The University of Trans-Disciplinary
Health Sciences & Technology

Annual Report

2019-20

Compiled and Edited by
Somashekhar B. S.

Page Design:
Suganthi Fathima J.

Basic Inputs & Photo Credits:
Project Leaders and Team Members of Respective Centres

Inhouse cordination for progress inputs:
Alexander P. J.

Production Coordination:
Somashekhar B. S.

Report Released:
December 2020

Annual Report 2019-20

The University of Trans-Disciplinary Health Sciences and Technology

Acknowledgments

- Ministry of Environment, Forest & Climate Change, Govt. of India
- Department of Biotechnology, Govt. of India
- UNDP India, New Delhi
- National Medicinal Plants Board, New Delhi

- State Forest Departments of Chhattisgarh, Karnataka, Kerala, Sikkim & West Bengal

- Department of AYUSH, Govt. of Karnataka

- State Biodiversity Boards of Manipur, Karnataka, Telangana & Haryana States

- State Medicinal Plants Board, Chhattisgarh

- Tata Education Trust
- Dabur India Limited
- JSW Steel Limited
- RIST - Rural India Supporting Trust

- Ashoka Trust for Research in Ecology and the Environment
- Attakkalari Centrefor Movement Arts
- BUGWORKS
- Dakshin Foundation
- Gaiagen Technologies
- The Institute of Bioinformatics and Applied Biotechnology
- Institute for Stem Cell Biology and Regenerative Medicine
- The Institute of Public Health
- National Centre for Biological Sciences
- National Institute for Advanced Studies
- Poorna Learning Centre
- St.John's Research Institute
- Srishti Institute of Art, Design and Technology
- Suchitra Cinema and Cultural Academy
- Takshashila Institution

Vice Chancellor's Message

I am sure readers will join me in congratulating the entire TDU team of around 250 personnel for the in-depth research, pioneering outreach and innovative educational programs executed this year.

The focus in TDU continues to be on research but the seeds for creative education are also being sown and I think in a few years from now, one will see the fruits.

In 2019-20, TDU faculty and researchers were engaged in a wide range of research activities, across different subject domains: from studying the impact of climate change on wild plants, to value addition of wild plant produce; from use of plant-based products for animal health to replace antibiotics, to basic biology of health-related physiological processes. There is research underway to solve (for industry) the problem of preventing early death of the guggul yielding tree after tapping its yellow fragrant oleo- gum resin, and investigating the molecular mechanisms responsible for (medicinally valuable) gall formation in the Pistacia plants.

TDU faculty and colleagues were associated with UNDP, MoEF &CC, GoI in implementing 3 projects of national importance: One under Secure Himalaya project in Sikkim, 2 projects under third NATCOM project of GoI-GEF-UNDP in Western Ghats. Colleagues are working with Forest Departments of Karnataka and Chhattisgarh States on resource augmentation of traded medicinal plants harvested from wild.

An important exploratory study is examining the anti-diabetic properties of honey, the genes involved in biosynthesis of medicinal alkaloids and the application of matching Ayurveda phenotypes between donors and recipients to enhance the sustainability of bone marrow transplantation. Strategic Research programs include building a unique, first of its kind, multi-disciplinary and cross-cultural data base on food ingredients and building an algorithm for linking food ingredients to personalised needs of individuals. Colleagues are also designing functional foods for nutritional deficiencies and TDU is amongst the few institutions to possess a brabender twin lab extruder. There is also preclinical and clinical research underway on trans disciplinary solutions for mild cognitive enhancement, effect of nootropics on Neuro degenerative conditions like Alzheimer's and Parkinsons, effect of classical Ayurveda formulations and traditional diets on fat and glucose metabolism, CKD (nephro protection), UTI, obesity, acne and malnutrition

We have been organising skill training programs for veterinarians from NDDB, AMUL, BAMUL, and even private sector companies like ABBOT, on herbal remedies for management of high morbidity conditions of cows. Another training stream is for skilling Ayurveda therapists, and for village-based community healers also on hands on skills for gene sequencing for students and professionals. We also train village-based BMCs in preparing biodiversity registers in Manipur, Karnataka and Haryana. We also did a practical skills program for students from Malaysia and Singapore on embedding Ayurveda into healthy lifestyles.

