UNVEILING THE PATH TO SUCCESS

ABSTRACTS OF THE PROJECTS

SANCTIONED UNDER PROJECT RELATED GRANTS

Submitted to

सत्यमेव जयते

DEPARTMENT OF SCIENCE & TECHNOLOGY (DST) GOVERNMENT OF INDIA

TELANGANA STATE COUNCIL OF SCIENCE & TECHNOLOGY (TSCOST)

ENVIRONMENT, FORESTS AND SCIENCE & TECHNOLOGY DEPARTMENT, GOVERNMENT OF TELANGANA
4TH FLOOR, ARANYA BHAVAN, SAIFABAD, HYDERABAD

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TELANGANA STATE COUNCIL OF SCIENCE & TECHNOLOGY (TSCOST)
DEPARTMENT OF ENVIRONMENT, FORESTS, SCIENCE & TECHNOLOGY
GOVERNMENT OF TELANGANA
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Marupaka Nagesh
Member Secretary

FOREWORD

Telangana State Council of Science & Technology (TSCOST) successfully executed the Project Related Grants (PRG) program sponsored by the State Science & Technology Program (SSTP) Division, Department of Science & Technology, Govt. of India.

Mapping of S&T Needs (MSTN) exercise paved the way for determining the focus areas for call for proposals under PRG. State Level Advisory Board (SLAB) and Expert Committee on TSCOST extended guidance in identifying Location Specific, Need-based and Resource-based Research Projects to be supported under PRG Program.

25 Location Specific Research Projects were implemented by eminent Academicians and Scientists from prestigious Universities and Research Institutions of Telangana in major socio-economic sectors viz. Environment, Energy, Agriculture, Animal Husbandry, Medical & Health, Biodiversity, Pollution Control and Water Conservation.

Congratulations to the team of Project Investigators and Project Co-Investigators for their sincere efforts in solving some of the intricate problems facing the society and environment. Several research projects are scalable and provide good scope for mainstream research, societal application, commercialization, and patenting.

I express my deep sense of gratitude to the Chairman of the State Level Advisory Board (SLAB) for MSTN and Expert Group on TSCOST, Dr. Rajat Kumar Garu, IAS., Special Chief Secretary to Govt., ES&T and Irrigation & CAD Depts. & Vice Chairman, TSCOST for his invaluable guidance which has helped immensely not only in addressing various components of the Project but also in its execution meticulously.

This book is a compilation of the good work done under the PRG Program and would serve as a guide to young researchers and Administrators for translation of research into action.

I express my sincere gratitude to Sri Allola Indrakaran Reddy Garu, Hon'ble Minister for Forests, Environment, Science & Technology, Law and Endowments, Govt. of Telangana; Dr. Srivari Chandrasekhar Garu, Secretary, DST, GoI, New Delhi; Dr.Debapriya Dutta, Head, SEED & SSTP Divisions, DST, GoI & Officials of DST, GoI for the kind support and guidance to TSCOST at every stage.

Hyderabad
23-06-2023

(MARUPAKA NAGESH)

BRIEF REPORT

Mapping of S&T Needs in Telangana State:

The Department of Science & Technology (DST), GoI sanctioned a Project entitled "Mapping of S&T Needs of the States". The DST convened a meeting on 17-02-2020 at DelNet, JNU campus, New Delhi and Chaired by Dr. Debapriya Dutta, Head, SEED and SSTP Division, DST, GoI. During the meeting, discussed about the implementation strategy of the "Mapping of the S&T Needs of the States/UTs" project. It was decided to refer the State SDG Index 2019 report and Localizing SDGs: Early Lessons from India 2019 report published by NITI Aayog as reference for the current project. From the SDGs, the States / UTs are free to select the appropriate goal for further mapping the S&T intervention needs, according to the State/UT priorities.

The Special Chief Secretary, E&ST department/Vice Chairman & Hon'ble Minister, EFS&T / Chairman, TSCOST-EC have approved and constituted the State Level Advisory Board (SLAB) as per the composition suggested by the Department of Science & Technology (DST), GoI.

Sr. No.	Category	Name	Position
A	Secretary, State Department of Science & Technology	1. Dr. Rajat Kumar, IAS, Special Chief Secretary, ES&T / Vice Chairman, EC-TSCOST	Chairman
B	Policy Makers	1. Representative from Telangana State Remote Sensing Agency (TRAC)of Planning Dept.	Member
C	Academicians from university departments and institutions	1. Dr. N Madhusudhana Rao, CEO, Atal Incubation Centre, CCMB	Member
		2. Prof. Srinivas Nanduri, NIPER, Hyderabad	Member
		3. Dr.Muralidhar Reddy, Asso. Prof. Dept. of Chemistry, Osmania University, Hyd.	Member
		4. Prof. Shakeel Ahmed, Emeritus Scientist, CSIR-NGRI, Hyderabad.	Member
D	Industry	1. Dr.Rakeshwar Bandichhor, Vice President and Head of Chemistry, API-PR&D, Dr. Reddy's Laboratories	Member
		2. Sri N Narasimha Rao, MD/CEO, CLONZE Biotech	Member
E	Leading NGOs	1. D Yugandhar Reddy, Founder & Chief Enabler, VREAP Foundation	Member
		2. Dr. Riyaz Syed, Chief Education Officer. VREAP Foundation	Member

As per the recommendations of the State Level Advisory Board (SLAB), the Council Authorities have approved for awarding the project "Mapping of S&T Needs in Telangana State" to Centre for Economic and Social Studies (CESS) for implementation of the Mapping of the S&T Needs Project. The following focus areas are identified for the S&T interventions in Telangana State:

1. Agriculture
2. Environment Protection
3. Bio-diversity Conservation
4. Forest Conservation & Development
5. Water conservation
6. Waste Management
7. Food processing
8. Energy Conservation, Production
9. Data Analytics for policy making
10. Other priority areas are Medical & Health, Information Technology, Remote sensing, Nano Sciences, Biotechnology, etc.

Project Related Grants (PRG):

In another sanction order, the Department of Science & Technology (DST)., GoI communicated the sanction of Project Related Grants (PRG). The guidelines given by DST on the utilization of the Project Related Grants (PRG) grants is that the grant has been released for the specific purpose of the sanction of the project on location specific challenges of the states. State S&T councils are requested to first carry out the Mapping of the S&T needs of states and them pursue for addressing those S&T needs through S&T projects by utilizing this PRG.

The outcome of the Mapping of S&T Needs will become a base for formulating Project Related Research proposals to address the issues which are being brought out in the Mapping of S&T Needs Project. The guidelines issued by DST, GoI on the implementation of Project Related Grant (PRG) is as under:

(1) State S&T Councils getting the PRG for the sanctioning of the project to the Institutions/Organizations in the States should give call for the proposal on the State Specific challenges.

(2) Constitute the Expert Group in States (EG in State) chaired by the renowned academician of the State in suggestion with DST, EG in State should have DST representative as member.

(3) Proposal should be screened and recommended by the EG in State may be further send to the DST for seeking the approval DST Tier 2 Screening Committee on SSTP by inviting the concerned Project Investigator.

(4) DST Secretariat will finally convey the approval of the proposal to the State S&T Councils for the release of the grant to the concerned PI's.

An Expert Group with the following members is constituted to scrutinize and recommended the project proposals received under PRG for forwarding to the DST for approval.

Sr. No.	Name, Designation, Department	Organization
01	The Special Chief Secretary / Vice Chairman, TSCOST-EC	Environment, Science & Technology, Govt. of Telangana as **Chairman**
02	Dr. Ahmed Kamal	Consultant, TSCOST as **Vice Chairman**
03	Prof. Shashidhar Professor, Department of Civil Engg	Indian Institute of Technology (IIT), Hyderabad
04	Dr. M.R. Vishnu Priya, Senior Principal Scientist, Technical Group	Centre for Cellular & Molecular Biology (CCMB), Hyderabad
05	Prof. P Reddanna, Dept. of Animal Sciences, School of Life Sciences	University of Hyderabad, Hyderabad
06	Dr. A Gangagni Rao, Chief Scientist	Indian Institute of Chemical Tech. Hyd.
07	Prof. M U R Naidu, Director	NATCO Pharma
08	Dr. A Ashok Kumar, Prl. Sci.	Crop Improvement, ICRISAT, Hyd.
09	Dr. S Sridhar, Senior Prl. Scientist	Water Purification, CSIR-IICT, Hyd.
10	Dr. Bhanu Prakash Reddy, Head, Biochemistry	National Institute of Nutrition, Hyderabad
11	Dr. V V Rao, Deputy Director	National Remote Sensing Agency, Hyd.
12	Member	Department of Science and Technology (DST), GoI
12	The Member Secretary	TSCOST as **Member-Convener**

As per the approval of the Council Authorities, the research project proposals from Universities, R&D Laboratories, Academic Institutions, Government Organizations in the focus areas are called for duly giving a notification in the TSCOST Website. The main objective is to identify state specific & need based programs with remedial measures/ S&T interventions / solutions thereby to establish linkages / involve the concerned line departments, National laboratories, Universities, Institutions, R&D laboratories etc so that transfer of technology to ground could be achieved.

The outcome of the proposed project is aimed at:

- R&D in Advancement in Basic / Applied Scientific Research which has social relevance.
- Demonstration / Training projects exclusively in SC/ST areas / population
- Generation / Innovation of new technologies for commercialization
- Studies and survey for identification of local problems with a suggestion for suitable S&T intervention

The focus and thrust areas in which proposals were invited are as under:

THRUST AREAS:

1) Registration of Patents, Copy Rights & Geographical Indicators (GIs) generated in the State for protection of Intellectual Property Rights (IPR)
2) Transfer of Technologies from Central R&D Institutions to the State Institutions for societal applications
3) To Coordinate with the Universities to assess the research work and to provide Central / State funding tie-ups such as Young Scientist Fellowship and Research Grants etc.,
4) To Conduct the Popularization of Science activities, Skill Development Activities etc., for the benefit of Students / unemployed youth of Telangana State.

FOCUS AREAS:

Agriculture

- Implementation of new approaches in Seed Preservation including indigenous seed varieties; Introduction of new crops of grains, new varieties of fruits, flowers suitable to the agro-climatic conditions at regional/zonal level, for example date palm; New methods for improvement of soil fertility, water conservation, crop yield etc. and New methods for protection of crop in association with Agriculture & Horticulture Departments, Agricultural Universities, Krishi Vigyan Kendras.
- Bamboo cultivation to be promoted in association with Centre for Innovation in Public Systems (CIPS) which contributes to livelihoods, with use of technology several products can be produced which are eco-friendly.
- Crop diversification or alternative cropping - reduces the stress on soil. Rather than continuously cropping paddy, which diminishes quality of soil. It can be regained with cropping of ID crops.
- Synthetic and Organic fertilizers – Bio-fertilizers shall be prepared using cattle waste
- Low-cost diagnostic toolkit for extension workers- Improving the Productivity in Agrl.

Environment Protection

- Implementation of new methods based on IoT, GPS, GIS, Remote Sensing and bio-technology for control of pollution of air, ground water, soil contamination, caused due to mining, industries, animal slaughter houses, textile mills, powerloom saree making clusters

- Implementation of new methods for conversion of plastics into bio-degradable material / other re-cyclable forms to reduce the effect on environment in association with TSPCB, EPTRI, Industries Dept. and Handlooms & Textiles dept.

Biodiversity Conservation

- Identification of problem areas associated with Protection of Life systems (botanical, zoological including aquatic) on Land and under Water and implementation of suitable methods for conservation of the same in association with TSBDB and respective line departments.
    - Liquid nitrogen and low-cost alternatives for animal semen preservation
    - Low-cost diagnostic toolkits for livestock veterinarians
    - Tissue engineering for laboratory-grown animal products
    - Low-cost veterinary pharmaceuticals (ideally thermostable)

Forest Conservation & Development

- Implementation of new methods based on IoT, GPS, GIS, Remote Sensing, bio-technology etc. for forest conservation & development
- Implementation of new varieties of plantations for feeding wood gasifiers, boilers and for other fuel needs in association with Forest Department.
- Creating and improving bio-diverse eco-systems with technology intervention

Water conservation

- Implementation of new approaches for conservation/ safety of drinking water, ground water, water in rivers, rivulets, lakes, aquifers etc. in association with Groundwater department, RWS, Panchayats, Municipalities, Municipal Corporations
    - Smart metering could be used to manage the demand
    - Desalination or reverse osmosis technologies can be implemented
    - Technology could enable increased leakage detection
    - Portable sensors for groundwater detection

Waste Management

- Implementation of new methods for Sewage treatment, Waste (Dry Waste, Wet Waste) to wealth generation mechanisms, new methods for drainage cleaning systems in association with Municipal Corporations, Municipalities etc.
    - Facilitate recyclable materials technologies, and apply to minimize industrial waste in the environment
    - Novel biodegradable packaging materials

Food processing

- Implementation of pilot scale plants in Food Processing, Fruit processing, Meat Processing, Fish Processing including Packaging, Marketing tie-up etc. in association with TSIIC, SERP, Rural Development Dept, Agriculture & Agricultural Marketing Dept. with proper waste treatment methods
    - Technology intervention in marketing of tribal (NTFP) products, strengthening tribal marketing institutions like the GCC and ITDAs

Energy Conservation, Production

- Implementation of new technologies in solar, wind, hybrid power systems, micro-hydel aiming at energy conservation & production and implementation of new technologies providing scope for saving of energy in industries in association with Energy dept, NREDCAP, Industries dept. etc.
    - District level action plans for electrifying the freight transport and embracing EVs for delivery and ridesharing
    - Constructing grain bins and silos with low cost technology; checking the performances of warehouses with advanced digitised tools
    - Smart grid management in industries to use both electricity & data at once

Data Analytics for policy making

- One of the missing links is the lack of data analytics for policymaking. Using data for policy decision for better outcomes.

Other priority areas are Medical & Health, Information Technology, Remote sensing, Nano Sciences, Biotechnology, etc.

A Pre meeting of the Expert Group was convened on 9th February, 2022 to finalize the guidelines and other important modalities. The following Members of the Expert Committee have attended the meeting.

1. Sri Nagesh Marupaka, Member Secretary, TSCOST
2. Dr. Ahmed Kamal, Consultant, TSCOST
3. Prof. Shashidhar, Professor, Department of Civil Engineering, IIT
4. Dr. M R Vishnu Priya, Chief Scientist, CCMB
5. Prof. P Reddanna, Professor, Department of Animal Sciences, UoH
6. Dr A Gangagni Rao, Chief Scientist, IICT
7. Prof. MUR Naidu, Director, NATCO Pharma
8. Dr. S Sridhar, Chief Scientist, IICT

The Expert Group have finalized that the proposal must have relevance to the State's specific problem and to provide a viable solution interims of S&T intervention and the expected outcome of the proposal needs to be application oriented rather than basic research. Once again, the Committee met on 18-2-22 and approved (26) projects and further to the approval of DST, vide email Dt.10-3-2022, the implementation of Research projects has taken place. Except one project, all the (25) projects were carried out.

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Status Updation and Conservation of Threatened Flora of Telangana State

Dr. Shilpi Sharma,
Telangana State Biodiversity Board
Aranya Bhavan, Hyderabad

Introduction:

Telangana State (15.835° to 19.917^0 N, 77.238^0 to 81.307^0 E) is located in the Deccan plateau in the south-central part of peninsular India. The conservation status of plants and animals is one of the most widely used indicators for assessing the condition of the ecosystems and their biodiversity. It also provides an important tool in priority- setting exercises for species conservation. At the global level, the best source of information on the conservation status of plants and animals is the *IUCN Red List of Threatened Species (IUCN 2012)*. The Red List provides taxonomic and conservation status, and distribution information on taxa that have been evaluated. This system is designed to determine the relative risk of extinction, with the main purpose of cataloguing and highlighting those taxa that are facing a higher risk of global extinction (i.e., those listed as Critically Endangered, Endangered, and Vulnerable). Species in these three categories are collectively referred to as 'threatened'.

Few endemic to southern India and threatened plant species are found in Telangana State. But they are in verge of local extinction due to their habitat fragmentation, livestock grazing, human encroachment, developmental activities, and use for a variety of tasks without knowing their specificity. Till date, no conservation efforts have been made to safeguard these species after the resent evaluation of their threat status in 2016. Also, as the data was collected five years back thus updation of the list is highly needed.

In this study, all the threatened species of higher plants and vertebrates present or known to be present in Telangana State was evaluated for their regional conservation status according to the ICUN system following the ICUN Red List Criteria at Regional and National Level: Version 4.0 (IUCN 2012), and the results of this assessment was presented in the report and conservation will be done to the selected plant species as per their category in government campus like EPTRI, Osmania university, Biodiversity Parks etc.

Scope:

The Taxa described from India and know from Telangana State were taken into consideration; the assessment region was Telangana State. Information on various aspects of such taxa were collected and complied for all the 31 districts – Adilabad, Komaram Bheem Asifabad, Nirmal, Nizamabad, Mancherial, Jagital, Peddapalli, kamareddy, Rajanna Sirsilla, Karimnagar, Jayashakar Bhupallapalli, Warangal Rural, Warangal Urban, Jangaon, Siddipet, Medak, Sangareddy, Hyderabad, Medchal –Malkajgiri, Yaddari Bhuvangiri, Mahabubabad, Bhadradri Kothagudem, Khammam, Suryapet, Nalgonda, Nagarkurnool, Wanaparthy, Jogulamba Gadwal, Mahabubnagar, Vikarabad and Ranga Reddy.

Status Assessment:

The status of all the species was assessed following the IUCN Red List Criteria at Regional Levels (IUCN 2012), which are the world's most widely accepted system for measuring relative extinction risk at regional scale. Species endemic to Telangana State were assessed following the IUCN Red List Criteria ver.3.1 (IUCN 2001). The methodology for this assessment is based on the collation and analysis of existing information. Status assessment provides an important tool for input to the conservation and development planning processes.

The Secondary Data was collected from taxonomic experts. Further, field survey with taxonomy experts from BSI and agriculture University was conducted to collect the seeds of the threatened species from forest area such as Amrabad forest reserve, Pakal Forest area, Kawal Reserve etc. These seeds were then germinated in the nursery at Jedcerla Botanical Garden. After the seedlings were collected and planted in the botanical garden at Jadcherla, Biodiversity Park. Moreover, an ex situ Plantation of 75 threatened species at Biodiversity pylon site, Gachbowli Hyderabad on the occasion of Azadi ka amruth mahotsava was also organized. As per the project proposal the ex situ plantation of threatened species was completed at the phylon site in collaboration with WWF, Hyderabad and TSIIC. The following threatened plants were planted *Buchanania lanzan, Caryea arborea, Caryota urens, Hardwickia binata, Phyllanthua emblica, Terminalia chebula, Terminalia bellerica, Terminalia tomentosa, Mytragyna parvifolia, Tectona grandis, Diospyros melanoxylon, Grewia telifolia, Acacia leucophloea, Acacia nilotica, Tabuebia rosea, Dolichondron falcate, Holerrhina pubescens, Haldenia cordifolia, Carissa carandus, C. spinarum, Flacourtia indica, Balanitis aegyptica, Dacrostachys ceneria, Ixora pavetta, Zyziphus nummularia, Tarenna asiatica, Gymnosperia heyneana, Grewia hirsuta, Grewia. Flavescens.*

An awareness program on identifying the threats to threatened plant species of Telangana state and discussion with the local communities, BMCs and other stakeholders was organized at Nalgonda, Jangaon and jadcherla Zilla Parishad Biodiversity Management Committee.

Smartphone-Enabled, Lab-Free and Onsite Multiplexed Diagnostic Device for Health Management of Rural and Underprivileged Population

Dr. Sanket Goel
Birla Institute of Technology & Science Pilani,
Hyderabad Campus Jawahar Nagar,
Kaparat Mandal, Hyderabad,
Telangana-500078

Objectives achieved:

1. Development of low-cost and mini Electrochemiluminescence (ECL) devices for the simultaneous and multiplex detection of various biomolecules.
2. Optimization and enhancement of the platform with novel and smart nanomaterials.
3. Design and development of a miniaturized, standalone, and portable ECL system integrated with a smartphone to detect various biomolecules (glucose, cholesterol, choline, dopamine, lactate, fructose, sucrose, and galactose).
4. Integrating the internet of things (IoT) for data communication and processing using machine learning (ML) models.

Place the mobile unit to achieve real data and train local manpower.

Date of Start: 1 April 2022
Total cost of Project: 4 lakhs
(Joining date of JRF, but the work was started by an existing researcher)

Summary of the performed research work:

An in-house 3D printed ECL platform (shown in Fig. 1.) is fabricated to eliminate the use of the dark room, and external power sources which will enable the ECL technique to be lab-free and make it capable of onsite detection. The platform smartphone enabled with a machine learning assisted graphical user interface to perform ECL signal acquisition, image segmentation, data interpretation and concentration prediction.

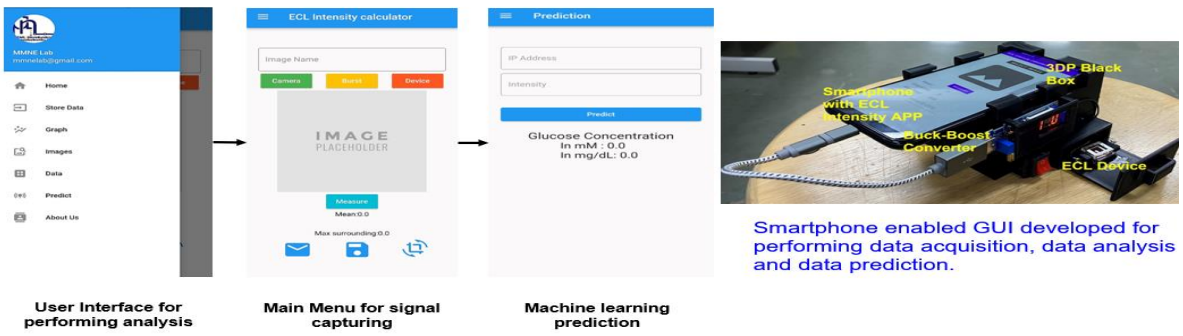
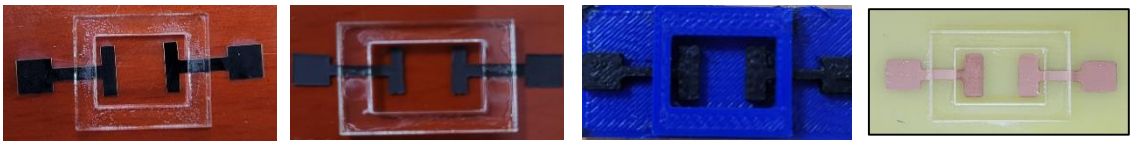


Fig. 1. Developed ECL system

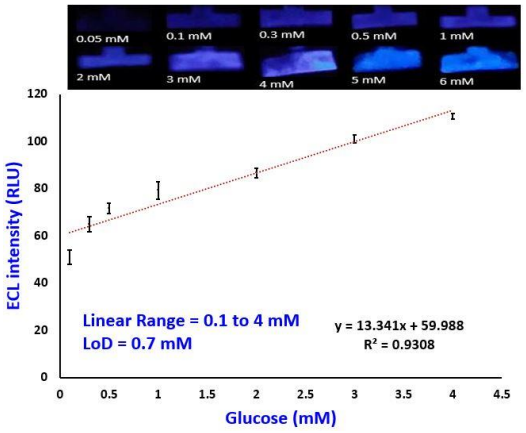
The four different fabrication approach were utilized to fabricate the ECL devices viz, Laser induced graphene (LIG), Screen Printing (SP), 3D printing (3DP), Direct laser writing (DLW) as shown in Fig 2. In the performed experimentation investigation conductivity analysis of the electrode material is performed by using 4-point probe test method. It was observed that SP and DLW has more than 20 times and 45 times more than LIG and 3DP respectively. In addition to this sensing of glucose is also performed for similar concentration and it was observed that the emitted signal has no significant change (<5%).



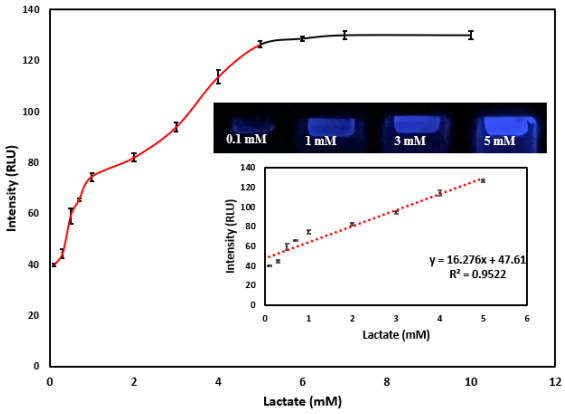
I. LIG II. Screen Printing III. 3D printing IV. DLW

Fig. 2. Fabricated devices

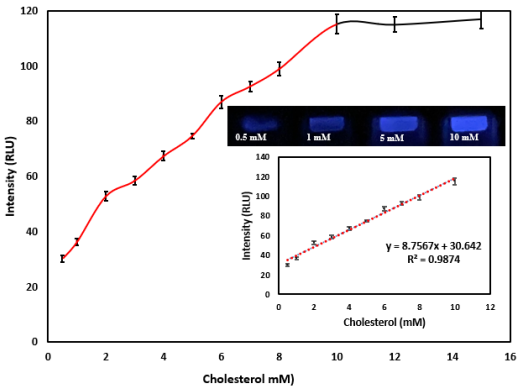
The detection of various biomarkers such as glucose, choline, lactate, and cholesterol performed and performed results are shown in Figure 3.



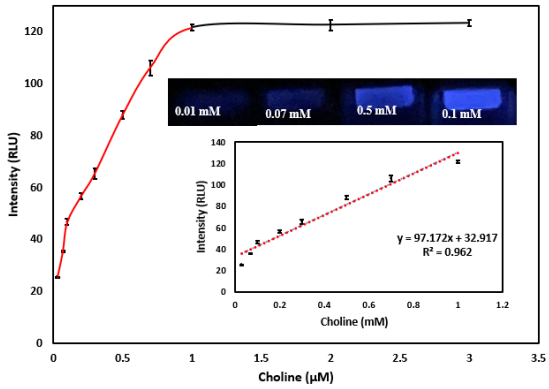
(a) Detection of glucose



(b) Detection of lactate



(c) Detection of cholesterol



(d) Detection of Choline

Fig. 3. Detection of Various biomarkers

Innovation:

- Application Potential: Lab-free detection of several biomolecules at a very low cost.
- Long Term: Final fabricated low-cost, easily disposable ECL device with a miniaturized portable system embedded with an IoT-based mobile application will be used for real-time testing.
- Immediate: The developed low-cost, rapidly realized, and miniaturized system can be used in many biomedical applications, environmental monitoring, and point-of-care testing.

Intellectual Outputs:

1. Mrunali D Wagh, Pavar Sai Kumar, Manish Bhaiyya, Abhishek Kumar, and Sanket Goel, Benchmarking Single Source Fabrication Approach for Chemiluminescence, Electrochemiluminescence, and Electrochemical Techniques: Experimental Validation via Choline detection, Microfluidics and Nanofluidics (under review).
2. Abhishek Kumar, Dravyansh Jain, Janhvi Bahuguna, Manish Bhaiyya, Satish Kumar Dubey, Arshad Javed and Sanket Goel, Machine Learning assisted and Smartphone integrated Homogeneous Electrochemiluminescence Biosensor Platform for Sample to Answer Detection of Various Human Metabolites, Biosensors and Bioelectronics (under review).
3. Abhishek Kumar, Manish Bhaiyaa, Satish Kumar Dubey, Arshad Javed and Sanket Goel, Insight into 3D printed eight well Electrochemiluminescence biosensing platforms with shared cathode: Towards multiplexed sensing, accepted for publication for the Proceedings of 3rd International Conference on Micro/Nanoelectronics Devices, Circuits, and Systems (MNDCS 2023), 2023.

Future Work:

- Development of a standard smartphone free platform for detecting glucose in natural blood.
- Development of a low-cost standard ECL platform for detecting lactate and Cholesterol. The standard available devices are more than 20000 INR in India and exported from outside India.
- Performing field trials to evaluate the performance of the developed device.
- Extending study for detection of proteins, toxins and bacteria using droplet microfluidics

Expenditure (Till 15th March 2023)			
Sr. No.	**Expenditure**	**Cost (in Rupees)**	**Utilization**
1.	Manpower	2,76,000	100%
2.	Contingency	1,24,000	100%
Total		**4,00,000**	**100%**

Developing Data driven clusters among subjects with Type 2 Diabetes & their correlation with clinical characteristics, response to various therapies and development of complications &

Estimation of biomedical waste generation and Carbon footprint from hemodialysis unit - Towards Green dialysis

Dr. Rakesh Kumar Sahay
Prof. & Head Department of Endocrinology
Osmania Medical College &
Osmania General Hospital
Hyderabad

Developing Data driven clusters among subjects with Type 2 Diabetes & their correlation with clinical characteristics, response to various therapies and development of complications:

Diabetes Mellitus is a chronic disease, which apart from the heavy social and economic burdens, leads to multiple complications, which have profound impacts on the life quality of patients and may potentially cause death in severe cases. The prevalence of diabetes is rapidly increasing worldwide, so effectively preventing and managing diabetes has become an important topic to ponder upon. Diabetes is characterized by hyperglycemia, the causes of which are highly heterogeneous [(1)]. While diabetes is diagnosed on the basis of a single metabolite, glucose, hyperglycemia can arise due to multiple complex etiological processes that can vary between individuals.

Various classifications are now being used for Diabetes Mellitus. All the classifications focus on the etiology. Previously according to WHO 1999 and ADA 2004 guidelines Diabetes Mellitus was classified as Type 1 Diabetes Mellitus(T1DM), Type2 Diabetes Mellitus(T2DM), Gestational Diabetes Mellitus and other specific types. WHO in 2019 revised the guidelines and classified Diabetes Mellitus into Type 1 Diabetes Mellitus(T1DM), Type2 Diabetes Mellitus (T2DM), Hybrid forms, Other specific types, Unclassified diabetes and Hyperglycemia detected in pregnancy.

The large group of true T2D is highly heterogeneous with respect to clinical characteristics, progression, and risk of complications. Even before diabetes onset, the two prediabetes states, impaired glucose tolerance and impaired fasting glucose, only show partial overlap, suggesting they may result from different pathophysiological mechanisms.

Hence, a novel approach to detailed characterize the diabetes population and explore the clinical features can be very beneficial to aid with the treatment of diabetes patients. In recent years, novel stratifications of diabetes have been attempted worldwide.

Objectives of the Project:

To cluster diabetes mellitus patients, and to explore the clinical characteristics, diabetic complications and medication treatment in each cluster and follow up the subjects for a period of 2 years to assess the treatment response, outcomes and complications and follow up them prospectively.

Methodology:

Patients coming to Endocrinology Department at Osmania Medical College, Hyderabad diagnosed with all types of Diabetes Mellitus except Type 1 DM except WHO 2019 classification were requested to join the study after excluding those subjects with Type 1 DM, Fibro calcific pancreatic Diabetes and monogenic forms of diabetes genetically diagnosed and those who are willing to give written informed consent and in the case of children with less than 18 years parent/parents were willing to give written informed consent and children willing to give assent were enrolled in the study.

Inclusion Criteria

1. Subjects attending the Endocrinology OPD with Diabetes Mellitus
2. Subjects who were willing to give written informed consent and in the case of children with less than 18 years' parent/parents were willing to give written informed consent and children were willing to give assent

Exclusion criteria

1. Type 1 Diabetes Mellitus
2. Diagnosed cases of Fibro calcific pancreatic Diabetes
3. Genetically diagnosed cases of MODY/ other Monogenic forms

The height, weight, waist circumference was measured and the body mass index (BMI) was calculated as body weight/height (kg/m^2). Every subject was screened for the presence of Acanthosis Nigricans and if present it was graded according to Burkhe et al. Blood pressure was measured for every subject.

Laboratory measurements were taken in a fasting state following the standardized procedures during the health examination to measure fasting blood glucose (FPG), serum Insulin, total cholesterol (TC), triglycerides (TG), high-density lipoprotein (HDL) cholesterol, low-density lipoprotein (LDL) cholesterol, S. Creatinine, GAD antibodies. And stimulated C-peptide (CP) concentrations. The stimulation for C peptide measurement was done with a meal tolerance test administered with 78 gm of Ensure powder dissolved in 300 ml water. Sample for C peptide measurement was taken after 90 minutes following the ingestion.

The FPG and CP were used to calculate homeostasis model assessment 2 estimates of insulin resistance (HOMA2IR) and homeostasis model assessment 2 estimates of b-cell function (HOMA2B) with the HOMA2 calculator v2.2.3 at www.dtu.ox.ac.uk

Ankle-brachial index (ABI) measurements were taken after a five-minute break with the supine position, which is used to identify the lower extremity arterial disease (LEAD)

including hardened vessels and arterial occlusion. The ABI values between 0.9 and 1.3, larger than 1.3 or less than 0.9 will be considered as normal and abnormal arterial, respectively. Both diabetic retinopathy and diabetic peripheral neuropathy (DPN) will be defined following the American Diabetes Association's criteria. The diagnosis of DPN was based on the multiple symptoms and diabetes history. For the impact on the small fibers, the symptoms usually involved pain and dysesthesia, which can be assessed with the pinprick and temperature sensation tests. As the impact developed on large fibers, the symptoms usually involved numbness and loss of protective sensation, which can be confirmed by the vibration perception and 10-g monofilament tests. For diabetic retinopathy, the diagnosis will be based on an initial dilated and comprehensive eye examination will be performed by an ophthalmologist. Enrolled subjects will be prospectively followed up for 2 years with yearly clinical evaluation and thereafter yearly prospectively

Results:

545 consecutive patients with diabetes were enrolled in the study, of which 40% were males and 60% were females. Majority of the patients 191 /545 were in the age range of 45-54 years, while the mean age of the population was 47.48 yr± 13.58 yr. With regard to the BMI of the enrolled subjects' majority of them were overweigh (n=193) or obese (n=212) while a small number were underweight (n=15).

Distribution of the patients as per the different parameters used for clustering of the subjects with type 2 diabetes it was seen that the major clusters observed were the severe insulin deficiency cluster with lower BMI, younger age and the cluster with older patients had lower HbA1c values with higher BMI.

Further details regarding the clustering are being studied while some of the reports are still awaited.

The preliminary observations from this study suggest that patients with type 2 diabetes following up at our hospital belonging to this region of the country have unique clustering into different groups as identified by a higher age and lower HbA1c in those who are in the cluster 3 with mild age related diabetes and a cluster 1 with lower BMI, higher HbA1c values and lower age while the cluster 2 is a group with combined insulin resistance and insulin deficiency.

Further correlations of these clusters with the presence of complications of diabetes is being analyzed.

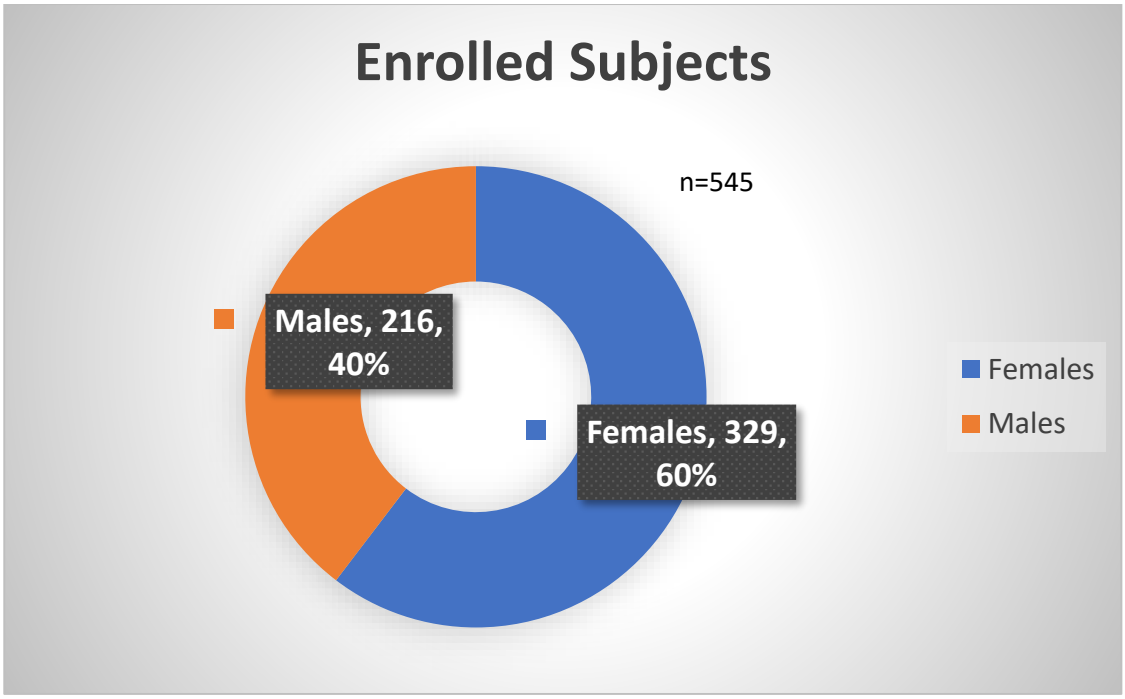


Figure 1: Sex distribution of subjects enrolled in the Cluster Study

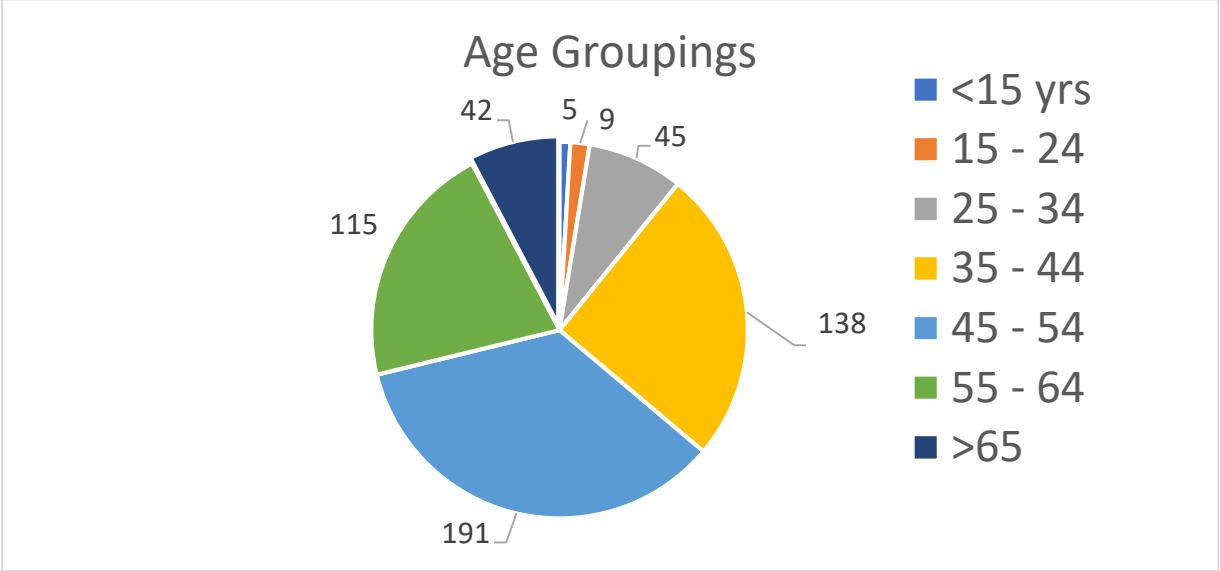


Figure 2: Age distribution of the subjects in the Cluster study

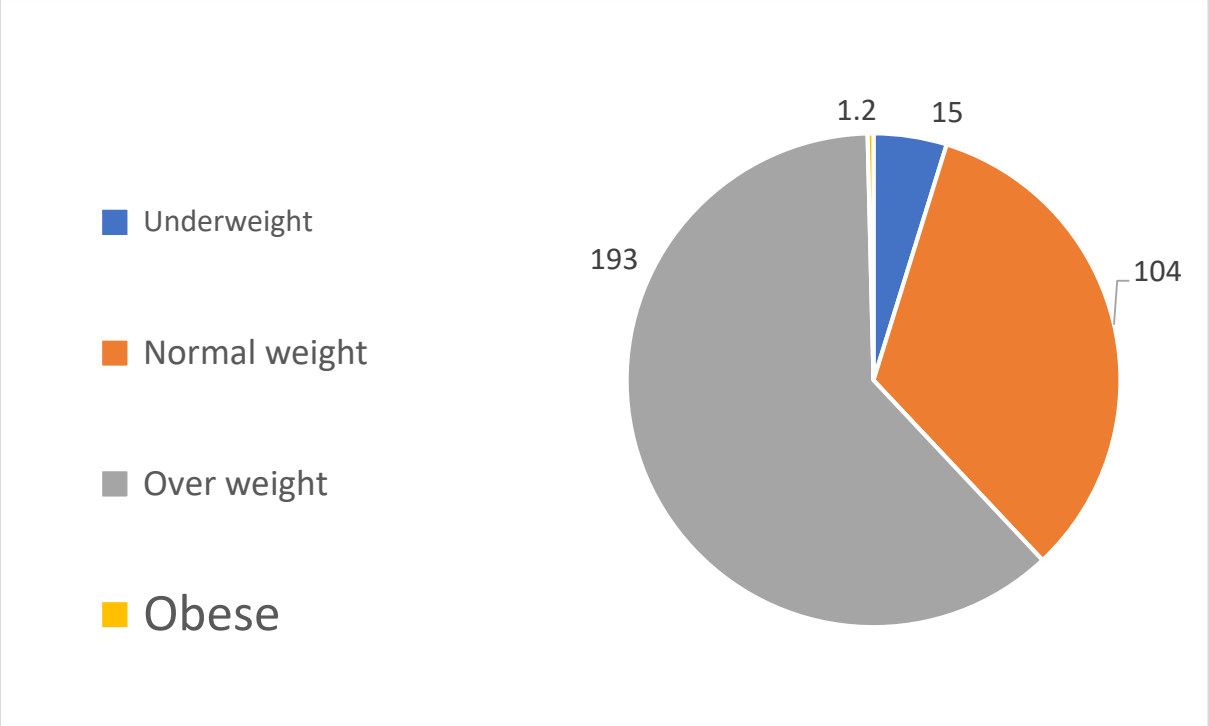


Figure 3: Distribution of subjects based on the BMI

Estimation of biomedical waste generation and Carbon footprint from hemodialysis unit - Towards Green dialysis:

Green Dialysis:

In the year 2010, more than 2.61 million patients worldwide were treated with dialysis. It is estimated that in the year 2025, about 4 million patients will be treated with dialysis worldwide. Majority of patients with end-stage kidney disease (ESKD) are treated with hemodialysis rather than peritoneal dialysis. Hemodialysis numbers in India are believed to be 1,75,000 (0.175 million) annually. It is likely that the number of dialyses will increase due to the dialysis initiative by the government of India.

Public-funded dialysis was initiated for the first time in the country in 2009 in the erstwhile Andhra Pradesh. Subsequently, the Telangana government initiated the hub-and-spoke model where there are three hub centers located in Hyderabad, which is the capital of Telangana, and each of these hub centers caters to 10–15 spoke centers in the neighboring districts. These units are providing dialysis at the doorstep for most of the patients.

There is an enormous generation of biomedical waste from hospitals. Hemodialysis is a major contributor towards biomedical waste. Improper waste disposal damages the natural fauna and flora and is a harbinger of many infectious diseases. Waste generation also has an important economic impact since the disposal of potentially hazardous or contaminated waste is extremely expensive. There are very few studies on the magnitude of biomedical waste generation from dialysis units in India and this prompted us to take up the study.

