entitled, "Fatliquor Synthesis from Indigenous Vegetable Oil for Pakistani Leather Industry", is presented in Chemistry Expo-2022, Innovative Ideas, organized by Dept. of Chemistry, FUUAST, Gulshan-e-Iqbal campus, Karachi in collaboration with ICCBS, HEJ Research Institute of Chemistry, University of Karachi and College Education Dept., Govt. of Sindh.

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Name of Laboratory/ Centre/ Unit:

PCSIR Laboratories Islamabad

Title of Project: Laboratory-Scale Mineral Processing of Lithium Ore for Battery Applications

Name & Designation of Project Leader:

Engr. Muhammad Yousif, JE

Name & Designation of Project Associate(s):

Ms. Razia Kalsoom, SSO
Dr. Anila Sajjad, Consultant
Ms. Fouzia Hussain, SSO
Dr. Uzma Rashid, SSO
Dr. Fouzia Noreen, SSO
Mr. Muhammad Afzal, JEO
Dr. Abdullah, JTO

Area(s) of Research:

Material Sciences, Extraction of the Lithium for Production of the Lithium Ions Batteries.

Duration:

03 Years

Date of Initiation:

2024

Project Brief:

In accordance with the Geological Survey of Pakistan, the country's lithium deposits predominantly originate from pegmatite deposits. These are coarse-grained igneous rocks that often contain valuable minerals, including lithium-bearing minerals such as spodumene and lepidolite. These lithium-rich minerals are typically located in the Skardu, Shigar, and Gilgit districts of Gilgit-Baltistan. Given the escalating adoption of electric vehicles and renewable energy storage systems, the demand for lithium, a critical component in lithium-ion batteries, is on the rise. It is imperative for Pakistan to tap into these underutilized resources to advance the nation's development.

Nonetheless, the availability of high-quality lithium ores is limited. Therefore, it is vital to establish efficient and effective mineral processing and beneficiation techniques to meet the surging demand. This project proposal outlines a laboratory-scale study dedicated to researching mineral processing and beneficiation techniques to achieve a high yield of lithium. The goal is to gain a comprehensive understanding of the ore's composition, properties, and behavior during various mineral processing methods. The project strives to enhance the extraction and concentration of lithium from the ore, with special attention to its suitability for battery applications. Moreover, this project holds notable significance for Pakistan due to the following reasons: Furthermore. the project holds significant importance due to the following reasons:

Lithium Recovery Optimization: The project aims to optimize the extraction and concentration of lithium from the ore. By systematically studying different mineral processing techniques and experimenting with various parameters, the project can identify the most effective methods for maximizing lithium recovery. This optimization is essential for ensuring a sustainable supply of lithium for battery applications.

Product Quality and Battery Performance: The project focuses on assessing the quality of the obtained lithium concentrate. Analyzing the lithium content, impurity levels, and particle size distribution will help determine the suitability of the concentrate for battery applications. By ensuring high-quality lithium products, the project contributes to enhancing battery performance, longevity, and overall energy storage efficiency.

Process Efficiency and Cost-effectiveness: Evaluating the efficiency and cost-effectiveness of the mineral processing techniques is crucial for scaling up the extraction process in a sustainable manner. By considering factors such as energy consumption, water usage, and waste generation, the project can provide insights into optimizing the process to minimize resource consumption and associated costs.

Scientific Knowledge and Future Applications: The project's findings and documentation contribute to the scientific understanding of lithium ore processing. The generated knowledge can serve as a valuable resource for researchers, industry professionals, and stakeholders involved in battery technology, mineral processing, and sustainable resource management. The project lays the foundation for further advancements in lithium ore processing techniques and their application in battery technologies.

Sustainable Resource Management: The project aligns with the principles of sustainable resource management by emphasizing the efficient utilization of limited lithium ore resources. By developing effective extraction methods and optimizing process parameters, the project contributes to minimizing waste generation and environmental impacts associated with mining and processing activities.

The primary objectives of this project are as follows:

- **Characterize the Lithium Ore:** Analyze the mineralogical, chemical, and physical properties of the lithium ore to gain a comprehensive understanding of its composition and characteristics.
- **Develop Mineral Processing Techniques:** Explore and evaluate different mineral processing methods, such as crushing, grinding, flotation, and leaching, to identify the most effective processes for lithium extraction and concentration.
- **Optimize Lithium Recovery:** Conduct systematic experiments to optimize the mineral processing parameters, including particle size, reagent dosage, pH levels, and residence time, to achieve maximum lithium recovery from the ore.
- **Assess Product Quality:** Analyze the quality of the lithium concentrate obtained from the mineral processing techniques, including the lithium content, impurity levels, and suitability for battery applications.
- **Evaluate Process Efficiency:** Assess the efficiency and cost-effectiveness of the mineral processing techniques by considering factors such as energy consumption, water usage, waste generation, and economic feasibility.
- **Generate Scientific Knowledge:** Document the findings and experimental data to contribute to the scientific understanding of lithium ore processing and provide valuable insights for future research and industrial applications.

Work Plan:

Sample collection and characterization
↓
Experimental design
↓
Process optimization
↓
Product analysis
↓
Efficiency and economic analysis
↓
Documentation and reporting

Funding Source (PSDP/SGI/RD&I/etc.):
RD&I

Cost:
Rs. 02.00 Million

Tangible Outcome:
The project outcomes of laboratory-scale mineral processing of lithium ore for battery applications can positively impact the socioeconomic development of a country. Through economic growth, industrial development, technological advancement, support for the energy transition, social welfare, and environmental sustainability, the project contributes to the overall progress and prosperity of the nation.

Achievements:
- Comprehensive understanding of the lithium ore's composition, properties, and behavior during mineral processing.
- Identification of the most effective mineral processing techniques for lithium extraction and concentration.
- Optimization of process parameters to achieve maximum lithium recovery and concentration.
- Assessment of the quality and suitability of the obtained lithium concentrate for battery applications.
- Evaluation of the process efficiency and cost-effectiveness.
- Contribution to scientific knowledge in the field of lithium ore processing and its application in battery technology.

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Name of Lab/Centre/ Unit:
Food and Marine Resources Research Centre/ PCSIR Labs Complex, Karachi

Title of Project: Micropropagation and Mass-multiplication of Exotic Cannabis Varieties to Produce Higher Medicinal Value Plants

Name & Designation of Project Leader
Dr. Beena Naqvi, PSO

Name & Designation of Project Associate(s):
Engr. M Ashraf, SE

Area(s) of Research:
Plant Biotechnology

Duration:
01 Year

Date of Initiation:
May 2023

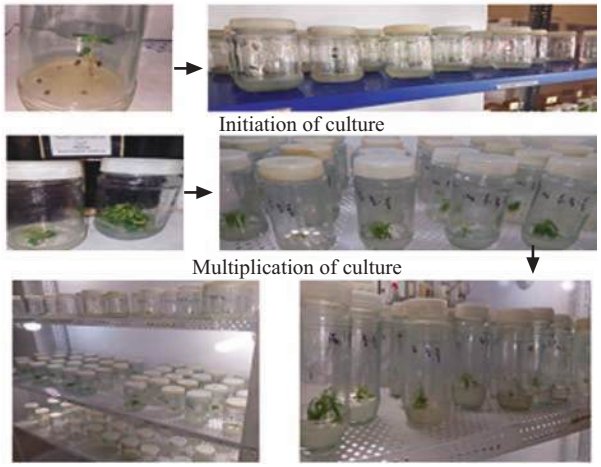
Project Brief:
Cannabis sativa is an annual herbaceous flowering plant indigenous to eastern Asia but now cultivated widely because of economically important medicinal compounds. The flowers of *Cannabis sativa* are unisexual and plants are most often either male or female. It has been cultivated as a source of industrial fiber, seed oil, food, recreation, religious and spiritual moods and medicine. *Cannabis sativa* seeds are chiefly used to make hempseed oil which can be used for cooking, lamps, lacquers, or paints. Historically, tinctures, teas, and ointments have also been common preparations. In traditional medicine of India in particular *C. sativa* has been used as hallucinogenic, hypnotic, sedative, analgesic, and anti-inflammatory agent.

Pakistan needs to act swiftly to join this rapidly growing industry and earn foreign exchange worth billions of dollars through export of non-narcotics cannabis products such as Cannabidiol (CBD) oil, fiber and dozens of other products. Till now only PCSIR has the permission to cultivate cannabis under strict security control of ANF. Developing the facility for cannabis production can be viable for economic uplift of the country.

Tissue culture multiplication has become important in producing medically important clones. Micropropagation of *Cannabis sativa* L. is an emerging area of research for genetic storage a uniform, true-to-type and large-scale production of clean planting material. Mircopropagation is an alternative approach for vegetative propagation that eliminated many risks like cross pollination, variety contamination, infection by pests, disease, and viruses. With an effective *in vitro* protocol, many genotypes can be maintained using significantly less space while providing a consistent supply of clean plants. Recently focus on cannabis tissue culture has increases, addressing many aspects including regeneration and screening for elite cultivars. Significant challenges still exist in Cannabis research and recent *in vitro* studies using medicinal Cannabis have only assessed a few cultivars, with most developed using a single genotype. It is also used to provide enough plantlets for planting from a stock plant of desired quality.

Objectives:

- Micro-propagation of *Cannabis sativa* through tissue culture technique.
- Mass-multiplication of true to type plant of our interestall round the year.
- To enhance the quantity of commercially important compounds (Plants Metabolites)



Funding Source (PSDP/SGI/RD&I/etc):
RD&I

Cost:
Rs. 4.00 Million

Tangible Outcome:
Micropropagation of *Cannabis sativa* L. will enable us to supply uniform, true-to-type plants in large-scale throughout the year.

Achievements:

- Micro-propagation of seven exotic, non GMO *Cannabis varieties* from USA has been initiated through tissue culture technique.
- Optimization protocol for mass multiplication is in progress.
- After mass multiplication of culture in enough numbers, next step will be optimization of rooting media.

Status:
On-going

★ ★ ★ ★

Name of Laboratory/Centre/Unit:
Food and Marine Resources Research Centre / PCSIR Laboratories Complex, Karachi

Title of Project: Establishment of Re-Circulating Aquaculture System (RAS) for Karachi-Sindh/Baluchistan Coastal Areas

Name & Designation of Project Leader:
Dr. Farman Ahmed, PSO

Name & Designation of Project Associate(s):
Dr. Samee Haider, PSO
Engr. Baitullah Kibzai, SE

Area(s) of Research:
Marine Aquaculture

Duration:
02 Years

Project Brief:

Re-Circulating Aquaculture System (RAS) is a technique that uses mechanical and biological purification to eliminate suspended particles and metabolites from water before recycling and reusing it. This technique uses the least amount of water and land feasible to breed several species of fish in greater density.

The RAS may be useful in this aspect. Because it allows fish to be farmed in net cages or tanks rather than open-air ponds and it enables farms to be built in areas where groundwater is scarce, and in urban areas where chlorine-free municipal water is used. Moreover, RAS based fish farms are proved to be major source of extraction of Vitamin E, Omega-3 Fatty Acids and Fish oil. Which have numerous benefits like Blood pressure control, increases immunity, cure to skin disease, reduces the risk of depression, dementia, diabetes, eyesight problem, asthma, allergies and etc. Due to these numerous benefits, the establishment of RAS farms in Karachi can be the course of aquaculture as a cost-effective solution with minimal environmental impact, as well as a source of revenue generation for the state treasury and the farmer in both the domestic and international markets.

Setting up a RAS can be complex but offers significant benefits, such as efficient water use, reduced environmental impact, and the ability to control growing

conditions. Proper planning, management, and maintenance are crucial for success.

The growing demand for sustainable sea food production has led to an increased interest in innovative aquaculture systems, particularly Re-Circulating Aquaculture Systems (RAS). These systems offer a controlled environment for fish farming, minimizing water use and reducing environmental impact.

1. System Components

i. Tanks
ii. Water Treatment
iii. Mechanical Filtration
iv. Biological Filtration
v. Chemical Filtration
vi. Disinfection
vii. Aeration
viii. Heating/Cooling

2**. Operational Processes**

i. Water Quality Monitoring
ii. Feeding Regimen
iii. Waste Management

3. Scope of Implementation

- Assess local demand for aquaculture products.
- Evaluate financial projections and operational costs.
- Construction activities include site preparation, tank installation, plumbing, and electrical work.
- Cycle the system for 4-6 weeks before introducing fish to establish biological filtration.
- Gradual acclimatization of fish to minimize stress.

Objectives

- Achieve a system design that ensures at least 80% water recirculation efficiency.
- Achieve a fish growth rate that meets or exceeds industry benchmarks for the chosen species.
- Minimize waste discharge by implementing a waste recycling system that reduces the volume of waste sent to disposal by 70%.
- Reduce the risk of disease outbreaks by maintaining water quality and biosecurity measures, resulting in healthier fish populations.
- Establish contracts or agreements with at least 2 distributors or retailers within the first year after implementation.

Work Plan:

Equipment Procurement (Phase I)

- Order tanks, filtration systems, pumps, and monitoring equipment.

Construction and Installation (Phase I)

- Set up tanks and plumbing for water circulation.
- Install filtration, aeration, and heating/cooling systems.

System Cycling and Initial Setup (Phase II)

- Run the system without fish to establish biological filtration (4-6 weeks).
- Monitor water quality parameters regularly.
- Develop feeding schedules and waste management plans.
- Create standard operating procedures (SOPs) for daily operations.

Stocking and Initial Production (Phase III)

1. **Fish Stocking:**
   - Gradually introduce fish to the system.
   - Monitor acclimatization and health.
2. **Operational Monitoring:**
   - Begin regular water quality checks, feeding, and health assessments.
   - Adjust feeding and management practices based on fish response.
3. **Performance Review:**
   - Analyze growth rates, health and water quality data.
   - Identify areas for improvement in operations.
4. **Market Launch:**
   - Begin marketing and sales efforts. Establish distribution channels for product delivery.

Funding Agency (PSDP/SGI/RD&I/etc.):

RD&I

Cost:

Rs. 102.69 Million

Tangible Outcome:

- Higher Yields: Due to optimized stocking densities and controlled environments, the system produces more fish per unit area and volume compared to traditional methods.
- Consistent production cycles, resulting in multiple harvests per year regardless of seasonal changes.
- Reduced Water Usage: Significant reduction (up to 80%) in water consumption compared to open pond or flow-through systems, as water is continuously filtered and reused.
- Lower Mortality: With better disease control and optimal water quality, fish health is improved, leading to higher survival rates.
- Reduced Disease Outbreaks: Tangible decrease in diseases and pathogen transmission due to advanced filtration and sterilization techniques.

Achievements:

The operational machinery has been delivered to the SITE (PCSIR-Karachi). The civil infrastructure (Shed Construction) is in progress. The amendments in the construction are being suggested according to the supplies received.

Status:

On-going

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Sponsored Projects

Name of Laboratory/ Center/ Unit:
Center for Environment Protection Studies

Title of Project: UF and MF Membranes Fabrication Technology Development for Water Purification

Name & Designation of Project Leader:
Dr. M. Hammad Khan, PSO

Name & Designation of Project Associate(s):
Mr. Javed Iqbal, SSO

Area(s) Research:
Product Development

Duration:
02 Years

Date of initiation:
2022

Project Brief:
Membrane separation is a state-of-the-art technology for water purification. Commonly used ones are microfiltration (particle separation), ultrafiltration (purification), nano-filtration (desalination) and reverse osmosis membranes (desalination). Currently, objective will be to develop technology for simple membranes (for aqueous phase separations). This project is focused at simple membrane fabrication.

Funding Source PSDP/SGI/RD &I/etc:
Pakistan Science Foundation (PSF)

Cost:
Rs. 4.966740 Million

Tangible Outcome:
- Limited know-how about the fabrication of the membranes in Pakistan industrial sector. It can be achieved in phases.
- This project will be focused on the polymer and water industry to improve the employment and better quality of life through pure water available to a common man.

Achievements:
- Prepared cellulose acetate solutions with different compositions.
- Prepared thin film by phase inversion process into membrane.
- Testing of the membrane under process.

★ ★ ★ ★

Name of Laboratory/Centre:
Gene Editing Laboratory/ Food & Biotechnology Research Centre, PCSIR Laboratories Complex, Lahore

Title of Project: Bio-process Development of Colors Pigments from Eco-friendly Microbes for Industrial Use

Name & Designation of Project Leader:
Dr. Sania Mazhar, SSO

Name & Designation of Project Associate(s):
Dr. Syed Hussain Imam Abidi, Chairman-PCSIR
Dr. Quratul Ain Syed, Director General/CSO

Area(s) of Research:
Microbiology/Food & Pharmaceutical Industry

Duration:
01 Year

Date of Initiation:
2023

Project Brief:
Bacterial bio-color production is an emerging field for various industrial applications as they are safer, healthier, biodegradable and exhibit more compatibility with environment. They can also have anticancer, antimicrobial and antioxidant activities. In Pakistan there is scarcity of knowledge regarding the production of natural grade color from chromogenic microbes and then to use them in different products for healthy life style. The bio-colors, which are being used in Pakistani industries, are being imported at high cost that ultimately have impact on the price of the finished product. Hereby, the present self-sustaining and marketable project will be a cost effective alternative to natural and synthetic color. Moreover, the successful completion of the project will help to upgrade the present research facilities along with an important role in human resource development, self-reliance of food, cosmetic, pharma-ceutical and textile industries and economic growth of country.

Funding Source (PSDP/SGI/RD &I/etc):
Pakistan Science Foundation (PSF)

Cost:
Rs. 2.0 Million

Tangible Outcome:
- Production of commercially significant natural colors of different shades

- Bio-process development without seasonal production problems
- Production of antibacterial, antifungal, anticancer and antioxidant natural colors
- Production of cheaper and good quality colors in short time
- Import substitution of natural and synthetic colors
- Help the industries to solve their issues appearing on the use of synthetic or imported colors in their commercial/finished products

Achievements:
- Screening and isolation of chromogenic microbes
- Production of antibacterial, antifungal, anticancer and antioxidant natural color has completed.
- Characterization of color pigments is in progress

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Name of Laboratory/Centre/Unit:
FBRC/ PCSIR Labs. Complex, Lahore

Title of Project: Zinc And Iron Contents in Biofortified Zinc Wheat Supply Chain

Name & Designation of Project Leader:
Dr. Ijaz Ahmad, CSO

Name & Designation of Project Associate (s):
Dr Quratulain Syed, CSO
Dr. Sania Mazhar, SSO
Mr. Mehroz Ahmad Khan, SSO

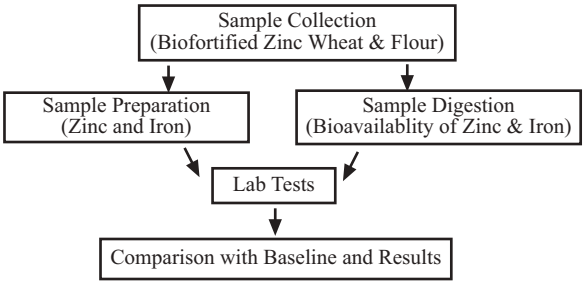
Area(s) of Research:
Food Science and Nutrition

Duration:
01 Year

Research Highlights:
Biofortification enhances the nutritional value of staple food crops by increasing the density of nutrients in a crop through conventional plant breeding, agronomic practices or biotechnology and is carried out in the agriculture sector.
Biofortified staple foods provide a potential opportunity to increase micronutrient intakes in populations that are at risk of micronutrient deficiencies without changing consumption patterns.
Zinc (Zn) deficiency is highly prevalent in the Pakistani population (22.1%), particularly in women and children (under 5 years) due to low dietary Zn intake.
In Pakistan, wheat is staple food and is poor in bioavailable Zn. An average daily wheat flour consumption in Pakistan is among the highest in the world - at 124 kg per capita per year.
Biofortified varieties of wheat are potential food vehicles for increasing zinc intakes that could significantly reduce the prevalence of zinc deficiency in the Pakistan population.

Objectives:
- Testing the Biofortified Zinc Wheat to know the Zinc and Iron content at various stages of the supply chain.
- A comparative analysis of the Biofortified Zinc Wheat with Analogue/ Conventional wheat varieties in terms of Zinc and Iron content at various stages of the supply chain.
- Evaluation of Bioavailability of Zinc and Iron contents.

Graphical Abstract:



Funding Source (PSDP/SGI/RD &I/etc):
The Global Alliance for Improved Nutrition (GAIN)

Cost:
Rs. 3.9564 Million

Tangible Outcome:
- The data of Zinc and Iron contents of Biofortified Zinc Wheat varieties grown in Multan, Khanewal and Bahawalpur will be available.
- A comparison of Biofortified Zinc Wheat with Analogue/ conventional wheat varieties in terms of Zinc and Iron content at various stages of the supply chain will be available 1st time in Pakistan.
- Evaluation of Bioavailability of zinc and iron from Biofortified wheat

Achievements:
The following Number of Grain & Flour samples have been analyzed:
- Basic Seed Samples = 04
- Multan = 66
- Bahawalpur = 58
- Khanewal = 101
- Total Grain Samples = 229
- Basic Seed Flour Samples = 04

★ ★ ★ ★

Projects to be Funded From Self-Generated Income (SGI) of PCSIR

Name of Laboratory/Center/Unit:

PCSIR labs. Complexes at Lahore, Karachi, Peshawar

Title of Project: Installation of 3.05 MW Solar Power Systems for the Conversion of Energy at PCSIR Karachi, Lahore, Peshawar

Name & Designation of Project Leader:

Engr. Ghulam Shabbir, Project Director

Name & Designation of Project Associate(s):

Engr. Haris Ikram, SE
Engr. Muhammad Younus, PE
Dr. Tahir Raffique, PSO
Engr. Ali Imran, JE

Area(s) of Research:

Energy

Duration:

01 Year

Date of Initiation:

2023

Project Brief:

Pakistan has always been in the grip of sustainable energy scarcity. There is an ever increase in energy demand that cannot be fulfilled using the current resources. Around the globe, solar energy, particularly, is positioned to become a new source of sustainable energy. The increased awareness towards environmental issues has prompted a new shift towards low-carbon energy alternatives. Pakistan, predominantly, requires alternate sources of energy to both deal with the environmental challenges and the energy shortage. The present project is in line with Government of Pakistan conservation of energy initiatives & resolve. Its implementation not only provides the Un-interrupted Power Supply that is vital for the smooth running of administrative affairs & for the sensitive equipments installed at PCSIR Labs Complexes and units but also help to reduce the reliance on commercial Power and Save Fuel cost as well that is being used to run the generators. Initially Solar System will be installed at PCSIR Labs Complex Lahore, Peshawar and Karachi in 1st phase. The main objectives of the project are as follows;

- Solarization of PCSIR lab. Complexes at Lahore, Karachi, Peshawar will help in conservation of energy, reduction in electricity bills and provision of constant source of uninterrupted power supply for smooth running of administrative, research & development activities.
- It will also ease up the limited funds used to run generators to keep up/make up for incessant load shedding. It is a revolutionary step in running the administration, research & development activities with efficiency and in economic manner.
- The training programs will be initiated on renewable energy technologies, energy efficiency and conservation mechanism.
- Installation of on-grid solar system will supply excess energy to national grid, which will not only reduce the burden on national grid, but also generate income.

Funding Source (PSDP/SGI/RD &I/etc):

SGI

Cost:

Rs. 582.283 Million

Tangible Outcome:

- To switch over to alternate and self reliant source of green energy
- The Scheme will help in the provision of the solar technology to PCSIR Labs Complexes that cope up the power crises in the country.
- The Provision of Solar Technology provides an un-interrupted power supply, will enable researchers & scientists to run business affairs in an efficient manner. Thus it ultimately increases the performance of the organization.
- It helps to reduce the Carbon Emission, the Electricity Cost and fuel Consumption by generators.

Achievements:

- Installation of Solar Pannel system is completed at PLC while installation at KLC and LLC is in process.

★ ★ ★ ★

Name of Laboratory/ Center/ Unit:
PCSIR Head Office, Islamabad

Title of Project: Construction of Three Floor (1st, 2nd & 3rd) on Extension Building of PCSIR Head Quarter Building Islamabad

Name & Designation of Project Leader:
Engr. Nazar Ahmed Bhutta, Project Director

Area(s) of Research:
Construction

Duration:
02 Years

Date of Initiation:
2023

Project Brief:

The PCSIR extension building basement was built in the year 2004 and ground floor (Guest house) was built in 2010. Currently, 11 different PSDP projects are in progress across PCSIR at different locations like Lahore, Karachi & Peshawar, along with many PSDP projects are underway/in pipeline under civil military collaboration frame work. Numbers of officials/staff has been recruited under these projects and placed in Head Office to stream line project activities & central procurement. Therefore, to provide the better environment and cope with the unavailability of infrastructure and offices to accommodate new program like creation of special initiative cells, commercialization, digitalization, planning & development (P&D) wings etc., the construction of three floors (1st, 2nd & 3rd floor) on Extension Building of PCSIR head office Islamabad is essential and need of time. The project is proposed to build three floors (1st, 2nd & 3rd floor) on Extension Building of PCSIR head office, Islamabad.

The specific objectives are as follows:

- To provide the better environment and additional space with vertical extension by constructing three floors (1st, 2nd & 3rd floor) are essential/necessary and demand of time.
- In the result of new construction of aforesaid three floors on extension building, the face of the building will be uplifted and cause to increase the aesthetic value.
- To meet the proper space with furniture & fixture requirement of PCSIR head office employees.

Funding Source (PSDP/SGI/RD&I/etc):
SGI

Cost:
Rs. 290.08 Million

Tangible Outcome:

- To save the rental expenditure
- To create new working space for existing employees & to be hired staff in hired

Achievements:

- Consultant appointed and design work completed

★ ★ ★ ★

Name of Laboratory/Centre:
PCSIR Labs. Complex, Lahore

Title of Project: Multifunctional Powered Aquaculture Controller Cost

Name & Designation of Project Leader:
Engr. Ali Imran, Project Director

Area(s) of Research:
Fisheries

Duration:
01 Year

Date of Initiation:
2023

Project Brief:

Aquaculture, the practice of cultivating aquatic organisms such as fish, crustaceans and mollusks for food, recreational and commercial purposes, has become an essential industry worldwide. As the global demand for seafood continues to rise, the aquaculture industry faces significant challenges, including increasing production yields, ensuring sustainability and optimizing profitability. One of the most critical factors in aquaculture production is the control of environmental parameters such as temperature, dissolved oxygen, pH and salinity. These factors significantly affect the growth and health of aquatic organisms and small deviations from the optimal range can result in reduced yields, increasing mortality rates and reduced profitability. Traditional aquaculture systems have limited control over these parameters, resulting in sub-optimal conditions and reduced yields. To overcome these challenges, present project proposes the Multifunctional Power Aquaculture controller, an advanced system that uses cutting-edge technology to provide precise control over the environmental parameters that affect aquatic organisms' growth and health. The system's advanced sensors and control algorithms enable farmers to maintain optimal conditions, resulting in increasing yields, improved growth rates and reduced mortality rates. The specific objectives are as follows:

- To improve the health and growth of aquatic animals.
- To automate routine tasks like feeding and water changes, reducing labor costs and minimizing human error.
- To optimize use of resources like water and energy.
- To monitor the system in real-time and quickly respond to any issues or imbalances which can prevent disease outbreaks and improve overall performance.
- To customize and scalable the control technologies, allowing farmers to expand their operations and add new components or features as needed.

Funding Source (PSDP/SGI/RD &I/etc):

SGI

Cost:

Rs. 29.60 Million

Tangible Outcome:

Multifunctional Aquaculture is a powerful tool for the aquaculture industry and can significantly contribute to meet the increasing global demand for seafood while ensuring sustainable production practices.

Achievements:

- Procurement of equipment is in process.

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Name of Laboratory/Center/Unit:

PCSIR Lab. Quetta./ Food division

Project Title: Green House with Automation for Cultivation of Hemp at PCSIR Laboratories Quetta

Name & Designation of Project Leader:

Ms. Hiba Amanat Ali, SO

Name & Designation of Project Associate(s):

Mr. Nasir Ali Baloch, CE
Mr. Khurram Shehzad, SO
Mr. Amir Raza, EO

Duration:

02 Years

Date of Initiation:

2023

Project Brief:

The more than 50 countries around the world have legalized some of medical cannabies while six countries have legalized cannabis for recreational use by adults. The global total cannabis market (regulated and illicit) is estimated to be $344 billion USD. The top five regional markets are:

- Asia ($132.9)
- North America ($85.6 billion)
- Europe ($68.5 billion)
- Africa (27.3 billion)
- Latin America ($9.8 billion)

Medicinal cannabis accounts for the majority share of the cannabis market. Many countries have legalized the usage of cannabis for medicinal purpose such Australia, Canada, Chile, Colombia, Germany, Greece,

Israel, Italy, Netherlands, Peru, and Uruguay among others. Global marketing is projected to grow by over $950 million by 2025, driven by a revised compounded annual growth rate (CAGR) of 9.6%. The growth in this market is mainly driven by legalization of medical cannabis, coupled with growing number of cannabis, coupled with the growing of cannabis testing laboratories.

Cannabis is verity of the hemp species that is grown specifically for the industrial use of its derived products. Cannabis as a drug and industrial cannabis both derived from the species Cannabis Sativa and contain the psychoactive component (THC), they are distinct strain with unique phytochemical composition and use. Cannabis has lower concentration of cannabidiol (CBD), which decreases or eliminate its psychoactive effects.

Green house are built provide ideal environment to the crop for growing while focusing entirely on maximizing products efficiencies and yield of the plant. The green house will serve two purpose i.e. growth of cannabis in controlled secured facility and avoiding the cross contamination of other spices that are likely to impact the yield of crop in concern.

The project is focused on facility generation for the "Speed breeding" of the Hemp Varieties. For the purpose separate and dedicate green house facility will be established for cultivation of both male and female plants to ensure the production of hybrid seeds. After that the seeds will be transferred to dedicated greenhouse for CBD only and female plant cultivation. This will include cultivation of 1 Acre each green house considering the aspect of future demands and scalability ton accommodate longer term facilitation.

Schematic Diagram:

Construction of Green House ⟶ Harvesting of Crop

as per demand ⟶ Phyto-chemical analysis of Hemp

Funding Source (PSDP/SGI/RD&I etc.):

SGI

Cost:

Rs. 2,84,10,694.89/-

Tangible Outcomes:

- To develop dedicated green house facilities for breeding of hybrid verities of cannabis with male and female plant.
- Optimized the verities of CBD.
- To conduct research for product development from cannabis
- To produce hemp-year round in controlled environment facilities.
- To optimize growing conditions for hemp cultivars to enhance crop yield.

Achievements:

- Installation of greenhouse automation is under progress, near to completion.

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In-House R&D Project

PCSIR Labs. Complex, Karachi (KLC)

(New Projects)

Name of Laboratory/Centre/Unit:
Applied Chemistry Research Center/ PCSIR Labs. Complex Karachi

Title of Project: Development of Formulation for Commercially Valuable Chemicals:
a) Blood Stain Remover
b) Glue/Adhessive Remover

Name & Designation of Project Leader:
Dr. Sofia K. Alvi, CSO

Name & Designation of Project Associates:
Dr. Saima Imad, PSO
Ms. Seema Firdous, SSO
Mr. Muhammad Aijaz, SSO
Syed Junaid Mehmood, SO

Area(s) of Research:
House Hold Cleaning Agents

Duration:
01 Year

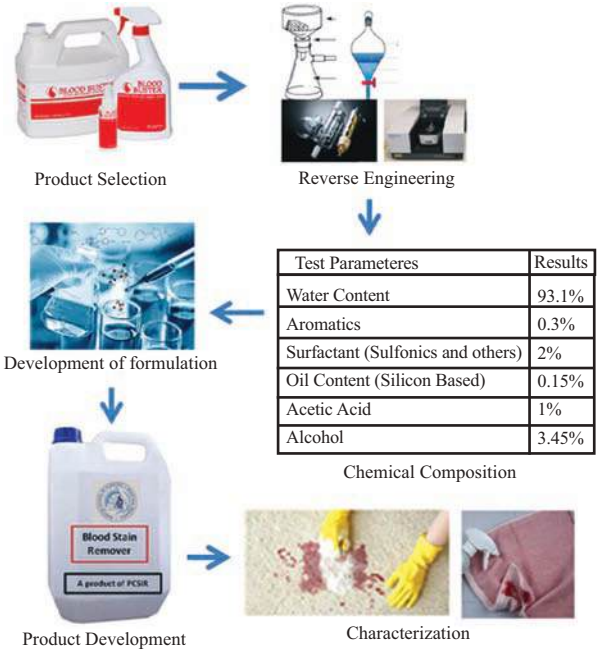
Date of Initiation:
2024

Project Brief:
Pakistan is importing various chemical formulation used as general purpose cleaning agents. These formulations contain more than 90% solvent which is most of the time water, alcohol or other materials available in the country. If the composition is estimated accurately the same product may be developed locally with available sources/chemicals. It may save foreign exchange and also reduce tax burden on the importers. During last 2 years we have received a number of requests for development of formulations of different materials which are now difficult to import due to rise in foreign exchange rate and/or ban on imports. Our target is to develop two products. Both products are imported and commercially available however they can be developed locally with available chemicals. This may develop and support our SMEs. The first product is blood stain remover; this product is used in hospitals and diagnostic labs for removal of blood stains from furniture, linen and beddings, floor etc. A local entrepreneur approached our lab with a target to estimate its chemical composition. The results of preliminary examination showed that the product can be developed locally. The product found to contain more than 90% water which means we are purchasing distilled water on account of foreign reserves. The second product is a cleaning agent used to remove any adhesive materials. This product is in phase of preliminary examination and chemical composition is almost estimated. The solvent base is kerosene oil which is available at much cheaper price as compared to the value of the product itself. The objectives are:

- Development of formulation of Blood Stain Remover
- Development of formulation of glue/adhesive remover

Client for these two formulations are available, however R&D is required to develop and evaluate these products. Meanwhile, reverse engineering of any other commercially viable product may also be carried out to develop them locally.

Graphical Abstract:



Test Parameteres	Results
Water Content	93.1%
Aromatics	0.3%
Surfactant (Sulfonics and others)	2%
Oil Content (Silicon Based)	0.15%
Acetic Acid	1%
Alcohol	3.45%

Quarterly Work Plan:

Quarter	(First Year)
1st Quarter:	Estimation of approximate composition of Blood Stain Remover and adhesive remover received from client
2nd Quarter:	Identification and quantification of chemical constituents via FTIR and other physical and chemical methods
3rd Quarter:	Development of formulation
4th Quarter:	Characterization of the product

Funding Source (PSDP/SGI/RD&I etc.):
In-House

Cost:

Tangible Outcomes:
- Development of formulation of Blood stain remover
- Development of formulation of glue/adhesive remover

Achievements:

Status:
New Project

★ ★ ★ ★

Name of Laboratory/Centre/Unit:
Applied Chemistry Research Center/Engineering Services Center/PCSIR Labs. Complex Karachi

Title of Project: Design and Fabrication of Impact Tester for Pipes as per Pakistan Standard and (45° Cantilever) for Bending Resistance PVC Material as per JIS 1096

Name & Designation of Project Leader:
Dr. Nighat Sultana, CSO Dr. Sofia K. Alvi, CSO

Name & Designation of Project Associates:
Dr. Saima Imad, PSO
Engr. Amanullah Lakho, PE
Engr. Adeel Ahmed, JE S.Junaid Mehmood, SO
Mr. Rehan, TO Mr. Mazhar Ali, TO

Area (s) of Research:
Testing Services of Polymeric Materials

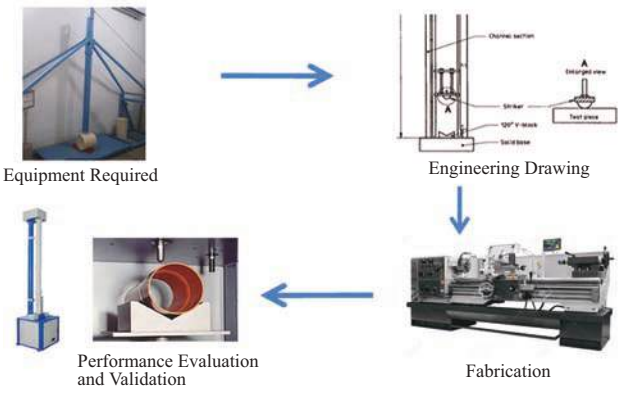
Duration:
01 Year

Date of Initiation
2024

Project Brief:
Plastic Polymer Section of ACRC is involved in routine test analysis services. We often receive testing requirements of certain materials based on specialized equipment which are not available locally, however their design is simple and they can be developed and fabricated at workshop facility of KLC. Recently we have received testing protocol for bending resistance PVC material as per JIS 1096. The test required wooden equipment (45° Cantilever) with specialized design mentioned in the testing protocol which can be fabricated at carpentry shop of KLC. Similarly the Impact tester as per Pakistan standard requires a mechanical equipment with variable masses and length to evaluate the resistance of pipes against dynamic impact energy. This equipment can also be fabricated at very low cost at our Engineering Service Workshop (ESC).

This project intends to develop this equipment locally and indigenously from available resources. The polymer section will facilitate the design requirements and also provide technical evaluation support to Engineering Services Center so that this equipment would develop locally. The objectives of project are as;
- Design and fabrication of:
- 45° Cantilever as per JIS 1096
- Impact tester for Pipes as per Pakistan Standard

Graphical Abstract:



Funding Source (PSDP/SGI/RD&I etc.):
In-House

Cost:

Tangible Outcomes:
- 45° Cantilever as per JIS 1096
- Impact tester for Pipes as per Pakistan Standard.

Achievements:

Status:
New Project

★ ★ ★ ★

Name of Laboratory/Centre/ Unit:
Applied Chemistry Research Center/ PCSIR Labs. Complex Karachi

Tile of Project: Development of Coolant Formulations for Vehicles

Name & Designation of Project Leader:
Dr. Saima Imad, PSO

Name & Designation of Project Associates:
Dr. Sofia Khalique Alvi, CSO
Dr. Tahir Rafique, PSO
Ms. Seema Firdous, SSO
Mr .Muhammad Aijaz, SSO
Mr. Muhammad Shahzad, Tech.

Area(s) of Research:
Industrial Chemistry, Advance Materials

Duration:
01 Year

Date of Initiation:
2024

Project Brief:
A coolant is a substance, typically liquid, that is used to reduce or regulate the temperature of a system. An ideal coolant has high thermal capacity, low viscosity, low-cost, non-toxic, chemically inert and neither causes nor promotes corrosion of the cooling system. The term "coolant" is commonly used in automotive and HVAC applications. However, in industrial processing, “heat transfer fluid” is one technical term more often used in high temperature as well as low-temperature manufacturing applications. The term also covers cutting fluids. Industrial cutting fluid has broadly been classified as water-soluble coolant and neat cutting fluid. Water-soluble coolant is oil in water emulsion. It has varying oil content from nil oil (synthetic coolant).

Coolant (or antifreeze) protects mechanical parts from freezing while defending components against corrosion. It is the combination of many constituents like antifreeze, pH stabilizers, dye, foam reducer, emulsifiers etc., depending on application. It plays a critical role in sustaining engine heat balance by removing heat. In a heavy-duty diesel engine, only one-third of the total energy produced works to propel the vehicle forward. During previous years ACRC received many requests from clients to develop different coolants due to import restrictions and high cost. This project intends to develop coolant formulations locally to provide substitute for imported products. These products may be commercialized to support industry. Objectives are;
- Development of methods for testing of coolants in Lab.
- Collection and testing of coolants available in market
- Development of formulations of coolants
- Comparison of properties of different coolants

Graphical Abstract:

Quarterly Work Plan:

Quarter	First Year	Second Year
1st Quarter	Market survey and collection of imported and local coolant.	Characterization of the finished product.
2nd Quarter	Method development of testing parameters and identification of chemical constituents	Trials in vehicles
3rd Quarter	Development of formulations	Pilot scale trial production
4th Quarter	Estimation of developed coolants via physical methods	Compilation of results and publication/patent

Funding Source (PSDP/SGI/RD&I etc.):
In-House

Cost:

Tangible Outcomes:
- Development of coolants for import substitution
- Publication/Patent

Achievements:

Status:
New Project

★ ★ ★ ★

Name of Laboratory / Centre/ Unit:
Applied Chemistry Research Center/ PCSIR Labs. Complex Karachi

Tile of Project: Development and Characterization of Nano Crystalline Cellulose Using Fabric and Paper Waste Materials

Name & Designation of Project Leader:
Mr. Muhammad Farhan, SSO

Name & Designation of Project Associate (s):
Dr. Saima Imad, PSO
Mr. Muhammad Aijaz, SSO
Mr. Kamran Ahmed, SEO
Mr. Mansoor Iqbal, SO

Area (s) of Research:
Chemical Sciences / Industrial Chemistry, Advance Materials/Polymeric Based Composites Materials

Duration:
01 Year

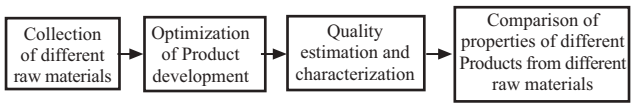
Date of Initiation:
2024

Project Brief:
Nano Crystalline Cellulose (NCC) is also known as nano structured cellulose or cellulose nano fibers (CNF). It is pseudo-plastic and inhibits the property of gel or fluid that is thick (viscous) under the normal conditions. The fibrils are isolated from any cellulose containing source like wood-based fiber (pulp fibers), paper waste, agro waste and fabric waste using different physical operations and chemical processes. The project is designed to produce an import substitute. The aerospace and automotive industries have demand of NCC as ingredients for light weight, high-strength composite material. Nanocrystalline cellulose is an important valuable product in pharma, food, cosmetic and other industries and is used as texturizor, an anti-caking agent, a fat substitute, an emulsifier and bulking agent in food industries and also as alternate of carboxy methyl cellulose (CMC) and as tabulating aid in pharma industries. A bulk quantity of nanocrystalline cellulose is being imported. A large amount of foreign exchange can be saved by producing this valuable product. Objective of the project is;
- Development of valuable eco-friendly product, Nanocrystalline Cellulose from paper and fabric waste

Work Plan:
- Development of Nano Crystalline Cellulose with different identified raw materials

- Quality estimation and characterization of the NCC Product
- Comparison of properties of NCC Products from different raw materials.

Graphical Abstract:



Quarterly Work Plan:

Quarter	First Year
1st Quarter	Collection of different raw material and optimization of process for Development of Nano crystalline Cellulose (NCC)
2nd Quarter	Development of Nano Crystalline Cellulose with an identified raw material i.e. paper waste and fabric.
3rd Quarter	Quality estimation and characterization of the developed NCC
4th Quarter	To conclude the results and preparation of report

Funding Source (PSDP/SGI/RD&I etc.):
In-House

Cost:

Tangible Outcomes:
Nano Crystalline Cellulose (NCC) developed as an import substitute from indigenously available raw material

Achievements:

Status:
New Project

★ ★ ★ ★

Name of Laboratory/Centre/Unit:
Applied Chemistry Research Center/PCSIR Labs. Complex Karachi

Title of Project: Synthesis of Nano Acid Dyes and Evaluation of Fastness Properties on Nylon & Wool Fabric

Name & Designation of Project Leader:
Mr. Kamran Ahmed, SEO

Name & Designation of Project Associate (s):
Dr. SaimaImad, PSO
Mr. Muhammad Farhan, SSO
Mr. Mansoor Iqbal, SO
Dr. Zeeshan Akhtar, Associate Professor, KU

Area(s) of Research:
Textile Dyes, Analytical, Synthetic and Surface Chemistry.

Duration:
01 Year

Date of Initiation:
2024

Project Brief:
Acid dyes are a large class of dyes and comprises various constitution. Most important are sulfonic acid derivatives of azoic dyes. The practical uses of these dyes are characterized by their capacity to dye protein and polyamide fibers. Under certain conditions, they may be used for dyeing poly-acrylonitrile fibers. Like direct dyes, they are anionic dyes with a general formula of RSO_3Na but they do not dye or feebly dye cellulosic fiber without consuming color fastness. Acid dyes are water soluble anionic dyes, bright in colors and have good washing fastness properties. Acid dyes contain a chromophoric group and an acidic group, usually – SO_3H, in the form of sodium salt, soluble in water. The objectives of the project are as under;

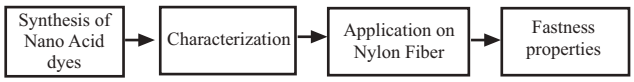
- Synthesis of nano acid dyes
- Application and evaluation of fastness property of nano acid dyes on nylon and wool

Work Plan:

- Synthesis using substituted aryl amines as diazo component and amino hydroxy-naphthalene

sulfonic acid as coupling component.
- Purification of dyes.
- Study of the dyeing performance of nano acid dyes on nylon fibers.
- Characterization by using different analytical techniques
- Application of dyes on wool fabric.
- Determination of properties like washing fastness, rubbing fastness, light fastness and color fastness to perspiration.

Graphical Abstract:



Quarterly Work Plan:

Quarters	Work Plan
1st Quarter	Identification of different intermediates to make Nano particles.
2nd Quarter	• Optimization of different reactions. • Finished Nano Acid dyes synthesized at lab scale with identified intermediates.
3rd Quarter	Quality estimation and characterization of the Nano Acid dyes.
4th Quarter	Evaluation of Nano Acid dyes on different fabric like Wool fabrics. Compilation of results and Publication

Funding Source (PSDP/SGI/RD&I etc.):
In-House

Cost:

Tangible Outcome:
Synthesized Non-toxic and Environment Friendly Novel Component Dyes

Status:
New Project

★ ★ ★ ★

Name of Laboratory/Centre/ Unit:
Applied Chemistry Research Center/ PCSIR Labs. Complex Karachi

Title of Project: Application of Indigenous Based Stones on Denim Fabrics Obtained from Various Areas of Pakistan

Name & Designation of Project Leader:
Mr. Mansoor Iqbal, SO

Name & Designation of Project Associate (s):
Dr. Saima Imad, PSO
Dr. Tahir Rafique, PSO
Mr. Muhammad Farhan, SSO
Mr. Kamran Ahmed, SEO

Area (s) of Research:
Textile, Dyeing

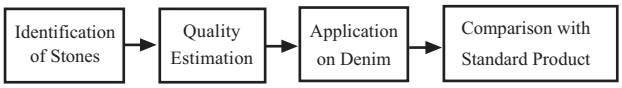
Duration:
01 Year

Date of Initiation
July, 2024

Project Brief:
The process of stone washing began towards the end of the 1970's, putting denim garments together with the pumice stones into the washing machines. As the wash drum rotates, the garments are repeatedly pounded and beaten by the stones, abrading the fibers and the indigo color on the denim fabric. Pumice stone is a natural volcanic stone used for grinding clothes. Together with stone washing, these stones strip the dye particles on the surface of the fabric yarn, creating a faded, worn and shiny effect on textile products. Stone-washing increases the softness and malleability of rigid fabrics like denim and it produces faded look on denim fabric which is a modern fashion demand of Textile Industries. To achieve this in factories, finished garments are placed into industrial front-load washing machines, along with large stones. Pakistan is very rich in natural resources and possesses many minerals including coal, sulphur, chromite, iron ore, barite, marble, quartzite, pumice and limestone. The objectives are as below;

- To use indigenously available pumice stone for application on textile as an import substitute.
- To save foreign exchange of the country.

Graphical Abstract:



Quarterly Work Plan:

Quarter	01 Year
1st Quarter	• Collection of stones from different location • Identification and quality estimation of stones
2nd Quarter	Application of various stones on denim fabric
3rdQuarter	Technical evaluation of denim Fabric
4th Quarter	Compilation of results and publication

Funding Source (PSDP/SGI/RD&I etc.):
In-House

Cost:

Tangible Outcomes:
- Using of indigenously available pumice stone will be helpful as an import substitute for textile industries.
- It will save foreign exchange

Achievements:

Status:
New Project

★ ★ ★ ★

Name of Laboratory/ Centre/ Unit:
Applied Physics Computer & Instrument Centre/ PCSIR Labs. Complex Karachi

Title of Project: Development of Embedded Software for Blood Collection Monitor

Name & Designation of Project Leader:
Mr. Arif Karim, PSO

Name & Designation of Project Associate(s):
Mr. Faisal Ghazanfar, SSO
Mr. Naseem Ahmed, SEO
Mr. Farhan Aziz, JTO
Mr. Kashif Husain, TO
Mr. RafiqulAzam, TA
Mr. Mansoor Hai, TO

Area(s) of Research:
Biomedical Instrumentation, Blood Bank

Duration:
06 Months

Date of Initiation:
2024

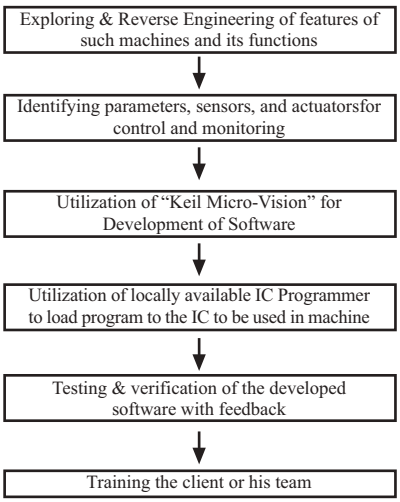
Project Brief:
Blood banks use a machine to collect blood from donor, named as "Blood Collection and Monitor". These machines are mostly imported thus consuming foreign exchange. In Karachi, a biomedical equipment supplier presented a proposal to APC&IC-KLC that they will develop the electro-mechanical structure of the said machine and requested us to develop its embedded software. The embedded software will be downloaded in the IC (Microcontroller: 89c52) of the machine. Team of instrumentation lab examine the said machine and it's IC (Microcontroller: 89c52) and under took the job of its embedded software. The aim of the embedded software in the IC is the overall control, monitoring and user interaction. Some of the working are given below:
- Ensuring the selected Quantity of Blood Volume, i.e. not exceeding the present value.
- Monitoring of blood leakage or blockage from person donating blood.
- Ensuring proper working of clamp for locking and unlocking of blood tubing during working.
- Shaking of blood bag by a tray attached to the machine to prevent clotting.

- Ensuring the proper working and calibration of load cell used for weighing the blood during collection.

The objectives are as follows;

- Development of Embedded Software for over all control and monitoring of "Blood Collection Monitor" which will be burned in the IC (Microconroller).
- The Software in the IC will perform the overall control, monitoring and user interaction.

Graphic Abstract:



Work Plan:

2 Months	4 Months	6 Months
Study and reverse engineering of a working machine which will be provided by the client.	Development of flowchart outlining the working and features of Embedded Software.	Development of software in Keil-Micro-Vision and its simulation.
Downloading the software in IC (Microcontroller) which will be used in the machine.	Testing of machine and providing operational training to the client.	

Funding Source (PSDP/SGI/RD&I etc.):
In-House

Cost:

Tangible Outcomes:

- Development of Embedded Software for over all control, monitoring and user interaction. The software will be downloaded in IC (Micro-controller) which will be used in the said machine, i.e. "Blood Collection and Monitor".

Achievements

Status:
New Project

★ ★ ★ ★

Name of Laboratory/ Centre/ Unit:
Applied Physics Computer & Instrument Centre/ PCSIR Labs. Complex Karachi

Title of Project: Performance Evaluation and Investigation of Various Energy Storage Devices (ESD)

Name & Designation of Project Leader:
Mr. Sheikh Kamaluddin, SSO

Name & Designation of Project Associate(s):
Dr. Abid Karim, SSO
Mr. Arif Karim, PSO
Mr. Faisal Ghazanfar, SSO
Engr. Muhammad Waleed, JE
Engr. Teecome-Das, JE
Ms. Fariha Shabbir, SO

Area(s) of Research:
Efficient Energy Storage, Batteries, Super Capacitors

Duration:
02 Years

Date of Initiation:

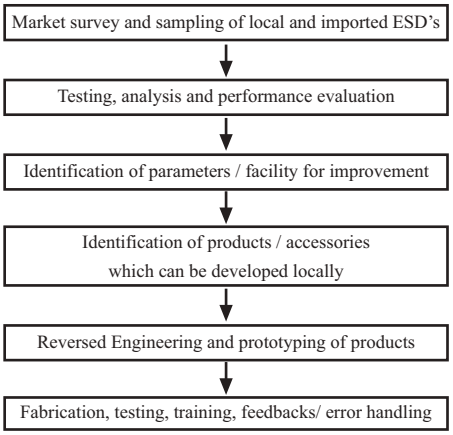
2024

Project Brief:

This project is aimed to investigate future investments in energy storage devices such as various kind of high-power energy storage devices for the large-scale power conservation in off-peak hours (solar / wind energy in peak hours) which can be utilized in the night time. The project includes an extensive research work of the existing manufacturing capacities of the country which mainly relies on lead-acid technology. These devices have major drawbacks of lower efficiency, lower life-span and environmental hazard. Several small-scale manufacturers and domestic users started to deploy the imported Lithium-ion batteries due to their lucrative claims regarding their efficiency and life span which results in several under-rated outputs with loss of huge up-front paid-up capital / investments. Several commercial banks offered investment / funding scheme for the solar energy with reverse-metering without the loan-cover for batteries which results in large scale installation of grid-tied solar energy systems producing excessive power during the sunshine hours and cause large scale grid-congestion. Therefore, it is not viable option to sale out the excessive energy to the regulator (K-Electric / WAPDA) in sunshine hours and re-imports it during night time. Globally, the issue is getting worse due to the congestion of national grids and regulator / government is looking for an alternate option to store the excessive energy and re-use it on-demand with minimal losses and paid-up capital for the infrastructure. The main objectives are as under;

- Demand patterns analysis and projections for the Energy Storage and off-peak hours usage
- Market surveys, analysis for the on-going current technologies at international and local markets/ SME's.
- Feasibility, analysis and investigation of the existing manufacturing facility of ESD's to upgrade the local industries
- Identification and short-listing of the ESD's related devices / which can be prototype and fabricated
- Testing, analysis and error / feedback control for the developed products.

Grahpical Abstract:



Work Plan:

Phase 1

- To test, analyze, evaluate the performance efficiencies for the locally manufactured and imported energy storage devices / accessories in the local market.
- Short list and prioritize the product / accessories which can be upgraded / innovated as already manufactured locally.

Phase-II *(Finances and costing will be outcome of the Phase-I)*

- Reverse engineering / Prototyping / innovation for the selected imported energy storage devices / accessories for their laboratory scale testing and fabrication.
- Consulting / training to the investors / industrialist to establish the industrial / manufacturing facility for the large scale production.
- Continuous monitoring and quality control in order to improve / innovate the product according to the latest research published in peer reviewed journals.

Funding Source (PSDP/SGI/RD&I etc.):

In-House

Cost:

Tangible Outcomes:

- The research will highlight the energy storage

devices / accessories which can be manufacturer locally by providing consultancy to the local investor / industrialist in order to help local manufacturing.

- The research will be disseminated / published / disbursed in the form of peer review published data and will be used to consult / train / quality control with the general public in order to optimize their products / accessories related to their energy losses and efficiencies.