In the field of TK informatics during 2019-20 we have completed a socially relevant medicinal plants and primary healthcare portal for the use of local communities of Heggadadevana Kote tauk, Mysuru district. TDU has also finalised the text of a unique Sanskrit- Kannada- English technical dictionary of Ayurveda, built data on integrative network pharmacology of key medicinal plants, a genomic plants database on genes, proteins, bio molecules, and pathways of important medicinal species

We collaborated this year with West Bengal, and Karnataka Forest Departments in revisiting insitu medicinal plant conservation areas, established several years ago for conservation of wild gene pools. We undertook for the State Horticulture Department, a taxonomic documentarian of the flora in the iconic Lalbagh garden in Bangalore. We have this year established several herbal gardens for private sector in Karnataka and Andhra Pradesh.

We are proud to announce the successful passing out of our first batch of five students in the MSc conservation program.

I wish the readers of this report an absorbing experience.

Darshan Shankar
Vice Chancellor

Contents

Contents

1. Centre for Ethno-Veterinary Science and Practice

1.1. Sustainable tapping of Guggul (Oleo-gum-resin) from Commiphora wightii (Arnott) Bhandari

Background

Commiphora wightii (Family – Burseraceae) is a small sized tree from the arid zones whose yellowish fragrant oleo-gum-resin called *Guggul,* is used in Ayurveda since time immemorial for treating inflammation, gout, rheumatism, obesity, and disorders of lipids metabolism. The natural presence of this species in wild is restricted to the dry regions of Rajasthan and Gujarat bordering Pakistan. Guggul products are exported from India to 42 countries, with an annual demand of 1000 tones while the annual consumption is about 2300 tones. India imports 500-1000 tons of Guggul from Pakistan. Guggul commands a high price, which varies from Rs 900-1900/ kg. However, decline in its natural production has been noticed in Gujarat in the last 50 years (from 30 t in 1963 to 2.42 t in 1999 to 1.6 t in 2013). Triggered by a constant increase for its demand, there are reports of many new tapping techniques to increase its production. However, all these methods are destructive in nature and therefore the wild population of *C. wightii* has witnessed a decline during the recent decades. Consequently *C. wightii* is assessed **critically endangered** and enlisted in the IUCN red list of threatened species.

The present project (supported by Dabur for 3 years) aims to upscale, field test and transfer the technology for sustainable tapping of oleo-gum resin from *C. wightii* populations using the method developed earlier. It is also intended to achieve optimum production of guggul and to ensure survival of the tapped plants in the wild. The plant is tapped using a "Mitchie Golledge"/ Gebung Knife with least injury to cambium. Tapping is restricted during February-April, allowing the plants to sufficiently recover and regenerate for the rest of the year. A growth hormone is used to increase the production and regeneration

Highlights of progress:

This experiment was carried out in select villages of Gujarat. Twenty-five plants from the Vandhay village were treated with 5.9% ethephon (2 chloroethyle phosphonic acid) on 14th February 2020 and tapped on 18th February. Seven plants out of 25 were tapped for the last 3 years and 18 were tapped last year. The first collection was made on 12th March 2020. The injuries from previous year's tapping had healed while only the scars remained. The plants from Faradi village were fresh stands belonging to a temple trust and were tapped for the first time. Profuse exudation was noticed in these plants. However due to a disagreement about the preconditions with the temple trustees, tapping was allowed only from 2 treated plants and a control.

(https://pubmed.ncbi.nlm.nih.gov/29746995/ accessed on 19 Sept 2020).