Material and methods:

This prospective study was carried out in the department of Nephrology in the dialysis unit over a period of 1 year. The measurement accuracy of the scale used for the measurement of dialysis disposables was 0.1g. The daily dialysis waste generated by the unit was measured using spring balance. The proportion of plastic and non-plastic waste was determined. The quantity of biomedical waste generated per person in a year was calculated. Water input to the dialysis unit was noted. Water consumption per dialysis was calculated. Liquid Chemical waste consumed was determined. Electricity consumed by the unit was measured by the electricity meter. The cost of waste disposal was calculated. The cost of electricity consumption and water consumption was also calculated.

Variables were presented as mean and standard deviation or as frequencies (percentages). Continuous variables were analyzed using Student's /-test or ANOVA. Kolmogorov–Smirnov test was used for testing normality. Nonparametric variables were compared using Mann–Whitney U or Kruskal–Wallis tests as appropriate. Pearson's x test or Fisher's exact test was used for categorical variables. $P < 0.05$ was considered to indicate a statistically significant difference. The statistical analysis was performed using Epi info ™ Version 7.1, Division of Health informatics and surveillance, Center for Disease Control, Atlanta, USA. The study was approved by Institutional Ethics Committee.

Results:

The approximate weight of waste disposables generated in 1 dialysis is shown in table 1. The waste generated per month and yearly from the dialysis unit is given in the table 2. Approximately 1.2 kg of waste is generated per person per dialysis. Each dialysis required 120 liters of RO (reverse osmosis) water and to generate 120 liters of RO water 250 liters of raw water was used. This happens as 125 liters of water is rejected during the generation of 125 liters of RO water. Thus, the net Water consumption for each dialysis was 250 liters. Chemical waste generated per dialysis includes 90 ml citric acid per dialysis and 130 ml bleach.

Each dialysis consumes unit 3 KV electricity. Cost of electricity for each dialysis was 8.5 INR per unit i.e., 25.5 INR per dialysis and cost of water was 100 Rs. per kiloliter i.e., 25 Rs. for each dialysis. Cost of waste disposal for each dialysis bed was 6 INR.

Conclusion:

A huge quantity of waste is generated during each dialysis. Proper segregation of waste at source, separation of biohazardous waste and recyclable waste helps in reducing the quantity of biomedical waste and thus protects the environment and reduces costs. Similarly repurposing of dialysis reject water and effluent water in toilets and reusing the dialyzer waste as concrete may further decrease waste generation. Installation of solar panels may reduce electricity consumption and reduce carbon footprint. Formulation of state and national policy on green dialysis may be an important step forward.

TABLE 1	**Material**	**Weight**	**Composition**
Dialyzer	Polycarbonate	200gm 300gm (wet)	Plastic
Blood tubing	PVC	250gm 350 gm (wet)	Plastic
Packing of Dialyzer + Blood tubing + syringes and fistula needle	PVC	25 g	Plastic
Fistula needles (×2)	Silicon + metal	50 gm	Silicon + metal
Saline bottles empty x 4	PP	50g	Plastic
Gauze	Cotton	2.5 g	
		0.7 kg (wet) 0.5 kg dry	

TABLE 2	**TOTAL waste per month (Kg)**	**DIALYSIS NUMBER/ month**	**Kg/ patient per dialysis**
April	2340	1800	1.3
May	2088	1740	1.2
Jun	2222.84	1822	1.22
July	2238.2	1805	1.24
Aug	2441.8	1864	1.31
Sept	2156.28	1812	1.19
Oct	2239.8	1821	1.23
Nov	2287.5	1830	1.25
Dec	2188.8	1824	1.2
Jan	2337.4	1798	1.3
Feb	2246.8	1812	1.24
March	2146.76	1804	1.19

Mining Novel Disease Resistance Sources in Wild Species of Groundnut for Late Leaf Spot and Rust Resistance and its Utilization to Breed Disease-Resistant Groundnut Cultivars for Telangana State

Dr. Janila Pasupuleti
ICRISAT

Groundnut or peanut (*Arachis hypogaea* L.) is an important food, oil, and feed crop cultivated in >5.0 m ha in India (FAOstat 2021). Late leaf spot (LLS) caused by *Phaeoisariopsis personata* and rust caused by *Puccinia arachidis* are the major foliar fungal diseases in India and across the world. The project focuses to breed foliar fungal disease-resistant groundnut varieties with high oleic acid content (~80%) and high yield potential. High oleic acid content groundnut offers consumer health benefits and shelf-life benefits to food processors. Besides, diversifying the genetic base for resistance to foliar fungal disease resistance is a key research gap that the project envisages address. An elite high oleic acid breeding line, ICGV 15074 was selected as a recipient parent and crossed with three different donors (groundnut synthetics) viz., ISATGR-265-5A (*A. kempff-mercadoi* × *A. hoehnei*), ISATGR-278-18 (*A. duranensis* x *A. batizocoi*), and ISATGR-206-B (*A. duranensis* x *A. valida*). F1s were obtained and are being advanced at ICRISAT

A popular Spanish bunch variety in Telangana, Kadiri 6 (K 6) is susceptible to LLS and rust diseases. This variety was improved for disease resistance and high oleic acid using MABC at ICRISAT. 30 breeding lines bred in K6 background were evaluated for yield and related traits at ICRISAT, Patancheru, and Regional Agricultural Research Station (RARS), Palem, Mahbubnagar in the rainy 2022 season. Six promising lines with yield increase over K6 (check) are ICGV 201054 (24%), 201069 (11%), 201076 (20%), 201057 (13%), 201053 (22%), and 201080 (12%) and are advanced to the next stage of testing.

Innovative Low-Cost Hybrid Road Cleaning and Sanitizing E-Vehicle for Municipal Corporations

Dr. M. V. Satish Kumar
Kamala Institute of Technology & Science,
Singapur, Huzurabad

Introduction:

Majority of municipalities and corporations rely on their manual workforce (sweepers) to clean roads and sanitize them. The COVID-19 pandemic has further increased the responsibility of cleaning and sanitization in municipalities and corporations. Due to this, the quantum of work has increased on the workers, which is affecting their efficiency. It is observed that municipal sweepers are facing lot of health problems in performing their duty. Due to prolonged standing and bending postures, they are facing knee joint problems, disk problems and varicose veins. Similarly, due to dust inhalation while sweeping the roads, they are facing issues related to lungs. Inspite of their continuous effort, cleanliness in municipalities and corporations are not up to the expectations. To address these issues, municipal corporations have purchased and hired mechanized road cleaning machines. But it increased the financial burden on them because of high initial investment and operational cost of those mechanized machines. Sweeping machines purchased by municipal corporations are also polluting the environment because they use fossil fuels. Moreover, those machines are useful only in cleaning the roads and hence corporations need to depute additional workforce for sanitization work. This has further increased the financial burden on municipalities and corporations. To address the above problems of health hazards of workers as well as financial burden on the corporations, there is a need to implement various methods that serve the purpose of road cleaning in municipalities and corporations.

This project was taken up with an aim to developing a hybrid vehicle with structures of travelling and road cleaning vehicles. It was also aimed to develop a low-cost e-vehicle which can take care of both cleaning and sanitization. Reducing pollution as well as operational cost and hence financial burden on municipalities/corporations were the other major concerns in this project. This was achieved by making the vehicle battery powered rather than using fossil fuels. Further operational cost was also minimized by using solar power to charge the batteries instead of electric power.

This project was completed in two phases. First phase consists of data collection and survey, whereas second phase consists of fabrication of e-vehicle.

In the first phase data related to Municipal Corporation, Karimnagar (MCK) was collected to know the quantum of cleaning work. Data pertaining to existing machines at MCK and the corresponding financial burden was also collected in this phase. From the collected data it is observed that MCK is spending around Rs.4-5 lakh per month for running the vehicles and Rs 1-2 lakh per month towards maintenance of the vehicles they have purchased.

In addition, a survey was conducted by interviewing around 90 sweeping workers of MCK and their health problems were recorded. For this a questionnaire was prepared to know the problems faced by the workers. The questionnaire also includes length of roads they clean every day, time taken to clean the roads, health problems they are facing, severity of problems etc. Their suggestions for improving the cleanliness were also considered in the survey form. From the analysis of the survey, it was observed that most of the workers are suffering from knee pain, lower disk problem, eye irritation, and cervical spondylosis. It was also observed that few workers were suffering from even more than one health problem.

In the second phase, parts to be fabricated / purchased are identified and they were made ready for assembly. First, a chassis was fabricated as per the required dimensions. Provision was made to fix the loader box, DC motor, batteries and an extra tire. Two vertical road cleaning brushes fitted at the front side of the vehicle to sweep the road. Another horizontal brush is fitted at the backside of the vehicle which pushes the dust in to the dust collection tray. A lifting mechanism was provided to transfer the dust from the tray to the dust carrier (loader box). Then a solar panel was fixed to the vehicle for charging the batteries. As the e-vehicle developed for cleaning needs to be charged at regular intervals, a charging station was installed to charge the batteries whenever necessary. Once the fabrication of e-vehicle is completed, a battery-operated double nozzle sanitizer sprayer was fixed to the vehicle to take up sanitization work along with the road cleaning.

Conclusively, in this project, a low-cost cleaning and sanitizing e-vehicle was developed for municipal corporations, with features similar to those of regular road cleaning machines. The developed e-vehicle has also facility to spray the sanitizer. This vehicle reduces lot of financial burden on the municipal corporations as its initial investment is very low when compared to the present machines hired/purchased by the municipal corporations. The vehicle developed in this project contributes for a pollution free environment by way of using battery power rather than fossil fuels. The charging station facilitates repeated charging for the e-vehicle with ease. This station can also be used for charging two wheelers used by the employers of the corporation.

A study of Sub Thalamic Local Field Potentials of Parkinson's Disease Patients Under Deep Brain Stimulation Therapy for Finding Potential Biomarkers

Dr. Dabbu Suman
Project Investigator
Osmania University, Hyderabad

Introduction:

Local field potentials (LFPs) have been widely used to investigate the neural mechanisms underlying Parkinson's disease (PD) and to develop diagnostic tools for this disorder. LFPs are low-frequency electrical signals that reflect the activity of groups of neurons in the brain is being widely explored for finding potential biomarkers of PD. This study uses LFP signals recorded from PD patients who are undergoing DBS. LFP signals are preprocessed by using digital filters with the cutoff frequencies limited to 0.5-350 Hz and analyzed further by feature extraction algorithms. Discrete wavelet transform is applied to the preprocessed signal to perform the segmentation of the LFP signals in to Alpha (8-12 Hz), Beta (13-30 Hz), Theta (5-8 Hz), broadband Gamma (50-250 Hz) and High frequency Oscillations (HFO) (200-350 Hz). Several features are derived from the filtered LFP's that includes Power Spectral Density, coefficient of variation, Alpha-Beta peak, Phase amplitude coupling and modulation index. The analysis has revealed that two features beta power and coupling of beta phase to HFO amplitude are significant for the detection of PD. Overall, LFP recordings have shown great promise as a diagnostic tool for PD. However, more research is needed to validate these findings and develop standardized protocols for LFP recording and analysis in clinical settings.

Methodology:

The analysis of local field potentials (LFPs) for the diagnosis of Parkinson's disease (PD) typically involves the following steps:

Recording LFPs:
LFPs are recorded from deep brain regions, such as the sub thalamic nucleus (STN) or globus pallidus interna (GPi), using implanted electrodes. The electrodes are typically inserted during deep brain stimulation (DBS) surgery, which is a common treatment for PD. Study participants are selected based on the inclusion and exclusion criteria of the study. Participants may include individuals with PD, healthy controls, or individuals with other neurological disorders. Participants are provided with informed consent documents that outline the study procedures, risks, and benefits. Electrodes are implanted into deep brain regions, such as the STN or GPi, using stereotactic surgery.

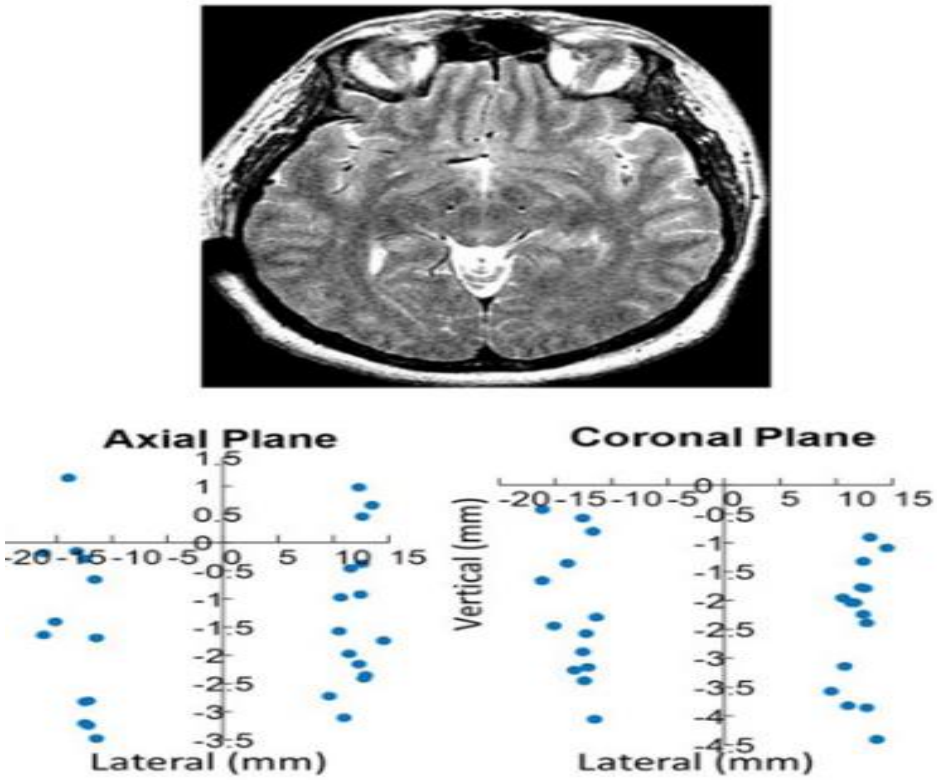


Fig.1.Placement of electrodes during recording of LFP's

Recording LFPs from different depths in the brain can provide insights into the activity of different populations of neurons and their interactions. For this study, the Electrodes are placed at different depths with respect to the target in the sub thalamic nuclei. Axial and coronal view of MRI image shown in fig.1.consists of electrode positions with labels 0mm, 1mm, 2mm, etc., and -1mm, -2mm etc., represents distance from the target for recording of LFP signals. LFP signals are recorded from the implanted electrodes using a data acquisition system. Participants undergo clinical assessments to evaluate the severity of PD symptoms, such as tremors, rigidity, and bradykinesia. Participants may undergo follow-up visits to monitor the progression of PD symptoms and to assess the long-term stability of LFP recordings.

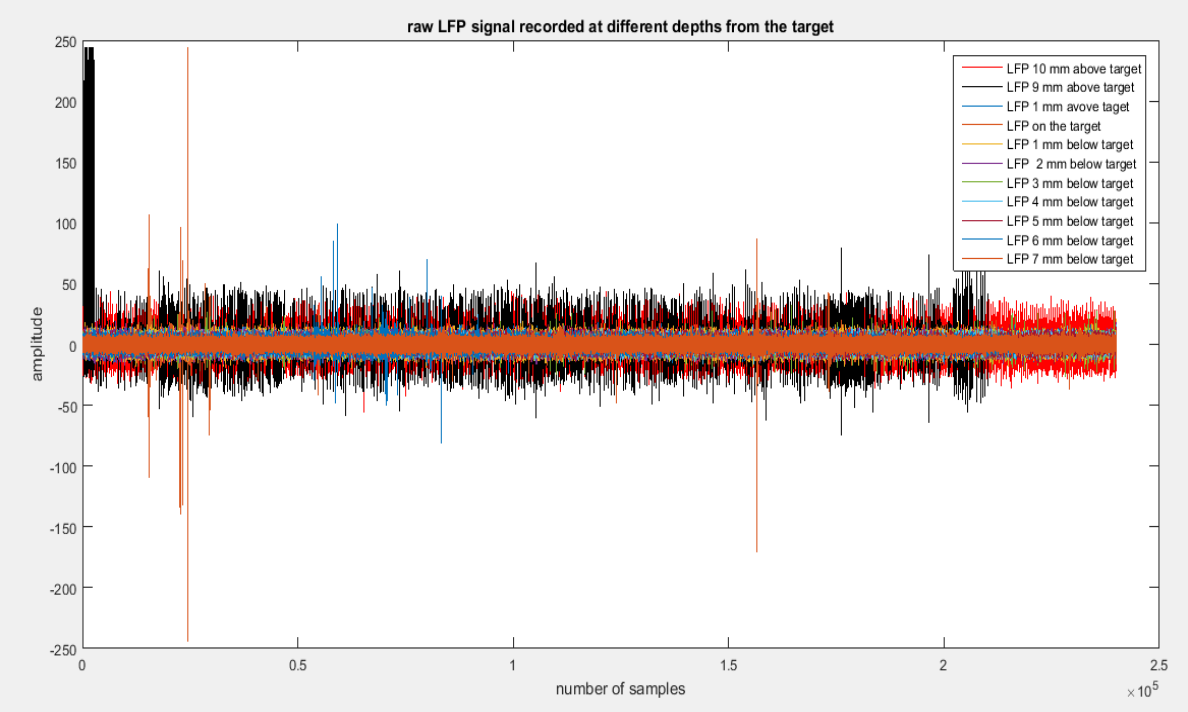


Fig.2. LFP signals recorded from different depths with target

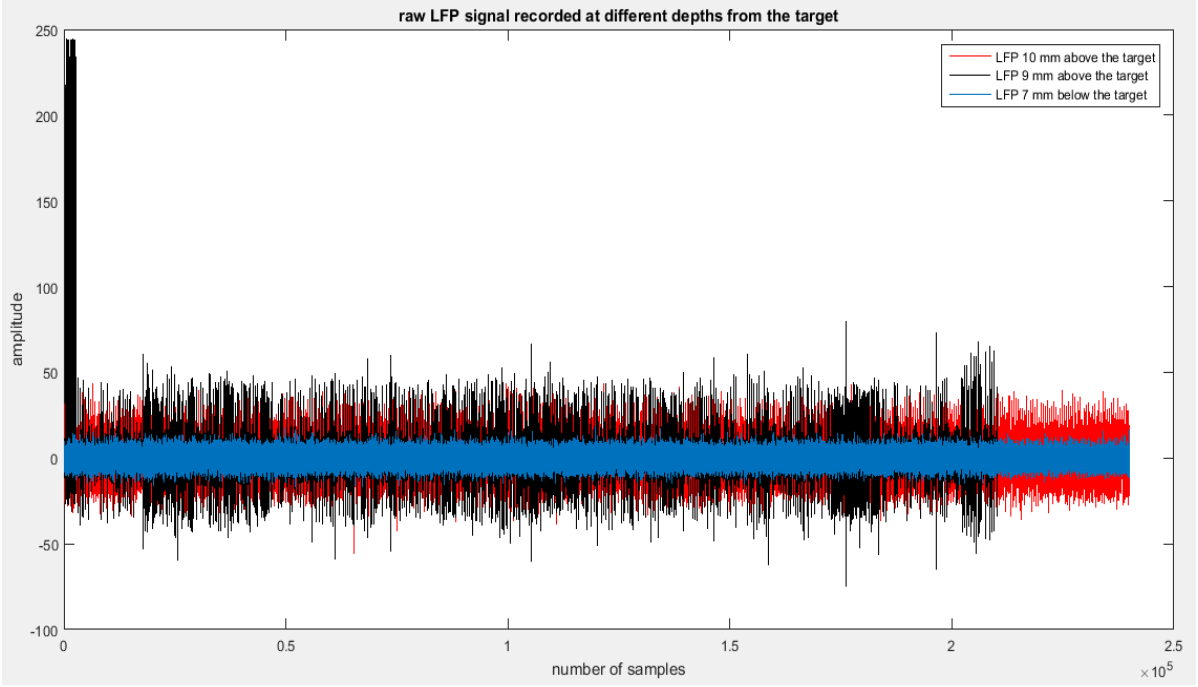


Fig.3.LFP recorded from different depths of the target

Pre-processing LFP data:

The raw LFP data acquired from a PD patient undergoing DBS is shown in fig.2 & fig.3. LFP signals are contaminated with noise and other unwanted signals. To remove these unwanted components, filtering is typically applied to the raw LFP data. This involves filtering the data to remove unwanted frequency bands, such as high-frequency noise or electrical interference. Preprocessing of local field potential (LFP) data is an important step in preparing the data for further analysis. A band-pass filter is used to extract the desired frequency range of interest. In this study, the frequency band of 4-30 Hz is used to analyse LFPs.

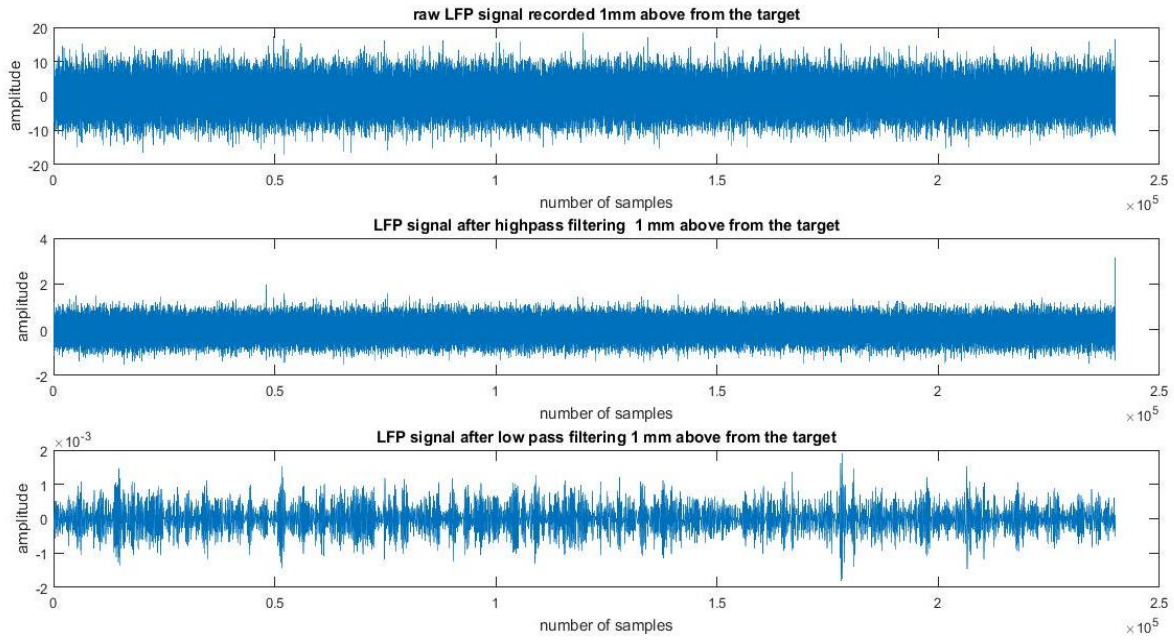


Fig.4.Raw and filtered LFP signals recorded 1mm above the target

The analysis to determine the specific biomarkers of Parkinson disease signal is performed for all the available samples. Samples are recording the LFP from STN of Parkinson diseases patients, theses are recorded during surgery. The results are placed on the tables. While undergoing DBS surgery for the movement disorders to evaluate LFP features that have been proposed as biomarkers for the Parkinsonian state. Comparing the STN LFP recording in the patients with amplitude, width, and frequency of the alpha-beta peak in the LFP power spectrum did not distinguish diseases groups. Our finding suggests that these metrics of alpha-beta band activity are not specific to the parkinsonian state. In humans, there has been no direct evidence that the presence of a prominent beta peak in the STN LFP power spectrum is a parkinsonians State-specific biomarker. Our results cast doubt on the disease specificity of the properties of the STN LFP examined in this study, that they represent normal STN physiology.

Coefficients of variations (CV) is varies from 0 to 2, there is no particular value because it depends on the patient activities. Similarly, RMS varies simultaneously it is due to electrode placed on the location, depth of the electrode into the brain, age, gender, other complication. Although invasive studies of basal ganglia physiology in healthy humans are ethically impossible, analysis of STN LFPs in additional disease states dystonia,

tremors, motor dysfunction (four primary symptoms: resting tremor, bradykinesia, muscular rigidity and postural instability).

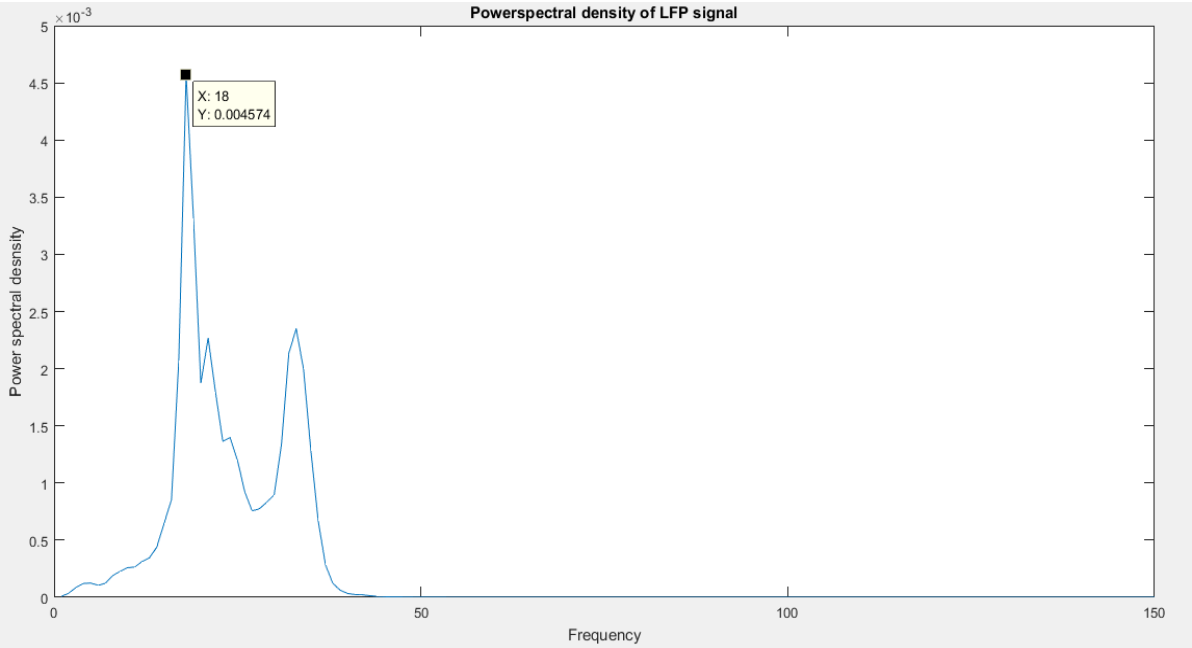


Fig.5.Powerspectral density of the LFP signals

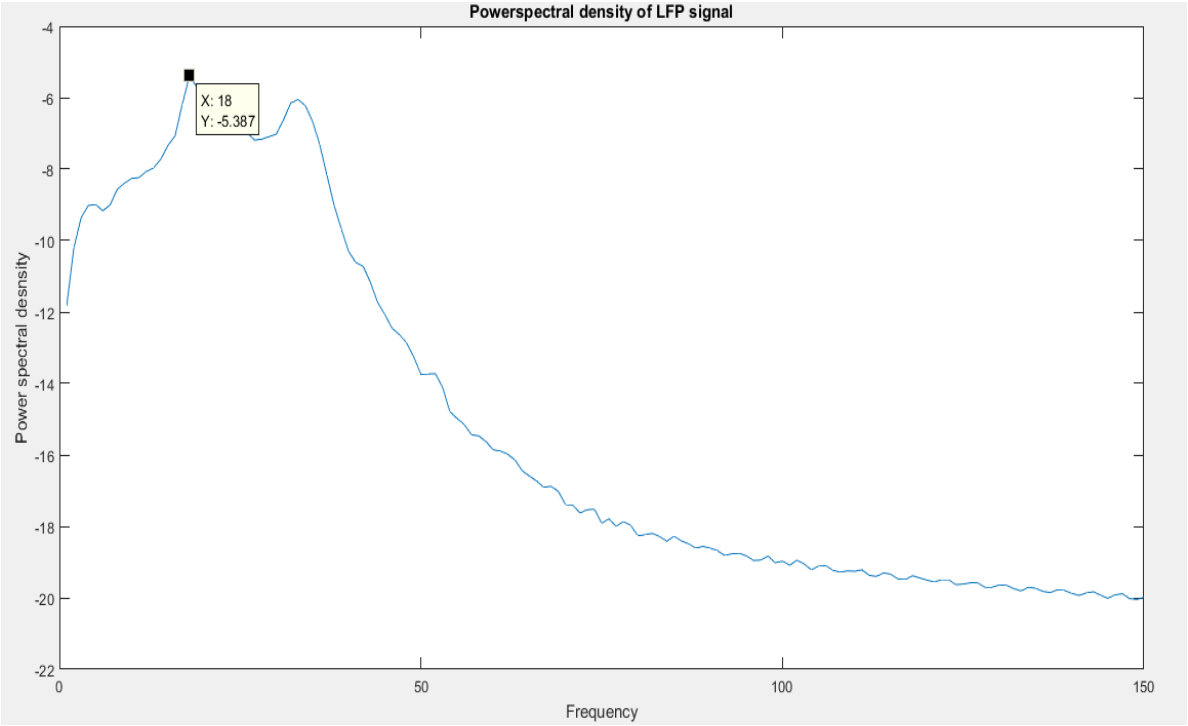


Fig.6.Log Powerspectral density of the LFP signals

Comparing LFP features across groups: The extracted LFP features are compared across groups of individuals with and without PD. This may involve statistical tests, such as t-tests or ANOVA, to identify significant differences in LFP features between groups. LFP

biomarkers are validated using cross-validation techniques, such as leave-one-out cross-validation or k-fold cross-validation. This involves training a machine learning algorithm on a subset of the data and testing it on the remaining data to evaluate its performance. Validated LFP biomarkers are translated to the clinic for use in the diagnosis and management of PD. This may involve developing a decision support system that integrates LFP biomarkers with clinical data to improve diagnostic accuracy or using LFP biomarkers to guide DBS therapy. Overall, the analysis of LFPs for the diagnosis of PD involves a combination of signal processing, statistical analysis, and machine learning techniques. While this approach shows promise for the development of LFP-based biomarkers for PD, further research is needed to validate the utility of these biomarkers in clinical practice

Conclusions and Future Scope:

Despite the promising potential of local field potentials (LFPs) as a biomarker for Parkinson's disease (PD), there are still some research gaps that need to be addressed. Some of these gaps include:

1. Lack of standardization: There is currently no standardization for LFP recording and analysis, which can make it difficult to compare results across studies. This hinders the ability to identify consistent biomarkers of PD.

2. Limited sample sizes: Many studies on LFPs in PD have small sample sizes, which can make it difficult to draw definitive conclusions about the relationship between LFPs and PD. Larger studies are needed to validate the findings from smaller studies.

3. Limited understanding of LFP changes over time: While LFP changes have been observed in people with PD, there is limited understanding of how these changes evolve over time. Longitudinal studies are needed to track changes in LFPs over the course of the disease and to identify potential biomarkers of disease progression.

4. Lack of specificity: LFP changes may be observed in other neurological disorders, making it difficult to determine the specificity of LFPs as a biomarker for PD. Studies comparing LFP changes in PD to those in other disorders are needed to identify unique LFP biomarkers for PD.

5. Limited validation of LFP biomarkers in clinical practice: While LFP biomarkers have shown promise in research settings, they have yet to be validated for clinical use. Large-scale clinical trials are needed to determine the utility of LFP biomarkers for the diagnosis, monitoring, and treatment of PD.

Addressing these research gaps will be crucial for advancing the field of LFP analysis as a potential biomarker for PD and improving the diagnosis and management of this debilitating disease.

Research Publications/Patents/Awards etc.

1. D. Suman, M Sri Lakshmi, Rukhmini M, Analysis of Local Field Potentials of PD patients during DBS for finding markers of PD, Defense Life Science Journal (Under Review).
2. D. Suman. Pavani Thadem, Zurian, BCI based home automation system by using SSVEP Signals, International conference on ICETE 2023: 2nd International Conference on Emerging Trends in Engineering, University College of Engineering, Osmania University, Hyderabad, India, April 28-30, 2023
3. D Suman, Pavani Thadem, a study of Sub-thalamic local Filed Potentials pf Parkinson's Disease patients under Deep Brain Stimulation therapy for finding potential biomarkers presented at an International conference on one health and translation research in neurosciences organized by CIIMS Nagpur and IIITN at CIIMS Nagpur during 10-12th November 2022.
4. D Suman, M Sri lakshmi, Rukhmini M, a comprehensive review of the Parkinsonism and future directions for the early detection of PD at International conference on current trends and futuristic challenges in chemical sciences held at UCS, Osmania University, during 29-30th July 2022.
5. Research Project grant: The funding provided by the TSCOST has played a vital role and in fact paved a way for getting a SERB-grant with the following details.

Sr. No.	Project Title	Funding Agency	Project worth in Rs.	Duration of the project
01.	**Smart Shoes: An advanced aid for the freezing gait of the Parkinson's Patients**	**SERB-DST-SCP**	**17,97,400.00**	**09/12/2022 - 08/12/2025**

BE/ME/PhD thesis contributions:

TSCOST project has provided the necessary support for the following students in completing their thesis and contributed for the project.

- Mr. M. Venkateswara Rao-PhD thesis on Gait analysis for the PD patients
- Guvvala Swetha- ME thesis on Local field potentials for PD patients
- Asoudu Ajay Teja- ME Thesis on EEG signal analysis for the detection of emotional stress

Evaluation of Determinants of Iron Deficiency Anemia among the SC/ST Non-Pregnant Women of Mancherial District of Telangana State followed by Interventions and Analysis of its Reach & Efficacy

Prof. A. Sajeli Begum and Dr. Swati Alok,
BITS-Pilani Hyderabad Campus

PURPOSE:

Despite years of nutritional and other efforts to mitigate Anemia among women of Telangana, 58.9% of the rural women of the Telangana state remain afflicted by the condition. Anemia not only directly affects women's health and economic state, but also leaves them vulnerable to other infections. The problem may be especially severe among the underprivileged Scheduled Caste and Scheduled Tribe rural women, who are likely to suffer disproportionately from nutritional deficiencies leading to anemia. Mancherial District of Telangana, with the highest representation of Scheduled Caste persons across all districts of Telangana, may therefore require specific attention to alleviate the challenge of anemia among rural women.

In view of these facts, the project work was planned to focus on three objectives namely:

1. To identify the various socio-demographic factors, eating practices, cooking practices, nutritional intake, social norms, belief that significantly influences and differentiates "Anaemic (Mild, Moderate and Severe) women against "Non-Anaemic" non-pregnant rural women.
2. To conduct interventions focusing on positive sustainable behaviour changes specially motivating the women to take iron pills, undergo compliances on iron pills intake as well as enhance focus on their own health through diverse nutritional food intake
3. To determine the effectiveness of interventions in improving the haemoglobin count among the intervened populations in absolute and relative terms along with any change in constructive sustainable behaviour.

STUDY DESIGN:

To fulfill these objectives, the project was completed in three phases, namely i) baseline study ii) interventions implementation and iii) post intervention study. Study was conducted in six villages of Mancherial District of Telangana State namely Suraram, Bommena, Jilleda, Laxmipur, Nagaram, Buyyaram, constituting more than 80% of SC/ST/OBC populations. Study targeted non-pregnant women belonging to age between 15-49 and data was collected among 327 women residing in these villages.

During Baseline study, the hemoglobin level (anemia status) of women were tested using pin- prick blood test method. This was followed simultaneously with information collection through questionnaire where their prevailing knowledge of anemia specially causes, consequences, symptoms was queried, their cooking as well as eating practices were identified along with their socio-demographic information. Hemoglobin test among the women helped in grouping them into four categories namely mild, moderate, severe

and Non-Anemic. Descriptive statistics and Chi square was conducted to test the influence of various factors that significantly differentiate between the 4 groups.

Baseline study enabled to identify the prevailing practices, social beliefs, norms that were adopted by targeted women. Also, it helped in understanding the status of anemia prevailing in these 6 villages. Accordingly, the customized training program was designed in the second phase of the project and finally the 3 out 6 villages were selected as experimental village. It was in these 3 villages; the training was conducted. Third phase began post 2 months, where impact of training program was analyzed. For this, data was once again collected from both control as well as experimental village. Hemoglobin test was once again measured among the women who attended the training program.

RESULT:

Result of the phase –I indicated that 89.2% of women were Anemic with 18.6% in "severe" (<8 G/dl) category, 55% "moderate" (8-10.9) category, 15.6% in "mild" (11-11.9). Only 9.3% were Non-Anemic. The percentage of "Severe" anemia was found to be high in Bommena (25%) village followed by Suraram, Jileda, Buyyaram, Nagaram, and Laxmipur. However, Laxmipur showed highest Non-Anemic status of 25%. Women falling under severe anemia category are mostly unmarried (72%), belongs to joint family (30%), working in agriculture sector (40%). Further analysis indicated that women with last pregnancy delivered at home (55%), showing < 21 days' menstruation cycle and those who was diagnosed with malaria 16 months ago showed "Severe" Anemia. Demographic data revealed that 10% of highly educated women falls under non-Anemic category, indicating influence of education on health.

Use of iron utensils to cook was found to have significant association with Anemic status, it was observed that 74% of women in severe Anemic category were not using iron utensils for cooking. And out of 56 women who were cooking food using iron utensils only 17 (30%) were in severe Anemic category. The chi-Square test results stated that eating arbi sag, amla, meat in regular diet i.e. daily or at least once a week showed significant difference in anemic status among the women, and thus these cooking practices made them fall under non-anemic category or not falling under severe anemic category.

Apart from understanding the prevailing behavior and anemic status of women residing in the 6 villages, baseline study helped in identifying the objectives of training program. It was concluded that training program should be focused on Unmarried women between age group 20-39 years, specially residing in villages namely Surram, Bommena and Jileda. Hence these villages were selected as experimental villages and rest three as control villages where there were no training interventions. As maximum women had received No Formal Education (NFE) and completely unaware of Anemia, its causes and symptoms, hence the training materials was designed with minimal textual material, more of games activities, videos and pictorial to enhance their knowledge scores. To bring changes in their attitudes especially their negligence towards own medical conditions, not understanding the importance of iron pills, skipping meal regularly led us to call medical expertise such as medical officer, Doctors to act as change catalyst during the training program. A mean family income of Rs. 7590 and a standard deviation of Rs. 2074 also depicts the uneven income distribution and overall poor standards of living required to have training program designed with the aim of providing pocket-friendly and sustainable

lifestyle changes. Also, it was ensured to emphasis on intake of iron rich food which are cheaply and widely available such as jaggery, drumsticks, arbi saag, amla, etc., and persuading them to cook their chutneys, non-veg food in iron pots during training program.

Phase-2 involved two sub stages namely i) designing training materials and ii) conducting training program. Brochures, posters, videos, playing cards were designed with the objective to enhance women's knowledge scores, enhance diverse food intakes, practices healthy/hygienic lifestyle as well as motivate them for iron pills intake with compliances. Finally, the training program was conducted in the primary school center located in Surram, where women from Bommena and Jileda were also invited. 145 from total of 165 women surveyed during pre-intervention stage attended the training program. They were provided with iron rich lunch during break session along with games and fun filled activities. ASHA workers were informed to provide iron pills to women who would come and ask for iron pills. Two months later, post interventions survey was once again conducted among 145 women that attended training. Also 160 women residing in the control villages too were surveyed to control the spillover effect (if any) in the behavioral change that might have occurred between pre and post intervention duration.

Phase-3 involved, analyzing the impact of training program post interventions. The hemoglobin level, knowledge score, eating practices, cooking practices, intention to use iron pills in future (if required) and food diversity scores of trainees (women from experimental village that attended training program) were compared with their pre implementation scores. Though 145 women attended the trainees, during post survey, we were able to conduct hemoglobin test, data survey on only 105 women. Rest were not available as they get migrated to city for livelihood during summer, whenever there are no agricultural activities in the village.

Percentage difference in pre-post comparison led us to conclude that the program had a positive impact on increase in hemoglobin level post interventions. With respect to change in hemoglobin level, in the village of Bommena, there was decrease of 100% in "severe" case of anemia, resulting in complete elimination of Severe cases. In the case of Jilleda, there was no case of improvement in the "severe" category, however, decrease in "moderate" (21%) and increase in "mild" (41%) category indicated positive improvement. Surraram showed good improvement namely, "severity" reduced by 12%, "moderate" decreased by 14 % while "mild" category of anemia increased by 90%.

Training showed positive impact in knowledge score showing increment of information related to i) causes of Anemia by 20% ii) identification of symptoms by 5% iii) linkage to malaria by 10% and connection with intestinal worming by 20%. The program's impact on cooking practices was noteworthy, with a 20.47% increase in the use of iron utensils for cooking. Own decision to use iron pills in future (if required) without being influenced by mother- in law or husband increased by 17%. Category of women who use to eat reheated food all the time (always) shifted to eating "sometime", showing 21% increment in positive eating practices. As recommended by WHO, food intake of 5 different varieties in last 24 hours indicated high diverse food intake, which was necessary for mitigating severe Anemia. When queried among women, post training program, there was no increase in intake of diverse nutritional food more the 5, however we could see that there was increment in food intake with 4-5 diverse food from 0-3 food diversity

level. Slowly women were moving towards diverse food, though not the optimum level of more than 5 as recommended by WHO. Even 8.93% increment from 0-3 category to 4-5 category shows positive improvement.

Overall, the program was successful in achieving its objectives, and it is recommended to continue the program to sustain and further improve the health and nutritional status of the community.

OUTCOME:

- Reusable artefacts, customized training materials in local language are designed for the government of Telangana to use for conducting training program. This may be reused by the state in other locations to support its programs targeting mitigation of severe anemia. Soft copy of the training materials will be provided.

- The project report support policy making by identifying determinants of anemia. For example, outcome of this project indicates that policy makers need to focus on bringing sustainable behavioral change, apart from distributing iron pills and folic tablets. Government should ensure that, policy should focus on motivating women to focus on their own health's, reinforce to complete the course of iron dosage (12 pills in 3 months) and emphasis on intake of iron rich food which are cheaply and widely available such as jaggery, drumsticks, arbi saag, amla, etc., and persuading them to cook their food in iron pots. Further, this project identified that unmarried girls are more anemic as compared to married women. Hence government should not only focus on mitigating severe Anemia by focusing on pregnant women, but also there is need to create program for adolescent unmarried girls. Creating awareness through school curriculum and reaching teachers of government school will help in mitigating severe Anemia among young women.

- Change in attitude of women towards their health, awareness of cause, symptoms of anemia, adopting productive eating/cooking practices and above all motivating women to approach ASHA workers of their respective village to collect and complete dosage of iron pills will help in mitigating severity of Anemic cases.

- Paper titled, "*Impact of Knowledge, Attitude, and Practices on Anemic Status Among Non-Pregnant Women: A Case Study in Telangana.*" was presented in a National Conference on "Women @ 75: Work, Life & Freedom", National Institute of Technology Rourkela, Odisha (2023, March 17- March 18).

- News on training program was published in local newspaper.