Achievements:

Status:

New Project

★ ★ ★ ★

Name of Laboratory/ Centre/ Unit:

Center for Environmental Studies/ PCSIR Labs. Complex Karachi

Title of Project: Development of Three-Way Banknote Checker Pen

Name & Designation of Project Leader:

Mr. Shahid Bhutto, PSO

Name & Designation of Project Associate(s):

Dr. Akhtar Shareef, PSO
Dr. Nusrat Jalbani, PSO
Ms. Rubab Fatima, SO
Syed Arif Hassan Rizvi, JEO

Area(s) of Research:

Security Paper Counterfeit (Inorganic & Physical Chemistry)

Duration:

02 Years

Date of Initiation:

2024

Project Brief:

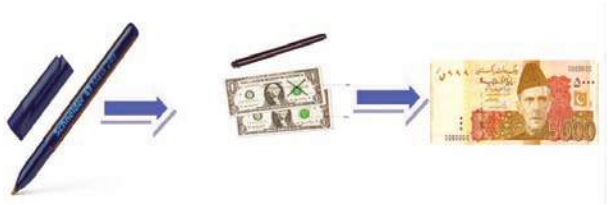
Counterfeit banknotes are a significant issue in many economies, leading to financial losses for both individuals and businesses. To combat this problem, there is a need for reliable and easy-to-use tools that can quickly identify counterfeit currency. One such tool is a banknote checker pen, which can help individuals and businesses verify the authenticity of banknotes on the spot. The development of an advanced banknote checker pen has the potential to significantly mitigate the risks associated with counterfeit currency. By leveraging advanced technology and rigorous testing, we aim to create a reliable and user-friendly solution that can be widely adopted by businesses and individuals. This project aligns with our commitment to innovation and addressing real-world challenges in the field of finance and security. Fake currency note and cheque are one of the alarming problems in our country. The Government recently announced to introduce new currency notes to avoid the dissemination of fake currency note. But due to advancement of printing technology and availability of such technology at cheap cost made the printing of fake security paper easy for criminals. In this situation it is necessary to provide easy to use gadget/tool for masses to check the authenticity of security paper on the spot in real time. The Banknote checker pen is already available in the market with sensitivity to change its color to yellowish brown on original security paper and to dark purple on fake security paper. But some time the change of color is medium and cause confusion for user. Similarly, the available pen only works on currency paper but is not suitable for cheque paper. Our invention will cover both currency and cheque paper by three-way checking steps. There will be two pen nips to produce two different colors along with UV light to check UV feature of the security paper.

The main objectives are as;

- The primary objective of this project is to develop an advanced banknote checker pen that offers improved accuracy, reliability, and user-friendliness compared to existing solutions by three-ways. The specific goals of the project include:
- Designing a pen-shaped device that is portable and easy to handle.
- Incorporating advanced counterfeit detection technology based on chemical reactions.
- Ensuring compatibility with various currencies, including polymer banknotes.
- Implementing user-friendly features such as visual

indicators for authentication results.
- Conducting rigorous testing to verify the accuracy and reliability of the device.

Graphical Abstract:



Work Plan:

The development of the three-way banknote checker pen will involve the following key steps:
- Research on existing banknote checker pens
- Identification of chemicals for counterfeit detection.
- Physical structure of the pen
- Identification of reliable suppliers
- Establish quality control processes

Funding Source (PSDP/SGI/RD&I/etc):

In-House

Cost:

Tangible Outcome:
- Development of a highly accurate and reliable three-way banknote checker pen.
- Increased confidence among businesses and individuals in verifying the authenticity of banknotes & security papers (currency and cheque paper).
- Reduction in financial losses due to counterfeit currency.
- Improved convenience and ease of use compared to existing counterfeit detection methods.
- Process Development
- Patent

Achievements:

Status:

New Project

★ ★ ★ ★

Name of Laboratory/Centre/Unit:

Centre for Environmental Studies/ PCSIR Labs Complex Karachi

Title of the Project: Production of Organic Liquid Fertilizer by Fermentation Method

Name, Designation of Project Leader:

Dr. Tooba Naveed, SSO

Area (s) of Research:

Biotechnology and Solid Waste Management

Duration:

02 Years

Date of Initiation:

July, 2024

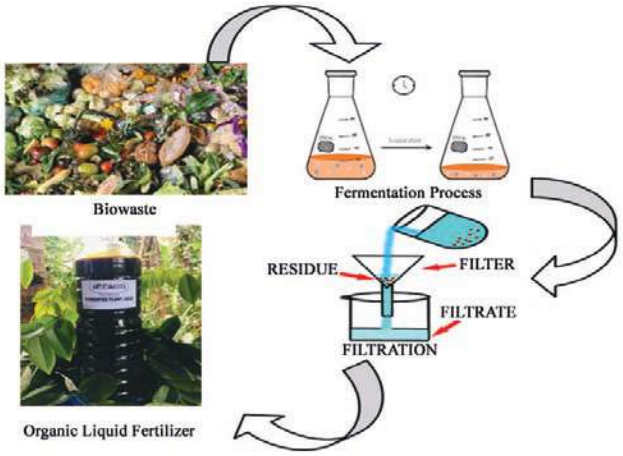
Project Brief:

The population of Pakistan is growing, leading to increase in demand of food. Fertilizers are essential for increasing crop yield, so the demand for fertilizers is expected to grow in line with the demand for food. On the other hand the increasing cost of mineral fertilizer has posed a barrier for small holder farmers, resulting in lower application rates, declined soil fertility status, and crop yield. Therefore, it is vital to look for cheap, impactful, and locally accessible organic fertilizer sources. Liquid organic fertilizer is expected to be one of the solutions to deal with the problem of organic waste in the environment. The ingredients for making liquid organic fertilizer are also relatively easy and cheap to obtain, the main ingredients for making liquid organic fertilizer usually use kitchen waste, such as vegetable waste, stale rice, fruit and vegetable peel, etc. Liquid organic fertilizer has an important role related to soil structure, maintaining soil health in good condition by increasing nitrogen supply and encouraging the growth of microorganisms in the soil. The main objective is;
- Organic Liquid Fertilizer by fermentation method using waste material

Work Plan:
- Collection of fruits and vegetable waste from different sources.
- Establishment of experimental setup for fermentation studies.

- Process optimization by observing effects of key parameters
- Shelf life studies
- Field trial experiments on vegetable crops and home garden plants.

Graphical Abstract:



Quarterly Work Plan:

Quarter	First Year	Second Year
1st Quarter	• Purchasing of raw material • Selection and purchasing of vessel for fermentation studies	• Shelf life studies
2nd Quarter	• Trial experiment of liquid fertilizer production by using different formulations on small scale	• Pot/field trial studies to check the affectivity of the product Shelf life studies
3nd Quarter	• Continuation of trial experiments. • Selection of best formulation on the basis of physico-chemical analysis.	• Shelf life studies
4th Quarter	• Optimization of selected formulations	• Shelf life studies • Compilation of data. • Publication

Funding Source (PSDP/SGI/RD&I/etc.):
In-House

Cost:

Tangible Outcome:
Development of Process for Organic Liquid Fertilizer

Achievements:
-

Status:
New Project

★ ★ ★ ★

Name of Laboratory/Center/Unit:
Engineering Services Center/ PCSIR Laboratories Complex, Karachi

Title of Project: Formulation of Lumbrokinase Extracts through Spray Drying Encapsulation and Emulsification

Name & Designation of Project Leader:
Dr. Nighat Sultana, CSO

Name & Designation of Project Associate(s):
Engr. Muhammad Ali Imran, SE
Mr. Umais Ihsan, EO
Mr. Tariq Bakshish, EO

Area of Research:
Herbal Drug Development

Duration:
01 Year

Date of Initiation:
2024

Project Brief:
Earthworms have been used as a traditional medicine in China, Japan and other far East countries for thousands of years. Oral administration of dry

earthworm's powder is considered as a potent and active supplement for supporting healthy blood circulation. It has been used as a traditional medicine and food source having many compounds with potential medicinal properties. It is usually administrated to treat inflammatory, hematological, and oxidative and nerve disease. Earthworms also have antimicrobial, antiviral and anticancer properties. Lumbrokinase is a fibrinolytic enzyme that comes from the earthworm Lumbricusbimastus. Fibrinolytic enzyme is made explicitly to break down clotting in the blood and promote healthy heart, blood lung levels, and is considered as an antithrombotic agent. The preparation method of Lumbrokinase has the characteristics of good quality controllability and stability of the production process. The water extract is partially concentrated in rotary evaporator under vacuum & adjust its concentration before the capsulation by spray drying without any additive and examined the process condition such as inlet air temperature extract feed rate and air flow rate. To protect the thermo sensitive compound during process and also storage, encapsulation in appropriate coating material, several coating material may be used but maltodextrin is most commonly used due to its ability to form film. Encapsulation has been widely used in chemical, pharma and food industries to protect bioactive compound from environmental conditions such as temperature and light. Encapsulation can be done by spray drying process involved atomizing extract dispersed in polymer solution into droplet by spraying, followed by rapid evaporation. In spray drying encapsulation, almost entirely, aqueous feed dispersion is used. Therefore water solubility of coating material is of major importance. The extracts were formulated to powder through encapsulation by drying after removal of the solvent. The main objectives are;

- Production of import substitute potential supplements by utilizing indigenous resources.
- To develop remedy for different pharmaceutical condition like inflammatory, hematological, oxidative and nerve disease, antimicrobial, antiviral and anticancer properties.
- To develop easily available and economical remedy by using our indigenous resources.
- Through this project the standardization of pharmaceutical active raw material will develop.

Work Plan:

- Method development for preparation of Lumbrokinase, powder making. comprising the steps of grinding, deslagging, salting-out, centrifuging, ultra-filtrating, column chromatography, degerming & spray-drying
- Analysis of Lumbrokinase (Earthworms) Powder.
- Adjust the dosage for oral administration.
- Microbiological analysis of compounds.
- Screening of pharmacological activities.

Quarterly Work Plan:

Quarter	Tasks
1st Quarter	• Source determination of Earth Warm • Taxonomical identification • Directly dry the earth warm and powdered by using the Oven and Sun heat.
2nd Quarter	• Grinding, deslagging, salting-out, centrifuging, ultra-filtrating and Minced by using chopper machine or by hand. • Hydrolization process carried out through water bath on temperature 70°C to 80°C under pH control using the enzyme papain • Hydrolization process carried out through water bath on temperature 70°C to 80°C under pH control using the enzyme acralas
3rd Quarter	• Filter and concentrate up to required protein (Brix) • Formulation of Lumbrokinase extracts through Spray Drying • Estimation of total protein • Estimation of Amino Acid profile will be carried out. • Detailed microbiological and pharmacological studies will be conducted on the final product
4th Quarter	• Production of potential supplements • Final product will be patented for commercial use

Funding Source (PSDP/SGI/RD&I/etc):
In-House

Cost:

Tangible Outcome:
- Development of product
- Process leased out to industry
- To save foreign exchange of the country as substitute of import products
- Utilization of indigenous material within the country thus promoting industrial growth of the country.
- It will improve the pharmaceutical business & in result increase the employment generation
- Project will be beneficial for local pharmaceutical industries as the product develop with least side effects, economically bearable & easily approachable for a common man
- Trainings & consultancies will be provided to clients & academia.
- Publications

Achievement:

Status:
New Project

★ ★ ★ ★

Name of Laboratory/Centre:
Food and Marine Resources Research Centre/ PCSIR Labs Complex, Karachi

Title of Project: Production of Microbial Protein as an Alternative Source for Animal Feed

Name & Designation of Project Leader:
Dr. Muhammad Asif Asghar, SSO

Name & Designation of Project Associate(s):
Dr. Farman Ahmed, PSO

Area(s) of Research:
Animal, Poultry Feed Industries

Duration:
02 Years

Project Brief:
One of the most prominent aspects of the global population is its rapid expansion, resulting in enormous pressure on global resources and the environment. Furthermore, there have been significant changes in the global animal feed price which will impact the price of animal agriculture. The feed cost accounts for 60–70% of total livestock production costs, and there is an increasing reliance on soybean meal and fish meal for protein supply in feeds. To date, the rising costs of protein feed ingredients have largely been experienced by livestock, poultry, and aquaculture producers, often with significant financial loss. However, higher costs of production have to be reflected in higher prices for meat and eggs. Consequently, the issues of alternative protein feed sources have generated as public concern. To address these deficiencies, advancements in agriculture, distribution, and food security initiatives are required. Different approaches are available for alternative sources of protein such as plant-based proteins, cultured meat, edible insects, and the most demanding microbial proteins (MPs). MPs refer to the type of microbial biomass that can be used as a source of protein for the human and animal consumption. MPs are produced by growing microorganisms, such as bacteria, yeast, and algae by fermentation process on various substrates like agro-industrial wastes, and industrial by-products. It has several applications regarding high protein content, resource utilization, and reducing environmental impact as compared to traditional protein. In addition, solid waste pollution is a significant environmental concern, and its improper disposal and management can cause severe environmental problems. However sustainable MPs production offers a promising solution due to utilizing of waste streams from various sources by converting them into protein. Animal feed industry is also passing through an era of inadequate and high cost availability

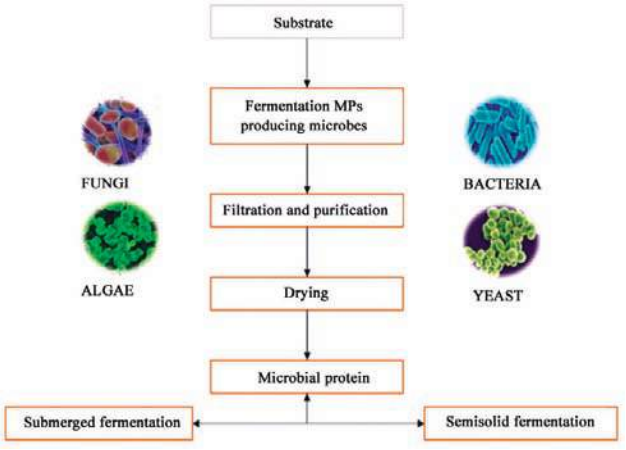
of conventional ingredients such as oil seed cakes and certain cereals. Also, there is a strong competition between human beings and livestock for conventional protein sources. Supplementation of vegetable proteins with animal proteins results in higher feeding costs. The global demand for high-quality, protein-rich foods will continue to increase as the global population grows, along with income levels. It is therefore important to produce economical quality proteins from non-conventional sources. Aquaculture is poised to help fulfill some of this demand, and is thus the fastest growing animal protein industry. A key challenge for it, though, is sourcing a sustainable, renewable protein ingredient. Microbial proteins (MPs) products, protein meals based on microbial or algal biomass, have the potential to fulfill this need. MP-based protein meals have the potential to provide the industry a sustainable, renewable feed ingredient to make up for the deficiencies of plant-based meals. Microbial protein basically comprises proteins, fats carbohydrates, ash ingredients, water, and other elements such as phosphorus and potassium. Aside from the nutritional benefits of MPs, other advantages of microbial protein technology are:

- Production throughout the year.
- It plays a role in waste management as waste materials are used as substrate.
- Small area of land is required and is made in less time.
- Helpful to manage the food and feed crisis.
- Cultivation of MP on the one hand provides alternative substrates, and on the other hand helps in solving problems of disposal caused during the process.

The main objectives are as;

- To produce the MPs from selected microbial strains.
- To utilized the different fruits and vegetable wastes as a substrate.
- To help solve modern waste disposal problems.
- To optimize the production protocol of MPs.
- To overcome the protein deficiency in animal feed and also helpful to improve the protein contents of animal feed.

Graphical Abstract:



Work Plan:

- Isolation, identification and characterization of suitable microorganisms
- Substrate (fruits and vegetable waste) collection and preparation
- Fermentation and optimization of the process
- Harvesting
- Optimization of the substrate
- Collection of microbial protein
- Estimation of biomass and protein content
- Application of harvested protein as a supplement in animal diet

Funding Agency (PSDP/SGI/RD&I/etc.):

In-House

Cost:

Tangible Outcome:

- Cost effective technology for MPs production and processing will be developed at national level.
- Bio plants/ Bioreactors can be installed in areas where they are needed most to cope the deficiency of essential nutrients at reasonable cost.
- Entrepreneurs may be attracted to this new business.
- A convenient and excellent Quality Protein may be produced for food and feed purpose of human and livestock, poultry and fish.
- Eye catching and fruitful business for small capital investors.

Achievements:

Status:

New Project

★ ★ ★ ★

Name of Laboratory/ Centre/Unit:

Food and Marine Resources Research Centre/ PCSIR Laboratories Complex, Karachi

Title of Project: Development of Dietary Protein Hydrolysates and their Application in Nutraceutical Drinks/Functional Food

Name & Designation of Project Leader:

Dr. Asad Ullah, SO

Name & Designation of Project Associate(s):

Dr. Muhammad Samee Haider, PSO
Mrs. Nida Saleem, SSO
Mr. Umeed Ali Soomro, SSO
Mr. Waqas Afzal, SO

Areas of Research:

Protein Hydrolysates, Bioactive Peptides and Amino Acids, Food Application of Hydrolysates

Duration:

02 Years

Date o Initiation:

2024

Project Brief:

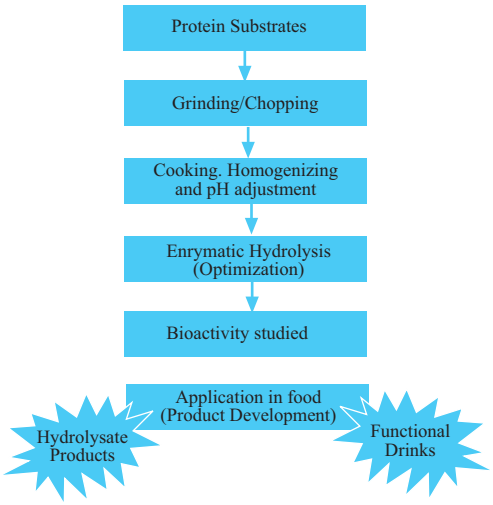
Protein hydrolysates (PHs) have vast application in food and agriculture. Hydrolysates of proteins have advantage to easily be absorbed and utilized for various metabolic activities rather than their respective whole proteins. Numerous researches in the last few decades have described that protein hydrolysates from several food sources, in addition to their nutritional properties, showed many biological functional effects including antioxidant, antimicrobial, hypotensive, anticoagulant, cholesterol-lowering ability, hypoglycemic effect, antitumor activity, etc. Such functional properties are related with their biopeptides, of 3–50 amino acid residues in length, present in the protein hydrolysates. Hydrolysis of proteins by various methods can increase solubility and lead to the formation of bioactive peptides, as well as other physicochemical properties. Fish protein hydrolysate (FPH) is well-known good nutritional supplements as their bioactive ingredients can simply be absorbed. Similarly, the enzymatic hydrolysates of whey proteins (WPHs) have more functional characteristics in food applications compared to intact whey proteins. Soy protein hydrolysates (SPHs) are produced from soy proteins by various methods and such methods have different effects on the property of educed hydrolysates. SPHs are important in the food industry due to their functional properties including gelling, emulsifying and water-holding properties. Protein hydrolysates offer high potential in different diets and nutritional effects. They are tremendous digested protein sources for human nutrition and physiological functions, as they are simply absorbed in the gastrointestinal tract more effectively than their native protein. Therefore, they are suitable for the production and fortification of elderly, infants, and patients (allergic, digestive issues, liver disease, etc.) foods. There are no reliable industries for the production of protein hydrolysate in Pakistan. According to the import data of "Volza's Pakistan" Pakistan imports most of the protein hydrolysate powder from India, Hungary and United States. Top three protein hydrolysate powder product categories of imports in Pakistan are under the HSN Code of 35040099, 35040000 and 35040010. Therefore, the developed protein hydrolysates and their products would be good import substitutes.

- Protein hydrolysates and peptides with notable biological properties are produced widely through the use of proteolytic enzymes.
- Paralleled to chemical treatments, an enzymatic proteolysis method is an appreciated method to prepare protein hydrolysates, due to the milder conditions the process requires and does not produce unwanted chemical impurities.
- Spray drying and freeze drying technologies will be under study for the hydrolysate powder formation.
- Quality evaluation of protein hydrolysate will be conducted through amino acid analyzer.
- Accelerated shelf-life study will be under taken for product stability

The main objectives are;

- To utilize the trash fish, dairy waste (whey) and Agri-waste (soy meal) for the production of protein hydrolysate powder
- To produce hydrolysates with characterized biological properties
- As product, protein hydrolysate powder will be made from selected biologically active hydrolysate (having essential and branched-chain amino acid and bioactive peptide)
- To prepare ready-to- use hydrolyzed protein based nutraceutical drinks/functional food

Graphical Abstract:



Work Plan:

- In the **first half** (6 months) of the project protein hydrolysis condition will be optimized to obtain a better yield of amino acids and/or bioactive peptide profile
- In the **second half**, bioactivities will be studied and food grade protein hydrolysate powder will be produced
- In the **last year**, protein hydrolysate Nutraceutical drinks/functional food will be developed. Composition (amino acid and peptide) and shelf life will be studied.

Funding Source (PSDP/SGI/RD&I etc.):

In-House

Cost:

Tangible Outcome:

- Process/technology development of Protein hydrolysate powder.
- Product development of Nutraceutical. food/beverage drinks using protein hydrolysate powder.
- Publications and patents
- Beverage, Confectionery and Nutraceutical food industries will be the main beneficiary.

Achievement:

Status:

New Project

★ ★ ★ ★

Name of Laboratory/Centre/Unit:

Microbiology Section of FMRRC, PCSIR Labs. Complex Karachi

Title of Project: Phenotypic and Genotypic Traits of Lactic Acid Bacteria (LAB) in Fermented Foods & their Potential to Use as Probiotic Formulation

Name & Designation of Project Leader:

Dr. Zulfiqar Ali Mirani, SSO

Name & Designation of Project Associate:

Dr. Abdul Basit Khan, PSO
Dr. Muhammad Naseem Khan, SSO
Mrs. Anila Siddiqui, SSO

Area of Research:

Microbiology

Duration:

1½ Years

Date of Initiation:

2024

Project Brief:

Fermentation has long been employed as a traditional method for preserving and enhancing various food products. These fermented foods offer numerous

health benefits, including improved digestion, fostering a diverse gut microbiota, enhancing nutrient absorption, and bolstering the immune system. Across diverse ethnic culinary traditions, including those in Karachi, fermented foods play a significant role. These foods are associated with beneficial microorganisms that contribute to their nutritional value. Inhabitants of the Sindh region, particularly in Karachi, regularly consume a variety of locally fermented foods, such as yogurt, cheese, milk, Lassi, and pickles. These fermented items are not only valued for their nutritional content, but also for their functional and probiotic properties. Studies have shown that they can help protect against foodborne illnesses. Probiotics, which are beneficial bacteria consumed in adequate amounts, have been found effective in addressing various health conditions, including diarrhea, *Helicobacter pylori* infections, inflammatory bowel disease, and urinary tract infections. Lactic acid bacteria (LAB) are a prominent group of bacteria widely used in food, dairy, probiotic, and beverage production. They are Generally Regarded as Safe (GRAS) and possess characteristics that make them suitable for such applications. LAB play a crucial role in fermentation, dominating the microflora in fermented products and contributing to their preservation by producing compounds like lactic acid, acetic acid, hydrogen peroxide (H_2O_2), bacteriocin, diacetyl, and carbon dioxide (CO_2). Despite the widespread consumption of fermented foods in Karachi, there is a lack of research on the microflora present in these foods and their potential health benefits. Thus, the objective of this study is to isolate LAB from traditional fermented foods and beverages in Karachi, evaluate their phenotypic traits, and explore their potential as probiotics. The aims of this study include isolation of LAB from various fermented food products in Karachi, identifying and categorizing the LAB strains using genotypic and phenotypic characteristics, assessing their probiotic qualities, evaluating their antibacterial efficacy against foodborne pathogens, and examining their potential industrial applications. Key questions to be addressed include whether the consumption of fermented foods in Karachi results in a diverse array of lactic acid bacteria species, which LAB strains are primary contributors to specific indigenous fermented dishes, whether there's a relationship between isolated LAB strains and their probiotic properties, and whether these strains can serve as starting cultures for commercial fermented product manufacturing.

Can lactic acid bacteria strains from fermented foods in Karachi be effectively used as starting cultures for commercial fermented product manufacturing?

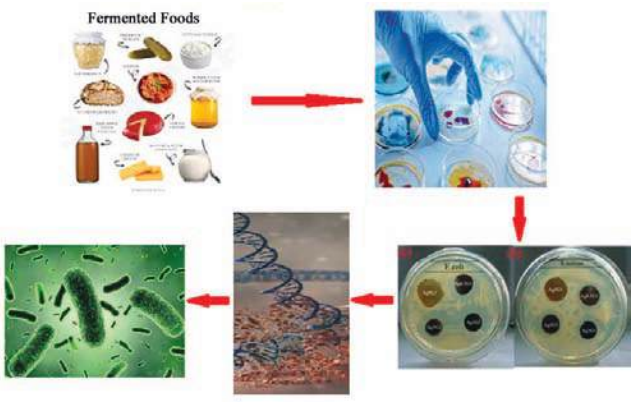
Do consuming fermented foods in Karachi lead to a diverse range of lactic acid bacteria species & their potential probiotic properties?

Which lactic acid bacteria strains play a significant role in fermenting specific indigenous dishes in Karachi?

Lactic acid bacteria strains are mainly used to contribute in controlled fermentation of variety of food items. In addition, they are also used for industrially relevant metabolites and use as probiotics. The study allows understanding the locally used LAB strains characteristics and subsequently its application as starting cultures for commercial fermented product manufacturing. The main objectives are as follow;

- Isolate LAB from different fermented food products in Karachi.
- Utilize genotypic and phenotypic traits for the identification and categorization of isolated LAB strains.
- Evaluate the potential probiotic qualities of the isolated LAB strains.
- Assess the antibacterial efficacy of the isolated LAB strains against foodborne pathogens.
- Examine the functional characteristics of the isolated LAB strains for potential industrial applications.

Grahpical Abstract:



Quarter Wise Work Plan:

	First Year	Second Year
1st Quarter	Collection of fermented food items and analysis for LAB	Antimicrobial activity against foodborne pathogens
2nd Quarter		Antibiotic susceptibility against antibiotics
3rd Quarter	Evaluation of probiotic potential	DNA extraction and PCR amplification of LAB genes
4th Quarter	Antimicrobial activity against foodborne pathogens	Report and manuscript writing

Funding Source:
In-House

Cost:

Tangible Outcome:
- Identification of LAB strains with desirable characteristics can lead to the development of novel starter cultures for commercial fermented food production. These cultures could improve product consistency, shelf life, flavor, and texture.
- The project may identify LAB strains with specific probiotic properties or bio-functional activities (e.g., antimicrobial properties). These strains could be used as functional food ingredients, enhancing the nutritional value and health benefits of commercially produced foods.
- If isolated LAB strains demonstrate strong probiotic potential (e.g., bile and acid tolerance, antagonistic activity against pathogens), they could be developed into probiotic supplements. These supplements could benefit gut health, immune function, and potentially address specific health conditions.
- The project's findings can raise awareness about the diverse LAB species present in Karachi's fermented foods. This knowledge can encourage the consumption of these traditional foods for their potential health benefits.
- The research findings are likely to be published in scientific journals, contributing to the global knowledge base on LAB diversity and functionality in fermented foods.
- The project can provide training opportunities for researchers and students in food microbiology techniques, potentially leading to a more skilled workforce in the food science sector.

Achievements:

Status:
New Project

★ ★ ★ ★

Name of Lab:
Food and Marine Resources Research Center/PCSIR Labs. Complex Karachi

Title of Project: Bio-control of Banana Wilt Disease Caused by *Fusarium oxysporum* f.sp.*cubense (Foc)* using Marine Microbial Sources

Name & Designation of Project Leader:
Dr. Muhammad Naseem Khan, SSO

Name & Designation of Project Associates:
Dr. Abdul Basit Khan, PSO
Dr. Zulfiqar Ali Mirani, SSO
Dr. Beena Naqvi, PSO

Area of Research:
Microbiology

Duration:
02 Years

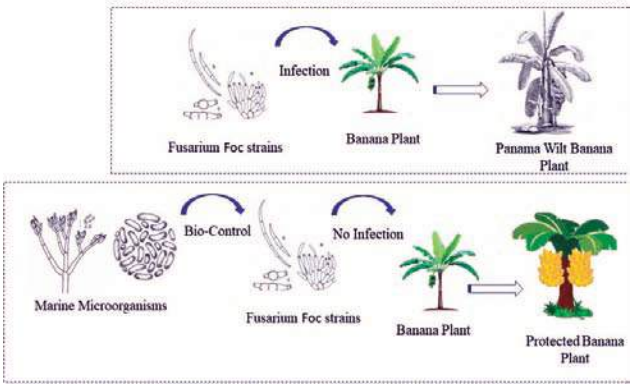
Date of Initiation:
2024

Project Brief:
Banana is a vital food crop and a primary source of income for millions of farmers worldwide. However,

it faces significant challenges, with disease being a major concern, particularly in subtropical regions where banana cultivation is prevalent. Diseases can directly reduce banana production, quality, and shelf life, or indirectly harm plant health, affecting fruit yield. Panama wilt, caused by *Fusarium oxysporum*f.sp. *cubense (Foc),* is highly virulent and destructive, posing a substantial threat to 'Cavendish' banana cultivars and potentially endangering banana production globally. The devastating impact of this disease has been observed in various parts of the world, as evidenced by its eradication of banana crops. In Pakistan, the Panama disease was first reported in 2015. The lack of effective management strategies has allowed this lethal disease to continuously devastate banana production, particularly in Sindh. Recent surveys have revealed varying disease incidences across eleven districts, indicating a pressing need for intervention. Fusarium wilt in banana is among the most destructive diseases, presenting a significant threat to the global banana industry, with no effective control measures currently available.Marine microbes represent a rich source of metabolites, with globally recognized antimicrobial properties. Utilizing these microorganisms on banana plants holds promising potential for controlling banana wilt disease. The main objectives are as follows;

- To isolate *Fusarium oxysporum* f. sp. *cubense* (*Foc)* from infected banana samples.
- To identify the fungi through microscopic, morphological, and molecular methods.
- To assess the antagonistic activity of marine microbes against *Fusariumoxysporum* f. sp. *cubense* (Foc) strains

Graphical Abstract:



Work Plan:

- Isolating *Fusarium* strains from infected plants
- Conducting morphological and microscopic identification of *Fusarium*
- Performing molecular identification of *Fusarium* strains
- Confirming *Foc* strains via specific genes
- Reviving marine microbial sources
- Screening the antifungal activity of marine isol ates against *Foc*
- Conducting morphological and microscopic identification of potential anti-Foc marine isolates
- Performing molecular identification of potential anti-Foc marine isolates

Funding Source (PSDP/SGI/RD&I etc.):

In-House

Cost:

Tangible Outcome:

- Method development for the identification of Fusariumoxysporum f. sp. cubense tropical race 04.
- Selection of potential anti-Foc biocontrol agents to mitigate the spread of the disease in Pakistan.

Achievements

Status:

New Project

★ ★ ★ ★

Name of Laboratory/Centre/ Unit:

Pharmaceutical Research Center/ PCSIR Laboratories Complex, Karachi.

Title of Project: Exploration of *Rumex dentatus* for Potential Anti-inflammatory and Analgesic Skin Application

Name & Designation of Project Leader:

Dr. Shazia Yasmeen, PSO

Name & Designation of Project Associate(s):

Dr. Ghulam Fareed, SSO

Dr. Hina Imran, SSO
Dr. Tehmina Sohail, SSO
Dr. Rashid Ali Khan, CSO

Area(s) of Research:
Natural Product Chemistry

Duration:
01 Year

Date of Initiation:
2024

Project Brief:

In Pakistan, a large population trust on folk medicines and it has become a definite part of its cultural heritage. However, due to fast life of cities the practice is now limited to only remote areas of the country. If the quality herbal medicinal products are provided in easy to use forms like tablets, syrups, ointments etc., there is huge potential of growth for herbal drug industry in Pakistan. Herbalist's approaches for R&D on herbs reported to develop formulations based on scientific data along with well defined quality assurance parameters. *Rumex dentatus*, a specie of flowering plant of family *polygonaceae* known by the common names like toothed dock, Indian dock or jungle palak. It is found through out Pakistan commonly in wetlands, hill sides, and cultivated fields of Khyber Pakhtunkhwa and Kashmir. It can be found in cities, urban areas, and mountainous regions. It is used as an excellent traditional medicine against many cutaneous disorders. It is reported to have a number of other important bioactive compounds like Endocrocin, Emodin, Emodin-glycoside, Chrysophenol-glycoside, Quercetin, Helonioside-A. These isolated compounds have been found active against cancer, inflammation, tumor, dermatitis, ascariasis, eczema and various bacterial infections. Taking into account the astounding pharmacological properties, simplicity of access and strong traditional values, *Rumex dentatus* has been chosen to be explored for the development of potential anti-inflammatory skin application. Skin-related health conditions affect millions of people around the country. They can cause symptoms like itching, swelling, and rashes that range from mild to severe. Medication for skin diseases can either be topical or oral. Topical applications have several advantages over oral drugs for treating skin diseases, including targeted delivery, less systemic absorption and ease of use. Although topical medications have fewer side effects than oral medication, still non-desirable side effects are associated with these medications. Natural products possess extraordinary specificity and potency compared to artificially designed molecules as drugs. These characteristics of natural products are due to nature's own high-throughput screening process for the optimization of bioactive compounds. The plant flora showed numerous assays with each part of the plant were found to act against particular disease. Herbal extracts having potential activities with fewer side effects can be utilized in skin applications like medicated ointments and cream. The project is designed to explore *Rumex dentatus* as potential source for the development of anti-inflammatory and analgesic skin application.The anti-inflammatory and analgesic activities will be performed on crude extracts and fractions thereof in animal models. Blending the active fractions with simple bases and emulsifying agents in dose dependent manner will provide a formulation for skin application in user-friendly form. Quality assurance parameter including finger printing profiles through modern techniques like GC and HPLC will be developed for the raw material and the finished product to assure safety and efficacy. The main objective of the project is;

- Development of herbal anti-inflammatory and analgesic application for skin.

Graphical Abstract:

Work Plan:

- Collection of authentically identified herb
- Drying under shade, and grinding
- Extraction
- To determine anti-inflammatory activity of crude extract in animal models
- To determine analgesic activity of crude extract in animal models
- Fractionation of extract
- Anti-inflammatory activity and Analgesic activity of fractions will be determined
- Incorporation of active fraction into formulations
- Study of anti-inflammationand analgesic activity of formulations in animal models
- QC parameter development for active fractions and formulation including finger printing profile through GC/HPLC

Quarterly Work Plan:

Quarters	First Year
1st Quarter:	• Plant collection authentically identified herb, • Drying under shade and grinding to powder form
2nd Quarter:	Extraction & Fractionation of the herb
3rd Quarter:	Anti-inflammatory and analgesic activity studies on crude and fractionated extracts in animal models
4th Quarter:	• Incorporation of active fraction into formulation • Anti-inflammatory and analgesic activity of developed formulation in animal models • QC parameter development for the formulation including finger printing profile through GC/HPLC • Compilation of results. • Paper/Patent

Funding Source (PSDP/SGI/RD&I/etc):

In-House

Cost:

Tangible Outcome:

- Formulation for anti-inflammatory and analgesic application for skin
- Process develop for leasing out
- Paper/Patent

Achievements:

Status:

New Project

★ ★ ★ ★

On-Going

Name of Laboratory/Centre/Unit:

Applied Chemistry Research Center/PCSIR Laboratories Complex Karachi

Tile of Project: Synthesis and Characterization of Chitosan and its Application

Name & Designation of Project Leader:

Dr. Sofia K. Alvi, PSO

Name & Designation of Project Associate (s):

Dr. Razia Sultana, CSO
Dr. Saima Imad, PSO
Dr. Tahir Rafique, PSO
Mr. Muhammad Aijaz, SSO
Mr. Sheraz Shafique, SSO
Syed Junaid Mehmood, SO

Area (s) of Research:

Chemical Sciences / Industrial Chemistry, Advance Materials / Polymeric Based Composites Materials

Duration:

03 Years

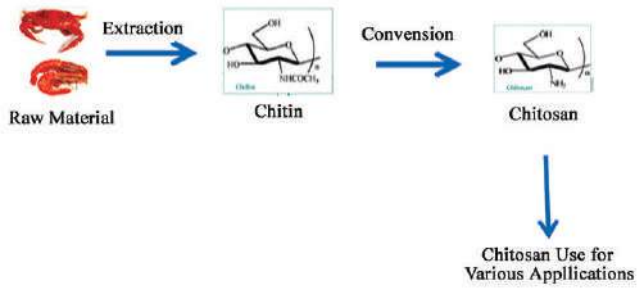
Date of Initiation:

2022

Project Brief:

Chitin is one of the most abundant natural linear polysaccharide made up of β-(1,4)-linked-N-acetyl-D-glucosamine units. Its main source of exploration is marine crustaceans. Chitin extraction from waste of shrimps and other crustaceans is economically feasible. Many valuable products like pigments and protein are also recovered which are utilized as additives in aquaculture, nutraceuticals etc. Purified chitin is converted to chitosan by hydrolysis of acetamide groups of chitin under alkaline condition. Generally, the reaction is carried out under inert atmosphere to avoid depolymerization and to prevent chain degradation. Chitosan is a bioactive polymer and it is characterized by its degree of deacetylation, molecular weight, appearance, purity, crystallinity, solubility, turbidity of polymer solution, ash content, etc. The wide varieties of applications of chitosan are due to its functional properties, unique cationic nature, its biocompatibility and biodegradability. It is soluble in acidic aqueous media and has wide range of applications mainly in food, agriculture and agro-chemistry, aquaculture, cosmetics, pharmaceutical industries, textile and fiber industries, paper industry, wastewater treatment

Graphical Abstract:



Funding Source (PSDP/SGI/RD&I etc.):

In-House

Cost

Tangible Outcomes:

- A valuable product chitosan will be synthesized
- Applications of Chitosan in nano-fertilizer synthesis.

Achievements:

- Raw material for chitin has been procured and graded.
- Chitin has been extracted at lab scale and reaction conditions have been optimized.
- A good quality and quantity of chitin has been extracted from the raw material
- Pilot scale production of chitosan is achieved
- The yield of chitosan is improved. The material is graded to estimate its degree of acetylation.
- Characterization of chitosan is in progress.

★ ★ ★ ★

Name of Laboratory/ Centre/ Unit:

Applied Physics Computer & Instrument Centre/ PCSIR Laboratories Complex, Karachi

Title of Project: IoT Based Lab Monitoring and Control System

Name & Designation of Project Leader:

Mr. Arif Karim, PSO

Name & Designation of Project Associate(s):

Mr. Faisal Ghazanfar, SSO
Mr. Naseem Ahmed, SEO
Mr. Farhan Aziz, JTO
Mr. Kashif Husain, TO
Dr. Abid Karim, SSO
Mr. Mujahid Hussain, RA
Mr. Noman Saeed, TO
Mr. Mansoor Hai, TO

Area(s) of Research:

Instrumentation, Lab Monitoring and Control

Duration:

2 Years (01 Year Extended)

Date of Initiation:

2023

Project Brief:

Internet of Things (IoT) is getting popularity and applicability in every walk of life, especially, industry, R&D Labs and Tele-health. The present project is the utilization of loT in Laboratory monitoring and

automation. There are several parameters to monitor in a lab, such as humidity, ambient temperature, fire and smoke detection. In addition, an equipment such as furnace or oven can be switched on and off remotely by user. There are a number of different embedded systems available in the market for implementation of IoT, such as, Arduino, ESP-32 and Raspberry- Pi. In this project, these embedded systems will be integrated for applicability in our lab (PCSIR-KLC). Initially, temperature and humidity will be monitored and recorded 4 to 24 times a day on a cloud application. In this way, after the end of month, we will be able to look at the recorded values for interpretation and utilization in our test & analysis calculations. In the second phase, smoke or fire sensors will be added to the system for safety of lab. In the third phase, equipment will be interfaced with the system for monitory and control like switching on and off. In this way, a scientist or user can remotely monitor their experiment and may switch off his equipment when an experiment is completed. The need of conventional Laboratory to Smart laboratory is increasing day by day especially in under developing countries. In R&D and Test & Analysis Laboratories, the instruments need to be monitored and controlled remotely for their status, so that when it is free or the process is completed, it can be shutdown. Similarly, the environment is needed to be monitored by a remote with logging of environmental parameters on cloud application for later use. The instruments may be furnace, oven, conditioning chamber or sophisticated scientific instruments. The parameters may be temperature, humidity, smoke, CO_2, O_2, methane gas, etc. The main objectives are;

- Transforming a conventional R&D or Test & Analysis Laboratory to a Smart Laboratory.
- Monitoring and control of instruments / equipment from remote location for their efficient use. The equipment may be furnace, oven, incubator, conditioning chamber or a scientific instrument.
- Monitoring and logging / storing of environmental parameters from remote location for safety and use in data analytics. The parameters may be Temperature, Humidity, Smoke, Light, Methane, CO_2, O_2 etc.

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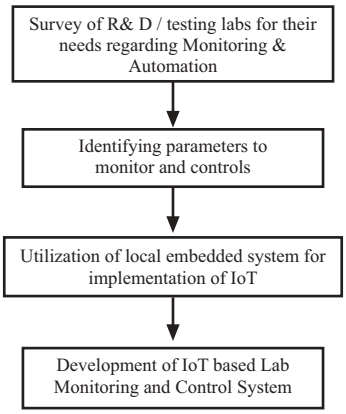

Work Plan:

- To accomplish the said work, it is preferred to utilize the locally available microcontrollers, embedded systems and sensors. It will ease the development process, especially their service and maintenance.
- In the first phase, temperature, humidity and light (Lux) will be monitored and stored on a cloud application. It will be visible for a remote user on smart phone or computer.
- In the second phase, gas sensors such as methane, smoke etc. will be interfaced. In the third phase, control mechanism will be added to the system to switch off or on an instrument from remote location using computer or a smart phone.
- In the final phase, the system will be converted to a fully functional prototype.

Funding Source (PSDP/SGI/RD&I/etc.):

In-House

Cost:

Tangible Outcome:

The outcome of the project will be a Fully Functional Prototype (FFP). The FFP will be capable of monitoring, control and logging of laboratory instruments and environmental parameters as stated in project objectives.

Achievements:

- Embedded Systems like Arduino, ESP-32 and Nod-32 has been evaluated.

- Temperature, humidity, light intensity, methane-gas sensors has been interfaced. They are monitored and data is stored on cloud application.
- Cloud application has been developed for "Thing Speak", "MIT-Inventer-App" and "Blynk". They are correspondingly tested for ESP-32 and Nod8266.

Status:
On-going

★ ★ ★ ★

Name of Laboratory/Centre/Unit:
Applied Physics Computer & Instrument Centre/ PCSIR Laboratories Complex, Karachi

Title of Project: Study of Wind-Solar Hybrid Energy using Machine Learning (ML) Techniques

Name & Designation of Project Leader:
Mr. Faisal Ghazanfar, SSO

Name & Designation of Project Associate(s):
Mr. Arif Karim, PSO
Dr. Abid Karim, SSO
Mr. Kashif Hussain, TO
Mr. Farhan Aziz Abassi, JEO
Mr. Naseem Ahmed, SEO
Mr. Mansoor Hai, EO
Mr. Mujahid Hussain, RA
Mr. Noman Saeed, TO

Area(s) of Research:
Artificial Intelligence (AI)

Duration:
02 Years

Date of Initiation:
2023

Project Brief:
In the field of renewable/alternate energy, especially Solar and Wind based power generation; the prediction of power generation from a plant, throughout the year is a great challenge. The power generation depends on environmental conditions, wind speed, wind direction, solar irradiance, temperature etc. The uncertainty in these parameters leads to uncertainty in power generation. To make the power plant efficient i.e., getting maximum output and its supply on the national grid with certainty, these parameters need to be calculated or predicted. This energy prediction model helps in utilizing solar and wind based power plants at their optimum level with certainty. This project is aimed at the utilization of Machine Learning (ML) techniques for the prediction of power production form solar and wind farm as a hybrid approach by considering a local wind farm situated at wind corridor of Sindh. In wind and solar based power plants, the certainty in power generation allows them to connect it to the national grid with their committed power. The certainty depends on the environmental parameters like wind speed, wind direction, solar irradiance, temperature etc. The estimation or prediction of these parameters is required for a specific plant throughout the year. This research work will utilize Machine Learning (ML) techniques for the prediction of these parameters especially for the wind-farm situated at wind corridor of Sindh. The obectives of the project are;

- To prepare comprehensive Model for the Optimal Management of Energy / Power production using ML techniques.
- To study different parameters like wind speed, direction, solar irradiance, temperature etc. for solar panels and wind turbines.
- Comparative study of ensemble and other modern methods of ML for the said application

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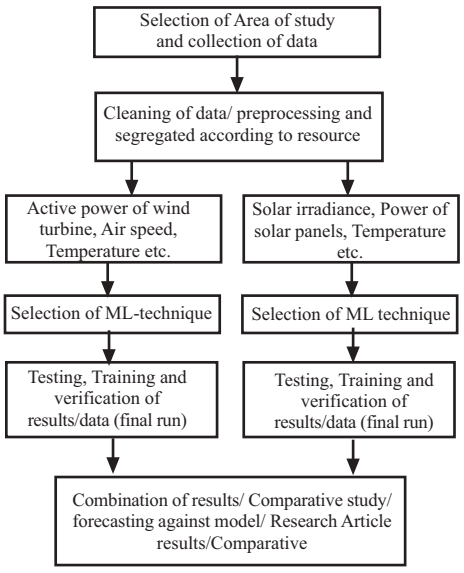


Funding Source (PSDP/SGI/RD&I, etc.):
In-House

Cost:

Tangible Outcome:
- The Trained-Model will help the power sector of renewable / alternate energy. This will eventually lead to clean and green energy production.
- The model is aimed to be applied on the Wind-Corridor of Sind where wind farm is already operative.

Achievements:
- Data collection and cleaning has been completed.
- Study of machine learning techniques such as support vector regression, Recurrent Neural Network has been completed

Status:
On-going

★ ★ ★ ★

Name of Laboratory/ Centre/ Unit:
Center for Environmental Studies/ PCSIR Labs. Complex, Karachi

Title of Project: Watermark Development on Ordinary or Thermal Paper Coupled with UV and Chemical Sensitivity

Name & Designation of Project Leader:
Mr. Shahid Bhutto, PSO

Name & Designation of Project Associate(s):
Dr. Akhtar Shareef, PSO
Dr. Nusrat Jalbani, PSO
Ms. Rubab Fatima, SO
Syed Arif Hassan Rizvi, JEO

Area(s) of Research:
Security Paper Counterfeit (Inorganic & Physical Chemistry)

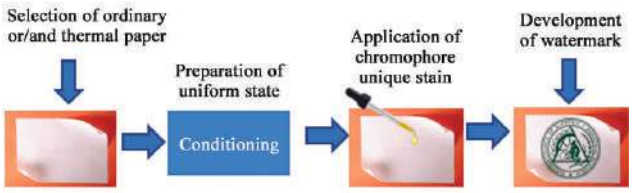
Duration:
03 Years

Date of Initiation:
2022

Project Brief:
Watermarking is a long-established paper industry technique for incorporating words, images and patterns into paper in an unobtrusive manner which does not interfere with the use but indicates the origin of the paper or guarantees that it is genuine. Thus, watermarking is widely employed in the manufacture of banknotes, security papers, Election balloting paper and high-quality branded or bespoke stationery for business or personal use. The uniqueness of watermark always attracts the client and gives trustfulness on the process or product. It also guarantees the safety from fraudulent in the documents or forgeries. This project will result in development of unique watermark with two extra features making it almost impossible to be copied by anyone. By adding UV feature and chemical sensitivity the watermark security will increase by tenfold. Because of more than a million permutation of its components, the development of an watermark development machine has the potential to significantly mitigate the risks associated with fake documentation and will reduce fraud criminal act within the society. We aim to create a reliable and trust worthy solution that can be widely adopted by businesses and individuals. This project aligns with our commitment to innovation and addressing real-world challenges in the field of Assets, finance and security. Fake and forged documentation is one of key reason for fraudulent in our society. The document authenticity will reduce the easy printing of important documents to get innocent people get lotted or trapped and become victim of such fraud. This technology will improve the authenticity of document with strict security features to make each case unique and easy to detect the fake document. The ordinary document could be processed to develop watermark and some chemical sensitivity feature along with UV features. This will be done with advanced technology and scientific approach to make the effect permanent. Such carefully developed paper will be utilized by different entities to ensure that their document is secure and no-one else can produce the similar document. This will enhance business trust, security and reliability. The objectives are;
- To develop a process for unique watermark on

ordinary or thermal paper.
- To improve the security of watermark by adding UV feature to it.
- To make it impossible being copied by adding chemical sensitivity
- Implementing user-friendly features such as visual indicators for authentication results.
- Conducting rigorous testing to verify the accuracy and reliability of the device.

Graphical Abstract:



Funding Source (PSDP/SGI/RD&I/etc):
In-House

Cost:

Tangible Outcome:
- Development of a highly accurate and reliable watermark development machine.
- Increased confidence among businesses and individuals in documents that represent financial asset or any value.
- Reduction in financial losses due to fake documentation.

Achievements:
- Two lab scale chemical trials have successfully completed.
- The fabrication of the prototype device is in progress, almost 30% of the work completed.

Status:
On-going

★ ★ ★ ★

Name of Laboratory / Center / Unit:
Centre for the Development of Laboratory Equipment/PCSIR Laboratories Complex, Karachi

Title of Project: Development of Digital Fundus Images Dataset for Artificial Intelligence Based Model Development and Performance Testing

Name and Designation of Project Leader:
Engr. Ghulam Mustafa, SE

Name and Designation of Project Associate:
Mr. Aqeel Ahmad Khan, SSO

Area(s) of Research:
Artificial Intelligence

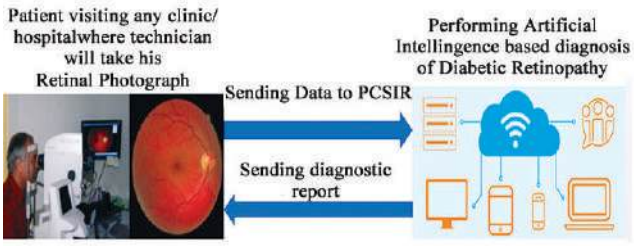
Duration:
02 Years

Project Brief:
Retina is the photosensitive layer present inside human eye which is responsible to receive photons and convert them into electrical signals. These electrical signals are carried to brain through optic nerve to convert them into meaningful information. Visual disorders like Age related Macular Degeneration, Diabetic Retinopathy, Glaucoma and hypertensive retinopathy affects retinal layer and optic disc's structure. These pathological changes progress gradually through the period of time and can lead to complete blindness if not detected timely. A regular checkup of fundus is therefore recommended to observe and treat preventable vision impairments. This increases the economic burden on patient and overloads the available diagnostic facility. High patient ratio also increases the chances of human error due to improper image acquisition and undetected pathological structures by specialist.

Advancement in the field of Artificial Intelligence (AI) is supporting clinical diagnosis. Ophthalmologists are increasingly taking benefit from the AI based decision support system in their diagnosis. Incorporating technological solution has reduced the cost and time of patient and has significantly improved the accuracy in clinical diagnosis. Most of these AI based solutions have been developed using high quality expensive fundus camera. These solutions can therefore perform well on high quality image data and therefore remains successful in the developed countries. The training and testing of Artificial Intelligence based models is done using labelled datasets of certain diseases. This dataset plays vital role in both the development and testing

phase of an AI based project. In this R&D project, we propose a collaborative project for the development of digital fundus images dataset with professional's labelling according to the presence of various retinal impairments. Al-Ibrahim hospital has showed their consent for collaboration and has also issued ethical approval of research. This dataset will be published online for free to the researchers to support them in their research related to automated diagnosis of retinal related disorders. The publication of this dataset will give PCSIR as the first national institute in Pakistan publishing dataset for supporting AI based research.

Graphical Abstract:



Funding Source (PSDP/SGI/RD&I, etc):
In-House

Cost:

Tangible Outcome:
- To support the technological industry in the development of low cost solutions.
- Giving PCSIR recognition at international platform for supporting AI based research.

Achievements:
- Ethical approval of study from Al-Ibrahim Eye Hospital.
- Printing of Patient consent forms for participation in research.
- Enrolled 1100 patients in the study.
- Collected data of digital fundus images from hospital.
- Developed five FCPS doctors' team specialized in diagnosing diseases via Retinal Photograph.
- Received 5,000$ credit from Amazon Web Services to perform computational work. These credits were utilized in various tasks related to Computational powers including
  - ➢ Sharing Retinal images on Cloud.
  - ➢ Labeling of Fundus Images.
  - ➢ Utilizing latest preprocessing techniques to improve the image quality of Digital Fundus Photograph.
- Labeled 300 images by four doctors.

Status:
On-going

★ ★ ★ ★

Name of Laboratory/Centre/Unit:
Centre for the Development of Laboratory Equipment/PCSIR Laboratories Complex, Karachi

Title of Project: Design and Development of Micro Bacterial Incinerator(500-900°C)

Name & Designation of Project Leader:
Mr. Sohail Akhtar, SSO

Name & Designation of Project Associate(s):
Mr. Aqeel Ahmed Khan, SSO
Engr. Ghulam Mustafa, SE
Mr. Zain-ul-Abdin, EO
Dr. Abid Karim, SSO
Mr. M. Mazhar, EO

Area(s) of Research:
R&D Organizations Laboratories and Universities

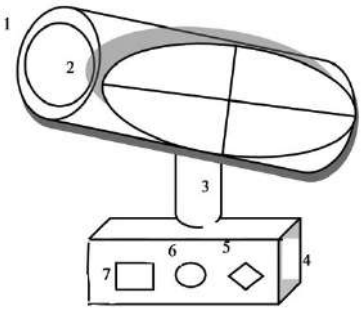
Duration:
02 Years

Date of Initiation:
2023

Project Brief:
Microbiological and clinical laboratories regularly strive through with infectious materials that needed sufficient disinfection, sterilization, and disposed off utensils against germs. The choice of sterilization method depends on the nature of the object or substance being sterilized, the desired level of sterility, and other factors such as material compatibility and cost-

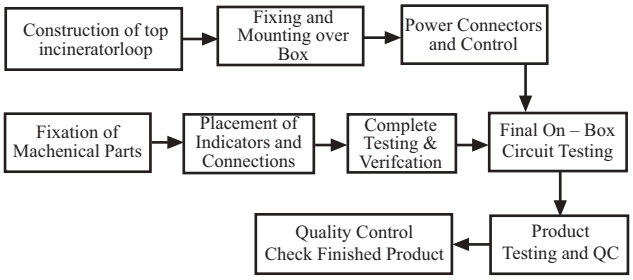
effectiveness. Heating under a Bunsen burner is the preferred method of sterilizing the metallic part of the inoculating loop and wire. But, an abrupt splatter while heating under the burner can create aerosols with viable organisms, contaminating the experimental and working region. By destroying bacteria, incinerators help to prevent food borne illness. A micro bacterial incinerator is a possible substitute for sterilizing the loops, wire and metals like a needle and lancet. A Micro bacterial incinerator is laboratory equipment that uses heat produced by infrared rays to sterilize inoculating loops and needles from waste materials generated during laboratory procedures. The micro incinerator is based on the incineration principle (destruction by burning), where heating metal objects and organic matter is performed in the absence of oxygen. The main objective of the project is the Development of Micro Bacterial Incinerator(500-900°C). A micro incinerator is designed to safely sterilize metal inoculating loops and needles without using an open flame. The infrared heat inside the ceramic tube protects the laboratory technicians from dangerous gases, flames and splatters. The infrared sterilizer reaches optimum sterilization temperature (900°C + 50°C), the loop or needle is sterilized within 20 seconds. Sample inlet diameter would be is Φ25 mm and the depth of the heated area is 160 mm. The quartz tube (internal part of the barrel) is heated by the infrared rays provided by the electric element in the barrel after connection to the electric source. The temperature inside the loop/barrel is upto 900ºC to incinerate the metal loop and needles. Since the loop/barrel is closed from all sides, the aerosols generated during sterilization stay enclosed and disposed off inside the barrel.