The average production from ethephon treated plants in Vanday village was 13.5 grs/plant (table 1.1), while the control plant yielded 1.72 gm/plant, while the corresponding collection from Faradi village was 204 .5 grams/plant and 33.2 gm/plant respectively (table 1.2). The second collection was not possible because of COVD19. After the rains, the plants developed new leaves and fruits. It produced_ apomictic seedlings.

Table 1.1. Yield of guggul from the plants tapped at Vandhay village

Sl.No	No. of plants tapped & Place	Date of tapping	Date of collection	Yield in grams	Remarks
1	25, Vandhay village	18/02/2020			18 plants were tapped last year and 7 were tapped for the last 4 years.
2			12/03/2020	337.5	Unexpected rains in March at Kutch. The temperature on 12/03/2020 at 10.30 was 19^{o}C. The gum resin was not dried and sticky. yield was less than expected
3	Average production			13.5	

Table 1.2. Yield of guggal from the plants tapped at Faradi village

Sl.No	No. of plants tapped & Place	Date of tapping	Date of collection	Yield in grams	Remarks
1	23	18/02/2020			18 plants were tapped last year and 7 were tapped for the last 4 years.
2	2		12/03/2020	409.3	The collection is done only on 2 plants and a control
3	Average per plant			204.5	The collection is done only on 2 plants and a control
	Control	18/02/2020	12/03/2020	33.2	Treated with distilled water

Team members:

M N Balakrishnan Nair & Botanists from GUIDE Gujarat

1.2. Training of Trainers on validated Ethno-veterinary practices and Veterinary Ayurveda for the Veterinarians, farmers, village resource persons

Background

Indiscriminate use of antibiotics in the dairy sector and in plants causes antimicrobial resistance (AMR)[2], among the microbes. AMR makes it harder to eliminate infections from the body (human and animal) as the existing drugs become ineffective. It is a worldwide problem affecting both human and animal health. The antibiotics used end up in the environment affecting the quality of water, soils, and biodiversity too. It is estimated that by 2050 the antimicrobial resistance (AMR[2]) will cause 10 million deaths per year (http://amr-review.org). One of the immediate challenges on AMR is to reduce the use of antibiotics both for human and animal health care. Adapting the Ethno-veterinary science and practices to combat infectious and other clinical conditions in livestock has been identified and tested as a key game changer in reducing the use of antibiotics and other veterinary drugs. It is also demonstrated that the cost-effective EVP formulations could be prepared and used by the farmers themselves which were helpful for them to prevent and manage clinical conditions in cattle. Our training programme (both TOT and direct training of farmers) intended to mainstream the use of Ethno-veterinary practices through organizations like National Diary Development Board (NDDB), AMUL, Karnataka milk Federation (KMF), milk unions from 14 states in India, veterinarians from government of Sikkim, LUVAS, Haryana, Abbott India Ltd. and BAIF to prevent and cure 19 clinical conditions in cattle. This programme is very important in view of the issues such as antimicrobial residues in foods of animal origin (milk, meat and egg) and prevalence of antimicrobial resistant microbes compromising treatment options

Highlights of progress

General scheme of training of veterinarians is in 2 phases. The first phase to include 4 days training at TDU followed by second phase at the center/organization where the veterinarians work. We have trained veterinarians from NDDB, ABBOTT BAMUL, AMUL Doodh Sagar, Baroda dairy, Haryana Government and LUVAS for both prevention and cure of 15 clinical conditions in cattle.

Table 1.3: Details of training of veterinarians from LUVAS & Haryana govt.

No	Date & place	Major topics covered	No of days
1	Phase 1 08-18 April 2019 at TDU	Contemporary relevance of Ethno-veterinary practices, Documentation assessment, validations Lab studies, clinical trial, field studies, Basic principles of Ayurveda antibiotic residue, Demonstration of preparation of EVP formulations and application, Field identification Medicinal plants days at TDU	7 days

[2]AMR is the ability of microbes to grow in the presence of a chemical (drug) that would normally kill them or limit their growth.