Development of a Rapid and Cost-Effective Advanced Mass Spectrometry Approach for the Evaluation of Vitamin D Deficiency

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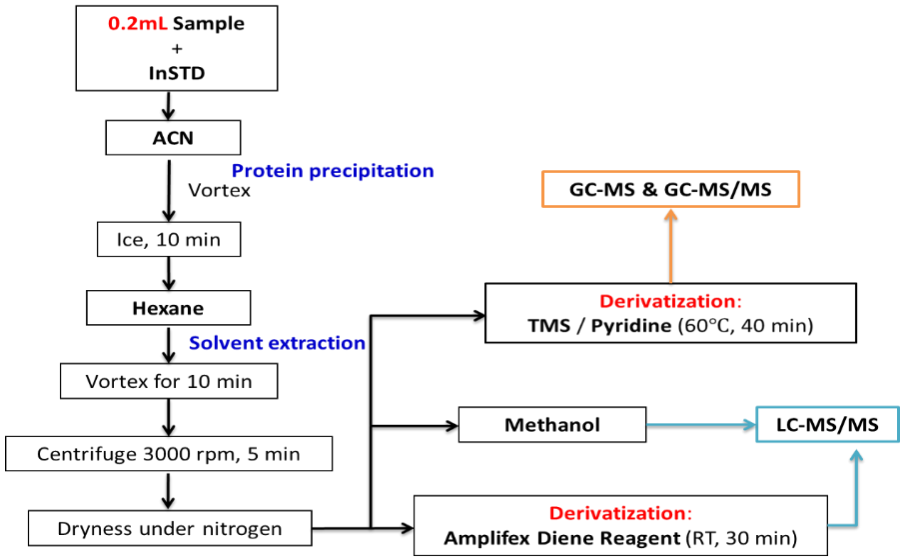
Introduction:

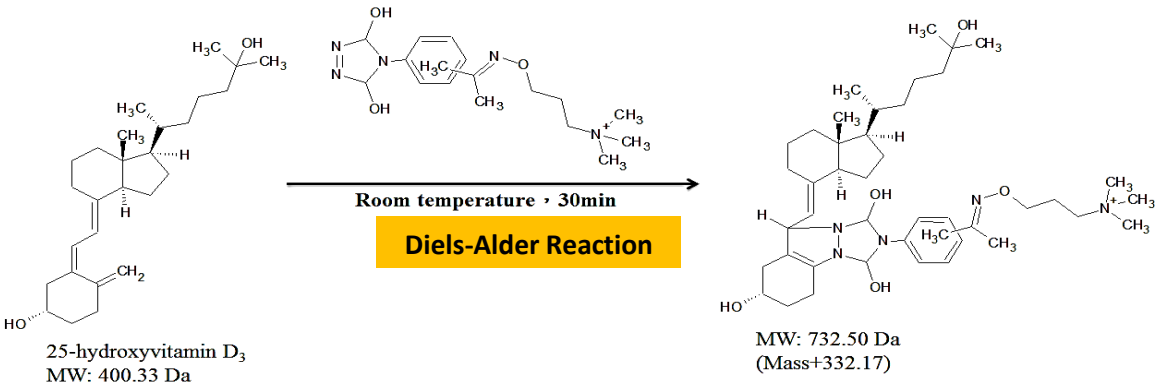
As the body's metabolism is dependent on vitamins, their deficiency can lead to changes in human body such as nutrient deficiencies, diseases. More recently, due to change in lifestyle and food habits vitamin D deficiency has become the highlight in affecting the human health like few to be noted is decreasing calcium intake thereby causing rickets, Osteomalacia and other related diseases, lowering immunity thereby prone to even pandemic diseases like COVID 19, muscle weakness. Hence, these problems urge to develop an economic, sensitive and quick detection method (kit) as a measure.

There are reports of detecting 25 hydroxy D3 measurements from dried blood spots using LC-MS method with DAPTAD (4-(4′-dimethylaminophenyl)-1,2,4-triazoline-3,5-dione) derivatization process, but the present study includes using vitamin D3 i.e., 25 hydroxyvitamin D3 and d6-25 hydroxyvitamin D3 as internal standards (ISs) to detect vitamin D by using N, O -Bis (trimethylsilyl) acetamide derivative for silyl derivatization with GC-MS method as detector (for first time) and second type of detection with LC-MS Amplifex Diene reagent using Diel's Alder reaction.

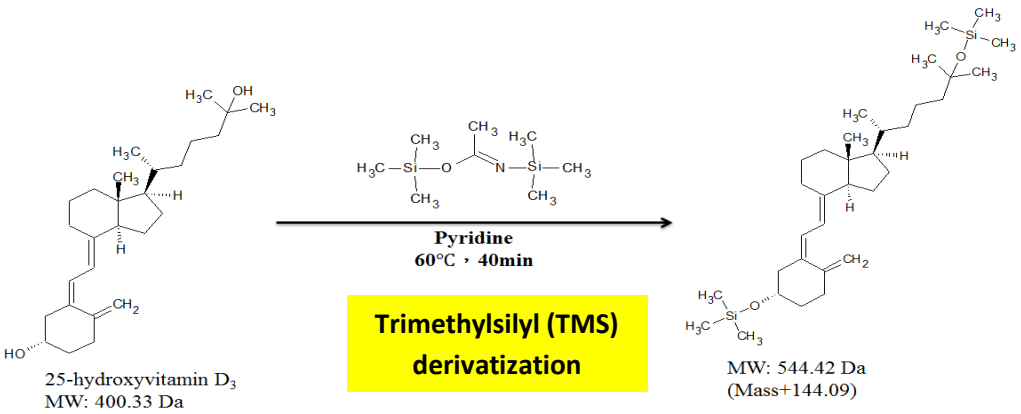
Before analyzing the plasma for 25 hydroxyvitamin D3, a preparation procedure was done that involves mixing the plasma with Acetonitrile to get rid off proteins and then adding Hexane to extract the 25 hydroxyvitamin D3. To make sure the analysis was accurate, standard solutions of 25 hydroxyvitamin D3 were prepared in methanol at different concentrations. To serve as an internal standard, d6-25 hydroxyvitamin D3 solution was added to both standard solutions and specimens, before the sample preparations as shown in following flow chart:



Derivatization technique was used to modify the structure of the analyte, making it easier to detect/identify/isolate. The sample was derivatized with Amplifex Diene reagent using Diel's Alder reaction which was injected into LC-ESI-MRM-MS (Liquid chromatography- Electrospray ionization – Multiple reaction monitoring- Mass spectrometry).



N, O-Bis (trimethylsilyl) acetamide is used to react with the hydroxyl group of 25 hydroxyvitamin D3 with the trimethyl silylation as shown in the following figure. The derivatized sample was injected into GC-EI-SIM-MS (Gas chromatography - Electron impact- Selected ion monitoring -Mass spectrometry).



Apart from the source of sunlight, vitamin D is also present in foods, but they are distributed unevenly. Comparatively, vitamin D is more in animal food sources like fish, egg, milk while they are present in very few plant sources. Henceforth, samples from different diet group of people (vegetarian, non-vegetarian and vegans) were separately tested with the MS techniques and was compared, where vegan diet people were affected quite commonly.

Further, the analysis was also done using chemi-luminescence assay for comparing the efficiency, affordability, time of the conventional method to that of the presented novel method, which is described in the form of table.

Assay methods	**Chemiluminescent immunoassay (CLIA)**	**LC-MS/MS**	**LC-MS/MS (Amplifex Diene Reagent)**	**GC-MS**	**GC-MS/MS**
Instrument	LIAISON® analyzer	Thermo Scientific Accela LC Systems; Thermo TSQ Quantum Ultra Triple Quadrupole LC Mass Spectrometer	Thermo Scientific Accela LC Systems; Thermo TSQ Quantum Ultra Triple Quadrupole LC Mass Spectrometer	Agilent HP 6890 Series GC System; Agilent HP 5973 Mass Selective Detector	Thermo Scientific TRACE™ Ultra Gas Chromatograph; Thermo TSQ Quantum Ultra Triple Quadrupole GC Mass Spectrometer
Solvent extraction	No	Yes	Yes	Yes	Yes
Derivatization	No	No	Yes	Yes	Yes
Sample volume	0.5 mL	0.2 mL	0.2 mL	0.2 mL	0.2 mL
Limit of quantification (LOQ)	4.0 ng/mL	50 ng/mL	0.78 ng/mL	12.5 ng/mL	1.5 ng/mL
Analysis time	First result in 35 minutes, throughput > 100 results/hour.	Run time: 12min.	Run time: 5min.	Runtime:13min.	Run time: 9min.
Cost Price (Rupees)	**∼500**	**∼150**	**∼600**	**∼50**	**∼50**

Conclusion

The samples collected were prepared and derivatized appropriately. Further, the derivatized samples were evaluated for vitamin D3 using different mass spectrometric techniques. We found that LC-MS had lower LOQ than GC-MS/MS and the cost of LC-MS method was over 10 times higher than using GC-MS/MS with TMS derivatization method. Henceforth, our method has been proved to be fast, accurate, sensitive, cost-effective way to estimate the Vitamin D3 levels in blood samples with an LOQ of 1.5 ng/mL and a total analysis cost of ~50 rupees per sample. Further, a comparative study of vitamin D deficiency in different diet habit people in India has explained that vegans have more deficiency than other group of diets. Our research findings, can be used to create dietary recommendations and monitor risk factor to improve the overall health of Indians.

Societal Applications

- The development of a new, quick and affordable way to test for vitamin D deficiency could help improve the accuracy and speed of diagnosis, leading to better treatment. This new method could also help researchers and public health officials understand how common vitamin D deficiency is and where it is most prevalent.
- The development of a rapid and cost-effective advanced mass spectrometry approach for the evaluation of vitamin D deficiency has numerous potential societal applications, ranging from improved diagnosis and treatment to personalized nutrition and environmental monitoring.

Innovativeness

This approach can help diagnose and treat vitamin D deficiency quickly and accurately, and may also help researchers study its impact on public health. Developing this approach requires advanced technology and expertise in various fields, and it has the potential to revolutionize the use of mass spectrometry (MS) for clinical applications. This is a promising project that could have a big impact on public health and research.

Advantages over existing methods

- **Speed:** Current methods for measuring vitamin D levels in the body can be time-consuming, often requiring several days or even weeks for results to be available. In contrast, the mass spectrometry (MS) approach can provide results within hours, allowing for quicker diagnosis and treatment.
- **Accuracy:** The MS based approach is highly accurate and can measure vitamin D levels with a high degree of precision. This can help reduce the risk of misdiagnosis or under-treatment, leading to better health outcomes for patients.
- **Affordability**: Current methods for measuring vitamin D levels can be expensive, requiring specialized equipment and expertise. The MS based approach can be more affordable, making it accessible to a broader range of healthcare providers and patients.
- **Versatility:** The MS based approach can be used to measure multiple forms of vitamin D, including both vitamin D2 and D3. This can provide a more complete picture of an individual's vitamin D status, allowing for more personalized treatment and nutrition plans.

- Overall, the MS based approach represents a significant improvement over existing methods for evaluating vitamin D deficiency. Its speed, accuracy, affordability, and versatility make it a highly promising approach for improving the diagnosis and treatment of vitamin D deficiency.

Patent

❖ German patent titled **"Novel Sensitive and Advanced Clinical Mass Spectrometry Kit for Evaluation of Vitamin-D Deficiency"** (**Bundesrepublik Deutschland) Patent Grant No: 20 2022 105 300 IPC: G01 33/82, Grant Date: 30/09/2022**

Publications

- Overview of the Effect of Covid-19 Pandemic on Forensic Pathology by G. Swetha, Revathy Sundara Moorthy, K. Premalatha, M. Kavitha and **P. Muralidhar Reddy**, *High Technology Letters, 2022, 28 (5), 134-139.* (DOI: https://doi.org/10.37896/HTL28.05/5810), **Impact Factor:2.7**, Publisher: gjstx-e.cn Publishing, Ltd., ISSN 1006-6748 **(Scopus, SCI & UGC care listed Journal)**

- "Stability Indicating Method Development and Validation, Stress Degradation Studies For Dacarbazine By Using RP-HPLC" A. Sanjeev, Narmada Vallakeerthi, N. Naresh Reddy, S. Bhaskar and **P. Muralidhar Reddy,** *NeuroQuantology*, 20 (9), (2022) 6270-6278 (doi: 10.14704/nq.2022.20.9.NQ44735). **Impact Factor: 1.576**, Publisher: AnKa Publisher (UK); eISSN: 1303-5150 **(Scopus, SCI & UGC care listed Journal)**

- "Nanoparticle Drug Delivery System for the Treatment of Neurological Disorder" K. Laxma Reddy, **P. Muralidhar Reddy*** and M. Kavitha**,** *NeuroQuantology*, 2022, 20(9), 6279-6284 (doi: 10.14704/nq.2022.20.9.NQ44736). **Impact Factor: 1.576**, Publisher: AnKa Publisher (UK); eISSN: 1303-5150 **(Scopus, SCI & UGC care listed Journal).**

- Method Validation for Quantification of Lopinavir in Human Plasma by using LC-MS/MS, S. Bhaskar, Narmada Vallakeerthi, A. Sanjeev, M. Kavitha, Anren Hu and **P. Muralidhar Reddy,** *Eur. J. Mol. Clin. Med.*, 2023, 10, 1083-1101, **Impact Factor: 0.793,** Publisher: EJMCM, International House, United Kingdom, ISSN: 2515-82. **(Scopus, SCI & UGC care listed Journal)**

Patent

Bundesrepublik Deutschland

Urkunde

über die Eintragung des
Gebrauchsmusters Nr. 20 2022 105 300

Bezeichnung:
Neuartiges empfindliches und fortschrittliches klinisches Massenspektrometrisches Kit zur Bewertung des Vitamin-D-Mangels

IPC:
G01N 33/82

Inhaber/Inhaberin:
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Tag der Anmeldung:
20.09.2022

Tag der Eintragung:
30.09.2022

Die Präsidentin des Deutschen Patent- und Markenamts

Cornelia Rudloff-Schäffer

München, 30.09.2022

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Design and Development of Knowledge Based Expert System to Assist Farmers for Monitoring of Agricultural Field Using Aerial Data Acquisition

Dr Lam Padma Sree, Dr Narra Dhanalakshmi
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Introduction

It is necessary to assists the farmers as well as Indian citizens towards agriculture through latest technologies. In agriculture, monitoring the crop conditions and taking necessary actions at right time play an important role in improving agriculture production. The field monitoring should be done regularly and could take decisions on various factors such as weed detection, disease detection and classification, crop nutrients and so on. In many situations, the farmers need advice from agricultural specialists and experts to get information for improved decision making. Unfortunately, assistance of the agricultural expert may not be available when the farmer needs it. To alleviate this problem, expert systems were identified as a powerful tool with extensive potential in agriculture. An Expert System (ES) is designed to mimic the problem-solving behavior of an agricultural expert. Hence, the primary objective is to carry the agriculture by allowing the farmer to spend less time in the monitoring of crop field and providing knowledge assistance to the farmer about the requirements of the agricultural field.

Description of Problem

The proposed system uses a drone-based monitoring mechanism as one of the best aerial data acquisition techniques. The drones can cover up to hundreds of hectares or acres in a single flight at a far greater resolution than satellite imagery provides. The image processing is done in the expert system where the field information from the aerial image data is extracted and then analysed to provide the requirements of the crop field. Then, these requirements are sent as message to farmers mobile to perform the necessary actions. This system can equip the farmers with basic knowledge of agriculture in order to create a better knowledge platform at farmer level for taking appropriate farm management decisions and also appropriate agricultural practices.

Objectives

1. To acquire agriculture field images using drones to the expert station.
2. To analyze the agricultural field data by using image processing techniques with blended practical knowledge from interactions of farmers-agriculture experts.
3. To communicate the requirements of the field to help farmers for monitoring the health of their fields directly from their mobile devices.
4. To perform necessary actions by farmer according to field requirements.

Project Description

We developed a complete solution for crop monitoring based on Artificial Intelligence and drone technology as shown in Figure1. In the designed system, crop health is monitored using the content available in aerial images captured by a drone. This enables the farmers to remotely monitor their agriculture field by receiving appropriate suggestions from the knowledge-based expert system. The methodology followed to develop this project is shown in Figure 2.

Figure 1: Framework of Designed System

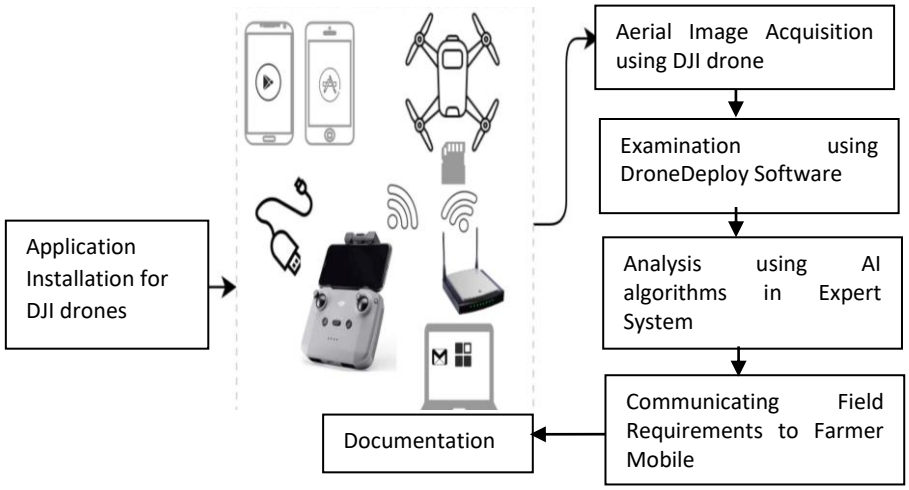


Figure 2: Methodology for the project development

In this work, the drone-based platform is chosen as the most suitable platform in terms spatial resolution, data collection frequency, distance between crop and the camera as compared to satellite-based platform. Few of the results from the aerial data acquisition is shown in Figure3.

		
Deployment of Drone at field	Sample aerial images of Brinjal crop	Mapping path of the drone in Drone Deploy software

Figure 3: Sample images for data acquisition.

The designed expert system brings AI advances in agriculture. Where, the analysis of field data provided in the form of aerial images is carried out using different deep learning techniques for deriving the requirements of crop about disease detection, weed detection and estimating the nutrients. The sample results are shown in Figure 4.

			
Weed detection results	Disease Detection and Classification results		

Figure 4: Brinjal crop results by using the designed expert system.

The farmer interactive system is developed to communicate these requirements to the farmer for appropriate action in the agriculture field. It is possible to focus more on digital agriculture through mobile devices and bring technology innovations to the farmers at their doorsteps. In this work, an interface is developed by making use of mobile to provide the farmers with the requirements of crop. The mobile environment is shown in Figure 5.

Figure 5: Farmers getting the crop requirements of their fields through cell phones

Novelty of the project

- The designed system adopts a visual inspection mechanism to mimic the behavior of a farmer while farming. This method can overcome the difficulty of data collection over tens and hundreds of hectares or acres both manually and using existing sensing technologies.
- The visual inspection mechanism using drones along with the machine learning algorithms also provide the scope of developing a non-invasive and non-destructive monitoring of the agriculture field.
- The problem formulation of a designed system performs recognition as well as localization of the infected area in the acres of agricultural land and carries out necessary actions at an infected area instead of entire field. This leads to the optimal use of pesticides and fertilizers, and improves the quality of crops.

Project Outcomes

- Development of a knowledge based expert system for self-diagnosis of farm problems and also to provide farm specific advisory services in time.
- The designed system enhances agricultural productivity of farmers and encourages agripreneurs by adopting recent technologies with maximum benefit - cost ratio of production.
- On-farm demonstrations have been organized at KVK and Dr D. Rama Naidu Vignana Jyothi Institute of Rural Development centers, to introduce the project innovations. The demo also included how the farmer can benefit from the designed AI based expert system if they use drones in their farms.
- On-field aerial images of a brinjal plant dataset have been created during this work. This is useful to the students, researchers, and technical professionals who want to carry out their research in aerial images.
- Conducted Awareness Programs regarding assembling and the importance of drone technology.
- Organized the awareness programs on **"Application of Drones and Artificial Intelligence Technologies in Agriculture"**. Both the students and the staff gained knowledge from this program.

Acknowledgement

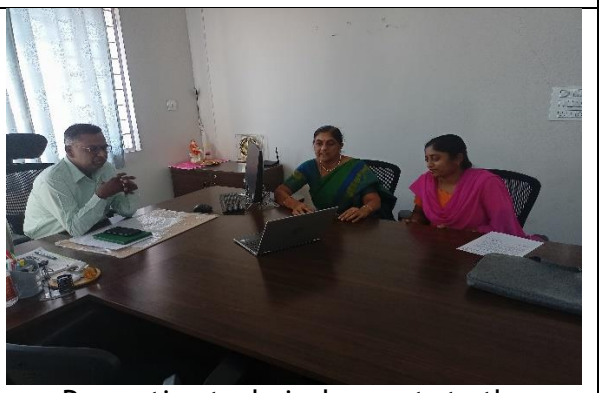
We would like to express our gratitude to Telangana State Council of Science & Technology - Department of Science and Technology (TSCOST-DST) and the Government of Telangana for providing financial support to carry out this project. We are thankful to VNR Vignana Jyothi Institute of Engineering & Technology, Dr D. Rama Naidu Vignana Jyothi Institute of Rural Development, Dr. Ramanaidu Ekalavya Grameena Vikas Foundation Krishi Vigyan Kendra (KVK) and ICRISAT for helping towards capturing the field images and developing an efficient knowledge base with the valuable suggestions from the pool of farmers, scientists, and subject matter experts.

Photographs (Experimental Interactions and Newspaper clips)

Conducted awareness programs on Drones and AI technologies in agriculture

Discussion with subject matter experts at KVK

Demonstrating the project at Dr D. Rama Naidu Vignana Jyothi Institute of Rural Development



Presenting technical aspects to the agricultural scientists at KVK

INDIAN COUNCIL OF AGRICULTURAL RESEARCH
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TO WHOMSOEVER IT MAY CONCERN

This is to appreciate the entire team members **Dr Lam Padma Sree** and **Dr Narra Dhanalakshmi** from the department of Electronics and Communication Engineering, VNR Vignana Jyothi Institute of Engineering and Technology (VNRVJIET), Hyderabad for undertaking the research project titled "Design and Development of Knowledge Based Expert System to Assist Farmers for Maintenance of Agricultural Field using Aerial Data Acquisition".

Further, we are very much glad to know that this project has been funded by Telangana State Council of Science & Technology (TSCOST), Department of Environment, Forests, Science & Technology, Govt. of Telangana under the aegis of Department of Science & Technology (DST), New Delhi.

After thorough discussion with the team members, and observed that the developed system allows the farmer to spend less time in the monitoring of crop field and also providing knowledge assistance to the farmer about the requirements of the agricultural field. We opined that the developed system would be further extended with some more technical features make it more effective for taking appropriate agricultural practices.

We wish all the best in their future endeavors

(Dr. Sambhaji Dattatray Nalkar)
Senior Scientist & Head
Krishi Vigyan Kendra

Place: **Tuniki, Medak Dist.**
Date: **15.02.2023**

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To whom so ever it may concern

This is to appreciate the team members **Dr Lam. Padma sree** and **Dr Narra Dhanalakshmi** from the department of Electronics and Communication Engineering, VNR Vignana Jyothi **Institute of Engineering and Technology**, Hyderabad for undertaking the research project titled "**Design and Development of Knowledge Based Expert System to Assist Farmers for Maintenance of Agricultural Field using Aerial Data Acquisition**".

Further, we are very glad to know that this project has been funded by **Telangana State Council of Science & Technology (TSCOST)**, Department of Environment, Forests, Science & Technology, Govt. of Telangana under the aegis of **Department of Science & Technology** (DST), New Delhi.

This work utilized the latest technology, such as Unmanned Aerial Vehicles (UAVs) like drones equipped with cameras, sensors, and GPS receivers in the agriculture domain. This work can deliver a variety of services related to field monitoring, by capturing images aerially from hundreds of hectares in a single flight without any damage to the crop. The team visited the **Dr. Rama Naidu Vignana Jyothi Institute of Rural Development** and utilized the fields for aerial image acquisition.

We wish all the best in their future endeavors

(Dr. P. Arjun Rao)
Director
Dr. D. RAMA NAIDU VIGNANA JYOTHI INSTITUTE OF RURAL DEVELOPMENT
Tuniki (Village), Kowdipally (Mandal)
Narsapur, Medak (District)

Place: **Tuniki, Medak district**
Date: **03.02.2023**

Appreciation letters

ఆంధ్రప్రభ

వీఎన్ఆర్ వీజేఐఈటీ అధ్యాపకులచే రైతులకు సహకరించే ఆవిష్కరణ

కుత్బుల్లాపూర్, మార్చి 27 (ప్రభన్యూస్) : వీఎన్ఆర్ విజ్ఞానజ్యోతి ఇన్స్టిట్యూట్ ఆఫ్ ఇంజనీరింగ్ అండ్ టెక్నాలజీ (వీఎన్ఆర్ వీజెఐఈటీ) కళాశాలలోని ఎలక్ట్రానిక్స్ అండ్ కమ్యూనికేషన్ ఇంజనీరింగ్ విభాగానికి చెందిన ఆచార్య డాక్టర్. లామ్ పద్మశ్రీ, డాక్టర్. నల్రా ధనలక్ష్మి వ్యవసాయ రంగానికి దోహదం చేసే పరిశోధన పూర్తి చేసినట్లు పేర్కొన్నారు. తమ పరిశోధనలో కృత్రిమ మేధ, వస్తు అంతర్జాలం డ్రోన్లు వంటి ఆధునిక సాంకేతికతలనువాడి పంట పొలాల్లో పంట ఆరోగ్యాన్ని అంచనా వేయవచ్చని తెలిపారు. ఒక డ్రోన్ విహంగ వీక్షణం ద్వారా వందల హెక్టార్ల పంటని ఒకేసారి చిత్రాల్లో బంధించి ఆ పై కృత్రిమ మేధతో ఆ చిత్రాలను విశ్లేషించి తదనుగుణంగా రైతులు తీసుకోవాల్సిన జాగ్రత్తలను నేరుగా వారి చరవాణులకే సందేశాలుగా పంపే విధంగా తమపరిశోధన పని చేస్తుందని ముఖ్యపరిశోధకురాలు ఆచార్య డాక్టర్. పద్మశ్రీ వివరించారు. మొక్కలలో పోషకాలను, చేలో కలుపు మొక్కలని, పంట తెగుళ్లలను గుర్తించే ఈ సాంకేతికత వలన రైతులు తరచుగా తమ పొలానికివెళ్లి చూడవలైన్న అవసరాన్ని తమ ఆవిష్కరణ తగ్గిస్తుందని సహ పరిశోధకురాలయిన సహాయా చార్యులు డాక్టర్ ధనలక్ష్మీ తెలిపారు. జై జవాన్, జై కిసాన్, జై విజ్ఞాన్, జై అనుసందాన్ అన్న ప్రభుత్వ నినాదం స్ఫూర్తితో తాము ఈ పరిశోధనను పూర్తి చేసినట్లు విజ్ఞానజ్యోతి సంస్థలెప్పుడు నేరుగా సమాజానికి ఉపయుక్తమైన పరిశోధనలను ప్రోత్సహిస్తా యని వారు తెలిపారు. తమ పరిశోధనకు ఆర్థిక సహకారాన్ని అందించిన తెలంగాణ రాష్ట్ర శాస్త్ర సాంకేతి సమితికి కృషి విజ్ఞాన కేంద్రంలోనూ, విజ్ఞానజ్యోతి సంస్థ నడిపే డాక్టర్ డి. రామానాయుడు విజ్ఞానజ్యోతి ఇన్స్టిట్యూట్ ఆఫ్ రూరల్ డెవెలప్మెంట్లోనూ తమకు సహాయసహకారాలు అందించిన శాస్త్రవేత్తలు, నిపుణులకు, తమ కళాశాల యాజమాన్యానికి ఆచార్య డాక్టర్. పద్మశ్రీ, డాక్టర్. ధనలక్ష్మీ కృతజ్ఞతలు తెలిపారు.

కృత్రిమ మేధ, వస్తు అంతర్జాలం డ్రోన్లుతో వీఎన్ఆర్ వీజేఐఈటీ అధ్యాపకులు రైతులకు సహకరించే ఆవిష్కరణ

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రైతులకు సహకరించే పరిశోధన ఆవిష్కరణ

విజ్ఞానజ్యోతి ఇన్స్టిట్యూట్ ఆఫ్ ఇంజనీరింగ్ అండ్ టెక్నాలజీ కళాశాలలోనే ఎలక్ట్రానిక్స్ అండ్ కమ్యూనికేషన్ ఇంజనీరింగ్ విభాగానికి చెందిన డాక్టర్ లామ్ పద్మశ్రీ, డాక్టర్ నల్రా ధనలక్ష్మి వ్యవసాయ రంగానికి దోహదం చేసే పరిశోధన పూర్తి చేసినట్లు పేర్కొన్నారు. ఈ సందర్భంగా పద్మశ్రీ ధనలక్ష్మి బి మాట్లాడుతూ తమ పరిశోధనలో కృత్రిమ మేధ, వస్తు అంతర్జాలం (ఇంటర్నెట్ ఆఫ్ థింగ్స్) డ్రోన్లు వంటి ఆధునిక సాంకేతికతలను వాడి పంట పొలాల్లో పంట ఆరోగ్యాన్ని అంచనా వేయవచ్చని తెలిపారు. ఒక డ్రోన్ విహంగ వీక్షణం ద్వారా వందల హెక్టార్ల పంటని ఒకేసారి చిత్రాల్లో బంధించి ఆ పై కృత్రిమ మేధతో ఆ చిత్రాలను విశ్లేషించి తదనుగుణంగా రైతులు తీసుకోవలసిన జాగ్రత్తలను నేరుగా వారి చరవాణులకే సందేశాలుగా పంపే విధంగా తమ పరిశోధన పని చేస్తుందని వివరించారు. మొక్కలలో పోషకాలను, చేలో కలుపు మొక్కలని, పంట తెగుళ్లను గుర్తించే ఈ సాంకేతిక వలన రైతులు తరచుగా తమ పొలానికి వెళ్లి చూడవలసిన అవసరాన్ని తగ్గిస్తుందని తెలిపారు. జై జవాన్, జై కిసాన్, జై విజ్ఞాన్, జై అనుసంధాన్ అన్న ప్రభుత్వ నినాదం స్ఫూర్తితో తాము ఈ పరిశోధనను పూర్తి చేసినట్లు విజ్ఞానజ్యోతి సంస్థలెప్పుడు నేరుగా సమాజానికి ఉపయుక్తమైన పరిశోధనలను ప్రోత్సహిస్తాయని వారు తెలిపారు. తమ పరిశోధనకు ఆర్థిక సహకారాన్ని అందించిన తెలంగాణ రాష్ట్ర సాంకేతిక సమితి (టీసిస్టెఎస్టిసి), కృషి విజ్ఞాన కేంద్రంలోనూ, విజ్ఞాన జ్యోతి సంస్థ డీమ్డ్ డాక్టర్ డి రామానాయుడు విజ్ఞాన జ్యోతి ఇనిస్టిట్యూట్ ఆఫ్ రూరల్ డెవలప్మెంట్ లోను తమకు సహాయ సహకారాలు అందించిన శాస్త్రవేత్తలు, నిపుణులకు తమ కళాశాల యాజమాన్యానికి ఈ సందర్భంగా వారు కృతజ్ఞతలు తెలియజేశారు.

Media coverage of the project development in daily newspapers

Clean Energy Resources from Renewable Biomass via Nanomaterials and Organometallics-based Catalytic Technology

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Introduction:

Lignocellulosic biomass is a renewable carbon source, derived from agricultural waste, capable of replacing fossil fuels. Hence, it is predicted that 20% of transportation fuel and 25% of chemicals can be produced from lignocellulosic biomass by 2030. Each year hundreds of billions of tons Lignocellulosic biomass is produced and out of which only 3% of is used. There are three components present in Lignocellulosic biomass namely cellulose, hemicellulose, and lignin, It is a complex fibrous material that originates in the cell walls of plants. Among the these, cellulose can be hydrolyzed to yield ethanol and platform chemicals such as levulinic acid. It is interesting to note that the Levulinic acid (LA) is one of the top twelve chemicals listed by the US Department of Energy.

Recently, the transformation of biomass derived LA to γ-Valerolactone (GVL) via catalytic hydrogenation and subsequent cyclization has been receiving great importance. GVL is a highly reactive keto-lactone and a promising platform biomolecule useful in alternative fuel industries. The use of GVL as fuel additive can reduce emissions and hence fight against environmental pollution. It has more energy than ethanol and could be used on its own or as an additive to other fuels. Besides, GVL can also be useful as a "green" solvent or a building block for generating renewable polymers from sustainable materials.

Market Scope for γ-Valerolactone (GVL):

GVL is a colourless liquid. It can be used as a fuel additive like ethanol, fuel precursor (e.g., HMF) and food ingredient. It can also be used for the production of other useful fuel additives, fuels, biofuels, and polymers. On the basis of geography, the market of GVL has been spread into South America (Brazil, Argentina, Rest of South America), Asia Pacific (China, Japan, India, South Korea, Taiwan, Australia, Rest of Asia-Pacific), Europe (Germany, France, Italy, United Kingdom, Netherlands, Rest of Europe), MEA (Middle East, Africa), North America (United States, Canada, Mexico). A comparative study of GVL and ethanol as fuel additives with a mixture of 10 v/v% GVL or ethanol and 90 v/v% 95-octane gasoline, has shown very similar fuel properties and it has been suggested as an attractive liquid fuel.

In this investigation, highly dispersed Ni nanoparticles supported on various supports (HZSM-5, SiO2, SBA-15, and COK-12) catalysts were developed for the selective catalytic hydrogenation of LA to γ-Valerolactone (GVL) under vapor-phase conditions. H2-TPR and pulse chemisorption results are evidenced for the highly Ni-dispersed on the support matrix and strong metal-support interaction between the metallic Ni and support matrix. Among all the synthesized catalysts, the Ni-supported COK-12 exhibited superior catalytic performance in the selective hydrogenation of LA to GVL products, which are due

to the greater Ni dispersion, superior AMSA, ample acidic sites, smaller Ni particle size, abundant active metallic sites, and strong metal-support interactions. These obtained results exhibited significantly robust stability for applying earth-abundant and inexpensive catalysts to upgrade biomass-derived platforms into valuable chemicals and biofuels.

According to the recent reports in the literature, the synthesis of GVL from catalytic hydrogenation of LA over a suitable catalyst is the highly efficient, selective, and economical process discussed. Among the reported catalysts, noble and non-noble metal-based catalysts are the most frequently used catalysts. But, the noble metal-based catalysts are having several limitations due to their being more expensive, lower thermal stability, and less abundance. Therefore, the researchers have undertaken the catalytic transformation of various earth-abundant transition metals dispersed on the high specific surface area of supporting materials for the selective hydrogenation of LA to GVL reaction under liquid phase conditions. However, at high pressure and temperature conditions, the leaching of active metal species is an important factor in the batch reactors, resulting in poor stability of the catalyst and futile recyclability. The catalytic reactions were carried out under the flow reactor process providing a significant solution to get a better of the drawbacks associated with the batch reactors (liquid phase reactions). Owing to these reasons, several research efforts have been employed to develop the metallic Ni nanoparticles supported catalysts for continuous LA hydrogenation reaction. The reports suggest that the Ni-based catalysts were more attractive structural, textural, and redox properties as well as significant economic and stability precedence for this reaction under a continuous flow reactor.

To date, very few reports have been focused on the continuous flow hydrogenation of LA to GVL. The researcher's attempt to optimize the selective hydrogenation of LA primarily focusing on the design and building of various metal oxide supports that have redox properties and electronic metal-support interactions, while the beneficial role of the inert supports (i.e., silica and mesoporous silica) have been studied individually. However, there is still unclear evidence to choose the best performed SiO_2-based supports for the more stable and high dispersion of Ni nanoparticle catalysts. Owing to the remarkable properties of SiO_2 supports are played an important role due to their high surface area, more thermal stability, and uniform pore size distribution. In this work, efforts were made to prepare Ni catalysts supported on the SiO_2, zeolites (ZSM-5), and ordered mesoporous silica materials (i.e., SBA-15 and COK-12) for the selective hydrogenation of LA to GVL reaction under the continuous flow reactor.

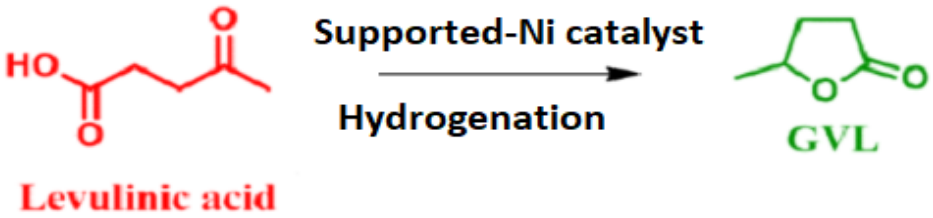
The high dispersion of Ni metal nanoparticles on silica-based supports can lead to nanomaterials that may lead to favorable synergistic catalysts with improved catalytic hydrogenation performance corresponding to the attractive physicochemical properties of the pure species. It is also interesting to understand how the metallic Ni nanoparticles interact with different silica (SiO_2, SBA-15, and COK-12) and zeolite (ZSM-5) supports, and the role of the resulting catalysts in optimizing the structure-activity relationship. The deep insight can produce significant information for the design and building of the advanced Ni nanoparticle-supported catalysts for various selective transformations. Based on this motivation, we have designed Ni supported on the SiO_2, ZSM-5, SBA-15, and COK-12

catalysts by impregnation procedure. The catalytic performance of these supported catalysts for the selective hydrogenation of LA in the continuous flow reactor was studied.

We focused on various catalyst supports (HZSM-5, SiO2, SBA-15, and COK-12) to develop highly dispersed Ni nanoparticulate catalysts for the selective hydrogenation of LA to γ-valerolactone (GVL) products under vapor-phase conditions. Ni supported on the SiO2, ZSM-5, SBA-15, and COK-12 catalysts have been prepared by impregnation procedure as shown below:

Ni/SiO2
Ni/ZSM-5 (Zeolite Socony Mobil–5 is an aluminosilicate zeolite)
Ni/SBA-15 (Santa Barbara Amorphous-15 mesoporous silica sieve)
Ni/COK-12 (Centrum voor Oppervlaktechemie en Katalyse no. 12)

The catalytic hydrogenation of levulinic acid to GVL was investigated over the Ni-supported catalysts under a flow reactor at 523 K for 5 h.



- Among all silica supports, the Ni-supported COK-12 catalyst showed higher LA conversion (~99%) with superior GVL selectivity (~98%) with minor selectivity towards the side products.
- The best performance of the Ni/COK-12 catalyst system was attributed to greater Ni dispersion, ample acidic sites, smaller Ni particle size, abundant active metallic sites, and strong metal-support interactions.
- One of the most important characteristic properties of the supported metal catalysts is metal-support interactions to exhibit cooperative catalysis.
- The results of H_2-TPR and TEM images of Ni/COK-12 catalyst indicated the stronger metal-support interaction than Ni/ZSM-5, $NiSiO_2$, and Ni/SBA-15 catalysts.
- These properties can be significantly played a key role in the selective formation of GVL from the LA over the NiCOK-12 catalyst.
- We monitored the reaction by GC-MS technique to evidence the presence of reaction intermediates by performing the reaction over the pure supports and supported Ni catalysts. These results indicated that the formation of angelic lactones in high selectivity is due to more acidic sites present in the supported catalysts.
- The supported Ni catalysts have both types of active sites (i.e., metallic and acidic sites). Therefore, it can be concluded that the reaction proceeds through both reaction pathways simultaneously.

Conclusions:

The bifunctional supported Ni nanoparticles-based catalysts, using different supports of ZSM-5, SiO_2, SBA-15, and COK-12 were performed for the selective hydrogenation of LA to GVL under vapor-phase conditions. The results of catalytic performance in a flow reactor under H_2 were combined with a wide-ranging characterization output to establish a structure-activity relationship. Especially, the Ni-supported ZSM-5 catalyst was found to be ~90% of LA conversion and lower selectivity toward the GVL (~75%). It could be explained by the ZSM-5 support as the greater number of acidic sites with the strength (i.e., Lewis and Bronsted acidic sites) play a major role in the production of side products such as α-, and ß-angelica lactones, MTHF, and valeric acid. Among all the catalysts, the Ni-supported COK-12 catalyst showed higher LA conversion (~99%) with superior GVL selectivity (~98%) with minor selectivity towards the side products. This could be explained by the NiCOK-12 catalyst exhibiting higher Ni dispersion, stronger metal-support interaction, smaller particle size, and greater active metal surface area. These properties can be significantly played a key role in the selective formation of GVL from the LA over the NiCOK-12 catalyst. The NiCOK-12 catalyst showed more stability in the constant conversion of LA and GVL formation until 30 h of reaction time. This research work is communicated to Journal 'Molecular Catalysis' (Elsevier Publishers).

Treatment of Leachate from Municipal Solid Waste Landfill by Chemical Technology

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Objectives: To treat municipal leachate by Chemical Technology (A & B) along with filtration.

Broad Area: Location Specific Research & Technology Development (LSR): **(√)**

Treatment Procedure:

Treatment A – Chemical Precipitation Technology:

The liquid chemical (A) was added in required quantity per litre to the polluted leachate water. Simultaneously stirring facility is arranged for proper mixing of the chemical in the leachate water. The chemical got mixed with the leachate water, when the chemical was uniformly distributed into the leachate water, immediately the chemical reacted with suspended solids, organic matter, algal matter, suspended and dissolved matter which get precipitated, and the oxidized precipitate matter will shrink into the water simultaneously. The total nitrates, sulphates and phosphates get removed and additionally, the biochemical oxygen demand (BOD) and chemical oxygen demand (COD) are reduced to pollution control norms and the sludge was settled down at the bottom of the vessel. After separation of sludge from semi treated leachate through filtration the treated water was further neutralize with chemical treatment (B) to remove remaining impurities along with neutralization in treatment (B). Experiments were repeated for the standardization of optimum dose, time and removal efficiency. The physio-chemical analysis was performed before and after treatment to know the efficiency of impurities removed.

Treatment B-Neutralization:

The second step of treatment involves dosing of liquid chemical (B) to the treated leachate water from chemical (A) by which removal of the remaining TSS, BOD, COD, nitrates, phosphates, sulphates were achieved where a clear water is remained. These precipitates (sludge) remaining matter and the precipitate formed was not re-dissolved in the treated water. The sludge formed by the treatment (B) was settled at the bottom of the vessel. Experiments were repeated for the standardization of optimum dose, time and removal efficiency. The physio-chemical analysis was performed before and after treatment to know the efficiency removal of impurities. The dosing procedure treatment (B) is same it is described in the case of treatment (A). The chemical used in this treatment (A and B) are non-toxic, non-pollutant and EDIBLE.

S&T Component involved:

Coagulation and flocculation processes are widely used in potable water treatment due to its high efficiency in turbidity removal. Today, the coagulation and flocculation processes are implemented with the purpose of agglomerate colloids and fine particles in water into larger particles, which is also known as floc. Therefore, reduction of turbidity and pollutants e.g. organic matter, inorganic matter, suspended solid, etc. can be achieved. This research covers the principle of coagulation and flocculation process which includes the charge neutralization and various binding mechanisms e.g. inter-particle bridging, sweeping coagulation, and absorption.

Likely Outcome of the project:

Chemical technology for treating municipal leachate is viable, sustainable and eco-friendly which can be replicated in municipal corporations and municipalities at low - cost. There will be no pollution of leachate either contaminating the ground water or at source.

The present study proved that the calcium hydroxide and Alum remove upto 69% and 54% of COD from the landfill leachate by coagulation. The calcium hydroxide and alum remove up to 99.9% and 94% turbidity from the leachate. Calcium hydroxide gave more removal of COD and turbidly. The optimum process variables of the coagulation of landfill leachate using calcium hydroxide were found as pH 8 at coagulant dosage of 25 g/L.

The risks of leachate generation can be mitigated by properly designed and engineered landfill sites, such as sites that are constructed on geologically impermeable materials or sites that use impermeable liners made of geo-membranes or engineered clay. The use of linings is now mandatory in US and European countries. However, despite much stricter statutory controls leachate from modern sites are found to contain a range of contaminants that may either be associated with some level of illegal activity or may reflect the ubiquitous use of a range of difficult materials in household and domestic products which enter the waste stream legally. We had emphasized on the treatment technologies that are suitable under Indian Criterion. And have finally come to a result that India being a developing country those technologies which are cheaper and capable of treating the highly toxic waste. So, from our study the worthiest technologies according to Indian standards are Coagulation and Flocculation, Biological treatment, Rotating Biological Contactor (RBC).