Graphical Abstract:



1. Loop./Barrel; 2. Inlet(Φ); 3. Stand; 4. Base and Control Box; 5. Power Switch; 6. Ready/Temperature; 7. Set/Display temperature

Work Plan:



- Designing for Nosal and Holding System.
- Procurement of spares and parts.
- Heating Element and glass apparatus assembling and manufacturing
- Mechanical fixture and art work
- Fixation of panel and parts

Funding Source (PSDP/SGI/RD&I/etc):
In-House

Cost:
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Tangible Outcome:
- To develop a low cost fully functional prototype model

Achievements:
- Procurement of spare parts.
- Designing & Assembly for Control Box
- Designing of Nosal System.
- Heating Element and apparatus assembling and manufacturing

Status:
On-going

★ ★ ★ ★

Name of Laboratory/Centre/Unit:
Centre for the Development of Laboratory Equipment/PCSIR Laboratories Complex, Karachi

Title of Project: Design and Development of Growth Chamber (Digital)(Temp Range: 0 to 50 °C) with Humidity control and Day/Night Timer

Name & Designation of Project Leader:
Mr. Sohail Akhtar, SSO

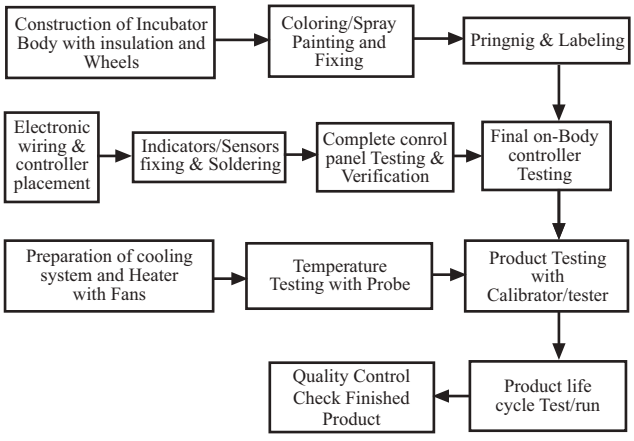
Name & Designation of Project Associate(s):
Mr. Aqeel Ahmed Khan, SSO
Mr. Zain-ul-Abdin, EO

Area(s) of Research:
R&D Organizations, Laboratories, Institutes and Universities.

Duration:
02 Years (01 Year Extended)

Project Brief:
The objective of this project is to develop commercial products from local indigenous resources for local market and fabricates laboratory equipment on engineering lab scale with price reduction and import substitution. The Plant Growth chambers are designed to produce environmental conditions (humidity and temperature) that maximize plant growth. Growth Chambers are routinely procured by educational institutes, R&D organizations, production Industries etc., from various manufacturers. To fulfil their needs (in buying costly imported equipment), the development of Growth Chamber has initiated. Growth Chambers are used in agriculture and botanical research applications like plant pathology, seed germination studies, plant research (photosynthesis /nutrition studies) and plant tissue culture studies. They provide real time environmental conditions favourable for Plants. The design of equipment works with cooling systems, humidity controller, temperature and timer for proper operation. The instrument will work 24/7 a cycle.

Graphical Abstract:



Funding Agency:
In –House

Cost:

Achievement:
- Procurement of spares and parts.
- Designing & Assembly of enclosure and Control
- Mechanical Structure and prototype Assembly
- Cooling and Heating System installation
- Functional prototype is under process

Status:
On-going

★ ★ ★ ★

Name of Laboratory/ Center/ Unit:
Center for Development of Laboratory Equipment/PCSIR Labs. Complex, Karachi

Title of Project: Exploring the effectiveness of Generative AI Models for Diabetic Patients

Name & Designation of Project Leader:
Engr. Ghulam Mustafa, SE

Name & Designation of Project Associates(s):
Dr. Shahla Basit, CSO
Mr. Sohail Akhtar, SSO
Mr. Zain-ul-Abedin, EO
Mr. Muhammad Shahid Ansari, JEO
Mr. Rehan Allaudin, TA

Area(s) of Research:
Artificial Intelligence, Diabetes Mellitus

Duration:
02 Years

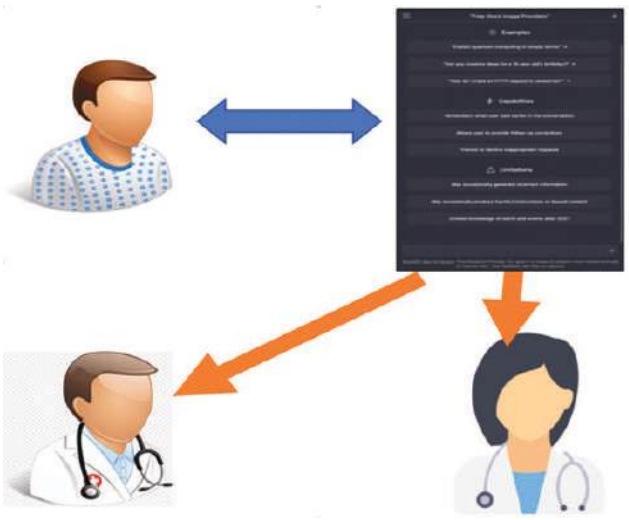
Date of Initiation:
2023

Project Brief:
Diabetes is rapidly spreading, affecting a significant number of adults, with a staggering total of 537 million diabetic individuals. This condition gives rise to various

complications that can lead to diabetic retinopathy, foot ulcers, cardiac problems, and kidney damage. However, many of these complications can be mitigated by providing patients with accurate information concerning their diet, stress management, and weight control. The recent advancements in Generative Artificial Intelligence-based chatbots have demonstrated their efficacy as intelligent assistants across various aspects of human life. In this study, we aim to assess the effectiveness of these Language Models in assisting patients. Our research plan entails the interaction between patients and chatbots like ChatGPT, both with and without human support, followed by evaluation of these interactions by specialists. Additionally, we will gather feedback from patients regarding their experiences and perceptions of the chatbot interactions. The main objectives are;

- To evaluate the efficacy of Generative AI-based chatbots in assisting diabetes patients.
- To assess patient-chatbots interaction.
- Gauge the accuracy, appropriateness, and effectiveness of information provided by chatbots.
- Collect patient feedback to understand experiences and perceptions of chatbot interactions.
- Determine the potential of AI chatbots to enhance patient education and support in diabetes management.

Graphical Abstract:



Tangible Outcomes:

- Publication of research article based on the evaluation of Patient-ChatGPT interaction.
- Development of mobile phone application based on tested models.
- Developing knowledge based method to cure Diabetic Patients

Funding Source (PSDP/SGI/RD&I/ect):

In-House

Cost:

Achievements:

- Project has been evaluated by National Institute of Health in United States and has got approval for conducting research. NIH Reference Number: NCT05883072. Website link: https://clinicaltrials.gov/ct2/show/record/NCT05883072
- Applied for ethical approval of our study at Aga Khan University Hospital.
- Evaluated the Large Language Model i.e., ChatGPT in various hospitals and healthcare centers. These hospitals includes
  - Al-Ibrahim Eye Hospital.
  - Fatimiyah Hospital.
  - OPD Clinic of PCSIR.
  - Diabetic patients camp.
- ChatGPT was successfully evaluated on 50 patients.

Status:

On-going

★ ★ ★ ★

Name of Laboratory/Center/Unit:

Engineering Services Center/PCSIR Laboratories Complex, Karachi

Title of Project: Method Development of Highly Potential Herbal Extracts for Various Herbal Formulations/ Screening of Herbs Extract for Pharmacological Activities

Name & Designation of Project Leader:

Dr. Nighat Sultana, CSO

Name & Designation of Project Associate(s):

Engr. Muhammad Ali Imran, SE
Mr. Umais Ihsan, EO
Mr. Tariq Bakshish, EO

Area(s) of Research:

Herbal Drug Development

Duration:

02 Years

Date of Initiation:

2023

Project Brief:

Many herbs have multiple therapeutic actions including adaptogenic, antimicrobial, anti-inflammatory, cardioprotective, and immunomodulatory effects etc. Plants contain multiple bioactive and phytochemical compounds which may be used carefully and to get maximum beneficial effects. Hence forth, we decided to develop herbal products by using indigenous resources for the cure and management of health conditions with less toxic or side effects. Herbal medicines contain multiple synergistic or antagonistic compounds and substances that are associated with attenuation of side-effects produced from therapeutic drugs. Scientists exploit traditional knowledge of indigenous plants to get some novel multipurpose remedies for relieving health conditions.

The aim of this project is to develop an effective and potent herbal product. Therefore, it is an effort to evaluate some locally available medicinal plants to develop cheap, effective and safe herbal formulation. Through this project the pharmaceutical active compounds and raw material will be developed. There are many potential herbal extract that are imported to our country but some important herbs that will be target for the urgent national need based program are *Alstonia scholaris*, *Ociumum tenuiflorum, Tribulus terrestris, Adhato davasica*, *Viola odorata*, garlic, mint, moringa, turmeric, lemon grass & alovera. etc. the objectives of the projects are;

- Production of potential herbal extracts for various herbal formulations
- Substitute for import
- Utilizing the indigenous resources
- To standardize the herbal extract to get reproducible and maximum effects
- To develop remedy for different pharmaceutical conditions like joint pain etc., with least side effects.
- To standardize the formulation to get reproducible and maximum effects.
- To develop easily available and economical remedy by using our indigenous resources.
- Through this project the standardization of pharmaceutical active compounds and raw material will be developed.

Work Plan:

- Extraction by chromatographic method
- Chromatographic analysis of the crude extracts
- Development of chromatographic or analytical method
- Microbiological analysis of herbal extracts/ compounds
- Screening of pharmacological activities

Funding Source (PSDP/SGI/RD&I/etc):

In-House

Cost:

Tangible Outcome:

- To save foreign exchange of the country as substitute of import products
- Utilization of indigenous herbs within the country thus promoting industrial growth of the country.
- It will improve the pharmaceutical business & in result increase the employment generation
- It will support the economy of Pakistan
- Project will be beneficial for local herbal pharmaceutical industries as the product develop with least side effects, economically bearable & easily approachable for a common man
- Trainings & consultancies will be provided to clients & academia.
- Process leased out to industry
- Publications

Achievements:

A process has been developed for the preparation of herbal tea bag, wherein the tea bag is prepared by using 7 herbs with their medicinal parts which act on CNS i.e Levander flowers, valeriana roots, cardamom seeds, borage flowers and rose petals. The herbal tea is in the form of infusion.

Status:

On-going

★ ★ ★ ★

Name of Laboratory/Center/Unit:
Engineering Services Center/PCSIR Labs Complex, Karachi

Title of Project: Designing and Fabrication of Salt Sprayer Test Chamber

Name and Designation of Project Leader:
Engr. Adeel Ahmed Khan, SE

Name and Designation of Project Associates:
Dr. Nighat Sultana, CSO
Engr. Aman Ullah Lakho, SE
Syed Kazim Raza, EO
Mr. Muhammad Kamran, SO
Mr. Tariq Mughal, Assistant

Areas of Research:
Metallurgical, Manufacturing, Automotive and Materials Engineering

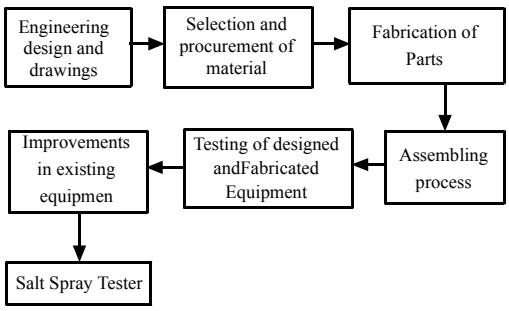
Duration:
02 Years

Date of Initiation:
2023

Project Brief:
Salt Spray Test chamber is equipment designed and developed for performing corrosion resistance tests on metallic parts. The test is performed by keeping the sample in salt sprayer chamber until white or red rust is produced by keeping the metal sample in foggy salt solution within the chamber. This test is used in automotive and manufacturing industry to ensure the quality of painted parts, nuts, bolts and fasteners for sustaining harsh environment and weather conditions.

The proposed research proposal covers the need of industry to conduct test for checking resistance of metallic parts. After developing the testing facility within our Lab, we will commercialize this product to the local market of manufacturing industry of sheet metal. The design of our equipment shall be able to conduct corrosion test according to the following methodology ISO 9227, ISO 9844 and ASTM B117.

Graphical Abstract:



Funding source (PSDP/SGI/RD&I/etc):
In-House

Cost:

Tangible Outcome:
- To develop a functional prototype of Salt Sprayer Chamber in order to conduct the corrosion resistance test according to ASTM B117, ISO 9227 and 9844 methods.
- To become capable of manufacturing locally designed and fabricated unit of the salt spray chamber within the country by using the locally available indigenous parts.
- This equipment after fabrication will provide a corrosion testing facility for automotive industry and other industrial MS & SS Products.

Achievements:
- Engineering Design & Drawing is ready
- Quotations of material to be purchased are received for fabrication.

Status:
On-going

★ ★ ★ ★

Name of Laboratory/ Centre/Unit:
Food and Marine Resources Research Center/ PCSIR Labs. Complex Karachi

Title of Project: Designing & Fabrication of Portable

Ultrasonic Humidifier for the Cultivation of Mushroom in Agri-Lab

Name & Designation of Project Leader:

Dr. Sofia Qaiser, SSO

Name & Designation of Project Associate(s):

Mr. Aqeel Ahmed Khan, SSO
Mr. Sohail Akhtar, SSO
Mr. Aijaz Ali Panhwar, SE
Mr. Mohammad Mazhar, TO

Areas of Research:

Designing and Fabrication of Equipment

Duration:

2½ Years (Extended for 06 Months)

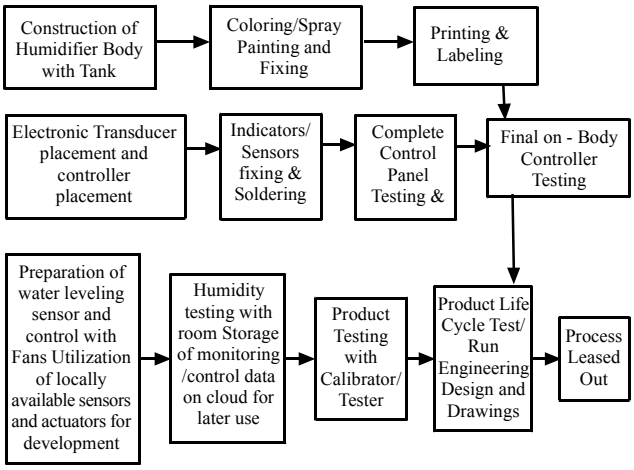
Date of Initiation:

2022

Project Brief:

Humidity control is the critical factor for the customized indoor agriculture, green houses, indoor environment and in cold storage of vegetables and fruits. One of the most important aspects of growing mushrooms indoors is providing the right fruiting environment. Unless managing adequate temperature, humidity and air exchange, mushroom will not produce any fruit. Providing adequate air exchange while maintaining high humidity is difficult to master, but there are several possible solutions of problem. The Ultrasonic humidifier can be placed in room/labs or inside the fruiting area. The amount of humidity that can be produced by the humidifier is determined by the number of discs the unit has in it.By means of practice, mushrooms can be easily grown indoors on many materials and in alignment with the seasonal and cyclical nature of plants growing. The designing and fabrication of a humidifier with the help of indigenous resources is focused in this project especially for edible mushroom for cottage industry and related sector/farms.

Graphical Abstract:



Funding Agency:

In-House

Cost

Tangible Outcome:

- Humidifier
- Patent

Achievement:

- Prepared Layout/ Design of humidifier
- Different methods of mist making were taken into consideration.
- Ultrasonic head complete
- Control and Casing will be procured for future assembling.

Ultrasonic Head is ready

Status:
On-going

★ ★ ★ ★

Name of the Laboratory/Center/Unit:
Food and Marine Resources Research Center/ PCSIR Labs. Complex Karachi

Title of the Project: Establishment of *Ganoderma lucidum* (Reishi) Farming Technology and Production of Pure Seeds as Product

Name and Designation of the Project Leader:
Dr. Sofia Qaisar, SSO

Name and Designation of the Project Associate(s):
Mrs. Anila Sidiqui, SSO

Area of Research:
Mycology, Biotechnology

Duration:
02 Years

Date of Initiation:
2023

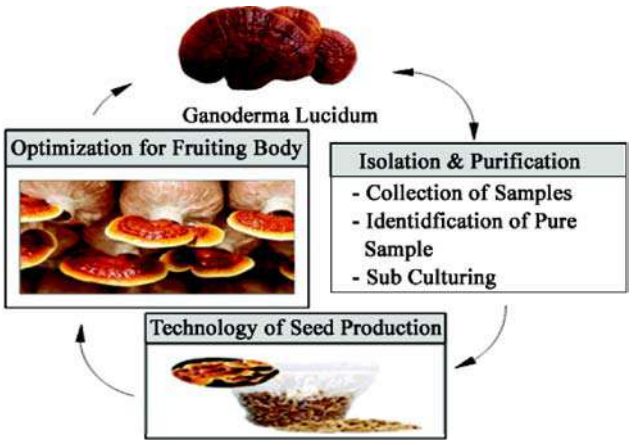
Project Brief:
Ganoderma lucidum (Reishi) is a medicinal mushroom; an ancient Chinese physician discovered the multiple properties of Reishi and it has been used for centuries to promote health, combat cancer, and reduce causes of cardiovascular disease and promote longevity, which earned Reishi the title, "Mushroom of Immortality". Indoor culture/farming of Reishi is an opportunity for cottage industry, especially for youth and woman to earn their livelihood, so agricultural land would not be burdened. Pakistan has also a big demand for mushrooms but continuous supply is still absent and this demand has been fulfilled through import from different countries. Reishi based imported products are also being marketed and sold in the country. Mushroom production is very limited due to unavailability of quality spawn material and unskilled labor. Mushrooms are expected to have fastest growth in global market**.** Asia Pacific is projected to hold highest market share in future. Pakistan also has plans for CPEC to increase business and Industry in the country, wherein, the mushrooms and medicinal mushrooms farming could contribute its part in current scenario. Herein, the cultivation of this medicinal miracle is the basis of this project. The main objectives of the project are;

- Establishment of Reishi mushroom cultivation/ farming module
- Production of pure seed

Work Plan:

- Reishi mushroom sample will be obtained through procurement and purified if needed.
- The spawn stage and growth stage will be optimized through mycological methodology. The spawn stage is also called seed of mushroom.
- Production of spawn / seed

Graphical Abstract:



Funding Agency (PSDP/SGI/RD&I) etc:
In-House

Cost:

Tangible Outcome:

- Technology development for ***Ganoderma lucidum*** farming in Pakistan.
- Customized training to interested parties for skilled

labor
- Model farming for entrepreneurs and especially empowering women earning through indoor culturing practice
- Production of seeds/ spawn

Achievements:
- Collection of medicinal mushroom species samples was accomplished.
- The samples subjected to purification methods.
- Three pure samples preserved in the form of stock slants.
- Reishi mushroom has been optimized to grow at lab scale.

Status:
On-going

★ ★ ★ ★

Name of Laboratory/ Centre /Unit:
Food and Marine Resources Research Center/ PCSIR Labs. Complex Karachi

Title of Project: Improving the Performance of Edible Food Packaging Films Using Nanocellulose as an Additive

Name & Designation of Project Leader:
Dr. Muhammad Asif Asghar, SSO

Name & Designation of Project Associate(s):
Dr. Farman Ahmed, PSO

Area(s) of Research:
Nanotechnology, Food Safety

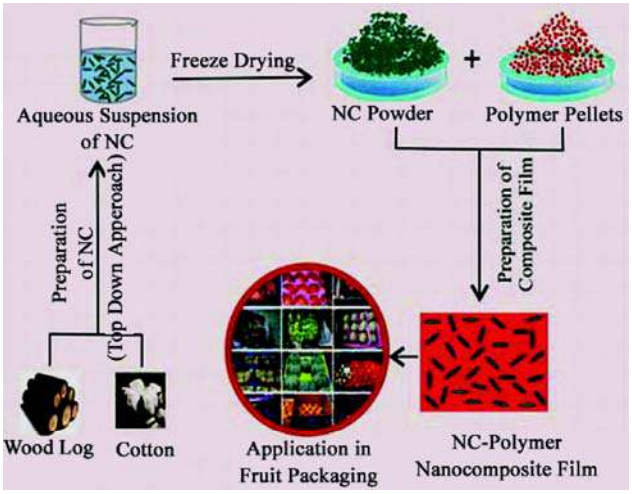
Duration:
02 Years

Date of Initiation:
2023

Project Brief:
The food industry is continuously demanding innovative and eco-friendly viable packaging materials with better physical, mechanical and barrier properties. The currently used materials are synthetic and non-degradable, therefore raising environmental concerns. Plastics are the most used packaging materials with improved properties. But, there is an increasing concern regarding the extensive use of petroleum-based plastics, which are used for a short period of time but then take long spans to degrade. Another emerging problem are the so called microplastics (< 5.0 mm) that are present in the air, water and soil, with harmful effects to both terrestrial and marine ecosystems. So, researchers are continuously working on the development of renewable and sustainable packaging materials. Bioactive packaging is gaining more and more attention not only due to its environment friendly nature but also due to its potential to improve food quality and safety during packaging. Some of the short comings of biopolymers, such as weak mechanical and barrier properties can be significantly enhanced by the use of nanomaterials such as crystalline nanocellulose (CNC). The use of CNC can also extend the food shelf life and improve the food quality as they can serve as carriers of some active substances, such as antioxidants and antimicrobials. Therefore, the proposed project is focused on the application of CNC in edible food packaging films. Due to abundance, renewability and degradability, physico-chemical and morphological properties of CNC shown outstanding potential to reinforce bio-based materials in food packing.
- Current food packages are composed of multiple and different petrochemical plastics which are difficult to recycle for individual components.
- Alarming plastic pollution as polymers do not degrade but break down to smaller pieces ending up in the air, soil and water as micro-plastics.

The main objectives of the projects are;
- Process developed for the production of biodegradable food packaging film using Nano Crystalline Cellulose.
- To reduce the environmental impact produced by the use of petroleum-based packaging materials.

Graphical Abstact:



Funding Source (PSDP/SGI/RD&I/etc):

In-House

Cost:

Tangible Outcome:

The key benefits of the project have both commercial and environmental features:

- The production of CNC based food packing film is cost-effective, simple, and easy to produce at large scale, environmental friendly, biocompatible and increase the sustainability, shelf life and improve the nutritional quality of food.
- The production of innovative food packaging that protects foodstuffs from moisture and heat while maintaining mechanical integrity.
- Reduce the overall environmental impact of the value chain through novel material selection (CNC), package designs, recycling methodologies and controlled product quality.
- Reduce levels of micro-plastic entering the environment, providing health benefits for general population and environmental health.
- Potential for increased compliance with environmental regulations (Plastic Packaging Tax).
- Under low humidity conditions, their voids is small in size and limited in diffusion, so it has low air permeability, which can further improve food quality and safety, with high efficiency and low cost.

Achievements:

- Cellulose has been extracted from the agricultural bio-waste materials.
- The extract cellulose has been converted into the nano-cellulose.
- The process for food packaging film is under progress using different materials.

Status:

On-going

★ ★ ★ ★

Name of Laboratory/ Centre/ Unit:

Pharmaceutical Research Center/ PCSIR Labs. Complex, Karachi

Title of Project: Soluble Fertilizer Formulations of Organo metallic Complexes for Foliar Feeding

Name & Designation of Project Leader:

Dr. Amir Ahmed, PSO

Name & Designation of Project Associate(s):

Dr. Kamran Ahmed Abro, SSO
Mr. Irshad Ahmed Khan, EO

Area(s) of Research:

Agrochemical

Duration:

03 Years (Extended for 1Year)

Date of Initiation:

2022

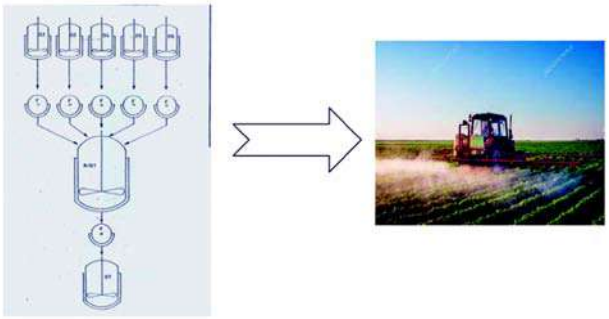
Project Brief:

Fertilizers are added to the soil or foliage of crops to supply elements needed for plant nutrition. Typically, Nitrogen (N), Phosphorus (P) and Potassium (K) are the principal components of such fertilizers, while

micronutrients replenishment has seldom done. Fertilizer formulations and methods are the subject of ongoing research, in order to improve the growth stimulating and stress tolerance effect on the plants. Additionally, there are on-going efforts to reduce the amount of fertilizer required for application to plants, to avoid leaching of nitrogen and phosphate into the ground water. Thus, there is a need for new fertilizer formulations and new methods of fertilizer application that supply nutrients in a readily available form and can be applied as a foliar product. The objectives are;

- The primary objective of this project is to produce locally develop low-cost foliar fertilizer.
- To reduce the dependence of imported high-cost fertilizer and save the foreign exchange

Graphical Abstact:



Funding Source (PSDP/SGI/RD&I/etc):
In-House

Cost:

Tangible Outcome:
New fertilizer formulations for application of nutrients in the agriculture fields which can be applied as a foliar product

Achievements:

- Process developed for Chelated Liquid Potash 22%
- 600 liters of Chelated Potash at the cost of Rs.600/- per liter is already Supplied to STEDEC ILD-Supply-2024-26860
  Total cost of Supply = Rs.360,000/-
- 400 Liter of Chelated Potash at the cost of Rs.600/- per liter is further supply to STEDEC in the coming month
  ILD-Supply-2024-28601
  Total cost of Supply = Rs.240,000/-

Status:
On-going

★ ★ ★ ★

Name of Lab/Centre/Unit:
Pharmaceutical Research Centre/ PCSIR Laboratories Complex, Karachi

Title of Project: Fungal Biosynthesis of Skin Lightening Agent: Kojic Acid and Evaluation of its Non-Cytotoxic Character Using Animal Tissue Culture Technique

Name & Designation of Project Leader:
Dr. Kauser Siddiqui, PSO

Name & Designation of Project Associates:
Dr. Saeeda Bano, PSO
Dr. Samina Iqbal, SSO
Dr. Kanwal Abbasi, SSO
Dr. Shagufta A Shaikh, SSO

Area of Research:
Biotechnology & Biochemistry

Duration:
02 Years

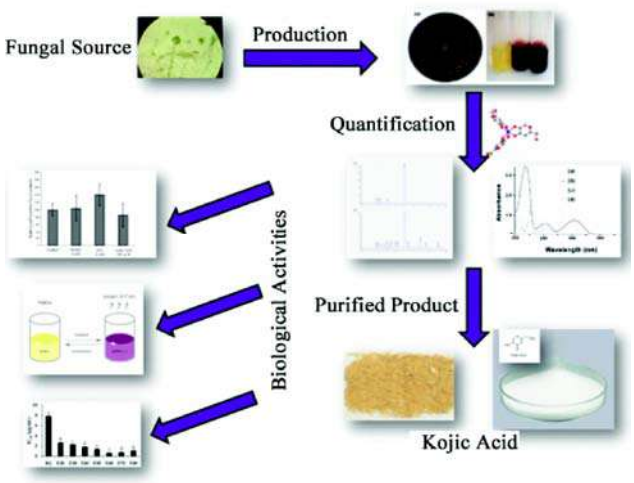
Date of Initiation:
2023

Project Brief:
Kojic acid is a natural skin lightening agent and UV protector. It inhibits the tyrosinase enzyme which is the main enzyme in melanin synthesis, a skin pigment produced by melanosome of melanocytes in skin. Kojic acid has many potential applications in cosmaceutical, pharmaceutical and food industry. Therefore, this skin lightening effect of kojic acid has made it important in cosmetics industry. Kojic acid and its derivatives

also has antioxidant and anti-microbial activity. It is also used in food preservation and colour stabilization in food industry. Kojic acid is an expensive chemical and mostly imported for industrial use. There is a dire need to produce it indigenously to get self-sufficiency. Fungal strains are used for KA production. Screening of fungal strains will provide insight of how to precede the project depending on the requirements of specified specie. Solvent alone or in combination will be used for extraction and quantification. Biological data collected will be addressed for its stability studies and final use in cosmetics or dermal care products. The objective of the project is;

- Process Development for production of Kojic Acid and its commercialization

Graphical Abstract:



Funding Source (PSDP/SGI/RD&I/etc):
In-House

Cost:

Tangible Outcome:

- Process for Kojic acid production
- Purified kojic acid

Achievements:

- *Aspergillus* strain was screened out and found to be most productive fungal strain for KA.
- Specie identified as *A. flavus*
- Fermentation conditions were optimized for locally identified specie for maximum yield
- Biochemical assays were performed to quantify the product KA
- Precipitation conditions were optimized for example, solvent system, ratio, temperature and time.

Status:
On-going

★ ★ ★ ★

Name of Laboratory/Centre/Unit:
Pharmaceutical Research Centre/PCSIR Laboratories Complex, Karachi

Title of Project: Production of Polyphenol Oxidase from Bluemold Specie for Potential Application in Bioremediation of Phenolic Compounds

Name & Designation of Project Leader:
Dr. Saeeda Bano, PSO

Name & Designation of Project Associates:
Dr. Kauser Siddiqui, PSO
Dr. Samina Iqbal, SSO
Dr. Shagufta Shaikh, SSO
Dr. Kanwal Abbasi, SSO

Area of Research:
Biotechnology & Biochemistry

Duration:
02 Years

Date of Initiation:
2023

Project Brief:
Polyphenol Oxidase (Laccase) is a copper containing phenol oxidase, which has broad specificity to hydrolyse many phenolic, non-phenolic groups, hydroxyl and aromatic amine. High quantity of laccase enzyme could be obtained from fungal origin. Laccase have been widely studied in degradation of xenobiotics, decolorization of dyes, depolymerisation of lignin,

pigment reduction, pulp and paper bleaching. Some fungal laccase degrade toxic fungal metabolites such as aflatoxin. Environmental effluents are a big threat to society. Bioremediation and detoxification of these effluents may be augmented with the treatment of green catalyst that is immobilized Enzyme Laccase. The enzyme polyphenol oxidase (PPO) catalyzes the oxidation of phenolic compounds into highly reactive quinines. Laccase treatment of phenolic compounds found in lignocellulosic hydrolysates is an alternative to reduce the growth inhibitory effect of these compounds on fermenting microorganisms. Laccases have shown to be efficient biocatalysts for the removal of recalcitrant pollutants from wastewater. Free laccases have poor reusability, high cost, low stability and sensitivity to different denaturing agents that may occur in wastewater. Therefore, immobilized laccase enzymes will be developed and tested for the removal of pollutants from wastewater. The main objectives are;

- To optimize process for maximum yield of laccase.
- Laccase immobilization and application for waste water treatment

Graphical Abstract:

Funding Source (PSDP/SGI/RD&I/etc):

In-House

Cost:

Tangible Outcome:

- Partially purified enzyme for bioremediation purpose

Achievements:

- Blue mould was borrowed from Karachi University Microbial culture bank
- Growth conditions were optimized for fermentation. Substrate selection and different reported media were also used to screen out the best for maximum yield of blue mould
- Laccase was extracted from fermented media
- Qualitative analysis of Laccase was carried out on agar plates

Status:

On-going

★ ★ ★ ★

Name of Lab/ Centre/ Unit:

Pharmaceutical Research Centre/PCSIR Laboratories complex, Karachi

Title of Project: Investigation of Corrosion in Biocompatible Metals for Implants of Medical Devices Using Modern Techniques

Name & Designation of Project Leader:

Mr. Muhammad Saleem Qazi, PSO

Name & Designation of Project Associate(s):

Mr. Mahmood-ul-Hassan, PSO

Area(s) of Research:

Natural Products and Microbial Transformation

Duration:

02 Years (Extended for 01 Year)

Date of Initiation:

2023

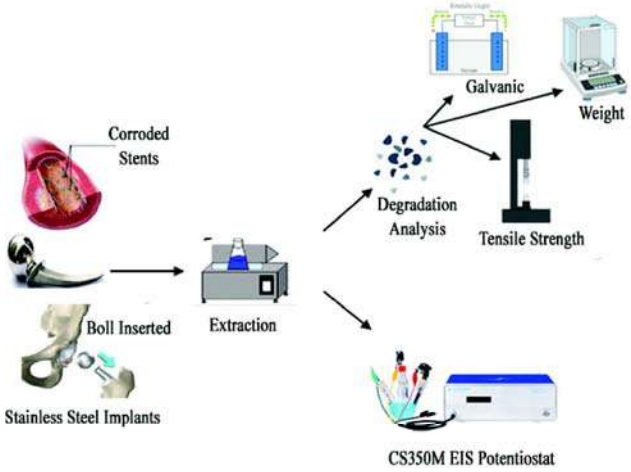
Project Brief:

Chemical stability, mechanical behaviour and biocompatibility in body fluids and tissues are the basic requirements for successful application of implant materials in bone fractures and replacements.

Corrosion is one of the major processes affecting the life and service of orthopedic devices made of metals and alloys used as implants in the body. Among

the metals and alloys known, stainless steels (SS), Co–Cr alloys and titanium and its alloys are most widely used for making of bio-devices for extended life of human body. Incidences of failure of stainless-steel implant devices reveal the occurrence of significant localized corroding viz., pitting and crevice corrosion. Corrosion prevention in biomaterials has become crucial particularly to overcome inflammation and allergic reactions caused by the biomaterials' implants on the human body. In addition to the hostile environment and a significant load encountered by the implant, the interaction between the material and the tissues is of prime importance. Such interactions induce corrosion/ionization of the implanted device. Corrosion can have two effects. First the implant may weaken and the premature failure will result. The second effect is the tissue reaction leading to the release of corrosion products from the implant.

Graphical Abstract:



Funding Source (PSDP/SGI/RD&I/etc):
In-House

Cost:
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Tangible Outcome:
- To enhance the quality and export of medical devices
- Development of analytical techniques to comply with ISO 10993-15 ASTM G71-81 and ASTM F2129-01

Achievements:
- Development of kit for quick detection of stainless-steel grade 316

Status:
On-going

★ ★ ★ ★

Name of Laboratory / Center/Unit:
Pharmaceutical Research Center /PCSIR Laboratories Complex, Karachi

Title of Project: Evaluation of Hepatoprotective Effect of Medicinal Plants (*Moringa olifera* & *Glycyrrhiza glabra*) in Animal Model

Name and Designation of Project Leader:
Dr. Tehmina Sohail, SSO

Name and Designation of Project Associates:
Dr. Hina Imran, SMO
Dr. Shazia Yasmeen, PSO
Dr. Rashid Ali Khan, PSO

Area(s) of Research:
Herbaceuticals

Duration:
02 Years

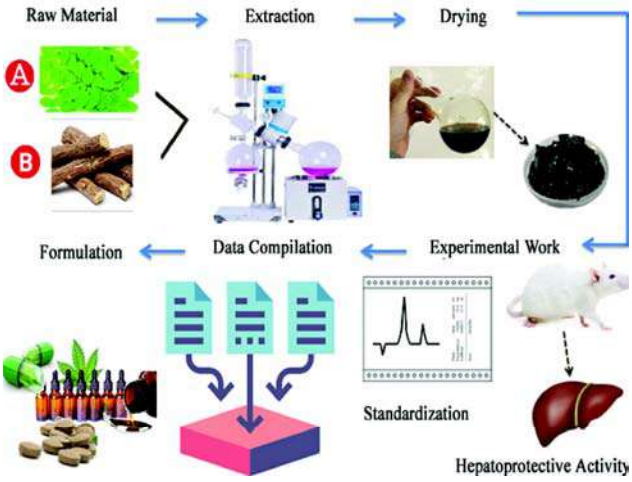
Date of Initiation:
2023

Project Brief:
The liver is a vital organ involved in various critical biochemical and physiological processes, including metabolism, detoxification of endogenous and exogenous compounds, homeostasis, growth, energy and nutrient supply. Hepatic injury, caused by hepatotoxic agents such as drugs, alcohol, and viral infections, is a significant concern worldwide. Medicinal herbs have been used for centuries in traditional medicine systems to treat liver diseases such as hepatitis, cirrhosis, and loss of appetite. The active compounds

present in these herbs are believed to exert beneficial effects on the liver by reducing inflammation, promoting liver cell regeneration, enhancing detoxification processes and improving overall liver function. Over 160 phytochemical constituents derived from 101 plants have been reported to possess potential hepatoprotective properties. These phytochemicals are natural compounds found in plants and have shown promise in protecting the liver from damage and promoting its regeneration. *Moringa olifera* & *Glycyrrhiza glabra* are selected on the basis of their medicinal properties along with their availability in local market so the end product will be cost effective and easily available. The main objectives are;

- To investigate the synergistic hepatoprotective effect of herbal formulation
- To develop a new hapatoprotective formulation with more efficacy and safety

Graphical Abstract:



Funding Agency:

In-House

Cost:

Tangible Outcome

- To formulate a cost-effective herbal medicine.
- Formulation with superior safety and efficacy with fewer side effects.
- Product from locally available raw material will discourage the import substitution and will boost up the economy.
- Being the indigenous product, it will be easily approachable to end user

Achievements

- Plant extract preparation and acute oral toxicity studies in albino mice is completed.

Status:

On-going

★ ★ ★ ★

PCSIR Laboratories Complex, Lahore

(New Projects)

Name of Laboratory/Centre/Unit:

Bioresource Utilization Laboratory, Food & Biotechnology Research Center, PCSIR Laboratories Complex Lahore

Title of Project: High- Performance Bating Agents for Soft, Flexible and Firm Hides as an Import Substitute

Name & Designation of Project Leader:

Dr. Shabana Kauser, SSO

Name & Designation of Project Associate(s):

Dr. Asma Saeed, CSO
Dr. Asma Sheikh, SSO
Engr. Muhammad Azam, JE

Area(s) of Research:

Bating of Hides/Leather Production/ Formulations/ Compositions as Bating Agents.

Duration:

1½ Years

Date of Initiation:

2024

Project Brief:

Pakistan is considered to be the hub of producing high quality leather and leather products, and there are about 800 tanneries in the country actively engaged in producing best quality finished leather of cow, buffalo, sheep and goat skins. Pakistan is rich in agricultural products and has a large livestock population which plays an important role in the economy of Pakistan by producing around 13.0 Million Hides and 47.4 Million Skins per annum (2022-23). Hides, which are the raw skins of animals such as cattle, sheep, and goats, undergo a series of processes to transform into leather. The production process consists of approximately 23 stages including preparation of hides, soaking, liming, fleshing, bating, tanning, dying and fat liquoring, and finally the finishing. The leather produced from hides is valued for its durability, natural beauty, and versatility, making it a popular choice for a wide range of applications. Although all the stages are important for the production of good quality leather from hides, however, bating is a crucial step in the leather tanning process that contributes to the overall success of leather production improving the quality of the leather and ensuring consistency in the final product. Bating involves the use of enzymes and bating agents that facilitate the breakdown of non-collagenous proteins, fats, and other unwanted substances present in the hides, leading to cleaner, softer, and more receptive hides for subsequent tanning processes. Proteolytic enzymes such as proteases and peptidases are commonly used in bating to break down proteins and fats present in the hides. Proteolytic enzymes in combinations with other materials like surfactants, chelating and buffering agents, and some synergistic additives can be used to make different bating compositions to ensure optimal conditions for the bating process and prevent fluctuations that could affect enzyme performance. Our Leather is higher in prices at "International market of Leather" than rest specially neighboring competing countries, which is around 15 – 20%. Moreover, Pakistan's leather industry relies on imports of various chemicals including bating agents to support its leather processing operations, with suppliers sourced from international markets such as the United States, European countries, and China based on factors such as cost, availability, and quality. The only way to be compatible is to bring leather products at par with international leather products in terms of quality and price. Pakistan's leather sector should have grown and generated significant foreign exchange earnings for the country.

The present project is designed to prepare bating formulation which are comparable to imported bating agents in performance but are cheaper as well. Therefore, ultimately decreasing the overall cost of good quality leather production. These bating formulations are potential import substitute contributing to the foreign exchange earnings for the country. The main objectives of the proposed project include:

- Preparation of different bating formulations as per requirement of the bating process
- To optimize all the conditions like pH, temperature, storage for the best performance of the bating agents

- To improve the shelf life of bating formulations with optimum activity retained.
- To prepare cost-effective bating formulations that can serve as import substitute.

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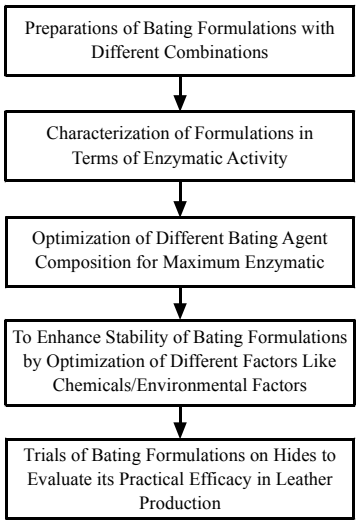

Timeline (Quarter Wise Plan):

First Year	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
	Procurement of raw materials	Activity assay of proteolytic enzymes from different sources	Preparation of different bating formulatio	To study the effect of different agents (surfactants, chelating agents, buffers) on the performance of proteolytic enzyme.
Second Year	• Optimization of environ-mental factors to enhance stability of bating compositions • Shelf life studies of most optimized bating formulations.	Practical trials of optimized bating formulation on the hides during the leather production process.		

Funding Source (PSDP/SGI/RD&I/etc):
In-House

Cost:

Tangible Outcome:
- An import substitute has been proposed through this project keeping in mind the low cost, environment friendly technology for preparing bating agents for production of leather that will save forging exchange.
- Use of locally available raw material is cost effective and will be helpful to develop cheaper product.
- The bating formulations will be highly beneficial for leather industry in terms of production cost of leather.
- The product has a high potential to be commercialized.
- Patent/report

Achievements:
New Project

★ ★ ★ ★

Name of Laboratory/ Centre/ Unit:
Bioresource Utilization Laboratory, Food & Biotechnology Research Center, PCSIR Laboratories Complex Lahore

Title of Project: Preparation of Different Ready-to-use Shilajit Drinks Enriched with Bioavailable Minerals and Antioxidants

Name & Designation of Project Leader:
Dr. Shabana Kauser, SSO

Name & Designation of Project Associate(s):
Dr. Asma Saeed, CSO
Dr. Asma Sheikh, SSO
Eng. Muhammad Azam, JE

Area(s) of Research:
Food Sciences & Pharmaceutical Industry

Duration:
02 Years

Date of Initiation:

2024

Project Brief:

Shilajit, is a complex natural biologically active resinous substance found mainly in Himalayan regions. It is formed over centuries through the decomposition of plant matter under high pressure and temperature conditions. It is rich amalgamation of organic compounds (60-80%), minerals (20-40%) and trace elements (5 %) making it veritable treasure for human wellness. It is often marketed and used in traditional medicine systems like Ayurveda, however, there is ongoing debate about its precise composition and medicinal properties. It contains a complex mixture of organic and inorganic compounds, approximately 80 bio-active components including fatty acids, benzoic acid, resin and waxy materials, albuminoids, gums, humic acids and fulvic acid, amino acids, phenolic lipids, minerals like silica, iron, antimony, lithium, manganese, calcium, copper, molybdenum, phosphorus, sodium, zinc, selenium and small amounts of dibenzo-α-pyrones. Mineral malnutrition, also known as micronutrient deficiency or hidden hunger, occurs when an individual's diet lacks essential minerals required for proper bodily functions. Micronutrients, such as iron, zinc, calcium, and various vitamins, play crucial roles in metabolism, immune function, growth, and overall health. Mineral malnutrition can have severe health consequences, including stunted growth, impaired cognitive development, weakened immune function, anemia, and increased susceptibility to infections and chronic diseases. The minerals in shilajit play vital roles in metabolism, enzyme function, bone health, immune function, and overall well-being. However, the concentration of these minerals in shilajit can vary, so initial determination of minerals is a prerequisite for its utilization.

The main objectives are:

- Utilization of shilajit as a source of minerals and antioxidants
- Preparation of different minerals enriched ready-to-use drinks to meet the RDI of minerals
- To study the shelf life of minerals enriched ready-to-use drinks.
- To study the bioavailability of minerals in shilajit enriched ready-to-use drinks.
- To optimize the quantity of shilajit in the drinks
- To maintain taste acceptance of developed products along with fulfillment of required minerals quantity.
- To conduct the toxicological studies of the shilajit enriched drinks

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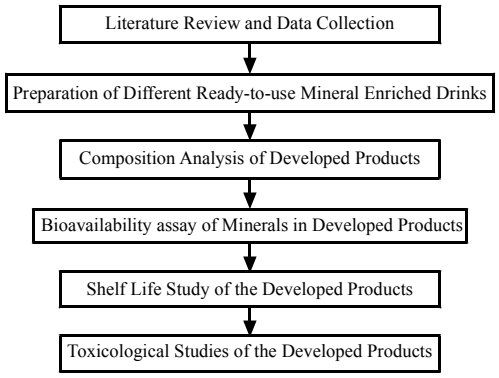

Timeline (Quarter Wise Plan):

First Year	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
	Procurement of raw material	Composition Analysis of raw material	Preparation of Different ready-to-use enriched Products enriched with salajeet	Composition Analysis of products
Second Year	Bioavailability assay of minerals in developed products	Shelf Life Study of the products	Report submission	

Funding Source (PSDP/SGI/RD&I/etc):

In-House

Cost:

Tangible Outcome:

Important outcomes of the project include:

- Preparation of ready-to-use drinks enriched with minerals using salajeet
- Product development to overcome the mineral malnutrition.
- To develop a cost- effective, technically feasible, and efficient technology.
- The products developed have high potential to be commercialized.

- To replace the imported fortified products/ supplements.
- Patent

Achievements:

New Project

★ ★ ★ ★

Name of Laboratory/Centre/Unit:

Food Additives & Contaminants Laboratory, Food & Biotechnology Research Centre, PCSIR Laboratories Complex, Lahore

Title of Project: Efficacy Study of Bio-preservatives in Extending Shelf Life of Spices

Name & Designation of Project Leader:

Dr. Naseem Zahra, SO

Name & Designation of Project Associate (s):

Dr. Syed Hussain Imam Abidi (Chairman PCSIR)
Dr. Qurat-ul-Ain Syed, CSO
Dr. Asma Saeed, CSO
Dr. Muhammad Khalid Saeed, PSO

Area(s) of Research:

Food and Environment

Duration:

01 Year

Date of Initiation:

2024

Project Brief:

Spices play an important role in daily meal to improve the flavor, color and appearance of food. Good quality spices will stay fresh for longer if stored properly. Moisture, light, heat is the enemies which may reduce the quality, color and essential oil contents of spices. Spices preservation usually involves preventing the growth of bacteria, fungi (such as aflatoxins), or any other micro-organisms, as well as retarding the oxidation of fats that cause rancidity thereby ensuring the spices safety. In modern years, a wide variety of packages and approaches have been employed to interact with food and provide desirable effects. Researchers have reported that artificial preservatives such as nitrates, benzoates, sulfites, sorbates, parabens, formaldehyde, BHT, BHA and several others can cause serious health hazards such as hypersensitivity, allergy, asthma, hyperactivity, neurological damage and cancer. There are so many methods to extend shelf life of spices but the safest is the use of bio-preservatives (Mustard oil, sugar, salt, vinegar, clove, cinnamon powder, turmeric, olive oil, ginger and garlic paste, flavonoids, rosemary, neem etc). Bio-preservatives may play an important role in extending shelf life of spices. The purpose of this demand driven project is to replace most commonly used artificial preservatives like benzoic acid, ascorbic acid, sodium benzoate, sodium metabisulphite and ethylene oxide (classified as a Group 1 carcinogen by the International Agency for Research on Cancer (IARC) etc. Storage of spices is the main issue which spice industry is facing these days. Numerous physical, chemical and biological changes in spices may spoil spice quality if not properly stored. The biopreservatives may provide protective veneer or barricade during processing, storage and handling. These may not only retards deterioration of spices, but may also enhance its quality. Appropriate packaging can slow the worsening rate and also may extend spices shelf life. The main obectives are;

- To study shelf life study of different spices
- To enhance shelf stability of various spices with bio-preservatives/packaging techniques including drying, freezing and vacuum

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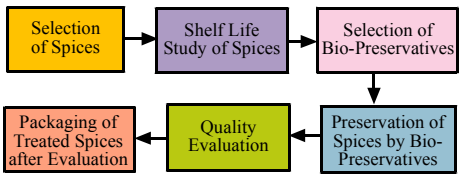


Timeline (Quarter Wise Plan):

1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Collection & selection of different spices	• Selection of bio-preservatives • Preservation of spices by bio-preservatives	• Shelf life study of spices • Quality evaluation of spices	• Packaging of spices after treatment • Report submission, patent and paper writing, etc

Funding Source (PSDP/SGI/RD&I etc):
In-House

Cost:

Tangible outcome:
- Preservation of different spices by undisruptive bio-preservatives after their shelf stability studies
- These treated spices will have a long shelf life under normal storage conditions with nutritional and microbial safety, convenient and easy handling, ready to use, reduced transport costs and large export potential, and local market potential
- Dissemination of study regarding spices shelf stability and safety by utilizing different bio-preservation techniques and processes for various spice industries through reports, patent, process commercialization and papers

Achievements:
New Project

★ ★ ★ ★

Name of Laboratory/ Centre/ Unit:
Toxicology and Plant Sciences Lab, Food & Biotechnology Research Center, PCSIR Laboratories Complex Lahore

Title of Project: Green Technology for Strategic Modification of Desert Land And Sustainable Agriculture

Name & Designation of Project Leader:
Ms. Shamma Firdous, PSO

Name & Designation of Project Associate(s):
Dr. Muafia Shafiq, SSO
Dr. Sajila Hina, SO
Dr. Asma Saeed, CSO

Area(s) of Research:
Agriculture

Duration:
03 Years

Date of Initiation:
2024

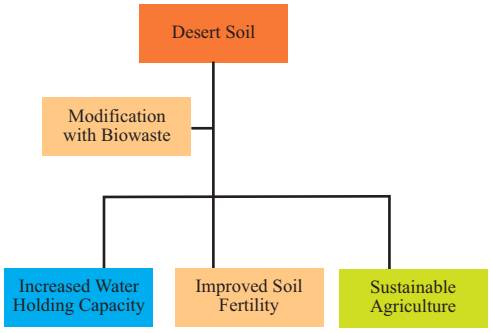
Project Brief:
Cultivating crops in desert regions poses several significant challenges due to the harsh environmental conditions and limited availability of resources. Some of the primary problems in cultivation in desert areas include water scarcity, high evaporation rates, salinity and soil quality, extreme temperatures, wind erosion, limited access to resources, pest and disease pressure, droughts, energy costs, sustainability concerns, adaptation to desert crops. To address these problems, innovative technologies and sustainable practices of soil modification will be helpful in making soil fertile and improving water holding capacity. However, with increasing water scarcity and changing climate patterns, there is a pressing need to enhance the water holding capacity of soil to support sustainable agriculture. Soil water holding capacity refers to the ability of soil to retain moisture for plant use. It is influenced by several factors, including soil texture, organic matter content, structure, and management practices. Improving soil water holding capacity is essential for mitigating the impact of droughts, optimizing irrigation, and reducing water wastage. This research proposal aims to investigate methods to modify desert soil, making it more suitable for agriculture by enhancing water-holding capacity and fertility. The arid and semi-arid regions of the world present significant challenges for agriculture due to their harsh environmental conditions, including high temperatures, low rainfall, and poor soil quality. Furthermore, the expansion of desert areas due to climate change exacerbates these challenges, posing a threat to ecosystems and human livelihoods. To address these issues, there is a critical need for innovative green technologies that can strategically modify desert land to make it suitable for sustainable agriculture while minimizing environmental impacts. The project aims to develop and implement environmentally friendly solutions to transform barren desert landscapes into productive agricultural zones. This project seeks to explore various technologies, including but not limited to:

i. Increasing water holding capacity of the soil
ii. Soil improvement by bio-waste utilization to enhance soil fertility and structure
iii. Research, select, and develop appropriate green technologies tailored to the specific needs and challenges of desert agriculture.
iv. Development of model desert regions to test the feasibility and effectiveness of green technology interventions. Monitor and evaluate key performance indicators such as crop yields, water usage efficiency and soil health.
v. Based on the results of model desert region projects, develop strategies for scaling up successful interventions to larger areas and replicating them in other desert regions. Identify barriers to scalability and develop mitigation strategies to ensure widespread adoption of green technologies.
vi. Transfer of technology

The main objectives of the project are;

- To assess the current soil conditions and quality in a specific desert region.
- To develop and test soil modification techniques to enhance water-holding capacity and fertility.
- To utilize waste biomass for soil amendment and enhancement of water holding capacity and soil fertility
- To establish sustainable agricultural practices in arid regions and to enhance food security and livelihoods.
- To evaluate the overall feasibility and sustainability of desert agriculture after implementing these modifications.

Graphical Abstract:



Funding Source (PSDP/SGI/RD&I/etc.):

In-House

Timeline (Quarter Wise Plan):

First Year	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
	• Acquisition of chemicals and other raw material and agriculture waste for onward use.	• Soil samples will be collected from the target desert region, and various parameters • such as pH, organic matter content, nutrient levels, and texture will be analyzed	• Different soil amendment techniques will be tested, including the incorporation of organic matter (compost, crop residues), the addition of minerals (vermiculite, perlite), and soil structure improvement.	• The effects of these amendments on water-holding capacity, nutrient retention, and microbial activity will be monitored
Second Year	• Pot experiments to evaluate the effect of modification on the soil fertility	• Depending on the pot experiment field experiment will be designed and executed.	• Development of model field	• Compilation of results
Third Year	• Data Analysis	Technology transfer	Report Submission	

Cost:

Tangible Outcome:

i. Product
ii. Technology
iii. Paper/Patent

Achievements:

New Project

★ ★ ★ ★

Name of Laboratory/Centre/Unit:

ACRC -LLC

Title of Project: Development of Process for the Production of Phthalate Free Plasticizer for PVC-Based Products (ATBC)

Name & Designation of Project Leader:
Dr. Zafar Iqbal, SSO

Name & Designation of Project Associate(s):
M. Usman Sabri, SSO

Area(s) of Research:
Organic Synthesis/ Plasticizers

Duration:
01 Year

Date of Initiation:
2024

Project Brief:

Acetyl tributyl citrate (ATBC) is an organic compound that is used as a plasticizer. Plasticizers are chemicals which are added into polymeric materials to increase their flexibility and workability. It is a non-toxic, odorless and safe plasticizer with excellent heat resistance, cold resistance, light resistance and water resistance. It is suitable for food packaging, children's toys, medical products etc. ATBC is a biodegradable, colorless organic solvent which is used as plasticizer and is potential replacement of non-biodegradable plasticizers like DEHP, DINP etc. Further phthalate-based plasticizers are banned by REACH standard in Europe due to potential hazardous impacts on human life and environment, while TBC is widely accepted for application in Pharmaceutical, cosmetic and other industrial products. Currently, it is being imported from various sources for various applications, after successful completion of this project, we may be able to lease out process to the local industry for catering our needs. ATBC will be synthesized by the acetylation of tributyl citrate (TBC) while TBC will be synthesized by esterification of citric acid and butanol. The process for the preparation of TBS and ATBC will be optimized and efforts will be made to lease out to the local industry for catering our need. These plasticizers are eco-friendly as are being biodegradable and fulfill the European standards. The main objective is;

- ATBC, a biodegradable and phthalate free plasticizer will be synthesized and process will be leased out to industry for strengthening of our local economy.

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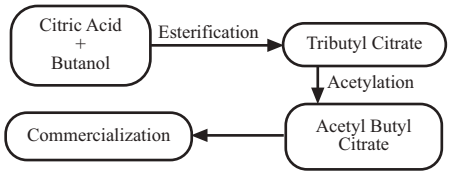


Time Line (Quarter Wise Plan):

1st Quarter	Designing of process and procurement of raw materials i.e. Citric acid, butanol, acetic acid and catalyst
2nd Quarter	Experimental trials for the preparation of tributyl citrate from citric acid and butanol in the presence of catalyst
3rd Quarter	Experimental trials for the preparation of acetyl tributyl citrate from tributyl citrate in the presence of catalyst
4th Quarter	Product evaluation by advance analytical techniques and efforts for its commercialization/process lease out

Funding Source:
In-House

Cost:

Tangible Outcome:

ATBC synthesis process will be leased to the industries which are using phthalate free plasticizer like PVC coating, Inks manufacturer, Cosmetic and food industries.