2	Phase 2 14-18 October 2019 at LUVAS	Field training includes feed-back from veterinarians their experiences of using EVP at field level, success stories, problem solving and field demonstrations	5 days
3	Phase 3 Yet to complete		5 days
Note: this training will create a well-functioning network of trainers actively promoting ethno-veterinary practices amongst smallholder livestock farmers in AH and DD in Haryana.			

Table 1.4: Details of training of veterinarians Phase 1: 4 days at TDU

Union/ organization	Number of trainee	Dates	Major topics covered
NDDB	42	5 to 7th August 2019	Contemporary relevance of Ethno-veterinary practices, Documentation assessment, validations Lab studies, clinical trial, field studies, Basic principles of Ayurveda antibiotic residue, Demonstration of preparation of EVP formulations and application, Field identification Medicinal plants at TDU
AMUL	150	Batch 1 : From 22nd to 25th April, 2019 Batch 2 : From 10th to 13th June, 2019 Batch 3 : From 24th to 27th June, 2019 Batch 4 : From 16th to 19th July, 2019 Batch 5 : From 20th to 23rd August, 2019	
BAMUL	24	10th to 13th Dec, 2019	
Baroda Dairy	5	10th to 13th Dec, 2019	
Baroda Dairy	5	27th to 30th Jan, 2020	
Doodh sagar Mehsana	6	Batch 1:27th to 30th Jan, 2020 Batch 2: 3rd to 6th March, 2020	

Table 1.5: Details of training of veterinarians Phase 2: 3 days at GLOHMSIVA Thanjavur, TN

Union/ organization	Number of trainee	Dates	Major topics covered
NDDB	14	02nd to 04th Jul, 2019	The field training includes feed- back from veterinarians their experiences of using EVP at field level success stories, problem solving and field demonstration, identification of Medicinal plants
NDDB	42	08th to 10th August, 2019	
NDDB	19	07th to 09th Jan, 2020	
ABBOTT Maharashtra	25	13th to 15th Nov, 2019	

32 village resource persons from Gokul dairy Kolhapur were trained on preparation and application of herbal formulation for Primary health care in animals and human beings.

Table 1.6 Training of LRPs on primary health care of animals & humans.

Sl. No.	Place	Major topics covered	No of days
1	GOKUL Milk Union, Kolhapur	Mastitis, Enteritis, FMD, Udder pox and metritis) and primary health care for human (Indigestion, Hyperacidity, fever, Leucorrhea, Dry cough, cough and respiratory problems and musculoskeletal pain)	3 days Feb4th to 7th 2020

Table 1.7 Feedback from various milk societies from NDDB through ENAP and from Abbott on the efficacy of EVPs for 19 clinical conditions in cattle

Sl. No.	Clinical condition	Number of Animals treated	% cure
1	Mastitis	38305	93.27
2	Indigestion	9212	90.68
3	Foot & Mouth (FMD)	11669	93
4	Foot lesion	4388	92
5	Fever	51691	92.5
6	Diarrhea	50015	96.72
7	Joint swelling	500	90
8	Bloat	1830	86.75
9	Udder edema	1982	95.49
10	Repeat breeding	4637	84.37
11	Deworming	5906	95.77
12	Wound	1335	83