Relevance of the present project proposal to the state's specific local problems:

- The Greater Hyderabad Municipal Corporation (GHMC) has been dumping about 7500 metric tonnes (MTs) of garbage daily in Jawahar Nagar dumpsite which generates 1,20,000 litres of leachate per day.
- While ground water is getting polluted due to this garbage dump, by leachate percolation.
- The Greater Hyderabad Municipal Corporation (GHMC) is facing trouble over pollution of ground water and lakes in the surrounding areas due to leachate (a solution resulting from leaching, as of soluble constituents from garbage).

- Improper and inefficient management of MSW is greatly affecting the public health and degrading the environment in the vicinity of dumpsite.
- The situation reached such a level where the Supreme Court of India has to intervene and give directions for the government to solve the municipal solid waste (MSW) problem in India.
- Municipal Solid Waste (Management and Handling) Rules 2000 is the result of such intervention.
- This apart, the Government of India and the State government are according top priority to the solving of MSW problems by way of allocating funds, human resources and reforms.
- This treatment can be used in any municipality of Telangana where the leachate problem is persisting due to unscientific way of municipal solid waste dumping.

Development and Standardization of Immunity Boosting Polyherbal Infusion Bags

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Introduction:

This proposal outlines the process of preparing an herbal infusion bag containing various lyophilized aqueous extracts of medicinal herbs such as Liquorice, Moringa, Brahmi, Ashwagandha, and Amritha/Guduchi. This report provides a brief overview of the extraction and purification process, estimation of biomarkers, and formulation of infusion bags. Additionally, it includes a review of the safety and toxicity of the extracts and their dosage guidelines for adults.

Extraction and Purification Process:

The Soxhlet extraction method was used to extract the medicinal compounds from the herbs. The crude extract was obtained by using ethanol and water as a solvent. The solvent was removed from the crude extract through distillation and vacuum-assisted rotary evaporator. Lyophilisation technology was used to prepare powdered extracts. The technology works on the principle of freeze-drying, where moisture is removed through sublimation. The resultant lyophilized extracts were standardized to obtain consistent product quality.

Estimation of Biomarkers:

High-performance Thin-Layer Chromatography (HPTLC) was used to estimate the biomarkers and identify the medicinal compounds in the extracts.

Safety and Toxicity Review:

The safety and toxicity of the extracts were reviewed based on available literature from the WHO monographs and Ayurvedic Pharmacopoeia of India. The extracts had a broad therapeutic window, meaning they are safe to use at therapeutic doses without causing any significant adverse effects. Toxicity study reports have shown that the extracts are safe even at doses higher than the recommended therapeutic doses.

Dosage Guidelines:

The following dosage guidelines were established based on the percentage yield, daily intake for getting therapeutic benefits, and toxic dose:

Liquorice: Root powder daily dose = 760mg to 1500mg per day per adult. Root contains 5-9% of Glycyrrhizin. Acceptable daily intake of Glycyrrhizin = 0.2-08mg/kg/ day

Brahmi: Leaf powder daily dose = 750-1500 mg per day per adult. Extract daily dose = 100mg/day. Standard dose for the therapeutic activity= 300mg/day. Leaf powder contains 5% of Bacosides some varieties are having 18mg.gm dry powder

Moringa: Leaf powder daily dose = 6-10gms per day per adult. Leaf powder contains Proteins = 22%, Kaempferol = 7mg/gm dry weight, Quercetin = 1mg/gm dry weight, and 46 other antioxidants.

Ashwagandha: Root powder daily dose= 250-300 mg twice per day per adult. Root powder contains 0.2-0.6% of with anolides along with 12 alkaloids.

Amritha/Guduchi: Stem powder daily dose= 3-6 g per day per adult. Extract daily dose = 300mg/day. Stem powder contains Terpenoids such as Cordifolioside A.

Herbal Infusion Bags:

The standardized extracts were then packed in infusion bags for easy and instant usage. This technique is highly marketable and quickly penetrates the market due to its instant usage.

Conclusion:

In conclusion, the proposed herbal infusion bags containing the standardized extracts of Liquorice, Brahmi, Moringa, Ashwagandha, and Amritha have been developed using Soxhlet extraction and lyophilisation technologies. The safety and toxicity profiles of the herbs were reviewed, and the therapeutic benefits were analysed based on the available literature. The daily doses were calculated for each herb, and the extracts were packed into infusion bags for easy consumption. The product is expected to provide significant health benefits to consumers.

Societal Applications

- The proposed polyherbal infusion bags contain standardized medicinal principles with mainly immune-boosting effects, which can have a direct positive impact on the health of consumers.
- The simple manufacturing process of the infusion bags presents an opportunity to train and empower individuals, particularly women and unemployed youth, to create a new source of income and improve their economic livelihood.
- By promoting the use of natural and traditional medicines, the proposed herbal infusion bags can contribute to preserving and propagating cultural and traditional knowledge related to medicinal plants.

Innovativeness

The proposed herbal infusion bags containing standardized extracts of Liquorice, Brahmi, Moringa, Ashwagandha, and Amritha have been developed using innovative Soxhlet extraction and lyophilisation technologies. The safety and toxicity profiles of the herbs were reviewed, and the therapeutic benefits were analysed based on the available literature. Daily doses were calculated for each herb, and the extracts were packed into infusion bags for easy consumption. The product is expected to provide significant health benefits to consumers and create new economic opportunities for women and unemployed youth. The innovative manufacturing process and standardization techniques ensure consistent product quality, and the in vitro immunostimulant property evaluation

demonstrates the efficacy of the extracts in stimulating the immune system. The proposed herbal infusion bags represent a novel and promising product in the growing market for natural health supplements.

Advantages over existing methods

Compared to existing methods, the proposed herbal infusion bags offer several advantages. Traditional methods of preparing herbal decoctions can be time-consuming, require specialized equipment, and may not provide consistent product quality. In contrast, the proposed infusion bags contain standardized extracts of medicinal herbs that have been extracted, purified, and packed into convenient bags for easy consumption. The dosage guidelines have been established, and the safety and toxicity profiles have been reviewed. Additionally, training people to manufacture and trade these infusion bags can create new opportunities for income generation and improve their livelihoods. Overall, the proposed herbal infusion bags offer a safe, convenient and effective way to support immune health and can provide significant benefits to consumers.

Study of factors influencing the progression of neuropathy in type II diabetic patients using cutaneous nerve biopsy

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Introduction:

Diabetic neuropathy (DN) is one of the most common complications of diabetes. The frequency of clinically evident neuropathy at the initial diagnosis of diabetes is around 7.5%, whereas, with increasing disease duration, the prevalence is approximately 50%.

DN is not a single nerve disease but a complex spectrum of neuropathies, including symmetrical or asymmetrical sensory or sensory-motor or cranial and autonomic neuropathies. Distal sensory predominant symmetrical polyneuropathy is the most common clinical presentation, followed by autonomic neuropathy, symmetrical proximal motor neuropathy, asymmetrical neuropathies, mononeuritis neuropathies and cranial neuropathies. Different pathological variants might have different path mechanisms. Degeneration of distal parts of the axon with progression towards the cell body, i.e., dying-back neuropathy, is a common pattern of neuropathy seen in diabetes.[5] Nerve biopsy is not a diagnostic test as it doesn't reveal specific histological findings in some patients with clear neuropathic symptoms.

Type I and II diabetes can develop neuropathy and is associated with retinopathy and nephropathy. DN was significantly associated with the duration of diabetes, diabetic retinopathy, cardiovascular diseases and unemployment.[6] The prevalence and severity may vary with the duration of the disease, degree of glycaemic control, and lifestyle modification. Though several factors have been identified in the development of DN, factors aggravating the conditions are unknown. Many past neuropathy diagnostic tools have been used, like physical examination, vibration perception score, neuropathy disability score Michigan Neuropathy Screening (MNSI) etc. Among all, MNSI has a sensitivity of 80% and a specificity of 95%.

Recent studies have begun evaluating cutaneous punched skin biopsy immunostained with pan axonal Immuno marker, protein gene product 9.5 for evaluating peripheral neuropathy. It is a minimally invasive and relatively simple way to visualise small unmyelinated fibres. In the intraepidermal nerve, fibres are markedly affected in clinically evident neuropathy and correspond to fibre loss in the nerve truck of the sural nerve. Though the whole peripheral nervous system is affected in DN, the peripheral nerves supplying the distal portion of the leg are more vulnerable because these are the longest cells in the body that require an adequate and continuous supply of nutrients through vascular channels for metabolism.[7] We can identify subclinical cases of DN with this technique.

Material and methods:

A biopsy is most commonly performed using a 3 mm disposable circular punch under a sterile technique and after local anaesthesia with lidocaine. No suture is usually required, and minor complications (excessive bleeding, infection, etc.) are rare. In most instances, healing occurs within 7–10 days. The biopsy contains the epidermis and dermis, including sweat glands. The technique was first described by researchers at the Karolinska Institute in Sweden (Wang et al., 1990) and further developed and standardised at the University of Minnesota (Kennedy and Wendelschafer-Crabb, 1993) and the Johns Hopkins University (McCarthy et al., 1995). In most studies of peripheral neuropathies, skin biopsies are obtained from the distal part of the leg (10 cm above the external malleolus) and in some cases also from the upper lateral aspect of the thigh (20 cm below the anterior iliac spine). The second sample from a proximal site is chosen to detect the length-dependent loss of cutaneous nerve fibres, a typical feature of axonal polyneuropathy.

Preparation of Biopsy & Fixation

After the biopsy has been obtained, the specimen is fixed in a cold fixative for up to 24 hours at 4 C. For bright-field microscopy, 2% paraformaldehyde-lysine periodate (2% PLP) is commonly used. After fixation, the specimen is kept in a cryoprotective solution for 1 night and thereafter serially cut using a cryostat. Each 3 mm biopsy yields about 50 vertical 50 mm thick sections. It is recommended not to use the first and the last few sections, as artefacts may occur there.

Quantification of Intraepidermal Nerve Fibre Density

Individual PGP 9.5 positive intraepidermal nerve fibres crossing the dermal–epidermal junction is counted at high magnification (i.e., 40) in at least three non-consecutive sections, whereas secondary branching is excluded from quantification. After measuring the length of the section using computer software, the density of intraepidermal nerve fibres is calculated and expressed as fibers per millimetre. Most commonly, only the nerve fibers crossing the epidermal basement membrane are counted. Counting of isolated nerve fragments in the epidermis that do not cross the basement membrane is preferred by Ebenezer et al. (2007) as it provides the advantage of including the isolated fragments in the count and a higher number of intra-epidermal nerve fibres with less error is likely to be obtained. They stress that this lower error becomes critically important in evaluating neuropathic sites where only a few fibres are present. Most groups, however, apply the rule that the intra-epidermal nerve fibres have to cross or originate at the dermal–epidermal junction and secondary branches and fragments are not to be counted (Kennedy et al., 2005). Principles of these most commonly used counting rules are followed. Calculation of intra-epidermal nerve fibre density is based upon measuring the length of the epidermis by both computerized image software and a microscope intraocular lens ruler. Both approaches have produced similar results (Wilder-Smith and Chow, 2006). By applying strict counting rules and proper training, a high

degree of inter- and intra-rater reliability may be achieved. Intra- and inter-observer variability on intra-epidermal nerve fiber density has been evaluated in several studies. G ransson et al. (2004) blindly assessed the intra-observer and inter-observer reliability. The mean difference in fibre density by intra-observer analysis was 0.2- 1.2 fibres/mm; 95% of the differences between paired counts were expected to lie within 2 standard deviations of the mean, defined as the limit of agreement. For intraobserver variability, this limit of agreement was 2.2 to 2.6 fibres/mm. The interobserver variability was higher than the intraobserver variability, with a mean difference of 0.4 1.5 and limit of agreement from 3.4 to 2.6 nerve fibres/mm. The results of blood sugar checks, foot checks, Any other health issues? New symptoms or health problems, enquiry about physical activity, details about Diabetic medicines, and vital sign monitoring were noted. The patient was considered to have regular, not regular and no physical activity if the patient walked 30 min for 4–7 days, 1–3 days/week, and less than once weekly, respectively. Clinical data related to the duration of diabetes, medications, the presence of nephropathy, diabetic retinopathy, hypertension, dyslipidaemia, cardiovascular disease, body mass index (BMI), and HbA1c were collected during follow-up.

Statistical analyses were made using suitable statistical tools of SPSS software (version 17). Descriptive statistics of parametric variables were represented by Mean ± SD and non-parametric variables by Median and IQR. Tests of significance for variables with nonparametric distribution by Mann–Whitney U test and Wilcoxon rank test.

Results:

DATA DESCRIPTION: The demographic characteristics of the study population are summarised in Table 1. The first row indicates the observed prevalence of neuropathies. 50.7% of the population had hypertension, and 30.1% of the population had dyslipidaemia as co-morbidities. The prevalence is slightly less than that found in the diabetic population in India but at par with the diabetic population seen in larger international trials. The average HbA1c of the study population was 8.3 % which is higher than the usual target level of 7% (ADA 2016 guidelines), probably due to poor compliance. The mean fasting blood glucose was 168.19 mg/dl, and the mean post-prandial blood glucose was 239.50 mg/dl, which shows that the mean values were considerably above target as per 2019 ADA guidelines.

Description of the study population

VARIABLE	CATEGORY	NO	MEAN	RANGE	STANDARD DEVIATION
Neuropathy	Present Absent	34.5% 65.5%			
Sex	Male Female	33.3% 66.6%			

Age			50.7	(30-64)	16.53
Duration of diabetes			9.02	(1,30)	6.34
Hypertension	With without	50.7% 49.3%			
Dyslipidemia	With without	31.0% 69.0%			
HbA1C			8.3	(5.0 11.8)	1.43
FBS (mg/dl)			239.51	(105, 460)	73.89
Glycaemic Exposure Index			3.66	(2.43, 5.02)	0.45

Hypertension and dyslipidaemia were evaluated as ordinal variables as only their presence or absence was documented, not the severity. These variables did not show any statistically significant association with neuropathy incidence. Still, inference cannot be drawn as absolute values of lipid levels and blood pressure would have been better metabolic parameters.

A group of 20 patients with sensory or sensorimotor neuropathy was included out of 50 cases to assess the diagnostic utility of the quantitation technique. The epidermal roof of the suction skin blister permitted detailed analyses of ENF density, morphology, and distribution across the epidermis and observation of ENF branching pattern. Morphological changes have been observed in epidermal and dermal nerves in peripheral neuropathy. The presence of diffuse morphological changes in intraepidermal nerve fibres with larger axonal swellings is considered as evidence of a pathological process affecting the normal structure of nerves. Axonal swellings have been described quantitatively as enlargement above 1.5 mm or semi-quantitatively as enlargements above twice the diameter of the fibre containing the swelling.

In the individuals with symptomatic sensory neuropathies, we noted an obvious reduction in intraepidermal fibres, as Holland et al. and McCarthy et al. previously reported. There was a greater reduction at the distal part of the leg site than in the thigh. In several cases with severe neuropathies, the dermis contained fibres with increased varicosities and segmentation, presumably representing degenerating fibres; the epidermis was devoid of PGP9.5-stained fibres. In general, this loss of intraepidermal fibres appeared to parallel the decrement in the number of fibres in the papillary dermal plexus. Still, in some cases, it was more dramatic and out of proportion to the loss of dermal fibres. Significant reductions (P=.001) in the density of intraepidermal fibres were found when controls were compared with patients with sensory neuropathy at both the thigh and the distal part of the leg. This difference was most marked at the distal part of the leg, reinforcing the concept that the patients with sensory neuropathy had length-dependent neuropathies.

Using the cut-off values for the 10th or fifth percentile for intraepidermal nerve fibre density, we calculated the performance characteristics using the normal controls and the cases of sensory neuropathy. The efficiency (percentage correctly classified) ranged from 82% to 88%, depending on the anatomical site and cut-off. Overall, the highest specificity, efficiency, and positive and negative predictive values were obtained with the use of the fifth percentile cut-off at the distal part of the leg.

Conclusions:

We have established a reference range for intraepidermal nerve fibre density in normal humans using a simple quantitation method based on the enumeration of individual intraepidermal nerve fibres on vertical sections of punch skin biopsy specimens stained with the sensitive panaxonal marker anti-protein gene product 9.5. The utility of the density measurement was confirmed for sensory neuropathy with a diagnostic efficiency of 88%. Skin biopsies may be useful to assess the spatial distribution of involvement in peripheral nerve disease and the response to neurotrophic and other restorative therapies. Our study suggests that it is often subclinical, and frank symptoms are less common. The frequency might double, considering the subclinical cases.

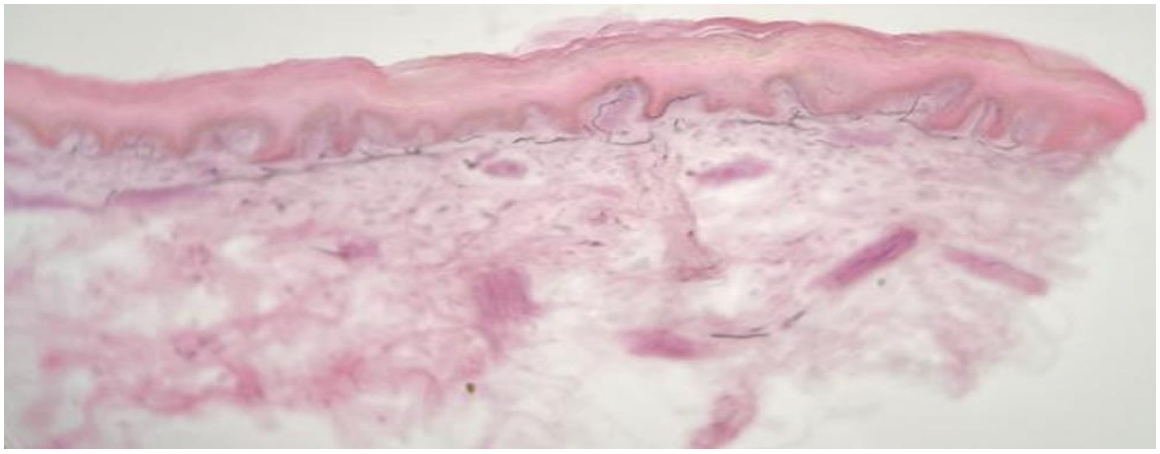


Figure 1: PGP 9.5 IHC stain

Development of Novel Technology Enabled Low Cost Secured Irrigation Water Management System (TE-IWMS)

Prof. Thatikonda Ramesh
Kakatiya University, Warangal

Objectives:

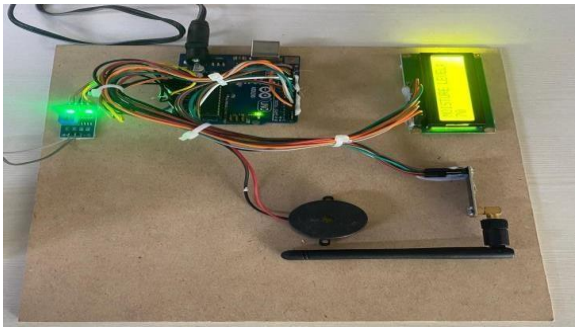
Development of novel technology enabled low cost secured irrigation water management system (TE-IWMS) to optimize the water utilization for avoiding wastage

- Optimization of water usage
- Security features included to avoid unauthorized operations
- Laboratory investigations successfully conducted

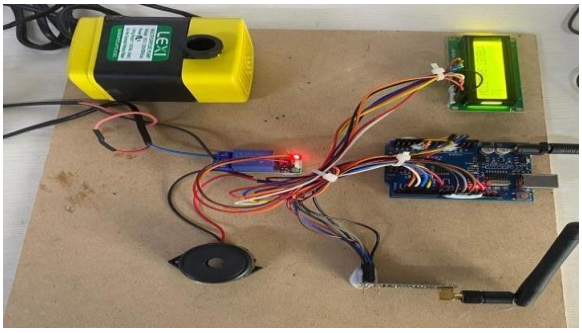
Summary of the performed research work

Agriculture conventional operations are requiring more than 80% of available water resources and around 30% of water wasted as per literature review. Therefore, the agriculture operations are required an innovative water management system to avoid wastage. Moreover, farmers are looking for an affordable low-cost secured system for efficient watering to avoid excess. Hence, the objective of project is to develop a novel low-cost secured technology enabled water management system.

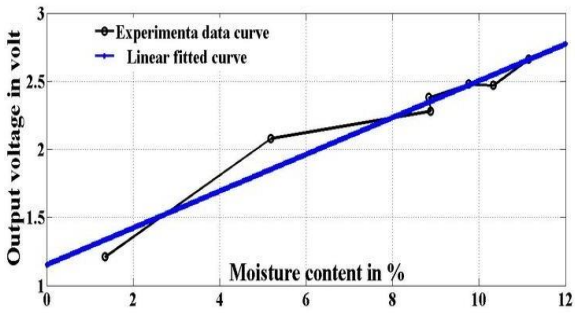
The innovative laboratory model of low cost Zigbee technology-based water management system successfully developed and tested. The system comprises of field monitoring and base station. The system has acquired the data from various sensors of soil moisture, temperature and humidity. The data was sent base station for meticulous processing and checking with inbuilt soil moisture thresholds. The base station was transmitted the instructions to field system to switch off or on the water motor. Therefore, the system will provide water as per the soil moisture conditions to avoid excess water. It is a secure system to avoid unauthorized operations. It avoids excess watering and wastage. Hence, the water utilization has optimized. The system operations are user-farmer- friendly. As a result, the efficient water management has been provided to community development.



(a) Field Station



(b) Base Station



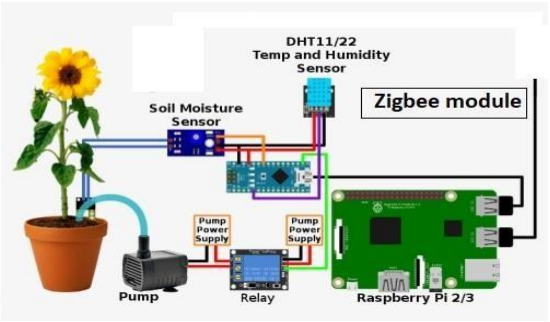


Figure (c) Lab Setup Figure (d) Moisture Vs Voltage

Figure I: System Modules

The prototype modules of TE-WMS shown in Figure (a) and (b). The Figure (c) shows the laboratory setup. Figure (d) shows the output voltage is linear proportional to soil moisture. Therefore, the farmers can decide the threshold to moisture with the data examination or with the experience. The threshold will be automatically encrypted to avoid unauthorized operations.

Innovations:

- The security features are incorporated in the system to avoid unauthorized operations
- Low power protocols interfaced to improve the battery life.

Intellectual Output:

- Low-cost prototype developed
- Security algorithms included
- UG and PG students were involved

Future Work:

- The system can be interfaced with IOT cloud computing for developing global standards with virtual farming.
- The system can be interfaced to drones (flying vehicles) for various diversified applications.

IOT Based Forest Management System for Illegal Deforestation, Fire Detection and Livestock Management

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Introduction

Forests - one of richest resources of the earth - provide shelter to thousands to even millions of species of flora and fauna thereby maintaining an ecological balance of the system. However, preserving the forest resources including wildlife for the forthcoming generations has become very much essential and the most challenging task due to illicit felling, encroachment etc. Despite of various Laws and Acts being forced by the concerned Government and Authority; forests are still vulnerable to illegal activities that demanding for a kind of automation in monitoring the periphery of the forests.

Project Proposal

To design an IoT based electronic system to alarm the intrusion of people for illegal cutting down of trees and poaching of wild-life animals. The GSM/LORA system incorporated in the system will automatically send the notification (with the location where the illegal activity is taking place) about the illegal entry from the periphery of the forest. This information will be sent from the spot to the central server system as well as the nearest forest officials through SMS so that an immediate action can be taken from the competent authorities. The system considered to be minimum three posts as deliverable will perform the following:

- Monitor and prevent the entry of unauthorized persons in the forest areas.
- Post to post message transfer and co-ordination through sensor network.
- Detection of fire and incident reporting with position information.
- App development and cloud service.
- Provision of power through non-conventional source like solar energy.
- Demonstration of the developed prototype which safe guards the forest resources.

As part of this program we aimed to develop a prototype having three posts fitted with the following sensors to accomplish the tasks:

- LASER sensors to detect the entry and exit of humans as well as animals into the forest through the periphery.
- PIR sensors to detect any sort of sabotage in order to protect the equipment.
- DHT and Flame sensors to detect the fire.

Through the identified entry points, the legal entrants (forest officials and licensed people) will be provided with RFID cards for authorized entry into the forest and all others may be identified as illegal entrants/intruders. The system can also be utilized to have the track of livestock.

Objectives

1. Design an electronic system to identify the unauthorized entry into the prohibited zone of the forest.
2. Design an alarming system so that the intruder leaves the place with a fear of getting caught as well as a notification system to inform the same to the control station, if any intrusion happens.
3. Integrate the system with DHT and flame sensors to detect the fire and inform the concerned personnel about it.
4. Make use of LoRa and cloud computing technologies to notify the competent authority about the type of incident and the location automatically.
5. Utilize renewable energy source (solar energy) for power requirement.
6. Design a prototype for real-time demonstration.

Deliverables as per the Proposal

The deliverables of the project will be the design of a prototype consisting of 3 posts which is capable of doing the following:

- Monitor the entry and exit of different species.
- Identification of human or animal.
- Post to post message transfer and co-ordination through sensor network.
- Detection of fire.
- Incident reporting with position information.
- User-friendly App development.
- Cloud service.
- Utilization of renewable solar energy for power requirements.
- Demonstration of technology integration to safe guard forest resources.

Proposed Design

The proposed work presents an IoT framework that detects the unauthorized entry into the forest through the periphery, at an early stage. Figure 1 shows the conceptual scenario of the proposed system, wherein two pairs of LASER beam sensors are mounted on the posts, one at a height of 4 feet and the other one at a height of 1 foot, to ensure the detection of intrusion even if it is just above the ground level.

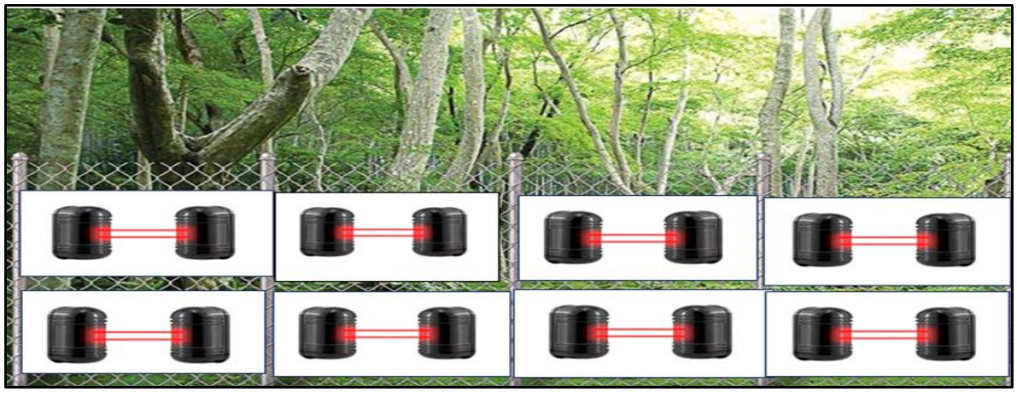


Figure 1: A scenario showing the proposed system

Each post is placed 100 meter apart. This distance is identified as per the considered LASER beam sensors, however, this can further be increased by choosing a different LASER beam sensors. When an unauthorized object tries to enter, it breaks the LASER system which generates a notification with the help of designed electronics. In addition, the posts have necessary sensors to detect fire as well as to protect the equipment. Figure 2 provides the Framework of the proposed system. The communication between the IoT node and the LoRaWAN Gateway (Pygate) is accomplished utilizing LoRa technology. The Gateway and the TTN server (The Things Network server – LoRaWAN network server) are connected through the Internet. The sensors data from the TTN server is pushed into the Thing Speak cloud (IoT cloud) which can be accessed at the application dashboard (control station) to monitor the periphery of the forest for unauthorized entries or to detect any fire in the vicinity or to detect any illegal activity, and thereby taking the necessary actions. Figure 3 depicts an IoT node defined for the proposed work.

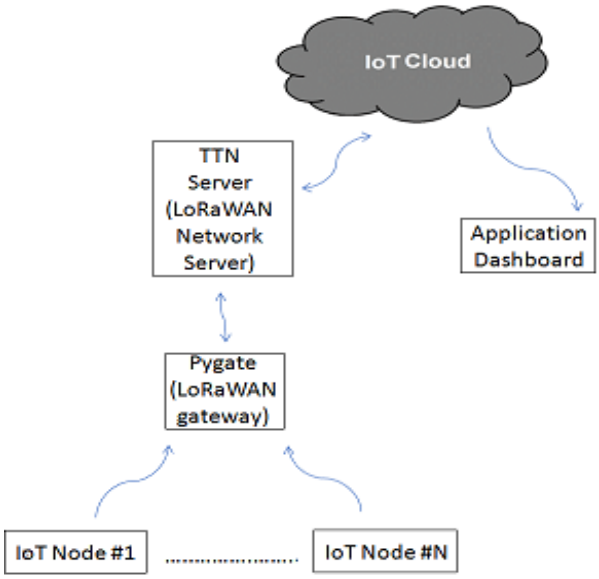


Figure 2: Framework of the proposed System

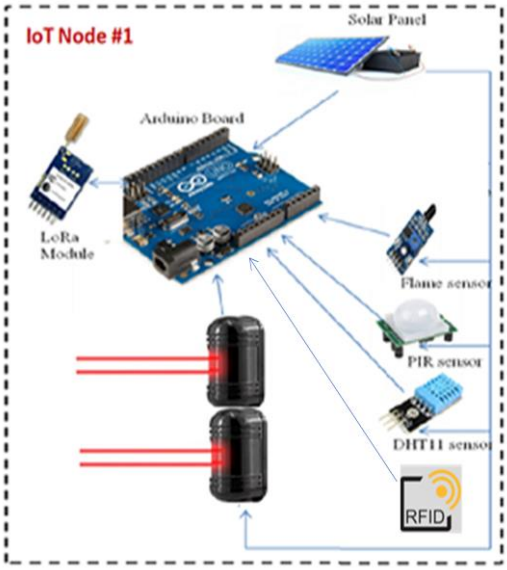
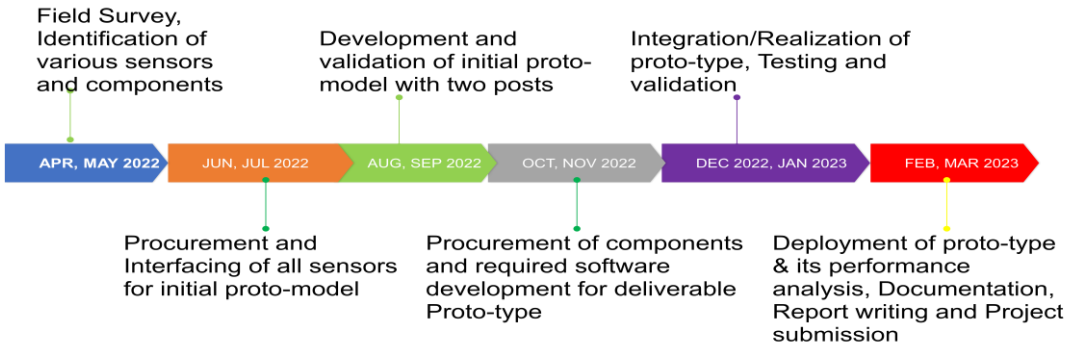


Figure 3: An IoT node defined for the proposed work

Timelines for the project



Accomplishment of the Project Objectives

Sr. No.	Objectives as per the approved project	Current status
1	Design an electronic system to identify the unauthorized entry into the prohibited zone of the forest.	Accomplished
2	Design an alarming system so that the intruder leaves the place with a fear of getting caught as well as a notification system to inform the same to the control station, if any intrusion happens.	Accomplished
3	Integrate the system with DHT and flame sensors to detect the fire and inform the concerned personnel about it.	Accomplished
4	Make use of LoRa and cloud computing technologies to notify the competent authority about the type of incident and the location automatically.	Accomplished
5	Utilize renewable energy source (solar energy) for power requirement.	Accomplished
6	Design a prototype for real-time demonstration.	Accomplished

Project Outcomes

1. System Design/Technology transferred: The prototype of the proposed system is deployed, validated at Eturnagaram Wildlife Sanctuary and handed over to the concerned authority for further observation.
2. Four students (2 M.Tech. and 2 B.Tech.) are trained in two phases.
3. Linkage has been developed with Forest officials of Eturnagaram Wildlife Sanctuary, Mulugu Dist. to work further towards the solutions for real-time problems in forest protection.

Publications

1. J. Bindu Reddy, Dr.J. Chattopadhyay, Dr. G.Prasad Acharya and Dr. P. Lavanya, "***Implementation of LoRa enabling Technology for IoT Applications***," Journal of Northeastern University, Vol. 25, Issue 04, ISSN: 1005-3026, 2022.
2. M. Bhargavi, Dr.J. Chattopadhyay, Dr. G.Prasad Acharya and Dr. V. Jayaprakasan, "***IoT based Intrusion Detection and Fire Detection System using LoRa***," Journal of Northeastern University, Vol. 25, Issue 04, ISSN: 1005-3026, 2022.
3. Aditya Reddy L., Prasad Acharya G., Lavanya P., Jayaprakasan V., "*Real-time Multi-node Metrological and Security Monitoring via LoRaWAN Gateway with Pygate and Wipy 3.0*," IEEE Sensors Journal (under submission)
4. Prasad Acharya G., Lavanya P., Jayaprakasan V., and Chattopadhyay J., "*Design, realization and Deployment of IoT based Forest Protection System using LoRa Technology*," IETE Journal of Research (under submission)

Significance of the Project in the Present Scenario

Our natural assets, the forests are being depleted year by year for various reasons thereby endangering the entire eco-system. The prototype developed in this project is able to detect any intrusion into the forest and nearby fire accidents. It also informs the same to the concerned personnel through notifications and thereby enables them to take the necessary actions. Further, the provision provided for protection of equipment and the solar powered design making the prototype very much useful to safeguard the forest resources in a very cost-effective way. The prototype can be upgraded utilizing AI technology, ubiquitous computing and wireless sensor networks. This project can also be used to safeguard the airports, shipyards, agriculture fields etc.

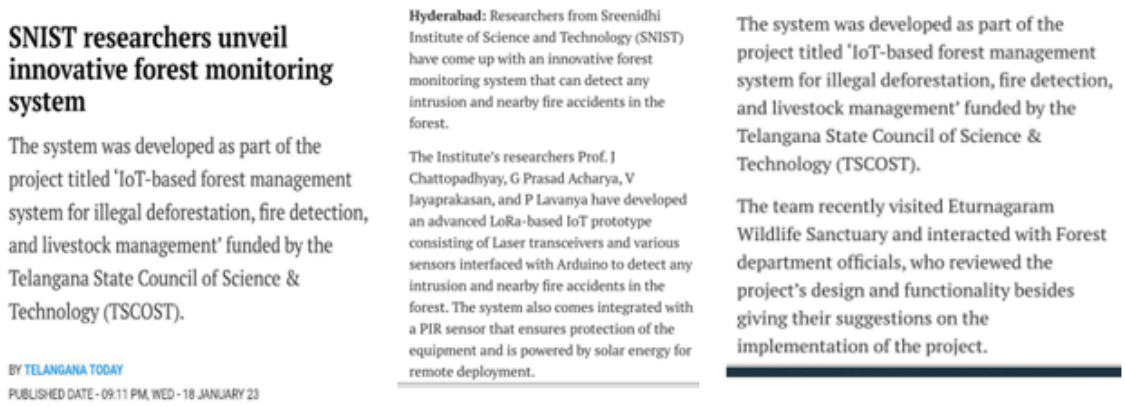
Acknowledgement

We are thankful to Telangana State Council of Science & Technology - Department of Science and Technology (TSCOST-DST); Environment, Forests, Science & Technology Department; Government of Telangana for providing us an opportunity to work on the area of forest.

Photographs (Prototype, Interactions and Newspaper clips)

Image 1: Research team interacting with Forest officials at Eturnagaram Wildlife Sanctuary, Mulugu Dist., Telangana

Image 2: Research team and forest officials along with the deployed prototype at Eturnagaram Wildlife Sanctuary.



SNIST researchers unveil innovative forest monitoring system

The system was developed as part of the project titled 'IoT-based forest management system for illegal deforestation, fire detection, and livestock management' funded by the Telangana State Council of Science & Technology (TSCOST).

BY TELANGANA TODAY

PUBLISHED DATE - 09:11 PM, WED - 18 JANUARY 23

Hyderabad: Researchers from Sreenidhi Institute of Science and Technology (SNIST) have come up with an innovative forest monitoring system that can detect any intrusion and nearby fire accidents in the forest.

The Institute's researchers Prof. J Chattopadhyay, G Prasad Acharya, V Jayaprakasan, and P Lavanya have developed an advanced LoRa-based IoT prototype consisting of Laser transceivers and various sensors interfaced with Arduino to detect any intrusion and nearby fire accidents in the forest. The system also comes integrated with a PIR sensor that ensures protection of the equipment and is powered by solar energy for remote deployment.

The system was developed as part of the project titled 'IoT-based forest management system for illegal deforestation, fire detection, and livestock management' funded by the Telangana State Council of Science & Technology (TSCOST).

The team recently visited Eturnagaram Wildlife Sanctuary and interacted with Forest department officials, who reviewed the project's design and functionality besides giving their suggestions on the implementation of the project.

Image 3: Media coverage of the project work in "Telangana Today", daily newspaper

Date: 08.02.2023
Place: Hyderabad

To

The Forest Range Officer,
Eturnagaram South Range
Wildlife Sanctuary Eturnagaram
Mulugu Dist., Telangana.

Respected Sir,

Sub: Handing over the working Prototype at Eturnagaram Wildlife Sanctuary,Mulugu Dist., Telangana – prototype developedby Faculty of Dept. of E.C.E., Sreenidhi Institute of Science and Technology, Hyderabad – project sanctioned by TSCOST-DST, Govt. of Telangana – Regd.

With reference to the research project titled, "IoT based Forest Management System for Illegal Deforestation, Fire Detection and Livestock Management" being funded by Telangana State Council of Science & Technology - Department of Science and Technology (TSCOST-DST), we havedeployed the prototype at Eturnagaram Wildlife Sanctuary, Mulugu Dist., Telangana. As per the recommendations of the TSCOST officials, the working Prototype consisting of the following equipments/accessories has been handed over for more inputs/observations during the operation of the equipment:

S. No.	Description of the Item	Quantity	Equipments/Accessories/Purpose
1	Pole-A (IoT node)	01	Consisting of Solar Panel and 3 Electronic Boxes (EB) EB_{A1} – LASER beam sensor (Transmitter to be paired with Pole-B Receiver (EB_{B1})) EB_{A2} – Lithium-ion solar battery, Charge controller,PCB with LoRa module, Flame sensor, DHT sensor and PIR sensor. EB_{A3} – LASER beam sensor (Transmitter to be paired with Pole-B Receiver (EB_{B4})) **LoRa Antenna**
2	Pole-B (IoT node)	01	Consisting of Solar Panel and 5 Electronic Boxes (EB) EB_{B1} – LASER beam sensor (Receiver) EB_{B2} – LASER beam sensor (Transmitter to be paired with Pole-C Receiver (EB_{C1})) EB_{B3} – Lithium-ion solar battery, Charge controller, PCB with LoRa module, RFID module, Flame sensor, DHT sensor and PIR sensor. EB_{B4} – LASER beam sensor (Receiver) EB_{B5} – LASER beam sensor (Transmitter to be paired with Pole-C Receiver (EB_{C3})) **LoRa Antenna**
3	Pole-C (IoT node)	01	Consisting of Solar Panel and 3 Electronic Boxes (EB) EB_{C1} – LASER beam sensor (Receiver) EB_{C2} – Lithium-ion solar battery, Charge controller, PCB with LoRa module, Flame sensor, DHT sensor and PIR sensor. EB_{C3} – LASER beam sensor (Receiver) **LoRa Antenna**
4	Lenovo Laptopwith charger	01	Consistsof all software components/tools required for the project
5	Pygate (LoRaWAN Gateway) with antenna	01	To receive the communication from the IoT nodes and to get connected to the TTN server

Dr G. Prasanthi Acharya
PI

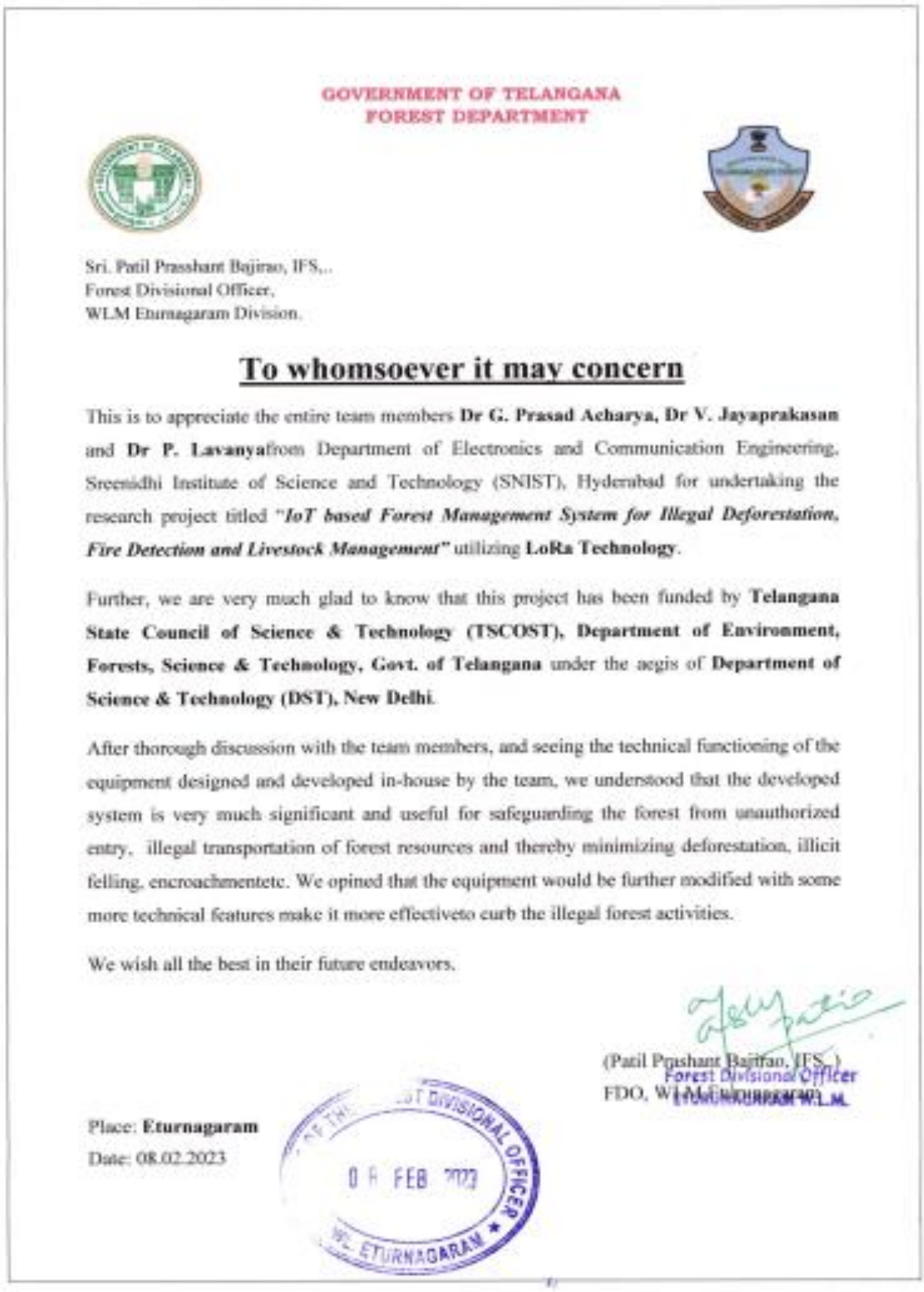
Dr V. Jayaprakasan
Co-PI-1

Dr P. Lavanya
Co-PI-2

Receivers Signature
Forest Range Officer
Eturnagaram South Range

(P.T.O. for deployed images)

Image 4: The working protype handed over to Forest officials at Eturnagaram Wildlife Sanctuary, Mulugu Dist, Telangana



GOVERNMENT OF TELANGANA
FOREST DEPARTMENT

Sri. Patil Prashant Bajirao, IFS,..
Forest Divisional Officer,
WLM Eturnagaram Division.