Achievements:
New Project

★ ★ ★ ★

Name of Laboratory/Centre/Unit:
ACRC -LLC

Title of Project: Development of Sunblock Formulation with Different Sun Protection Factors

Name &Designation of Project Leader:
Dr. Saima Siddique, SSO

Name &Designation of Project (Associate(s):
Dr. Zahida Parveen, PSO

Area(s) of Research:
Applied Chemistry

Duration:
01 Year

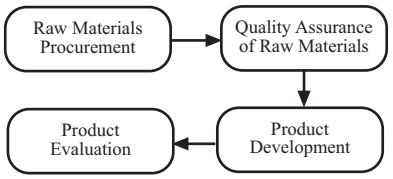
Date of Initiation:
2024

Project Brief:

Our skin is susceptible to the sun's rays which can lead to skin cancer, discoloration and wrinkles over the time. Around one million people are diagnosed with skin cancer every year out of which about 10,000 people die from malignant cancer. These harmful effects of solar radiation are caused by predominantly UV region of the electromagnetic spectrum which may be divided in to three sub regions: UVA (320-400nm; UVB (290-320nm; UVC (200-290nm). Among these sub regions, UVB is not completely filtered by ozone layer and causes sun burns, while UVA reaches deeper layers of epidermis & dermis which provokes premature aging and skin cancer. Pakistan has extreme weather with long and hot Summers. People are more exposed to harmful UV radiations and need more protection form sunrays. Various types of sunblock formulations are available in the market out of which the imported ones are costly while the local ones are not much effective. The revenue in the Sun protection market in Pakistan amounted to US$48.80 million for the year 2024 and is expected to grow by 5.72 % per year (2024-2028). The scope of the present project is to develop Sunblock Creams and Lotions to facilitate local industry in response to the rapidly growing demand of sunblock. The objectives of the project are as under;

- To develop an effective sunblock with Sun protection factor (SPF) 50-100.
- To develop a sunblock with combination of physical and chemical filters.
- To evaluate the efficacy of developed product.
- Collection of various physical filters and determination of their particle sizes.
- Collection of chemical filters.
- Development of sun blocks using a combination of filters.
- Determination of SPF of developed product.

Gracphical Abstract:



Funding Source (PSDP/SGI/RD&I/etc):
In-House

Cost:

Time Line (Quarter Wise Plan):

1st Quarter	Literature Survey and Collection of raw material
2nd Quarter	Product development by using chemical filters, mineral filters, & by combination of chemical and mineral filters
3rd Quarter	Product evaluation by UV-Visible Spectro-photometry & Atomic Absorption Spectroscopy
4th Quarter	Product evaluation by application to volunteers and leasing out

Tangible Outcome:

- Strengthening of local industry
- Low-cost good quality product to customer.
- Import substitution

Achievements:
New Project

★ ★ ★ ★

Name of Laboratory / Centre /Unit:
ACRC -LLC

Title of Project: Desulfurization, Deodorization and Decolonization of Kerosene Oil

Name & Designation of Project Leader:
Mrs. Mubeen Akhter, SSO

Name & Designation of Project Associate(s):
Mr. Muhammad Usman Sabri, SSO

Area(s) of Research:
Oil & Gas, Petrochemicals, Automotive

Duration:
01 Year

Date of Initiation:
2024

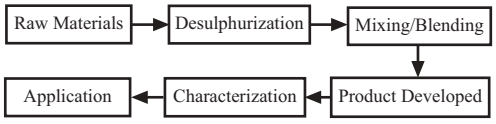
Project Brief:

Kerosene is a flammable liquid and used in many industries and homes around the world as a fuel, light and power. It is typically pale, yellow or colorless. Kerosene is a petroleum distillate and combustible hydrocarbon liquid. It is widely used as a fuel in aviation as well as household. It is also used as a solvent for greases and insecticides. Kerosene is extracted from crude oil first and then diesel as kerosene has a lower boiling point than diesel.

Desulphurization is essential step to reduce the sulphur content in fuel because sulphur is oxidized during combustion and can damage engine and exhaust. When sulphur is released in air, it can cause acid rain and harmful for human. Desulphurization of kerosene reduces the sulphur content to 10 ppm or less. The oxidized sulphur compounds after treatment exhibits high solubility in water. It is more cost effective than traditional hydrodesulphurization. Objective of the project is:

- The primary objective of project is to desulphurize kerosene oil by using Adsorptive desulphurization (ADS) method which utilize solid materials as adsorbents to selectively adsorb sulfur from fuel. The purpose of removing the sulphur is to reduce the sulphur dioxide.

Graphical Abstract:



Time Line (Quarter Wise Plan)

1st Quarter	• Designing of process • Procurement of raw material.
2nd Quarter	• Treatment of material by using different chemicals. • Washing, Distillation/separation of deodorized product.
3rd Quarter	Analysis of product will be carried out according to standard methods.
4th Quarter	Product evaluation by GCMS and process lease out.

Funding Source (PSDP/SGI/RD&I etc.):
In-House

Cost:

Tangible Outcome:

- Strengthening of local industry
- Low-cost quality product availability to consumer
- Use of local raw material.

Achievements:
New Project

★ ★ ★ ★

Name of Laboratory/ Centre/ Unit:
ACRC -LLC

Title of Project: Synthesis of 2-Ethoxyethanol Acetate, a Versatile Solvent

Name & Designation of Project Leader:
Dr. Zafar Iqbal, SSO

Name & Designation of Project Associate(s):
Mr. Muhammad Usman Sabri, SSO
Ms. Mubeen Akhtar, SSO

Area(s) of Research:
Solvent for NC Lacquer, Paints, Inks and Varnishes

Duration:
01Year

Date of Initiation:
2024

Project Brief:

2-Ethoxyethanol acetate is a clear, colourless, and volatile liquid and has a mild sweet odour. It is used in automobile lacquers to retard evaporation and impart high gloss. It is used as a solvent for oils, resins, and nitrocellulose. It retards 'blushing' in lacquers and varnish removers. It is used in wood stains, leather and cosmetic ingredients. It is also used in the semiconductor industry.

2-ethoxyethanol acetate is being imported in Pakistan from various sources. Efforts will be made to synthesize it in lab and specifications will be meet as compared to the imported product. After successful completion of this project, import of this product may be reduced by the help of local industry. 2-ethoxyethanol acetate will be synthesized by the acetylation of 2-ethoxyethanol in the presence of catalyst. Then its purification will be carried out by neutralization and followed by removal of water and unreacted solvent.

The main objective is to produce 2-ethoxyethanol acetate from the acetylation of 2-ethoxyethanol in the presence of a catalyst. Second objective is to reduce import of this product by leasing out this process/ technology to the local industry.

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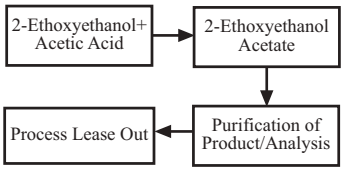


Funding Source (PSDP/SGI/RD&I/etc):

In-House

Cost:

Tangible Outcome:

NC lacquer, paints, Inks and varnishes manufacturer

Achievements:

New Project

★ ★ ★ ★

Name of Lab/Centre /Unit:

ACRC -LLC

Title of Project: Edge Color Coating Formulations for Leather Finishing

Name & Designation of Project Leader:

Mrs. Asma Inayat, PSO

Name & Designation of Project Associate(s):

Mr. Shahid Rehman Khan, SSO

Area(s) of Research:

Leather Technology

Duration:

01 Year

Date of Initiation:

2024

Project Brief:

Leather products are commonly colored along their edges to enhance aesthetics and durability. However, traditional edge color formulations often contain synthetic chemicals that can be harmful to the environment and human health. In response to growing environmental concerns, there is a need to develop edge color formulations for leather that offer both aesthetic appeal and sustainability. Existing edge color formulations for leather often rely on synthetic dyes and chemicals that pose environmental risks. This raises concerns about the ecological impact of leather processing and end-of-life disposal. Developing edge color formulations is essential to address these environmental challenges and promote sustainable practices in the leather industry. The research project will focus on:

- Identifying environment friendly materials suitable for edge coloring of leather.
- Formulating edge colorants using eco-friendly pigments, binders and additives.
- Evaluating the color fastness, durability and environmental impact of the developed formulations.
- Optimizing application methods for achieving

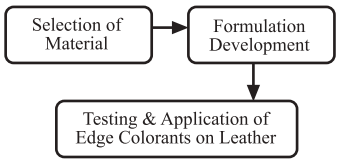
consistent and attractive edge colors on different types of leather.

The main objective of this research work is to develop edge color formulations for leather that offer sustainable alternatives to conventional synthetic dyes. Specific goals include:

- Identifying environment friendly materials suitable for edge coloring.
- Formulating eco-friendly edge colorants with desired color, intensity and stability.
- Assessing the environmental impact of the developed formulations.

Graphical Abstract:

The schematic diagram illustrates the work flow and key components involved in the research project, including:



Time Line (Quarter Wise Plan):

1st Quarter	• Purchase of raw materials and preliminary experimental work
2nd Quarter	• Optimization of developed formulation • Testing of quality parameters for formulation.
3rd Quarter	• Application of formulations on leather Materials. • Evaluation of materials after application.
4th Quarter	• Leasing out of process developed.

Funding Source (PSDP/SGI/RD&I/etc):

In-House

Cost:

Tangible Outcome:

The tangible outcome of this project will be the development of edge color formulations for leather, along with optimized application methods. This technology product/process will benefit leather manufacturers, consumers, and the environment by offering sustainable alternatives to conventional edge colorants, thereby promoting environmental conservation and human health.

Achievements:

New Project

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Name of Laboratory/ Centre/ Unit:

Pakistan Institute of Technology for Minerals & Advanced Engineering Materials (PITMAEM), PCSIR Labs. Complex, Lahore

Title of Project: Development of Environment Friendly GO/HAP Hybrid Composites for Biomedical Applications

Name & Designation of Project Leader:

Ms. Sumaira Nosheen, SSO

Name & Designation of Project Associate(s):

Ms. Farzana Habib, PSO
Engr. Bilal Waseem, JE

Area(s) of Research:

Advanced Engineering Materials/Biomaterials

Duration:

01 Year

Date of Initiation:

2024

Project Brief:

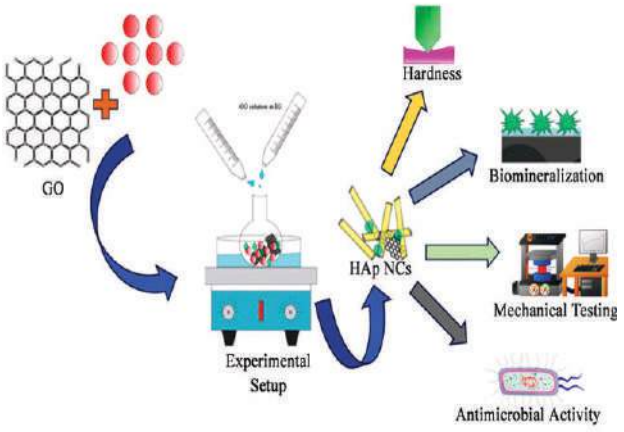
Hydroxyapatite (HA) has been widely used in fields of materials science, tissue engineering, biomedicine, energy and environmental science, and analytical science due to its simple preparation, low-cost, and high biocompatibility. To overcome the weak mechanical properties of pure HA, various reinforcing materials can be incorporated with HA to form high-performance composite materials. Due to the unique structural, biological, electrical, mechanical, thermal,

and optical properties, graphene has exhibited great potentials for supporting the biomimetic synthesis of HA. Graphene has attracted great attention in the fabrication of various novel nanomaterials due to its unique two-dimensional (2D) structure and innovative biological, electrical, mechanical, thermal, and optical properties.To overcome the weak mechanical properties of pure HA, various reinforcing materials can be incorporated with HA to form high-performance composite materials. Due to the unique structural, biological, electrical, mechanical, thermal, and optical properties, graphene exhibit great potential for supporting the biomimetic synthesis of HA. Graphene has attracted great attention in the fabrication of various novel nanomaterials due to its unique two-dimensional (2D) structure and innovative biological, electrical, mechanical, thermal, and optical properties. As a result of the growing interest in the biological and mechanical performance of hydroxyapatite (HA)–graphene nano-sheets (GNs) composite systems, reduced graphene oxide (rGO) reinforced hydroxyapatite nano-tube (nHA) composites will be synthesized *insitu* using a simple hydrothermal method in a mixed solvent system. The composites will be characterized by X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR) enabling confirmation of the synthesis and reduction of the nHA and rGO, respectively. The structure of the synthesized powder and cell attachment on the sintered sample will be confirmed by scanning electron microscopy (SEM). The effects of the rGO on the mechanical properties and the *invitro* biocompatibility of the nHA based ceramic composites will be investigated.

The main objectives are:

- Development of nHA/rGO polymer composites
- Study of elastic modulus and fracture toughness of the sintered samples
- Study of Cell culture and viability
- Study of mechanical properties of nano composite before and after sintering and by changing the filler percentage.

Graphical Abstract:



Funding Source (PSDP/SGI/RD&I/etc):

In-House

Cost:

Tangible Outcome:

- Improvements in both their biological and mechanical properties.
- The process will be developed for the said R & D work.

Achievements:

- First phase of synthesis has been completed.

Year (2024 -25)	1st Quarter (July-Sep, 2024)	2nd Quarter (Oct-Dec, 2024)	3rd Quarter (Jan-Mar, 2025)	4th Quarter (Apr-Jun, 2025)
	Development of nHA/rGO polymer composites	Study of elastic modulus and fracture toughness of the sintered samples. Study of Cell culture and viability	Study of mechanical properties of nano composite before and after sintering and by changing the filler percentage	Characteri-zation and report writing

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Name of Laboratory/Center/Unit:

Pakistan Institute of Technology for Minerals & Advanced Engineering Materials (PITMAEM), PCSIR Labs. Complex, Lahore

Title of Project: Development of Excavator Bucket Tooth Material and Optimization of Heat Treatment Process for Wear Properties

Name & Designation of Project Leader:

Engr. Farooq Iftikhar, SE

Name & Designation of Project Associates:

Engr. Muhammad Irfan, SE
Engr. Muhammad Nouman, JE
Engr. Ahmed Raza, JE

Area of Research:

Material Development

Duration:

01 Year

Date of Initiation:

2024

Project Brief:

Excavators are essential pieces of heavy machinery used in construction, mining and other earth moving operations. The excavator bucket attached to the end of the excavator's arm play a critical role in these operations by allowing the machine to scoop, dig and move large quantities of material. One of the key components of an excavator bucket is its teeth, which significantly affect the bucket's performance and efficiency. These teeth are crucial for breaking into hard materials and provide a griping surface for the bucket to scoop up material. Given the demanding conditions they operate in, bucket teeth are subject to significant wear and impact. As a result excavator bucket teeth are typically made from high strength materials to withstand the extreme wear and tear they encounter. Keeping in view the importance of this alloy, this project aims to investigate and develop an advanced alloy tailored specifically for excavator bucket teeth material. The research will focus on identifying the optimal combination of alloying elements to enhance properties such as hardness, toughness, and wear resistance, crucial for extended performance in abrasive environments.

Advanced metallurgical techniques including alloy design, heat treatment and microstructural evaluation will be explored to achieve the desired material characteristic. The development of Excavator bucket teeth material faces several critical challenges that need to be addressed for further advancement:

1) **Cost Effectiveness:** Currently the excavator bucket teeth used in our construction and mining operations are imported from foreign suppliers. This reliance on imported components present several challenges such as high cost , supply chain dependence, limited customization options and long lead times**.**
2) **Wear Resistance:** Enhancing wear resistance remains a primary concern, especially in abrasive environments. The material should withstand continuous contact with harsh materials like rocks, gravel and abrasive soils without rapid deterioration.
3) **Impact Resistance:** Bucket teeth often endure high impact forces during operation. Improving impact resistance is crucial to prevent fractures or premature failure that can lead to maintenance costs.
4) **Toughness:** Balancing hardness with toughness is essential. While hardness is necessary for wear resistance, the material must also possess sufficient toughness to withstand sudden shocks and impacts without brittle fracture.

Technical Information:

Excavator bucket teeth are typically made from high-strength steel alloys due to their excellent combination of hardness, toughness, and wear resistance. A breakdown of the technical aspects regarding materials used for excavator bucket teeth is as follow.

1) **Steel Alloys**

- **Manganese Steel (Hadfield Steel):** Known for its high toughness and wear resistance, manganese steel is a popular choice for excavator bucket teeth. It can withstand significant impact and abrasion without fracturing.
- **Boron Steel:** Boron steel alloys are characterized by high hardness and abrasion resistance. They are particularly suitable for applications where wear

resistance is critical.

- **Low Alloy Steel:** often used in conjunction with other alloying elements to enhance specific properties such as strength, hardness and toughness. Low alloy steels offer a good balance of performance and cost effectiveness.

These materials are chosen for their hardness, toughness and resistance to wear.

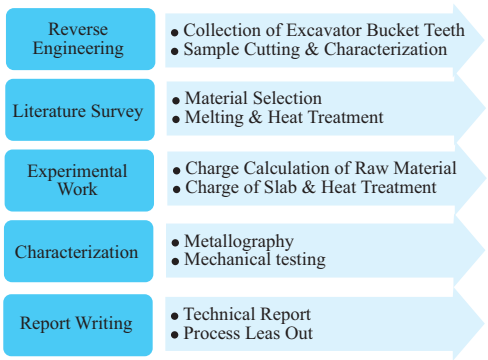
2) **Heat Treatment:** After shaping, bucket teeth undergo heat treatment process like quenching and tempering to achieve the desired hardness and toughness. This helps in enhancing wear resistance and durability.

The above mentioned technical aspects highlight the complexity and engineering involved in ensuring that, excavator bucket teeth withstand the harsh conditions they encounter in construction and mining applications.

The objective of the project is;

- Addressing the above mentioned problem statement and technical information, research efforts will be focused on material development, including heat treatment, characterization and testing of the developed alloy to optimize and enhance the performance of excavator bucket teeth.

Graphical Abstract:



Funding Source (PSDP/SGI/RD&I/etc):

In-House

Cost:

Timeline (Quater Wise Plan):

Year (2024 -25)	1st Quarter (July-Sep, 2024)	2nd Quarter (Oct-Dec, 2024)	3rd Quarter (Jan-Mar, 2025)	4th Quarter (Apr-Jun, 2025)
	Literature survey and reverse engineering of material (Mechanical and Metallo-graphy)	Collection of raw material and compilation & analysis of reverse engineering data	Experimental work (different trials) and optimization of process parameters	Characteri-zation, Report writing and final submission

Tangible Outcome:

- The resulting alloy will contribute to improve the durability and efficiency of excavator equipment leading to cost savings and increased productivity in various industries reliant on earth moving operations. Moreover, this study will contribute towards the indigenous production of excavator bucket tooth.
- Import substitute
- Technology transfer to the local industry.
- Lease out the process developed

Achievements:

The sample of excavator tooth has been collected for reverse engineering

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Name of Laboratory/ Centre/ Unit:

Pakistan Institute of Technology for Minerals & Advanced Engineering Materials (PITMAEM), PCSIR Labs. Complex, Lahore

Title of Project: High Entropy Alloys (HEAs) Coatings for Extreme Environment Applications

Name & Designation of Project Leader:

Engr. Badaruddin Soomro, JE

Name & Designation of Project Associate(s):

Engr. Muhammad Irfan, SE
Engr. Waqas Iqbal, JE
Mr. Salman Ahmad, Sr. Tech.
Mr. Taj Muhammad Khan, Jr. Tech.
Mr. Rashid Iqbal, JEO

Area(s) of Research:

Thermal Spraying Technology

Duration:

01 Year

Date of Initiation:

2024

Project Brief:

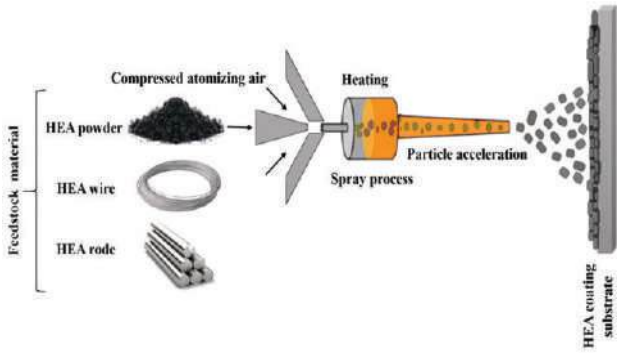
High Entropy Alloys (HEAs) are novel alloys also known as multi component or multi principal element alloys (MPEAs), which differ from traditional alloys having a single principal element. HEA-based coatings have emerged as a potential surface protective coatings on account of their attractive surface protection ability. These coatings exhibit precipitation, hardenability, light weight, antioxidation, high ductility, wear and corrosion resistance etc., which further extend their applications in various sectors.Consequently, more diverse properties can be obtained by employing several constituent elements, such as transition metals, refractories, nitrides, and carbides systems. In surface protection and engineering, diverse applications of HEAs are also being counted to benefit from their attractive performances in various environments. The performance of HEA coatings is governed by the type of elements, composition and microstructures of the coatings.Most of the industrial parts/components are worn out and corroded due to high temperature and acidic/chemical environment.

Thermally sprayed metallic HEA-related coatings consist of basically FeCoNiMnCr series elements which are generally known as Cantor-based alloys. HEA-related alloys and coatings have been widely investigated in various surface engineering applications due to their attractive properties and unique applications in extreme environments. Recently, there have been rapid developments in HEA coatings.

The main objective of the project is;

- The main objective of this project is to protect/ reclaim the surface of part/component by applying the coatings of different metals as per their requirement.

Graphical Abstract:



Funding Source (PSDP/SGI/RD&I/etc):

In-House

Cost:

Timeline (Quarter Wise Plan):

Year (2024 -25)	1st Quarter (July-Sep, 2024)	2nd Quarter (Oct-Dec, 2024)	3rd Quarter (Jan-Mar, 2025)	4th Quarter (Apr-Jun, 2025)
	Selection of base material and coating material and technique	Deposition of different coating trials for optimization of parameters	Characterization of deposited coating	Report writing and final submission

Tangible Outcome:

Process will be developed and leased out to industry.

Achievements:

New Project

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Name of Laboratory/ Centre/ Unit:

PCSIR Labs. Complex Lahore/ Glass and ceramics research centre/ Lahore

Title of Project: Nano-materials Based Polymeric Coatings for Multifunctional Impacts on Substrate.

Name & Designation of Project Leader:

Dr. Phool Shahzadi, SO

Name & Designation of Project Associate(s):

Mr. Akhtar Shahnaz, SO
Dr. Bakht Bahadur Rana, CSO

Area(s) of Research:

Sheet Glass Industry

Duration:

02 Years

Date of Initiation:

2024

Project Brief:

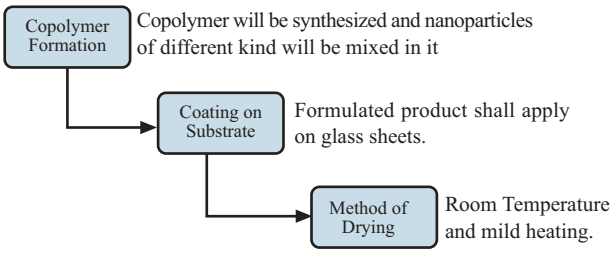
In this research work, protective and antimicrobial acrylic paint containing Titanium and silver nanoparticles (Ag NPs) will be prepared using the facile Ag+ in situ reduction process, in which $AgNO_3$ and reducing agent sodium acrylate will be refluxed with acrylic polymeric solution to obtain an antimicrobial and antifungal polymeric material for substrate coating. A polymer coating consists of a thin layer of polymer applied to irregular objectives or flat surfaces. These coatings can serve as decorative and protective layers. A functional coating is one that provides a specific function, such as photographic films or adhesives etc. As corrosion inhibitors or as decorative paints, they may be used for many purposes. Moreover, they can be used to modify surfaces, for example, hydrophobic coatings and paper coatings etc. Organic materials are commonly used in polymeric coating. In some cases, however, contains may be ceramic grains or metallic in order to enhance their endurance, appearance, or properties. Aside from their excellent chemical resistance and blocking resistance, they also offer very good scratch and abrasion resistance. Additionally, these coatings have excellent adhesion to metal and plastics, short drying times, fast hardness development, and easy formulation, as well as superior gloss and matt looks. Polymer coatings are generally designed to form a polymer film. Efforts should be made to speed up the process. Coating methods vary in accordance with the thickness, rheology, and web speed of the covering.

- Indoor effluents are common communal issues causing health hazards and microorganism contamination on substrate surfaces is arousing increasingly causing serious health issues.
- Acrylic paint doped with silver nanoparticles holds great promise as a multifunctional coating material with enhanced antimicrobial, antifungal properties. Polymeric material will be synthesized by using different acrylates by polymerization under controlled condition. Then Nanoparticles will be doped by in situ and other appropriate method. Then applied on substrate for following purposes:
  - To Protect Public health from microorganisms.
  - To reduce microbial growth.
  - Prevention from infections.

The main objective is;

- To revolutionize various industries, from healthcare to construction, by providing durable and effective solutions for maintaining hygienic and safe environment.

Graphical Abstract:



Timeline (Quarterwise):

	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
First Year	Literature review	Procurement of chemicals	R&D	Formulation of different coatings
Second Year	Application on substrate	Characteri-zation	Evaluation	Report writing

Funding Source (PSDP/SGI/RD&I/etc):

In-House

Cost:

Tangible Outcome:

Local sheet glass industry can get benefited from

this;

- Environment friendly glass
- Glass surfaces in sanitary areas (showers, mirrors)
- Window glass and construction glass (conservatories, high-rise buildings)
- Automotive glass (front and side windows)
- UV-stability enables functionality for a number of years, approximately the lifetime of the coated surface

This is very simple and economical method than CVD and PVD coatings. In this way we can develop new formulations and products for coating different substrates.

Once the project is completed successfully, research and development in this field could lead to the widespread adoption of such coatings, contributing to improved public health and environmental sustainability.

Relevance with PCSIR National Priority areas:

- To boost up local glass Industry
- To reduce unemployment for skilled worker
- To save foreign exchange

Achievements:

New Project

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Name of Laboratory/ Centre/ Unit:

Mineral Processing Laboratory/ Mineral Processing Research Centre/ PCSIR, LLC

Title of Project: Beneficiation of an Indigenous Low Grade Rock Phosphate and its Utilization for Preparation of Commercial Grade Phosphoric Acid

Name & Designation of Project Leader:

Mr. M. Arif Bhatti, PSO

Name & Designation of Project Associate(s):

Ms. Samreen Zahra, PSO
Dr. Irfan Hafeez, PSO
Ms. Uzma Zafar, PSO
Mr. Ansar Mahmood, SSO
Mr. Rashid Mahmood, SO

Area(s) of Research:

Minerals

Duration:

01 Year

Date of Initiation:

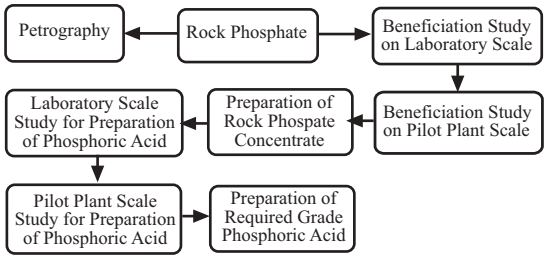
2024

Project Brief:

Phosphorus is a vital plant nutrient and is taken up by plant roots, usually as the dihydrogenphosphate ion ($H_2PO_4^-$) derived from phosphoric acid, H_3PO_4. The manufacture of fertilizers that are used to recover phosphorus deficiencies in soils depends on the supplies of phosphoric acid. Phosphoric acid can by prepared by utilizing low grade rock phosphate after up-gradation by removing gangue minerals that mainly include dolomite, silica, iron oxide and aluminum oxide. The commonly employed commercial methods for the manufacture of phosphoric acid include wet process, thermal process and dry kiln process. The challenge is to remove the impurities i.e. dolomite, silica, iron oxide and aluminum oxide from rock phosphate by employing an appropriate beneficiation process comprising of steps depending on the type of rock followed by the preparation of phosphoric acid by a cost-effective and environment friendly process. Phosphoric acid produced can be used in phosphate fertilizers production (DAP, MAP, SPA), manufacture of high grade chemicals, pharmaceuticals, detergents, food products and other non-fertilizer products. The main objective of the project is;

- To develop a process for the beneficiation of low grade indigenous rock phosphate for its potential use in manufacturing phosphoric acid on commercial scale.

Graphical Abstract:



Funding Source (PSDP/SGI/RD&I/etc.):

In-House

Cost:

Tangible Outcome:

- A process will be developed on pilot scale for the preparation of commercial grade phosphoric acid through exploitation of indigenous mineral resources employing a feasible and ecofriendly route for industrial scale production.

Achievements:

New Project

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Name of Laboratory/Centre / Unit:

Coal Testing Laboratory/Mineral Processing Research Centre/PCSIR-LLC

Title of the Project: Beneficiation of Low-Rank Coals by Dense Media Separation Method and Study of Washability Characteristics

Name & Designation of Project Leader:

Mr. Zahid Mahmood, PSO

Name & Designation of Project Associate:

Mr. Muhammad Asif Ali,Tech

Area(s) of Research:

Coal Beneficiation

Duration:

01 Year

Date of Initiation:

2024

Project Brief:

Majority of the coal deposits in Pakistan are ranked to be as lignite to sub-bituminous/bituminous category. The ash and sulphur content in many seams is usually high. In order to improve the coal quality prior to combustion, different coal cleaning processes are being adopted worldwide.

Dense Media Separation is a method of separating minerals from coal by specific gravity difference which produces sinks and floats materials. The coal impurities are composed of minerals such as quartz, pyrites, carbonates, and clays. The minerals in coal appear in the various forms like grains, nodules, lenticels and bands. The physical characteristics of coal are directly related to the presence and association of mineral matter present in it. The washability characteristics of a coal seam can be predicted from small samples. The operational parameters may differ from sample to sample depending upon coal rank and mining conditions. The objectives of this project are:

- To optimize process parameters to develop environmentally friendly clean coal from ingenious resources having lower percentage of ash and sulphur and improved Heating Value.
- Studies on coal samples arranged from Khushab (Punjab) and Thatta (Sindh) are aimed to be carried out on lab scale.
- Work Scheme: Selection of Low Rank Coal → Sample preparation as per ASTM → Application of DMS methods → Optimization of Process parameters → Evaluation of coal fractions → Compilation of Results/Data

Funding Source:

In-House

Cost:

Tangible Outcome:

- Development of process for washing of low rank coal to produce upgraded yield.
- Process may be leased out or published in a peer-review journal

Achievements:

New Project

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Name of Laboratory/Centre/Unit

CEPS

Title of Project: Characterization and Utilization of MF and UF Membranes for Water Purification

Name & Designation of Project Leader:

Dr. Muhammad Hammad Khan, PSO

Name & Designation of Project Associate(s):
Mr. Javed Iqbal, SO

Area(s) of Research:
Water Treatment and Material Science

Duration:
01 Year

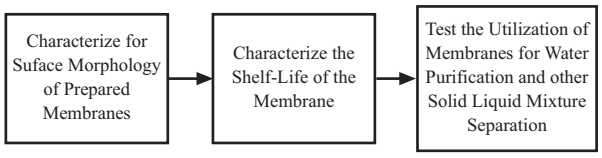
Date of Initiation:
2024

Project Brief :

Membrane technology is the ultimate technology for the water purification. Microfiltration and ultrafiltration technology is required for pretreatment of wastewaters. The project is focused to improve the water and wastewater facilities by preparation of membranes. In the PSF project, UF and MF membrane were prepared and characterized for basic parameters. Now, further characterization and shelf-life testing are required. Pakistan has to import all the membranes. Membrane technology separated the particles from liquid phase bawd on the pore size of membranes. Microfiltration and ultrafiltration technology is required for pretreatment of wastewaters. The main objective of the project is;

- Characterize the developed polymeric membranes and test utilization for water purification nand other solid/liquid mixtures.

Graphical Abstract:



Work Plan:

- The prepared polymer will be tested for the pore size and surface morphology.
- Shelf life of the prepared membranes will be established.
- Shelf life will be improved with physical and chemical post treatments.
- The prepared membranes will be tested for their utilization for different solid/liquid mixture separations including but not limited to water purification, wastewater treatment, food and industrial applications

Timeline (Quarter Wise Plan):

	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
First Year	The prepared membranes will be characterized for their pore size and surface morphology	The shelf-life of the membranes will be tested and improved with post treatments	The membranes will be utilized for different applications including water, wastewater, food, chemicals sectros	Optimization the membrane preparation and characteriza-tion of morphology

Funding Source (PSDP/SGI/RD&I/etc):
In-House

Cost:

Tangible Outcome:

- Patent and Paper
- Process will be leased out to suitable clients

Achievements:

Two UF and MF membranes were prepared and characterized for their basic parameters.

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Name of Laboratory/ Centre/ Unit:
Center for Environment Protection Studies

Title of Project: Affectivity of Composite Materials for Treatment of Industrial Effluent

Name & Designation of Project Leader:
Dr. Naeem Abbas, SSO

Name & Designation of Project Associate(s):
Dr. Farah Deeba, PSO

Area(s) of Research:

Wastewater Treatment

Duration:

01 Year

Date of Initiation:

2024

Project Brief:

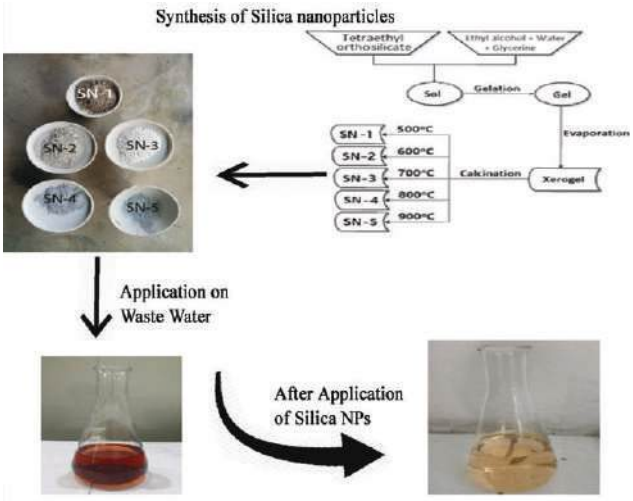
Industrial effluents often contain hazardous pollutants that conventional treatment methods struggle to remove effectively. Silica composites materials have unique properties such as their large surface area, high reactivity, and customizable functional groups. This research aims to develop a more efficient and sustainable approach to purifying industrial wastewater as well as to synthesize silica composite materials, characterizing their properties, and testing their effectiveness in removing contaminants from textile effluents, ultimately contributing to cleaner water resources and reduced environmental impact. Textile wastewater causes environmental challenges and requires a cost effective, sustainable and scalable solution. This project will involve the synthesis of various silica composite materials. These materials will be characterized using advance analytical techniques to determine their structural and chemical properties. The scope includes evaluating the adsorption and degradation capabilities of these nano composites on textile effluents, focusing on pollutants like dyes, heavy metals, and organic compounds. Response surface methodology will be conducted to optimize parameters such as pH, contact time, and nano composite dosage. The main objectives are as under;

- Synthesis of silica composite materials and characterization and its application on wastewater
- Optimization of Treatment Parameters including dosage, contact time, pH etc.

Work Plan:

- Synthesis of different slica composite materials.
- Characterization of synthesized materials.
- Application on industrial wastewater.

Graphical Abstract:



Time Line (Quarter Wise Plan):

First Year	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
	Synthesis of various composite materials	• Optimization of synthesis procedure. • Characterization of prepared materials.	Characterization of prepared materials FTIR, SEM, EDX etc.	Application of prepared material to wastewater treatment.
Second Year	Optimization of Treatment process through response surface methodology.	Compilation of data. Process write up.	Research article write up.	Submission of research article in national and international journal

Funding Source (PSDP/SGI/RD&I/etc):

In-House

Cost:

Tangible Outcome:

- Patent would be published and process lease out.

Achievements:

The synthesized silica composite materials have been characterized by FTIR, SEM, EDX, XRD and UV.

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Name of Laboratory/ Centre/ Unit:

Centre for Environmental Protection Studies (CEPS), Pakistan Council of Scientific and Industrial Research, Lahore

Title of Project: Plant Mediated Biosynthesis of Metallic Nano-alloys for Dyes Degradation of Industrial Effluents and Formulation of Anti-bacterial Paints: A Sustainable Approach

Name & Designation of Project Leader:

Engr. Dr. Muhammad Irfan, SE

Name & Designation of Project Associate:

Dr. Farzana Bashir, PSO

Area of Research:

Nanotechnology, Environment

Duration:

02 Years

Date of Initiation:

2024

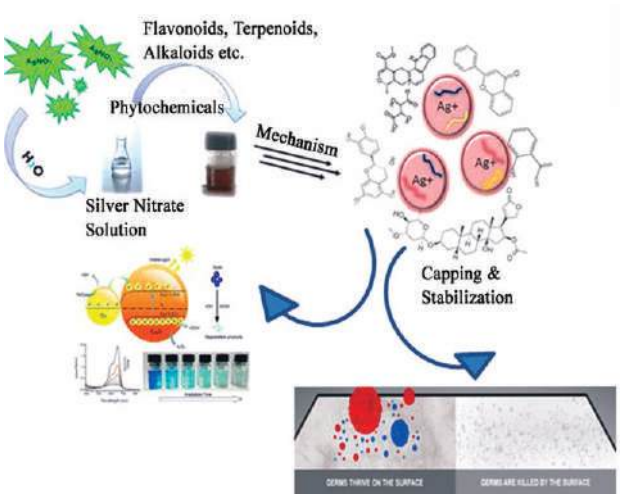
Project Brief:

In Pakistan, agriculture is crucial to the economy, generating significant natural and agricultural waste. Historically undervalued, this waste is now seen as a potential resource amid the country's economic and energy challenges. Traditionally used for energy generation, biomass burning contributes to air pollution and smog. This environmental issue has spurred scientific efforts to find eco-friendly and economically viable alternatives. Recent research highlights the extraction of valuable phytochemicals from plant waste to produce metallic nanoparticles (NPs) especially silver and copper which are renowned for their antimicrobial properties. These nanoparticles address the global health threat of antibiotic-resistant bacteria, complicating bacterial contamination control in water and on surfaces, particularly in medical settings. The COVID-19 pandemic has underscored the urgency of effective antibacterial solutions. These nanoparticles can enhance antibacterial effectiveness particularly for the development of antibacterial and antifungal paint, crucial for maintaining sterile environments in hospitals and other settings, significantly reducing pathogen transmission risks. The project also explores nano-particle use for degradation of dyes in industrial effluent, addressing water pollution and industrial waste management. This dual focus on health and environmental sustainability positions the project as a multi-faceted solution to pressing challenges.

Research into the phytochemical properties of plant waste, such as leaves and bunches, has uncovered high levels of bioactive compounds. These findings spotlight the potential of using agricultural waste for nanoparticle synthesis, utilizing its natural reducing agents and bio-stabilizers. This approach not only presents a sustainable way to handle bio-waste but also paves the way for the development of new technologies used for dyes degradation and development of antibacterial and antifungal paints. Utilizing plant biomass for NP synthesis and exploring these desired applications can revolutionize industries, offering eco-friendly alternatives for various applications, thereby aligning with both economic and environmental goals. The main objective is;

- To integrate synthesized nanoparticles using bio-waste materials across multiple applications: (1) as antimicrobial and antibacterial agents for the development of antibacterial paints for maintaining sterile environments, and (2) for degradation of dyes in industrial effluents enhancing wastewater treatment processes.

Graphical Abstract:



Funding Source (PSDP/SGI/RD&I/etc):

In-House

Cost:

Time Line (Quarter Wise Plan):

1st Year	
1st Quarter	Comprehen-sive review of existing research on plant mediat-ed biosynthe-sis of metallic nano-alloys and their applications in dye degrada-tion and anti-bacterial paints. Identify and select appro-priate plants for the biosyn-thesis process based on liter-ature review and prelimi-nary tests.
2nd Quarter	Conduct initial synthesis experiments to optimize conditions for nano-alloy formation.Use techniques such as XRD, TEM, and UV-Vis spectro-scopy to characterize the synthesized nano-alloys.
3rd Quarter	Optimization of process parameters to enhance yield and quality of nano- lloys. Begin scaling up the synthesis process to produce larger quantities of nano-alloys for further testing.
4th Quarter	Test the efficacy of synthesized nano-alloys in degrading various industrial dyes. Analyze degradation efficiency using spectrophotometric method. Adjust synthesis parameters based on degradation results to improve performance.
2nd Year	
1st Quarter	Develop for-mulations in-corporating nano-alloys into paint matrices. Conduct preliminary antibacterial tests on the formulated paints using standard microbio-logical assays.
2nd Quarter	Refine paint formulations to maximize antibacterial efficacy. Perform extensive tests on paint formula-tions, including durability, adhesion, and antibacterial properties.
3rd Quarter	Conduct small-scale Field trials to assess real performance of the antibacterial paints. Make its comparison with traditional paint for quality evaluation.
4th Quarter	Compile all data and findings into a final report. Publish results in scientific journals or present at conferences.

Tangible Outcomes:

- An innovative approach for transforming agricultural industry solid waste into valuable industrial products.
- Development of material for dyes degradation of industrial effluent – an environmental friendly application
- Development of material for production of anti-bacterial and antifungal paint – an environmental and health potential application.
- Commercialization of material to textile and paint industries

Achievement:

- In collaboration with the Chief Sales and Marketing Officer of Rhino Paints which are focusing on developing antibacterial and antifungal paints.
- This paint company is actively engaged in research and development to develop this type of paint in Pakistan and ensure high-quality evaluation using various methodologies.
- Currently, they import their antibacterial materials, but we are working closely with them to produce these materials locally at the PCSIR lab.
- This initiative could be a highly innovative step forward for the industry's development.

★ ★ ★ ★

On-Going

Name of Laboratory/Centre/Unit:

Food & Biotechnology Research Centre, PCSIR, Lahore

Title of Project: Extraction, Isolation of Natural Flavonoids from Various Indigenous Sources and its Application as a Antioxidants and Bio-preservative

Name & Designation of Project Leader:

Dr. Muhammad Khalid Saeed, PSO

Name & Designation of Project Associates:

Dr. Naseem Zahra, SO
Dr. Asma Saeed, CSO

Area of Research:

Food Chemistry

Duration:

01 Year

Date of Initiation:

2023

Project Brief:

The use of anthocyanins in different commercial sectors such as pharmaceutical food and chemical industries signifies the need of the most appropriate and standard method to extract anthocyanin from fruit, flower and leaf. Along with conventional methods, numerous new methods have been established but till now no single method is regarded as standard for extracting flavonoids i.e. anthocyanins from plants. These are one of the six subgroups of large and widespread group of plant constituents known as flavonoids and these are responsible for the bright and attractive orange, red, purple, and blue colors of most fruits, vegetables, flowers and some cereal grains. More than 600 structurally distinct anthocyanins have been identified in nature. Earlier, anthocyanins were only known for their coloring properties but now interest in anthocyanins pigments has intensified because of their possible health benefits as dietary antioxidants, which help to prevent neuronal diseases, cardiovascular illnesses, cancer, diabetes, inflammation, and many such others diseases. Ability of anthocyanins to counter oxidants makes them atherosclerosis fighters. Therefore, anthocyanins-rich foods may help to boost overall health by offering an array of nutrients. The incorporation of anthocyanins into food and medical products is a challenging task due to their low stability toward environmental conditions during processing and storage. So, in this project, flavonoids are in corporated in food items as a natural bio-preservative. The main objectives of the project are;

- The present project will be carried out to obtain the maximum recovery of flavonoids/anthocyanins with different extraction conditions such as different solvents, extraction time temperature and different extraction methods.
- The obtained extract will be subjected to determination of anthocyanins and estimation of total phenolic content and antioxidant activity using DPPH assay and reducing power activity method.
- Application of these flavonoids as a natural preservative in food products.

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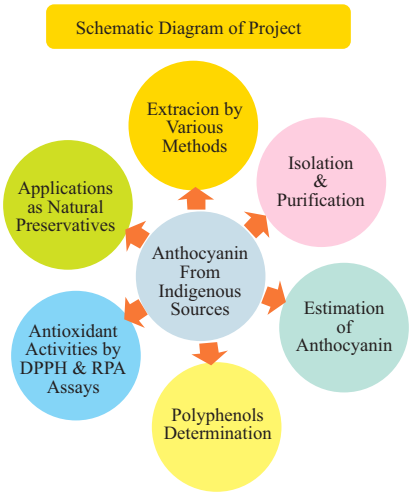

Timeline (Quarter Wise Plan):

1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Collection & selection of raw- materials and its Processing.	Extraction of flavonoids by using various solvents for maximum recovery	Estimation of total phenolic content & Flavonoids. Determination of antioxidant activity	Application of these flavonoids in various food products

Funding Source:
In-House

Cost:

Tangible Outcome:
- Anthocyanins are natural flavonoid organic compounds widely existing in natural fruits and vegetables. Many researches have confirmed the diverse health-promoting effects, as natural colorants, as natural antioxidants and bio-preservatives. The extraction methods of anthocyanins from fruits/vegetables need optimized conditions because of the sensitivity of anthocyanins. This latest research progress in extraction and isolation of anthocyanins analyzed and compared the effects of different extraction isolation and purification methods on the extraction rate and purity of anthocyanins and its utilization in food products as a bio-preservative. Moreover, studies relating to anthocyanins as a bio-preservative in Pakistan are not yet in practice and it may minimize the expenditure and save the foreign exchange by utilizing of local easily available resources with the collaboration of indigenous industries. It may provide the awareness and consultancy/process services through PCSIR Laboratories Complex Lahore.

Achievements:
- Collection, selection and processing of Raw-materials like red cabbage & citrus peel are completed. After dehydration and grinding its powder formation is completed.

★ ★ ★ ★

Name of Laboratory/ Centre/ Unit:
Aflatoxin Lab/FBRC / LLC

Title of Project: Extraction of Lime Yellow Food Color from Gul E Kesu (*Butea Monosperma*)

Name & Designation of Project Leader:
Mrs. Alim-un-Nisa, PSO

Name & Designation of Project Associate(s):
Dr. M. Ashraf, SSO
Mr. Faizullah Khan, SSO
Dr. Shahid Masood, SSO

Area(s) of Research:
Medicinal and Botanical Plants

Duration:
02 Years

Date of Initiation:
2023

Project Brief:

This process taps into the unique pigments present in Gul e Kesu, offering a distinct lime yellow hue not commonly found in synthetic alternatives. This novel approach aligns with the increasing consumer demand for plant-based and natural ingredients in the food industry. The lime yellow shade derived from Gul e Kesu has the potential to bring a fresh and vibrant appeal to a variety of food and beverage products. The developed lime yellow food color from Gul e Kesu represents a novel and natural alternative, meeting both aesthetic and consumer-driven preferences in the food industry. This novel approach aligns with the increasing consumer demand for plant-based and natural ingredients in the food industry.

- Water soluble food color
- Natural free of chemicals
- Heat stable
- Fresh and vibrant appeal to a variety of food and beverage products.

The main objectives are as under;
- To develop eco friendly production technology for natural food dyes
- To develop food grade natural color
- To save foreign exchange with replacement of imported substitute

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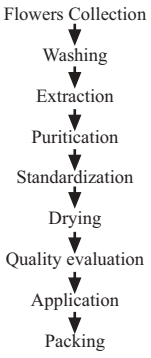

Work Plan:

1st and 2nd Quarter:
Literature review and customer trends

3rd and 4th Quarter:
Selection of raw material

5th and 6th Quarter:
Production and standardization of Technology

7th and 8th Quarter:
Application and quality evaluation of final product

Funding Source (PSDP/SGI/RD&I/etc):
In-House

Cost:

Tangible Outcome:
- Paper Publication
- Process lease out
- Technical report
- Patent

Achievements:
Gul e Kesu (*Butea monosperma*) has been selected for extraction of food grade natural lime yellow food color. Flowers are easily available in local environment. Initial trials have been successfully conducted to prepare the crystalline heat stable powder.

★ ★ ★ ★

Name of Laboratory/ Centre/ Unit:
Fruit and Vegetable Processing Laboratory/FBRC/ LLC

Title of Project: Development of Protein Enriched, Gluten Free Flour and Other Therapeutic Food Products from Faba Beans

Name & Designation of Project Leader:
Mr. Faizullah Khan, SSO

Name & Designation of Project Associate(s):
Dr. Muhammad Ashraf, SSO
Dr. Shahid Masood, SSO
Mrs. Alim-un-Nisa, PSO
Dr. Asma Saeed, CSO

Area(s) of Research:
Food Science & Technology

Duration:
02 Years

Date of Initiation:
2023

Project Brief:
Faba beans is among untapped/unidentified crops in Pakistan, globally Faba beans are emerging as sustainable quality plant protein sources, with the potential to help meet the growing global demand for more nutritious and healthy foods. Faba beans have high protein content and well-balanced amino acid profile including essential amino acids i.e. lysine, histidine, leucine, and methionine, contains bioactive constituents with health-enhancing properties, including bioactive peptides, and phenolic compounds. Faba bean peptides released after gastrointestinal digestion have shown antioxidant, antidiabetic, antihypertensive, cholesterol-lowering, and anti-inflammatory effects. The faba bean in addition to an excellent source of protein, it is a good substitutes of meat protein. It also contains valuable mineral micronutrients i.e. potassium, iron, zinc and selenium. Selenium has anti diabetic character, Fe, Zn, aids as immuno-nutrients. Being gluten free, it is suitable for celiac diseases and other gluten sensitive patients. Faba bean contains a very low sodium amount, which is a desirable trait considering that high sodium consumption is associated with heart diseases and elevated blood pressure.

The objectives are;
- Production of plant protein alternative to animal protein from indigenous sources
- Development of production technology for vegetable meat
- Production of lactose free milk
- Production of protein enriched gluten free innovative products
- Utilization of untapped crop for product development to provide a new avenue of income generation.

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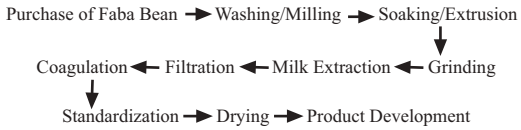

Work Plan:

1st Quarter	• Literature review and customer trends • Selection, collection and purchase of raw materials, packaging and other required items.
2nd Quarter	• Nutritional analysis of selected faba bean • Trails for development of lactose free faba milk • Nutritional analysis of developed product
3rd Quarter	• Trails for development of faba meat • Nutritional analysis and sensory evaluation of developed product. • Shelf life study of developed products
4th Quarter	• Compilation and submission of technical report of developed products. • Compilation and submission of research papers
5th Quarter	• Trails for development of gluten free protein enriched baby food items.
6th Quarter	• Shelf life study of developed products • Nutritional analysis and consumer evaluation of developed products
7th Quarter	• Trails for development of gluten free protein enriched bakery items. • Nutritional analysis and shelf life study of developed product.
8th Quarter	• Compilation of technical reports, patents, and research papers. • Efforts for lease out of developed products

Funding Source (PSDP/SGI/RD&I/etc):
In-House

Cost:

Tangible Outcome:
- Untapped resource will be made useable and marketable.
- Faba bean functional food products will increase its raw material prices that will provide a source of income for mountain farmers.
- Lease out of developed Processes.

Achievements:
- Two products Developed i.e.
  1. Lactose free faba bean milk
  2. Faba bean meat
- Proximate, mineral and vitamin analysis of faba bean completed.
- Organoleptic, proximate, mineral and vitamin analysis of developed products (Lactose free faba milk and Faba bean meat) completed.
- Shelf life study of developed products is under progress.
- Trials for development of protein enriched baby food are under progress.

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Name of Laboratory/Centre/Unit:
Aflatoxin Laboratory, Food & Biotechnology Research Centre, PCSIR Laboratories Complex, Lahore

Title of Project: Development of Value Added Products for Dogs and Cats by using Indigenous Resources

Name & Designation of Project Leader:
Dr. Naseem Zahra, SO

Name & Designation of Project Associate (s):
Dr. Syed Hussain Imam Abidi, Chairman-PCSIR
Dr. Qurat-ul-Ain Syed, CSO
Dr. Asma Saeed, CSO
Dr. M. Khalid Saeed, PSO

Area(s) of Research:
Pet Industry

Duration:
02 Years

Date of Initiation:
2023

Project Brief:
Pet will need food constantly which should be vital

to keep up with pet's food needs. Depending on the kind of food, the brand, and the quality, the price may change. The humanization of pets is the key trend driving the pet food market. Many pet owners are looking for pet food that reflects their own taste. As a result, there has been an increase in premium products - with 'natural', 'raw' and 'organic' food on the rise – giving lots of choice for owners. Premium, luxury, healthy and functional foods are moving into the mainstream as owners seem more focused on their pet's diet. The pet food industry is continuously growing to stay ahead of consumer demands. Europe is considered as one of the leaders in the industry, generating around 30% of the total pet food and pet care sales, worldwide. The rise of both pet food expenditure and pet ownership in recent years shows the strong worldwide involvement that owners have with their pets. The pet market is therefore highly emotive. Numerous manufacturers of different pet foods are developing complementary; wet, dry, snacks & treats or raw. Pakistan is importing pet food and spends a lot of expenditure every year. In Pakistan, the trend is exponentially on the rise as people have become more aware. They're learning about pet care, different kinds of foods and their composition. PCSIR can help in this scenario to save foreign exchange consumed on pet food import from other countries especially Thailand and China.

The objectives of the project are;

- To prepare different pet food (cats and dogs) products using different indigenous ingredients.
- To check physico-chemical and nutritional aspects of prepared pet food
- To save foreign exchange consumed on pet food import

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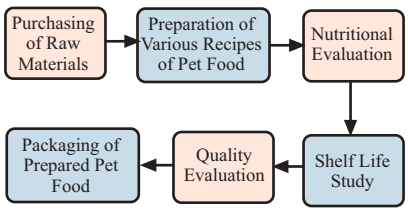

Funding Source (PSDP/SGI/RD&I etc):

In-House

Cost:

Tangible Outcome:

- This project will be helpful for flourishing the pet food industry by getting support from PCSIR.
- This study will help Pakistani supermarket consumers who own pets to expand current knowledge of the decision making process and more specifically the influence of demographic characteristics, consumer trends and product attributes.
- It will provide practical benefit to pet food manufacturers and pet food marketers. Identification of reason for pet food purchasing choices, the evaluation of pet food product attributes as well as involvement level with pets and subjective knowledge will assist pet food manufacturers in their decision making of marketing and product development.

Achievements:

- Different dog food recipes (dog biscuits from indigenous cheap materials, chicken meat balls, beef baked chunks for dog, puppy biscuits) have been prepared.
- Cat biscuits with different recipes have been prepared and nutritional and toxicological analysis of cat biscuits has been done.
- Hemp cat and dog biscuits have been developed.
- Work is in progress

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Name of Laboratory/Centre/ Unit:

Meat & Dairy Testing Labs, Food & Biotechnology Research Centre, PCSIR Laboratories Complex, Lahore

Title of the Project: Development of Techniques/ Methods for Shelf Life Study and Enhancement of Different Food Products

Area of Research:

Food and Nutrition

Name and Designation of Project Leader:

Dr. Khurram Shahzad, PSO

Name and Designation of Project Associates:

Dr. Salman Saeed, PSO
Dr. Shaista Nawaz, SSO
Dr. Abdul Ahid Rashid, SSO

Area of Research:

Food Preservation/Safety

Duration:

02 Years

Date of Initiation:

2022

Project Brief:

Food products are mostly perishable with a short shelf life. Part of the product development cycle is to set its suitable shelf life. Due to ever increasing population, the demand for microbiologically safe, convenient food with a long shelf life is increasing on daily basis. Food safety and product shelf life are inextricably linked. Shelf life is a guide for the consumer that describes for how long that food can be kept in defined storage conditions before it starts deterioration. Shelf life testing describes how long a food will retain its quality during storage. A separate shelf life study needs to be carried out for each type of food product. Two main methods used are direct (real-time study model) and indirect (accelerated storage or predictive microbiological modeling) methods.

Most of the local manufacturers/SMEs do not have the basic infrastructure for quality assurance as well as shelf life assessment of their products. Being one of the main objective of PCSIR is to help the local industry, this project was designed to establish a facility to estimate a realistic shelf life and date mark for a food product by developing new techniques/methods, which may help to ensure the safety and quality with an increased shelf life of valued food products.