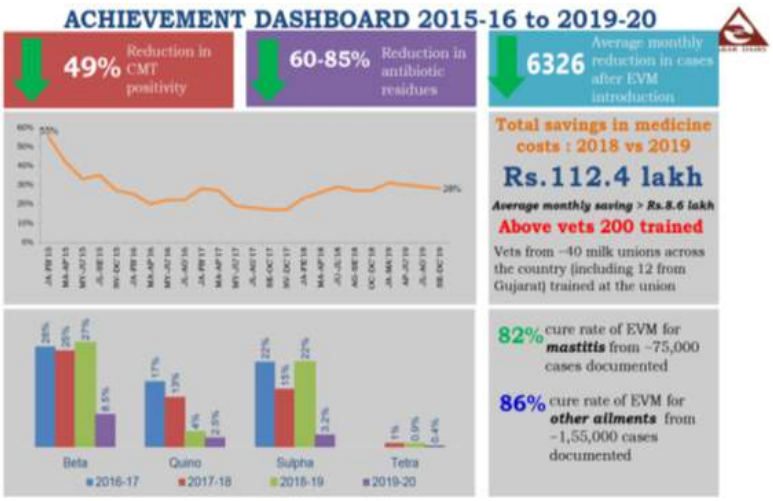


Fig 1.1 Achievement report from NDDB after using EVP from 2015-2016to 2019-2020

An intervention impact study undertaken (with the support of Department of Science and Technology, Government of India), encompassing 220 farmers from 11 milk societies in Karnataka, Kerala, and Tamil Nadu indicates that milk from 123 (87.86%) farmers out of 140 was without any detectable antibiotic residue. There is a reduction in the incidence of mastitis, enteritis, repeat breeding and cowpox from 2016 to, 2018 and 2019 when herbal alternatives were used (under publication) (Table 1.8).

Table 1.8 Reduction of the incidence of Mastitis, Enteritis, repeat breeding and cow pox from 2016 to 2019 among the cows of the farmers selected for the study

Disease	Mastitis			Entritis			Repeat breeding			Cowpox		
Year	2016	2018	2019	2016	2018	2019	2016	2018	2019	2016	2018	2019
Average per union	66	37	11	11	7	4	9	2.5	0.38	2.38	2.13	0
Per cent reduction		44	83.3		36.4	63.6		72.2	95.8		11	100

Fig 1.2 Inauguration of Haryana & LUVAS Veterinarians training program

Fig 1.3 Medicinal plants identification - Haryana Veterinarians training program

Fig 1.4 Veterinarians from **AMUL at TDU for training**

Fig 1.5 Visit to Veterinary College and Research Institute, Orathanadu Tamil Nadu during NDDB field training of vets

Fig 1.6-1.8 Preparation of Formulation to treat Enteritis at Gokul, Kolhapur

Publications

- M N Balakrishnan Nair. "Ethno-Veterinary Sciences and Practices for Reducing the use of Antimicrobial and OtherVeterinary Drugs in Veterinary Practices". EC Veterinary Science RCO.01 (2019): 16-17.
- P Dutta, AV Hari Kumar, SK Rana, SB Patel, DD Patel, KR Patel, N Punniamurthy, MNB Nair and GK Shrama. "Management of common ailments of dairy animals with ethno-veterinary herbal preparations in Gujarat. The Pharma Innovation Journal 2020; SP-9(8): 67-70. http://www.thepharmajournal.com

National work shop

- M N Balakrishnan Nair, N. Punniamurthyand Kumar S.K. Attended the brainstorming session on Ethno-veterinary Practice (EVP) and veterinary Homeopathy and presented a paper "Contemporary relevance of EVP" at Department of Animal husbandry, Chandigarh, Punjab, 21st November 2019

Team members

Prof. M N Balakrishnan Nair, Prof. N Punniamurthy, Dr S K Kumar, Prof. Satish, Dr. Sivaraman and Anitha

2. Centre for Functional Genomics and Bio-informatics

2.1 Elucidation of molecular mechanisms involved in *Pistacia*-aphid gall development

Background

Karkada Shringi, is an important traditional ayurvedic raw drug entity that refers to the horn shaped galls of tree *Pistacia chinensis subsp. integerrima* (J. L. Stewart ex Brandis) Rech. f. The galls are used in several - ayurvedic formulations such as *shringiadi churna, karkatadi chura, balachaturbhadra churna, brihat talisadi churna, devadarvayadi kwatha churna, shatavaryadi ghrita, chyavanprasha avaleha, dashmularista, siva gutika, khadiradi gutika* etc.