To whomsoever it may concern

This is to appreciate the entire team members **Dr G. Prasad Acharya, Dr V. Jayaprakasan** and **Dr P. Lavanya**from Department of Electronics and Communication Engineering, Sreenidhi Institute of Science and Technology (SNIST), Hyderabad for undertaking the research project titled ***"IoT based Forest Management System for Illegal Deforestation, Fire Detection and Livestock Management"*** utilizing **LoRa Technology**.

Further, we are very much glad to know that this project has been funded by **Telangana State Council of Science & Technology (TSCOST), Department of Environment, Forests, Science & Technology, Govt. of Telangana** under the aegis of **Department of Science & Technology (DST), New Delhi**.

After thorough discussion with the team members, and seeing the technical functioning of the equipment designed and developed in-house by the team, we understood that the developed system is very much significant and useful for safeguarding the forest from unauthorized entry, illegal transportation of forest resources and thereby minimizing deforestation, illicit felling, encroachmentetc. We opined that the equipment would be further modified with some more technical features make it more effectiveto curb the illegal forest activities.

We wish all the best in their future endeavors.

(Patil Prashant Bajirao, IFS.)
Forest Divisional Officer
FDO, WLM Eturnagaram

Place: **Eturnagaram**
Date: 08.02.2023

DIVISIONAL OFFICER
08 FEB 2023
WL ETURNAGARAM

Image 5: Appreciation letter from the Divisional Forest Officer, Eturnagaram Wildlife Sanctuary, Mulugu Dist, Telangana

Application of Advanced Remote Sensing Technologies for Land Use Land Cover Studies Along with Soil Moisture

Dr. M.V.S.S. Giridhar
Centre for Water Resources,
Jawaharlal Nehru Technological University Hyderabad
Kukatpally, Hyderabad – 500085

Introduction:

Regular monitoring of vegetation, soil and water body is required for sustainable management. One of the most important factors that affect plant habitat is the water and soil quality. Traditional field-based measurement of soil moisture and water quality generally fails to provide continuous spatial coverage and regular sampling rate. A basic understanding of soil/water/vegetation interactions will help irrigators efficiently manage their crops, soils irrigation systems and water supplies. Marriguda mandal is taken as the study area to study the interaction of water with soil and with vegetation and influence among them in all the village of the Mandal. Paddy crop is the prominent crop growing in the villages and trying the relation between soil, water and vegetation in all varieties of crop using advanced remote sensing technologies. Developed Land Use Land Cover classification for the study area. Soil Moisture for the study area is determined using Optical Trapezoid Model.

Optical Trapezoid Model (OPTRAM) was first introduced by Sadeghi et al. (2015) to estimate the soil moisture from remote sensing images. Soil drainage characteristics give essential information for agricultural production and management, as well as for establishing environmental sustainability plans (Basu et al., 2021). Soil moisture data can aid better water resource management, particularly in agriculture. Remote sensing techniques provide a robust tool for spatially monitoring the significant soil moisture variability (Babaeian et al., 2018).

Yao et al. (2022) used the OPTRAM model to map soil moisture in the Hexi Corridor, an irrigated area in north-western China. Soil moisture was first estimated, then converted to soil water content, and change detection was performed from 1990 to 2020. The acquired results were confirmed using Google Earth Engine (GEE), and an accuracy of about 100 per cent was demonstrated. Verné et al. (2021) evaluated the OPTRAM model for mapping soil moisture content in an agricultural area in Hungary. Compared to ground-truth soil data, the model indicated a significant relationship of 0.74. The study concluded by highlighting the model's ability to detect soil moisture and monitor changes over time. Babaeian et al. (2019) used the OPTRAM model successfully at the watershed scale. The study looked into the usage of phenotyping scanners with an ultrahigh spatial resolution for precision agriculture applications. The resulting accuracy was 0.045 and 0.057 cm^3 cm^{-3} at the near-surface and root zone, respectively. These findings can help with farm-scale precision irrigation management to increase cropping system water usage efficiency and conserve water in water-scarce areas of the world. Huang et al. (2019) calculated soil moisture using OPTRAM model in Landsat 8 satellite imagery for a semi-arid agricultural area Songnen Plain, China during growing season. The model showed a regional average

soil moisture value of 23 cm^3 cm^{-3}. Around 22% of the study area showed soil moisture of 0.10-0.20 cm^3 $cm^{-3}$and another 28 % varied between 0.10 and 0.20 cm^3 cm^{-3}.

Sadeghi et al. (2017) used remote sensing data to re-examine the trapezoid model. The OPTRAM model was used to compare Sentinel 2 and Landsat 8 data for Walnut Gulch and Little Washita watersheds research area. The volumetric errors for the obtained model were less than 0.04 cm^3 cm^3. The study demonstrated a substantial advancement that just requires a single uniform parametrization, opening up a new path for obtaining soil moisture utilizing remote sensing. Sadeghi et al. (2015) pioneered the use of the Optical Trapezoid Model (OPTRAM) to determine soil moisture content using NDVI and shortwave infrared (SWIR) transformed reflectance. The linear relation between NDVI and SWIR reflectance values was shown in Landsat and MODIS data. The RMSE ranged between 0.005 to 0.012 for different soil conditions.

Deep learning (DL) is a subfield of machine learning that has been widely employed in the domains of Artificial Intelligence due to its low cost and time, impressive processing of large amounts of data, and significant improvement in learning abilities (Deng,2014). A DNN typically consists of an input layer, a hidden layer of neurons (processors) activated by inputs or weightages, and an output layer. The model is efficient because each neuron is coupled to the input via an activation function. The Eurosat dataset is made up of 27,000 tagged and geo-referenced Sentinel-2 satellite images that cover 13 spectral bands and are divided into 10 classes. The labelled classes consist of Annual Crop, Forest, Herbaceous Vegetation, Highway, Permanent crop, Pasture, Residential, river and so on. This dataset is being used in Deep Learning Neural Network to identify features in remote sensing images easily. The 27,000 high resolution labelled datasets have all been obtained from the Kaggle website for this study.

Remote sensing (RS) combined with deep learning algorithms can provide significant information on the aforementioned challenges over a larger spatial extent and time series. Detection of water and soil quality, as well as effects on the surrounding environment, using RS and deep learning, will aid in data analysis and visualization. Deep learning algorithms can also distinguish between land use and land cover changes that occur over time. The most recent advancements in the field of remote sensing using hyperspectral provide an extremely detailed perspective of such data. Every element in the resources has a unique hyperspectral pattern that can be recognized in satellite images without any field work. Hyperspectral remote sensing is concerned with vast amounts of data that provide precise information about all geographical characteristics. As a result, modern approaches such as deep learning techniques and robust data such as hyperspectral remote sensing data can aid in determining the relationship between soil, water, and vegetation.

Developed spectral signatures for 13 varieties of paddy at different growth stages using hyperspectral remote sensing for the Marriguda mandal. Further, the finding from the project are Unique Spectral signatures of 13 Paddy crop types viz. Batukamma, Kunaram sannalu, Tellahamsa, WGL 505, NlR 335, Telangana Sona, PDR 1140, Pradyumna, Jagitial Sannalu, JGI 2443, Anjanna, Sheetal and Nellore mashuri were collected. The spectral signatures of Paddy, soil and water were obtained from one field in each

seventeen villages of Marriguda Mandal. The 52 unique spectral libraries of four stages namely Sapling, blooming, fruiting and harvesting stages were created for 13 Paddy crop varieties from the spectral signatures. Signatures of from the field of villages in Marriguda Mandal have been obtained and 68, spectral libraries were created for Paddy for four stages, Water and Soil respectively. The 3D Convolution Neural Network model with four hidden layers containing 3 convolution layer, 3 max pooling, 3 ReLU and 1 softmax activation layer was employed for Land Use Land Cover Classification and Seven classes have been identified for LULC classes *namely* water body, settlements, agriculture, barren, open scrub, open mixed jungle and fallow. The overall accuracy for the 3D CNN classification was more than 90% and Kappa coefficient was between 0.80 - 0.97 for the years 2013 to 2020 making the algorithm a reliable classification.

The Spectral Angle Mapper (SAM) was employed for satellite image classification, and it was shown to be effective in categorizing pixels based on their spectral similarity, providing a significant p value of 0.5 and R^2 of 0.95. Crop acreage was obtained from the spectral classified image for 13 varieties of Paddy crop for the years 2016 to 2020 of Kharif and Rabi seasons for Marriguda Mandal. Highest Crop acreage was seen for the year 2017 i.e., 872.40 ha and lowest is 246.40 ha in the year 2020 for Rabi season. During Kharif season, highest crop acreage was observed for the year 2020 i.e., 909.0 ha and lowest in the year 2016 426.6 ha. Soil Moisture was derived using OPTRAM model for Rabi and Kharif season from 2013 to 2020. The trapezoidal form was obtained for STR vs NVI graphs for 2013 to 2014 indicated a favourable relationship between STR and NDVI showing that the OPTRAM was well-parametrized.

Acknowledgement

I would like to express my special thanks of gratitude to the Member Secretary, Telangana State Council of Science & Technology (TSCOST), Hyderabad for their financial support for this research project during the Financial Year 2022-23.

Development of Sensor Based Real Time Water Level Measurement and Irrigation Scheduling System in Paddy Fields for Increasing Water Use Efficiency

Dr. B. Krishna Rao
WALAMTARI, Rajendranagar, Hyderabad

Objectives of the Project:

1. To identify and calibrate suitable water level measurement sensors in paddy fields.
2. To develop a sensor based real time water measurement and Irrigation scheduling system in paddy fields.
3. To evaluate the sensor based real time water measurement and Irrigation scheduling system at field level.

Our irrigation system is a supply-based system with a fixed schedule, where watering schedule involves specific run-times and days with the controller executing as per schedule regardless of the season or weather conditions. But it should be demand based system with a focus on climate, crop stage and weather condition. Watering should be done as and when required and in right quantities. Good water management practices will increase yields, improve crop quality, water use efficiency and water productivity and also conserve water, save energy, decrease fertilizer requirements, and reduce non-point source pollution. Information is most critical to decide on exact amount of water required by a crop in a given climatic condition and for effective design and management of irrigation system, irrigation scheduling, etc. There is need to increase the on-farm water application efficiency through supply side and demand side management. On farm efficiency can be increased using automatic irrigation scheduling system based on soil moisture. Keeping these considerations in view, the present study is conducted. The Sensor based flow depth measurement system consists of sensor unit, depth measurement unit and wireless sensor network (WSN) base station. The development of sensor based real time water level measurement and irrigation scheduling system in paddy fields is described below.

Objective1: Identification & calibration of suitable sensors

Based on the literature, market enquiry, material availability and cost the Ultrasonic sensors were used to measure water level in paddy fields and soil moisture sensors were used to measure the soil moisture content in irrigated dry crops.

Water level was measured by using an ultrasonic sensor which is kept inside the bowman tube. But, because of water vapor in paddy field rust was formed on sensor and it was damaged. After several trials it was kept in a small plastic box and a water proof ultra-sonic sensor was used in the system. The water levels in paddy fields were obtained whenever a call was made with the help of GSM module. To determine if the ultrasonic sensor could be used to automate water level measurements in rice production fields, the automated measurements were compared to the manual measurements to determine if there was a linear relationship. Based on the data, it was observed that Pearson correlation coefficient is close to 1. It is concluded that the water level obtained with sensor-based bowman tube unit were similar to similar to manual measurements.

Objective2: Development of Sensor Based Real Time Water Level Measurement and Irrigation Scheduling System in Paddy Fields

To measure real time water levels in paddy fields and to plan proper irrigation schedules a sensing unit was developed with Bowman tube, Arduino UNO R3, GSM Module, Ultra sonic sensor, Jumper wires, Solar panel, Battery (12 volts), Relay Module, Power Supply Unit and other necessary accessories and this unit accurately measured the water level in paddy fields. The field water tube of 30 cm long PVC plastic pipe having diameter of 10 cm was used in this system, so that the water level is easily visible, and it is easy to remove soil inside the tube. The perforations are made on the tube up to 20 cm depth, so that water can flow readily in and out of the tube. This perforated end of the tube is inserted in the paddy fields up to 15cm depth.

When the field is flooded water level will be 5cm above the ground. After few days, based on the crop & weather conditions, water level in the field is reduced up to 15cm below the ground. The sensors are fixed inside the cap of PVC (Bowmen) tube. This sensing unit is connected to the solar power based battery. The mobile sim card is connected to GSM bands to disseminate the water level information to the designated farmer's telephone numbers through wireless sensor network (WSN) base station. With this sensor unit farmer need not go to farm and measure water level. He can get the message to his phone directly. For this he has to call to the SIM that is connected to GSM. Immediately farmer will receive a message of water level in the field in centimeters. Based on the information received farmer can plan for irrigations.

As per the project objectives, real time water depth sensing unit in paddy fields was developed with water proof ultra-sonic sensor, Bowman tube and other necessary accessories and this unit accurately measures the water level in paddy fields.

Water measurement was done with the help of the developed sensing unit. For scheduling irrigations, the above observations were taken into consideration. Immediately after watering, 5 cm standing water is there in the field. At 0 cm field is fully saturated and at -2.35 cm also field is in saturated state only. At -5 cm level few hair line cracks were developed. At -8 to -9 cm water level broader cracks were developed and it was observed that, at this stage more and more water was required for irrigating the field than the normal. At above -10 to -15 cm stage there was irrecoverable loss in plant and almost plants died at this stage and 15 -20 days' time required in some plants for rejuvenation. So, based on all these observations it is found that, irrigating the field at -5 cm level stands good. At this stage irrigation water saving was observed without any damage to crop.

Objective 3: Field evaluation of sensor based real time water measurement and Irrigation scheduling system unit

The developed sensor based real time water level measurement system was evaluated in the paddy fields. For the evaluation, these systems were installed in two locations one at Research & Development Farm, WALAMTARI, Himayat Sagar and second one at Project Development and Demonstration Farm, Chelgal, Jagitial District under Sriram Sagar Project (SRSP) command area. These systems give daily water depth information by messages through wireless network. Based on the messages received irrigations are being scheduled.

The sensor-based irrigations reduced the number of irrigations from 14 to 10, water quantity from 4316 to 3120 m3/ha, energy consumed from 157 to 116 kwh. The sensor-based system enhanced the water productivity from 1.26 kg/m3 to 1.98 kg/m3. The sensor-based irrigations reduced the number of irrigations from 31 to 44, water quantity from 4316 to 8948 m3/ha, energy consumed from 451 to 650 kwh. The sensor-based system enhanced the water productivity from 0.4 kg/m3 to 0.67 kg/m3. This system

saved 30% water and 31% energy in rabi season. The better crop growth and higher yields were recorded in both kharif and rabi seasons.

Highlights

- Based on the literature, market enquiry, material availability and cost, ultrasonic sensors were identified to measure water levels in paddy fields and soil moisture sensors were identified to measure the soil moisture content in irrigated dry crops
- To measure real time water levels in paddy fields and to plan proper irrigation schedules a sensing unit was developed with Bowman tube, Arduino UNO R3, GSM Module, Ultra sonic sensor, Jumper wires, Solar panel, Battery (12 volts), Relay Module, Power Supply Unit and other necessary accessories and this unit accurately measured the water level in paddy fields.
- Based on the data, it is concluded that the water level obtained with sensor based bowman tube unit were similar to manual measurements.
- The sensor-based irrigation system in rabi season, the number of irrigations from 14 to 10, water quantity from 4316 to 3120 m3/ha, energy consumed from 157 to 116 kwh. The sensor-based system enhanced the water productivity from 1.26 kg/m3 to 1.98 kg/m3. This system saved 28 % water and 26 % energy
- The sensor-based irrigation system in rabi season reduced the number of irrigations from 31 to 44, water quantity from 4316 to 8948 m3/ha, energy consumed from 451 to 650 kwh. The sensor-based system enhanced the water productivity from 0.4 kg/m3 to 0.67 kg/m3. This system saved 30% water and 31% energy.

Publications:

A research paper on Development of Sensor Based Real Time Water Level Measurement and Irrigation Scheduling System in Paddy Fields for Increasing Water Use Efficiency is prepared and will be communicated to high impact journal.

Additional work

Automation of pump & motor operation

The designed automated irrigation system in this project consists of ATmega328 microcontroller, GSM module, sensor unit and motor control unit is shown in Fig. The Bowman tube with the help of ultra-sonic sensor determines the depth of water in the root zone of the paddy field. The Global System for Mobile communication (GSM) module in the designed irrigation system is used for sending and receiving the messages between the microcontroller and Smartphone. Based on the data received from sensor, microcontroller manages the irrigation by controlling the motor unit and periodically updates the information to the farmer. When the depth of water below -5 cm, then call should be done in order to ON or OFF the motor unit.

The working principle of a GSM-based relay switch control for a motor using mobile ring to start the motor and another ring to off the motor involves the use of a mobile phone as a remote control for switching a relay that controls the motor. Here's how the system works: The user calls the mobile phone number connected to the GSM module from another mobile phone to start the motor. The GSM module detects the incoming call and

activates the relay to turn on the motor. The motor starts running and drives the machinery. When the user wants to stop the motor, they call the mobile phone number connected to the GSM module from another mobile phone to turn off the motor. The GSM module detects the incoming call and deactivates the relay to turn off the motor. In summary, the system allows farmers or agricultural workers to remotely control the switching of a relay to turn on and off a motor that drives agricultural machinery using a mobile phone call instead of an SMS.

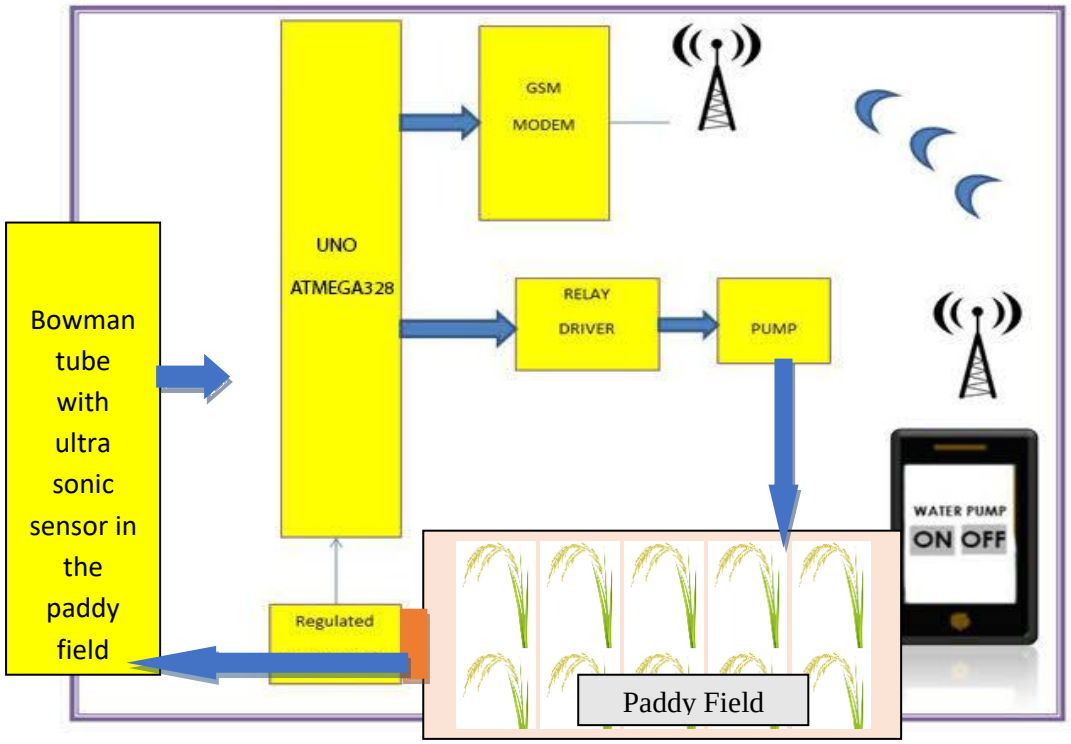


Fig. Work flow of the designed automated irrigation system

Soil moisture sensor unit to measure the moisture in the Irrigated Dry crops

Soil moisture sensors measure the water content in soil. All plants need water to grow and survive. Soil moisture sensors used to determine percentage of water available to the plants. Three sensors have been installed in R&D farm, WALAMTARI at 10 cm, 15 cm and 20 cm depth to schedule the irrigations. In kharif cotton crop was grown as id crop, later rabi, vegetables crop (Bottle guard) was sown in the field.

Soil moisture sensors installed at R&D Farm, WALAMTARI

The soil moisture sensors are calibrated before installation in the field. Soil samples were randomly collected from different soil moisture conditions ranging from very dry to wet concurrently with soil moisture sensor reading. After calibration, it is found that at 60 – 65 % depletions at 5 cm depth irrigations have been planned as the crop is in early stage and more over it has been cultivated under drip. It needs further research for getting proper recommendations for different irrigated dry crops.

Design, Development and Cost Evaluation of DC House Prototype to Promote the Use of Renewable Energy for Rural Electrification

Principal Investigator
Prof. P. Satish Kumar, UCE,
Osmania University, Hyderabad

Introduction:

There are few backlogs in AC power utilization for home applications, which includes high power utilization when compared to DC power, Storage of AC power and power distribution may not possible in rural and forest areas. If DC power implemented for home applications may solve above problems.

In the current scenario, many of household applications are able to operate with DC power such as solid-state lighting (LED), fans with BLDC motors, DC compressors will run with DC power and utilizes less current which results low power consumption. This gives hope to initialize the AC to DC conversion at single time instead of converting at every application that causes 5-10% of power loss per each conversion.

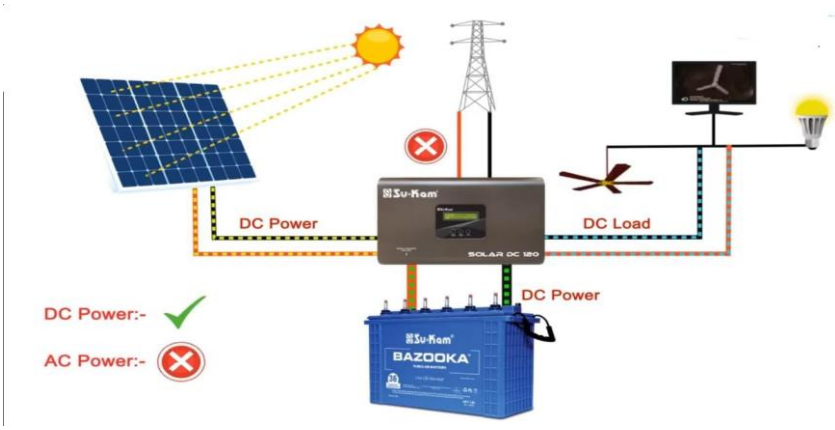
Solar Powered Systems powering Direct Current based are available in the country. These systems have limitation in terms of the size and also the range of gadgets used- like DC light and fans that can are currently used. Street lighting, a classic example of completely DC solutions implemented at the village is a proven solution. However, as they use LEAD Acid based batteries, which needs to be maintained regularly, there is high maintenance cost and periodically, the same needs to be replaced every 5 years.

Main Objectives:

- The main objective of this project is to Implement DC power for all home applications, so that power consumption will be reduced, and that DC power can be stored using batteries, eliminates the dependency of normal power.
- Introducing the technologies related to low power, low voltage DC in residential applications/homes.
- To develop the small scale, easy approach to rural electrification by using the small scale, rurally available, renewable energy sources using the DC supply rather than AC supply.
- To make a model Green house at Low and affordable cost off-grid powered with alternative power source. This will be "Self-Reliant IDLE Zero Carbon Emission Home" and not just net-zero emission.
- To develop an actual DC two bed-room home model in the Department of electrical Engineering which consists of with connected loads of lights, fans, refrigerator, air cooler, exhaust fans and television etc.

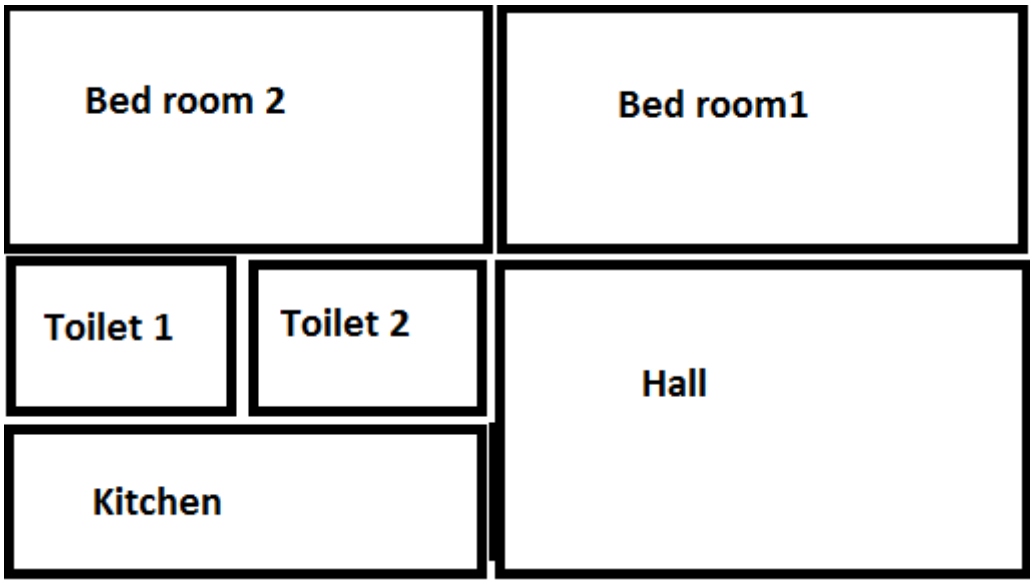
Methodology detailing stepwise activities and sub-activities:

- To implement DC power by converting AC supply to the DC at the mains of home.
- To upgrade the applications to run with the DC supply.
- To develop new home applications that uses the DC power.
- To develop AC to DC Converter as per required power ratings.
- To change the home applications such as LED bulbs and fans circuitry to run with the DC power.
- To upgrade the lines in accordance to transmit DC power including plugs, connectors and switches.
- To investigate the power utilization over the period of one month.
- Analyze the power consumption.
- To make improvements from the analysis report.
- Report the overall process.



The Propose Two Bed Room House Model:

The propose model contains one Hall and two bedrooms, one kitchen and two toilets. All the electrical components in the model all are working with DC power supply with load consumption of about 500W.



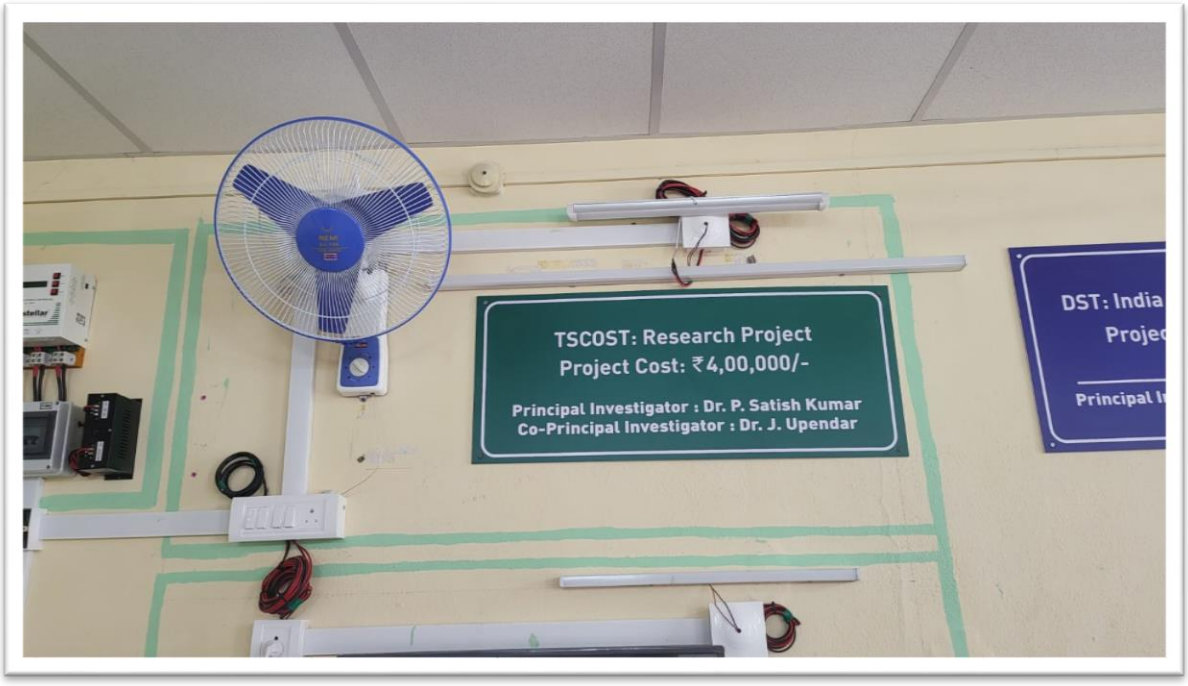
TWO-BED ROOM DC HOME MODEL

Drawing Hall Model:

The Drawing Hall is equipped with LED TV (DC (18-22V)/ AC (100–240 V, 50/60 Hz), 32", 60W), Fan – 22 W/12V DC, Tube Light 20W/12 VDC, Mini Light 8W/14W, 12 VDC, Laptop Charger – 65W and Mobile Charger- 5 W. All the devices in this model are working directly with the DC supply taken from the solar panel.

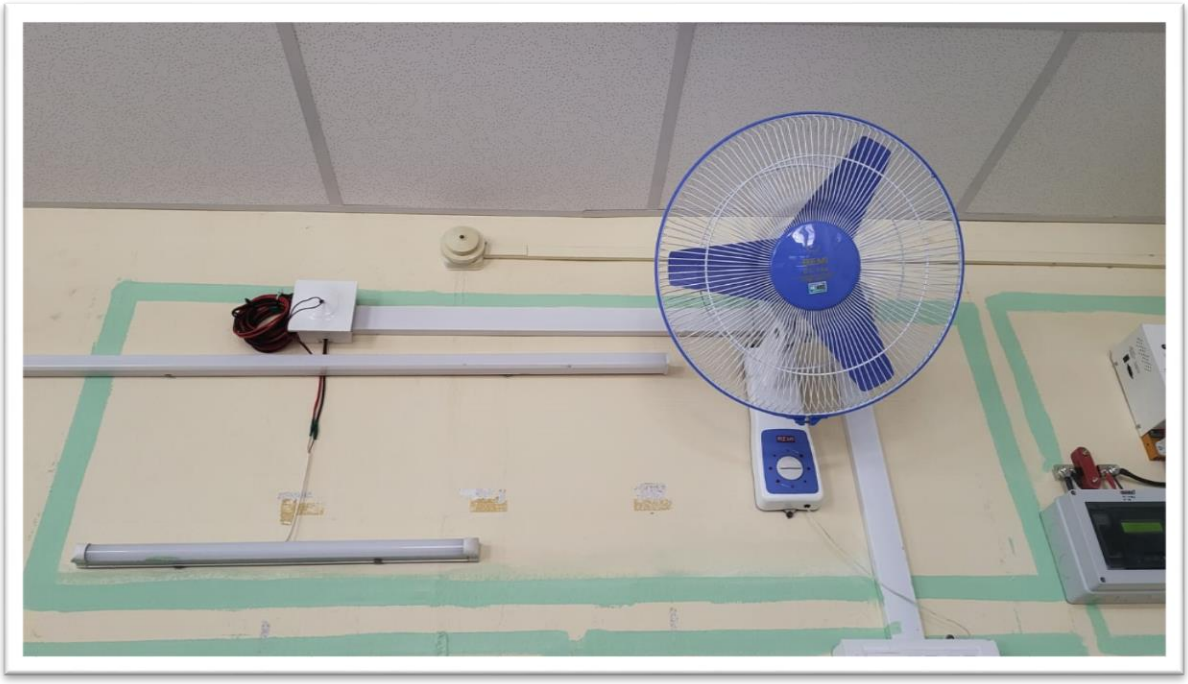
Master Bedroom Model:

The Master Bedroom is equipped with Fan – 22 W/12V DC, Tube Light 20W/12 VDC, Mini Light 14W, 12 VDC. All the devices in the bedroom model are working directly with the DC supply taken from the solar panel.



Children Bedroom Model:

The Children Bedroom-2 is equipped with Fan – 22 W/12V DC, Tube Light 20W/12 VDC, Mini Light 14W, 12 VDC. All the devices in the bedroom model are working directly with the DC supply taken from the solar panel.



Toilet - 1, Toilet - 2 Models:

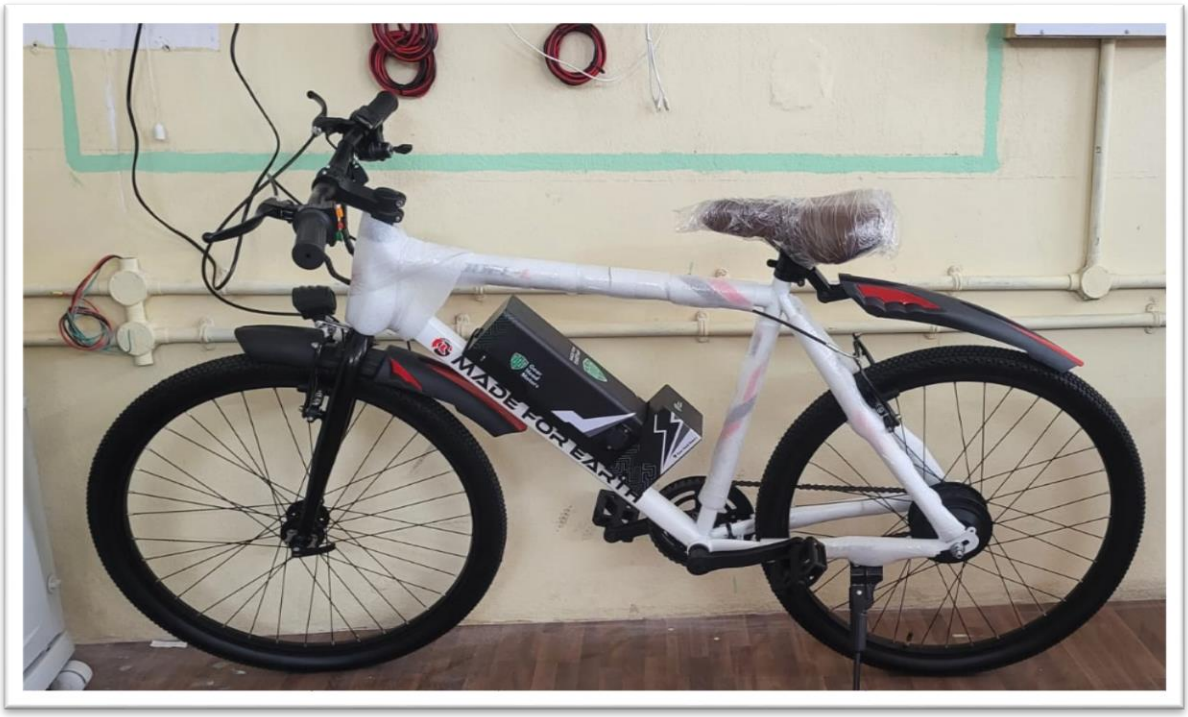
The Toilet-1 and Toilet-2 are equipped with Mini Light 14W, 12 VDC. All the above devices in the toilet model are working directly with the DC supply taken from the solar panel.

Kitchen Model:

The Kitchen is equipped with Fan–22 W/12V DC, Mini Light 14W, 12 VDC, Light, Refrigerator– 60 W, AC 230 V. All the above devices in the kitchen model are working directly with the DC supply taken from the solar panel.

Electric Bicycle:

The Electric Bicycle - 200-400 Watt motor, 5Ah- 7Ah Battery.



Solar Panels:

The proposed model will get the DC power supply from the seven solar panels. The equipments in this model are getting the power supply directly from the solar panels . The each Solar Panels is with 200 Watt, the total maximum power delivered by this is 1400 W. (200 W x 7 no.)

Battery Backup:

The proposed model is connected with the Batter backup and Controllers. The each battery is with 150Ah @12.8 V capacity and two batteries are used to manage the full load. The total power delivered by the battery 3 KWh.

Solar MPPT Charge Controller:

The proposed model is having he Solar MPPT Charge controller rated 12 VDC with RS485 Remote monitoring, and with the capacity of 40 Amp or Equivalent. Total 2 of controllers are used in this model to manage all the loads.

Room wise load connected:

S.No.	Location	Connected Load	Type	Qty	Capacity
1	**Drawing Hall**	TV	DC	1	60 W
		Fan	DC	1	22 W
		Mini LED Tube light	DC	1	14 W
		Mini LED Tube light	DC	1	8 W
		Laptop Charger	DC	1	65 W
		Mobile Charger	DC	1	5 W
2	**Master Bed Room**	Fan	DC	1	22 W
		Main LED Tube light	DC	1	20 W
		Mini LED Tube light	DC	1	14 W
3	**Children Bed Room**	Fan	DC	1	22 W
		Main LED Tube light	DC	1	20 W
		Mini LED Tube light	DC	1	14 W
4	**Toilet -1**	Mini LED Tube light	DC	1	8 W
5	**Toilet -2**	Mini LED Tube light	DC	1	8 W
6	**Kitchen**	Fan	DC	1	22 W
		Mini LED Tube light	DC	1	14 W
		Fridge	AC/DC	1	60 W
Total Load					**398 W**

Conclusions:

In this project, investigations on technical and economic feasibility of solar powered DC distribution system for 2BHK home electrification have been carried out.

The model houses with power requirements of 400W have been constructed in the Department Research laboratory of Electrical Engineering Department, University College of Engineering, Osmania University. Typical residential home appliances such as TV, lights, fans, and laptop charger, mobile charger have been considered. It has been observed that the solar DC distribution system is technically feasible.

For detailed analysis, A simulation model with AC Wiring-AC Load and DC Wiring-DC Load are examined. It is observed that the power loss is minimum in case of DC Wiring-DC Load configuration when compared to the AC Wiring-AC Load. DC Wiring-DC Load, are examined experimentally for all above 400 W capacity of 2BHK house model. The experimental result establishes the feasibility of solar DC power distribution.

The solar panels with 200W capacity each of total seven number are used in this model to supply the full load. All the devices and equipment are run by the DC power supply in the 2BHK model and all are connected with DC cables from the solar panels. No AC devices and No inverters are used in this 2BHK model house. The detailed cost analysis also gives a good indicator for field implementation of this technology. With more users for DC loads, the cost will definitely come down. For field demonstration of the technology, is implemented at the Research Lab in Department of Electrical Engineering, University college of Engineering (A), Osmania University with the solar DC power. It is remarked that this technology will definitely gain momentum.

Development of Electromagnetic Absorbing Materials for Electronic Industry

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The Y3Fe5O12 (YIG) and Gd3Fe5O12 (GdIG) nanoparticles were prepared using microwave-hydrothermal method at 160ºC/30 min. The prepared powders were sintered at 950ºC/2h using conventional sintering method. The XRD patterns of YIG and GdIG confirms the single phase cubic phase belongs to Ia3d space group. The sintered powders of YIG -Polypyrrol and GdIG-Polypyrrol nanocomposites were mixed at different weight percentages, 15, 30 and 45 wt%. It is observed that no impurity phases were detected. The lattice constant for YIG and GdIG is 12.365 Å and 12.472 Å. It is observed that with increasing polymer content, the lattice constant is not varied much for YIG-polymer and GdIG polymer content. The FESEM image shows that agglomeration for both the composites increased due to the magnetic nature of the ferrites. The unit cell volume (V) of YIG-Polymer nanocomposites increased with polymer addition from 1890.52 Å3to 1891.90 Å3. The unit cell volume (V) increased with polymer addition for GdIG-polymer composites from 1940.03 Å3 to 1941.89 Å3. The decrease in X-ray density for YIG-polymer from 5.185 to 5.182 g/cm3 is because of the presence of amorphous polymer present in the samples. The decrease in X-ray density for GdIG-polymer from 6.455 to 6.449 g/cm3 is because of the presence of amorphous polymer present in the samples. The FTIR spectra shows peaks at 1455 cm-1 and 1598 cm-1 can be assigned to the polypyrrol. It is noted that with increasing polymer content in YIG matrix,and GdIG, the Ms is decreased due to the nonmagnetic nature. The dielectric properties such as dielectric constant (ε) and dielectric loss (tanδ) of YIG-polymer and GdIG-polymer composites were decreased with frequency. The dielectric constant and loss is higher for YIG and GdIG as compared to composites. Such composites are useful for high frequency applications.

Keywords: YIG; GdIG; composites; magnetic properties; dielectric properties.

Biocontrol of Dieback disease of Neem Tree Using Plant Extract

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Introduction:

Azadirachta indica is commonly known as Neem (Meliaceae) and is known for its medicinal properties. It is a perennial, evergreen, native tree of the Indian subcontinent. Neem is a large evergreen tree that may grow up to 20 m in height. The leaves are alternate and the leaflets contain leaves that may appear in March-April. The leaves are bitter [1]. Chemistry Extensive investigations have been carried out on the chemistry of neem tree products. In particular, the leaf of neem is a 'storehouse' of organic compounds. Neem leaves contain 0.13 per cent essential oil, which is responsible for the smell of the leaves [1]. Principle constituents of neem leaves are identified by proximate analysis [2,3]. More than 140 active substances that are chemically diverse and structurally complex have been isolated from different parts of the neem. [3-7].

Antiviral Activity Aqueous neem leaf extract exerts antiviral activity against Vaccinia virus, Chikungunya and measles virus in vitro [8]. Rao et al. [9] found that a 10 per cent water extract of tender leaves exhibits antiviral activity against vaccinia and variola viruses.

Antifungal Activity High antimycotic activity of the extracts of different parts of neem has been reported [5]. Extracts of neem leaf are effective against certain human fungi, including Trichophyton, Epidermophyton, Microsporum, Trichosporon, Geotricum and Candida [10]

Antibacterial Activity The oil from the neem leaves are recognized to possess antibacterial activity against a wide spectrum of Gramnegative and Gram-positive microorganisms, including M.tuberculosis and Streptomycin-resistant strains [10].

Antimalarial Activity Neem leaf extracts are effective against malarial parasites. Components of the alcoholic extract of leaves are found to be effective against both chloroquine-resistant and sensitive strains of the malarial parasite [11].

Antifertility Activity Administration of neem leaf powder for 24 days resulted in a decrease in the weights of seminal vesicles and ventral prostate, reduction in epithelial height, nuclear diameter and the secretory material in the lumen [12]. Mateenuddin et al. [13] have demonstrated the anti-estrogenic activity of neem leaf extract

Antipyretic, Antiinflammatory and Analgesic Activities Neem leaf is strongly antipyretic and traditionally used for fevers. A methanol extract of the leaves has been reported to exert antipyretic effects in male rabbits [14]. Khatak et al. [15] obtained an antipyretic effect from various fractions of 90 per cent ethanolic leaf extract.