Funding Source (PSDP/SGI/RD&I etc.):

In-House

Cost:

Tangible Outcomes:

As shelf life of the food products is one of the important parameters for keeping their quality, this project may be helpful for the Establishment/Up gradation of the facility for developing techniques/ methods for shelf stability estimation as well as enhancement of different food products manufactured by local industry to provide their consumers with safe and quality packed products having long shelf life. The main objective of this project is to establish a facility to estimate a realistic shelf life and date mark for a food product by developing new techniques/ methods, which may help to ensure the safety and quality of valued food products sold with the following main features;

- Meet any nutritional claims provided on the label by keeping its appearance, odor, texture, and flavor intact
- Long shelf life with defined stability under recommended storage conditions
- 100% natural, with no preservatives or additives added
- Convenient and easy handling
- Less likely to carry disease-causing bacteria
- Ready to use with less transportation cost
- Vast export as well as local market potential

Achievements:

- Since the initiation of the project, a total of 6 processes regarding shelf life studies/ enhancement of different food products like meat, bakery, snacks products, salt etc., have been developed and leased out to the concerned Clients.
- Shelf life enhancement of Chicken meat at refrigeration temperature utilizing Natural Preservatives has been initiated.

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Name of Laboratory/ Centre/ Unit:

Meat & Dairy Testing Labs, Food & Biotechnology Research Centre, PCSIR Laboratories Complex, Lahore

Title of the Project: Development of Halal Pancreatin from Slaughter House Waste

Name and Designation of Project Leader:

Dr. Shaista Nawaz, SSO

Name and Designation of Project Associates:

Dr. Khurram Shahzad, CSO
Dr. Salman Saeed, PSO
Dr. Abdul Ahid Rashid, SSO

Area of Research:

Functional Food/Neutraceutical

Duration:

01 Year

Date of Initiation:

2023

Project Brief:

Enzymes are protein like substances which act as catalysts in the body and play important role in different metabolic functions of the body. Some enzymes are used therapeutically and are marketed as nutritional supplements. Pancreatin is a mixture of digestive enzymes (proteins) that mainly consists of amylases, lipases and proteases. It is normally secreted by pancreas as pancreatic juice, which plays an extremely important role in human digestive system for digesting fats, proteins and sugars. Under normal circumstances, the pancreas secretes sufficient amount of these enzymes, but when pancreas is not functioning properly like in chronic pancreatitis and cystic fibrosis or partially removed such as surgical pancreatectomy, then lesser amount of pancreatic enzymes are secreted. Thus Pancreatin has to be supplemented orally and it may be provided from animal source. It is used as medicine to treat digestion problems that result when the pancrease has been removed or it is not working properly. It is used for intestinal gas (flatulence) or as a digestive aid. It may also be used to treat a condition called steatorrhea (loose, fatty stools). It has been claimed to help with food allergies, celiac disease Auto immune disease, weight loss and cancer. Some common side effects of pancreatin may include: nausea, mild stomach pain; diarrhea; or mild skin rash. Pancreatin is generally prepared from mammalian pancreas (pigs or cow) and usually Porcine (Pork/Pig) pancreas is preferred worldwide, due to its higher amylolytic and lipolytic activities. However, it cannot be consumed in Muslim world as consuming Halal is a divine obligation and an essential part of the Islamic faith. Therefore, Halal pancreatin developed from Pancreas of Halal animals is of particular importance in Islamic as well as public health perspectives. The main objectives of this project are;

- To develop in house technology for pancreatin preparation at lab scale
- Utilization of slaughter house waste
- To prepare pancreatin from Halal animal by product as import substitute

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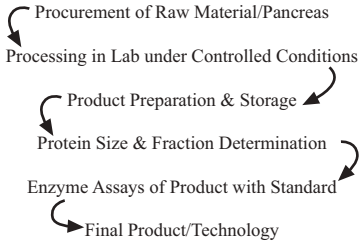

Funding Source (PSDP/SGI/RD&I etc.):

In-House

Cost:

Tangible Outcomes:

- Development of an indigenous technology/product for Halal pancreatin at lab scale by utilizing slaughter house waste which may help to substitute imported non-Halal pancreatin products.

Achievements:

- Literature Survey
- Procurement of the raw materials and chemicals
- Trails initiated for production of product in the powdered form utilizing freeze drying technology

★ ★ ★ ★

Name of Laboratory/ Centre/Unit:

Nutrition Lab/ FBRC

Title of Project: Formulation of Nutritionally Enriched Gluten Free Products for Gluten Intolerants

Name & Designation of Project Leader:

Ms. Shumaila Usman, SSO

Name & Designation of Project Associates:
Dr. Saima Nazir, SSO
Ms. Ammara Yasmeen, SO

Area of Research:
Food Science & Nutrition

Duration:
01 Year

Date of Initiation:
2023

Project Brief:

Celiac disease is a permanent intolerance to specific storage proteins in various cereal grains like wheat (gliadin), barley (hordein) and rye (secalin) which are collectively called gluten. Ingestion of gluten causes damage to the small intestinal mucosa by an autoimmune mechanism in genetically susceptible individuals. This can lead to a various symptoms and nutritional deficiencies. A gluten free diet is currently the only effective means of treating the individuals with celiac disease. Consuming such diet enables celiac patients to control their symptoms and avoid various complications associated with this condition. However, gluten removal results in major problems for bakers and currently many gluten free products available in the market are of low quality exhibiting poor mouth-feel and flavor. Thus, an increasing trend in research is focusing on the application of alternative grains and other gluten free sources potentially healthy to develop gluten free products. The most consistent is the use of cereals (rice, corn and sorghum) minor cereals (fonio, teff, millet) or pseudocereals such as amaranth, buckwheat and quinoa. Health food plays an important role in health improvement in celiac disease in which the only treatment includes nutritional therapy. Specific considerations are important when designing such health food products. Various factors should be kept in mind such as health problems, current demand, cost and acceptability. Therefore, an attempt has been made by keeping in mind all the considerations which play an important role in the development of health foods for celiac patients. As mentioned above main protein fractions of gluten; glutenin, and gliadin, play a key role in baking quality characteristics, being responsible for water absorption capacity, cohesive ability, viscosity, and elasticity of dough. Hence, gluten removal results in major problems especially for bakers in terms of quality. A part from this, other challenges faced by the developers include safety of the product, its acceptability and affordability and being in line with the guidelines approved by FDA (Food and Drug Administration). So, keeping all these view points, there is excessive need of developing gluten free nutritionally enriched products and several considera-tions to be followed while developing any these products for gluten intolerants.

Development of gluten free products is needed for celiac patients, intolerant to specific wheat protein gluten. Which will help to fulfill daily protein needs of body, as wheat is staple cereal in Pakistan. Technical and Physico Chemical Evaluation of material used for development of gluten free flour standard protocols. The main objectives are;

- Baking techniques used for products development.
- To develop gluten free products for gluten intolerants
- To progress nutritional management strategy plan to handle any intolerance rather than avoiding
- To improve the nutritional and sensory characteristics of gluten free products

Funding Source (PSDP/SGI/RD&I/etc):
In-House

Tangible Outcomes

- Process Development
- Technical Report submission
- Paper Publication

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Name of Laboratory/Centre/Unit
APC&IC, PCSIR, LLC

Title of Project: Physical Properties of Solutions and Development of Standards for Instruments

Name & Designation of Project Leader:
Dr. Zeeshan Ali, CSO

Name & Designation of Project (Associate (s):
Ms. Samina Tariq, PE
Mr. Hamid Iqbal, SO

Area(s) of Research:
Instrumentation

Duration:
02 Years

Date of Initiation:
2023

Project Brief:

The physicochemical properties of solutions for the development of standards are essential for calibration of industrial and clinical laboratory instruments. The analytical measurements i.e., photometry, conductometry, viscometry, voltametry, thermo gravimetery, turbididometery etc., are frequently used in industrial, clinical labs and instrumental standardizations are common practices. The research work is being initiated for development of standards for import substitutions, eventually foreign exchange being spent for imports. The basic instrumentations and experimental data are essential for process & product developments. The Center is already engaged in providing industrial calibrations and metrology of basic parameters; temperature, pressure, weights/mass, volumes, dimensions, electrical, time and frequency. The extended scope would have a commercial impact on industrial services. The main objective is;

- Development of standards range for pH, Conductometers, Viscometers, Turbidity meter, Moisture analyzers etc

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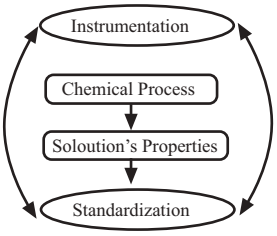


Work Plan:

- Calibrations of instruments & methods accreditations
- Experimental studies and data of mentioned properties of soloutions
- Lab scaled development of standards
- Evaluations of standards
- Commercialization of products

Funding Source (PSDP/SGI/RD&I/etc):
In-House

Cost:

Tangible Outcome:

- Standard reagents for instruments
- Calibration of instruments
- Application for industrial & clinical labs

Achievements:

- Calibration of pH Meter
- Standard pH Reagent

★ ★ ★ ★

Name of Laboratory/Centre/Unit
APC&IC, PCSIR, LLC

Title of Project: Solar Chemical Process Design & Development of Biofuels

Name & Designation of Project Leader:
Dr. Zeeshan Ali, CSO

Name & Designation of Project Associate(s):
Mrs. Samina Tariq, PE
Mr. Tanvir Ahmed, SSO
Mr. Muhammad Munir, SSO
Mr. Hamid Iqbal, SO
Mr. Usman Alvi,SO
Mr. Khalil-ur-Rehman, SO

Area(s) of Research:
Solar Energy

Duration:
02 Years

Date of Initiation:
2023

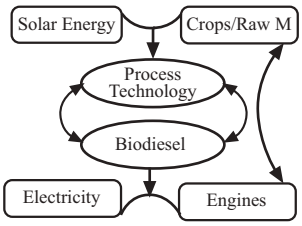
Project Brief:

The world fossils fuels are continuously decreasing, the fluctuating oil prices and environmental impacts have intensified the search for alternative biofuels as a renewable, biodegradable/eco-friendly fuels. The chemical process design and development for biofuels is vital for techno feasible production of fuels at rural areas. The detailed work on biodiesel production through chemical process of fixed oils/fats is being optimized. The work on solar energy assisted chemical process design and development is initiated to minimize the process energy cost and availability of agro based fuels at remote and rural areas. Feasible process of biodiesel production for agricultural equipments/ machinery, engines etc. In-edible oils bearing crops, agrowaste materials, industrial byproducts, waste frying oils, animal/poultry fats etc., may be chemically processed for bio fuels.

The main objectives are;

- Low cost fuel production technology
- Eco friendly fuel for diesel engines
- Fuel production for agricultural equipments/ machineries
- Agro based fuel production for rural developments

Graphical Abstract:



Work Plan:

- Laboratory process development
- Solar energy based chemical process
- Fuel evaluations and applications
- Product development
- Process prefeasibility studies
- Commercialization of technology

Funding Source (PSDP/SGI/RD&I/etc):

In-House

Cost:

Tangible Outcome:

Low cost solar based biofuel technology for rural areas and agricultural farms applications

Achievements:

Conventional process technology is developed

★ ★ ★ ★

Name of Laboratory/Centre/Unit:

APC&IC, PCSIR, LLC

Title of Project: Development of Pressure Standards for Medical Oxygen

Name & Designation of Project Leader:

Dr. Zeeshan Ali, PSO

Name & Designation of Project Associate(s):

Mr. Usman Alvi, SO
Mr. Khalil-ur-Rehman, SO

Area(s) of Research:

Instrumentation

Duration:

01 Year

Date of Initiation:

2023

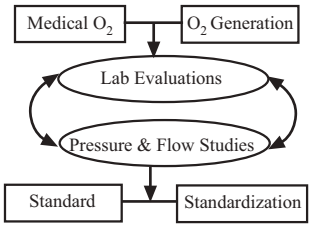
Project Brief:

The accuracy of gaseous or liquid flow meters and pressure indicators are not only industrially important for process optimization but also for healthcare products such as medical oxygen ventilators. The concentrations, pressures and flows of fluids are proportional. The detailed studies are in process for Oxygen standards and standardizations of medical equipments. The standard pressure and flow metrology of sensitive medical equipments. The Center is already engaged in providing industrial calibrations and metrology of fluids pressure and flows. The work is being initiated for scope extension and services in the healthcare sector. Main objectives of the projects are as under;

- Standards development
- Pressure and flow measurements

- Standardization of healthcare equipments

Graphical Abstract:



Work Plan:
- Development & evaluations of standard
- Pressure and flow meterology of Oxygen
- Standardization of medical equipments
- Commercialization & Calibration services.

Funding Source (PSDP/SGI/RD&I/etc):
In-House

Cost:

Tangible Outcome:
- Standards development for healthcare applications
- Standardization of medical equipments
- Product commercialization & healthcare services

Achievements:
- Pressure metrology and calibrations

★ ★ ★ ★

Name of Laboratory/Centre/Unit:
Minerals Testing Laboratory/ Minerals Processing Research Centre (MPRC)/ PCSIR Labs Complex, Lahore (LLC)

Title of Project: Process Development for the Extraction of Precious Elements Platinum (Pt) and Palladium (Pd) from Ores and Metals/Electronic Wastes

Name &Designation of Project Leader:
Ms. Uzma Zafar, PSO

Name & Designation of Project Associates:
Mr. Arif Bhatti, PSO

Area(s) of Research:
Minerals/Metallurgy

Duration:
01 Year

Date of Initiation:
2023

Project Brief:
The most valuable ore deposits contain metals crucial to industry and trade, along with "precious metals" which are rare naturally occurring metallic elements of high economic value. The best-known precious metals are gold and silver, other precious metals include the platinum group metals (PGM): ruthenium, rhodium, palladium, osmium, iridium and platinum. These metals make up essential components of electronic devices. The demand for precious metals is driven not only by their practical use but also by their role as investment, because precious metals have much higher prices than common industrial metals. The properties of these metals make them ideal for recycling and reuse instead of sitting in landfills. However, feasible extraction and recovery process cannot be uniform for all available resources, require several processing steps before the metal extraction process can begin, combined with purification technologies, including solvent extraction and electrowinning. Therefore, the present work aims for the process development for the extraction of precious elements Platinum (Pt) and Palladium (Pd) from ores, metals/electronic wastes.

Funding Source (PSDP/SGI/RD&I/etc):
In-House

Cost:

Tangible Outcome:
- There are multiple ecological benefits for effectively recovering metals from these devices from reducing the economic burden of electronic recycling to reducing the demand for mining ore.
- As the metals recovery from these wastes becomes more feasible and more strictly regulated, sustainable green technologies will be developed with the goal to make recycling simple and more efficient for well-preserved environment.

Achievements:

- Process for the extraction of silver, gold and copper from electronic waste has been developed

★ ★ ★ ★

Name of Laboratory/ Centre/ Unit:
Mineral Processing Research Centre, PCSIR (LLC)

Title of Project:Recovery of Oxides of Lead from Spent Lead Acid Batteries for their Safe Disposal

Name & Designation of Project Leader:
Ms. Samreen Zahra, PSO

Name & Designation of Project Associate(s):
Mr. Ansar Mahmood, SSO
Mr. Rashid Mahmood, SO

Area(s) of Research:
Minerals

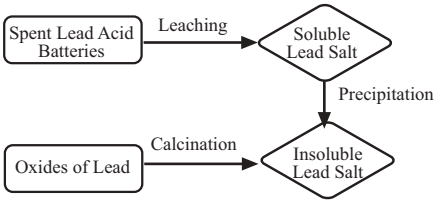
Duration:
1½ Year

Date of Initiation:
2023

Project Brief:

Lead acid batteries are widely used in transportation, communication and power. Their demand is increasing year by year, as a result of which a large number of spent lead acid batteries has been generated. Due to the large quantities of lead present, spent lead acid batteries have been declared as hazardous waste since lead has serious adverse effects on the human health. Hence, their improper disposal can cause severe environmental problems. This project is therefore aimed at the recovery of lead as oxides of lead from spent lead acid batteries for their safe disposal.

Graphical Abstract:



Funding Source (PSDP/SGI/RD&I/etc.):
In-House

Cost:

Tangible Outcome:

- Conversion of lead waste to its value added products
- Saving the natural resources of lead
- Import substitution

Achievements:

- Leaching of soluble salts
- Precipitation of lead salts

★ ★ ★ ★

Name of Laboratory/ Centre/ Unit:
Mineral Processing Research Centre, PCSIR (LLC)

Title of Project: Lithium Ore Evaluation, Beneficiation and Preparation Lithium Based Chemicals

Name & Designation of Project Leader:
Dr. Irfan Hafeez, PSO

Name &Designation of Project Associate(s):
Mr. M. Arif Bhatti, PSO

Area(s) of Research:
Mineral/Chemicals

Duration:
1½ Year

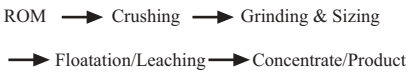
Date of Initiation:
2023

Project Brief:

Lithium is a soft, silvery-white, metal. Mostly lithium may be extracted from five types of ores, pegmatite spodumene, as well as to lesser extent, from amblygonite, lepidolite and petalite. Lake brines and

playa evaporites also contain lithium. Chile has the world's largest known lithium reserves; other countries include Australia, Argentina and China. In Pakistan, there are no authentic/estimated deposits of lithium ore. However, its presence is being explored by local persons like pegmatites of Chitral and Gilgit, super arid salt lakes of Chagai and Sindh. Other well defined deposits are present in Azad Kashmir area. Lithium has applications in batteries of electric vehicles, smartphones, cars and other equipments. Lithium ore processing methods are hand-selection, flotation, chemical leaching and flotation. In present investigation, indigenous sample of lithium ore will be evaluated and beneficiated up to maximum, using suitable techniques along with its utilization for chemical preparation like lithium carbonate on bench scale.

Graphical Abstract:



Funding Source (PSDP/SGI/RD&I/etc):

In-House

Cost:

Tangible Outcome:

Presently, all the lithium containing batteries/ concentrates are being imported from different countries. The investigation/Technology will be a better substitute to reduce the import and useful for Local Mineral Based Industry.

Achievements:

- Literature survey has been conducted for extraction of lithium.
- The ore samples of different area have been chemically evaluated.
- Ore of Chitral area revealed that it has lithium 0.06%.
- Investigation is in process to extract lithium contents in the form of lithium carbonate.

★ ★ ★ ★

Name of Laboratory/Centre/Unit:

Upgraded Modernized Workshop (UMW), PCSIR Laboratories Complex, Lahore

Title of Project: Development of Duckweed Based Fish Feed Supplement

Name & Designation of Project Leader:

Engr. Ali Imran, JE

Name & Designation of Project Associate(s):

Dr. Naseem Zahra, SO

Dr. Awais Ali, Project Consultant

Area(s) of Research:

Feed Industry

Duration:

1½ Year

Date of initiation:

2023

Project Brief:

Duckweed belongs to Lemnaceae family and is known as smallest specie of flowering plants i.e. macrophytes. Duckweed floats on or just beneath the surface of freshwater and wetlands. It is protein enriched source. They may produce larger quantities of protein rich biomass. Duckweed is consumed as human food in some poor areas of South Asia like Thailand, Myanmar and Laos. In Israel, it is also cultivated as vegetable. Duckweed is widely accepted as best animal feed internationally. It has also potential of reducing chemical loads in facultative sewage lagoons. These plants are used as food for fresh/pond water animals and fish.

It is expected that world population may rise from 6.7 billion in 2006 to over 9.0 billion in 2050 (UN population division, 2007). With drastic increase in population, the demand of protein rich food will also increase. It is imperative now to explore protein rich sources in order to tackle with future drastic conditions. All the issues regarding protein rich food and feed will

rise in future. As a result of which resource base for livestock may shrink and cost of feeding non-ruminant may become unaffordable, so it is dire need to search other protein sources which are cheap and easy to grow, produce food, feed and their related products. This study will entail the Duckweed for development of fish feed supplement.

Funding Source (PSDP/SGI/RD&I etc):

In-House

Cost:

Tangible Outcome:

- Technical report
- Research article
- Patent filling
- Supplement Utilization in Fish Feed

Achievements:

Paper Published

★ ★ ★ ★

Name of Laboratory/Centre/Unit:

Upgraded Modernized Workshop (UMW), PCSIR Laboratories Complex, Lahore

Title of Project: Design and Development of Hemp Fiber Extractor

Name & Designation of Project Leader:

Engr. Ali Imran, JE

Name & Designation of Project Associate (s):

Dr. Syed Imam Hussain Abidi, Chairman-PCSIR
Dr. Quratulain Syed, Director General-LLC
Engr. Arslan Ali, Sr. Tech.
Dr. Awais Ali, Hemp Consultant

Area(s) of Research:

Feed Industry

Duration:

02 Years

Date of Initiation:

2023

Project Brief:

Hemp, is also known as industrial hemp.The hemp plant variety *Cannabis sativa* cultivated for its fiber, does not have any psychoactive effects. Many strains of hemp have no associated mental effects. This type of industrial hemp has been used as a fiber source, for oil production, and as an important source of nutrition for thousands of years. As hemp becomes a key part of the mainstream fashion industry, people drawn towards reinventing its fibers to ensure their clothing is also carbon-dated. After all, hemp was one of the oldest plants — around 8,000 BC old. Hemp fiber is light weight and pretty breathable. Pakistan is lacking in Hemp by products utilization and similar is the case for hemp fiber utilization specially when Pakistan is agriculture-based country and textile and its products have more then 25% contribution in its GDP. This Study encompases machine development that will bring the self-reliance step in Hemp Fiber production.

Funding Source (PSDP/SGI/RD&I etc):

In-House

Cost:

Tangible Outcome:

- Machine Development through Indigenous Resources
- Technical Report & Patent filling
- Basic Hemp Fiber Extraction Process Development

Achievements:

- Design report completed.
- Patent is in pipeline

★ ★ ★ ★

Name of Laboratory/Centre/Unit:
Upgraded Modernized Workshop (UMW), PCSIR Laboratories Complex, Lahore

Title of Project: Development of Bacterial Cellulose as a Neurosurgical Haemostatic Agent Through Different Processing Techniques

Name & Designation of Project Leader:
Engr. Ali Imran, JE

Name & Designation of Project Associate (s):
Dr. Quratulain Syed, Director General-LLC
Dr. Naseem Zahra, SO
Dr. Awais Ali, Hemp Consultant

Area(s) of Research:
Pharmaceutical, Surgical Industry

Duration:
1½ Years

Date of Initiation:
2023

Project Brief:
A major concern during neurosurgical procedures such as craniotomies and spinal surgeries is the loss of blood when an artery or a vein is accidentally cut. Injuries spanning a few cubic millimeters can result in impairment of neurological functions. The blood that flows out of the vessels can also impede the surgeon's field of vision, which can cause inability to see the very tissues they are trying to fix. Clearly, this is a problem where the stakes are very high and so the efforts made to overcome this problem have been equally remarkable. Several neurosurgical haemostatic agents have been employed over the past years, each corresponding to a peculiar demand of the same problem i.e. blood loss. The purpose of this experiment was to investigate the absorption efficacy of bacterial cellulose which is crucial for haemostatic applications.

Funding Source (PSDP/SGI/RD&I etc):
In-House

Cost:

Tangible Outcome:
- Development of Haempstatic Agents
- Technical Report & Paper Writing

Achievements:
Paper is in process

★ ★ ★ ★

Name of Laboratory/Centre/Unit:
Upgraded Modernized Workshop (UMW), PCSIR Laboratories Complex, Lahore

Title of Project: Piezo Enhanced Activity for Waste Water Treatment from BNT/KNN Ceramics

Name & Designation of Project Leader:
Engr. Ali Imran, JE

Name & Designation of Project Associate (s):
Mr. Muhammad Atif, Sr. Tech.
Engr. Arslan Ali, Sr. Tech.

Area(s) of Research:
Advance Engineering Materials

Duration:
1½ Years

Date of Initiation:
2023

Project Brief:
All the new materials are a competitor with lead-based ceramics that must be stable at high temperature, sintered at low processing temperature and have high degree of electric, magnetic, and piezoelectric properties. This can be done by doping to enhance the performance with replacing lead-based materials. Correspondingly, industries are looking for replacing lead-based materials with lead free components for large-scale commercial applications. In this context, impedance studies of ceramics with adding amount of CuO to improve its sintering were carried out to study the structure property relationship of the Lead Zirconate Titanate (PZT) free materials. It is to design the components for the application-based properties and are considered one

of the key electronic materials for the applications of actuators, sensors, energy storage capacitor applications, switching andsensing device, nanoposioning, piezocatalysis, nanosensors and energy harvesting. The toxicity of lead, including environmental risks during mining, PbO evaporation during calcination and sintering and disposal, restricted use of Lead Zirconate Titanate (PZT) around the globeStrong driving force toward the research of non-toxic replacements brought several substituents, e.g., K0.5Na0.5NbO3 (KNN), and Bi0.5Na0.5TiO3 (BNN). Mostly it is synthesized by a solid-state method that has a perovskite structure and has a range of properties like residue polarization (Pr), piezoelectric response, energy density piezoelectric strain, thermal stability, coercive field (Ec), conductivity, piezoelectric coefficient (d33), P-E hysteresis loop and Curie temperature (Tc). these will be evaluated after the doping of KNN and BNT.

Funding Source (PSDP/SGI/RD&I etc):
In-House

Cost:

Tangible Outcome:
- Development of Piezoelectric Material
- Utilization in Waste Water Treatment
- Technical Report & Paper Writing

Achievements:
- Experimentation in Process
- Review Paper write up completed and Submitted for Publication
- Result analysis in Process
- Patent in pipeline

★ ★ ★ ★

Name of Laboratory/Centre/Unit:
Upgraded Modernized Workshop (UMW), PCSIR Laboratories Complex, Lahore

Title of Project: Shrimp Farming by Using Biofloc Technology

Name & Designation of Project Leader:
Engr. Ali Imran, JE

Name & Designation of Project Associate(s):
Dr. Imam Hussain Abidi, Chairman-PCSIR
Dr. Quratulain Syed, Director General-LLC
Dr. Awais Ali, Consultant
Engr. Arslan Ali, Sr. Tech.
Egnr. Sheraz Yousaf, Sr. Tech.

Area(s) of Research:
Biofloc Aquaculture Forming

Duration:
02 Years

Date of Initiation:
2023

Project Brief:
Biofloc Technology (BFT) is considered as the new "blue revolution" in aquaculture. In a world where more than 800 million people continue suffering from chronic malnourishment and the global population is expected to grow by another 2 billion to reach 9.6 billion people by 2050, it is important to meet the huge challenge of feeding our planet while safeguarding its natural resources for future generations. On the other hand, global aquaculture has yet to face some serious challenges. For instance, aquaculture has been accused of being an unsustainable activity, because it includes the competition for land and water, the introduction of exotic species around the globe, the overexploitation of ocean fish stocks to obtain fishmeal and oil, and the dispersion of pathogens. In Biofloc, nutrients can be continuously recycled and reused in the culture medium, benefited by the minimum or zero-water exchange. Also, the sustainable approach of such system is based on the high production of fish/shrimp in small areas. In addition, the bioflocs is a rich protein-lipid natural source of food available *insitu* 24 hours per day due to a complex interaction between organic matter, physical substrate, and large range of microorganisms. This natural productivity plays an important role in recycling nutrients and maintaining the water quality. The consumption of biofloc by shrimp or fish has demonstrated numerous benefits such as improvement of growth rate, decrease of FCR, and associated costs in feed.

Funding Source (PSDP/SGI/RD&I etc):
In-House

Cost:

Tangible Outcome:
- Production of shrimp by using minimum resources
- Production of high quality shrimps to cope with malnutrition.
- Prototype for small and medium aquaculture farmers.

Achievements:
- Already have 42000 liter Tank
- Successfully trialed the *Pangasius* fish in RAS
- Aeration System Installed

★ ★ ★ ★

Name of Laboratory/Centre/Unit:
Upgraded Modernized Workshop (UMW), PCSIR Laboratories Complex, Lahore

Title of Project: Development of Fast Breeding of *Pangasius*

Name & Designation of Project Leader:
Engr. Ali Imran, JE

Name & Designation of Project Associate (s):
Dr. Imam Hussain Abidi, Chairman (PCSIR)
Dr. Quratulain Syed, Director General-LLC
Dr. Awais Ali, Consultant
Engr. Arslan Ali, Sr. Tech.
Engr. Sheraz Yousaf, Sr. Tech.

Area(s) of Research:
Bio Floc Aquaculture Forming

Duration:
03 Years

Date of Initiation:
2023

Project Brief:
Pangasius sp is commonly called as river or silver stripped catfish, Siamese shark, sutchi catfish, or swai catfish. This fish species live in freshwater and endemic to the Mekong basin. It is a riverine catfish belonging to the members of the family Pangassidae. It exhibits fast growth when cultured, given a good environment. It is cultured due to its good market demand, fast growing; few countries dominate the culture production, and being the third most important freshwater fish group within aquaculture sector. *Pangasius* is now cultured in several countries in the world like Thailand, Nepal, Pakistan, India, Bangladesh, Vietnam, Laos, Maynmar, Indonesia, and Cambodia. *Pangasius* is an air-breathing fish that can tolerate low Dissolved Oxygen (DO) content in the water and can be cultured in ponds, concrete tanks, fish cages or pens. Unfortunately this specie is not famous among Pakistani farmers due to:
- Lack of awareness
- Unavailability of *Pangasius* seed
- High cost of *Pangasius* seed

To resolve these issues a project is designed to breed and market *Pangasius* seed at low price for its promotion and farming at large scale. Pakistani farmers have limited choice of fish species to culture which is the basic problem affecting the growth of aquaculture industry.

A special project is designed at LLC for developing an efficient artificial breeding technology for Males and females *Pangasius* fish growth at similar rates, with the reproduction temperature between 26 and 28°C. The spawning period is between February and October, with the age of sexual maturity known to be 3 - 3.5 years. *Pangasius* are also highly fecund; females can produce up to 80,000 eggs/kg and can be spawned several times.

Funding Source (PSDP/SGI/RD&I etc):
In-House

Cost:

Tangible Outcome:
- Development of an efficient artificial breeding method.
- Aquaculture farmers awareness
- Production of *Pangasius* seed large scale
- Promotion of *Pangasius* specie in Pakistan

Achievements:

- Already have 100,000 liter Tank
- Successfully trialed the *Pangasius* fish in RAS
- Aeration System Installed
- More then 1KG weight has been achieved by the *Pangasius* that is raring at LLC
- 50 breeders are separated in 42,000 liter tank maturity time will start in mid 2025.

★ ★ ★ ★

Name of Laboratory/ Centre/ Unit:

Upgraded Modernized Workshop, LLC

Title of Project: Production of Refused Derived Fuel (RDF) by Using Hemp Waste/By-product

Name & Designation of Project Leader:

Engr. Ali Imran, JE

Name & Designation of Project Associate(s):

Dr. Syed Hussain Imam Abidi, Chairman-PCSIR
Dr. Quratulain Syed, Director General-LLC
Mr. Muhammad Atif, Sr. Tech
Engr. Arslan Ali, Sr. Tech.
Mr. Sheraz Yousaf, Sr. Tech.

Area(s) of Research:

Industrial Research

Duration:

01-02 Years

Date of Initiation:

2023

Project Brief:

Refused Derived Fuel (RDF) is a type of fuel produced from non-recyclable waste materials. It is typically created by shredding and drying waste materials such as household and commercial waste, industrial waste, and biomass. The resulting RDF can be used as a substitute for fossil fuels in various industries, including cement kilns, power plants, and industrial boilers. RDF offers several benefits. Firstly, it helps reduce the amount of waste sent to landfills, thereby minimizing environmental pollution. Secondly, it provides an alternative energy source, reducing the reliance on fossil fuels and contributing to a more sustainable energy mix. Additionally, RDF production can create job opportunities in waste management and renewable energy sectors. Pakistan belongs to one of the developing countries which is facing fuel crisis. Many industries run short of fuel source which badly affect their production process. Refused Derived Fuel (RDF) can be a potential alternative to fossil fuels in addressing the fuel crisis in Pakistan. The main objective of the project is;

- Production of RDF pallets by using hemp waste/ Biomass

Manufacturing Refused Derived Fuel (RDF) from hemp biomass follows a similar process as creating RDF from other waste materials. Here are the steps involved in manufacturing RDF from hemp biomass;

1. Collection and Sorting: Collect hemp biomass waste from various sources, such as hemp farms, hemp processing facilities, or hemp fiber production sites. Sort the biomass to remove any contaminants or non-biomass materials.
2. Shredding: Use industrial shredders to break down the hemp biomass into smaller pieces. The size of the shredded material may vary depending on the specific requirements of the RDF production facility.
3. Drying: Hemp biomass typically contains a high moisture content, which needs to be reduced to create RDF. Dry the shredded hemp biomass using methods like hot air drying or rotary drum drying. This step is crucial to ensure the RDF has consistent and optimal energy content.
4. Conditioning: After drying, the hemp biomass may undergo additional conditioning processes, such as screening or grinding, to achieve a uniform particle size and remove any remaining impurities.
5. Pelletizing or Briquetting: The conditioned hemp biomass can be further processed into pellets or briquettes for easier handling, storage, and transportation. This step involves compressing the material using pellet mills or briquetting machines. Binders or additives may be used to enhance the pellet or briquette formation, depending on the specific requirements.
6. Quality Control: Perform quality control tests to

ensure that RDF meets the desired specifications and standards (BTU). This may include testing the energy content, moisture content, ash content, and other relevant parameters.

7. Storage and Distribution: Store the manufactured RDF in a suitable facility to maintain its quality and prevent degradation. It's important to note that the manufacturing process may vary depending on the specific equipment and technologies used by RDF production facilities. Additionally, local regulations and guidelines regarding the production and use of RDF should be followed to ensure compliance with environmental and safety standards.

Funding Source (PSDP/SGI/RD&I/etc):
In-House

Cost:

Tangible Outcome:
Distribute the RDF to end-users, such as cement kilns, power plants, or industrial boilers, as a fuel source.

Achievements:
- RDF pellets developed
- Characterization in process

★ ★ ★ ★

Name of Laboratory/ Center/ Unit:
Center for Environment Protection Studies

Title of Project: Scale Up of the Inert Material Development for Heavy Metal Removal from Underground Water at Semi- Pilot Plant Level (LLC, Campus Water Treatment Facility Extension)

Name & Designation of Project Leader:
Dr. M. Hammad Khan, PSO

Name & Designation of Project Associate(s):
Mr. Javed Iqbal, SSO

Area(s) Research:
Material Science for Environmental Issues

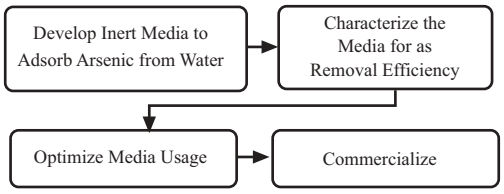
Duration:
02 Years

Date of Initiation:
2023

Project Brief:
Pakistan is forecast to face the water shortage in near future. This requires water purification and wastewater recycling. The membrane technology is the ultimate technology for the water purification. Microfiltration and ultrafiltration technology is required for pretreatment of wastewater. The project is focused to improve the water and wastewater facilities by preparation of membranes. In the PSF project, UF and MF membrane were prepared and characterized for basic parameters and required further characterization and shelf-life testing. High-tech water and wastewater treatment require membranes that are being imported currently. This project is designed to develop indigenous technology of membrane fabrication. Membrane technology separated the particles from liquid phase bawd on the pore size of membranes. Microfiltration and ultrafiltration technology is required for pretreatment of wastewaters. Objective of the project is as;

- Characterize the developed polymeric membranes and test utilization for water purification and other solid/liquid mixtures.

Graphical Abstract:



Funding Source (PSDP/SGI/RD &I/etc):
In-House

Cost:

Timeline:

	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
First Year	Prepared the inert material for the As removal	Tested the material for the As removal from water and morphology and found good As removal but low mechanical stability	Improved the process for stability by altering the raw material and sintering temperature	Tested the modified material and found high As removal with better mechanical stability
Second Year	Tested the material for prolonged As removal and found the material washes out with time on every activation.	Carbonaceous material will be modified with crosslinkers and test for the As removal.	Modify the carbonaceous material with different salts and activate for As removal and test the efficiency.	Improve the carbon modification for better As removal.

Tangible Outcome:

- This project will improve quality of life by facilitating the water purification at low cost and at small scale.

Achievements:

- We prepared an inert material, at lab scale, to remove the toxic heavy metals from underground water, cost effectively.
- The material was tested in batch type and column type reactors.
- A large batch of inert material will be prepared and used to test at semi-pilot plant scale to assess cost efficiency of the process.

★ ★ ★ ★

Name of Laboratory/ Centre/ Unit:

Center for environment Protection Studies

Title of Project: Process Development for Production of Analytical Grade Chemicals (HCl, H_2SO_4, HNO_3 and CH_3COOH, Ammonium Hydroxide Solution) on Lab Scale

Name & Designation of Project Leader:

Dr. M. Hammad Khan, PSO

Name & Designation of Project Associate(s):

Dr. Naeem Abbas, SSO
Dr. Farah Deeba, PSO
Dr. Muhammad Irfan, SSO

Area(s) of Research:

Industrial Chemicals

Duration:

Continuous Project

Date of Initiation:

2021

Project Brief:

Analytical grade mineral acids are routinely used for the testing of various types of samples from different industries such as water, wastewater, dairy, mineral water, food items, glass and ceramic, cement, mineral processing etc. This is a small effort for process development using local raw material for import substitute. The main objective of the project are;

- Import substitute
- To supply the manufactured chemicals to local industry and R & D organization

Work Plan:

- Purchase of Raw material for production of high purity mineral acid for year 2024-25.
- Testing, Quality Control, Packaging and Labeling of Product
- Supply on Demand to LLC research center.

Funding Source (PSDP/SGI/RD&I/etc):

In-House

Cost:

Tangible Outcome:

The production of this developed product will fulfill the requirements of Pakistan Council of Scientific and Industrial Research and save foreign exchange of Pakistan.

Achievements:

Production and quality testing of sulfuric acid (98 %), Nitric Acid (67 %) and hydrochloric acid (36 %) were done along with labelling and packing of acid bottle for their supply in research Centre of LLC.

★ ★ ★ ★

Name of Laboratory/ Centre/ Unit:

Center for Environment Protection Studies

Title of Project: Development of Indigenous Technology to Produce High Fuel From Agro Industrial Waste

Name & Designation of Project Leader:

Dr Muhammad Khalid Iqbal, SSO

Area(s) of Research:

Waste to Energy

Duration:

02 Years

Date of Initiation:

2023

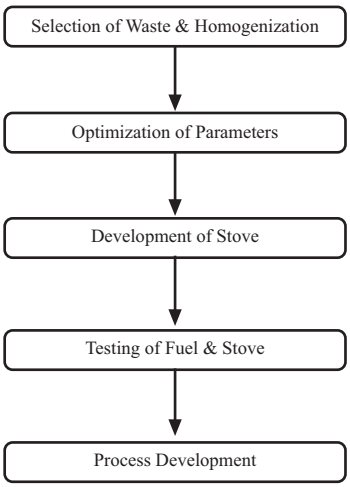
Project Brief:

Today, the world demand for renewable energy source is due to rise in population rate and industrial growth. It leads to a steady rise in waste generation; fast filling up of dumping sites and new areas are becoming scarce. This factor coupled with the decrease in natural reserves led the experts to look at other sources of fuel to compensate the shortage. The energetic valorization of coconut, almond, sludge, husk, bagasse, corn cobs, stem, leaves, pine leaves, and cones could be utilized to obtain energy in consistent manner with little or no rlease of greenhouse gases. These wastes are renewable energy sources and their use in original form is not possible. The development of eco-friendly alternative fuel from such waste is one of the applications that can be produced by shredding, mixing and pelleting. This project will develop the confidence of end users by using fuel with minimum emissions, high energy and low cost. Pakistan meets 53 percent of its total energy requirements through indigenous oil and gas production, whereas other indigenous resources further meet 19 percent of the country energy needs. The remaining 28 percent of energy needs are critical and required an alternative energy sources. So it is the need of time to implement in public sector.

The main objectives are;

- To develop a comprehensive indigenous technology for splendid and eco-friendly fuel.
- Development of Low cost and efficient stove for house use.
- Less reliance on commercial fuels.

Graphical Abstract:



Work Plan:

- Selection of waste and its homogenization
- Optimization of parameters like bulk density, particle size, moisture, BTU, compressive strength and particle density.
- Optimize the conditions for stove development.
- Testing shelf life of fuel with stove.

Funding Source (PSDP/SGI/RD&I/etc):

In-House

Cost:

Tangible Outcome:

- Development of Process for energy production from agro-industrial waste

Beneficiary

- Local industry (Herbion Natural) etc**.**

Achievements:

- Development of RDF process from Industrial Coconut Waste.

★ ★ ★ ★

PCSIR Laboratories Complex, Peshawar

New Projects

Name of Laboratory/Center Unit:

Food Microbiology and Mycotoxin Research Section of PCSIR Laboratories Complex Peshawar, Khyber Pakhtunkhwa-Pakistan

Title of Project: Bio-Detoxification and Biodegradation of Aflatoxins in Poultry and Fish Feed Using *Bacillus subtilis*

Name and Designation of Project Leader:

Dr. Javid Ali, SSO

Name and Designation of Project Associate(s):

Dr. Arshad Hussain, PSO
Ms. Hina Tariq, JSO
Mr. Zia Ur Rahman, Sr. Tech.

Area (s) of Research:

Biotechnology

Duration:

01 Year

Date of Initiation:

2024

Project Brief:

Aflatoxins (AFs) are a group of highly toxic and carcinogenic mycotoxins which contaminate food, in general and agricultural products, in particular. Aflatoxigenic fungi can produce toxins on agricultural commodities in the field or even after the harvest. Occurrence of aflatoxins in poultry and animal feed stuffs is quite common in many countries. It can contaminate the feed thereby affecting animal and human health. Mycotoxicosis has been implicated to influence quality of poultry feeds. Poultry is one of the most sensitive groups of livestock to aflatoxicosis. Profitability of poultry production can be greatly affected due to the frequency of feed contamination and the detrimental effects of the aflatoxins on performance of chicken. The consequences of mycotoxin contamination in fish feeding are similar to those found in other animal species intended for human consumption, and they are directly related to production losses, specially reduced weight gain and feed conversion, but also immune impairment and organ lesions. Mycotoxins in aquaculture and fish feed is an emerging and an underestimated problem for the industry. Biological treatments to eliminate mycotoxins, or so-called bio-detoxification strategies, are favored because of their efficiency, specificity, and environmental safety. Beyond suppression of the toxin producing organism, bio-detoxification is a targeted biological method to reduce mycotoxins. This approach includes the application of plant extracts, enzymes, or microorganisms which are able to degrade or bind the mycotoxins

Biological control with the use of microorganisms, is one of the most effective and sustainable post-harvest strategies to control the pathogenic fungi. A wide range of microorganisms are used for this propose of which biologically-active bacteria, especially those belonging to the genus *Bacillus* are well known for their antagonistic properties against different pathogenic fungi. *Bacillus subtilis* (*B. subtilis*) is commonly known as generally recognized as safe (GRAS), which are recognized as biological control agents against a variety of fungi. It was reported that *Bacillus* was found in 21% of the research articles on controlling aflatoxigenic fungi and AFB_1. Because of its fast growth rate, and its ability to produce a wide range of antifungal compounds, *Bacillus* has been widely used in the control of aflatoxigenic fungi and the production of aflatoxins. Currently, probiotic *Bacillus* species are extensively utilized as dietary supplements in food and animal feed to modulate the gut microbiota and improve health and immunity.

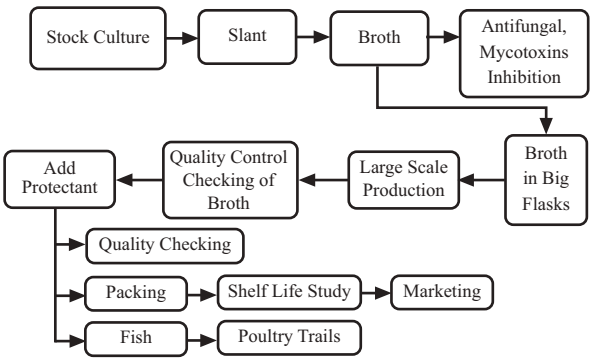
The biological detoxification of mycotoxins, using microorganisms to degrade mycotoxins to non- or less toxic compounds, can be a choice of such technology. The exposition of AFs from contaminated food and feed is a serious threat to human and animal health because of its carcinogenicity, hepatotoxicity and immune suppression as well as it also causes economic losses in agriculture on a global basis. Many physical and chemical measures have been taken to remove or eliminate AFs. However, the required effectiveness,

safety, and nutritional retention have not been achieved. Biological methods have attracted widespread attention because of their many advantages, for example, small losses in product quality, safety, economic and environmental protection, etc. Bioremediation, as a friendly environmental remediation method, can convert toxic substances into nontoxic substances or small-molecule chemicals for assimilation. Microbial degradation has become an effective alternative to AFs reduction because it can degrade and remove toxic substances under mild conditions to avoid the loss of nutritional value of food. *Bacillus subtilis* is one of the bacterial strains which use as a biocontrol agent is well documented. It has been found that this species secretes different antifungal substances into the culture medium. These substances generally belong to lipopeptide compounds which are mainly classified as surfactin, iturin and fengycin families. These lipopeptides are synthesized by nonribosomal peptide synthetases (NRPS) or hybrid polyketide synthases/NRPS in bacterial cells. *Bacillus spp.* could also produce extracellular enzymes capable of degrading chitin or cell walls of fungal mycelium like exo-chitinase, endochitinase, and β-1, 3-glucanase. In the field of detoxification, some researchers have proven the toxin degradation capability of *B. subtilis* strains. However, there are a few published documents about other mechanisms of aflatoxin suppression by *Bacillus* genus. For aflatoxin degradation, the strains could produce some enzymes which would break the aromatic structure of the aflatoxins. Dehydrogenase, hydrolase and laccase are the main toxin degrading enzymes of *Bacillus spp*. which can break or cleave the lactone ring of AFs.

The main objectives are;

- A strain of *B. subtilis* will be isolated from local soil. It will be grown in different culture conditions including different incubation times, temperatures and culture media.
- To develop a process for the production of antifungal and anti-mycotoxin *B. subtilis* based product.
- The development of biological preservatives that can effectively control the growth, toxicity and AFs of *Aspergillus* species in poultry and fish feed.
- To develop an indigenous low cost biotechnological process at national level industry to solve the feed mycotoxin problems.

Graphical Abstract:



Time Line (Quarter Wise Plan):

1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Bacillus subtilis activation, slant, Petri dish growth and mother culture preparation.	Mass production of *Bacillus subtilis,* its ability to check anti-fungal, Aflatoxin production inhibition and Aflatoxin degradation or either cell wall adsorption in liquid medium.	Large scale production of *Bacillus subtilis* cell mass, quality checking and product development.	Quality checking, packing and shelf life study of the end product. The product checking to inhibit and biodegrade AFs in poultry and fish feed.

Funding Sources (PSDP/SGI/RD&I/etc):

In-House

Cost:

Tangible Outcome:

- Development of an indigenous technology/product to control fungal and mycotoxins contamination issues in poultry and fish feed.
- Process designing, patent submission and technical reports writing.
- Research publication in peer-reviewed journals and conference presentations to disseminates the findings to the scientific community.

Achievements:

New Project

★ ★ ★ ★

Name of Laboratory/Center Unit:

Food Microbiology and Mycotoxin Research Section of PCSIR Laboratories Complex Peshawar, Khyber Pakhtunkhwa-Pakistan

Title of Project: Production of Phosphate Solubilizing Bacterial Based Biofertilizer - A Sustainable Approach for Managing Phosphorus Deficiency in Agricultural Soils

Name and Designation of Project Leader:

Dr. Javid Ali, SSO

Name and Designation of Project Associate (s):

Dr. Arshad Hussain, PSO
Ms. Hina Tariq, JSO
Mr. Zia Ur Rahman, Sr. Tech.

Area(s) of Research:

Biotechnology

Duration:

01 Year

Date of Initiation:

2024

Project Brief:

Biofertilizer is defined as a product that contains living microorganisms, which exert direct or indirect beneficial effects on plant growth and crop yield through different mechanisms. Biofertilizers when applied to seeds, soil, or plant surfaces, enhance the availability of plant nutrients and growth stimulus to target crops. Biofertilizers are known to deliver many benefits, including plant nutrition, disease resistance, and tolerance to adverse climatic conditions. During the past few decades, notable progress has been made to explore microbes' potential and for biofertilizer production to enhance agricultural productivity. All biofertilizers are known to be environment-friendly and valuable inputs for the farmers. Their application has been considered an essential component of integrated nutrient management and a potential alternative to chemical-based agriculture due to its vital role in food security and sustainable crop production. Currently, biofertilizer demand and production are gaining momentum, as there is burgeoning passion for organically grown food among the health-conscious societies. Various initiatives and affirmative regulations laid by government institutions and agencies would further be fueling the extension of the biofertilizer market worldwide. Application of these eco-friendly and cost-effective inputs would not only promote growing healthy food, but also help to maintain a sustainable environment and holistic human well-being. Massive utilizations of chemical fertilizer in agriculture sector to improve the farming productivity have created increasing possibility of environmental damages. Severe human health issues, global warming, poor fertility and high cost of soil maintenance are the major side effects of the utilization of inorganic fertilizers and needs immediate attention. During recent high input farming systems and technologies, chemical fertilizers are applied excessively to meet the plant nutrient requirement for increasing the agriculture productivity worldwide. However, only a limited amount (30–40%) of these nutrients is absorbed by the plants due to low fertilizer-use efficiency and rest is lost to soil causing environmental pollution. To overcome these issues, agriculture farming has been shifted towards the development of biofertilizers using natural bio-resources. Biofertilizers have several advantages like low-cost, produced from renewable resources and are highly efficient to improve the productivity of soil and agriculture product. Additionally, bio-fertilizers not only increase the production, nutrients and organic matter but also neutralize the harmful impacts caused by the chemical fertilizers due to the potential combination of the microorganisms with organic wastes. Thus, the production strategy of bio-fertilizers using the combination of sugar cane molasses and scum of Gur/Jaggery, compost, peat, organic natural manure, agro-food food wastes biomass and microorganisms are feasible and low cost.

A group of heterotrophic microorganisms solubilize the fixed phosphorous by producing organic acids, enzymes, biomolecules and make them available to the crops. This group of microorganism is called Phosphorous Solublising Microorganisms (PSM). Phosphate solubilizing bio-inoculants/biofertilizers are prepared from the microbes which solubilize fixed form of phosphate in the soil. The Phosphate solubilising bacterial strains in the starter cultures are needed to be

grown on large scale in fermentor and bioreactor for mass production. Then they will be mixed with a suitable liquid or solid stable carrier. In the current study two bacterial stains (*Bacillus subtilis* and *Bacillus megaterium*) are selected as phospahte solubilizing bacteria to produce a liquid and solid biofertilizers of low cost. The objectives are;

- To develop a process for the production of biofertilizer based on indigenous raw materials sources as carrier.
- To evaluate and optimize different experimental condition for the maximum biomass production of the *Bacillus subtilis* and *Bacillus megaterium*.
- Evaluation of impact of application of the prepared biofertilizer on different indigenous crop's productivity.
- To meet the increasing demand for bio-fertilizer in Khyber Pakhtunkhwa and popularization of this technology in the local community.

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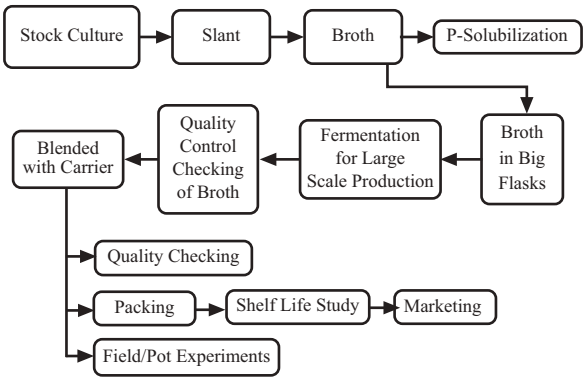


Time Line (Quarter-Wise Plan):

1st Quarter	2nd Quarter	3rd Quarter	4st Quarter
Bacillus sp. collection, characterizati on, growing, mother culture preparation, biomass production and quality checking.	Phosphate solubilization qualitative and quantitative capacity.	Large scale production of *Bacillus* biomass, blending with solid and liquid carrier.	Quality checking of the prepared biofertilizer, field and pot trails experiments of selected vegetables. Packing and shelf life study.

Funding Sources (PSDP/SGI/RD&I/etc):
In-House

Cost:

Tangible Outcome:

- Development of an indigenous technology/products of biofertilizer production at laboratory, pilot plant and industrial level by utilizing local raw material as chief, sustainable and feasible sources.
- Research publication, Patent, process designing and technical reports.
- bio-fertilizer production would employ hundreds of young people in the rural and remote areas.
- socio-economic growth and development will be enhanced
- technology transfer or leased out especially at the village levels.

Achievements:
New Project

★ ★ ★ ★

Name of Laboratory/Centre/ Unit:
Food Nutrition & Biochemistry/Food Technology Centre/PCSIR Laboratories Complex, Peshawar

Title of Project: Development and Physico-chemical Evaluation of Functional Detox Beverages

Name & Designation of Project Leader:
Dr. Abdul Wajid Khalil, SSO

Name & Designation of Associate(s):
Dr. Arshad Hussain, PSO
Mr. Muhammad Saddique, Jr. Engr.

Area(s) of Research:
Food Science Industry and Nutrition

Duration:
01 Year

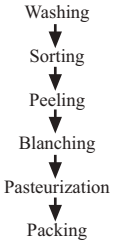
Date of Initiation:
2024

Project Brief:

This project aims to develop and evaluate the nutritional, physicochemical and sensory properties of Detox beverages using a combination of fruits and Herbs. Detox beverages aid in removing toxin and impurities from the body, supporting liver and kidney function. These beverages are rich in antioxidant, which help protect the body against free radicals and promotes a healthy immune system. Moreover, this beverage contributes to daily fluid intake, help in maintaining proper hydration and support overall health. The available beverages in the market have high calories and sugar, and low in essential nutrients. These synthetic beverages contribute to health problems like obesity, diabetes and tooth decay due to high artificial flavor and color. There is a need for innovative and effective detox beverage formulation that addresses specific health concern, such as digestive health and immune function. It may be Substitute of the available synthetic beverages in local market. Objectives are;

- Select suitable fruits and herbs for detox drink development.
- Conduct nutrition and physicochemical evaluation.

Graphical Abstract:



Time Line (Quarter Wise):

1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
• Procurement of seasonal fruit • Pulping & preservation of the collected fruits • Peeling, Crushing, and Extracting Juice from Ginger	• Development of formulations by blending pulp of various fruit with ginger extract • Physico-chemical and antioxidant evaluation of each formulation	• Shelf life studies • Technical report/ Research article	• Pilot production • Commercialization/ marketing/ Process lease out

Funding Source:

In-House

Tangible Outcome:

Process/product development.

Achievements:

New Proejct

★ ★ ★ ★

Name of Laboratory/Centre/Unit :

Materials Science Centre, PCSIR Labs Complex, Peshawar

Title Project: Development of Bone Char Filter for Industrial Waste Water Treatment

Name & Designation of Project Leader:

Dr. Waheed Ur Rehman, SE

Name & Designation of Project Associates:

Mr. Amin Ur Rehman, PSO
Mrs. Asma Yamin, SSO
Mr. Sohail Noor, JTO

Area(s) of Research:

Materials, Environment

Duration:

01 Year

Date of Initiation:

2024

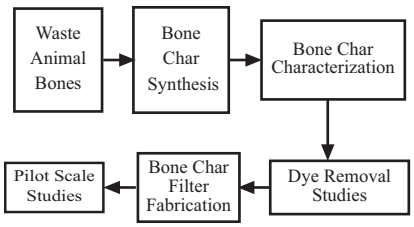
Project Brief:

Wastewater from various industries, particularly textile, contains harmful dyes that pose serious environmental and health risks. Conventional wastewater treatment methods often struggle to effectively remove these contaminants, leading to pollution of water bodies and adverse effects on ecosystems. The development of innovative, cost-effective, and sustainable solution is imperative to address this pressing issue. The proposed project aims to tackle this challenge by exploring the efficacy of bone char as a filtration medium for the removal of contaminants from industrial wastewater.