The galls are developed on Pistacia plant due to the infestation of leaves and petioles by an insect (Baizongia pistaciae L.) However, in the recent decades there has been an overall decrease in the gall formation, possibly due to climate change or human interventions. Molecular mechanisms responsible for the induction and development of galls are not studied, while there is absence of any genomic information. This study was thus an attempt to understand the molecular mechanisms of gall development (plant-insect) through the genome, transcriptome and proteome analysis of Pistacia galls. These molecular resources are expected to help understand the Pistacia genes and pathways responsible for the gall formation.

Highlights of progress

For the first time, whole genome sequence of *Pistacia chinensis subsp. integerrima* was generated in this study. The whole genome assembly yielded 549 Mb, while a total of 51290 genes were identified from the Pistacia genome. Likewise, 231624 SSRs were identified from the genome. As expected, mononucleotide motifs were the most abundant type of repeats (74.1%) in genome of Pistacia followed by di- (17.3%), tri-nucleotide repeats (6.9%). Other highlights are as below:

- A total of 76186 and 46327 transcripts were identified from the gall and leaf, respectively.
- Highly expressed genes were identified in the gall for biosynthesis of secondary metabolites, plant-aphid interactions, stress responses, phytohormone signal transduction and terpene biosynthesis.
- 21 peptides were identified against *Cajanus cajan*, 10 peptides against *Arabidopsis thaliana* and 14 peptides against *Drosophila melanogaster* from Pistacia gall.
- A total of 24 fungi and 6 bacteria were isolated from *P.chinensis* gall and leaf.
- Submistted the genome information and microbial sequences to NCBI

Team members

Dr. Pavithra N, Dr. Noorunnisa Begum, Dr. Malali Gowda

2.2. Report on the correlation between HLA and Prakriti types in context with cases of Bone Marrow transplantation from Mazumdar Shaw Medical Centre

Background

Human Leukocyte Antigen (HLA) genes on chromosome 6 are considered the most polymorphic genes in the human genome. Alleles from HLA genes in an individual indicate sensitivity or resistance to numerous allergies, infectious diseases (e.g., HIV, TB, Dengue, etc.), autoimmune disorders (e.g., psoriasis, rheumatoid arthritis), cancer and self/non-self-recognition of organs/tissues during transplantation. It is believed that the probability of finding HLA match is higher in siblings within a family, followed by relatives, and then ethnic groups.

Interestingly, Ayurveda classifies human populations irrespective of the gender, geography and ethnicity through phenotypic characteristics (prakriti), based on typical behavioral, psychological and physical characters (Caraka Samhita). In 2005, Bhushan et al., showed that a significantly high correlation exists between HLA allele types and the three phenotypes of Ayurveda Prakriti. We hypothesize that higher probability of HLA match and improved organ engraftment among Ayurvedic Prakriti types. If so, then it influences the methods for creating HLA registries with inbuilt potential to facilitate matches for organ transplantation. However, the strategy of matching HLA types for transplantation among Prakriti types has not been attempted due to lack of knowledge about its potential in the field of organ transplantation. In this study it was attempted to study the correlation between HLA and Prakriti types in the context of Bone Marrow transplantation, using the cases at the Mazumdar Shaw Medical Center.

Necessary collaboration was established (Dr Sharath Damodar, Senior Consultant Haematologist and Head of Haematology, & Bone Marrow Transplant). Ethical Committee approval was obtained from Narayana Health Academic Ethics Committee (NHAEC) to conduct the study, while the study trial was registered with the Clinical Trial Registry India (CTRI). Study subjects with the age group of 18-65 who have undergone or who will be undergoing bone marrow transplant, were recruited for the prakriti analysis.

Highlights of progress

The pilot study of Prakriti analysis was carried out with 41 subjects recruited at IAIM and TDU. Following prakriti types were identified: KV(13), KP(4), VK(8), VP(8), PK(4), PV(4), SAMA(4). Additionally, the Prakriti analysis was carried out among 7 Malaysians, who underwent the treatment at IAIM. Following prakriti types were found: VP(3), VK(1), KP(1), PV(1), SAMA(1)

Team members

Dr. Pavithra N, Dr. Poornima Devkumar, Dr. Prasan Shankar, Ms. Namitha R, Ms. Manasa K H (TDU), Dr. Sharath Damodar (Mazumdar Shaw Medical Centre), Prof. Malali Gowda

2.3. Genomic resource database for mining genes, proteins, biomolecules and functional pathways for 50 high volume traded medicinal plants of India

Background

Several medicinal plant sequencing projects are underway worldwide, which submit the sequence information with functional information of genes and proteins to National Centre for Biotechnology Information (NCBI).