Antiulcerogenic Activity Neem leaf has proven successful in treating stomach ulcers. Its antihistamine and antibacterial compounds can reduce inflammation and destroy ulcer-causing bacteria such as Helicobacter pylori [16]. Garg et al. [17] have

observed antiulcer effects of neem leaves in rats exposed to restraint cold stress or ethanol orally.

Antihypertensive and Antihyperglycaemic Effects An alcoholic extract of neem leaf has been reported to produce a significant and dose-related fall in blood pressure [18]. Aqueous neem leaf extract has been found to reduce blood glucose levels and prevent adrenaline and glucose-induced hyperglycaemia [19].

Neuropharmacological Activity Varying degrees of central nervous system (CNS) depressant activity in mice were observed with neem leaf extract. Singh et al. [20] observed a CNS-depressant activity by acetone extract of neem leaves. Leaf extract up to a dose of 200 mg/kg body weight produced significant anxiolytic activity in rats [21].

Antidermatophytic Activity Neem has a remarkable effect on chronic skin conditions that often fail to respond to medical drugs. Local application of a lotion prepared from the 70 per cent alcoholic extract of neem leaves was found to be effective in chronic skin diseases such as eczema, scabies and ringworm infection [22].

Orodental Protection Neem leaves have been used in the treatment of gingivitis and periodontitis. Neem has also shown greater efficacy in the treatment of oral infections and plaque growth inhibition in periodontal disorders [23,24]. Recently, Pai et al. [25] have demonstrated that a dental gel containing neem leaf extract (25 mg/g) reduces plaque index and bacterial count (Streptococcus mutans and Lactobacilli).

Hepatoprotective Effect Both aqueous as well as alcoholic extracts of neem leaf were found to offer protection against paracetamol-induced liver damage [26, 27].

Immunostimulant Activity The aqueous extract of neem leaf exerts its immunostimulant activity by enhancing both humoral and cell-mediated responses [28,29].

Antioxidant and Antigenotoxic Effects Chattopadhyay [30] reported the radical scavenging properties of neem leaf. Neem leaf has been documented to decrease the extent of lipid peroxidation.

Anticancer Activity Neem leaf preparations have been reported to possess anticancer properties. Yadav and Rathore [30] observed inhibition of mitotic activity by neem leaf extract

The Neem tree with a carbon sequestration capacity of 1.45 lakh tonnes in its lifetime. On average, one tree produces nearly 260 pounds of oxygen each year. A neem tree requires very little water and nutrients. The tap root system goes deep into the subsoil and extracts water and nutrients. The leaves that fall underneath act as litter and contribute to fertility by humus formation. Neem reclaims soil by converting acidic soils to neutral by accumulating calcium. The benefits of neem as a fast-growing plant and a good source of firewood are well known. Neem saves the environment from air pollution. The inflorescence purifies when the wind blows. Like other trees, it exhales oxygen and keeps the oxygen level in the atmosphere balanced. Neem plants control floods and reduce salinization and soil erosion as marginal crops. All parts of the plant are a source of indigenous and ayurvedic medicine. Neem is replacing pesticides with biopesticides with does not harm human health and beneficial organism of the environment. Directly

and indirectly, neem can control 700 disease and pest pathogens. The leaves and twigs of Neem are used as a household pest controller in grain storage pots and against rodents. Neem plant is known to reclaim wastelands lands example of its value as an environmental panacea. The Neem plant is a windbreaker and protects from storms and strong wind.

As a shade plant neem has all the good characteristics for various social forestry programs. Neem trees produce dry biomass of 10 to 100 tons/ha, thus the great benefits of neem in improving the soil environment.

Effective management of plant diseases is essential since plants are important to us both economically and aesthetically. Fungal diseases of plants are primarily controlled by the application of fungicides [33]. Die-back of neem can be managed by spraying Bavistin 50 W.P. [31]. It is not an eco-friendly approach to use synthetic fungicides as they are reported to have carcinogenic, teratogenic, oncogenic and genotoxic properties [35,36]. According to Rathmell [34], synthetic fungicides are biohazardous and adversely affect the components of an ecosystem. Further, the constant use results in the development of resistance in the pathogens against these fungicides [37]. Thus the use of eco-friendly alternative approaches for the management of plant diseases has attracted attention [38,39]. A good number of plant-derived natural products are reported to be antifungal in nature [40]. Green plants, which are reservoirs of various defence chemicals can provide systemic, non-phytotoxic, easily biodegradable and host metabolism stimulatory pesticides [41]. Essential oils have been used by several workers for controlling fungi, bacteria, viruses and insect pests [42]. The antimicrobial properties of essential oils invariably depend on the chemical nature of the constituents present in them [43].

Despite having such vital properties, is infected by various pathogens belonging to bacteria and fungi. The most destructive pathogen of neem is Phomopsis azadirachtae, a deutero mycetous fungus, which causes die-back disease [31,32]. The chief symptoms of the disease are twig blight, inflorescence blight and fruit rot. The disease results in almost 100% loss of fruit production because of which, neem seeds used as a raw material in the preparation of biopesticides, medicines and various industrial products are not obtained.

The Neem affects leaves, twigs and the inflorescence of neem trees of all ages and sizes. It has almost always caused a 100% loss of fruit production in severely infected trees (Bhat et al. 1998). The disease is spreading alarmingly in different parts of India. it is possible to detect the disease-causing agent.

The occurrence of die-back of neem was first reported from new forests of Dehra Dun, North India (Sateesh et al.) first identified and reported the pathogen causing die-back of neem – Phomopsis azadirachtae. The disease symptoms include twig blight, inflorescence blight and fruit rot. At present, it is the major, devastating disease of neem. The disease has been noticed in neem trees irrespective of age, size and height. The disease is more pronounced from August to December, though can be observed throughout the year. The appearance of symptoms starts with the onset of the rainy season and becomes progressively severe in the later part of the rainy season and early winter season. The terminal branches are mainly affected. The disease results in the progressive death of the tree, year after year. Twig blight is the major symptom. The disease also results in inflorescence blight and fruit rot resulting in almost 100% fruit yield loss. Disease spreads

through conidia that are disseminated by rain droplets and insects. The pathogen is also seed-borne.

Material and Methods:

Satellite images, Erdas-2015 Sentinel-2 software and Arc GIS was used to generate the data of Impact of Dieback disease in the study area.

Identification of Micro-organism:

CXL Binocular Microscope Medlab was used for identification of the causative microorganism. The chemicals used were Sd Fine analytical grade.

Inhibition Studies:

Zone of inhibition was studied with disk diffusion method

Fermented product Preparation:

Citrous fruit peels, Carbohydrate source, water and microorganisms were added and fermented for 50 days.

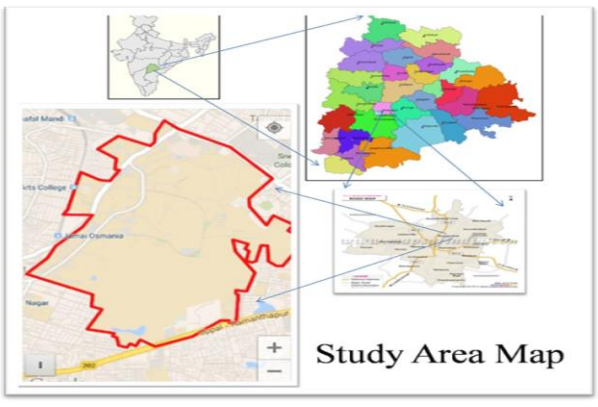
Objectives:

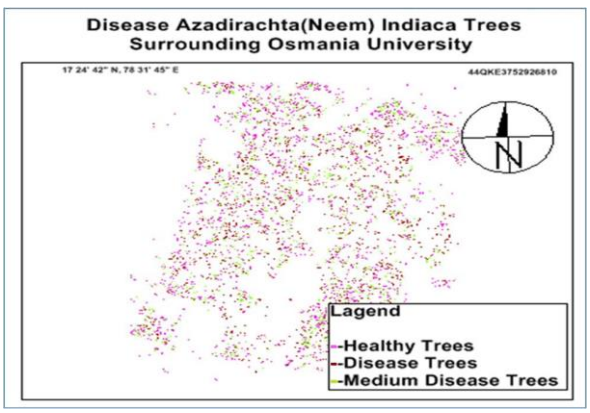
- Understand the severity by using Remote sensing and GIS (ARC GIS and ERDASS software)
- Isolation of fungal organisms
- Maintenance of fungal organisms
- Extraction of plant extracts from Medicinal plants.
- Application of various extracts for biocontrol studies.

Results and discussion:

Objective 1:

PI took Osmania University as a sample to depict the severity of the problem. With help of satellite images tried to evaluate the infected and moderately infected and not affected for two times in the study period first time data was collected in January 2022. And for the second time it was done in the month of Nov -December 2022.

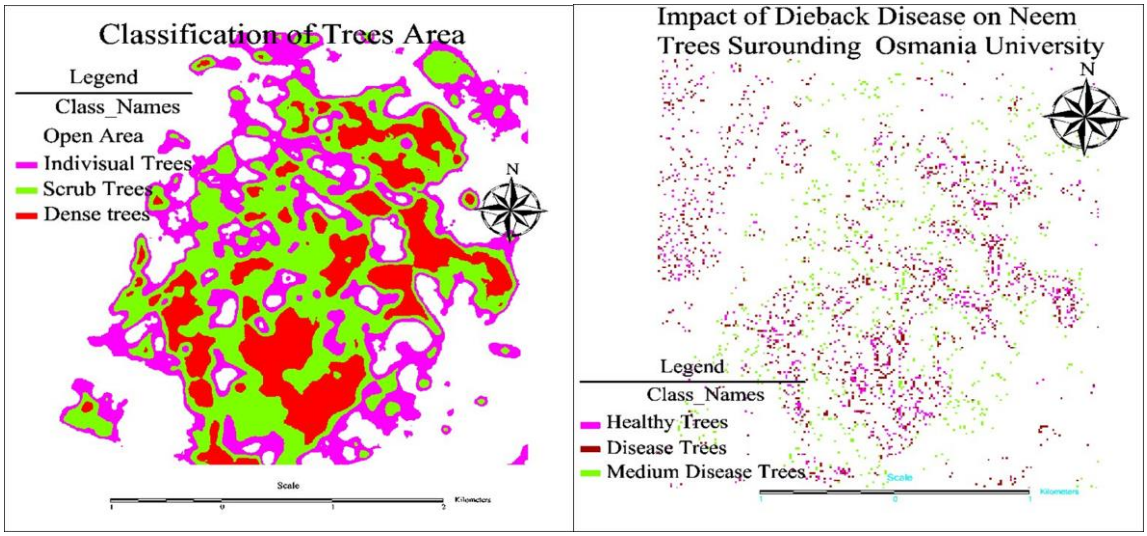




S.No.		pixels	Total Area Sq. Mtrs,	Each Tree Area	Total Trees
1	Healthy Trees	3124	312400	49.12	6230
2	Moderately infected trees	2312	231200	49.12	4706
3	Completely infected Trees	1801	180100	49.12	3566
4	Group of trees	27512	2751200	49.12	56009
5	Scrub Area trees	16157	1615700	49.12	32892
6	Individual Trees	10405	1040500	49.12	21181

With the help of Satellite images, Erdas-2015, Sentinel-2 software and Arc GIS, Study area was exposed to know the impact of Dieback disease. In the study area, obtained data was categorized in to three groups, they are, healthy trees Moderately infected and completely infected. Nearly 3566 are completely infected, 4706 were moderately infected and nearly 6230 healthy trees were observed in the study area.

The similar study was conducted for the second time in the month of Nov – Dec then there was increased severity was observed. There 3850 trees fall into the Completely infected category Moderately infected are 4910 and healthy trees were 5952. This data clearly indicates the severity of the disease.



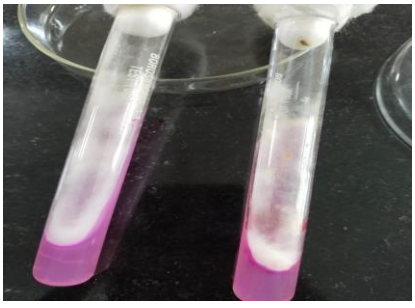
Neem Tree Details					
S.No	**Classification**	**Total Area Square meters**	**Each Tree Area**	Total trees	
				Jan 22	nov-dec 22
1	Healthy Trees	292400	49.12	6230	5952.769
2	moderately infected Trees	241200	49.12	4706	4910.423
3	disease Trees	189130	49.12	3566	3850.366
4				14502	14713.56
Tree Calculation in study area					
S.no	Classification	Total Area Square meters	Each Tree Area	Total Trees	
1	group of trees	2851200	49.12	56009	58045.6
2	scrub Area	1515700	49.12	32892	30857.08
3	individual Trees	940500	49.12	21181	19146.99

After realizing the severity of the problem, from the literature survey it was better to follow the biocontrol method and followed the following steps.

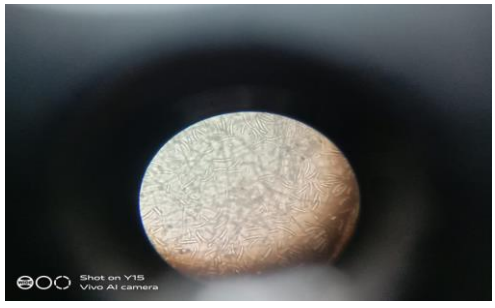
Isolation and culturing the Organism:

The infected twigs collected from die-back affected neem trees were cut into 2-3 cm pieces including the middle transition region of healthy and infected portions using sterile blades. Healthy twigs served as control. Both healthy and infected twig pieces were washed separately with running tap water for an hour. Then they were cut into 1-1.5 cm segments with the transition zone at the middle portion. The bark was removed and the segments were washed thoroughly with running tap water and surface-sterilized using sodium hypochlorite solution (with 5% available chlorine), then they were rinsed five times with sterile distilled water. The surface-sterilized twig segments were placed in Petri dishes containing potato dextrose agar (PDA, Himedia, Mumbai, India) amended with 100 ppm of chloramphenicol (20 ml per plate), aseptically at the rate of four segments per plate. The inoculated plates were incubated for 10 days at 26±2ºC with a 12h photoperiod and observed for the growth of the pathogen from the twig segments. The incubation was continued for 15 days to allow sporulation. The spores were identified microscopically and the presence of P. Azadirachtae was confirmed as per Sateesh et al. (1997).

After isolations organisms were cultured in to the slants and are maintained.



Pure culture



Spores of Phomospsis

Biocontrol studies:

Hyptis, Parthenium and Marrigold dried (used) flowers were taken for the biocontrol study. Reason for selecting them is they are Weeds and Used flowers they are freely available in large quantities in addition to that, from the literature itis evident that they possess antimicrobial activity (Ijeh II et al 2007,Okonogi S et al 2005)

Collection of plant material:

Hyptis and Parthenium areal parts, used flowers were collected and leaves, stems and inflorasence were separated and shade dried to ensure the zero moisture in the material. The antimicrobial activity of the samples was initially evaluated by modified agar well diffusion assay. Autoclaved Growth medium (25 ml) was poured into Petri dishes at 50–70 °C and it was left to solidify under ultraviolet (UV) light for 15 min. Subsequently, a sterile cotton swab was dipped into Phomopsis culture suspension. An agar plate was inoculated by evenly streaking cotton swab over the agar medium. Then wells with a diameter of 8 mm were cut in the medium with a sterile corn borer. The tested samples and controls (100 µl) were dispensed into the wells. The plates were incubated at 37 °C for 24 h. Then the diameters of growth inhibition zones around the wells were measured. Controls were also maintained.

Preparation of Samples:

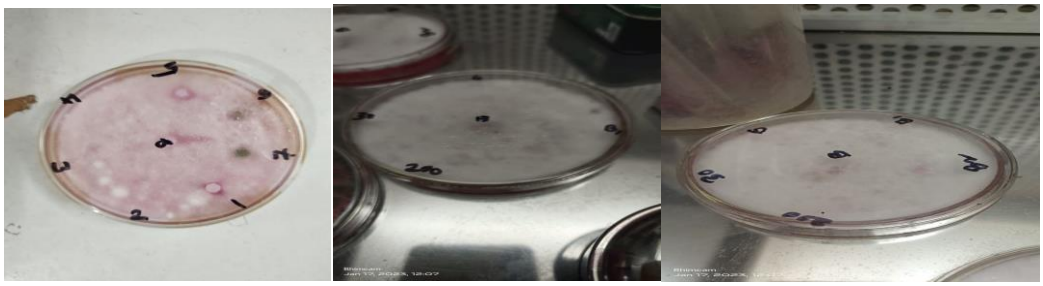
Fresh leaves were (10g) taken washed them properly under running water, whipped off with tissue paper. Leaves were macerated by adding water to it, then filtrated was made upto 100 ml which becomes 10% solution. Same process was repeated with Parthenium and Marigold flowers.

Plant Extractions

Determination of MIC values:

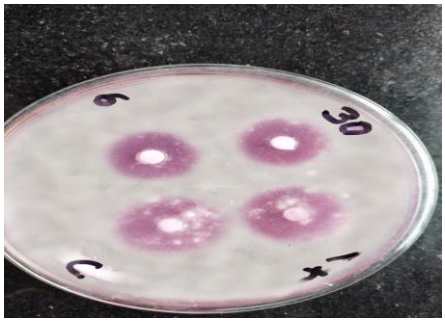
Determination of Minimum inhibitory concentrations (MIC) of plant crude extracts was done using broth micro dilution method. The sample concentration range was prepared from the stock solutions by two-fold dilutions in sterile broth. Inhibition zone is calculated with the help of scale and measured in mm. Ethanol and Acetone extractions are to made with different concentration, carrying inhibition studies. Prepared concentration could not

produce any inhibition zone. Aqueous extraction does not show any inhibition. Higher concentrations are to be prepared. When different plant material was studied for the biocontrol method inhibition zone was not found.



Different plant extracts were studied but there is no inhibition zone

Inhibition zone study with Fermented product:



Zone of inhibition 6.30x1 are different concentration of fermented product, C is synthetic fungicide (triazole)

This below is Further work was done with the insights from the experts and their critical comments.

- This is the comparative study of Fermented product with the Synthetic fungicide (triazole fungicide). The inhibition zone of7mm was found with fermented product and 9mm inhibition was found with Synthetic fungicide.
- Characterization of the Fermented product: Essential Macro elements, Lipids, proteins, fiber contents and the compounds listed out from GC analysis were given below.

Comparison of Fermented product and Synthetic chemical

1. Fermented product. (7mm radius)
2. Synthetic fungicide (triazole fungicide) (9mm of radius)

The Images and Pictures of the Public Outreach program at Numaish Industrial Exhibition, Nampally, Hyderabad.

Crop Protection through Bird Scaring Using Artificial Intelligence Assistant Unmanned Aerial Vehicles (UAVs)

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Introduction:

Recently Unmanned Aerial Vehicles (or) Drones have gained a widespread applicability in different applications including agriculture, health care, goods delivery etc. Among these sectors, agriculture sector has attained major concentration by involving drones at various stages like seeding, pest control, pesticide spraying etc. With such inspiration, this project developed a novel prototype to control the loss in the yield. A new drone-based prototype is developed to scare the bird flocks from crops. Since the bird flocks creates so much damage to the crop, their prevention is necessary. In the state-of-art, several manual methods are deployed like stretching the net over entire crop, gun firing, drum beating etc. However, all of them are expensive and involves manual labor which creates addition cost burden over the farmers. Hence, this project developed a drone-based bird scaring system which automatically identifies the bird flocks and scares them without doing any harm to them. Moreover, the developed prototype can also cover larger area like 10-50 acres with less cost and time. The overall working schematic of developed prototype is shown in Figure.1.

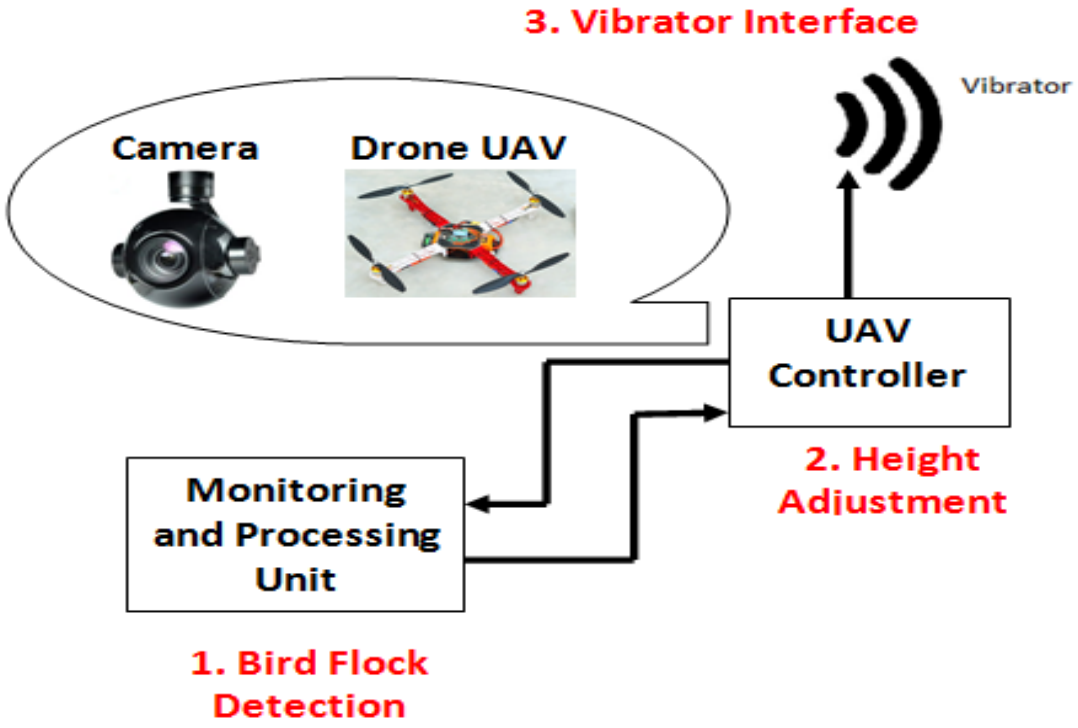

Figure.1 Overall working schematic

The working process of developed prototype is as follows:

Step 1. The monitoring and processing unit consists of a Raspberry Pi controller which takes the video as input and applies computer vision algorithm for the identification of bird flocks. The video is acquired through a camera mounted on the drone and connected to the Raspberry Pi controller. An example frames with birds is shown in Figure.2.

(a) (b)

Figure.2 (a) Samples frames showing bird flocks (b) Bird identiifed after compuervision algorithms

Step 2. The UAV controller adjusts the height of a drone based on the height of Birds. The developed prototype follows bird flocks continuously and scares them until they go very far from the crop. This is done by a Drone pilot who controls the fleet (height and direction) of drone. For this purpose, we used software called “Mission Planner” in which the drone fleet related programming is drone. The complete prototype is shown in Figure.3 and its fleet over different crops in shown in Figure.4.

Step 3. The vibrator is a simple type of buzzer mounted on the drone and it gets switched on when it receives a control signal from Raspberry Pi controller. The control signal signifies the presence of bird flocks and hence the vibrator turns on to scare them. It sounds continuously until the birds’ presence is there in the crop. Once the birds are moved away, the buzzer sounds off and the prototype lands off on the ground.

Figure.3 complete prototype

(a) (b)

Figure.4 prototype fleet on (a) Mustard crop and (b) Paddy

Biochemical Characterization and Inhibitor Screening Against Essential Protein (Rv1462) in Mycobacterium Tuberculosis for Novel Druggable Target

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Osmania University, Hyderabad-500007

Objectives:

- Overexpression and purification of Rv1462 protein by affinity column chromatography.
- Biochemical and biophysical characterization of Rv1462 protein by biological assays, dynamic light scattering and isothermal calorimetry.
- Structure based virtual screening and identification of novel inhibitors of Rv1462 as potent antitubercular agents against M. tuberculosis.

Summary:

- Cloning of Rv1462 gene in SUMO-pRSFDUET-1 vector.
- Standardization and optimization protocol for overexpression and purification of SUMO-Rv1462 fusion protein using Ni-NTA affinity chromatography.
- Purification of SUMO-Rv1462 protein by Fast Protein liquid chromatography to acquire pure protein that can be used for biological assays and structural analysis.
- Prediction of 3D-structure and ligand binding sites of Rv1462 protein using Homology modeling and Cofactor tool.
- Virtual screening and identification of novel inhibitors for Rv1462 protein.
- Overexpression and purification of ULP1 protease enzyme protein using Ni-NTA affinity chromatography and Fast Protein liquid chromatography to retain enzyme biological activity.

Methodology:

1. Cloning of Rv1462 gene in Sumo-pRSFDUET1 vector

The gene coding for Rv1462 was PCR amplified from pET28a-Rv1462 plasmid using Taq DNA polymerase (Takara). After amplification of the target gene by sense (CGGGATCCATGACCGCTCCTGGTC) and antisense(CCGCTCGAGTTAGCTCACGGTGG)

primers corresponding to the 5' and 3' sequence of Rv1462 gene, the PCR-amplified fragment was digested with BamHI and XhoI. It was then cloned into the vector Sumo-pRSFDUET1 encoding Sumo tag and N-terminal hexahistidine tag to facilitate soluble expression and purification respectively. Plasmids isolated from transformed colonies when subjected to restriction digestion with BamHI and XhoI enzymes released Rv1462 insert from Sumo-pRSFDUET1 vector revealing that cloning was successful. Additionally, PCR check with gene specific primers resulted in a band at around 1.2kb thus confirming the presence of Rv1462 gene in positive clone. The sequence of positive clone was determined by DNA sequencing using gene specific primers. The sequences generated from the sequencer were perfectly aligned with Rv1462 sequence deposited in mycobrowser database revealing that there were no mutations in the cloned sequence.

2. Optimization of overexpression of Rv1462 protein

2.1 Optimization of protein overexpression with varying IPTG concentration ranging from 50µM -1mM

Overexpression of protein was performed as follows: A small aliquot(5-10µl) of bacterial glycerol stock was grown in 5 ml of LB brothovernight at 37 oC. The overnight culture was reinoculated in 10ml fresh LB broth tubes and grown until the absorbance 600 was 0.6-0.8 at 37 oC. 1ml of culture was collected from each of these cultures and serve as uninduced samples. The remaining culture was used for overexpression and was induced by the addition of 50 µM ,75 µM ,100 µM ,250 µM ,500 µM ,1mM Isopropyl-D-thiogalactopyranoside (IPTG) in each culture. The temperature was switched to 30oC and the culture allowed to incubate for another 4hrs. All steps were performed in the presence of kanamycin (50µg/ml) with shaking at 200rpm. After incubation cells were pelleted and resuspended in lysis buffer (50 mM Tris/HCl, 500mM NaCl,1% Triton X, 10mM DTT,10mM ß-mercaptoethanol). The cells were lysed by sonication using 5min pulse on and 5 min pulse off at 70% of maximum power. After sonication the cell lysate was subjected to centrifugation to separate supernatant and pellet fractions. The samples from both the fractions were dissolved in 4X SDS loading buffer and run on SDS-PAGE.

2.2 Optimization of protein overexpression at different temperatures ranging from 18°C to 37°C with 1mM IPTG concentration

Overexpression of protein was performed as follows: A small aliquot(5-10µl) of bacterial glycerol stock was grown in 5 ml of LB broth overnight at 37 oC. The overnight culture was reinoculated in 10ml fresh LB broth tubes and grown until the absorbance600 was 0.6-0.8 at 37 oC. 1ml of culture was collected from each of these cultures and serve as uninduced samples. The remaining culture was used for overexpression and was induced by the addition of 1mM Isopropyl-D-thiogalactopyranoside (IPTG) in each culture and each tube is incubated at varying temperatures such as 37oC, 30oC, 25oC, 18oC for 3hrs, 4hrs, 8hrs and 16hrs respectively . All steps were performed in the presence of kanamycin (50µg/ml) with shaking at 200rpm. After incubation cells were pelleted and resuspended in lysis buffer (50 mM Tris/HCl, 500mM NaCl,1% Triton X, 10mM DTT,10mM ß-mercaptoethanol). The cells were lysed by sonication using 5min pulse on and 5 min pulse off at 70% of maximum power. After sonication the cell lysate was subjected to centrifugation to separate supernatant and pellet fractions. Both uninduced and induced pellet samples were dissolved in 4X SDS loading buffer and run on SDS-PAGE.

3. Protocol optimization for purification of Rv1462 protein using Ni-NTA affinity chromatography

Overexpression and SDS-PAGE was performed as above-mentioned protocol. Protein was extracted from soluble fraction by resuspending pellet in lysis buffer (50mM Tis-HCl, 500mM NaCl, 1% (v/v) Triton X-100). The cells were lysed by sonication using 5min pulse on and 5 min pulse off at 70% of maximum power. After sonication the cell lysate was subjected to centrifugation to separate supernatant and pellet fractions. The supernatant was subjected to binding with Nickel-nitrilotriacetic acid (Ni-NTA) beads for 2hrs at 4oC. Purification was carried out using immobilized metal affinity chromatography which is referred here as Ni-NTA affinity chromatography. The column was equilibrated with pH-

8.0 buffer A (25mM Tris-HCl, 500mM NaCl, 10mM imidazole), washed with pH-8.0 buffer B (25mM Tris-HCl, 500mM NaCl, 20mM imidazole) and finally protein was eluted with pH-8.0 elution buffer (25mM Tris-HCl, 500mM NaCl, 300mM imidazole). The eluted protein concentrations were determined using nanodrop. Furthermore, different fractions such as supernatant, pellet, flow through, wash and elutions were run on SDS-PAGE to trace the protein of interest (POI).

4. Prediction of 3D-structure and ligand binding sites of Rv1462 protein using Homology modeling and Cofactor tool

Determination of 3D-structures of proteins facilitate structure-based drug discovery. Knowledge of protein active, catalytic and binding sites is the need of the hour to carry out biological and inhibition assays. Hence, we predicted structure of Rv1462 protein using ITASSER tool. The Rv1462 protein sequence was retrieved from mycobrowser database in fast format and given as input for ITASSER server. The best built model was further beautified using pymol tool. Furthermore, ligand binding residues of Rv1462 protein were predicted using Cofactor tool.

5. Virtual screening and identification of novel inhibitors for Rv1462 protein

Various Quinazolinone molecules were analyzed through molecular docking using Autodock Vina 1.5.6 software. The modelled protein (Rv1462) was loaded into Autodock Vina and the molecule was prepared by addition of missing bonds or atoms, and removal of extraneous structures such as water molecules. Afterward ligand. pdbqt is loaded and grid box was generated by selecting “Center on ligand” and saved it. Configuration file was prepared for ligand and its coordinate based on grid output txt file and molecular docking was performed by “Command Prompt” and the output file was saved as log.txt. Thereafter all the selected ligands are prepared by ChemDraw Ultra and converted to 3D structure and saved as pdb files. Molecular docking was performed on optimized structure of protein and the ligand interaction 2D and 3D representations were acquired using Discovery studio.

6. Overexpression and purification of ULP1 protease enzyme

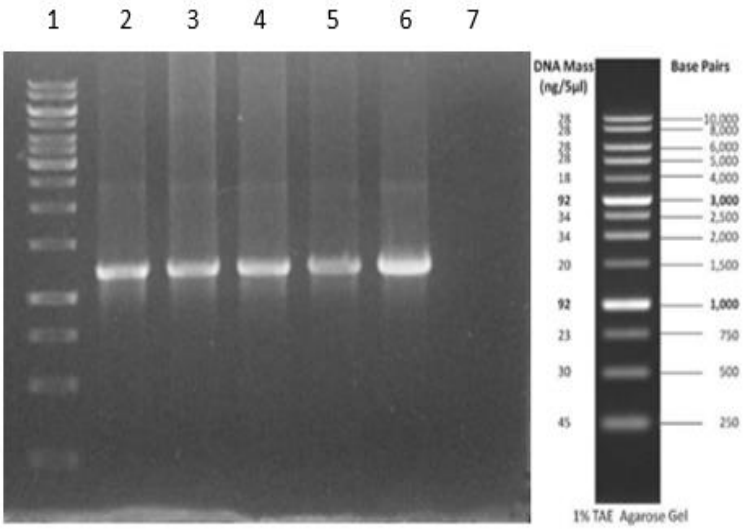
A small aliquot(5-10µl) of bacterial glycerol stock was grown in 5 ml of LB broth overnight at 37 oC. The overnight culture was reinoculated in 10ml fresh LB broth tubes and grown until the absorbance 600 was 0.6-0.8 at 37 oC. 1ml of culture was collected from each of these cultures and serve as uninduced samples. The remaining culture was used for overexpression and was induced by the addition of 1mM Isopropyl-D-thiogalactopyranoside (IPTG) and incubated at 16oC for 16hrs. All steps were performed in the presence of kanamycin (50µg/ml) with shaking at 200rpm. After incubation cells were pelleted and resuspended in lysis buffer (50 mM Tris/HCl, 500mM NaCl,1% Triton X, 10mM DTT,10mM ß-mercaptoethanol). The cells were lysed by sonication using 5min pulse on and 5 min pulse off at 70% of maximum power. After sonication the cell lysate was subjected to centrifugation to separate supernatant and pellet fractions. The supernatant was subjected to binding with Nickel-nitrilotriacetic acid (Ni-NTA) beads for 2hrs at 4oC. Purification was carried out using immobilized metal affinity chromatography which is referred here as Ni-NTA affinity chromatography. The column was equilibrated with pH-8.0 buffer A (50mM Tris-HCl, 500mM NaCl, 20mM imidazole, 3mM ß-mercaptoethanol),

washed with pH-8.0 buffer B (50mM Tris-HCl, 500mM NaCl, 20mM imidazole) and finally protein was eluted with pH-8.0 elution buffer (25mM Tris-HCl, 500mM NaCl, 1M imidazole). The eluted protein concentrations were determined using nanodrop. Furthermore, different fractions such as supernatant, pellet, flow through, wash and elutions were run on SDS-PAGE to trace the protein of interest (POI).

RESULTS AND DISCUSSION:

1. Cloning of Rv1462 gene

Plasmids were isolated from cells and when subjected to PCR with gene specific primers amplified Rv1462 insert from Sumo-pRSFDUET1 vector revealing that cloning was successful.



Lane	Sample
1	1Kb ladder
2	Clone1 plasmid
3	Clone2 plasmid
4	Clone3 plasmid
5	Clone4 plasmid
6	Positive control
7.	Negative control

Fig:1 Confirmation of clones with PCR

2. Optimization of overexpression of Rv1462 protein

2.1 Optimization of protein overexpression with IPTG concentration ranging from 50µM - 1m

Overexpression at 1mM, 500 µM, 250 µM, 100 µM, 75 µM, 50 µM were carried out as an attempt to achieve maximum expression of the recombinant protein. Over expression bands were observed between 30kDa and 37kDa marker. Expression rate varied at different IPTG concentration in media being maximum at 1mM and minimum at 50 µM suggesting 1mM IPTG as the optimized concentration for large scale experiments. Overexpression bands were visible only in soluble fractions.

2.2 Optimization of protein overexpression at different temperatures ranging from 18°C to 37°C with 1mM IPTG concentration.

Overexpression at 18°C, 25°C, 30°C, and 37°C were carried out for 14-16, 12, 6, and 3 h respectively as an attempt to achieve highest and soluble expression of the recombinant protein. Overexpression bands were observed between 30 kDa and 37 kDa marker. Expression rate varied at different temperature being maximum at 18°C and minimum at 37°C suggesting lower temperatures for large scale experiments. Overexpression bands were visible in soluble fractions. Hence, it was decided to induce cultures at 18°C for maximum protein expression at a stable rate for further trials.

3. Protocol optimization for purification of Rv1462 protein using Ni-NTA affinity chromatography

Overexpression band was observed in soluble fraction. Recombinant protein was obtained and checked for a band of 56KDa.

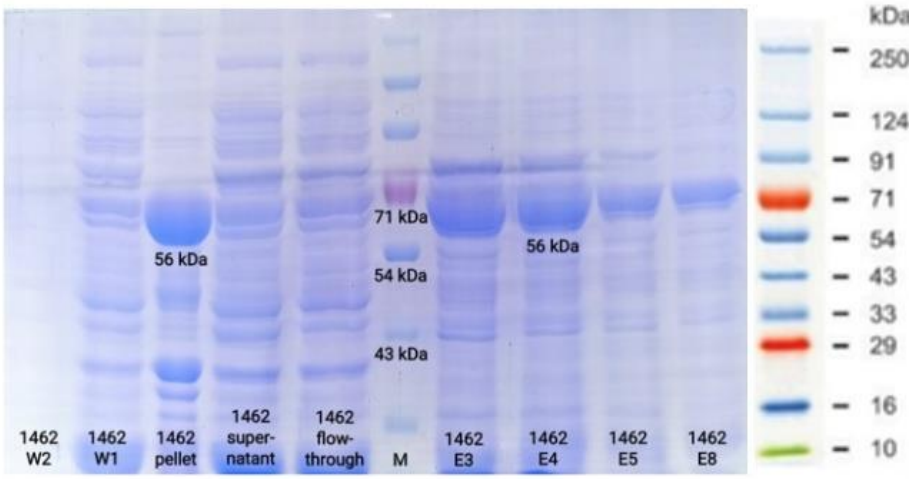


Fig:2 Purification of Rv1462 protein

Purification of Rv1462 protein by Fast Protein liquid chromatography

Fig:3 Purification of Rv1462 protein

4. Prediction of 3D-structure and ligand binding sites for Rv1462 protein

I-TASSER used the TM-align structural alignment program to identify best templates in the PDB library. This section reported top 10 proteins from the PDB that have the closest structural similarity to the predicted I-TASSER model (TM score). TM score of model 1 was found to be 0.7 and its structural analog in PDB was identified as 2ZU0. TM score of >0.5 suggests the correct topology and can be used for determining the structure class or protein family of the predicted query protein structure. From these results it was confirmed that models were predicted accurately and demonstrate that in Rv1462 most of

the residues form alpha helix followed by random coils and least form beta strands. Furthermore, ligand binding site of Rv1462 protein were predicted as 37, 40, 41, 287, 302, 304, 305, 306, 308, 309, 310, 311, 312, 313, 314, 315, 316, 317, 318, 319, 320, 321, 323, 325, 326, 327, 328, 329, 330, 331, 332, 333 residues using Cofactor tool.

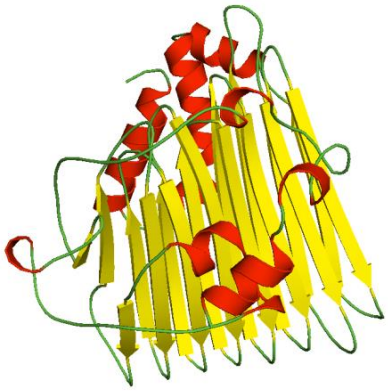


Fig:4 Homology model building for Rv1462 protein

5. Virtual screening and identification of novel inhibitors for Rv1462 protein

Quinazolinones are an important class of fused heterocycles with a wide range of biological activities like anti-inflammatory, antimicrobial, antioxidant, anticancer and antihypertensive activities. It has been reported that substitution of different heterocyclic moieties at 2 or 3 position of quinazolinone nucleus modulates the biological activity. It is a versatile lead molecule for the design of potential bioactive agents. This characteristic feature of quinazolinones would make a good template for a lead generation library. The quinazolinone moiety is a building block for approximately 150 naturally occurring alkaloids and drugs.Therefore these molecules were subjected to virtual screening and molecular docking. Results obtained through this study identified Auronamide B and Auronamide C as potential Rv1462 inhibitors with binding energy scores as -5.27 and -6.15 respectively. For in-depth study of the binding interaction, we have selected the best posed ligand and the 2D interactions ligand with Rv1462 protein revealed binding at the active site of protein.

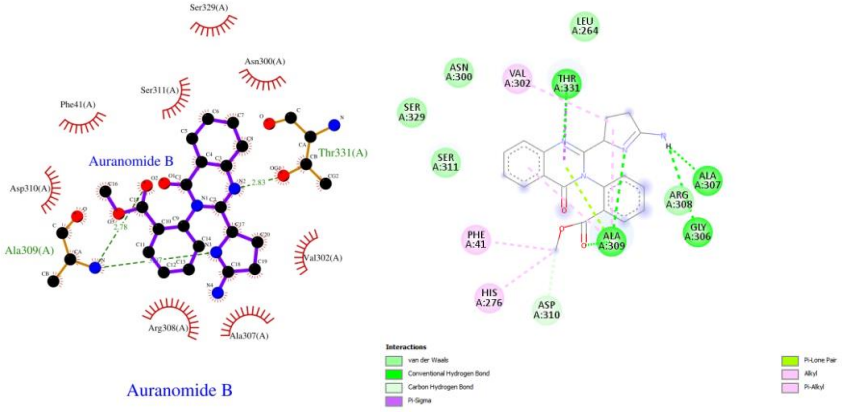


Fig:5 Molecular docking studies of Auronamide B with Rv1462 protein

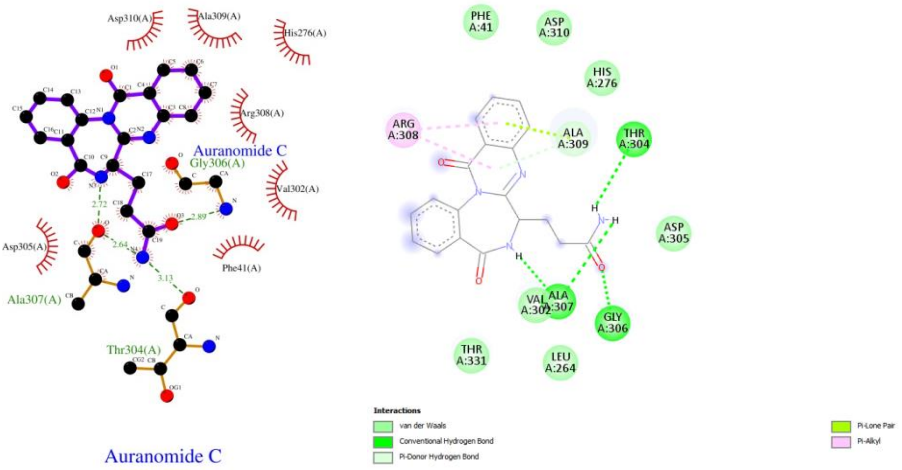
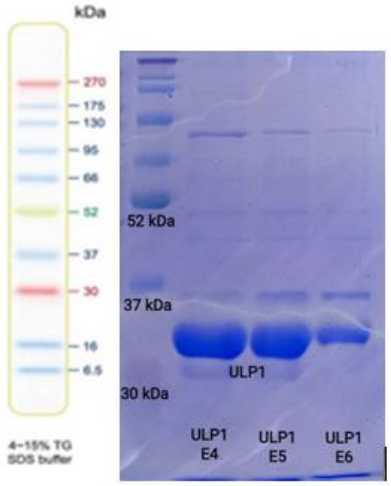


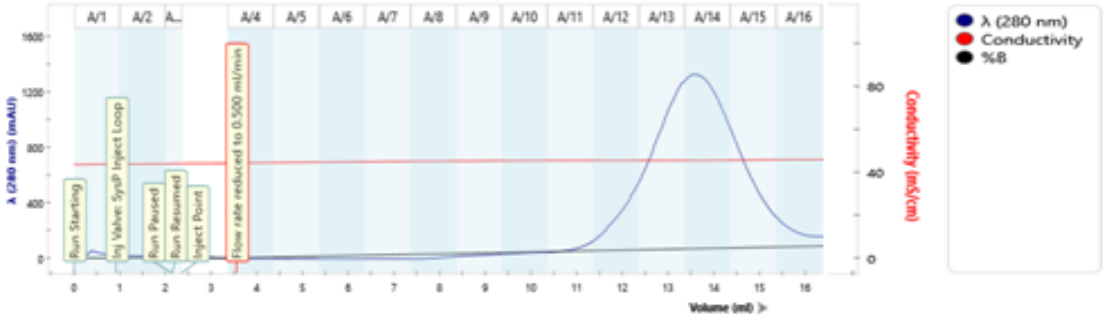
Fig:6 Molecular docking studies of Auronamide C with Rv1462 protein

6. Overexpression and purification of ULP1 protease enzyme

Overexpression band was observed in soluble fraction. ULP1 protease protein was purified and checked for a band of 33KDa.