Industrial waste water often contains hazardous chemicals that, when discharged into water bodies through waste water can contaminate the environment and endanger aquatic life. Therefore, there is an urgent need for the development of efficient and sustainable technologies for the treatment of industrial wastewater. Bone char, a porous carbonaceous material derived from the carbonization of animal bones, has shown promising potential as an adsorbent for various contaminants in water and wastewater. Its high surface area, porosity, and chemical composition make it an attractive candidate for the removal of contaminants from industrial wastewater. The main objectives are;

- Design and development of efficient bone char filter for removal of contaminants from industrial wastewater.
- Mitigation of environmental hazards associated with the untreated waste streams.

Graphical Abstract:



Quarter Wise Work Plan:

The project will be executed in the following phases:

1st Quarter:	• Raw materials procurement. • Bone char production from waste animal bones.
2nd Quarter:	• Characterization of bone char. • Investigation of adsorption parameters of bone char.
3rd Quarter:	• Filter designing and fabrication. • Performance evaluation of various properties of bone char filter.
4th Quarter:	• Performance evaluation of various properties of bone char filter. • Compilation of results in the form of technical report

Funding Source (PSDP/SGI/RD&I/etc):

In-House

Cost:

Tangible Outcome:

- Fully optimized bones char filtration system capable of effectively removing a wide range of contaminants from wastewater.
- Standardized procedures for the preparation, operation, and maintenance of bone char filters, ensuring consistency and reliability in performance.
- Guidelines for the integration of bone char filtration technology into existing wastewater treatment plants, facilitating seamless adoption and implementation.

Achievements:

New Project

★ ★ ★ ★

Name of Laboratory/Centre/Unit :

Materials Science Canter, PCSIR Labs Complex, Peshawar

Title Project: Preparation of Chromate Salts from Indigenous Chromite Ore

Name & Designation Of Project Leader:

Mrs. AsmaYamin, SSO

Name & Designation of Project Associate(s):

Dr. Waheed Ur Rehman, SE
Mr. Amin Ur Rahman, PSO

Area(s) of Research:

Minerals

Duration:

02 Years

Date of Initiation:

2024

Project Brief:

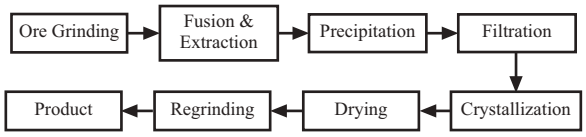
Chromite is widely used in metallurgical, chemical and refractory industries. Huge deposits of this ore occur in Pakistan, which can be exploited as basic raw material for chromite chemical industries. In Khyber

Pakhtunkhwa (KPK) chromite deposits occur in Dargai, Malakand agency, Heroshah, Malakand agency, Jijal, Kohistan and small deposits are also occur in areas of Waziristan agency with chromite (Cr_2O_3) contents varying from 27-48%. The country requirements of Chromite chemicals are met through import. A sizeable amount of foreign exchange is being spent on the import of sodium chromate, sodium dichromate, potassium dichromate, potassium chromate, chromium oxide and chromium based pigments.

Chrome chemicals are extensively used in paints, pigments, tanning and dyeing of leather, corrosion inhibitor, drilling mud, catalysts, wood and wood treatment. So there is a huge potential to develop demo plants for production of chrome salts from locally available Chromite ore. The main objectives are;

- To utilize indigenous Chromite ore for the preparation of value added products.
- To save the foreign exchange being spent on the import of chrome chemicals.
- Development of technology for semi large scale production for commercialization.
- To encourage the public and private sector investment in utilization of mineral resources of the country.

Graphical Abstract:



Quarter Wise Work Plan:

The project will be executed in the following phases:

1st Quarter:	• Procurement of raw materials. • Analysis and characterization of Chromite ore.
2nd Quarter:	• Optimization of parameters for bench scale preparation of products from Chromite ore
3rd Quarter:	• Characterization of product samples by the physical and chemical methods
4th Quarter:	• Upgradation of bench scale developed technology to semi pilot plant scale. • Performance evaluation of various properties of bone char filter.

Funding Source (PSDP/SGI/RD&I/etc):

In-House

Cost:

Tangible Outcome:

- Preparation of Techno economic feasibility reports
- Commercialization of the pilot plant process.

Achievements:

New Project

★ ★ ★ ★

Name of Laboratory/Centre/Unit:

Materials Science Canter, PCSIR Labs Complex, Peshawar

Title Project: Development of Grafted Styrene Butadiene Rubber Adhesive

Name & Designation of Project Leader:

Dr. Mahmood Iqbal, PSO

Name & Designation of Project Associate(s):

Dr. Waheed Ur Rehman, SE
Mr. Sohail Noor, JTO

Area(s) of Research:

Polymer

Duration:

02 Years

Date of Initiation:

2024

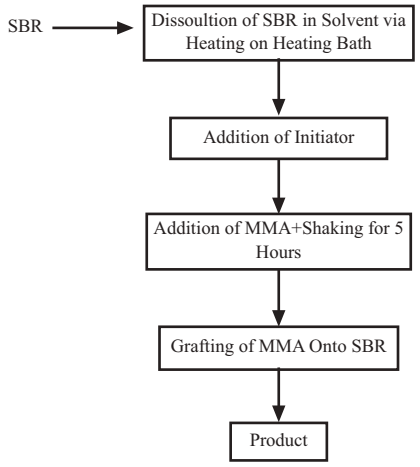
Project Brief:

Styrene Butadiene Rubber (SBR) adhesive is the most widely used synthetic rubber adhesive/sealant, which is produced from copolymer of styrene and butadiene rubber. SBR adhesive shows abrasion, crack & heat resistance and aging stability. They have various applications such as in tapes and flooring. SBR adhesive is resistant to water, chemical and general abrasion.

It is actively tough for the flooring installation, whether it is indoor and outdoor. Simple SBR rubber adhesive has weak adhesion properties due its non-polar nature and low molecular weight. Focusing on the enhancement of adhesion properties, surface grafting treatment has been proved effective. By grafting methyl methacryalte onto Styrene Butadiene Rubber will enhance its adhesion properties and also increase the heat resistance while also reduces drying time. Grafting of MMA onto SBR will increase the demand in flooring application which provides lucrative growth in SBR based adhesive in the market. These adhesive are used for bonding high pressure laminates, roofing-membrane attachment, furniture, kitchen cabinets, custom display cabinets, interior and exterior panels, wall partition, shoe soles, and many other applications where quick, high-strength, permanent bonds are needed. The degree of grafting will be further increased in order to improve the adhesion. The main objectives are;

- To prepare Methyl methacryalte-graft Styrene Butadiene Rubber adhesive with enhanced physical properties at low cost.
  To utilize indigenous facilities and resources for the preparation of methyl methacryalte-graft Styrene Butadiene Rubber adhesive.

Graphical Abstract:



Quarter Wise Work Plan:

The project will be executed in the following phases:

1st Quarter:	• Procurement of raw materials. • Characterization of raw materials.
2nd Quarter:	• Synthesis and grafting
3rd Quarter:	• Characterization of product developed on bench scale.
4th Quarter:	• Up gradation of bench scale product to pilot plant • Compilation of results in the form of technical report

Funding Source (PSDP/SGI/RD&I/etc):

In-House

Cost:

Tangible Outcome:

- Indigenous technology will be developed for the production of value added products.
- The program will be helpful in uplifting the industrial as well as social sector in the country.
- Proposed Technology will save foreign exchange.

Achievements :

New Project

★ ★ ★ ★

Name of Laboratory/Centre/Unit :

Materials Science Canter, PCSIR Labs Complex, Peshawar

Title Project: Preparation of Water Proofing System for Durable Concrete Structures

Name & Designation of Project Leader:

Mr. Qazi Muhammad Sharif, PSO

Name & Designation of Project Associates:

Dr. Mahmmod Iqbal, PSO
Dr. Sohail Noor, JTO
Mr. Gul Hassan, ST

Area(s) of Research:

Construction Industry

Duration:

01 Year

Date of Initiation:

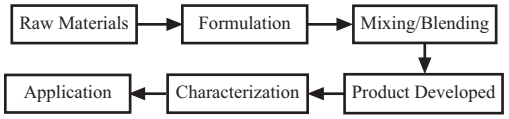
2024

Project Brief:

The ingress of water and aggressive substances is the primary reason for the chemical and physical degradation of concrete infrastructure, leading to a reduction in durability and shortening of life span. In practice, different integral waterproofing admixtures and surface coatings have been widely used to prevent or mitigate this problem. Compared with surface protection, the incorporation of integral waterproofing admixtures (such as densifiers, water repellents, and crystalline admixtures) in concrete has several benefits, such as ease of application, elimination of regular maintenance, and little or no deterioration over time. So far, there is no comprehensive work on integral waterproofing admixtures and their effects on various properties of concrete. Concrete is inherently porous and has numerous micro-cracks in the matrix, making it vulnerable to the ingress of water and other aggressive fluids. A reduced life span over time is expected for concrete infrastructure exposed to an aggressive environment because of physical and chemical degradation. Likewise, concrete infrastructure located near the groundwater table or in a highly humid environment is also susceptible to deterioration due to the ingress of water. Without intervention, significant maintenance for critical infrastructure is required with high associated repair costs. To reduce/eliminate the need for maintenance, suitable measures can be adopted to significantly reduce the water absorption rate of concrete. Various measures have been adopted to reduce the water absorption of concrete. Traditional methods include adding supplementary cementitious materials (SCMs) to the concrete mixture, reducing the water-to-cement (w/c) ratio, and using additional reinforcement to control concrete cracking. More recently, researchers proposed a few other methods for developing waterproof concrete, such as the use of external membranes, surface coatings, or integral waterproofing. In particular, the use of integral waterproofing admixtures has been considered a viable alternative to the other commonly used waterproofing methods. In this regard, many different integral waterproofing admixtures have been tried, and the findings show that their effectiveness in reducing water absorption varies significantly. The most widely used densifiers are various SCMs, such as silica fume, fly ash, and slag. The efficacy of these densifiers in decreasing concrete water absorption has been well established, but they can seldom reduce water absorption by over 30%. Thus, the developed concrete by only adding SCMs cannot be recognized as waterproof concrete. Therefore, this research work will mainly focus on concrete with hydrophobic and crystalline admixtures. Typical hydrophobic admixtures include silicone-based compounds, fatty acids, calcium stearate, and fats and oils. The effect of water proofing admixtures on durability of concrete such as dosing of admixtures, setting time, mechanical strength, flexural strength, water absorption, porosity will also be ascertained. This project is directed to prepare a suitable water proofing admixture and surface coating that can enhance mechanical properties of concrete structures and reduce water seepage by utilization of indigenous resources. The main objectives are;

- Development of process for the preparation of water proofing admixtures for concrete structures.
- Development of water proof membrane system for combating water seepage into concrete structures.
- To save foreign exchange being spent on the import of such type of materials.

Graphical Abtract:



Quarter Wise Work Plan:

The project will be executed in the following phases:

1st Quarter:	• Purchase of raw materials • Preparation of water proofing admixture.
2nd Quarter:	• Formulation of water proof membrane system
3rd Quarter:	• Characterization/ testing of the products • Up gradation of bench scale studies to pilot plant
4th Quarter:	• Up gradation of bench scale studies to pilot plant • Compilation of results in the form of technical report

Funding Source (PSDP/SGI/RD&I/etc):
In-House

Cost:

Tangible Outcome:
- The developed value added product of water proofing admixture will be leased out to interested industries/entrepreneurs for further commercialization.
- The program will be helpful in uplifting the industrial as well as social sector in the country.
- Proposed Technology will save Foreign exchange regarding its imports.
- Creation of job opportunities.

Achievements:
New Project

★ ★ ★ ★

Name of Laboratory/Centre/Unit:
Analytical Chemistry Section/ Medicinal Botanic Center/ PCSIR Laboratories Complex, Peshawar

Title of Project: Development of Skincare Product from *Brassica Juncea* Seeds for the Treatment of Skin Disorders

Name & Designation of Project Leader:
Dr. Muhammad Akram, PSO

Name & Designation of Project Associate (s):
Mrs. Farina Kanwal, PSO
Dr. Kishwar Sultana, SSO
Dr. Mushtaq Ahmad, SSO
Dr. Farah Gul, SSO
Dr. Hina Fazal, SSO
Mr. Ziaf-ur-Rehman, SO

Area(s) of Research:
Cosmetics/ Skincare Product Development

Duration:
01 Year

Date of Initiation:
2024

Project Brief:
Brassica juncea L. an important Rabi season oil seed crop and belongs to family Cruciferae and genus *Brassica*. It is a plant species commonly known as Brown/Chinese/Indian mustard. It is considered as one of the first domesticated crops used in agriculture and locally known as 'rai' or 'raya'. It is widely cultivated for its seeds, leaves, and oil, and used for centuries in many parts of the world, particularly in several parts of Asia, Europe, Cannada, Australia, Russia and North America. It is an economically important plant that has been well-known for centuries for its medicinal and nutritive values and the seeds have been applied for various diseases in traditional Chinese or Indian Medicine. The oil has potential health benefits due to its high content of monounsaturated and polyunsaturated fatty acids (MUFA and PUFA) as well as antioxidants like omega-3 and omega-6 fatty acids, Vitamin E (tocopherols) and Phytosterols. This research project aims to identify the bioactive compounds of *B. juncea* seed oil of Lakki Marwat region (KP) for development of effective and affordable natural skin care products to overcome synthetic one which will enhance the capacity of the scientific and healthcare community. The key active compound of *B. juncea*is Allyl Isothiocyanate (AITC) is a sulfur-containing compound responsible for the pungent taste and smell of oil. AITC is known for its antimicrobial and antiparasitic properties and are being used in various medicinal formulations for years due to their non-toxic effects. Scabies (*Sarcoptes scabiei*) and dandruff (*Malassezia*) are common skin and scalp conditions caused by mites and fungi, leading to significant discomfort and social stigma. AITC is known to disrupt the cell membranes of *S. scabiei* parasite and inhibit their growth and also inhibit the growth of *Malassezia* fungi, thereby reducing dandruff which are the targeted diseases of this research project.
- *B.juncea* oil has a wide range of applications in skincare and pharmaceuticals.
- There is no single herbal process/product developed from *B.juncea* seeds cold pressed oil in Pakistan to promote hair growth, tonourish scalp, to prevent

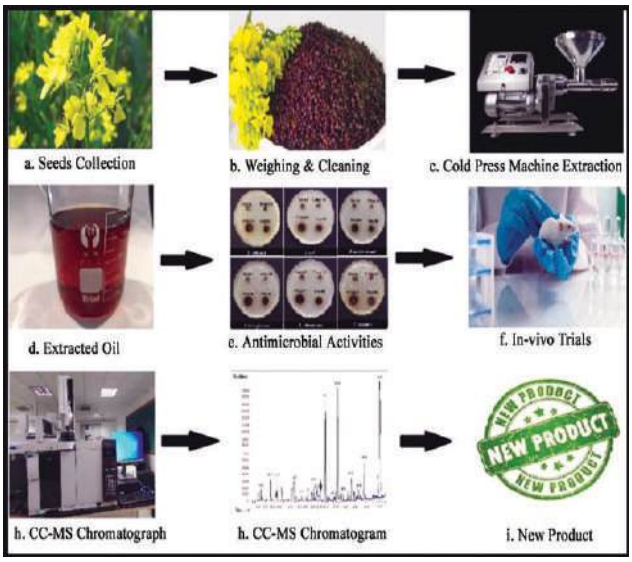
dandruff, to reduce acne/rashes, to alleviate pain and for bone and muscle strengthening.

- This Natural oil is traditionally used and extremely good for treating skin infection (scabies), promoting hair growth and to reduce dandruff.
- The oil will be utilized in the preparation of new Herbal skincare products. It will be a good initiative and will open a new door for further work in the area of Herbal Skincare products development.

The main objectives are;

- Extraction of oil from *B. juncea* seeds using cold press extraction technique and identification of active compounds of *B. juncea* seed oil.
- Formulation of topical skincare products e.g., Oil, Shampoo, Cream and Lotion.
- Evaluation of the product's efficacy and safety through in vitro and in vivo studies.

Graphical Abstract:



Quarter wise Work Plan:

1st Quarter	• Procurement of Raw material • Identification/Authentication of Raw Material • Extraction of oil
2nd Quarter	• Qualitative assessment of oil • Product development
3rd Quarter	• Biological screening of the Product • Shelf-life studies of Product
4th Quarter	• Evaluation of product through volunteers • Compilation of Data

Funding Source (PSDP/SGI/RD&I/etc):
In-House

Cost:

Tengible Outcome:

- Herbal skincare Products and Process Development.
- Technical Report
- Publication

Achievements:
New Project

★ ★ ★ ★

Name of laboratory/Centre Unit:
Medicinal Botanic Centre PCSIR Labs. Complex, Peshawar

Title of Project: Eco-Friendly Processing of Fish and Poultry for Value Added Products

Name & Designation of Project Leader:
Dr. Shuja-ud-Din Badar, SSO

Name & Designation of Project Associate(s):
Dr. Humaira Inayat, SSO

Area(s) of Research:
Food Industry

Duration:
01 Year

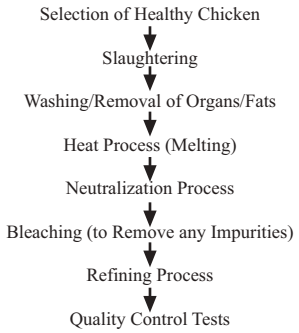
Date of Initiation:
2024

Project Brief:
A valuable derivative of poultry by-product, holds immense potential across diverse industries due to its versatile applications and nutritional attributes. Extracted from chicken fat, this liquid offers a spectrum of culinary, food processing, and animal nutrition possibilities. As a rich source of essential fatty acids and devoid of impurities, refined chicken oil not only enhances the flavor and texture of various food products

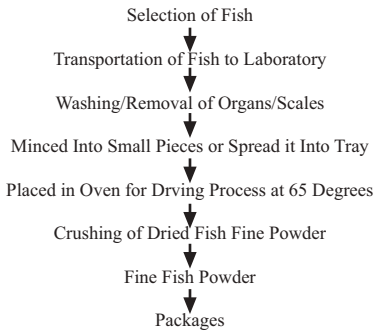
but also serves as a sustainable ingredient in animal feed formulations. A concentrated and versatile ingredient prepared from fish, plays a pivotal role in various industries due to its nutritional richness. Prepared through a meticulous process of fish dehydration and grinding, fish powder retains essential nutrients such as proteins, omega-3 fatty acids, vitamins, and minerals, offering a convenient and sustainable source of nutrition. In this project, we explore the preparation process, nutritional composition, and wide-ranging applications of fish powder and chiken oil for addressing global food security challenges, and enhancing food product quality. Despite its significant potential in various industries, the production and utilization of refined chicken oil and fish powder face several challenges that hinder their optimal utilization and market penetration. These challenges include inconsistencies in quality, lack of standardized production processes, limited awareness of their benefits and applications. Addressing these issues is crucial to unlock the full potential of these products and maximize its value across culinary, food processing, and animal nutrition sectors. It is the cheapest source of high proteins which can replace expensive proteins or other refined seed oils. This research will be focused on production of low-cost fish powder (meal) by eco friendly method to minimize the use of other expensive proteins in different products manufacturing. Chicken Oil : Refined Chicken oil, a valuable byproduct of poultry processing fats is rich in protein . Chicken oil is extracted from chicken fats, fats collected from butcher shop through heating process, possessing a melting point typically between 25 to 35 degrees; oil is further process to neutralization to get their desire pH level, bleaching process to remove any impurities in it. Avoiding chemical solvent for pure end product, it can be utilized for frying, baking and flavor enhancement, as well as in feed processing for animals as a cheap, cost effective protein source which is collected from the waste materials. Most of oil used at different restaurants (KFC/McDonald) is imported from other countries at high prices. Fish powder is prepared from waste materials of fish which are dried at 65 degrees for 24 hours in dryers. After drying process, dry materials are further processed to prepare fine fish powder. It can be used in production of pet food/poultry feed by replacing expensive source of proteins like soya bean meal/canola or other proteins used in it. The main objectives are;

- Utilization of economical raw material for the production of valuable products
- Substitute of costly protein sources.

Graphical Abstract:



Fish Powder (Meal) Preparation Process:



Quarter Wise Work plan :

1st Quarter	**(Project Planning):** • Define project • Project proposal • Discuss project goals & objectives • Discuss project plan & outlines
2nd Quarter	**(Research Studies & Analysis):** • Conduct research studies • Conduct Market research • Gather information & Requirements • feasibility studies
3rd Quarter	**(Product Development & Implementation):** • Product Development process • Analytical studies for product • Conduct tests & Quality insurance • Manage risks & issues(reporting)

4th Quarter	**(Submission & Findings):** • Roll out product & services • Evacuate developed product against objectives • indentify area of improvements • publication & technical report writing

Funding Source(PSDP/SGI/RDI):
In-House

Tangible Outcome:
- Product and process development
- b. Publication and Technical Report.

Achievements:
New Project

★ ★ ★ ★

Name of Laboratory/Centre/Unit:
Process Development Lab, MBC, PLC

Title of Project: Ensuring Safety: Advanced Techniques for Steroids and Antibiotics Detection in Food and Pharmaceuticals

Name & Designation of Project Leader:
Dr. Mushtaq Ahmad, SSO

Name & Designation of Project Associate(s):
Dr. Humaira Inayat, SSO
Ms. Aaliya Saleem, SO
Mr. Ziaf-Ur-Rahman, SO
Mrs. Farina Kanwal, PSO

Area (s) of Research:
Food and Pharmaceutics

Duration:
01 Year

Date of Initiation:
2024

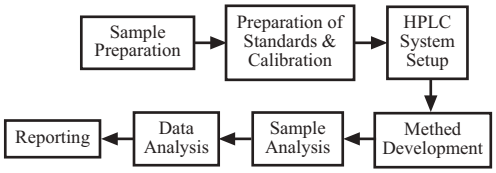
Project Brief:
Steroids are a class of hormones that are commonly used to treat a range of medical conditions. Their importance and side effects vary depending on the type of steroid and its usage. They are usually used for anti-inflammatory and immunosuppressive effects, hormonal replacement therapy, cancer treatment, allergy and asthma treatment, dermatological conditions, etc. At the same time, they may display some serious side effects as well in case of over dosage, self medication and improper utilization. These side effects may be short term like, increased appetite, weight gain, insomnia, mood swings, elevated blood pressure, acne, fluid retention, and mood alterations or long term like, osteoporosis, diabetes, liver damage, cardiovascular issues, testicular shrinkage, infertility, and psychiatric effects like aggression. Most commonly used steroids include, prednisone, hydrocortisone, dexamethasone, methylprednisolone, betamethasone, testosterone, and beclomethasone. Likewise, antibiotics are powerful medications used to treat bacterial infections. Their importance in modern medicine cannot be neglected, but they also come up with potential side effects and risks that must be managed carefully. Antibiotics are used for treating a wide range of bacterial infections, including pneumonia, urinary tract infections, skin infections, and more. They help prevent the spread of contagious diseases. They are also used as surgical prophylaxis that is; they are used before and after surgeries to prevent infections that could complicate recovery. They play a vital role in managing chronic conditions like tuberculosis and bacterial endocarditis. But they may came up with different side effects as well. Common side effects include nausea, diarrhea, vomiting, abdominal pain, loss of appetite. Allergic side effects (reactions) include rashes, itching, and swelling. Severe reactions like anaphylaxis, which can be life-threatening, can also occur. Overuse and misuse of antibiotics can lead to antibiotic resistance making infections harder to treat. Antibiotics can disrupt the balance of beneficial bacteria in the body, leading to conditions like severe diarrhea and colitis. Some antibiotics can cause toxicity to specific organs, such as kidneys (nephrotoxicity, leading to kidney damage), liver (hepatotoxicity, or liver damage), ears (ototoxicity, leading to hearing loss). Most commonly used antibiotics include, amoxicillin, azithromycin, ciprofloxacin, cephalexin, doxycycline, clindamycin,

metronidazole, sulfamethoxazole/trimethoprim, levofloxacin, and penicillin.

The accurate detection and quantification of steroids and antibiotics in pharmaceutical formulations and food items are critical for ensuring drug and food safety, efficacy, and compliance with regulatory standards. Traditional methods may lack the sensitivity, specificity, and efficiency required for comprehensive analysis. There is a need to develop and validate robust HPLC methods for the detection and quantification of a range of commonly used steroids and antibiotics. The methods should achieve high precision, accuracy, and reproducibility across different sample types, while minimizing sample preparation time and resource consumption. High-Performance Liquid Chromatography (HPLC) is a widely used analytical technique for detecting and quantifying steroids and antibiotics in various samples. The methodology for detection through HPLC involves several key steps, from sample preparation to data analysis and reporting. By following these steps and protocols, HPLC can effectively detect and quantify steroids and antibiotics in various samples, providing valuable information for research, clinical diagnostics, and quality control. The main objective of the project is;

- To ensure the safety, efficacy, and quality of food and pharmaceutical products, thereby protecting public health and supporting regulatory compliance.

Graphical Abstract:



Work Plan:

1st Quarter	Procurement of standards (steroids & antibiotics)
2nd Quarter	Samples preparations (collection, pretreatment, extraction, concentra-tion), preparation of standards and related calibration curves (stock solutions, dilutions and calibration curves).
3rd Quarter	HPLC system setup (column selection, mobile phase selection and detector selection)
4th Quarter	Method development (optimization of HPLC parameters and validating the methods by assessing parameters like linearity, sensitivity, precision, accuracy, and reproducibility), sample analysis (injection, run time and detection), data analysis (peak identification and quantification), reporting (documenta-tion and interpretation).

Funding Source (PSDP/SGI/RD&I/etc):
In-House

Cost:

Tangible Outcome:

- Enhanced public health and safety
- Regulatory compliance
- Technological advancements
- Consumer confidence
- Patents, publications and technical reports
- Test capabilities enhancement

Achievements:
New Project

★ ★ ★ ★

Name of Laboratory/Centre/Unit:
Additive Manufacturing and Reverse Engineering (AMRE), ESC, PCSIR Labs. Complex, Peshawar

Title of Project: Design and Fabrication of Fused Deposition Modeling (FDM) 3D Printer

Name and Designation of Project Leader:
Engr. Fazli Subhan, JE

Name and Designation of Project Associate(s):
Engr. Waqar Ahmad, JE
Engr. Muhammad Younas, PE
Engr. Noor Faraz Khan, JE

Mr. M Bilal Afza, JEO
Mr. Fazal Kareem, JTO

Area(s) of Research:
Mechanical/ Additive Manufacturing, Mechatronics

Duration:
01 Year

Date of Initiation:
2024

Project Brief:

A 3D printer is an additive manufacturing technique where 3D objects and parts are made by the addition of multiple layers of material. It can also be called as rapid prototyping. It is a mechanized method where 3D objects are quickly made as per the required size machine connected to a computer containing blueprints of any object. The additive method may differ with the subtractive process, where the material is removed from a block by sculpting or drilling. The main reason to use 3d printer is for 90% of material utilization, increase product life, lighter and stronger. 3D printing is efficiently utilized in various fields such as aerospace, automobile, medical, construction and in manufacturing of many household products. 3D Printer is more useful and reliable than our conventional manufacturing processes. The process of 3D printer does not require any permanent guidance as in conventional method such as moulding, machining etc. The project aims to design and develop an indigenously manufactured Fused Deposition Modeling (FDM) 3D printer as an import substitute. Additive manufacturing, particularly FDM technology, has gained significant traction due to its versatility and cost-effectiveness.

The main objective are;

- Design and develop a FDM 3D printer suitable for PCSIR's research and development activities.
- Optimize the printer's performance to achieve high-quality prints with various engineering-grade thermoplastics.
- Implement safety features to mitigate emissions and ensure operator safety.
- Evaluate the economic viability and environmental impact of the close chamber FDM printer compared to conventional open chamber printers.
- Provide training and technical support to PCSIR staff for effective utilization of the close chamber FDM printer.

The Technical Specification of Close Chamber FDM 3D Printer are as follows:

Build Volume:
Length: 250 mm
Width: 250 mm
Height: 200 mm

Printing Technology:
Fused Deposition Modeling (FDM)

Print Resolution:
XY Axis: 50 microns
Z Axis: 20 microns

Layer Height:
Minimum: 200 microns
Maximum: 400 microns

Filament Diameter: 1.75 mm

Material Compatibility:

Compatible Materials: PLA

Extruder(s):
Number of Extruders: Single
Maximum Extruder Temperature: 250°C

Print Bed:
Material: Glass
Maximum Temperature: 100°C

Control Interface:
Display: 4.3-inch touchscreen
Connectivity: USB

Software Compatibility:
Supported File Formats: STL, OBJ, AMF
Compatible Slicing Software: Simplify3D, Cura

Power Requirements:

Input Voltage: 220-240V AC
Power Consumption: 300 watts

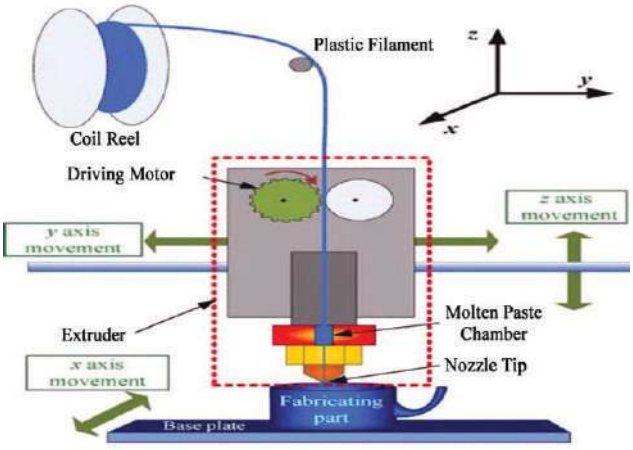
Physical Features:

Frame Material: Aluminum
Weight: 50 kg

Additional Features:

Heated Build Plate: Yes
Auto Bed Leveling: Yes

Graphical Abstract:



FDM 3D printer

Quarter Wise Work Plan:

1st Quarter	• Research and Requirements Gathering • Conceptual Design
2nd Quarter	• Detailed Design and Engineering
3rd Quarter	• Fabrication and Assembly
4th Quarter	• Testing and Validation

Funding Source (PSDP/SGI/RD&I/etc):

In-House

Cost:

Tangible Outcome:

a. **Local Manufacturing Capability:** Establishment of local design and fabrication capacity for close chamber FDM printers.

b. **Skill Development:** Opportunity for skill enhancement among Pakistani engineers, technicians, and researchers.

c. **Research Infrastructure Enhancement:** Strengthening of Pakistan's research infrastructure in additive manufacturing technology.

d. **Technology Transfer and Collaboration:** Facilitation of technology transfer and collaboration between PCSIR and local industries, universities, and research institutions.

e. **Cost-Effective Solutions:** Provision of cost-effective alternatives to imported technology, reducing procurement and operation costs.

f. **Job Creation:** Creation of employment opportunities in Pakistan's technology sector, contributing to economic development.

g. **Global Competitiveness:** Enhancement of Pakistan's global competitiveness in the technology sector, attracting investments and partnerships.

Achievement:

New Project

★ ★ ★ ★

Name of Laboratory/Centre:

Engineering Services Centre, PCSIR Labs. Complex, Peshawar

Title of Project: Development of a Sustainable Energy Solution Speed Breaker System for Power Generation

Name and Designation of Project Leader:

Engr. Muhammad Younas, PE

Name and Designation of Project Associate(s):

Engr. Noor Faraz Khan, JE
Mr. Muhammad Bilal Afzal, JTO
Engr. Waqar Ahmad, JE
Engr. Fazli Subhan, JE
Mr. Fazal Karim, JTO
Mr. Muhammad Usman, RA

Area(s) of Research:

Energy, Mechanical

Duration:

01 Year

Date of Initiation:

2024

Project Brief:

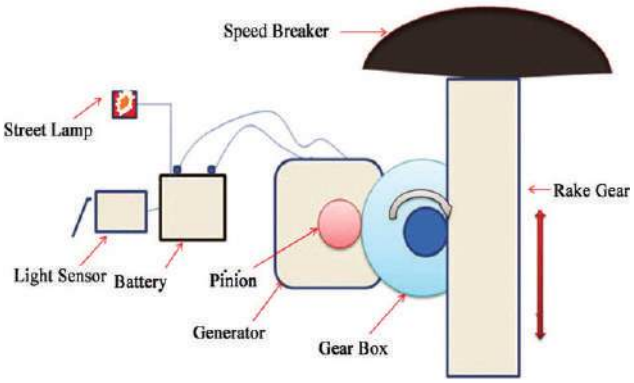
The project aims to address the energy inefficiency associated with conventional speed breakers by developing a Smart Speed Breaker Energy Generation System. This system will harness the kinetic energy from vehicles passing over speed breakers to generate electricity, thereby contributing to sustainable energy solutions for urban environments. Conventional speed breakers lead to energy wastage due to movement of passing vehicles, presenting an opportunity for energy recovery. However, current solutions are limited in their ability to efficiently convert this wasted energy into usable electricity. The project seeks to overcome this limitation by designing and implementing a smart speed breaker system capable of effectively capturing and converting kinetic energy into electrical power. The Smart Speed Breaker Energy Generation System will employ a mechanical assembly comprising metal sheets, linkages, and a spring arrangement. This assembly will facilitate the conversion of reciprocating motion of the speed breaker into rotary motion using a rack and pinion arrangement. The rotary motion will then drive a generator motor to produce electricity. The scope of the project includes:

- Designing and prototyping the Smart Speed Breaker Energy Generation System.
- Developing the necessary mechanical components and electrical connections.
- Testing the system's efficiency and effectiveness in converting kinetic energy into electrical power.
- Assessing the system's durability and reliability under real-world conditions.
- Exploring potential scalability and integration with existing infrastructure.

The primary objectives of the project are as follows:

i. Designing and developing a robust Smart Speed Breaker Energy Generation System capable of efficiently converting kinetic energy into electrical power.
ii. Conducting thorough testing to ensure the system's reliability, durability, and performance under varying traffic conditions.
iii. Establishing feasibility for widespread implementation and integration into urban road networks.
iv. Contributing to the advancement of sustainable energy solutions through innovative technology.

Graphical Abstract:



Quarter Wise Work Plan:

The project will be executed in the following phases:

1st Quarter	Research and Conceptualization • Review existing literature and technologies related to energy generation from speed breakers. • Develop conceptual designs for the Smart Speed Breaker Energy Generation System.
2nd Quarter	Design and Prototyping • Finalize the design of the system components, including mechanical assembly and electrical connections. • Fabricate prototypes for laboratory testing and evaluation.

3rd Quarter	Testing and Optimization • Conduct comprehensive testing of the prototypes to assess efficiency, reliability, and durability. • Identify areas for optimization and refinement based on test results
4th Quarter	Documentation and Dissemination • Document the design, development, testing, and implementation processes. • Prepare reports and presentations summarizing the project outcomes and findings. • Disseminate project results to stakeholders, including government agencies, urban planners, and energy researchers.

Funding Source (PSDP/SGI/RD&I/etc.):

In-House

Cost:

Tangible Outcome:

The tangible benefits of this deployment include:

- **Electricity Generation:** The Smart Speed Breaker Energy Generation System will produce measurable amounts of electricity from the kinetic energy of passing vehicles. This electricity will be fed into the local power grid or utilized for local applications, such as street lighting or traffic signals.
- **Energy Savings:** By capturing and converting kinetic energy that would otherwise be wasted, the system will contribute to energy conservation and efficiency in urban areas. This can lead to reduced reliance on traditional energy sources and lower carbon emissions.
- **Infrastructure Integration:** The smart speed breaker system will be seamlessly integrated into existing road infrastructure, demonstrating its feasibility and scalability for widespread implementation. This tangible outcome showcases the system's compatibility with urban environments and its potential for large-scale adoption.
- **Data Collection and Analysis:** Throughout the deployment phase, data will be collected on the system's performance, including electricity generation rates, durability, and maintenance requirements. This data will be analyzed to assess the system's effectiveness, identify areas for improvement, and inform future iterations or deployments.
- **Stakeholder Engagement:** The deployment of the Smart Speed Breaker Energy Generation System will engage various stakeholders, including local authorities, transportation agencies, and the general public. Tangible outcomes of stakeholder engagement may include increased awareness of sustainable energy solutions, community involvement in infrastructure projects, and support for future initiatives.

Achievement:

New Project

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On-Going

Name of Laboratory/Centre/Unit:
Environmental Research Section, FTC, PCSIR Labs. Complex, Peshawar

Title of Project: Characterization and Production of Wood Vinegar from Local Biomass

Name and Designation of Project Leader:
Dr. Inayat-ur-Rehman, SSO

Name and Designation of Project Associate(s):
Dr. Muhammad Akram, PSO
Dr. Javid Ali, SSO
Dr. Waheed-Ur-Rehman, SE
Engr. Arbab M. Siddique, JE
Engr. M. Younas, PE
Mr. M. Ilyas, Sr. Tech
Mr. Tufail Ahmad, Technician

Area(s) of Research:
Product Development (Green Chemistry)

Duration:
01 Year

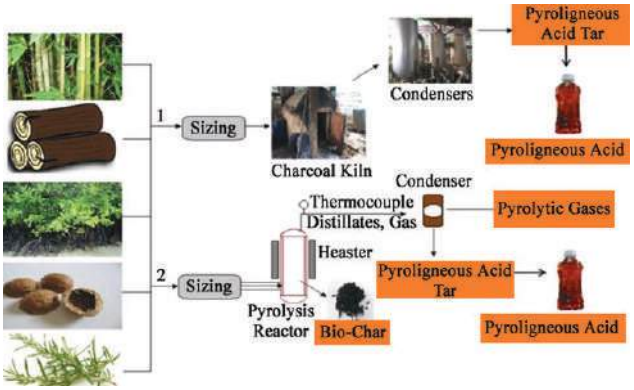
Date of Initiation:
2023

Project Brief:
Pyroligneous acid also called wood vinegar is an aqueous liquid produced from pyrolysis of lignocellulose waste and biomass. It is a 100% natural garden and plant fertilizer with no added chemicals and makes a superb bio-stimulant for plants. It is very complex solution; the major proportion is water (80–90%) and minor proportion is more than 200 species of organic compounds. Recently, wood vinegar has been wildly applied for various purposes such as medicine, smoky aroma, food and platelet aggregation and anti-dermatophyte activity in pharmaceuticals. In particular, in organic agriculture, a great number of toxic-chemicals are replaced by wood vinegar, a natural product, which has been used to combat disease and pests, stimulate plant growth, improve the quality of fruit, accelerate the speed of plant seed germination and serve as herbicides. However, the physiochemistry and biological activity of wood vinegar are affected by many factors such as chemical composition of biomass, pyrolysis system and refining method. The source/feed stock to this process will be the junk and wood waste from seasonal cuttings of trees/branches of the trees and plants namely; **1**. *Parthenium hysterophorus*, **2.** *Melia azedarach* (Bakain), **3.** *Morus alba Linn* (Shahtoot), **4.** *Dalbergia sissoo* (shisham) **5.** *Eucalyptus globulus* (Laichi) **6.** *Broussonetia papyrifera* (Paper mulberry) **7.** *Acacia nilotica* (Vachellianilotica), and to convert them into beneficial products like wood vinegar and charcoal. The product (wood vinegar) is not available in Pakistan on technical grounds. Though raw material (local biomass) for its production is available abundantly and wasted without utilization. The importance of wood vinegar in the agricultural sector is well established from literature. The product as well as its process development is of utmost importance. Technical Information: Wood vinegar is made by heating organic biomass material in an environment that is oxygen reduced. This leads to the material's thermal decomposition along with the release of gases. The exhaust smoke is then cooled into a liquid. This liquid is then separated and refined into wood vinegar. The junk and waste wood pieces and leaves are the only feed stock used and the heat needed to make it comes from the feed stock. The liquid distillation plant will be designed and fabricated accordingly for optimal yield/recovery of wood vinegar and other byproducts. Wood vinegar is an environmentally friendly pest control alternative to most inorganic toxic pesticides. It is widely used as plant growth promoter in various developed countries like Canada, Japan, Brazil, and Germany. In addition, it also shows herbicidal and fungicidal properties. For this, the industries involved in production of these toxic herbicidal products will be contacted for their utilization.

The main objectives of the project are;

- To design and fabricate the production unit for wood vinegar by using different biomass.
- To develop a process to produce wood vinegar and it's by products.
- To utilize the local biomass and wood waste to help in proper management and utilization/recycling of local waste biomass.

Graphical Abstract:



Funding Source (PSDP/SGI/RD&I/etc.):
In-House

Cost:

Tangible Outcome:
- Design and fabrication of prototype of production unit
- Development of Product (wood vinegar) and byproduct (charcoal).

Achievement:
- Product developed.
- Publication in process.
- Patent filling in progress.

★ ★ ★ ★

Name of Laboratory/Centre/Unit:
Food Processing and Quality Control lab./FTC/PLC

Title of Project: Value Addition of Seasonal Fruits with Aloe Veragel as Natural Preservative

Name & Designation of Project Leader:
Mrs. Salma Iman, SO

Name & Designation of Associate (s):
Dr. Rehman-Ullah Khan, SO
Dr. Arshad Hussain, PSO

Area(s) of Research:
Food Science

Duration:
01 Year

Date of Initiation:
2023

Project Brief:

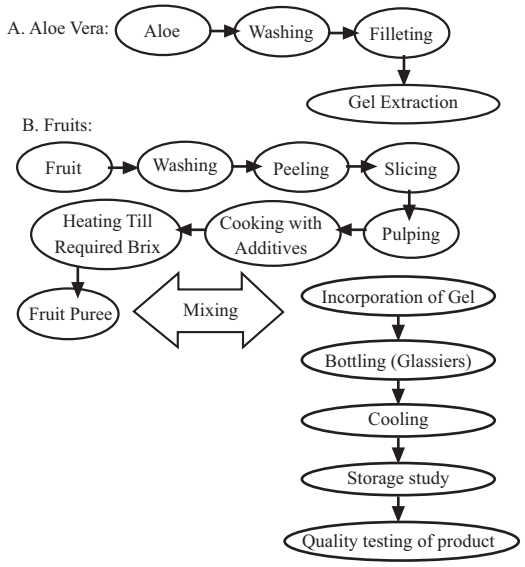
Nowadays, most people tend to eat the ready-made food available in the market, rather than preparing it at home. Such foods contain some kind of additives and preservatives, so that their quality and flavor is maintained and they are not spoiled by bacteria and yeasts. Food additives are used since ancient time and their utilization is frequently increasing day by day. Major additives are synthetic and can give adverse effects to consumers. Nowadays, consumers are moving towards bio-based and natural additives due to their health concern. Although, food additives deliberate good advantages to food sector such as food manufacturers, food retailers, food customers etc., consumption of them should be carried out carefully. More than 3000 additives and preservatives are available in the market, which are used as antioxidants and antimicrobial agents. Some of the commonly used food additives and preservatives are aluminum silicate, amino acid compounds, ammonium carbonates, sodium nitrate, propyl gallate, butylatedhydrozyl toluene (BHT), butylatedhydroxyanisole (BHA), monosodium glutamate, white sugar, potassium bromate, potassium sorbate, sodium benzoate, etc. Some modern synthetic preservatives have become controversial because they cause respiratory or other health problems. Aloe vera juice also has antibacterial properties against Gram-positive bacteria. Aloe vera gel contain elements of medicinal value, namely as anti-inflammatory, antiviral, antibacterial and antifungal against some diseases like diabetics, cancer, allergy and AIDS. Aloe vera has shown antibacterial property against gram positive and gram-negative pathogens. Aloe vera also contains Antraquinone and Acemannan, a good anti-bacterial, anti-viral and anti-fungal agents. Synthetic food additives have negative impact on the consumer health if utilized more than permissible limits. Example of in vitro study shows that sodium benzoate and potassium benzoate give genotoxic impacts on host. There are many types of reactions that can occur as a result of food additives. Some of these reactions appear to be

allergic while many others do not show any allergy, rather intolerance. Besides allergies, these foods may cause stomach pains, vomiting, breathing problems, hives and skin rashes. **Sulfites** are common preservatives used in various foods, and are well known to cause a variety of symptoms. **Nitrates** and **Nitrites** are used as curing agents in meat products. Reactions to nitrates and nitrites include urticaria, itching and anaphylaxis. **Benzoates** are used in foods as antimicrobial preservatives, and have been responsible for worsening asthma, allergic rhinitis, chronic urticaria, skin rashes, flushing and brain damage in some people. **Sorbates/sorbic acid** are added to foods as antimicrobial preservatives. Reactions to sorbates are rare, but have shown symptoms of urticaria and contact dermatitis. Bromates can cause nausea and diarrhea. Saccharin may lead to toxic reactions that impact the gastrointestinal tract and heart, as well as cause tumors and bladder cancer. Other types of preservatives that have a negative impact on health are formaldehydes. Formaldehyde is more familiar to people as formalin. This compound is carcinogenic, so it is strictly prohibited to use as a food preservative.The negative impact of using preservatives for food can be suppressed if natural ingredients are used for food preservation.

Aloe vera is a type of plant that can be used as natural preservative because it contains anti-oxidants. The main purpose of this research work is to evaluate the quality attributes of fruit with aloe vera gel in spread form and to check the preservative effect of aloe vera on overall product quality. Fruits blended with aloe vera gel are good alternative for development of new products. Such products have nutrition as well as medicinal properties. The blending of fruits like mango, guava, peach, apple, strawberry, cherry etc., with aloe vera gel in appropriate proportion could improve the nutritional and therapeutic quality of the processed food. Based on the above mentioned potential applications of Aloe vera on different seasonal fruits, a new product will be developed. In the present research work, the preservative effect as well as product developed from value addition of aloe vera with different seasonal fruits will be studied. The main objective of the project is;

- Minimization or elimination of chemical preservatives used in food products by utilizing aloe vera as natural preservative.

Graphical Absract:



Funding Source:

In-House

Cost:

Tangible Outcome:

- Process /Product Development

Achievements:

- Apple aloe vera blended fruit spread is successfully developed.
- Shelf life studies of the prepared fruit spread is completed
- Technical report is submitted.

★ ★ ★ ★

Title of Project: Design, Development and Performance Evaluation of ECO Solar Dehydrator with Thermal Energy Storage System

Name and Designation of the Project Leader:

Engr. Muhammad Saddique Arbab, JE

Name and Designation of the Project Associate(s):

Dr. Arshad Hussain, PSO
Engr. Muhammad Younas, PE
Dr. Abdul Wajid Khalil, SSO

Engr. Waheed-Ur-Rahman, SE
Engr. Syed Messam Raza,JE

Area of Research:

Renewable and Applied Energy, Sustainability and Society

Duration:

02 Years

Date of Initiation:

2023

Project Brief:

Environmental and economic development of a country is closely dependent upon the production and consumption rate of energy. The direct solar radiation in form of heat (electromagnetic wave) and light (photon) is considered to be one of the most destined sources of energy in many parts of the world. The drying sector is a big consumer of energy. For reducing the energy consumption in drying sector, the drying systems can be operated by using solar energy because solar energy is available in large quantity and free of cost and subsequently utilized for the drying of fruits and vegetables. The drying of foods in the open sun is a practice being followed in many countries since ancient times, especially by individual households and small scale enterprises. Drying is a part of many conventional food preparations. It also helps to impart special taste and store food items for longer periods. One disadvantage of this conventional method of drying is that the products may be spoiled due to adverse weather conditions and also contaminated with dust, insects and excreta. Further, the process is time consuming, drying may not be uniform, and the area requirement is large. The product is also susceptible to re-absorption of moisture, which reduces its quality. Drying is dependent on two fundamental processes: mass and heat transfer. In the indirect type solar dryer, heat has to be first transferred from the heated absorber plate in the collector to the air draft. Heat has to then transfer from the flowing hot air to the moist material in the drying chamber which is then followed by moisture removal to attain the desired moisture level of the product. The effectiveness of drying depends both on the rate of drying and the extent of drying. These, in turn, depend on parameters like dry bulb temperature, relative humidity, air draft and loading condition. They also depend on the properties of the material to be dried like moisture content and the tenacity with which moisture is held. The present study focuses on the design and fabrication of a novel Thermal Energy Storage system for enhancing the efficiency of the Solar dryer. The novelty behind this research is (i) achieving maximum temperature upto 68 ^{o}C in off hours and evening in the month of October. (ii) Reducing drying time from 24 hrs to 10 hrs, (iii) In northern areas, as the sunny hours are less, so the proposed design is very suitable in achieving the drying process efficiently. The above facts are closely based on the design and fabrication of the TES chamber. We have severe energy crises in the country and depend mainly on fossil fuels. Some drying techniques are expensive and others are taking much drying time as compared to the designed solar dehydrator. Moreover, Solar dryer without TES chamber has an intermittent nature and is a big problem. Through simple solar dehydrator, we can not achieve the desired temperature and dehydration time.

- High temperature thermal energy storage (TES) is a crucial technology ensuring continuous supply of heat energy from solar energy and would play a major role in improving the thermal efficiency of the Solar Dryer.
- Based on the heat absorption and emitting concept of the TES materials, it is a hybrid technology; it would operate in the off-hours.
- The convective air circulation makes it ideal from the rest of the dryers because of the principle of simultaneous heat and mass transfer.
- The solar dehydrator has the potential applications in fruit processing industry, agriculture sector, dried crops export industry etc.

Main objectives of the project are;

- To design and fabricate the Thermal Energy Storage (TES) Chamber for indirect solar dehydrator for agriculture crops (fruits and vegetables) of Peshawar and Northern areas of KPK.
- To perform the Parametric Studies with and without TES Chamber reflecting the drying efficiency.
- To perform the Parametric Studies by incorporating the forced draft fans inside and outside positions of the solar collector.

- To synthesize the TES materials and its incorporation into the TES chamber for getting better heat absorption and thermal efficiency.
- Performance evaluation and optimization studies.
- To commercialize the optimized and fully equipped hybrid solar dehydrator.

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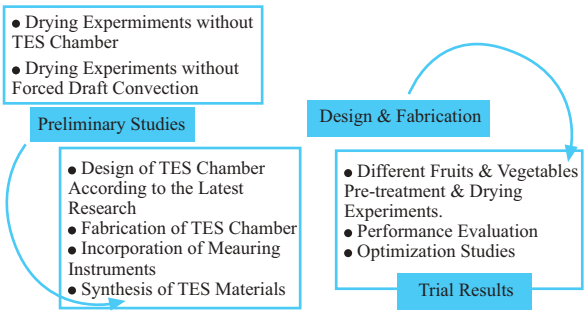


Funding Source (PSDP/SGI/RD&I/etc.):
In-House

Cost:

Tangible Outcome:
- Technology development in the form of modified solar dehydrator with enhanced performance.
- Process development with reduced time and energy.

Achievements:
- Technology Developed:
- Patent Filed: Design/Patent Filed 22346-D/2023
- Technical report is submitted.

★ ★ ★ ★

Name of Laboratory/Centre/Unit:
Medicinal botanic Centre PCSIR Labs. Complex, Peshawar

Title of Project: Development of Low Cost Dog Food from Indigenous Material

Name & Designation of Project Leader:
Dr. Shuja-Ud-Din Badar, SSO

Area(s) of Research:
Dog Food Preparation

Duration:
01 Year

Date of Initiation:
2023

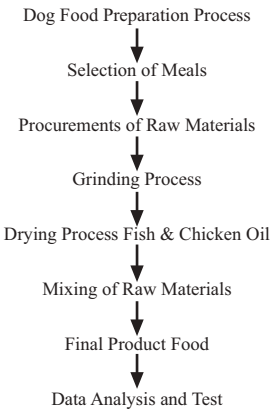
Project Brief:
Dog food plays a fundamental role in the health and well being of our canine companions; it is a specialized type of pet feed Specifically formulated to meet the nutritional needs of dog. Proper dog feed is essential to ensure their growth, vitality, and overall health. It involves selecting the right ingredients, formulating a diet that meets their specific nutritional needs, ensuring the quality and cost effectiveness while using the waste product of animals.

The most expensive meal Soya bean replaced to fish powder to meet the required Crude proteins levels in feed. Since the beginning of 2022, Pakistan imported pet food worth is US 5 million dollars. The Pakistan board of revenue estimated pet food market amount to UD 221.80M dollars in 2023. Market is expected to grow annually by 6.43%, although pet food is available in country but some of pet owner cannot afford it due to a sharp rise in prices. According to recent report in 2021, Pakistan ranked 68th in the world for pet food. As per report, demand for pet food in Pakistan is set to reach almost 10 million kilograms by 2026, growth rate 3.8%. Some of campines provide pet food in pakistan include Punjab feed limited, Feed sol limited, Sharif feed mill, Lahore feed mill, Hi-tech group. Dog food is mostly being imported in Pakistan that is much expensive; therefore, it is aimed to develop the Dog feed with a balance ratio of nutrients as per requirement of animal according to their age. It is focused to produce low-cost dog food by utilizing different raw materials which are easily available at local markets. To identify cost effective, high quality raw materials for dog feed in this case. Fresh and good source of protein enriched materials will be selected. Development of nutritionally balanced diet. To optimized ingredients ratio.To reduce cost without compromising quality and developed formulation. To cater different life stages and dietary need of animal. Quality Control and safety Measures: a quality control plan will be developed to ensure the Nutritional quality and safety of the dog feed, implement testing and inspection protocols for raw materials and

finished product. Method which is followed during the dog feed preparation ensures to replace the excess use of soyabean meal with fish powder without compromising required quality/nutritional values. Continuous improvement system for low cost feed production and monitoring feedback will be established. Maintain records of the manufacturing process, quality control results, and any necessary adjustments made during production. The main objectives are;

- To produce the cost effective product as per requirements.
- Replace use of soyabean meal to fish powder up to 10%.
- To produce nutritional balanced diet food by using waste of materials animals. (Chicken, Fish).

Graphical Abstract:



Funding Source(PSDP/SGI/RDI):
In-House

Cost:

Tangible Outcome:

- Product Developed Dog Food.
- Publication and Technical Report.

Achievements:

- Process Developed
- Product Developed
- Paper Publications- In Process
- Technical Report submitted

★ ★ ★ ★

Name of Laboratory/Centre/ Unit:
Medicinal Botanic Centre PCSIR Labs Complex Peshawar

Title of Project: Product Development from Carbon Dioxide (CO_2) Supercritical Extracts of Some Important Selected Plants

Name and Designation of the Project Leader:
Muhammad Siddique, PSO

Name and Designation of the Project Associate (s):
Dr. Muhammad Akram, PSO
Mrs. Farina Kanwal, PSO
Dr. Hina Fazal, SSO

Area(s) Research:
Cosmetics, Medicine

Duration:
02 Years

Date of Initiation:
2023

Project Brief:

Carbon dioxide extraction (CO_2) is a cutting-edge method of obtaining high-quality ingredients from natural sources. During supercritical fluid extraction, CO_2 components are separated from a solid or liquid carrier material by using supercritical CO_2 as solvent. Carbon dioxide (CO_2) is the most frequent solvent used that is fairly nontoxic and can be easily removed from the extract. The elimination of CO_2 is easily achieved since CO_2 is in a gas state at room temperature. CO_2 in the supercritical state has a moderate critical temperature (31.3°C) and pressure (7.38 MPa). Supercritical state is when gas and liquid are indistinguishable. At this state, it is compressible but posses a density of a liquid. Supercritical CO_2 makes a good solvent because of the gas-like state that is attributed to low viscosity and high diffusion coefficient. For many applications, CO_2 has well-suited solvent properties which can be easily controlled by varying the pressure and temperature. In addition, carbon dioxide in the supercritical state has a very low viscosity and no interfacial tension. Therefore, it can penetrate

well into complex structures and materials. These properties make it suitable for many different processes. CO_2 extract is a new technology based raw product. Its use in herbal products is opening a new door in the world of herbal industries. Keeping in mind all these properties, CO_2 will be used for extraction process of different useful plants available in the local areas. For this purpose, some commercially important plants were selected. By using CO_2 extracts, new medicinal and cosmetics products will be developed.These selected plants are :

1. *Curcuma longa* (Turmeric, Haldi),
2. *Glycyrrhiza glabra* (Liquorice, sweet wood)
3. *Cannabis sativa* (Hemp, Bhang)
4. *Capsicum annuum* (Chili, Pepper, LalMirch)
5. *Berberis lyceum* (Berberry, Sumblo)
6. *Livistonia chinensis* (Livistonia, Fan palm)
7. *Daucus carota* (Carrot)
8. *Carica papaya* (Papita, Papaya)
9. *Rosa centifolia* (Cabbage rose)
10. *Eucalyptus globulus* (Eucalyptus, Sufeda)

To obtain the highest possible amount of bioactive compounds from plant biomass, effective extraction procedures are required. Utilizing carbon dioxide extraction (CO2) for obtaining high-quality ingredients from selected plants has significant potential in the fields of herbal products i.e., cosmetics, and pharmaceuticals. Supercritical CO2 (carbon dioxide) extraction is a popular and efficient method for extracting essential oils, flavors, fragrances, and other compounds from various materials, such as plants, herbs, and spices. It is considered a safe and environmental friendly technique.

Extraction Process consists of three stages:

1. Compression
2. Separation
3. Collection

MBC has well equipped Labs with sophisticated instruments which includes CO_2 supercritical extraction machine, GC/MS, AAS and HPLC etc. Antimicrobial and antifungal activities will be carried out at microbiology section. Selected plants having good potential value will be collected and processed for CO_2 supercritical extraction. The CO_2 supercritical extract obtained will be subjected for instrumental analysis to know their different chemical constituents. CO_2 extract has a wide range of applications in various industries, including skincare and pharmaceuticals. In the skincare industry, CO_2 extract is commonly used for its anti-inflammatory and antioxidant properties. In the pharmaceutical industry, CO_2 extract is used for its medicinal properties.

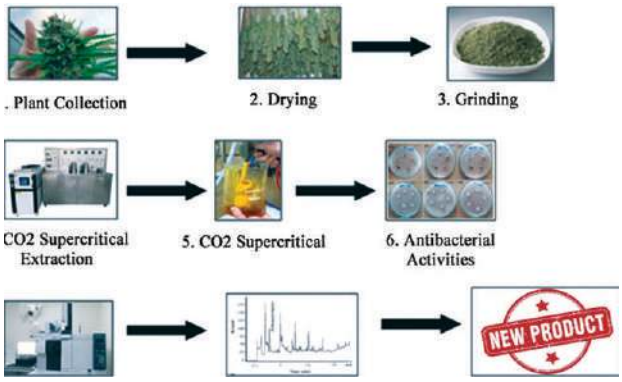
Two types product will be developed i.e,

1. Pharmaceticals
2. Cosmetics

The main objectives are as under;

- To utilize indigenous plant raw material.
- To prepare CO_2 supercritical extracts of some commercially important selected plants.
- Analysis of the extracts through different sophisticated instruments
- Development of herbal cosmetic and medicinal processes\ products
- To find out different relevant bio-activities of the extracts and the products thereof.

Graphical Abstract:



Funding Source (PSDO/ SGI/RD&I/etc.):

In-House

Cost:

Tangible Outcome:

- Product and process development.
- Report
- patent
- paper

Achievements:
In Progress

★ ★ ★ ★

Name of Laboratory/Centre/ Unit:
Medicinal Botanic Center, PCSIR Laboratories Complex, Peshawar

Title of Project: Cloning, Functional Expression and Purification of Recombinant *TAQ* DNA Polymerase from *Thermus Aquaticus*

Name and Designation of the Project Leader:
Dr. Yaqoob-Ur-Rehman, SO

Name and Designation of the Project Associate (s):
Dr. Sanam Islam Khan
Mr. Ziaf-ur-Rehman
Dr. Noman Salehzada, Project Associate

Area (s) Research:
Molecular Biology, Enzymology

Duration:
02 Years

Date of Initiation:
2023

Project Brief:
Polymerases are enzymes that synthesize long chains or polymers of nucleic acids including DNA or RNA from nucleotides. They assemble nucleic acids by copying a DNA or RNA template strand using base-pairing interactions. One of the polymerase enzymes, *Taq* DNA polymerase, originally isolated from *Thermus aquaticus (Taq)* is a widely used enzyme in molecular biology so far. The thermostable properties of this enzyme have contributed majorly to the specificity, automation, and efficacy of the polymerase chain reaction (PCR), making it a powerful tool for today's molecular biology researches across the globe. The purifcation of *Taq* DNA polymerase from the native host results in low yield, more labor and time consumption. Therefore, many studies have been previously conducted to obtain this enzyme using alternative hosts. So far, all the existing methodologies are more laborious, time-consuming and require heavy expense. In proposed project, we will use a novel approach to purify the enzyme with relatively high efficiency, yield and minimum time consumption using *Escherichia coli (E. coli)* as an alternative host. We will clone a *Taq* DNA polymerase gene into *pET28a(+)* vector, containing a His tag, downstreaming of tac promoter and overexpressed it using isopropyl β-d-1-thiogalactopyranoside (IPTG) as an inducer. The enzyme was efficiently purifed using novel chromatography approaches (His tag purified) and will be functionally characterized. The project will help in finding novel approach to facilitate the availability of polymerases for molecular and diagnostic studies and provide alternative to high-cost commercially available *Taq* polymerases.

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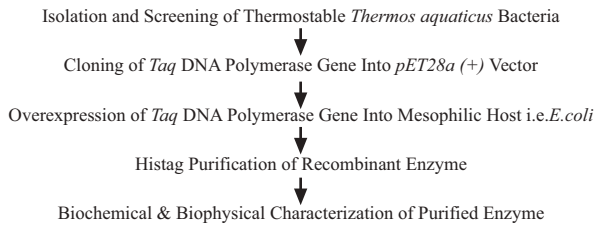


Funding Source (PSDP/SGI/RD&I/etc.):
In-House

Cost:

Tangible Outcome:
Basic Research

Achievements:
Procurement of Kits and Required Strains is in Progress.

★ ★ ★ ★

Name of Laboratory/Centre/ Unit:
Medicinal Botanic Centre, PCSIR Laboratories Complex, Peshawar

Title of Project: Strengthening of Lab. for the Quantification of Pesticides and Antibiotic Residues in Different Varieties of Honey Leading to ISO

Certification

Name and Designation of the Project Leader:
Dr. Muhammad Akram, PSO

Name and Designation of the Project Associate(s):
Dr. Muhammad Qaisar, PSO
Dr. Yousaf Ali, SSO

Area (s) Research:
Food Safety and Quality Control

Duration:
02 Years

Date of Initiation:
2022

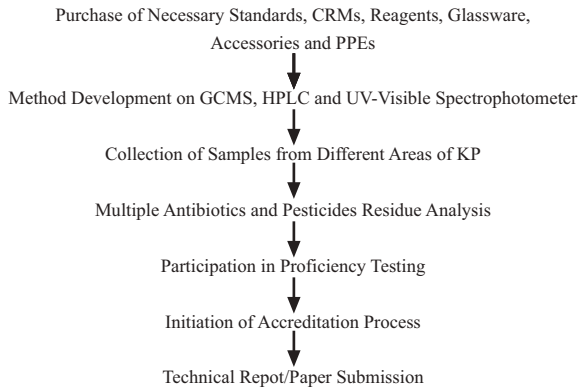
Project Brief:

Honey has the image of being a natural and healthy product. However, today honey is produced in an environment, polluted by different sources of contamination. The contamination sources can be environmental and apicultural ones. Environmental contaminants are pesticides, heavy metals, bacteria and radioactivity. These contaminants are present in air, water, soil and plants and are transported to bee hives by bees. Contaminants from beekeeping practice includes acaricides used for parasitic mites (mainly Varroa) control, bee repellents used at honey harvest, pesticides for wax moth and small hive beetle control and antibiotics. Antibiotics are found in honey largely because they are used in apiculture for treatment of bacterial diseases. Oxytetracycline is commonly used to treat European foul brood disease (EFB) and American foul brood diseases (AFB) caused by (*Bacillus*) and *Paenibacilus larvae* bacteria, respectively. However, there are now reports of tetracycline *Streptococcus pluton* resistance in these bacteria because of its widespread use. Other antibiotics such as erythromycin, lincomycin, monensin, streptomycin, enrofloxacin etc., are also reportedly used in bee keeping. The use of antibiotics in beekeeping is illegal in some EU countries. Moreover, there are no Maximum Residue Limits (MRLs) established for antibiotics in honey according to the European Community regulations, which means that honey containing antibiotic residues are not permitted to be sold.

Funding Source (PSDP/ SGI/RD&I/etc.):
In-House

Cost:

Graphical Abstract:



Tangible Outcome:

- The project was initiated to develop a testing facility for the quantification of pesticides and antibiotic residues in different varieties of honey in KPK.

Achievements:

- Method has been developed for the screening of Honey samples against 24 pesticides on GCMS.
- Method has been developed for the quantification of Chloramphenicol and Oxytetracycline on HPLC.
- Further work is in progress

★ ★ ★ ★

Name of the Laboratory/Centre/Unit:
Material Science Section, PCSIR Labs. Complex, Peshawar

Title of Project: Chemical Demineralization/ Desulphurization of High-Sulphur Indigenous Coal

Name and Designation of Project Leader:
Dr. Mahmood Iqbal, PSO

Name and Designation of Project Associate(s):
Mr. Sohail Noor, JTO
Dr.Waheed-Ur-Rehman, SE
Mr. Amin-Ur-Rehman, PSO

Duration:
01 Year

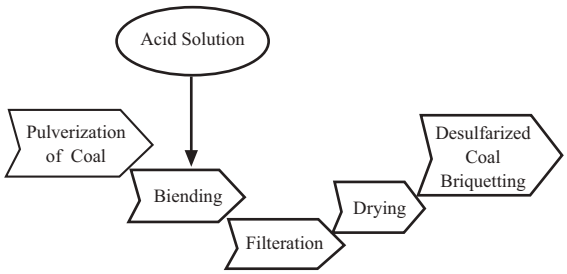
Date of Initiation:
2023

Project Brief:

Coal is one of the most extensively used fossil fuels for energy production around the world, resulting in increased sulphur dioxide (SO_2) emissions into the environment. The combustion of coal with higher sulphur content is a key contributor to acid rain and accompanying environmental deterioration. The study of coal desulfurization is critical for environmental and socioeconomic growth. The goal of this investigation is to desulfurize coal using acid and base washing. As a result, sulphur compounds that are hazardous to the environment will be reduced. The widespread use of coal as a source of energy has led to significant environmental and health issues, primarily due to the high sulfur content in coal. When burned, sulfur in coal forms sulfur dioxide (SO2), a major contributor to air pollution and environmental degradation. This pollutant not only contributes to acid rain but also poses serious health risks to both humans and ecosystems. Although various desulfurization methods exist to mitigate sulfur emissions from coal combustion, they face significant limitations. Current approaches may lack the desired efficiency, are often expensive to implement on a large scale, and might have adverse environmental impacts, such as the generation of additional waste or use of harmful chemicals. The project focuses on developing efficient and cost-effective coal desulfurization technologies. This includes chemical and physical methods, aiming to enhance sulfur removal from coal while minimizing environmental impact. The scope encompasses optimizing efficiency, reducing costs, ensuring environmental sustainability, compatibility with existing infrastructure, scalability, and compliance with regulatory standards, ultimately advancing cleaner and more sustainable coal-based energy solutions. The main objectives of the project are;

- Enhancing sulfur removal efficiency while optimizing processes.
- Reducing desulfurization costs and implementing cost-effective techniques.
- Minimizing the environmental impact of sulfur removal methods.
- Designing scalable technologies for easy industrial integration.

Graphical Abstract:



Funding Source (PSDP/SGI/RD&I/etc):
In-House

Cost:

Tangible Outcome:

A technique/process will be developed that may be leased out to various industries that require low sulphur content coal.

Achievements:

- The raw coal was analyzed for sulfur, ash, volatile matter and for gross calorific value
- Bench work has been started, sample has been processed for desulphurization
- Sample will be analyzed for sulfur.

★ ★ ★ ★

Name of Laboratory/Centre/Unit:

Materials Science Centre, PCSIR Labs. Complex, Peshawar

Title of Project: Development of Cultured Quartz from Indigenous Quartz Ore

Name & Designation of Project Leader:
Dr. Engr. Waheed-Ur-Rehman, SE

Name & Designation of Project Associates:
Mr. Amin-Ur-Rehman, PSO
Mr. Qazi Muhammad Sharif, PSO

Area(s) of Research:

Construction Industry

Duration:

01 Year

Date of Initiation:

2023

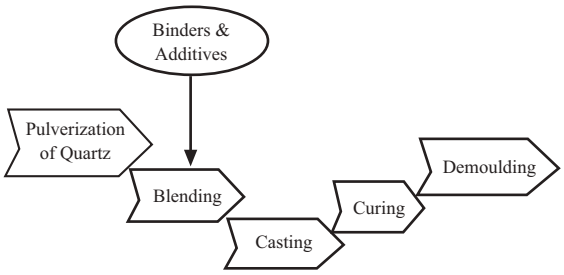
Project Brief:

Pakistan is known to have significant reserves of quartz, a mineral widely used in various industries. The country's quartz reserves are estimated to be substantial, with deposits found in several regions including Baluchistan, Khyber Pakhtunkhwa, Punjab, and Gilgit-Baltistan. These reserves encompass both high-quality quartz suitable for industrial applications and gem-grade quartz used in jewellery.

Existing processes for converting quartz ore into high-quality cultured quartz tiles are inefficient, resource-intensive, and environmentally burdensome. Key issues include suboptimal manufacturing techniques, high energy consumption, material waste, and the need for environmentally harmful chemicals. Additionally, achieving consistent quality, colour variations, and patterns in cultured quartz tiles remains a significant obstacle. Addressing these challenges is essential to optimize production efficiency, reduce environmental impact, and ensure the consistent production of high-quality cultured quartz tiles for various applications in the construction and interior design industries. The project aims to optimize the production of cultured quartz tiles from ground quartz, focusing on key technical aspects. This includes understanding ground quartz properties and employing efficient processing techniques like grinding and milling to achieve the desired particle size. Selecting suitable binders and additives is critical for enhancing tile strength. Additionally, the study involves exploring tile forming methods, surface finishing, and implementing quality control measures. Energy efficiency and sustainability are prioritized, aligning with market trends and economic viability considerations. The goal is to produce uniform, aesthetically appealing cultured quartz tiles meeting market demands and technological advancements. The main objective of the project is;

- To establish a production process for cultured quartz using quartz ore as the primary raw material. Cultured quartz is a versatile and high-performance material widely used in construction industry just like the cultured marble. By developing a cost-effective and efficient production method, the project aims to meet the growing market demand for cultured quartz while ensuring consistent quality and performance.

Graphical Abstract:



Funding Source (PSDP/SGI/RD&I/etc):

In-House

Cost:

Tangible Outcome:

- The production of high-quality cultured quartz products with desirable properties
- The establishment of a robust and optimized production process
- The generation of an intellectual property

Achievements:

- Cultured Quartz samples were produced comprising of 2 feet diameter table top and 2 feet (length) x 3 feet (width) table top.
- The samples are being analyzed for water absorption, density, compressive strength, and flexural strength.
- Technical Report will be submitted.

★ ★ ★ ★

Name of Laboratory/Centre/Unit:

Materials Science Centre, PCSIR Labs. Complex Peshawar

Title of Project: Synthesis of Detergent Grade Zeolite 4A from Indigenous Resources

Name & Designation of Project Leader:
Mr. Amin-Ur-Rahman, PSO

Name & Designation of Project Associates(s):
Mr. Qazi Muhammad Sharif, PSO
Dr. Waheed-Ur-Rehman, SE
Mrs. Asma Yamin, SSO

Area(s) of Research:
Chemical Industry

Duration:
01 Year

Date of Initiation:
2023

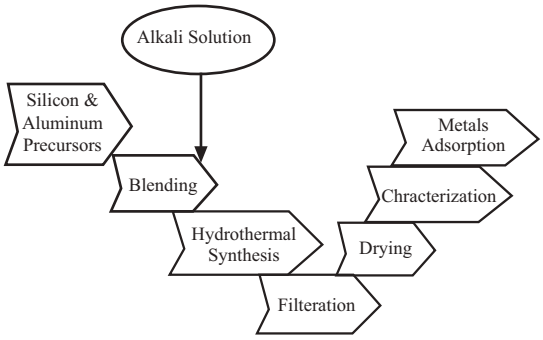
Project Brief:

Laundry detergents generally contain phosphate builders which remove Ca^{2+} and Mg^{2+} ions present in hard water thus enhancing the efficiency of surfactants. Phosphate builders are regarded as the main culprit of eutrophication in lakes and ponds and causes environmental issues. Zeolite A has high selectivity and capacity for Ca^{2+} and Mg^{2+}ions and is being used as an alternative to phosphates builders. Zeolite A is both environmental friendly and safe for humans. At present, Pakistan meets its Zeolites requirement through import. The proposed project is a step forward towards the development of indigenous technology which will be helpful in uplifting the industrial as well as social sectors. Phosphate-based builders have historically been effective in enhancing detergent performance, but their use is increasingly restricted due to their detrimental environmental impact, notably water pollution and eutrophication. Consequently, there is a critical need to develop a robust and efficient production process for zeolite-4A to replace phosphate-based builders in detergents while ensuring comparable or superior detergent performance. The synthesis of detergent-grade zeolite-4A involves preparing sodium aluminate and sodium silicate solutions, forming a gel, crystallizing the gel under controlled conditions, and processing the resulting crystals. The scope of work includes optimizing the process for optimal crystal properties, analyzing reaction conditions, characterizing and ensuring quality, minimizing waste and promoting sustainability, assessing cost-efficiency, evaluating scalability, and comparing detergent performance with traditional phosphate-based builders. It aims to achieve a sustainable, cost-effective, and high-quality zeolite-4A for detergent formulations, reducing environmental impact.

Main objectives are as under;

- To develop technology for the synthesis of Zeolite A from indigenous resources meeting specifications for the detergent grade Zeolite.
- To assess the techno-economic feasibility of the process and transfer the laboratory scale studies on pilot scale.
- To save the foreign exchange being spent on the import of Zeolite for detergent industry.

Graphical Abstract:



Funding Source (PSDP/SGI/RD&I/etc):
In-House

Cost:

Tangible Outcome:

- Zeolite A meeting specifications for detergent grade Zeolite
- Techno-economic feasibility report
- Patent and publications

Achievements:

- Synthesis of Zeolite 4A from commercial grade chemicals has been carried out

- XRD results were obtained which are in good agreement with the literature.
- Characterization of prepared sample using SEM is in progress.

★ ★ ★ ★

Name of Laboratory/Centre Unit:

Materials Science Centre, PCSIR Labs. Complex Peshawar

Title of Project: Synthesis of Graphene for Industrial Applications

Name & Designation of Project Leader:

Dr. Mahmood Iqbal, PSO

Name & Designation of ProjectAssociates(s):

Mr. Amin-Ur-Rahman, PSO
Mr. Qazi Muhammad Sharif, PSO
Dr. Waheed-Ur-Rehman, SE
Mr. Sohail Noor, JTO

Area(s) of Research:

Polymer Sciences

Duration:

01 Year

Date of Initiation:

2023

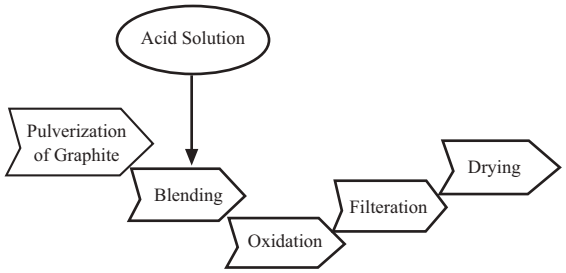
Project Brief:

Graphene has great prospects for industrial applications, such as polymer composites, conductive coatings, fuel cells batteries, and ultra capacitors due to its distinctive properties of high strength and exemplary electrical and thermal conductivity. These applications demand large quantities of graphene in the form of nanoparticles or nanoplatelets. Graphene-based nanocomposites are increasingly being used for the development of new materials for alternative energy sources, for example, in lithium-ion batteries, Graphene-based nanocomposites show better performance as they have high power density and energy density and a fast-charging speed in hydrogen fuel cells. Graphene is also used as an electrode material to enhance electrocatalytic activity, in solar cells. Graphene-based nanocomposites are used in photovoltaic devices because of their unique characteristics of high carrier mobility and low resistivity; and in thermoelectric materials. The properties of graphene nanocomposites are dependent on chemical compatibility between the filler and the matrix, the volume fraction of the filler and the processing conditions such as dispersion and exfoliation of filler.

The synthesis of graphene presents a significant challenge due to the intricate atomic structure and unique properties of graphene. Achieving a scalable, cost-effective, and reproducible method for synthesizing high-quality graphene is crucial for its widespread commercial utilization. Current synthesis techniques often involve complex processes, high costs, or produce graphene with limitations in terms of size, quality, or uniformity. This research aims to address these challenges by investigating novel synthesis methods, optimizing existing approaches, and exploring eco-friendly alternatives to achieve efficient and scalable graphene synthesis with enhanced properties for various applications. The synthesis of graphene presents a challenge due to its unique properties. This involves understanding graphene's structure and properties, exploring various synthesis techniques and precursor materials, optimizing the synthesis process, and employing advanced characterization methods. Environmental sustainability and safety considerations are paramount. Applications of graphene in diverse fields are crucial to explore. Scaling up the synthesis process for commercialization and analyzing the market landscape are essential steps towards realizing the potential of graphene in various industries. The ultimate goal is to develop efficient, scalable, and sustainable methods for high-quality graphene synthesis to meet diverse application needs. The main objectives of the project are;

- Exploration of diverse graphene synthesis techniques for efficiency and scalability.
- Investigation of precursor materials, including upgraded graphite ore, for optimal synthesis.
- Development of eco-friendly synthesis methods for sustainable graphene production.

Graphical Abstract:



Funding Source (PSDP/SGI/RD&I/etc):
In-House

Cost:

Tangible Outcome:
- Synthesis of graphene
- Preparation of nanocomposites
- Characterization of nanocomposites
- Preparation of graphene for industrial application

Achievements:
- A few experiments were conducted to synthesize graphene.
- The samples were characterized. The results indicate that the sample requires further treatment to enhance its purity

★ ★ ★ ★

Name of Laboratory/Centre/Unit:
Materials Science Centre, PCSIR Labs Complex, Peshawar

Title of Project: Upgradation of Low-Grade Indigenous Graphite Ore

Name & Designation of Project Leader:
Dr. Engr. Waheed-Ur-Rehman, SE

Name & Designation of Project Associates:
Mr. Amin-Ur-Rehman, PSO
Mr. Qazi Muhammad Sharif, PSO

Area(s) of Research:
Minerals Processing

Duration:
01 Year

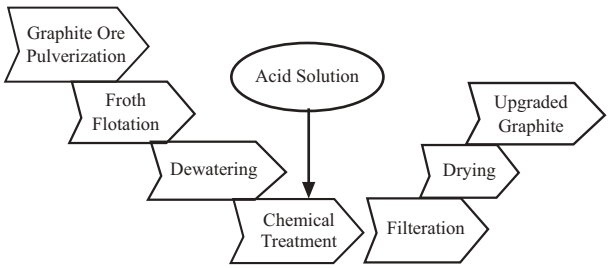
Date of Initiation:
2023

Project Brief:
Graphite is a naturally occurring mineral and anallotrope of carbon. It is characterized by its unique structure, consisting of carbon atoms arranged in a hexagonal lattice, resulting in layered sheets that give graphite its distinctive greasy texture and excellent electrical conductivity. Graphite possesses several remarkable properties, including high thermal conductivity, chemical stability, and resistance to high temperatures. Due to its diverse range of properties, graphite finds numerous applications in various industries, such as batteries, refractories, lubricants, foundry operations, electrical components, and heat management systems. It is a critical material for emerging technologies like electric vehicles and renewable energy storage, making it a highly valuable and sought-after resource worldwide. Pakistan is known to have significant graphite ore deposits, particularly in the northern regions of the country. The graphite occurrences in Pakistan are mainly associated with the crystalline rocks of the AJK, GB, and KP provinces. In proposed project, indigenous graphite ore will be upgraded through froth flotation and chemical techniques to increase the carbon content and thus make it suitable for subsequent industrial applications. Graphite ore is primarily composed of carbon, but it may contain varying amounts of impurities such as silicates, mica, and other minerals. The quality of graphite ore is determined by its carbon content, flake size, and purity. The impurities present in native graphite ore hinder its applications in high-tech industries. Therefore, these impurities must be reduced to the permissible level to achieve higher-quality graphite with larger flake sizes and lower impurity levels that is generally more desirable and commands a higher market value. Beneficiation of low-grade graphite ore aims to enhance its carbon content and remove impurities for specific applications. This involves understanding ore characteristics, comminution, physical and chemical beneficiation methods, and thermal treatment. Techniques like froth flotation, acid

treatment, and thermal exfoliation are used. The scope includes achieving desired purity for applications like batteries, lubricants, and composites, with ongoing research for improved efficiency and environmental impact reduction. Objectives of the project are as under;

- The concrete objectives of researching the beneficiation of low-grade graphite ore are to optimize beneficiation techniques for higher efficiency and cost-effectiveness. This involves maximizing carbon content and minimizing impurities to tailor the graphite for specific applications, including batteries and composites. The research aims to adopt sustainable and eco-friendly practices, ensure economic viability, and integrate technological advancements. Additionally, it involves rigorous ore characterization, pilot-scale testing, compliance with regulations, and active dissemination of knowledge within the scientific and industrial communities.

Graphical Abstract:



Funding Source (PSDP/SGI/RD&I/etc.):

In-House

Cost:

Tangible Outcomes:

- Enhanced Product Quality
- Increased Profitability
- Environmental Sustainability

Achievements:

- Froth flotation experiments were conducted. An initial carbon content of 23% in the raw graphite ore was upgraded to 35% in the concentrate.
- The 1st stage Cleaner Flotation step upgraded the graphite to a further concentration of 51%.
- The 2nd stage Cleaner Flotation step upgraded the graphite to a further concentration of 65%.
- Further concentration will be carried out in next step.

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PCSIR Laboratories Islamabad (IL)

(New Projects)

Name of Laboratory/ Centre/ Unit:
PCSIR Laboratories Islamabad

Title of Project: Studies on Nano Composite Films for Water Purification and Development of Flavored Alkaline Water

Name & Designation of Project Leader:
Dr. Uzma Rashid, SSO

Name & Designation of Project Associate(s):
Dr. Ahmed Bilal. Director
Ms. Razia Kalsoom, SSO
Ms. Fozia Hussain, SSO
Dr. Anila Sajjad, Consultant
Dr. Fouzia Noreen, SSO
Mr. Muhammad Afzal, JEO

Area(s) of Research:
Environmental Sciences, Biotechnology, Water Treatment/Purification

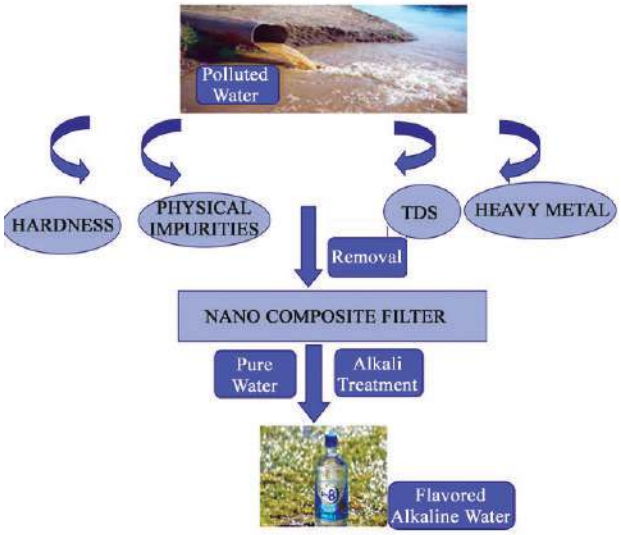
Duration:
02 Years

Date of Initiation:
2024

Project Brief:
Membrane separation systems are used for water treatment because of their high potential to remove micropollutants. As pollution levels are getting higher, membranes with suitable and enhanced properties are required to fulfill the requirements of this process. Many research activities on new membrane materials containing nano dimensions have been done in the last years, resulting in the formation of nanocomposite filtration membranes. Alkaline water has been used globally for centuries. The first record of use of alkaline water dates back to ancient Greece, where it was used as a treatment for various medical conditions. In more recent years, alkaline water has seen resurgence in popularity as people look for natural ways to improve their health. The health and medical therapeutic effects of alkaline mineral water have been widely studied and reported in human medicine, including improvement in cancer patients' quality of life, antioxidant effects, promoting intestinal health, treating intestinal inflammatory diseases and diarrhea. Pakistan is facing serious water crisis and there is a continuous need for new materials and new technologies for specific water treatment as only ten percent of the water is globally available for domestic use. Therefore, it is the need of time to make the available water pure and more beneficial for health by using indigenous resources, new materials and technologies. In the current scenario, composites have gained popularity in various fields such as constructional, aeronautical, vehicular, biomedical, industrial etc. The use of the said materials in water & wastewater treatment is becoming the focus of researchers. The properties offered by composites include specific strength, processability, and design flexibility that can facilitate polluted water purification. On the other hand, alkaline water has a higher pH level than regular tap water. This means that it is less acidic and can help neutralize stomach acid. Calcium is an essential mineral that helps to regulate the body's pH levels. Calcium-infused alkaline water can help to reduce the risk of ulcers and other gastrointestinal problems & improves bone resorption. The objectives are;

- To develop sustainable, cost-effective and indigenous technology for water treatment with respect to Islamabad water quality.
- To synthesize an effective nano composite from Plant extracts as a green, ecofriendly solution.
- To develop improved alkaline water process with enhanced flavor.
- To give water chemical free water treatment solution.
- To support water industry by introducing green technology.
- To optimize and explore scientific data in the related fields.

Graphical Abstract:



Work Plan:

- The study involves the identification of plant source for synthesis, isolation & optimization of nano particles production.
- Their characterization by SEM, TEM, XRF, XRD etc.
- Composite making
- Polymer Mixing
- Membrane Casting
- Phase inversion process.
- Real sample application.
- Shelf life & interferences studies.
- Process development for flavored alkaline water.
- Marketing and promotion.

Funding Source (PSDP/SGI/RD&I/etc.):

In-House

Cost:

Tangible Outcome:

- Smart Eco-friendly technology for management of water quality problems in Islamabad City; as conventionally used chemicals may be harmful for environment.
- After development of these nano filters; PCSIR may be able to provide more economical water treatment solution to related industries and stake holders compared to existing ones.
- The study would be a worthy addition in water treatment research.
- Process development for nano composite filters.
- Process development for flavored alkaline water.

Beneficiaries are, Common consumers, Water related industries.

Achievements:

- Development of nanocomposite filters using indigenous resources for water treatment technologies.
- Development of environment friendly biodegradable nanocomposite filters having minimal environmental impact.
- Process leased out and technology transfer.
- Knowledge Transfer and Skill development.

★ ★ ★ ★

Name of Laboratory/ Centre/ Unit:

PCSIR Laboratory Islamabad

Title of Project: Formulation of Chocolate Coated Fruit Delights as Natural & Nutritious Substitute of Synthetic Sweets

Name & Designation of Project Leader:

Dr. Ahmad Bilal, PSO

Name & Designation of Project Associate(s):

Dr. Anila Sajjad, Consultant
Ms. Razia Kalsoom, SSO
Dr. Uzma Rashid, SSO
Dr. Fouzia Noreen, SSO
Ms. Fouzia Hussain, SSO
Dr. Abdullah, JTO

Area(s) of Research:

Food Technology

Duration:

02 Years

Date of Initiation:

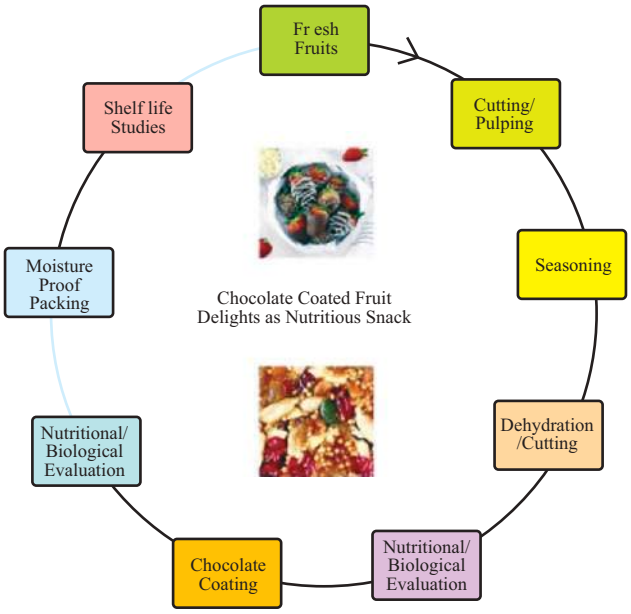
2024

Project Brief:

Sweets are the part and parcels of life and hold significant cultural and social value in society, often representing celebrations, traditions, and moments of indulgence. However, the presence of additives like artificial colors, flavors, synthetic sweeteners, and preservatives in these sweets pose potential health hazards such as obesity and metabolic disorders. The project aims to address health concerns associated with chemical additives found in conventional sweets by focusing on fresh fruits as natural and nutritious substitutes coated with chocolate. These fruit-based alternatives offer a plethora of health benefits and serve as wholesome replacements for various confectionery items, including bakery sweets, candies, and artificially flavored treats. Consumption of fruit-based items increases the intake of nutrients and phytochemicals which leads to the positive health effects and could help the adults especially children to gain the recommended intake. The excessive consumption of synthetic sweets can lead to many health issues due to their high sugar content. This includes tooth decay, weight gain and malnutrition. High sugar absorption can cause blood glucose fluctuations, resulting in hyperactivity, mood swings, and fatigue. Habitual intake may elevate the risk of type 2 diabetes, cardiovascular disease, and metabolic disorders. The use of chemical preservatives in synthatic sweets/ chocolates may affect kidneys, liver and other body organs. Raising awareness about the adverse effects of sugar overconsumption has stimulated the production of low or sugar-free products using alternatives. Promoting fruits as a nutritious item fosters healthy eating habits, reducing intake of sugary treats and improving overall well-being. Chocolate-coated fruits present an appealing and vitamins rich substitute to synthetic sweets, providing natural sweetness alongside nutritional value while satisfying sweet cravings of both children and adults. The objectives of the proposed projects are:

- Providing essential nutrients like vitamins, minerals, fibers from fruits, and antioxidants from dark chocolate.
- Promotes a balanced eating approach with the blend of sweetness and nutritional value.
- Chocolate-coated fruits satisfy sweet cravings.
- Offering a variety of fruits and chocolate coatings with different flavors and textures.
- Diversification of Palate.
- Moisture proofed packaging of product
- Shelf life studies

Graphical Abstract:



Funding Source (PSDP/SGI/RD&I/etc.):

In-House

Cost:

Tangible Outcome:

- Natural sweets as compared to synthetic sweets
- Reduced sugar intake
- Improved nutritional intake
- Enhanced dietary variety
- Availability of fruits in off-season
- Improved dental health and overall well-being
- Chocolate-coated fruit delights will provide essential vitamins, minerals, fiber, and antioxidants from the fruits and chocolate contributing to better overall nutrition for human consumption especially children.

Achievements:

New Project

★ ★ ★ ★

On-Going

Name of Laboratory/ Centre/ Unit:
PCSIR Laboratories Islamabad

Title of Project: Extraction of Orange Peels Oil Using Microwave Assisted Solvent Extraction Technique

Name & Designation of Project Leader:
Dr. Fouzia Noreen, SSO

Name & Designation of Project Associate(s):
Dr. Ahmad Bilal, PSO
Dr. Uzma Rashid, SSO
Ms. Razia Kalsoom, SSO
Ms. Fouzia Hussain, SSO
Mr. Abdullah, JTO

Area(s) of Research:
Natural Product/Green Chemistry

Duration:
02 Years

Date of Initiation:
2023

Project Brief:

With the increase in production of processed fruit, waste generation is increasing enormously. A large amount of this waste poses the problem of disposal without causing environmental pollution. It can be effectively disposed off by manufacturing useful by products from them. Orange peel oil has been chosen for extraction because it provides a great potential for further commercial usage. Peel of citrus fruit has numerous glands that contain oil that is typically recovered as major by product. The current methods for extracting orange oil are time-consuming, inefficient, and may lead to the loss of essential oil components due to exposure to heat and extended processing times. This project aims to develop a more efficient and sustainable method for orange oil extraction using microwave technology. Microwave-assisted solvent extraction also called microwave extraction is a new extraction technique, which combines microwave and traditional solvent extraction. Study shows that microwave-assisted extraction has many advantages, such as shorter time, less solvent requirement, higher extraction rate, better products with lower cost. The apparatus of microwave-assisted extraction is simpler and cheaper and can be used to extract more materials with less limit of the polarity of extraction. The scope of orange oil extraction is primarily related to the production of essential oil from citrus fruits, particularly oranges. Orange oil is a valuable product with a wide range of applications in various industries like flavor and fragrance Industry, food and beverage Industry, Pharmaceuticals, Insecticides and pest control, cosmetics and toiletries etc. The main objectives of the project are;

- To determine the optimum time, temperature and power to extract orange essential oil for the highest yield and quality by using Microwave Assisted Solvent Extraction.
- To apply as natural soap and air freshener after extracting the main component of essential oil.
- To reduce environmental pollution converting waste material into useful product.

Graphical Abstract:

Funding Source (PSDP/SGI/RD&I/etc.):
In-House

Cost:

Tangible Outcome:

- An Eco-friendly choice for management of waste product.
- The study would be a worthy addition in ongoing research.
- Research findings will be submitted for patent filing.
- Development of process for the industry.

Achievements:

Status
On-going

★ ★ ★ ★

PCSIR Labs Complex, Quetta (QL)

New Projects

Name of Laboratory/Centre/ Unit:
Food Technology Division, PCSIR Labs Quetta

Title of Project: Process Development and Formulation of Whey-Based Vegetable Soups and Evaluation of their Nutritional Properties

Name & Designation of Project Leader:
Mr. Junaid Ahmed, SO

Name & Designation of Project Associate(s):
Ms. Hiba Amanat Ali, SO

Area(s) of Research:
Food Technology

Duration:
02 Years

Date of Initiation:
2024

Project Brief:

The surge in protein-rich diet consumption in recent years reflects a growing global awareness of health benefits. With increasingly busy lifestyles, many find it challenging to maintain a consistently nutritious diet. Consequently, there's a heightened demand for convenient sources of nutrients. This has led to a rise in protein supplements and fortified foods, offering quick, efficient alternatives to traditional meals. As such, the market for protein-rich options continues to expand, meeting the dual needs for health-conscious choices and convenience in today's fast-paced world. Whey, a protein complex dived from milk is being acknowledged as a functional food with a number of health benefits. The biological components of whey, including lactoferrin, betaloctoglobulin, alpha lactalbumin, glycolmacropeptide and immunoglobulin demonstrate a range of immune enhancing properties. Whey offers benefits such as lowering cholesterol levels and aiding in weight loss. Whey powder is used as an ingredient in the processing and production of wide verities of food from chocolate and sugar confectionaries to bread, soups and sauces, baby food etc. Whey has the ability to act as an antioxidant, antihypertensive, antitumor, hypolipidemic, antiviral, antibacterial and chelating agent. Today, whey is a popular dietary protein supplement purported to provide antimicrobial activity, immune modulation, improved muscle strength and body composition, and to prevent cardiovascular disease and osteoporosis. Several nutritionally important constituents in whey having excellent functional characteristics enhance opportunities for a wide-range application of whey and whey constituents in the food industry.

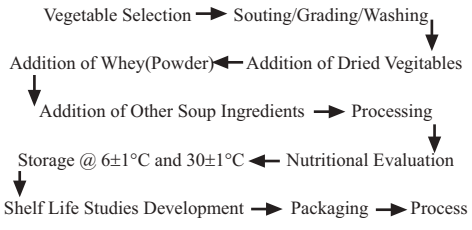
Dried soup powders have an advantage of protection from enzymatic and oxidative spoilage and flavor stability at room temperature over long periods of time (6-12 months). In addition, they are ready for reconstitution in a short time for working families, hotels, hospitals and restaurants.

- Exploring different ratios and combinations to achieve desired teste, texture and nutritional profile and formulation development meets the dietary guidelines
- Investigating various processing techniques for integrating whey and vegetable ingredients in to soup formulations. Feasibility of different processing techniques like blending, emulsification and homogenization for soup production is also assessed
- Conducting comprehensive nutritional analysis for whey-based soups to determine macronutrient and micronutrient profiles.

The main objective is;

- Development of whey-based-vegetable-soup can supply better nutrition to the health-conscious consumers as vegetable soups are liked for its taste, color and aroma.

Graphical Abstract:



Funding Source (PSDP/SGI/RD&I/etc):
In-House

Cost:

Tangible Outcome:
- Development of cost effective and nutritionally rich whey based vegetable soups
- Current research aims to impact the economy positively through profitable product development with minimal investment
- Development of instant soup mixes providing quick and easy meal options

Achievements:
New Project

★ ★ ★ ★

On-Going

Name of Laboratory/Centre/ Unit:
Mineral Technology Division, PCSIR Labs, Quetta

Title of Project: Study of Precious Metals and Upgradation of Copper Ore of Balochistan

Name & Designation of Project Leader:
Mr. Khurram Shehzad Buzdar, SO

Name & Designation of Project Associate(s):
Mr. Muhammad Aamir Raza, EO

Area(s) of Research:
Mineral Upgradation

Duration:
2 ½ Years

Date of Initiation:
2023

Project Brief:

Huge reserves of copper ore are presents/reported in chagai District of balochistan. Reko Diq, saindak, amuri represent one of the largest copper and gold reserves in the Pakistan having estimated reserves of 5.9 billion tons of ore grading 0.41% copper and gold reserves amounting to 41.5 million tons. The area has been a subject of research and exploration by mining companies due to its potential for large scale mining operations. typically focus on evolution precious metals as well as up gradation of copper in reko diq copper ore.The global market has announced copper as a modern energy metal and finds its extensive utilization in the electrical wiring, power transmission lines, alloying, anticorrosive, coating, heat exchangers, refrigeration tubing, etc. Copper ore is primarily beneficiated from sulphide mineral deposits. Due to high-grade copper sulphide deposit exhaustion, the focus has now shifted towards recovery from different lean-grade oxide and mixed ore deposits. Extensive research has been carried out on the flotation of copper sulphide ore as compared to copper oxide and mixed type ores. Huge and different types of ore are reported in Chaghi District Balochistan. This project will be

helpful to provide data of precious metals and up gradation of copper ore. The main objectives are;

- To exploit the natural resources of the province.
- To develop cost effective process

Graphical Abastract:

ROM → Crushing, Grinding & Screening → Chemical Analysis →

Beneficiation/Froth floatation/ shaking table → Concentrate →

Chemical evolution Final Product

Funding Source (PSDP/SGI/RD&I/etc):

In-House

Cost:

Tangible Outcome:

- Up gradation of copper ore for commercial use.
- Identification of precious metals.

Achievements:

- Collection of samples has been done.
- Crushing and grinding completed.
- Screening/mesh size completed.
- Chemical analysis of head sample and different mesh sizes is in progress.

★ ★ ★ ★

Name of Laboratory/Centre/ Unit:

Mineral Technology Division, PCSIR Labs Quetta

Title of Project: The Development of Hydro-metallurgical Process for Separation of Associated Silica from Ferromagnetic Sand of Balochistan

Name & Designation of Project Leader:

Mr. Khurram Shehzad Buzdar, SO

Name & Designation of Project Associate(s):

Mr. Muhammad Aamir Raza, EO

Area(s) of Research:

Mineral Upgradation

Duration:

2 ½ Years

Date of Initiation:

2023

Project Brief:

Magnetite is a ferrimagnetic mineral with chemical formula Fe_3O_4, one of several iron oxides and a member of the spinel group. The chemical name is iron oxide and the common chemical name is ferrous-ferric oxide. The formula for magnetite may also be written as $FeO{\cdot}Fe_2O_3$. Magnetite is the most magnetic of all the naturally occurring minerals on earth. Naturally magnetized pieces of magnetite, called lodestone, will attract small pieces of iron Magnetite has been very important in understanding the conditions under which rocks form. Magnetite reacts with oxygen to produce hematite, Small grains of magnetite occur in almost all igneous and metamorphic rocks. Magnetite also occurs in many sedimentary rocks, including banded iron formations. In many igneous rocks, magnetite-rich and ilmenite-rich grains occur that precipitated together from magma. Magnetite is also produced from peridotites and dunites by serpentinization. These sedimentary rocks have been used to infer changes in the oxygen content of the atmosphere of the Earth. Magnetic iron oxides are often used in magnetic storage. For example, in the magnetic layer of hard disks, floppy disks and cassette tapes. Magnetite powder efficiently removes arsenic from water, the efficiency of which increases ~200 times when the magnetite particle size decreases from 300 to 12 nm. Arsenic contaminated drinking water is a major problem around the world, which can be solved using magnetite as a sorbent. In Balochistan, magnetite minerals are found in Chagai district.Pachinkoh - 45 million tons with average iron content 49%, predominantly magnetite, Chigendik - 05 million tons with average iron content 45% predominantly magnetite, Chighazi - 20 million tons.

Magnetic sand naturally occurred in various areas of Chaghi district and a good source of Iron. Up gradation of magnetic sand will be helpful for local community. The main objective is;

- To explore the mineral of Baluchistan for value added products

Graphical Abstract:

Sample → Screening → Chemical Analysis →

Beatification/magnetic separator / shaking table → Concentrate →

Chemical evolution → Final Product → Report writing

Funding Source (PSDP/SGI/RD&I/etc):
In-House

Cost:

Tangible Outcome:
- To develop cost effective processes for synthesis of iron on industrial scale.

Achievements:
- Chemical analysis of head sample is completed
- Sieving analysis of head sample {06 mesh sizes}
- Chemical analysis of iron and silica of 06 different fractions obtained from sieve analysis is completed.
- Four mesh sizes (-50 + 80, -80 + 100, -100 +150 and -150) introduced on magnetic separator.
- 500g of combined mesh sizes results
- Concentrate of iron obtain 259.10 g
- Slime weight 240.60 g
- Head sample upgrade 51.82 % with 12.20% silica
- To minimize percentage of silica and to increase percentage of iron content trails are under way by using shaking table technique to get maximum iron percentage.

★ ★ ★ ★

Name of Laboratory/Centre/ Unit:
Mineral Technology Division, PCSIR Labs Quetta

Title of Project: Study and Classification of Coals by Rank of Different Coal Fields in Baluchistan

Name & Designation of Project Leader:
Mr. Khurram Shehzad Buzdar, SO

Name & Designation of Project Associate(s):
Mr. Muhammad Aamir Raza, EO

Area(s) of Research:
Mineral Upgradation

Duration:
2 ½ Years

Date of Initiation:
2023

Project Brief:

There are six main coal producing areas in Balochistan where coal-mining activities are in progress. These are - Khost–Shahrig–Harnai 76 million Tonnes; Duki 50 million Tonnes; Sor Rang–Daghari 50 Million Tonnes; Pir Ismail Ziarat 2 Million Tonnes; Mach 23 Million Tonnes and recently mining was started in Chamalang area. The heating value of coal produced from Balochistan varies from 9637 to14357 Btu/lb. The current estimated coal import in Pakistan is around 3-5 million tons per year in the year 2013 and the coal consumption is expected to be more than double in the next few years as the government has planned to convert some existing oil based thermal power plants to coal, and also to establish new power plants based on coal consumption. The international market price of coal is 70 to 120 USD which equals to 7000 to 12,000 PKR per metric ton. In this regard, the coal importers are spending an amount of 300 to 500 million Pakistani rupees for the import of coal, this amount can be reduced to 50% if we develop and utilize our local coal resources. Coals classification will establish categories of coal based on gradational properties that depends principally on degree of metamorphism to which the coal was subjected while buried. These categories indicate ranges of physical and chemical characteristics that are useful in making broad estimate of the behavior of coal in mining, preparation, and use. Classification of coal is based on fix carbon and gross caloric values (GCV). The higher rank coal is classified according to fixed carbon on dry basics on other handed of lower ranks coals are classified according to gross caloric valued (GCV) on the moist basics. It will be useful/ helpful for researchers and local mining industry. The main objective is;

- To utilize the indigenous coal resources for economic growth of the province and the country.

Graphical Abstract:

Samples from different coal fields → crushing grinding → proximate Analysis → gross calorific value (GCV) → evolution of data ASTM-D388 → Report writing

Funding Source (PSDP/SGI/RD&I/etc):
In-House

Cost:

Tangible Outcome:

- Classification of coal will be useful in making broad estimate of the behavior of coal in mining sector and use.
- Tabulated data of classification of coals rank will be helpful for local mining sector, mine owners and for further research in field of coal.

Achievements:

- Coal samples from different coal fields (sharag, mach, musa khel and duki) in Balochistan has been collected
- Crushing and grinding of collected samples has been completed.
- Gross calorific values of 12 samples which collected from different coal fields in balochistan have been completed.
- Proximate analysis in progress.

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PCSIR-Fuel Research Centre (FRC)

New Projects

Name of Laboratory / Centre / Unit:
Fuel Research Centre – PCSIR Karachi

Title of the Project: Extraction of Metal Oxides from Coal Bottom Ash

Name & Designation of Project Leader:
Dr. Anila Sarwar, SSO

Name and Designation of Project Associate(s):
Syed Kabir Shah, SSO

Area of Research:
Fuel & Energy

Duration:
02 Years

Date of Initiation:
2024

Project Brief:

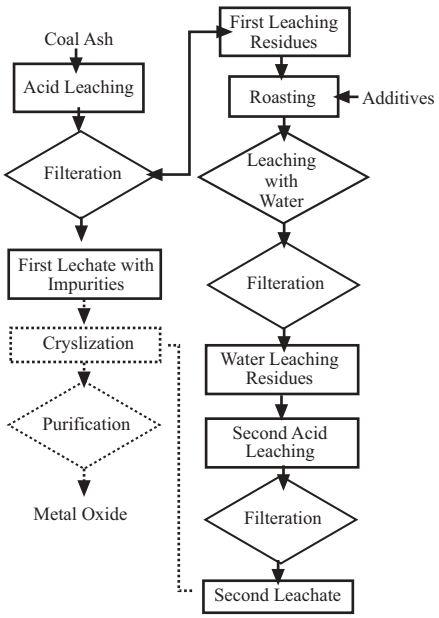
Coal plays an important role in electricity generation worldwide. In Pakistan, several thermal power plants are using lignite and bituminous coals as its major fuel source. These power plants are working in Sahiwal (Punjab), Lasbella (Balochistan), Lakki Marwat (KPK), and Tharparkar, Port Qasim & Karachi (Sindh) with a total Capacity of 7376 MW. However, the use of coal in electricity generation has led to increase in waste production *i.e.* Coal Bottom Ash(CBA) that brings forth environmental issues and human health effects, such as air pollution, respiratory diseases and groundwater contamination due to leaching of heavy metals into ground water. The CBA is highly heterogeneous product consists of a few main components such as Ferric Oxide (Fe_2O_3), aluminum oxide (Al_2O_3), calcium oxide (CaO), potassium oxide (K_2O), titanium oxide (TiO_2), sodium oxide (Na_2O), phosphorus oxide (P_2O_5), and sulphur trioxide (SO_3). In order to reduce impacts of CBA on environment and human health, it is advisable to extract heavy metals from CBA. Due to high demand of coal to generate electricity results in the increment of coal power plant waste. This leads to the annual production of a huge volume of CBA. These vast volumes pose a problem in the disposal which conventionally is loaded onto ash dumps located landfill.

CBA is considered as a hazardous material also since it contains high levels of toxic heavy metal which can cause public health threats and environmental risks such as air pollution, pulmonary diseases and groundwater contamination. Extraction of the metal oxides will be conducted by means of chemical leaching, and after which, the metal oxides will be separated. Chemical leaching is the process of separation of heavy metals from coal bottom ash by dissolving metals into liquid form, as shown in schematic diagram. In other words, metal oxides bound in CBA are turned into metal ions that are released into the acid solution. For example, immobilized metals will become mobilized after the chemical leaching treatment. The extraction of metal oxides from the CBA brings potential of its usage to the various industries.

The main objectives are;

- To extract metal oxides from waste (CBA).
- Conversion of waste into valuable product which has industrial applications

Graphical Abstract:



Funding Source (PSDP/SGI/RD&I/etc.):
In-House

Cost:

Tangible Outcome:
- It is expected that metal oxides can be successfully extracted from the CBA, and hence promoting sustainability, and the potential of the metal oxides to be used in many industries.

Achievements:
New Project

★ ★ ★ ★

Name of Laboratory / Centre / Unit:
Fuel Research Centre – PCSIR Karachi

Title of the Project: Conversion of by-Product of Humic Acid Pilot Plant to Clean Fuel

Name & Designation of Project Leader:
Mr. Amanat Ali, SO

Name and Designation of Project Associate(s):
Dr. Anila Sarwer, SSO
Mr. Nadir Buksh, SO

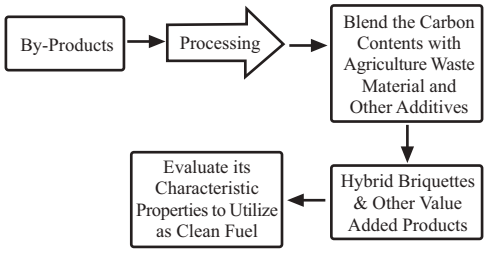
Area(s) of Research:
Environment, Energy, Industry etc.