Purification of ULP1 protease by Fast Protein liquid chromatography



Conclusion:

- Cloning of Rv1462 gene in Sumo-pRSFDUET1 vector increases protein solubility facilitating crystallization studies
- Optimization of overexpression revealed higher expression of Rv1462 protein after 16 hours of induction with 1mM Isopropyl-ß-D-thiogalactopyranoside at 18°C
- The expressed protein was collected in the soluble fraction of cell lysate, purified using Ni-NTA affinity column chromatography and Fast Protein Liquid Chromatography. SDS-PAGE analysis demonstrated that our construct efficiently produces target recombinant protein with a molecular weight of 56 KDa
- Insilico prediction of 3D-structure for Rv1462 protein enables virtual screening of Quinazolinones and Auronamide B and Auronamide C were identified as potent inhibitors.
- Purification of ULP1 protease enzyme aid in cleavage of Sumo tag and histidine tag facilitating generation of native Rv1462 protein for biophysical and biochemical experiments.

Sustainable use of Coal Gangue for Geotechnical and Geo-Environmental Applications

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National Institute of Technology, Warangal

Introduction:

Safe disposal of coal mine waste is a serious problem effecting mining authorities. Huge piles of non- combustible coal mine waste, also known as coal-gangue (CG) is dumped in open lands that are environmental harmful and suffering local occupants. Direct interaction of rainwater with CG lead to formation of acidic leachate, which pollute the ground water and surrounding farm lands. In view of these, this study has evaluated various Geotechnical means for the Sustainable use of CG for different Infrastructure Construction activities such as a fill material in embankment, as a subgrade and subbase material in pavements and as a landfill liner material.

The following are the Comprehensive objectives identified for this study:

1. To evaluate geotechnical, chemical, mineralogical and environmental characteristics of
2. CG.
3. To evaluate the trace metal element leaching characteristics from coal gangue.
4. To evaluate the performance of coal gangue treated with Calcium Carbide Residue
5. To estimate the environmental impact of coal gangue utilization by performing Carbon
6. Footprint Analysis (CFA) and Cost Analysis (CA).
7. To perform stability analysis on CG based embankments and reinforced earth wall.
8. To evaluate the performance of CG based geopolymer (A novel Cementitious Project)

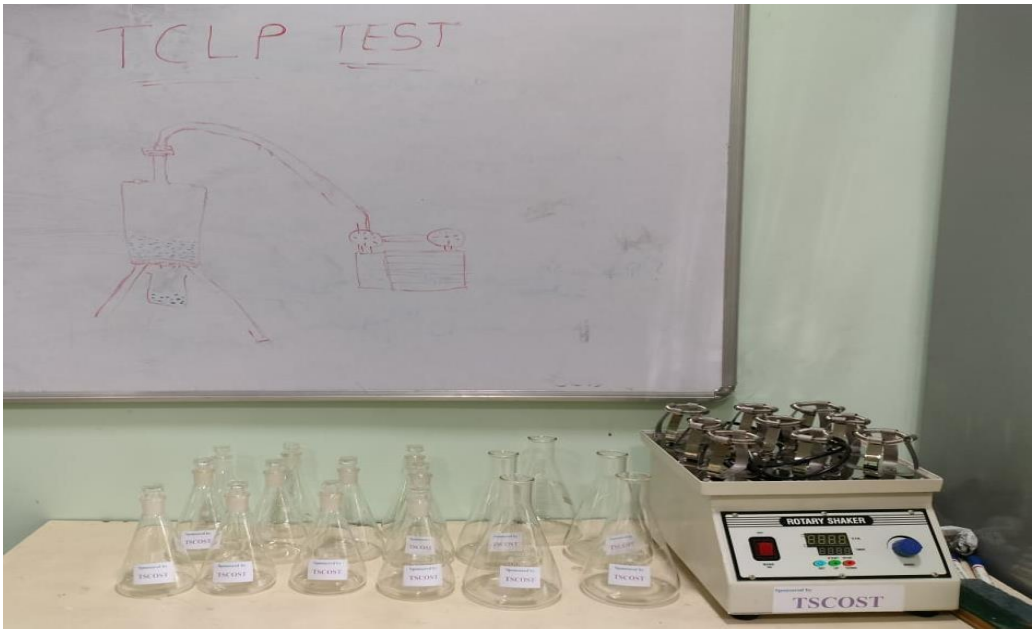


Figure 1: Apparatus procured through grants aided from TS-COST

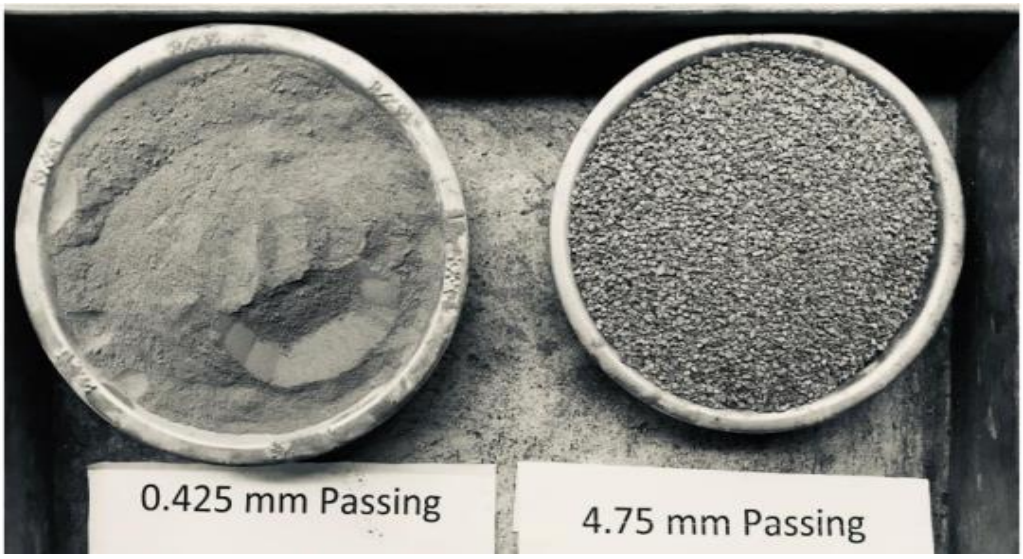


Figure 2. Coal Gangue Fractions used in this study

Figure 3. Leaching Apparatus for testing contaminant migration

Geotechnical Characterization:

Figure-2 depicts the photographs of CG used for this study, where in two fractions of CG 0.425mm passing material for liner/filler applications and 4.75mm passing materials is for pavement subgrade/embankment applications. The physical and geotechnical characterization of CG are tabulated in Table 2. All the tests were performed in

accordance with standard recommendation in IS2720 and ASTM code provisions. Further, the detailed grain size distribution of CG passing through 4.75mm sieve is compared with conventional materials like fly-ash and alternate mine tailings in Figure 4. The physical and Geotechnical characteristics preliminarily ascertain the possible use of CG for various Geotechnical applications.

Table 2. Physical and Geotechnical Characteristics of Coal Gangue

Property	Value	Value
Grain Size Distribution(GSD)		
Coefficient of Uniformity	2.2	4.1
Coefficient of Curvature	0.7	0.7
Proctor Compaction Characteristics		
Optimum Moisture Content (%)	15	17
Maximum Dry Density (g/cc)	1.8	1.76
Hydraulic Conductivity (cm/s)	6.4×10^{-4}	2.9×10^{-3}
Shear Strength Parameters		
Effective Cohesion (kN/m^2)	26	32
Effective Angle of Internal Friction	39°	43°
California Bearing Ratio (%)		
Unsoaked Conditions	19	27
Soaked Conditions	18	26
Coefficient of Consolidation, Cv (cm^2/sec)	0.06	0.077

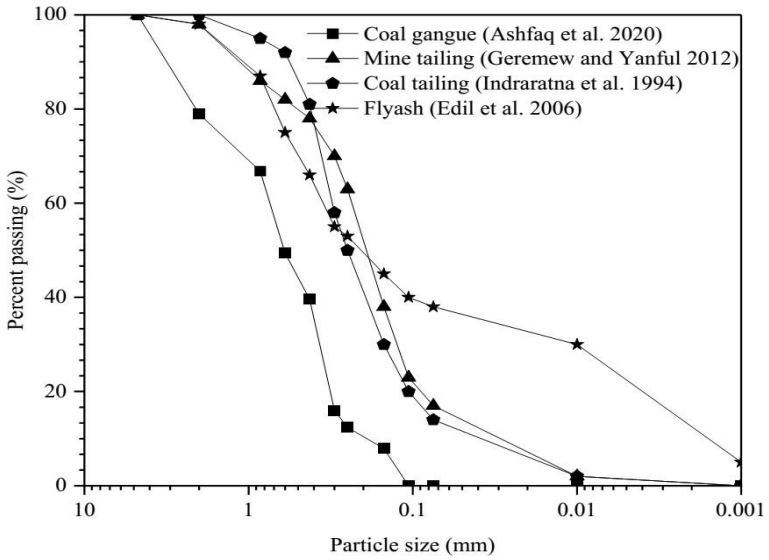


Figure 4. Grain size distribution of CG (passing 4.75mm) and alternate materials

Table 3 summarises the important chemical properties that are relevant with regard to the leaching characteristics of materials used in geotechnical applications. The pH of coal gangue is found to be slightly alkaline and the EC, TDS values support its alkalinity. Similar observations have been reported by Padmakumar et al., (2012) for sandy soils. The alkaline nature of coal gangue makes it corrosion free, thereby allowing its utilization in reinforced cement concrete. The X-ray fluorescence testing results in Table 3 indicate that CG composition is predominantly constituted with silica (52.7) and

alumina (22.5) and accounted for 75.2%. Figure 5 depicts the X-ray Diffractograms of coal gangue, which indicate the presence of crystalline minerals namely Quartz (SiO2), Kaolinite ($Al_2Si_2O_5$ $(OH)_4$), Almandine ((MgO0.6Fe2.4)Al2(SiO4)3) and Diopside ($MgCaSi_2O_6$).

Table 3. Chemical Properties and Composition of CG

A. Chemical Properties	
Property	*Value*
pH	7.2
Electrical Conductivity (µs/cm)	260
Total Dissolved Solids (ppm)	160
B. Chemical Composition	
Constituents	*Value (%)*
Silica (SiO_2)	52.70
Alumina (Al_2O_3)	22.60
Ferric (Fe_2O_3)	6.37
Calcium (CaO)	3.45
Magnesium(MgO)	1.72
Titanium (TiO_2)	0.98
Potassium (K_2O)	2.68
Sulphur (SO_3)	0.53
Sodium (Na_2O)	0.75
Loss on ignition	8.22

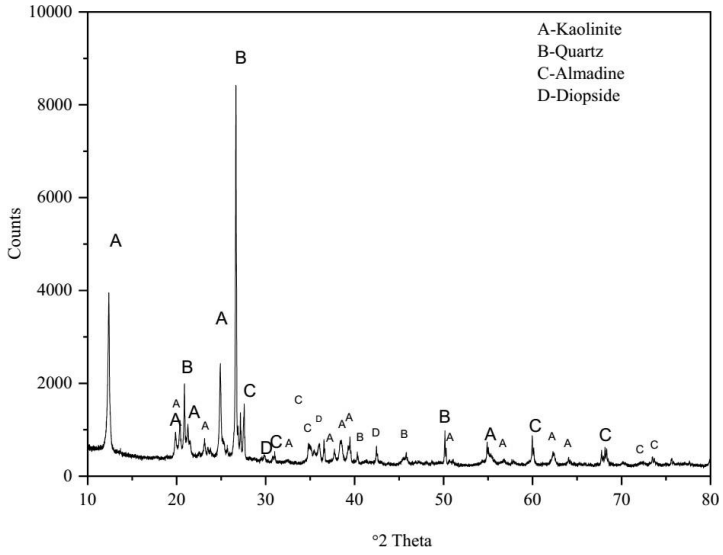


Figure 5. X-Ray Diffractograms of Coal Gangue

Compaction and Shear Characteristics

The compaction behavior of any geometrical demonstrates the viability of its use in embankments or earthen dams. From the compaction results presented in Figure 6 it can be observed that the maximum dry density (MDD) and optimum moisture content (OMC) of CG are 1.99 (g/cm3), 16% and 2.31 (g/cm3), 18% for standard and modified compaction, respectively. Further, the relatively lower MDD values of CG facilitates its greater

workability as a fill material with relatively lower lateral earth pressure compared to conventional fill materials.

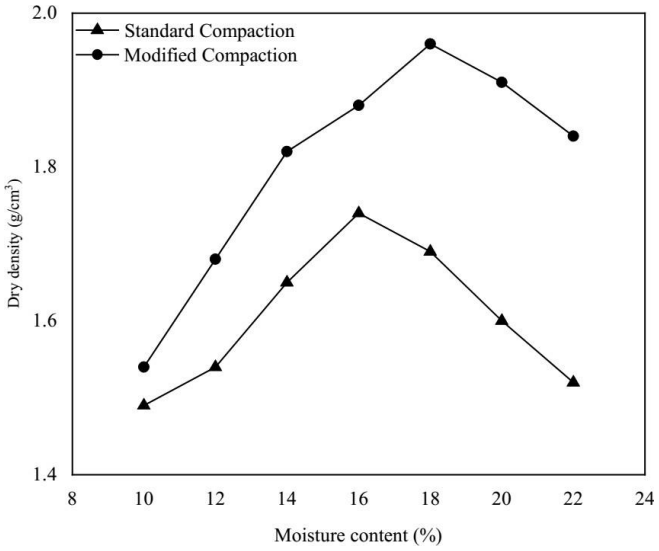


Figure 6: Standard and Modified compaction characteristics of coal Gangue

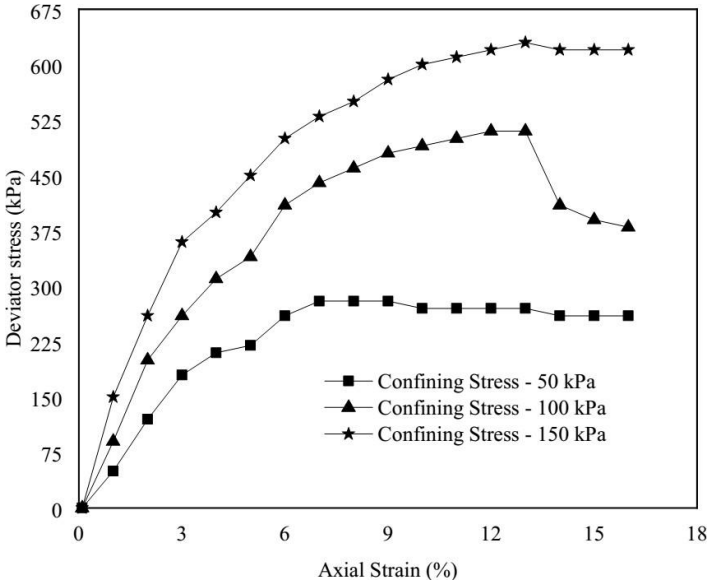


Figure 7: Triaxial shear strength testing results of CG at various confining stresses

In order to study the effect of confining stress (CS) on the stress-strain behaviour of CG, unconsolidated undrained tri-axial test was performed and the results are presented in Figure 7. This distinct stress-strain behaviour of CG can be attributed to dense interlocking arrangement of CG particles which yields higher frictional resistance with relatively higher void ratio. Further from the direct shear testing of CG, the shear strength parameters i.e. cohesion (C) and angle of frictional resistance (φ) are observed to be 26 & 32 kN/m2 and 39° & 43° respectively. Similar observations for bottom ash were made by Huang and Lovell, (1990). The favourable shear strength parameters of coal gangue provide a viable substitute to the traditional geomaterial in the construction of embankments.

Seepage and Compression Characteristics:

From the hydraulic conductivity tests, it is noted that hydraulic conductivity of CG varies between 10-3 and 10-4 cm/s which is comparable to high permeable soils such as sands. These values of CG were relatively lower compared to coal combustion residues like flyash and pond ash. The lower HC can also be attributed to the presence of traces of coal and clay fraction. Based on the hydraulic conductivity of coal gangue, it can be inferred that coal gangue exhibits excellent drainage characteristics and can be used as an alternate filter material for earthen dams.

The coefficient of consolidation (Cv) of coal gangue is noted to be in the order of 0.06 - 0.077 (cm2/s) (Table 4.1). The Cv value of coal gangue is very high compared to natural soils with the attainment of primary consolidation in a short duration (minutes). With this in view, it is expected that primary consolidation completes during the construction phase with relatively negligible settlements postconstruction. The favourable compressibility behaviour of coal gangue makes it an alternative fill material in embankments and structural fills. Similar observations were made for flyash and coal ash (Pandian, 2004; Prakash and Sridharan, 2009).

CBR Strength and Collapsible characteristics:

To assess the viability of using coal gangue for road embankments and subgrade of the pavements, understanding the CBR behaviour is essential. The load vs penetration curves for 0.425 mm passing fraction are presented in figure 4.6 and it can be noted that the maximum penetration attainable for soaked and unsoaked conditions were identical and it was around 13% and the corresponding load was close to 3000 kPa. The CBR observed is comparable to sands. Based on the CBR values, it is suggested that coal gangue can be used for backfilling narrow deep utility trenches under the pavements (Ghataora, Alobaidi and Billam, 2000; Sivapullaiah and Moghal, 2011). Further, it is implied that the observed CBR values of CG satisfy the design requirements for subgrade material as specified by IS 1498. However, the stabilization of CG with traditional additives like lime and cement can enhances its CBR value further, which is always desirable for any subgrade material. Similar observations for coal tailings were made by (Indraratna, 1994).

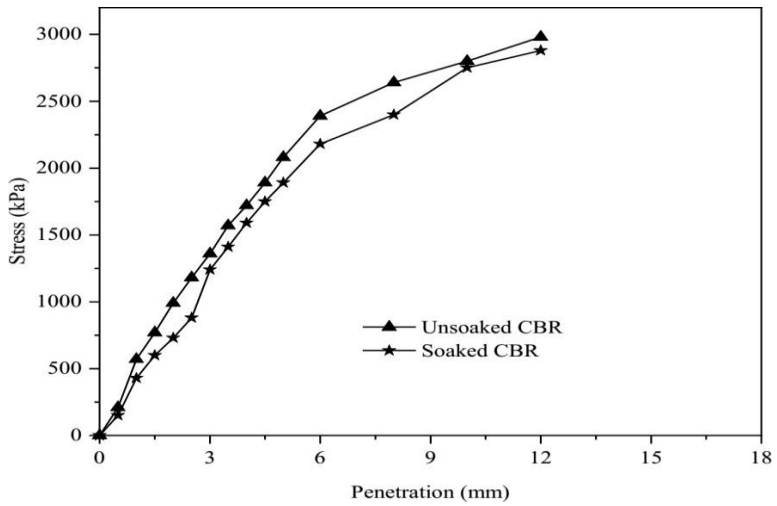


Figure 8. CBR testing results of coal gangue in soaked and un-soaked conditions

Collapsibility is a property of relevance to assess the susceptibility of fill material to one dimensional collapse with an increase in moisture content. Understanding collapse behavior is of paramount importance for materials used in hydraulic structures. In the present study, collapse potential was determined using the following equation:

$$Cv = \Delta e/(1 + e_o)$$

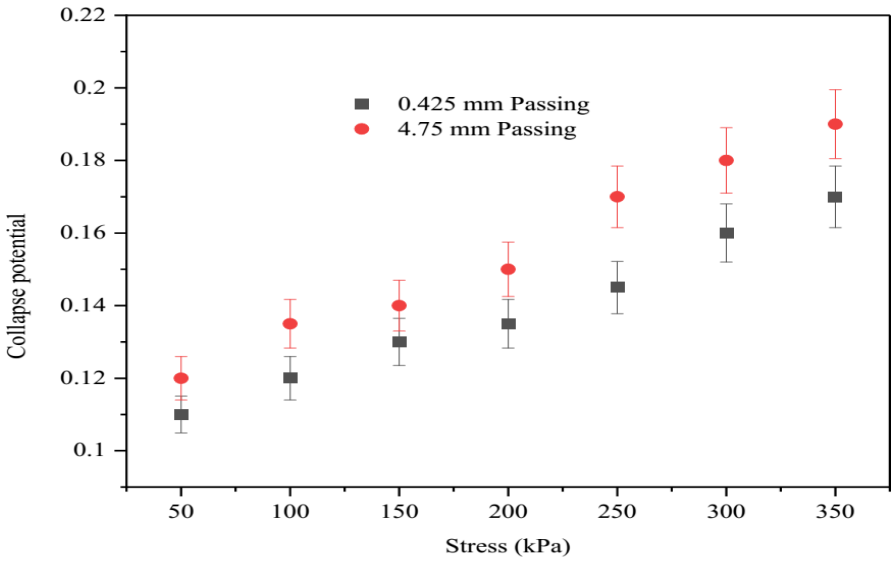
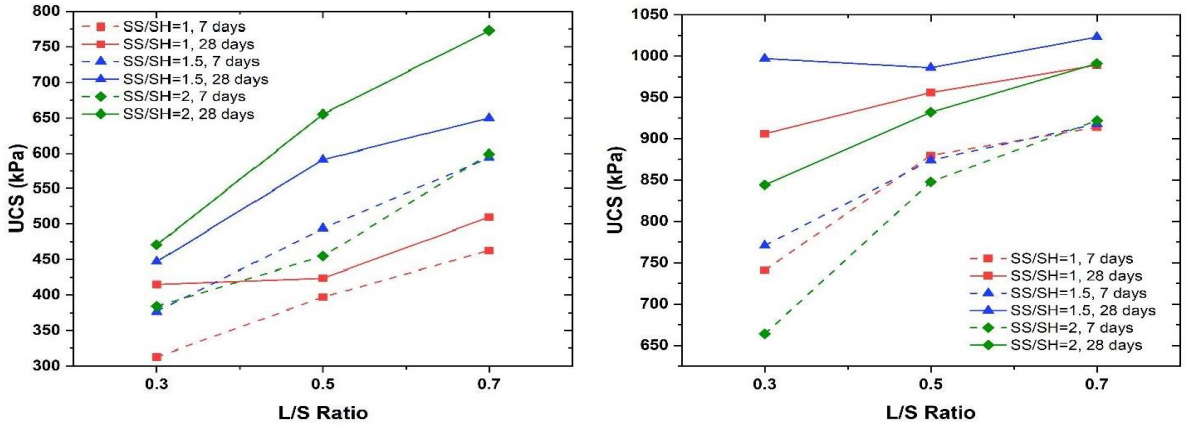


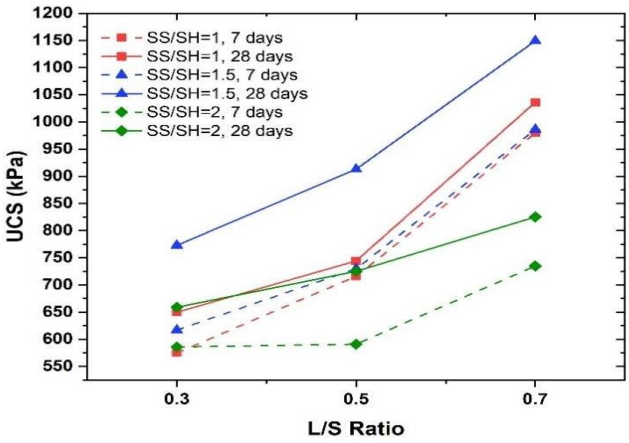
Figure 9. Collapse behaviour of coal Gangue

From Figure 9, it can be understood that for both fractions of coal gangue, the collapse potential is marginal at any given seating load (vertical stress). The loss of suction on wetting was not noticed in coal gangue and this point is further validated by negligible decrease in CBR values of soaked samples. Similar observations for coal ash were made by (Trivedi and Sud, 2004). The collapse potential of both the fractions of coal gangue is much lower than values reported for sands (Houston, Houston and Spadola, 1988; Indraratna, 1994). Thus, the utilization of coal gangue for embankments can sustain infiltration by heavy rainfall.

Novel Use of CG for Geo-polymers UCS of CG Based Geo-polymer:



(a) (b)



(c)

Figure 10 Response of Unconfined compressive strength with variation in L/S ratio a) BCS:CG=90:10; b) BCS:CG=80:20; c) BCS:CG=70:30

The effect of varying L/S ratio on the Unconfined Compressive Strength characteristic for various soil-binder compositions is reported in Figure 10. A significant increase in strength is observed for L/S equal to 0.3 and 0.7, irrespective of amount of CG present within. This is due to the rise in activator content which contributes to the dissolution of CG. The strength development was attributed to the rise in soluble silica concentration that induces silicon unit polymerization for all the precursor contents of 10%, 20%, and 30% of CG. Higher the silicate content, longer would be the silicate oligomers as well as Al-O-Si complexes contributing to more closely packed gels McCormick et al., 1989. Further, the strength of the soil is more after 28 days of curing when compared to 7 days irrespective of L/S ratio and SS/SH ratio (De Vargas et al., 2011, Duong and Skvara, 2016, Abdullah and Ahmad, 2017).

This behaviour is highly attributed to the evolution of short-term (i.e., cation exchange and flocculation-agglomeration) and long-term (i.e., pozzolanic and polymerization activity) reactions as well as the formation of more cementitious compounds like N-A-S-H gels in the voids. The interlocking of the clay particles during the development of these new materials results in tremendous strength.

Figure 11 reported that as the SS/SH ratio varies from 1.0 to 2.0, there is a continuous rise in UCS after 28 days of curing for 10% CG content. However, for increased CG contents of 20% and 30%, strength increased from SS/SH 1.0 to 1.5 and significantly decreased. The silicon enhancement in the matrix was responsible for the enhancement in the UCS of soil with change in CG concentration from 10% to 20% (Murmu et al., 2019). The alkali activator dissolves the silica and alumina in the CG dissolve effectively for SS/SH 1.0 and 1.5, which led to the creation of a monomer, followed by polycondensation, from which a geopolymer network including N-A-S-H gel was produced through the soil structure. But, in the case of 20% and 30% CG content, for beyond SS/SH = 1.5, the strength of the soil was reduced. This is ascribed to the surplus sodium silicate, which decelerates the geopolymerization by the precipitation of the Si-Al phase. This precipitation opposes to create the contact between the CG and activating solution (Kong

et al., 2007, Cheng et al., 2018, Y. Li etc., 2021). Prevalence of residual CG in the mix as a result of inadequate alkali activator content would account for lower strength for 30% when compared to 20% CG content (Heah et al., 2012).

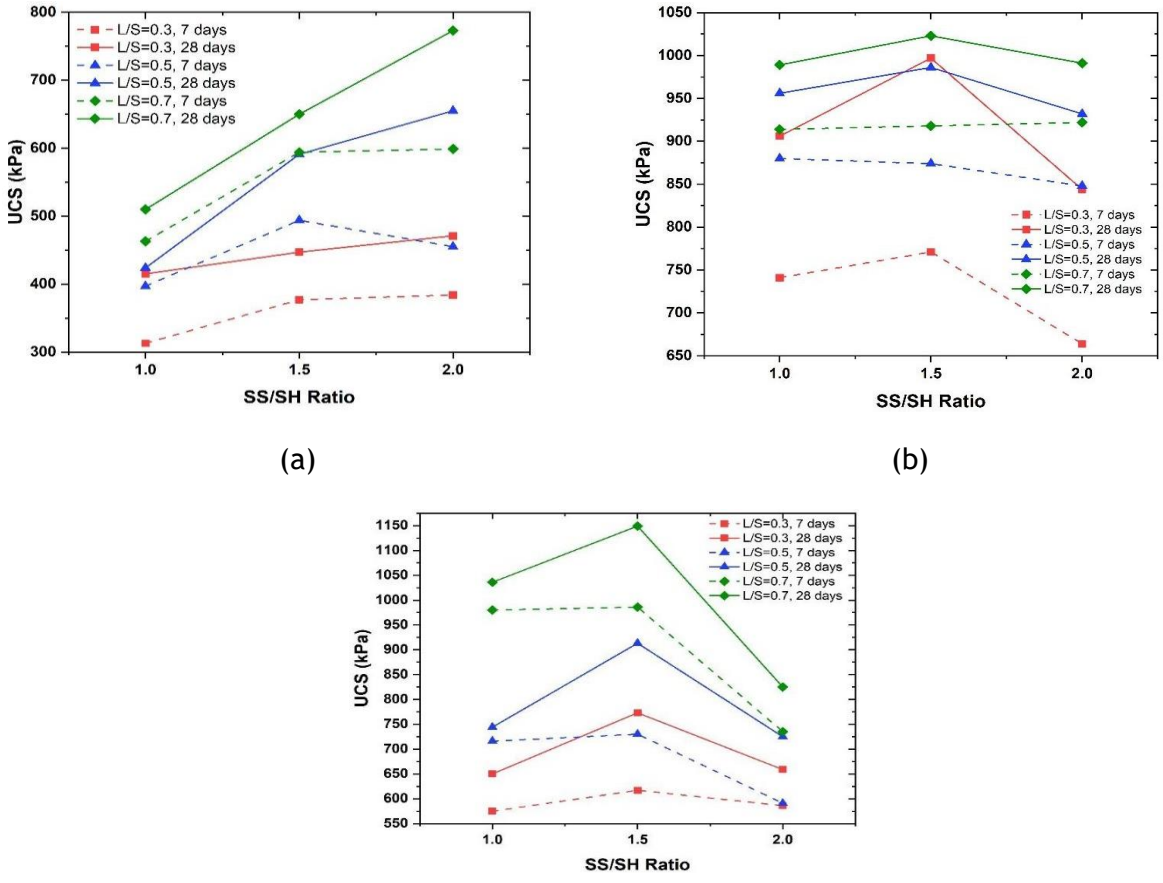


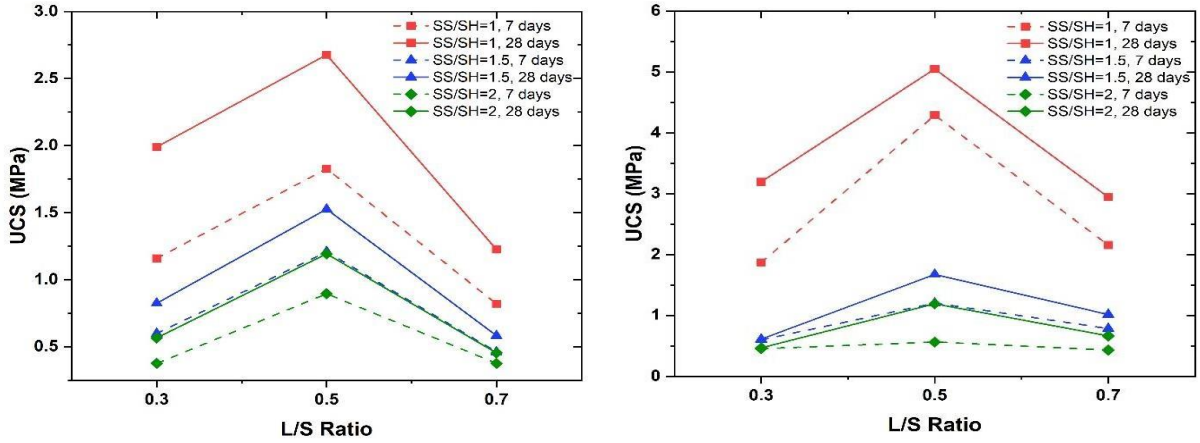
Figure 11 Response of Unconfined compressive strength with variation in SS/SH ratio a) BCS:CG=90:10; b) BCS:CG=80:20; c) BCS:CG=70:30

DURABILITY STUDIES OF CG BASED GEOPOLYMER:

The wetting and drying cycle of BCS stabilized with CG geopolymer at 20% and 30% CG content resulted in a substantial proportion of volume and mass losses for first cycle of wetting and drying. For 10% CG content, the samples got failed completely inspite of high strength (Figure 11a). This is due an inadequate durability of CG based geopolymer for alternate wetting and drying. Therefore, further study is conducted at 20% and 30% precursor content by partially replacing CG with GGBS in proportions of CG: GGBS=50:50 (CG and GGBS are proportioned in equal amounts 1:1) and CG: GGBS=25:75(CG and GGBS are considered in 1:3) in addition to the dosage of BCS. Similar study conducted by Alam et al., (Alam et al., 2019) where red mud and GGBS are blended together used as precursor showed improved durability. Relating this work, the mix proportions of the further study is considered as BCS:CG: GGBS=80:10:10 and BCS:CG: GGBS=80:05:15 for 20%

precursor content and BCS:CG:GGBS =70:15:15 and BCS:CG:GGBS= 70:7.5:22.5 for 30% precursor content respectively.

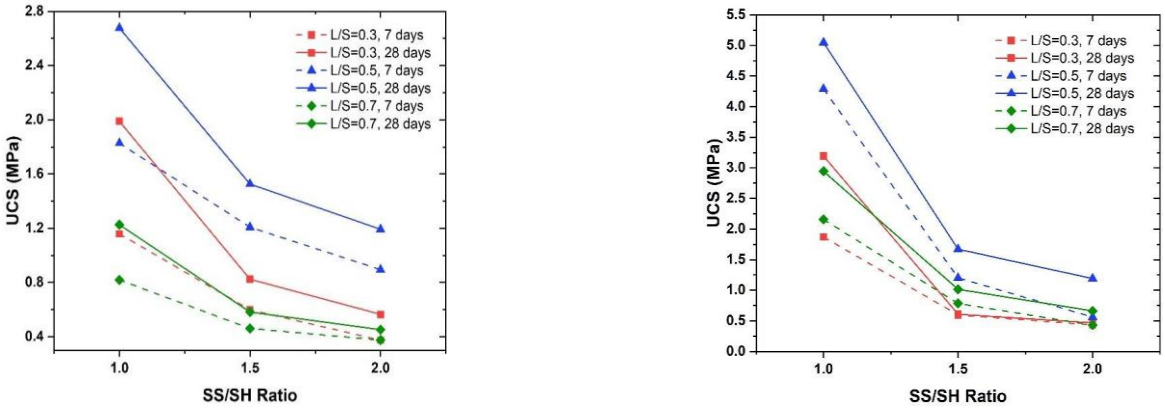
EFFECT OF GGBS CONTENT:



(a) (b)

Figure 12 Response of Unconfined compressive strength with variation in L/S ratio at CG: GGBS= 50:50 a) BCS:CG: GGBS=80:10:10; b) BCS:CG: GGBS=70:15:15

Figure 12 demonstrates the effect of varying L/S ratio on the unconfined compressive strength characteristics for various soil-binder compositions with CG: GGBS in 50:50 proportion. It is evident from the figure 12 that, there is a significant rise in strength from L/S of 0.3 to 0.5. Simultaneously, the strength is observed to decrease irrespective of the amount of precursor content present within. The strength was observed to be low at L/S of 0.3 and 0.7 due to insufficient activator content at L/S=0.3. While at L/S=0.7, the hydroxylation of CG and GGBS particles was hampered by the presence of fewer Al and Si species in the aqueous phase, that led to lower compressive strengths (Cheng et al., 2018, Imtiaz et al., 2020). Besides this, the strength is improved when the precursor dosage is increased from 20% to 30%. This is due to the calcium ion concentration in matrix (present in GGBS) which was escalated with increase in precursor content (Ma et al., 2019).



(a) (b)

Figure 13 Response of Unconfined compressive strength with variation in SS/SH ratio at CG: GGBS= 50:50 a) BCS:CG: GGBS=80:10:10; b) BCS:CG: GGBS=70:15:15

It was noticed that the strength is significantly reduced with increase in SS/SH ratio. For the ratio of silicate to hydroxide greater than 1.0, the matrix exhibits a porous microstructure with a decrease in the compactness which combined effect the compressive strength. The improvement in the strength of the soil with the variation of SS/SH ratio for CG-GGBS precursor is, due to the presence of high reactive silica content in GGBS which is a drawback in the case of CG alone. When CG and GGBS are combined, a new structure with a different silica to alumina ratio is produced. The activator caused the amorphous silica, alumina, and calcium present in GGBS to dissolve resulted in the formation of C-(A)-S-H gel in addition to N-A-S-H gel. This causes the coagulation rate to be higher, which likely increased the compressive strength significantly.

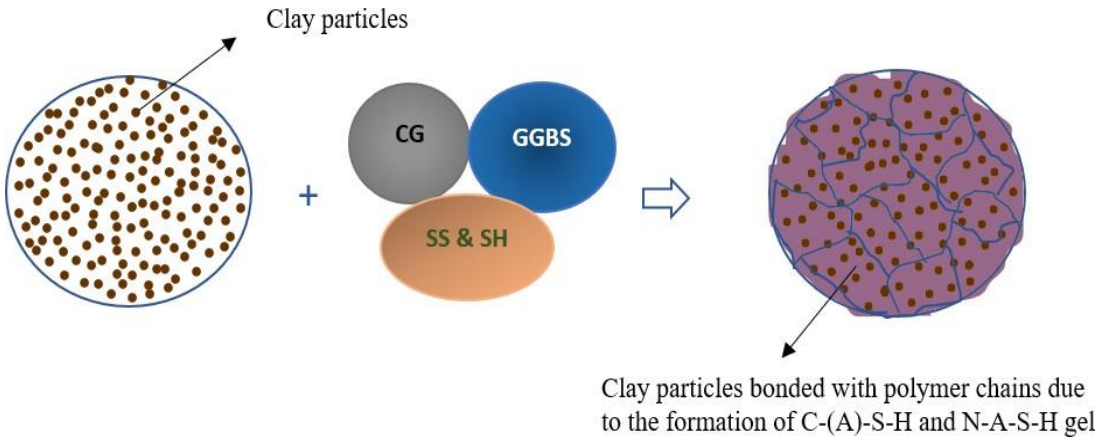


Figure 14 Possible mechanism of CG-GGBS-Geopolymer in treating Black Cotton Soil Effect of SS/SH ratio

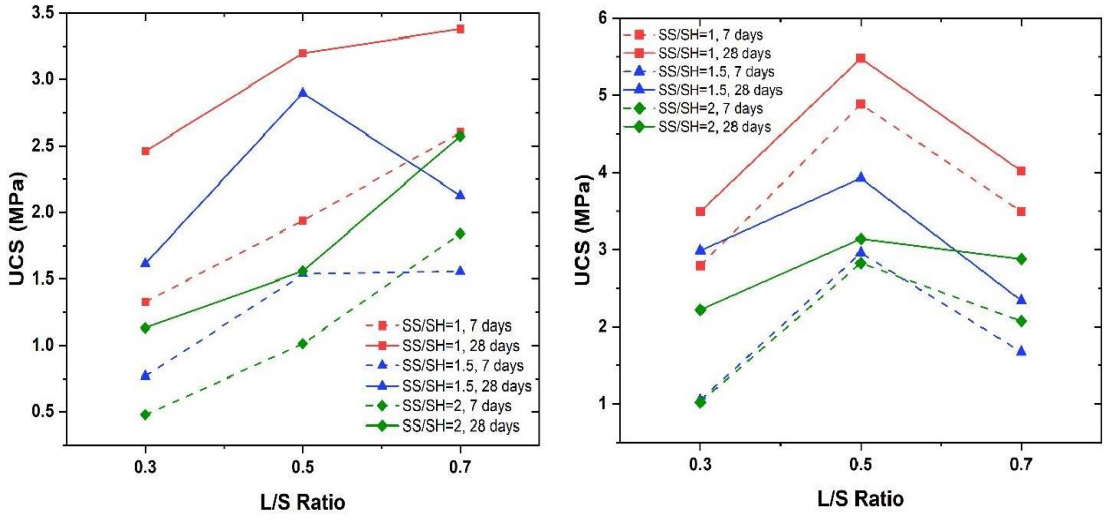


Figure 15 Response of Unconfined compressive strength with variation in L/S ratio at CG: GGBS= 25:75 a) BCS:CG: GGBS=80:05:15; b) BCS:CG: GGBS=70:7.5:22.5

As illustrated in figure 15, the patterns of development in strength for 20% and 30% precursor content with L/S ratios are nearly identical to those of CG: GGBS= 50:50 proportion. However, the strength for CG: GGBS= 25:75 proportion are observed to be greater than 50:50 proportion irrespective of the precursor content, L/S ratio, and SS/SH ratio. This is due to the increase in GGBS dosage leading to an increase in the reactive silica and CaO contents. High CaO content causes a reduction in microstructural porosity, which leads to the formation of CASH gel (Van Jaarsveld et al., 1998, Xu and Van Deventer, 2002). High CaO content also increases silicate and polysialate network formation and hardening throughout the matrix, which is more likely to result in strength development (Phair & Van Deventer, 2001).

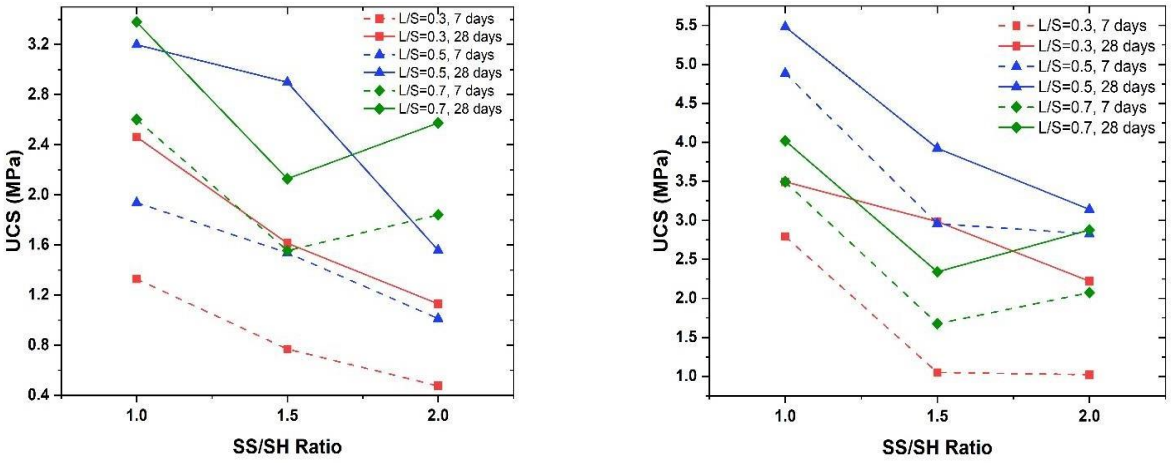


Figure. 16 Response of Unconfined compressive strength with variation in SS/SH ratio at CG: GGBS= 25:75 a) BCS:CG: GGBS=80:05:15; b) BCS:CG: GGBS=70:7.5:22.5

Figure 16 demonstrates the effect of SS/SH ratio on strength characteristics of CG-GGBS based binder for 25:75 proportion. In general, it is observed that the strength is reducing as the SS/SH ratio increased, which is likely due to reduced alkalinity caused by the addition of sodium silicate to sodium hydroxide, which in turn slows down the hydrolysis of the precursor (Duxson et al., 2005).

In contrast, for 20% and 30% precursor content at L/S=0.7, the strength is improved with an increase in SS/SH from 1.5 to 2.0. This is ascribed to the decreased ability of sodium silicate to produce alkalinity is probably countered by the rise in hydroxyl ions brought by the addition of more alkaline activator.

An increase in the reactive silica and CaO contents. High CaO content causes a reduction in microstructural porosity, which leads to the formation of CASH gel (Van Jaarsveld et al., 1998, Xu and Van Deventer, 2002). High CaO content also increases silicate and polysialate network formation and hardening throughout the matrix, which is more likely to result in strength development (Phair & Van Deventer, 2001).

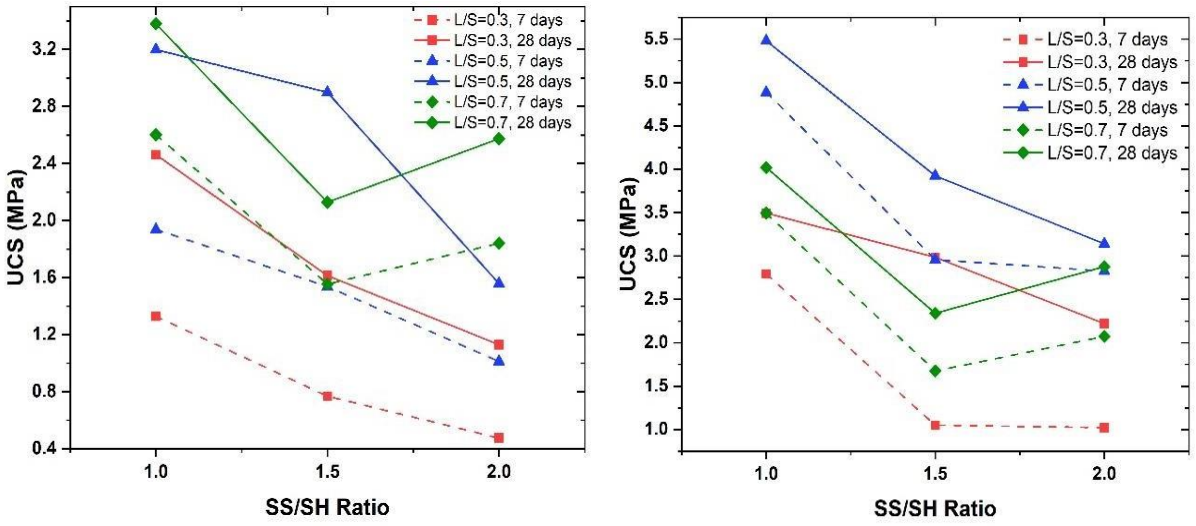


Figure. 16 Response of Unconfined compressive strength with variation in SS/SH ratio at CG: GGBS= 25:75 a) BCS:CG: GGBS=80:05:15; b) BCS:CG: GGBS=70:7.5:22.5

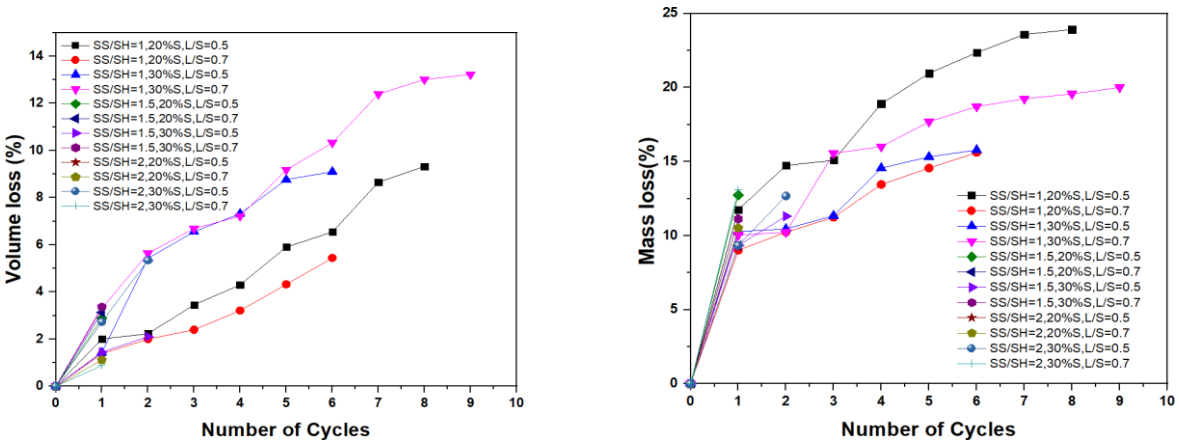
According to the test results from UCS, addition of GGBS to CG resulted in the development of effective geopolymer gel i.e., more homogenous and denser, which revealed the significance of the precursor (CG-GGBS). It is concluded that mechanical characteristics of BCS treated with CG-GGBS based geopolymer is effective. Za Based on the findings made in the figure 12 through figure 16, it is evident that there is increase in strength with increasing the percentage of GGBS from 50% to 75%, however it is suggested to use CG: GGBS=50:50 in order to promote higher utilization of CG as well, it meets the strength requirements for subgrade and subbase applications. So, further durability tests were conducted for the CG: GGBS=50:50 mix fraction for L/S=0.5 and 0.7.

DURABILITY STUDIES OF BCS TREATED WITH CG-GGBS BASED GEOPOLYMER:

Figure 17a depicts the volume loss of BCS improved with CG-GGBS based geopolymer subjected to wetting and drying cycles. The loss of volume is evaluated by measuring the dimensions of the specimens at the time of moulding and after each cycle of wetting-drying using a digital Vernier- callipers. The dimensions are duly measured at three different locations along height and diameter to ensure the correctness of the measurements. Corresponding percentage loss in weight of the sample is evaluated in accordance with guidelines of ASTM D559M-15 and the results are depicted in figure 17b.

The percentage of soil mass loss is increased with each cycle of wetting and drying (figure 17b). The percentage loss for samples with SS/SH ratios of 1.5 and 2.0 was significantly higher than that for samples with SS/SH ratios of 1.0. Further, it is observed that all the samples prepared with SS/SH ratios of 1.5 and 2.0 failed to hold up to even three cycles of wetting and drying. The increase in mass loss up to the fourth cycle for samples prepared with an SS/SH of 1.0 is likely caused by the leaching of dissolved Si, Al, and Ca ions. However, after 4 cycles of wetting and drying, there is a little effect on volume loss. Similar observations were made for corresponding loss in mass of the

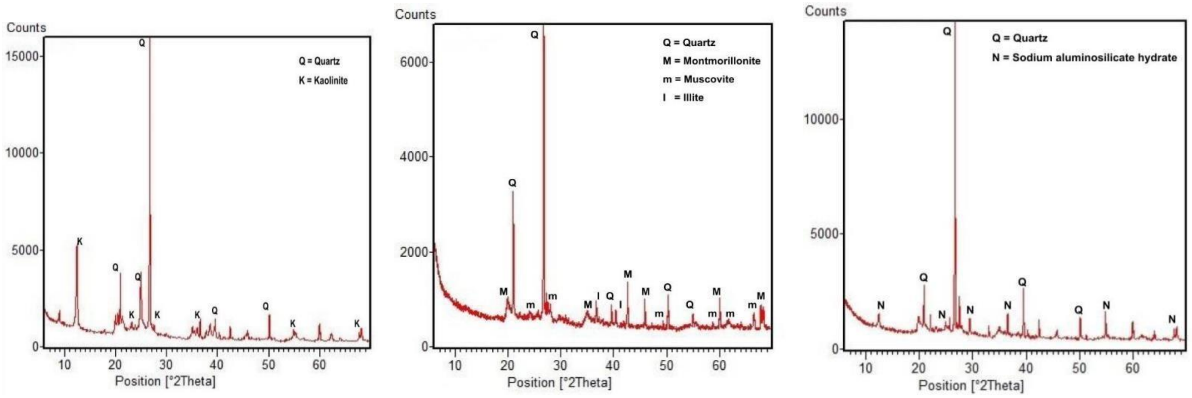
specimens. Along with loss in volume and mass samples, the samples exhibited signs of cracking on the surface. The cracks are expanded and extended with increase in number of cycles and ultimately leads to failure. Based on the UCS and Durability results of CG: GGBS= 50:50 mixtures, samples made with an SS/SH ratio of 1.0, L/S ratio of 0.5 and 0.7, and at precursor content of 20% and 30% were observed to perform better in comparison to other mixtures.

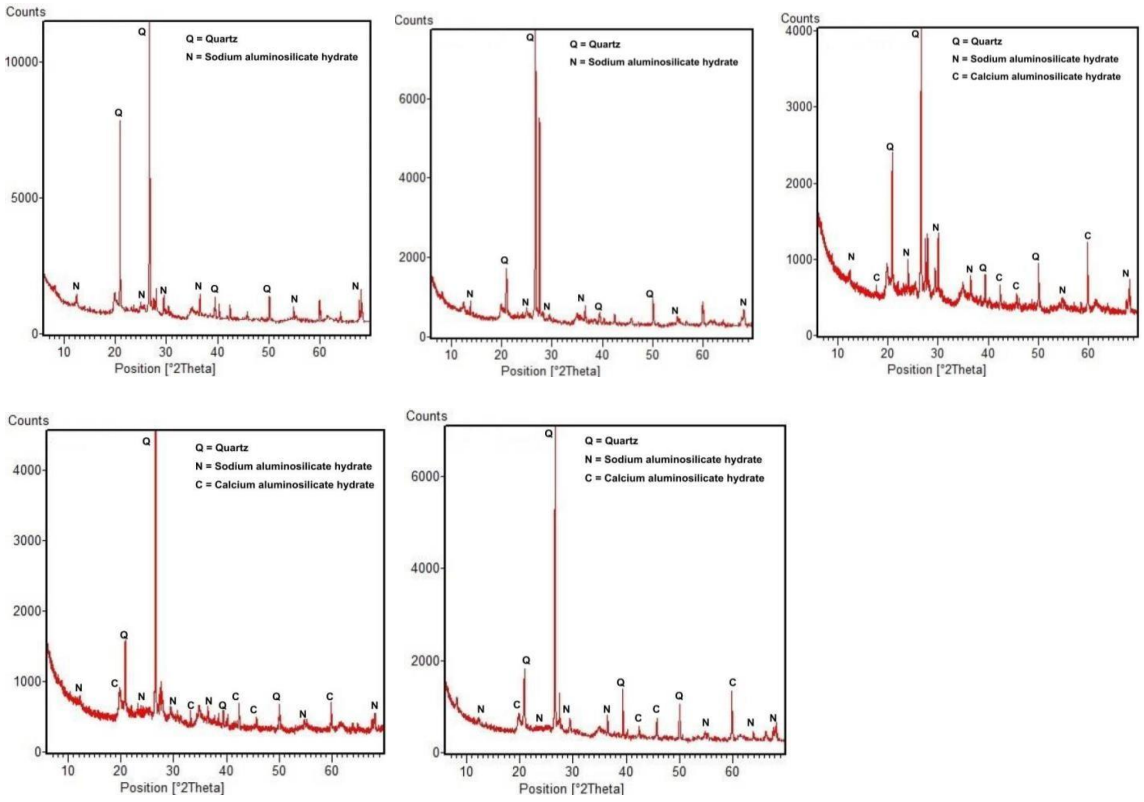


(a) (b)

Figure 17 Durability behaviour of CG-GGBS geopolymer treated BCS at 20% and 30% precursor contents(S) with varying SS/SH ratio a) Volume loss (%) b) Mass loss (%)

Figure 18 XRD patterns of selective soil sample mixtures (a) Raw Coal Gangue (b) Raw BCS (c) BCS:CG=80:20, L/S=0.5, SS/SH=1.0 (d) BCS:CG=80:20, L/S=0.5, SS/SH=1.5, (e) BCS:CG=80:20, L/S=0.5, SS/SH=2.0, (f) BCS:CG: GGBS=70:15:15, L/S=0.5, SS/SH=1.0, (g) BCS:CG: GGBS=70:15:15, L/S=0.5, SS/SH=1.5, (h) BCS:CG: GGBS=70:15:15, L/S=0.5, SS/SH=2.0





X-Ray Diffraction (XRD) Analysis:

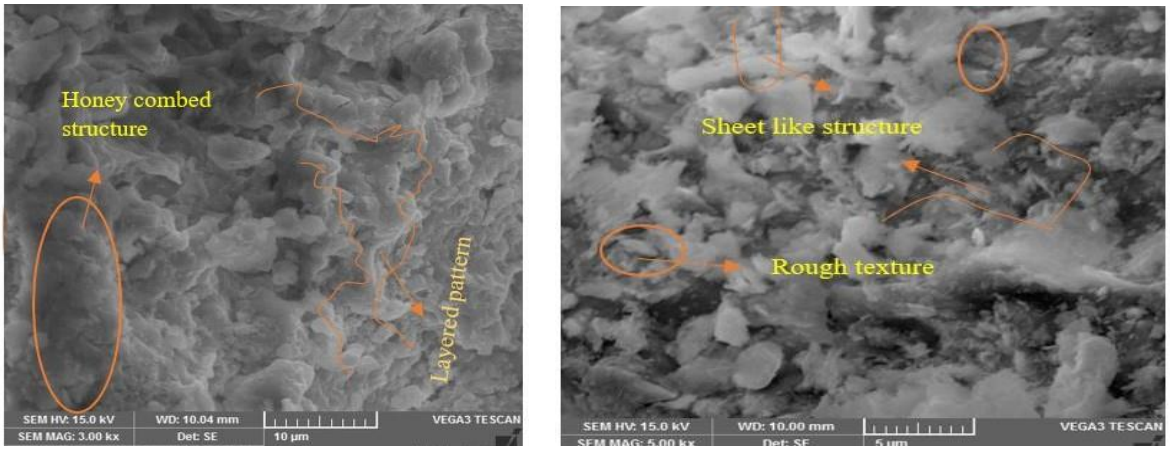
Figure 83 depicts the mineralogical composition of selective geopolymer specimens after 28 days of curing as determined by X-ray diffraction analysis. The major crystalline mineral present in all samples is quartz, with a peak at 2θ=21.9o,26.8o,39.5o, and 50o was remained unchanged even after the geopolymerization, due to its nonreactive nature (Yao et al., 2009, Reig et al., 2013). In figure 18c through figure 18e, after geopolymerization of CG alone, the XRD pattern indicates the formation of sodium aluminosilicate hydrate (NASH) at peaks corresponding to the kaolinite minerals present in raw CG observed from figure 18a. This confirms the conversion of Kaolinite to NASH. Further when CG is partially replaced with GGBS, in addition to NASH new peaks of CSH and CASH were detected due to presence of CaO in GGBS (Granizo et al., 2002, Yip et al., 2008, Ma et al., 2019). From figure 18f through figure 18h it can be observed that XRD patterns of BCS treated with CG- GGBS geopolymer mixtures at SS/SH=1.0 (corresponding to great compressive strength as observed in figure 12 and figure 13) had high crystalline phase intensities when compared to SS/SH=1.5 and 2.0.

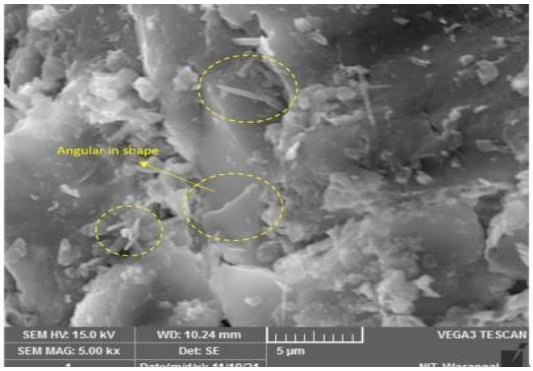
Scanning Electron Microscopic (SEM) Analysis:

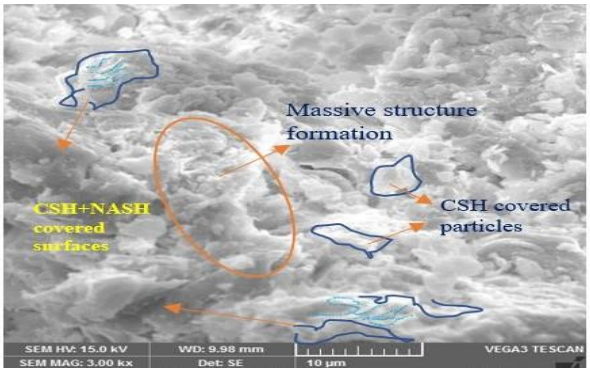
SEM was used to interpret the morphological and microstructural characteristics of selective geopolymer mixtures that had been curing for 28 days and shown in figure 19. It can be seen from figure 19a through figure 19c that the Raw BCS has a layered structure while the GGBS has angular shaped particles, and the surface of coal gangue is rough with a sheet like structure. The alkali activation process of CG leads to a dissolution of the

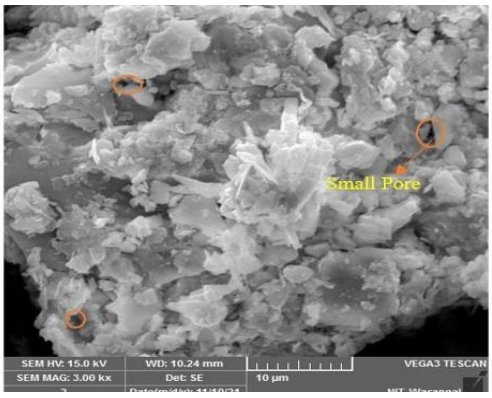
aluminosilicate precursor, producing tetrahedral polymers that bond with one another forming three-dimensional chains distributed over the surface of the sample, as seen in figure 19d through figure 19g. As seen from figure 19d, CG geopolymer stabilized soil confirms the loose matrix with larger number of non-reacted or partially reacted CG particles. As, CG is crystalline in nature with limited dissolution, presence of unreacted particles in CG based geopolymer leads to incomplete geopolymerization (Hajjaji et al., 2013). The unreacted coal gangue particles on the surface loosen the structure of coal gangue geopolymers, increase the porosity, and hence reduce the strength. SEM micrographs in figure 19e through figure 19g indicate that the CG-GGBS geopolymer stabilized soils are more compacted, denser, and less porous than the sample prepared by CG alone as precursor. This is due to the formation of C(-A)-S-H gel and (N-A-S-H) gel as presented in figure 14. Also, the unreacted and partially reacted CG particles of varying sizes, which are embedded in the matrix act as filler materials thereby enhancing the strength. Reig et al., (Reig et al., 2013) and Zhang et al., (Zhang et al., 2016) reported that the particle sizes have the main influence on the geopolymerization reaction rate. Hence, the inclusion of finer GGBS gives rise to a distinct product morphology and contributes additional binding that reflects the microstructure of the sample providing more massive structure (Nath and Sarker, 2014, Zhang et al., 2014). It can also be observed from figure 19e that samples prepared with SS/SH=1.0 are appeared to be denser, flocculent structure, and more homogenous. While the samples prepared with SS/SH=1.5 and 2.0 are characterized by large porous structure, as observed in figure 19f and figure 19g respectively, these voids are responsible for reduction in compressive strength as observed in figure 12 and figure 13. In CG- GGBS based geopolymers, when compared with SS/SH=2.0, samples prepared with SS/SH=1.5 has smaller number of voids and smaller volume of pores. Hence, the porosity is influenced by the concentration of soluble silicon similar to observations made by Duxson et al., (Duxson et al., 2005).

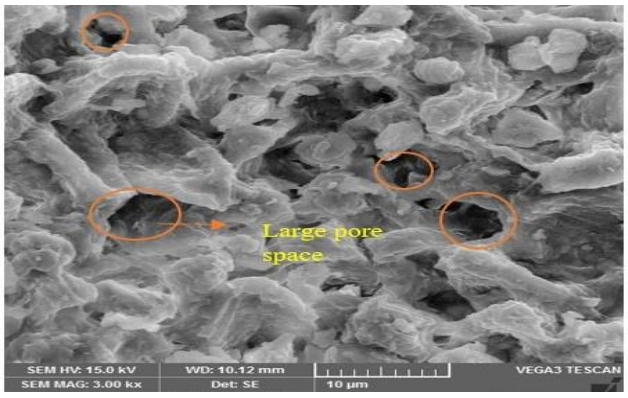
Figure 19 SEM images of (a) Raw BCS (b) GGBS (c) Raw Coal Gangue (d) BCS:CG=80:20, L/S=0.5, SS/SH=1.5 (e) BCS:CG: GGBS=70:15:15, L/S=0.5, SS/SH=1.0, (f) BCS:CG: GGBS=70:15:15, L/S=0.5, SS/SH=1.5, (g) BCS:CG: GGBS=70:15:15, L/S=0.5, SS/SH=2.0











Practical Inference:

The strength developed by CG-GGBS geopolymer tabilized BCS at mix proportion of L/S = 0.5, 0.7; and SS/SH=1.0 is much higher than the recommended minimum strength requirement (>1700kPa) for sub-base course as per AASHTO 1993, ARA 2004. Further according to IRC: SP 89 (2010), the stabilized soil should yield a CBR >15%. From the Table 3, it is evident that all the geopolymer treated soil satisfied the criteria. The maximum CBR achieved by the treated soil in its soaked condition is 145% which is a way superior to required recommendations. Based on the UCS and CBR values, environmental impact of CG and cost of alkaline activators, CG-GGBS geopolymer tabilized BCS at 30% precursor content, L/S=0.5, SS/SH=1.0 is beneficial and found suitable for subgrade as well as sub-base application as per IRC: SP 37 (2012) and IRC: SP 72 (2007). Positively with these results, there is a high chance of using this treated soil as a part of Inverted Base Pavements which is not yet practiced in Asian countries according to Cortes et al., (Cortes et al., 2012), Papadopoulos and Santamarina (Papadopoulos and Santamarina, 2019).

Summary:

In the characterization studies on coal gangue, physico-chemical, mineralogical and geotechnical characterization of coal gangue was performed on two grain sized fractions (4.75mm passing and 0.425 mm passing) to ascertain its applicability for bulk civil engineering applications. The following conclusions are drawn:

- The physical characterization has shown the non-plastic behaviour of coal gangue with specific gravity and gradation behaviour similar to that of poorly graded sands (SP).
- The chemical characterization revealed the presence of Silica (SiO2) and Alumina (Al2O3), which are of prime importance for necessitating pozzolanic behaviour which enhances its suitability for various geotechnical applications.
- The mineralogical characterization confirmed the presence of minerals like Quartz, Kaolinite, which are ubiquitous in soils, thereby making it an appropriate alternative to geomaterial.
- The higher angle of friction and greater dry densities of coal gangue aid in its bulk utilization as a backfill/embankment material.
- The hydraulic conductivity of coal gangue was found to be relatively higher than most of the soils, and this can aid in its application as a filter material for embankments.
- The CBR and collapse behaviour of coal gangue ascertained its feasibility as potential subgrade material.
- The performance of Novel geopolymer using CG has performed better with respect to strength consideration but failed in Durability criteria. The durability of novel geopolymer black cotton soils were further improved using GGBS as a partial additive in the Geopolymer precursor and found to be the best possible material.

Antioxidant and Cryoprotective Action of Amino Acid as Low-Cost Alternative for Animal Semen Preservative and Improve the Sperm Quality & Fertility in Cattle of Telangana State

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P.V. Narsimha Rao Telangana Veterinary University

Objectives:

- To assess the effect of taurine on Freshly collected semen, pre-freezed and post-thaw semen quality parameters, Bio-chemical parameters, sperm Kinematics (CASA), antioxidant and oxidative stress profiles in cattle semen samples.
- To study the effect of Taurine as an alternative for animal semen preservative fertility rate / conception rate in cattle of Telangana State.

The present investigation was conducted on Taurine as an amino acid additive and extender for cryopreservation of cattle bull semen. The present study was undertaken at the Veterinary Clinical Complex, Rajendranagar, Hyderabad in collaboration with Frozen Semen Bull Station (FSBS), Karimnagar under Telangana State Livestock Development Agency (TSLDA), Hyderabad, Government of Telangana.

Each ejaculate of freshly collected semen samples were evaluated immediately after collection for volume, colour, hydrogen ion concentration (pH), mass motility and sperm concentration.

Methods:

Freshly collected semen, pre-freezed and post-thawed semen samples were selected based on biophysical parameters. Each sample was split into four equal aliquots after dilution with the Tris-citrate-glycerol extender. Group: I, II, III and IV contained 0 mM (the control), 25 mM, 50 mM, and 100 mM concentration of taurine, respectively. Freshly collected semen, pre-freezed and Frozen-thawed semen samples were analysed for Bio-physical, Functional, motility parameters (total individual & progressive forward motility), kinetic and velocity parameters by computer-assisted sperm analyzer (CASA), viability, acrosome integrity and biochemical (oxidative stress like MDA and anti-oxidant parameters like SOD & TAC) profiles and Fertility / Conception rate was estimated by inseminating the processed semen samples in healthy, eligible donor cows and conception and pregnancy diagnosis was done by ultrasonography.

Results:

Colour: The colour of bull's semen samples were creamy white in colour and about 10 per cent of bulls produce yellowish colour of semen which might be due to lipochrome pigment derived from the epithelium of ampulla during seminal secretion and considered as normal colour, which is harmless to spermatozoa and has no influence on the fertility of the bull.

pH: The pH of the bull semen was evaluated by using pH meter. There was no significant difference found among the selected bulls. pH of the semen samples were found within normal range in this present. The slight acidic nature of the spermatozoa was opined that higher pH of the semen was neutralized by various vaginal acids, which were secreted from vaginal mucus glands.

Volume: The ejaculate volume was found to be significantly ($P < 0.05$) higher in native bulls than crossbred bulls, which is positively correlated with mass motility and sperm concentration.

The results of this present study were similar to that of Dasinaa and Pagthinathan (2015) and Rahman et al. (2014). Among the selected elite bulls Ongole, the native animal produce higher amount of semen sample per ejaculation, when compared to the crossbred bulls.

Sperm concentration: The concentration of spermatozoa in the freshly collected semen samples without dilution or extender was determined by the digital-photometer at 530nm wavelength. The average sperm concentration was recorded higher in native breeds semen samples than the crossbred semen samples. The results in present study revealed that the sperm concentration of native cattle breeds had significantly highest concentration of spermatozoa when compared to cross bred.

The variation in the results might be due to environmental factors, age factor (Ahmad et al., 2003), season (sardar, 2007), breed, frequency of collection (Kumar, 1979), nutrition, managemental practices, scrotal circumference and genetics (Mathevon et al., 1998).

Mass motility: The total / mass motility of spermatozoa was graded from the collected semen samples. The semen was processed as per standard protocol and incorporated Taurine an amino acid as anti-oxidant at different concentrations.

In freshly collected semen samples showed the significantly ($P<0.05$) highest motility followed by pre-freezed semen samples. The significantly ($P<0.05$) lowest motility was recorded in post-thaw semen samples.

Among the pre-freezed and post-thaw semen samples, addition of Taurine @ 50 mM concentration had showed the significantly ($P<0.05$) highest motility followed by control group, where there was no addition of Taurine. The moderate motility was recorded in semen samples treated with Taurine @ 25 mM and significantly lowest motility was recoded in semen samples treated with Taurine @ 100 mM. These results of the present study were in accordance with Perumal. P et. al., 2022.

The variation in the mass motility of the spermatozoa has been attributed to factors like season, age of the bull, frequency of collection, degree of stimulus provided and type of thrust (Tomar, 1984). Since, mass motility is assessed through naked eye under the microscope, the experience of the worker can also affect the results (Farooq et al., 2013).

Individual motility: The collected semen samples were analyzed for their progressive/individual motility by using CASA (Computer Assisted Semen Analyzer). The highest mean progressive motility of spermatozoa was observed in fresh semen sample when compared to pre-freezed and post thaw semen samples.

Among the fresh, pre-freezed and post thaw semen samples, the samples treated with 50 mM conc. of Taurine recorded the highest progressive motility where as, the lowest progressive motility of spermatozoa was found in semen samples treated with Taurine@100 mM conc. The present results are in accordance with Perumal et al. (2022), Mostari et al. (2005), Mandal et al. (2005) and Ray & Ghosh, (2013).

The present study proved that, the supplementation of taurine @ 50mM had shown the highest progressive motility of spermatozoa when compared to control, pre-freezing and post thaw semen samples.

Sperm viability:

The sperm viability was calculated using Eosin-Nigrosin stain used as per the method described by Evans and Maxwell (1987).

The mean sperm viability was recorded higher in semen sample treated with taurine@50 mM, followed by the control group and the lowest was observed when semen treated with taurine @100 mM.

The variation in sperm viability of cattle might be due to type of extender used for semen straw preparation, environmental affliction, freezing, temperature, shock, state of maturation, frequency of collection etc.

Our present study revealed that the addition of taurine @50 mM concentration to tris egg yolk citrate extender enhanced the sperm viability of semen sample by reduction in the cryodamage of spermatozoa due to reactive oxygen species (ROS).

Acrosomal integrity:

Th acrosomal integrity indicates the importance of the presence of an acrosomal cap in the fertilization process and bull semen fertility. Significantly highest value was observed in control and semen samples supplemented with Taurine@50mM concentration whereas lowest values was observed in @100mM of taurine as well as Pre-freezed and Post-thaw semen samples.

Hypo Osmotic Swelling Test (HOST):

The hypo osmotic swelling test used for evaluating the membrane integrity of spermatozoa.

The mean HOST reactive sperm percent was recorded highest in semen samples treated with taurine @50 mM, followed by 25 mM and the lowest was found in control group at pre-freeze and post thaw stages.

Addition of taurine @50mM enhanced plasma membrane integrity compared to control and other groups. A significant ($P<0.05$) positive correlation of HOST positive spermatozoa with acrosomal integrity, observed in the present study is in harmony with the findings of Sharma et al. (2012), Shaikh (2014), Prasad et al. (1999) and Srivastava and Kumar (2006).

CASA parameters:

CASA parameters i.e. sperm kinematics like curvilinear velocity (VCL), straight line velocity (VSL), average path velocity (VAP), straightness (STR) values were increased with taurine treated semen sample @ 50mM concentration followed by 25mM, and decreased sperm kinematics were observed in control group. Significantly lowest sperm kinematic values were recorded in 100mM treated semen samples.

Addition of taurine @50mM concentration to tris egg yolk citrate semen extender elevated sperm kinematic values when compared to control group in fresh, pre freeze and post thaw semen samples. Supplementation of 50 mM concentration of taurine protected the integrity of acrosome and biochemical membranes than in the untreated control and other taurine treated groups.

Biochemical and Anti-oxidant parameters:

Mammalian sperm membrane has higher poly unsaturated fatty acids and it renders the sperm very susceptible to lipid peroxidation, which occurs as a result of the oxidation of the membrane lipids by partially reduced oxygen molecules. Lipid peroxides impair the sperm function through altered sperm motility, membrane integrity and damage to sperm DNA and fertility through oxidative stress and production of cytotoxic aldehydes. In addition, antioxidant system of seminal plasma and spermatozoa is compromised during semen processing. Therefore, inclusion of exogenous antioxidant taurine may modulate the antioxidant system of semen.

Super oxide dismutase (SOD units/mg of protein):

The mean SOD values of freshly collected semen samples was recorded the highest in the control group, followed by @50 mM taurine, 25mM and 100mM the least. Whereas, in pre-freezed semen samples taurine @ 50mM has highest value followed by followed by control, 25mM and 100mM groups. Post thaw semen samples showed highest SOD activity by taurine @50mM group followed by control, 25mM and 100mM groups.

Present findings are in acceptance with Perumal P.et al., (2022), Taurine at a dose of 50 mM improved the sperm motility in cryopreserved semen and displayed antioxidative properties and elevated the catalase level in association with higher SOD concentration.

Total anti-oxidant capacity (TAC µmol/L):

The mean values of freshly collected TAC was recorded to be the highest when semen samples were treated with 50mM and control group whereas lowest TAC was observed in 25mM and 100mM treated taurine group. Pre-freezed semen samples showed increased TAC values in taurine@50 mM group followed by control, whereas the lowest was found in 25 mM and 100 mM taurine group. In Post thawed semen samples treated with

50mM concentration of taurine group revealed highest TAC activity compared to other groups followed by control group, 25mM and 100mM.

Taurine a sulphonated amino acid improved antioxidant status of semen sample that prevents cryodamage that occur during process of preservation. Further, taurine, a permeating cryoprotectant acts as an antioxidant and causes membrane lipid and protein rearrangement, which results in increased membrane fluidity, greater dehydration at lower temperature and therefore increased ability of spermatozoa to survive during the cryopreservation. This could be one of the reasons for improved motility, viability and membrane integrity of spermatozoa in taurine-treated semen (Perumal P. et al., 2022).

Malondialdehyde (MDA mmol/L):

The MDA values of freshly collected semen samples was recorded the significantly highest in samples treated with taurine @100mM followed by 25mM, whereas significantly lowest values were observed in @50 mM and control group. Similarly, Pre-freezed semen samples revealed highest MDA values in @25mM and @100mM treated semen samples. Very least values of MDA activity recorded in 50mM and lowest was observed in control group. In Post thawed semen samples showed significantly highest MDA activity in 25mM group followed by 100mM, whereas the lowest was found in control group and 50mM of taurine group.

The present study correlate with Singh et al. (2013), Chhillar et al., 2012 who reported that the addition of 50mM Taurine to the freezing semen samples extender resulted in significantly decreased Malondialdehyde (MDA) at post-thaw stage in bulls.

Perumal et al. (2013) have also found significantly lowered Malondialdehyde (MDA) level at 50 mM Taurine concentration but for the liquid storage of mithun bull semen.

The high MDA values indicate oxidative stress which is some extent reduced in semen samples containing taurine additive @50mM. During preservation or cryopreservation, the semen is exposed to cold shock at atmospheric oxygen which in turn increases the susceptibility to lipid peroxidation due to higher production of reactive oxygen species (Perumal et al., 2009). The free radicals are known to be involved in lipid peroxidation as well as DNA and sperm membrane damages which may lead to decreased sperm motility or cell death.

Therefore, in the present study addition of Taurine in semen might be a beneficial factor in avoiding the process of damage and reduce generation of ROS which would otherwise have negatively affected the spermatozoa (Chiller et al., 2012).

The extender containing 50 mM taurine led to a significant enhancement in viability, acrosomal integrity, plasma membrane integrity, motility (progressive and total motility), and the oxidative damage or cryodamage of spermatozoa was significantly reduced in taurine treated (@ 50mM) semen samples when compared to untreated control groups ($P<0.05$) and Taurine treated with 25 mM & 100 mM concentration samples. Moreover, in addition to significant improvement in kinetic and velocity profiles, 50 mM taurine protected the integrity of acrosome and enhance the biochemical & Anti-oxidant parameters in order to prevent the cryodamage of spermatozoa than in the untreated

control and other taurine treated groups (@ 25 mM & 100 mM). Inclusion of 50 mM taurine held a clear advantage over the control or 25 mM or 100 mM taurine in cryopreservation of cattle semen.

Conclusion:

Taurine (50 mM) supplementation in semen extender and can be used as an Antioxidant and Cryoprotective action of Taurine as low-cost alternative for animal Semen preservative and improve the sperm quality & fertility in Cattle of Telangana State and can be utilized to reduce oxidative stress and improve post-thaw semen quality in cattle of Telangana State. Hence, semen additives i.e. Taurine at 50mM concentration added to semen extenders prior to semen cryopreservation which elicit beneficial effect on post-thaw semen quality to improve the conception rate of cows inseminated with fresh, pre-freezed and cryopreserved semen which was processed with Taurine alternative semen extender in control (with-out Taurine) and treatment groups (Taurine as semen extender).

Assessment of Naturally occurring radioactive materials (NORM) and Radon exhalation studies in soils of Siddipet District of Telangana State

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Radionuclide concentration and exhalation studies are important in a variety of fields, including environmental monitoring, radiation protection, and nuclear medicine. These studies help assess potential radiation hazards in the environment, protect workers and the public from radiation exposure, and improve the safety and efficacy of medical procedures involving radionuclides. By measuring the concentration of radionuclides in soil, water, air, and other media, researchers can determine whether levels are safe and develop strategies to reduce exposure to harmful substances. Radionuclide concentration and exhalation studies play a crucial role in ensuring the safety of workers, the general public, and patients undergoing medical procedures.

Siddipet, a district in the Indian state of Telangana, is lies within the Godavari River Basin and has undergone extensive irrigation projects, which have significantly altered its environment and geology. However, studies have indicated that the levels of radium in Siddipet district are generally low and not a significant threat to health. Additionally, the district experiences natural background radiation, which is the ionizing radiation that constantly exists in the environment due to sources like cos mic rays, radon gas, and terrestrial radiation. The level of natural background radiation in Siddipet district are within safe limits and do not pose any significant health risks to the local population.

The development of major irrigation projects in Siddipet district has brought significant changes to the local environment and geology. The construction of large dams and reservoirs has disrupted the natural flow of rivers, and destroyed habitats. Excavation of vast amounts of soil and rock for construction has also disturbed the district's natural geological formations. Nonetheless, the irrigation projects have brought positive impacts on the district's economy and agriculture.

The study assesses the levels of Naturally Occurring Radioactive Materials (NORM) and radon exhalation in soil samples from 10 locations across Siddipet District in Telangana state. reveals that the average concentration of 226Ra is 52.57±20.844 Bq/Kg. It is observed that the lowest and highest activity concentration of 226Ra recorded are 30.7 Bq/Kg and 94.9 Bq/Kg, respectively. The mean activity concentration of 40K is 1155.91±271.18 Bq/Kg. The minimum and maximum activity concentration of 40K are observed to be 880 Bq/Kg and 1786 Bq/Kg, respectively. The mean surface exhalation rate is found to be 44.09 ± 23.29 mBq m-2 h-1. It is notice in the study that the lowest and highest surface exhalation rate recorded are 16.02 mBq m-2 h-1 and 85.88 mBq m+ h-1.

The activity concentration of both 226Ra and 40K in the ten different locations have been observed to vary in a significant manner. The highest activity concentrations of 226Ra (94.9 Bq/Kg) and 40K (1786 Bq/Kg) have been observed in Warangal. The lowest activity concentration of 226Ra (32.1 Bq/Kg) and 40K (880 Bq/Kg) are identified in Dubbaka,. The activity concentration of 226Ra and 40K are in the range between these extremes across other locations in the district.

The surface exhalation rate is identified to vary across ten locations. The highest value is found in Warangal (85.88 mBq m-2 h-1) and the lowest value is recorded in Markook (16.028 mBq m-2 h-1). The surface exhalation rate is indication of the amount of radon which is released from the soil. The surface exhalation rate is influenced by different factors such as the radionuclides concentration in the soil, soil properties like porosity and permeability and environmental conditions. Therefore, it can be concluded that that the variability of exhalation rates across the ten locations is because of the various influencing factors.

The results obtained in the investigation of radionuclide concentration and exhalation rates reveal that mean values of radionuclide concentration have been observed to be under global average values (UNSCEAR, 2000).

The natural background gamma radiation levels at various locations in the Siddipet district of Telangana state, India have been estimated. The process of estimation involves Micro-survey meter as one of the active instruments along with deployed methods in the investigation. The average natural background radiation levels were recorded at different mandals in the outdoor areas of the study site, as shown in Table 1. We found that the levels of natural background gamma radiation on the ground ranged from 148 nGy/h to 487 nGy/h, with an average of 243±54 nGy/h. At a height of 1 meter, the levels ranged from 139 nGy/h to 435 nGy h-1, with an average of 235±47 nGy/h. The highest levels were observed in Raipole mandal (location 3), while the levels were elevated in Markook mandal (location 1). These levels are higher than the national average of 75 nGy/h (Shankaran et al., 1986), but similar to those reported in other parts of Telangana state (Sreenivasa Reddy et al., 2001; Vinay Kumar Reddy et al., 2003; Sreenath Reddy et al., 2010). The elevated levels in these areas may be attributed to the geology of the study site. The predominant granitic rocks in the area act as good geochemical hosts for U, Th, and K, which may result in high concentrations of these radioactive elements in the soil.

In this investigation, we analyzed the distribution of natural background gamma radiation levels in soil samples collected from the Siddipet District of Telangana State. To analyze the distribution, we used QQ plots, which are graphical methods, and measured gamma radiation levels using a micro survey meter. The QQ plots indicated that most gamma radiation levels followed a normal distribution, but some data points deviated from normality due to external factors. To further investigate the distribution, we conducted statistical tests, such as the Shapiro-Wilk and Kolmogorov-Smirnov tests, which confirmed that the gamma radiation levels did not follow a normal distribution. However, we observed a normal distribution for the indoor to outdoor ratio of natural background gamma radiation levels, as verified by a QQ plot.

The distribution of gamma radiation levels is important for assessing health risks associated with exposure to natural radiation. Non-normal distributions can affect the estimation of risk coefficients used to calculate excess cancer risks. The use of appropriate statistical methods is crucial in accurately estimating the distribution of natural background gamma radiation levels and cancer risks, thereby protecting public health. Overall, the use of QQ plots proved to be a valuable tool in analyzing the distribution of natural background gamma radiation levels in the Siddipet District of Telangana State.

In this research, an attempt is also made to investigate the potential health risks associated with different types of wall and floor materials used in building construction. We measured the gamma radiation levels in 63 dwellings constructed with various materials such as brick, cement, mud walls, and different flooring materials including granite, marble, and cement. To collect the data, we used a portable micro survey meter and measured gamma radiation levels at multiple locations within each dwelling.

Our results demonstrated a significant impact of the type of wall and floor materials on gamma radiation levels. Dwellings constructed with mud walls exhibited the highest gamma radiation levels, followed by those with brick and cement walls. Similarly, dwellings with marble and granite flooring had higher gamma radiation levels compared to those with cement flooring. These findings are particularly noteworthy since exposure to high levels of gamma radiation can pose various health risks, including cancer. Therefore, it is crucial to identify and mitigate sources of indoor gamma radiation, particularly in dwellings built with materials that may contribute to elevated radiation levels. One possible approach to reduce indoor gamma radiation levels is to use building materials that contain low levels of naturally occurring radioactive materials (NORM), such as low-radiation cement and low-radiation granite. Additionally, improved ventilation and the use of alternative cooking and heating fuels may also help in reducing indoor gamma radiation levels.

The study investigated the variation of natural background gamma radiation levels in dwellings constructed with different types of building materials in the Siddipet District of Telangana State. The results highlighted significant differences in gamma radiation levels depending on the type of floor and wall materials used in construction. Dwellings with mud walls and marble or granite flooring had the highest gamma radiation levels. The findings have important implications for public health and can inform policies and interventions aimed at reducing indoor gamma radiation exposure. However, further research is necessary to identify effective mitigation strategies and understand the factors contributing to indoor gamma radiation levels. Based The study conducted an IDW analysis to examine the spatial distribution of Excess Lifetime Cancer Risk (ELCR) in the Siddipet District, Telangana State. Results showed a heterogeneous pattern of ELCR distribution, with higher ELCR values observed in areas with higher concentrations of naturally occurring radioactive materials (NORM) like uranium and thorium. These findings suggest that NORM is a significant contributor to the increased ELCR values in the study area. The IDW analysis proved to be a useful tool for visualizing the distribution.

This project has provided valuable insights into the levels of naturally occurring radioactive materials (NORM) and radon exhalation in soils in Siddipet district. Soil samples were collected from various locations in the district, and the results have revealed important information about the distribution and concentration of NORM and radon exhalation in the area.

The study found that the levels of NORM in soils in Siddipet district were generally within safe limits and did not pose a significant health risk to the local population. The average concentration of uranium in the soils was 3.9 ppm, which is below the recommended limit set by the International Atomic Energy Agency (IAEA). Additionally, the levels of uranium and potassium in the soils were also found to be within safe limits. The study also investigated the radon exhalation rates in soils in the district, which is a naturally occurring radioactive gas known to be a significant health risk when accumulated in enclosed spaces. The results showed that the average radon exhalation rate in soils was well below the recommended limit set by the IAEA and UNSCEAR, 2000. The study also investigated Annual effective dose and excess life time cancer rate (ELCR) and found that they were generally below the recommended limit set by the IAEA. The rates were higher in soils with higher concentrations of uranium and thorium. The study has provided valuable insights into the geological characteristics of Siddipet district and the distribution natural background gamma radiation levels in the region. The data generated by the study can be used to develop strategies to manage and mitigate the risks AED and ELCR associated with soils and building materials in the region.