Duration:
01 Year

Date of Initiation:
2024

Project Brief:
Low grade coal is utilized for various purposes. One of them is to extract organic matter for industrial purpose. After the extraction of organic matter, the major by-products consist of carbon that may convert to value added products such as activated carbon and solid fuel etc. Humic acid Pilot Plant is in active condition at PCSIR FRC, Karachi to promote FRC developed technologies. During the production of liquid humic acid, the solid contents of coal are produced as by products that contain carbon and cationic mass that leads environmental pollution if discarded to the environment as land filler. The aim of this study is to utilize the by-products for the production of value added products to generate revenue and reduce the environmental pollution. Neutralization, washing and blending of neutralized mass of coal with 10-20% agriculture waste and other additives to produce the hybrid briquettes and evaluate the characteristic properties for consuming as boiler fuel. The main objectives of the project are;
- Value addition to industrial & agriculture waste material
- Revenue Generation

Graphical Abstract:



Funding Source (PSDP/SGI/RD&I/etc.):
In-House

Cost:

Tangible Outcome:
- Revenue Generation
- To convert waste material to value added products
- To utilize the by-product of Humic Acid Pilot Plant in a fruitful manner.
- To promote the developed technologies

Achievements:
New Project

★ ★ ★ ★

On-Going

Name of Laboratory / Centre / Unit:
Fuel Research Centre – PCSIR Karachi

Title of the Project: Waste-to-Energy Conversion: Potential, and Development of Renewable Fuel from Indigenous Biomass Waste

Name & Designation of Project Leader:
Dr. Anila Sarwar, SSO

Name and Designation of Project Associate(s):
Syed Kabir Shah, SSO

Area(s) of Research:
Fuel & Energy

Duration:
02 Years

Date of Initiation:
2023

Project Brief:

The Government of Pakistan (GOP) is proactively pursuing the exploitation and utilization of its indigenous resources in order to achieve its top priority strategic objectives of energy security, decreasing dependence on imported fuels and providing sustainable energy supplies for economic growth. The GOP is emphasizing on utilization of indigenous and environmentally clean energy resources. In this regard, the promotion of alternative and renewable technologies is amongst the top priorities which provide a favorable environment for the sustainable growth by resolving the two major issues of country, *i.e.,* natural gas crisis and solid waste management. Pakistan is struggling with the worsening crisis of natural gas during the recent years. The power sector is the largest consumer of natural gas, followed by households and industries. Recently, natural gas shortage is badly hitting domestic and industrial consumers. Unavailability of gas and high prices of electricity are pushing the industries back and reducing the export levels. It causes negative impact on the economy. Another option for industry is to switch to wood and coal; but it leads to deforestation, and environmental pollution. It could also put exports at risk as foreign countries are very particular about climate change and prefer exporters who follow the regulations. Household consumers of gas are already facing load shedding and finding alternatives to keep their stoves burning. The problem of low pressure and inadequate supply of natural gas to domestic consumers did not go away with the winter. The entire summer of 2023 was gas-deficient. Many areas of the country faced gas load shedding even on hot days. The intensity of the problem was felt severely during Ramazan when both Sui Southern and Sui Northern announced their schedules for gas supply during sehri and iftari hours. Low pressure and load shedding of gas become a routine in Pakistan, forcing some household consumers to illegally use a device to increase pressure which comes under gas theft. Solid waste management is also becoming a critical issue in Pakistan with a rapid increase in population. The rapid growth in cities has resulted in a severe shortage of space for the storage of solid waste, as most of the existing landfills have reached their capacity. The improper management of these wastes poses a serious threat to the environment as well as to human health. This problem needs to be dealt effectively in order to ensure that the country's natural resources are not depleted and that the health and safety of its citizens are also protected. A good option to overcome natural gas crisis for domestic and industrial consumers is the conversion of biowaste into alternate fuel. This option will also resolve solid waste management issue related to biowaste. This proposal addresses two main issues related to strategic objectives of the country. First is the shortage of natural gas which is decreasing the economic growth of country. And the second is solid waste management which badly impacts on climate change. The major types of solid waste addressed in this proposal are crop residues, waste biomass and food wastes. Pakistan is producing 108 million tons of crop residues annually. According to a report by the Ministry of National Food Security & Research, the yearly food waste in Pakistan is 19.6 million tons. Therefore, by the pyrolysis of bio-waste, a process for an alternate fuel of natural gas will be developed. The present research proposal is the development of a process for an economical conversion of agro residues and food wastes into environment friendly alternate fuel through wet cold densification technique. Waste agro residues may include residual stalks, straw, leaves, roots, husk, nut or seed shells, jute sticks, bagasse, sawdust and waste wood. It offers

not only an effective route for the control of the environment issues associated with agricultural waste biomass but it also increases the share of renewable energy in the energy mix. The main objectives of the project are;

- The potential of bio-waste towards clean energy production will be elucidated.
- Value-added by-products through pyrolysis of biomass will be isolated.

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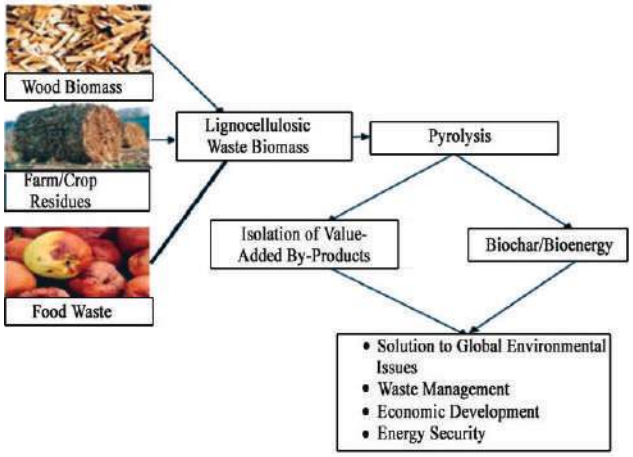


Funding Source (PSDP/SGI/RD&I/etc.):

In-House

Cost:

Tangible Outcome:

- Process / technology development of waste biomass into fuel conversion

Achievements:

- Biomass waste materials were collected from indigenous resources.
- Laboratory scale pyrolysis of waste biomass has been carried out.
- Isolation / conversion processes are in progress.

★ ★ ★ ★

PCSIR-Leather Research Center, Karachi (LRC)

New Projects

Name of Laboratory/Centre/Unit:
Leather Research Centre, PCSIR, Karachi

Title of Project: Reduction of Heavy Metals in Tannery Effluent through Phycoremediation using Microalgae

Name & Designation of Project Leader:
Dr Rajkumar Dewani, SSO

Name & Designation of Project Associate(s):
Dr. Farman Ahmed, PSO
Mrs. Tahira Ayaz, SSO
Mr. Sikandar Ali Soomro, JTO

Area(s) of Research:
Leather and Textile

Duration:
02 Years

Date of Initiation:
2024

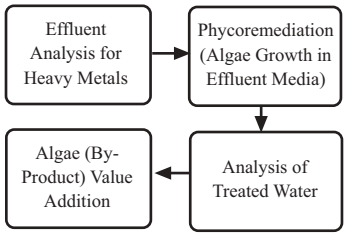
Project Brief:

Leather and textile are among the major industries of Pakistan. Both industries utilize large amounts of water that should ideally be recycled for sustainable use. The effluent water has a significant amount of degradable organic waste and a significant amount of inorganic contaminants and heavy metals, especially hexavalent chromium (VI), which is highly toxic to living beings. The use of microorganisms to treat industrial effluents is a promising area, since it achieves the reduction of polluting compounds and also generates biomass, which can be used in different processes biotechnology. Phycoremediation may be defined as 'the use of algae to bioremediate' wastes or wastewaters. The use of microalgae has attracted the most attention, due to its ability to reduce the concentration of inorganic nutrients such as nitrogen and phosphorus and decrease the concentration of dissolved heavy metals such as Nickel, Cobalt, Copper, Lead, Arsenic and Chromium. Likewise, microalgal biomass can be used in the production of biofuels such as biodiesel, bioethanol, and biogas etc.

Problem Statement. The leather and textile effluent containing heavy metal pollutants may cause serious problems when it enters the natural environment, posing threat to human health and natural ecosystems. Effective mechanism for effluent treatment is the need of the hour to align our direction towards the Global Sustainability Development Goals (SDG) by 2030. The commonly detected heavy metals in textile and leather effluent are Chromium, Cadmium, Mercury, and Arsenic etc. Various bio based resources may offer potential for remediation to treat industrial waste water prior to their discharge into treatment plants or wastelands. Algae can also be explored for this purpose. The major algal strains reported for the removal of the organic and inorganic pollutants with biomass production from the contaminated sites are *Chlorella, Nannochloropsis, Microcystis* and *Scenedesmus* species. Additionally, the ability to tolerate the organic and inorganic contaminants varies amongst algae species. The most resistant algae are *Stigeoonium, Oscillatoria, Chlamydomonas, Scenedesmus, Chlorella, Nitzschia*, and *Euglena*, especially when it comes to organic contaminants. There is a lot of working space on cleaner technology in leather sector. The establishment of Leather Working Group (LWG) is also a part of this common goal. Phycoremediation of chromium will be focused along with other metals like Lead, cadmium, mercury, arsenic etc. in tannery effluent. The main objective is;

- Reduction of heavy metal (such as Cr, Pb, Cd, Hg, etc.) concentrations through adsorptive strategies using bio based resources, e.g. microalgae.

Graphical Abstract:



Timeline (Quarter Wise Plan):

First Year	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
	• Literature Survey • Development of test method for heavy metal analysis in textile and leather effluent water	• Micro-algae culture and growth in fresh water.	• Microalgae culture and growth in effluent wastewater. (1st Cycle)	• Analysis of effluent water after microalgae culture. (1st Cycle)
2nd Year	**1st Quarter**	**2nd Quarter**	**3rd Quarter**	**4th Quarter**
	• Microalgae culture and growth in effluent wastewater with Modifica-tions. (2nd Cycle)	• Analysis of effluent water after modifica-tion. (2nd Cycle)	• Processes / Patents / Publications	• Feasibility assessment for commer-cialization • Final Reports

Funding Source (PSDP/SGI/RD&I/etc.)

In-House

Cost:

Tangible Outcome:

- The expected outcome of project is a process that may be updated to a technology depending on the performance. The novelty may lead to reuse of effluent water, reduction of hazardous metal in tannery effluent, Effluent treatment at individual local tannery scale and good quality research article/ Technical Report. The immediate beneficiary would be leather and textile industries of Karachi. The success of the project may benefit and involve a wider range of industrial sectors, Environmental Protection Agency (Sindh) or private investors interested in commercializing the process.

Achievements:

★ ★ ★ ★

Name of Laboratory/ Centre/ Unit:

Leather Research Center PCSIR, Karachi

Title of Project: Recovery of Halal Gelatin for Food and Cosmetics from Untanned Leather Wastes.

Name & Designation of Project Leader:

Mr. Barkat Ali Solangi, PSO

Name & Designation of Project Associate(s):

Dr. Farman Ahmed, PSO
Dr. Uzma Nadeem, SSO
Mr. Muhammad Zeeshan, PT
Dr. Beena Zahra, SSO

Area(s) of Research:

Leather

Duration:

01 Year

Date of Initiation:

2024

Project Brief:

Leather industry has been categorized as one of the highly polluting industries and there are concerns that leather-making activity can have adverse impact on the environment. Gelatin is an animal by-product, the partially hydrolysed collagen tissue of various animal parts. It has halal status. Most gelatin is of two types:

I. Type A gelatin is exclusively made from pork skins, and is hence Haram for Muslims to use.
II. Type B gelatin is made either from cattle and calf skins or from demineralized cattle bones. If any non-Muslim slaughters animal cattle or calf; it's also prohibited for Muslims, called haram. Muslims slaughter the animal according to Sunnah, which is halal.

Before the leather processing in the tannery, unwanted parts of hides and skins were trimmed to save chemicals and other overhead charges. These parts go to waste and contain a high amount of proteineous material, according to a literature survey. Animal hide and skin contain proteins (90–95% of solids, 35% by

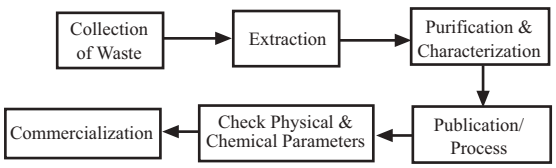
weight.), carbohydrates, lipids, water, and mineral salts. Trimmings, shaving, splitting, and buffing dust) mainly contain 30%–35% collagen protein. It's dumped in a waste bin or thrown in a landfill, which creates pollution. The unpleasant odor emanating from the decomposition of proteinous waste material and the presence of sulphide, ammonia and other volatile organic compounds are also associated with tanning activities. Cattle hides from halal-slaughtered animals are received from the trimming operations of leather production. The hide pieces are usually de-haired chemically with a lime and sulphide solution, followed by a mechanical loosening. Gelatin is a source animal protein extracted from leather wastes collagen by the hydrolyzing it. Gelatin is used in the food, cosmetic, and pharmaceutical industries. Being extracted from collagen, gelatin closely resembles collagen in amino acid composition. Gelatin is used in many food products, including jellies, ice cream, confectionery, cookies, and cakes. It is also used in non-food products, including medical products, and in veterinary applications. Thus, due to high consumer usage and demand, it is a good project for Pakistan industry to earn from wastes to wealth. The main objectives of the project are;

- To develop a method for the extraction of gelatin from the waste bovine and fish.
- To characterize long chain and short chain gelatin.
- To develop value-added products for the food and cosmetic industries.
- To check chemical parameters as per the food and cosmetic industry.

Work Plan:

- Collection of leather wastes from leather industry.
- Extraction of collagen and gelatin with low temperature.
- Purification and characterization of recovered gelatin.
- To check physical and chemical parameters as per standard method.

Graphical Abstract:



Funding Source (PSDP/SGI/RD&I/etc):
In-House

Cost:

Tangible Outcome:

- Process developed
- Product would be developed on lab scale
- Publication

Achievements:
New Project

Timeline (Quarter Wise Plan)

First Year	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
	Collection of leather wastes from leather industry,	Extraction of collagen and gelatin with low temperature	Purification and characterization of recovered gelatin.	• To check physical and chemical parameters as per standard method • Patents should be submitted • Publication

★ ★ ★ ★

Name of Laboratory/ Centre/ Unit:
Leather Research Center, PCSIR

Title of Project: Develop a Bio-polymer for Safe Leather Re-tanning Process & Study the Environmental Impact

Name & Designation of Project Leader:
Dr. Beena Zehra, SSO

Name & Designation of Project Associate(s):
Raja Asad Ali, Sr. Tech.

Area(s) of Research:
Leather Processing Chemicals

Duration:
1 ½ Years

Date of Initiation:

July, 2024

Project Brief:

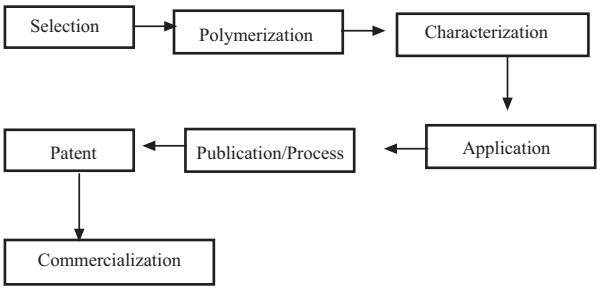
Raw skin/Hide is converted into a useful durable form called leather after various tanning stages. Re-tanning of leather fills the looser areas of hides and skins and improves the leather physical properties. Re-tanning process of leather requires various types of polymers to provide leather full softness, fullness, filling efficiency, increase in shrinkage temperature, etc.

Mostly re-tanning is being carried out with imported and costly chemicals e.g. acrylic based polymers. The sustainable products for leather processing are gaining more interest for better consumption of product recycling and biodegradation.

Most commonly monomers are Acrylonitrile, Acrylic Acid, Ethyl Acrylate, Butyl Acrylate Methacrylate, Acroleic Acid, etc. For the reduction of environmental impacts of acrylic re-tanning alternate products are highly demanded by tanners. Therefore, this project is emphasized to prepare new bio-based polymers from natural resources. The bio monomers are being develop from starch, proteins, PVA, urea, acrylamide with other natural polymer The polymerization of bio-based products will increase the efficiency of products beside the clear elimination of hazardous re-tanning chemicals with a positive economic impact.

Objectives:

- Preparation of Bio-polymers for re-tanning process
- Environmental Assessment for application in leather processing
- Develop a biopolymer not originating from petrochemicals to reduce environmental impact.



Work Plan:

- Polymerization under suitable conditions
- Characterization and Application of bio-polymers in leather processing
- The develop product will be experimented in comparison with standard petrochemical based product and finally leather product and effluent will also be assessed.
- Publications/Patent

Funding Source (PSDP/SGI/RD&I/etc):

In-House

Cost:

Tangible Outcome:

The following outcomes are expected after the completion of the project:

- Development of new process / methods
- Bio-Polymer product development for Leather
- Cost savings in application
- Commercialization
- Publications

Achievements:

New Project

Timeline (Quarter Wise Plan):

First Year	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
	• Collection of Raw Materials • Selection / Purchasing of Chemicals	• Preparation of Bio-Polymers	• Analysis of Bio-Polymers	• Optimization of whole process conditions
2nd Year	• Application of Developed Bio-Polymers	• Comparison of Product with Market available Retanning Polymers to check performance of Retanning Bio-Polymers	• Patent Submission	• Industries Marketing • Possible efforts for lease-out.

On-Going

Name of Laboratory/Centre/Unit:
Leather Research Centre, PCSIR, Karachi

Title of Project: Optimization of Traditional Analysis of Important Analytes in Water and Wastewater through Modern Techniques

Name & Designation of Project Leader:
Dr. Rajkumar Dewani, SSO

Name & Designation of Project Associate(s):
Mrs. Tahira Ayaz, SSO
Mrs. Sarwat J. Mahboob, SSO
Mr. Sikandar Ali Soomro, JTO

Area(s) of Research:
Chemical Analysis

Duration:
02 Years

Date of Initiation:
2023

Project Brief:

Pakistan is passing through a phase of severe economic crisis which is drastically affecting its industrial sector. To overcome these challenges, the industrial sector must be facilitated in all possible ways. Unfortunately, after production the export oriented products have to go through stringent quality testing as per international standards that aids to difficulties of the industrialists. The test costs are heavily charged in foreign currency which is an additional load. The current project is designed to mitigate some of these difficulties by developing test methods that are low cost, optimized and validated to be comparatively efficient as the standard methods if not better. The traditional methods for analysis of heavy metal pollutants require State-of-the-art equipment for quantification that aid to the total production costs of our export-oriented industry. Modified methods with medium cost and lost cost analysis techniques could be further explored to address some of these issues. Metal complexation and consequent screening through visible spectrophotometry is the conventional technique for analysis of vast number of metallic species. A metal-ligand pair provides a specific peak wavelength (lambda max.) for quantitative application. By replacing the ligand, the sensitivity of the technique, the linear range, and resistance to interference may be enhanced. Similarly, advanced sample preparation and pre-concentration techniques can offer better detection limits as compared to those already reported. These potential dimensions will be explored to produce analytical results that are near (if not comparable) to advanced analytical techniques like Flame atomic absorption spectroscopy etc. The main objective of the project is;

- To optimize the existing testing methods for analytes like chromium (both tri and hexavalent), iron, arsenic, cadmium, mercury, lead, ammonia nitrogen etc. through colorimetric methods utilizing newer ligands for metal complexation. Focus would be to introduce and apply modern sample preparation methods to improve analysis results and / or their credibility and ranges.

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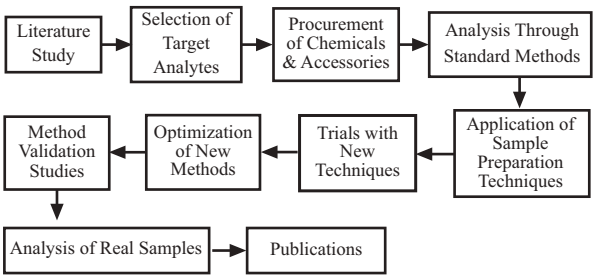


Funding Source (PSDP/SGI/RD&I/etc.):
In-House

Cost:

Tangible Outcome:

- Predicted enhancement in income generation through adhoc testing
- Publications
- Process development
- Projected cost savings in analysis
- Projected development of new methods
- Projected novel or modified sample preparation / pre-concentration methods

Achievements:

- A process has been developed:
  - Synthesis of Iron – Gallic acid complex for quantitative applications.

★ ★ ★ ★

PCSIR-Laboratories Hyderabad (HL)

New Projects

Name of Laboratory/ Centre/Unit:
PCSIR Laboratories Hyderabad

Title of Project: Extraction and Utilization of Fiber from Banana Stem

Name & Designation of Project Leader:
Ms. Ammarah Kanwal, SSO

Name & Designation of Project Associate(s):
Mr. Fahim Haider Jamali, SO
Ms. Saniya Soomro, SO
Mr. Muhammad Yaqoob Kapri, JTO

Area(s) of Research:
Sustainable Agriculture, Agricultural Waste Management, Bioproducts Development

Duration:
1 ½ Years

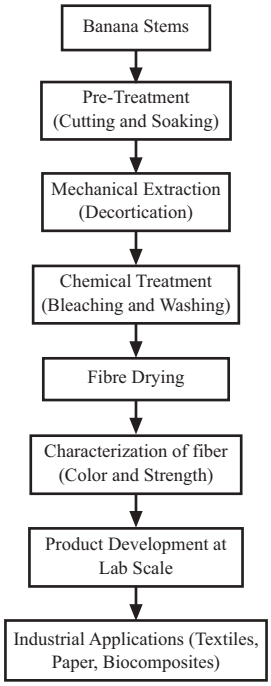
Date of Initiation:
2024

Project Brief:

Banana plants (Musa spp.) are widely grown in tropical and subtropical regions. After the fruit is harvested, the banana stem is typically discarded as agricultural waste. However, this stem contains high-quality fibre that can be utilized in various industries. The extraction of fibre from banana stems not only provides an additional source of income for farmers but also contribute to sustainable agricultural practices by reducing waste. Despite the potential benefits, the extraction and utilization of banana stem fibre are not widely practiced due to a lack of awareness, technical know-how, and infrastructure. This project aims to address these challenges by developing an efficient and scalable process for fibre extraction and promoting its applications. The project will focus on the mechanical and chemical processes involved in extracting fibre from banana stems. It will explore the properties of the extracted fibre and its potential applications in textiles, paper, and biocomposite materials. The scope includes developing a pilot-scale extraction unit and assessing the economic viability of the process. Currently, Banana fiber is widely used in textile sector. There is very high demand of banana fiber in European countries, USA and Korea. So, by exporting banana fiber, Pakistan will earn wealth from waste in the form of foreign exchange. The main objectives of the project are;

- Develop a sustainable and efficient method for extracting fibre from banana stems.
- Characterize the properties of the extracted fibre.
- Identify potential applications for the fibre in various industries.
- Develop product at lab scale

Graphical Abstract:



Funding Source (PSDP/SGI/RD&I/etc):
In-House

Cost:

Timeline (Quarter Wise Plan):

First Year	
1st Quarter (July 2024 - September 2024)	• Literature Review and Preliminary Research • Development of Extraction Process (Initial Phase)
2nd Quarter (October 2024 - December 2024)	• Development of Extraction Process (Continued) • Fibre Charac-terization (Initial Phase)
3rd Quarter (January 2025 - March 2025)	• Fibre Charac-terization (Continued) • Product Development at Lab Scale
4th Quarter (April 2025 - June 2025)	• Dissemination and Training • Planning for Pilot Scale Funding
Second Year	
5th Quarter (July 2025 - September 2025)	• Pilot Scale Preparation (Subject to Funding Approval)
6th Quarter (October 2025- December 2025)	• Pilot Scale Implementation (Subject to Funding Approval) • Final Reporting and Dissemination

Tangible Outcome:

- Technology: A scalable fibre extraction process from banana stems.
- Product: High-quality banana stem fibre for various applications.
- Process: A sustainable method for agricultural waste management.
- Beneficiary: Farmers, textile industry, paper industry, biocomposite manufacturers.

Achievements:

- Successful development of a lab-scale extraction unit.
- Characterization of banana stem fibre properties.
- Identification of multiple industrial applications for the fibre.
- Enhanced income opportunities for farmers through the sale of banana stem fibre.
- Contribution to sustainable agricultural practices by reducing banana stem waste.

★ ★ ★ ★

PCSIR-Laboratories, Skardu (SL)

New Projects

Name of Laboratory/ Centre/ Unit:
PCSIR Labs Skardu

Title of Project: Cultivation/Propagation & Development of Value-added Products of Blackberry

Name & Designation of Project Leader:
Mr. Tariq Umar Khan, Director

Name & Designation of Project Associate(s):
Mr. Muhammad Iqbal Khan, SSO
Mr. Muhammad Arif, Engineer

Area(s) of Research:
Agriculture / Food

Duration:
03 Years

Date of Initiation:
2023

Project Brief:

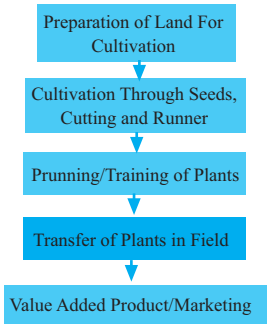
Blackberries (*Rubus fruticosus)* belong to family rosaceae are popular fruit known for their distinct taste and nutritional benefits. They are indigenous to continents including Asia, Europe, North and South America. Due to improved cultivars, effective marketing initiatives, and increasing demands of consumers, blackberries have now become a common fruit in marketing outlets around the world. Blackberries grow well in temperate and cool-climate regions in fertile, well-drained soils with adequate moisture. Blackberries can be reproduced primarily using tissue culture techniques, runners, and cuttings that have been rooted. With the help of these vegetative methods of reproduction, blackberry plants are efficiently multiplied, enabling successful cultivation and greater accessibility to this delicious fruit. The benefits are:

- Due to its therapeutic and beneficial qualities, Blackberry plants (***Rubus fruticosus***) have been extensively utilised in herbal medicine. They exhibit antimicrobial, anticancer, antidysentery, antidiabetic, and antidiarrheal effects, along with high antioxidant activity. Vitamin C, niacin, pectin, sugars, and anthocyanins are blackberries' essential components. Due to the high concentration of the phenolic compounds (flavanols and ellagitannins), they have a significant potential to act as an antioxidant. According to some researchers, these phenolic compounds protect against age-related neurodegenerative diseases, oxidative stress-related disorders, and bone loss.
- Blackberries fruit is known for nutritional benefits.
- Commonly people are unaware about its cultivation, nutritional and medicinal benefits.
- Black berry plant is not easily available in market.
- Due to high demands of consumers, blackberries have now become a common fruit in market.
- Black berry fruits can be utilized by value addition and processing of ripe fruits pulp by making juices, jam, jellies and fruit candies etc.
- Blackberries grow well in temperate and cool-climate regions, in fertile, well-drained soils with adequate moisture.
- Blackberries can be propagated through runners and cuttings. With the help of these vegetative methods of reproduction, blackberry plants are efficiently multiplied.
- Black berry fruit can also blended with other fruits like cherry, mulberry, Seabuckthorn etc for value addition.

The main objectives are;

- Technology development for black berry farming in Gilgit-Baltistan.
- Model farming for entrepreneur, farming community and interested grower.
- Development of experimental field / land for cultivation of black berry.
- Conduct research for product development from black berry fruit.

Graphical Abstract:



Funding Source (PSDP/SGI/RD&I/etc):
In-House

Cost:

Tangible Outcome:
- Establishment of model research farm.
- Production of nursery plants.
- Process Development.

Achievements:
New Project

★ ★ ★ ★

Name of Laboratory/ Centre/ Unit:
PCSIR Labs Skardu

Title of Project: Embellishment Artifact Using Semi Precious Stones, River Pebbles and Cobbles

Name & Designation of Project Leader:
Mr. Muhammad Iqbal Khan, SSO

Name & Designation of Project Associate(s):
Mr. Tariq Umar Khan, Director

Area(s) of Research:
Gems And Minerals

Duration:
03 Years

Date of Initiation:
2023

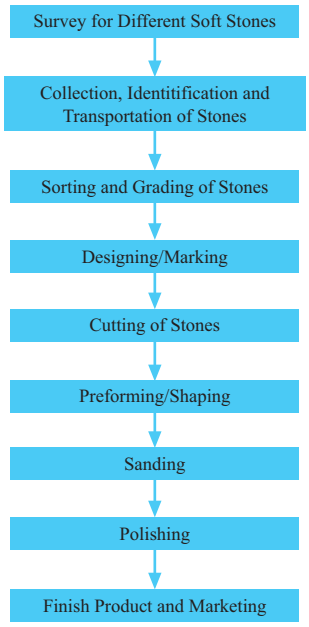
Project Brief:

Quartz (Rutile quartz, amethyst, smoky quartz, diamond quartz) Tourmaline, Jade (green Jade, white Jade), Nephrites, Serpentine, K2nite, Topaz, Granite etc are commonly found semi precious stones and minerals found in Gilgit-Baltistan. Semi precious stones have hardness range from 4 – 8 and can be cut into different shapes and ability to accept a polish. These properties make it a popular ornamental gemstone. **Serpentine is** a mineral or rock consisting essentially of a hydrous magnesium silicate having green color. Serpentine is also known for its ease of being cut into different shapes and ability to accept a polish. Some varieties of serpentine can be carved into beautiful stone sculptures in different range of size from under one centimeter to several meters in height. It is most often cut into ornaments such as (bowls, vases, desk sets, table clock, tea set, paper weight etc of different shapes and sizes) jewelries (cabochons, beads, ring, earrings, bracelet, pendants etc) can be made from serpentine. **River pebbles and cobbles** are known as river rock. Pebble tools are among the earliest known man-made artifacts. Inland pebbles and cobbles (river rock) are usually found along the shores of large rivers and lakes. Pebbles and cobbles are often used to cover walkways and driveways, around pools, in and around plant containers, and for landscaping, construction and as decorative elements. They are an easy material to obtain in Skardu. There are various ways to use these stones to create awesome crafts. They are used for variety of purposes, both outdoors and indoors. There is dire need to make a range of ornamental & decorative items such as (wash basin, candle stands, lamps, door mats, table mats, and bowls, etc) using local available semi precious stones, river pebbles and cobbles to develop indigenous technology for local people and industry. Most of these items are not much focused in Skardu. Moreover, Precious, Semi precious stone and minerals deposits are found in Gilgit-Baltistan. The properties of many gems and minerals are still unidentified. Due to lack of technology, training and un-availability of tools & machinery these gems are usually wasted during mining. Many precious value added products can be prepared by these gemstone and minerals. There are high demands of ornamental products in market but entrepreneurs in this field could not produce value added products of gemstones and

minerals in the local market. Main objectives are;

- Technology development for making different product from semi precious and minerals.
- This project aims to establish efficient and effective techniques by developing different value added products to meet the market demand
- The purpose of the project is to develop research study on lab scale for research students and people belonging to the field of mining sector.
- The aim of the project is to identify the most effective method for development of finished value added products on lab scale.
- Minimizing wastage of semi precious stone from mining.
- Promote and facilitate local cottage industries of gemstones business.

Graphical Abstract:



Funding Source (PSDP/SGI/RD&I/etc):

In-House

Cost:

Tangible Outcome:

- Process Development.
- Production of Value added Products in scientific manners.
- Provision of skills to youth for establishment of cottage industries in the area.
- Meet the market demand.

Achievements:

New Project

★ ★ ★ ★

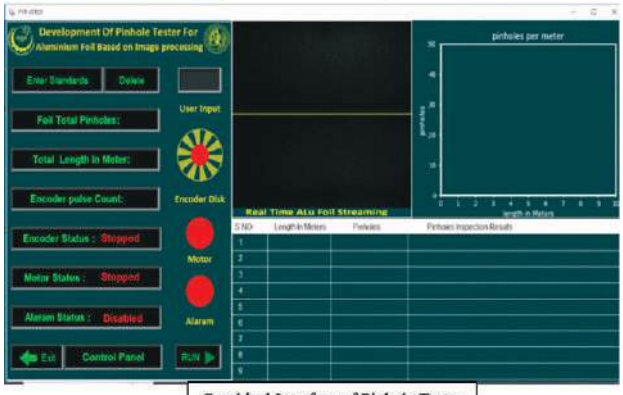
Sub Completed Projects for the Year 2023-2024

PCSIR Laboratories Complex, Karachi

Completed Projects

S. No.	Title of Project	Achievements
1.	**Development of herbal formulations based on *Allium sativum*, *Aloe vera*, *Trigonellafoenum-graecum*for the management of hyperlipidemia.**	• Two products are developed: a. Syrup Formulation b. Capsule formulation • One paper is published entitle "Preventive effects of Trigonellafoenum-graecum and Allium sativum against Triton induced hyperlipidaemia in rabbits" Hina Imran, Tehmina Sohail, Rashid Ali Khan, Shahla Basit, Shazia Syed. *J Pre Clin Clin Res*. 2023;17 (3):145-148. • One paper on toxicity of formulation is under compilation • Patent is under process • Products are ready for commercialization
2.	**Process optimization for the isolation of pungent component capsaicin from capsicum fruits for medicinal purpose.**	• The red chillies were extracted and the oleoresin obtained was chromatographed on HPLC for standardization. • The oleoresin was used in the formulation for analgesic cream and ointment. • Preclinical efficacy and clinical trials of cream and ointment are completed. • The formulation of cream has been submitted for patent • Cream sample has already been submitted to the marketing section for marketing of the product. • The formulation for Cream/ointment-based bandages for localized pain is also completed.
3.	**Facility development for residual analysis for organic impurities in pharmaceutical APIs and packaging material on GCMS**	• Extraction and GCMS method has been developed for the residual analysis in pharmaceutical samples except Nitrosamine due to non-availability of standard. • Methods have been developed for leachable and extractable compounds in pharmaceutical samples using GCMS.
4.	**Evaluation of selected Blue green algae and fungi for their nutritional value and their use as effective food supplement**	• Few species are grown at lab scale. • Dried Biomass is produced • Survival of species were determined • Toxicological study of certain species after successful survival was accomplished • Nutritional evaluation accomplished • Dried powder is ready for formulation
5.	**Bioactive Chemical Profiling of Micro propagated, *In vitro* tissue culture, and Naturally Growing Plantlets of *Chrysanthemum grandiflorum* and *Stevia rebaudiana***	• Successful developed media and protocol for *in vitro* tissue culture of *Chrysanthemum grandiflorum* to produce valuable plant from medicinal point of view. • Paper publication is under process. • Process of *in vitro* tissue culture is ready to be leased out.

S. No.	Title of Project	Achievements
6.	**Process Development for Amino Acid Based Organic Fertilizer from Food Processing By-Products**	• Process has been developed on Lab scale for foliar solution, optimized up to 10% of proteinhydrolyzates (free amino acids). • Patent/ Paper is in progress • Commercialization is being executed and ready to be transferred.
7.	**Characterization and Beneficiation of Bentonite Clay for Industrial Applications**	• Samples of Bentonite clay have been collected from different regions of province Sindh • Samples were analyzed for various physical and chemical parameters to establish baseline data • Swelling index of the samples have been determined • It was found that majority of the samples were Calcium Bentonite having low swelling index • Different experiments were performed to increase the swelling index of the samples • Research Article is under progress
8.	**Application of natural dyes and finishes to enhance antimicrobial properties of textiles**	• Various extraction processes have been developed. • Extracts were applied on fabric to get antimicrobial textiles.
9.	**Development and Commercialization of Standard Reference / Quality Control Materials for the estimation of major and trace elements in Soil**	• A batch of Soil (20Kg) reference material for the estimation of some major and trace elements have been prepared by following a well-defined protocol • Concentration/values of the elements in LRM have been estimated by repeatability and reproducibility studies • Homogeneity studies of the LRM has been done on continual basis with different time intervals • Stability studies has been done • Shelf life study was done • Number of vials have been prepared with complete specification • Samples were sent in other laboratories for comparison of assigned values
10.	**Development of nursery of superior quality Sugarcane via Bud Chip technique**	• Development of nursery of superior quality Sugarcane via Bud Chip technique at Damloti and Tando Mohammad Khan as demonstration site for seeding material
11.	**Random amplified polymorphic DNA-based molecular heterogeneity analysis of *Salmonella enterica*isolates from environment and hospitals**	• Developed a RAPD-based method for Salmonella differentiation. • Currently compiling data. • Drafting the research paper is in progress.
12.	**Synthesis of Metal Nanoparticles Using Microalgae to Detoxify Aflatoxins Contamination**	• Iron, zinc and selenium nanoparticles products developed • 02 papers are in process • Process Developed: In vivo study on the Nile Tilapia fish

S. No.	Title of Project	Achievements
13.	**Application of Edible Nut Shells as a Nanoadsorbent to Minimize Aflatoxins Contamination in Poultry Feed**	• Nanoadsorbents from edible nuts shells developed • 01 International Paper • In vitro study with aflatoxins and poultry feed process developed
14.	**Development of Technology for Candied Fruit Processing**	• An ToRs was signed b/w PCSIR Labs Complex, Karachi and M/s. Foodex, having office address, 259-H, Block # 6, P.E.C.H.S, Karachi, Pakistan (Asif Ilyas, CEO) entitled "Grant of Non-Exclusive Process Relating to Developing and Transferring Dehydration Fruits & Vegetables Processes" • Adhoc-Reciept on account of ILD/Process/2022-15921 of Rs. 250000/- for the process development of dehydrated fruits and vegetables is received in June 2022. • Five processes have been developed till now i. Development of Naturally dehydrated Cherry through conventional oven drying. ii. Development of Candied Mango through osmotic dehydration. iii. Development of Candied Apricot through osmotic dehydration. iv. Development of Candied Banana through osmotic dehydration. v. Development of Candied Papaya through osmotic dehydration
15.	**Design & Fabrication of Pinhole Tester for Aluminum foil (Analytical Equipment)**	• Pinhole detection is an important step in ensuring safety and quality, whether it'spharmaceutical drugs or foods packed in aluminum foil. That is way the significance ofthis project lies in its potential to revolution-ize the quality control process in thealuminum foil packaging industry. • New cost-effective and indigenous technology for Analysis of PIN HOLE in Aluminum Foil has been developed. • Patent is in preparation  Pin Hole Tester  Graphical Interface of Pinhole Tester

S. No.	Title of Project	Achievements
16.	**Establishment of Testing Facility for Flowmetery**	• Prototype Flowmetry test bench for liquids has been developed from 1.0 LPM to 220 LPM • Patent has been filed.
17.	**Designing and fabrication of thermo electric cooler based air conditioner (Peltier Effect)**	• A prototype model was designed and fabricated using peltiers.
18.	**Preliminary Determination of Nitrogen dioxide (NO_2) exposures from cooking stoves by using LPG and CNG as fuel in Karachi city.**	• In this R&D project the sampling analysis have been successfully completed, more than fifty houses using CNG and LPG as domestic kitchen fuel have been covered, and data have also been compiled. • The findings of the results will be published as a research paper and have highlighted areas needing improvement, a new R&D project proposal is being prepared to address these issues. • The team is committed to ensuring the successful implementation of remedial measures and continuous improvement based on the project outcomes.

SGI Project

S. No.	Title of Project	Achievements
1.	**Development of an Automated Hydroponic Greenhouse for the Cultivation of Industrial and Medicinal Cannabis at PCSIR-Labs Karachi**	Hydroponic Greenhouse for the Cultivation of Industrial and Medicinal Cannabis has been completed as per tender at PCSIR Labs Complex, Karachi.
2.	**Development of State-of-the-Art Testing Facilities at Leather Research Centre (LRC) to Comply with ZDHC, REACH, LWG & CE Marking to Support Export Oriented Leather Sector of Pakistan.**	Step-1 Meeting of PCSIR 3rd Departmental Working Party DWP The meeting was held at the PCSIR Head Office, Islamabad. The Director General of PCSIR Laboratories Complex, Karachi, attended the meeting via Zoom online for the re-validation of the approved project. The approved cost of the project has been enhanced to 141.37 million instead of 100.65 million. Step-2 Tender Opening meeting at Member Technology Office, Head Office, PCSIR, Islamabad The meeting was held on 27-03-2023, at Office of Member (Technology), PCSIR, Head Office Islamabad. The tender was advertised for the purchasing of equipment for the project, 'Development of State-of-the-Art testing facilities at Leather Research Center (LRC) to comply with ZDHC, REACH, LWG & CE marking to support Export Oriented Leather and Textile sectors of Pakistan Step-3 Delivery of equipment New equipment has been received under the SGI-funded project as follows: • Atomic Absorption Spectrometer • GC-MS • Contact Heat Transmission Tester • Small Drops Molten Metal Splash Tester • Degree Flammability Tester • Biological Microscope • Radiant Protective Performance Tester (RPP) • Protective Clothing Molten Metal Splashes Impact Resistance Tester • Thermal Protective Performance Tester (TPP) • Blade Cut Resistance Tester • TDM Cut Test Machine • Weathering Machine with Xenon

S. No.	Title of Project	Achievements
		Steps 4 Installation of equipment's The installation and training on the above-mentioned equipment will continue and may be completed in February 2024. Article has been submitted entitled "Enhancement of the Capability of Leather Research Centre (LRC) to Comply with the Guide Lines of ZDHC, LWG, REACH & CE Certification to Facilitate the Export Oriented Pakistan Leather Industry" to Pakistan Leather". Inauguration of Advanced Safety Testing Laboratory, REACH, ZDHE, LWG and CE marking facilities now available at, Leather Research Centre, PCSIR. The Inauguration of Safety Lab with State-of-the-art REACH, ZDHC, LWG and CE marking testing facilities by the Chief Guest, Dr Hafiz Rub Nawaz, CSO / Director General, PCSIR Laboratories Complex, Karachi on 1st Feb, 2024, at Leather Research Centre, PCSIR, received by Barkat Ali Solongi, PSO/ Director LRC has received guest Mr. Zuzzer Ali Shamsuddin, Ex Director, LRC and Dr. Farman Ahmed, Head of FMRRC-KLC, PCSIR, Mr. Jamshed Amjad, DGM, and team members from Midas Safety, Mr. Jamil Ahmed and Sheikh M. Ali from Fine Grip, Mr. Syed Akhter Ali from Shafi Tanneries were among other distinguished guests

PCSIR Laboratories Complex, Lahore

Completed Projects

S. No	Project Title	Achievements
01	**Efficient Canola Seed Processing and Value Addition Byproducts (RD&I Project)**	• Technology / Product / Process Developed **Process** Continuous process for the extraction of edible oil from canola seeds and the valuable application of canola cake/meal for protein extraction as food source has been successfully developed **Products:** 1. Oil from canola seeds 2. Canola protein of high purity (99%) has been prepared. • Paper Publications : Nil • Patent Filed : Nil • Commercialization Status 1. Oil from canola seeds is ready for Commercialization. 2. Canola protein of high purity (99%) is ready for Commercialization.
02	**Production of Provitamin A Enriched Edible Oil from Carotenoid Concentrate Extracted from Different Seasonally Grown Vegetable Sources.** **(In-House project)**	Process for the green production of Provitamin A Enriched Edible Oil from Carotenoid Concentrate has been developed successfully. • Provitamin A Enriched Edible Oil concentrate is prepared • Provitamin A Enriched Edible Oil concentrate is ready for Commercialization.
03	**Extraction of Soda Ash from Halophytes** **(In-House project)**	• Process for extraction of soda ash from sajji khar has been developed successfully. • Soda ash of high purity (98-99%) has been prepared • Soda ash of high purity (98-99%) is ready for Commercialization
04	**Customization of old existing juice and squash production facility at PCSIR Lahore**	• Process has been developed for Mango Juice Drink • **Paper Publications** 1. Nutritional evaluation of quince fruit of Baltistan region and development of value-added products. *Adv Food Technol Nutr Sci J.* 2023; 9(1): 1-5. 2.Nutritional Evaluation of Jamun Fruit and Development of Value-added Product Squash paper submitted for publication in Acta Medical Science • Process has been leasesed out for production of **Mango Juice Drink t**o M/S Rising Karakurum Food and Beverages Gilgit Baltistan ILO # **119 /02-02-24**

S. No	Project Title	Achievements
05	**Flattering the use of green olive leaves, their bioactive compounds, food applications and antioxidant properties (In-House project)**	• **Paper Published** Olive (*Olea europaea* L.) Leaves promising byproduct as a source of bioactive compounds and natural antioxidants, Abstract published in Abstract Book of 4rd International Conference on "Emerging Trends in Earth and Environmental Sciences (ETEES 2023) held on 04th–06th December 2023 **page 61**, at College of Earth & Environmental Sciences, PU, Lahore, Pakistan. • Table Olives: A Nutritional Approach to Health, J. Nutrition and Food Processing, 6(4); 2023. • Commercialization Status: In progress
06	**Development of banana peel powder and its application as wound healing allergies and skin irritations (In-House project)**	• Technical report entitled "Development of Banana Peel Powder & Its Applications" submitted. • **Paper Published** Banana peels a contemptible source of dietary fiber and natural antioxidants. Acta Pharm. Sci. Vol 62:(1), 2024, 89-103. DOI: 10.23893/1307-2080.APS6206. • Commercialization Status: In progress
07	**Production of Eco-friendly Edible Cutlery to Replace Plastic Utensils (In-House project)**	Edible plate and spoon has been developed • **Paper Publications** Edible Cutlery: A Sustainable Alternative to Plastic Cutlery for a Better Future, LGU Journal of Life Sciences, 6(2): LGUJLS MS.ID- 146. • Process for the development of edible cutlery is ready for commercialization
08	**Extraction of sweetening substances from *Stevia Rebudiana* Plant**	• A comprehensive research was carried out on *Stevia Rebudiana* plant and successfully stevia powder was obtained. • "Novel efficient green extraction process of natural sweetening agents from *Stevia Rebudiana* leaves", Patent application No. 680/2023 Filed on 06 October 2023. Process is leased out to Ali Riaz Greenhouse village (Pvt.) Ltd. Islamabad ILO # 819/21-3-23.
09	**PSF funder project: UF and MF membrane fabrication development for water purification PSF/Res/P-PCSIR/Chem/ (606)**	• The Technology for the porous thinfilm sheet was developed and optimized • Paper Publications -Contact angle measurement for polymeric membranes: software selection for ease of use and precision, Journal of Adhesion Science and Technology, https://doi.org/10.1080/01694243.2024.2317043 SCI-e IF= 2.53

S. No	Project Title	Achievements
10	• **Hot Air Convention Aging Oven** • **Digitalization of Bomb calorimeter** • **CVD Furnace 100C** • **Longitudinal Chamber Furnace** • **Cancellation Drying Oven** • **Overhead Agitator** • **Dry Block timer based** • **Incubator Digital** • **Heavy Duty Hot Plate 300°C (Separate control)** • **Autoclave (Digital)** • **Hot Air Forced Aging Oven 130L with 1000 hr** • **Heating Resistance Furnace** • **Muffle Furnace large 1000C** • **UV Trans illuminator**	• These equipment have been supplied to the various clients in Pakistan
11.	**Design & Development of movable weight lifting hoist to facilitate calibration samples handling for Calibration**	• Product / Equipment developed, customized as per requirements of Calibration Lab, LLC. Currently equipment is being used in APC&IC, LLC

PCSIR Laboratories Complex, Peshawar

Completed Projects

S. No	Project Title	Achievements
1.	**Development of *Aloe vera* based blended fruit beverages**	• The following processes/ products have been developed and the shelf life studies of the said products have been completed successfully. i. Mango *Aloe vera* blended squash ii. Guava *Aloe vera* blended squash iii. Apple *Aloe vera* blended squash iv. Orange *Aloe vera* blended squash • Process Ready for commercialization.
2.	**Development a Process for the Production of Liquid Fertilizer from Paper Mills Waste Water**	• Liquid Bio-Fertilizer Process Developed • Field Trial Study on different vegetables were carried out • Technical Report on the process has been written • Patent writing is in process. • Prodcut Ready for commercialization.
3.	**Development of low-carb and fiber rich Diet flour using super food grains**	• Product developed. • Technical report on the product is currently in process. • Ready for commercialization.
4.	**Characterization and Production of Wood Vinegar from Locally Available Bio-mass**	• Product developed. • Publication in process. • Patent filling in progress. • Ready for commercialization.
5.	**Value addition of seasonal fruits with Aloe vera Gel as natural preservatives**	• Apple aloe vera blended fruit spread is successfully developed. • Shelf life studies of the prepared fruit spread is completed • Technical report writing on the product is in process. • Ready for commercialization.
6.	**Design, Development and Performance Evaluation of Hybrid Solar Dryer with Thermal Storage System**	• **Technology Developed:** • **Patent Filed:** Design/Patent Filed **22346-D/2023** • Ready for commercialization.
7.	**Upgradation of Low-Grade Indigenous Graphite Ore**	• Technology/Product/Process has been developed. • Paper publication is in progress. Potential client has been contacted for the process lease out.
8.	**Development of Cultured Quartz from Indigenous Quartz Ore**	• The project is completed and Technology/Product/Process has been developed. • Commercial feasibility has been submitted to M/S Sadiq Bagh Marble & Mining Company, Buner on payment basis.

S. No	Project Title	Achievements
9.	**Synthesis of Detergent Grade Zeolite 4A from Indigenous Resources**	• Technology/Product/Process has been developed on bench scale. • Pilot Plant trials have been conducted and the samples are under characterization.
10.	**Desulphurization of High–Sulphur Indigenous Coal**	• Process has been developed on bench scale. • 70% sulfur has been removed from the coal. • Ready for commercialization.
11.	**Synthesis of Graphene for Industrial Applications**	• Process has been developed on bench scale for Reduced Graphene Oxide. • Ready for commercialization.
12.	**Commercial Cultivation of *Aloe vera* and Production of Food, Cosmaceutical and Medicinal Products**	• More than 10,000 plants of *Aloe vera* were cultivated • Development of Agro-based Technology for large scale cultivation of *Aloe vera* • Till now, more than 500 kg material provided for R&D and commercialization. • Sold out plants and leaves worth Rs: 100,000/- till now. • Products (Aloe gel, Aloe soap, Aloe based herbal drinks, *Aloe vera* pickle, *Aloe vera* powder) • Processed 40-50kg Aloe gel to produce *Aloe vera* white powder - Commercialization of Aloe based products is in progress
13.	**Identification and phylogenetic analysis of medicinal plant species from Pakistan by DNA barcoding approach**	1). Method Development • Isolation of genomic DNA • Amplification of DNA • Visualization of DNA 2. DNA Isolation, Amplification and visualization Studies DNA from the Cannabis sativa leaves Stevia plant
14.	**Neuropharmacological and Therapeutic Medicinal Potential of Selected Medicinal Plants / Synthetic Drugs.**	• Technical reports submitted • Paper under publication process
15.	**Strengthening of Lab. for the Quantification of Pesticides and Antibiotic Residues in Different Varieties of Honey Leading to ISO Certification.**	• Method have been developed for the screening of pesticide residues (24 + 20) on GCMS and antibiotic residues (chloramphenicol and Oxytetracycline) on HPLC. • Samples of export quality have been screened for pesticide and antibiotic residues on GCMS/HPLC • Testing of honey for pesticide residues and antibiotic residues have been included in the scope extension of ISO 17025. Lab. Has planned to participate in PT round expected in April/May 2024.

S. No	Project Title	Achievements
16.	**New Process Development for the Maximum Extraction of Nicotine from Tobacco Leaves**	• Process Developed • Paper Publications- In Process • Patent Filed- In Process • Process ready for commercialization.
17.	**Formulation of Balance Feed for Broiler Chicken and Pet Animals by Utilizing Abundantly Available Local Nutritional Items**	• Process Developed • Product Developed • Paper Publications- In Process • Technical Report submitted • Process/Product ready for commercialization
18.	**Preparation of CO_2 Supercritical Extract of some Important Plants**	• The following samples of different plants have been processed for CO_2 supercritical extraction 1. Samples of dry cannabis plant material (12) 2. Samples of fresh cannabis plant material(2) 3. Fresh rose flower petals 4. Dry rose flower petals 5. Tobacco dry leaves • MBC staff has been Trained on the CO_2 supercritical machine.

PCSIR Laboratories, Islamabad

Completed Projects

S. No.	Title of Project	Achievements
01	**Fuller's Earth As A Potential Adsorbent For Purification Of Vegetable Oils (Canola Oil)**	• A Process was developed for the purification of Canola Oil using Fuller's Earth. • Paper Publications in process • The project has been completed during the year 2023-24. Now the developed process will be forwarded to OIC Commercialization to be delivered to potential client.
02	**Exploration of Eco-friendly Antiscalant for Industrial Water Treatment from Indigenous Sources**	This project was derived from the need of a strategic industry, who referred a case of coolant water analysis used in the hydraulic press installed in their Facility. The quality of water at the facility was found unsatisfactory as per OEM standards for cooling water and will cause scaling if used without treatment. The experimental trials with commercially available antiscalant were initiated. It was found that the commercially available antiscalant were not working as per OEM specifications & the final solution for water treatment is RO system as per water quality. Earning: • Overall, **Rs. 300,000/-** has been earned through this consultancy based on Comprehensive water analysis, sample treatments & visits. • Technical report has been submitted to the Client comprising all lab data and treatment solutions. • The project has been completed successfully.

PCSIR-Leather Research Centre

Completed Projects

S. No	Project Title	Achievements
01.	**Preparation of Retanning Material, Tend to Produce White Leather for Leather Industries**	• **Process Developed: 05** 1. Synthesis of Polymer Retanning Agent, "Res-Acrylan" Developed from Resorcinol' Sarwat Jahan Mahboob, Tahira Ayaz, Rajkumar Dewani, and Muhammad Kashif Pervez. 2. Synthesis of Metal Complex Syntan for Leather Making. 3. Application of Metal Complex Syntan on Wet Blue for Leather Making. 4. Application of Metal Complex Syntan:Zirconium Sulphate (1:1) on Wet Blue for Leather Making. 5. Application of Metal Complex Syntan:Zirconium Sulphate:Naphthalene Syntan (1:1:1) on Wet Blue for Leather Making. • **Paper Publications: 02** 1. "Self-Colored Leather Making in Fawn Shades by Application of a Resorcinol Based Synthetic Tanning Agent on Sheep Crust", CUKUROVA, 10th INTERNATIONAL SCIENTIFIC RESEARCHES CONFERENCE, April 2-4, 2023, *Full Text Book,* ISBN: 978-625-367-062-7, 553-562, Adana, Turkiye. 2. "Self-Colored Leather Making in Fawn Shades by Application of a Resorcinol Based Synthetic Tanning Agent on Sheep Crust", CUKUROVA 10th INTERNATIONAL SCIENTIFIC RESEARCHES CONFERENCE *ABSTRACT BOOK,* ISBN: 978-625-367-063-4, P 119, April 2-4, 2023 Adana / TURKIYE. • The project leader associates participated in CUKUROVA 10th International Scientific Researches Conference, on April 2-4, 2023/ Adana, TURKEY. Later they achieved the certificates of this technical participation in the above conference via email.
02.	**Preparation of Eco-Friendly Finishing Binder for Patent Leather**	• A process developed for Eco-friendly Finishing of Patent Leather • "Kitchen microwave strategy: Novel Co-polymers Acrylic finishing Binders" submitted for grant of patent to Intellectual Property Organization, Government of Pakistan, The Patent Office, Karachi. Patent application no. 74/2023 dated 15th Feb, 2023. Receipt No of Patent Office 19335. • Commercialization Status: Under Process

PCSIR-Fuel Research Centre

Completed Projects

S. No	Project Title	Achievements
1.	**Instability Measurement in some Commercial Grade Liquid Fuels and to Explore its REMEDY for Recovery of Fuel Performance Characteristics**	• Expertise of technical staff members have been developed and enhanced to improve the fuel characteristics as per standard specification by introducing the various kinds of additives. FRC technical staff is now well aware to propose remedy to recover degraded fuel for their clientele • Paper Publications: In progress
2	**Environmental Accounting for Municipal Solid Waste Management: A Case Study of District Malir Karachi East**	• Expertise of technical staff members have been developed and enhanced to account solid waste Management and to up-date the concerned regarding current situation accumulating the waste in District Malir Karachi East. • **Paper Publications:** 01 • Organic refuse-derived fuel (ORDF) is an alternative fuel for the Pakistan's domestic use in the post-Covid-19 green recovery.2023. *Journal of Biodiversity and Environmental Science.* Volume.21, No.4, Page. 101-108. For other publication, questionnaire survey has been completed, data compiling for publication process is in progress.
3	**A Study on Improving the Properties of Coal Water Slurry and Coal Water & Oil Slurry in Order to Utilize the Indigenous Coal of Various Qualities for Producing Efficient and Clean Fuel for Pakistani Industrial Sector**	• Coal based slurry fuel that were prepared utilizing indigenous coal of various types and other additives that are easily available from local market could be utilized as a low cost fuel and as a continual available source of energy for local industries. • This technology may be admirable if following points are considered: • Firstly, if coal water slurry combustion chamber with effective spraying system are locally available to install by the industrialist • Secondly, if coal slurry fuel supplies are available near to the industrial area. • This technology is not commendable for local industrialist for various reasons such as: • Comparatively low bench stability of coal based slurry fuel as compare to other fuel • Requirement of special expertise to manage the activity for coal water slurry and coal water & oil slurry fuel production • Requirement of specific equipment, other supplies, additional area and man power to manufacture the coal water slurry and coal water & oil slurry fuel. • Maintenance of coal water slurry and coal water & oil slurry fuel Spray System is a tedious job and if it is chocked during the production process that yields financial loses.

S. No	Project Title	Achievements
4	**To Develop Analytical Testing Facilities for Liquid Fuel at FRC**	• Following 02 process are developed: i. To assess the purity of Copper (Cu) Wire by using Atomic Absorption Spectrophotometer ii. To determine the Total Sulfur in Coal by Manual / Chemical Method • Paper Publications: In progress • Commercialization Status: Services are being provided to FRC Clientele
5	**Improvement in Commercial Grade Diesel Fuel Quality**	• Expertise of technical staff have been developed and enhanced to improve commercial grade diesel fuel quality at lab scale. • Paper Publications: In progress

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