The present study, compiles the sequence data and functional genomic information of high volume traded medicinal plants from the NCBI into a database. In certain cases, functional information of the downloaded sequences is not available in the NCBI, during which the assessment of gene and protein information was carried out at the TDU. The project also attempted to collect botanical information of medicinal plants, chemical and structural information of the bioactive compounds, biosynthesis pathways of active molecules and further protein target information of drug molecules in the humans. All the information obtained and analysed will be made available through a webpage, which will serve as searching and downloading hub for information such as sequence data, pathway data, and data on protein interaction. As a pilot study, the website and database will provide information on the 50 high volume traded medicinal plants in India and will be further extended, subject to resource availability.

Highlights of progress

Out of 50 prioritized medicinal plants, sequence data of 15 plants (*Abrus precatorius, Andrographis paniculata, Artemisia annua, Catharanthus roseus, Cissus quadrangularis, Embelia ribes, Ipomoea nil, Lactuca sativa, Mentha longifolia, Moringa oleifera, Mucuna pruriens, Nelumbo nucifera, Ocimum tenuiflorum, Punica granatum, and Zingiber officinale)* were downloaded. Following are the other highlights.

- A genome browser page was constructed for the visualization of medicinal plants genome (gene coordinates, mRNA boundaries and coding sequences using the established genome browser) (Figure 2.1).
- A BLAST search page was constructed to compare sequences against the genome sequences compiled in the database (Figure 2.3 and 2.4).

Team members

Dr. Prasanna S Koti, Ms. Namitha R, Ms. Manasa K H, Hon. Advisor: Prof. Malali Gowda

2.4. Integrated genomics-assisted breeding for efficient development of superior finger millet varieties for Karnataka

Background

The Finger Millet consortia (ICRISAT-Hyderabad, UAS, CCAMP, TDU - Bangalore, IIMR, Hyderabad and ZARS Mandya) aimed at around 1000 Finger Millet germplasm from Indian and African origin for selection of superior traits using genomics assisted breeding technology. The present project aims at developing superior traits of finger millet using the genomics assisted breeding technology. The samples were selected from field trials. These were re-sequenced, and data of minicore set of germplasm, and mapping population was made available. As this is a collaborative project with ICRISAT, the fourth objective for the Karnataka Finger millet germplasm was taken up here in TDU which deals with database development, data management and capacity improvement in the area of bioinformatics.

The Finger millet germplasm from Karnataka were selected for the genomics study. The released varieties from UAS Bangalore, having blast resistant, blast susceptible traits along with few drought and temperature tolerant germplasm were selected for the study. In this study, identification of mutations (point mutations, insertions and deletions) in the selected germplasm were targeted. For this, whole genome re-sequencing was carried out and bioinformatic data analysis to mine the point mutations, insertions and deletions for the study samples was carried out. This is the Phase I of the genomics assisted finger millet breeding, where the study of the selected varieties was carried out for future breeding programs.

Highlights of progress

Whole genome re-sequencing of 118 selected Finger millet germplasm was completed. Following are the details:

- Released Finger Millet varieties: 33
- Blast susceptible and Blast resistant germplasm: 53
- white grain germplasm: 6
- Drought tolerant germplasm: 26

These were constituted for genome re-sequencing by ICAR-AICRP on SM and C-CAMP/TDU. Among these, in the present year at TDU, six Blast susceptible varieties, eight Blast resistant varieties, six white grain varieties thirty and 26 drought tolerant germplasm were re-sequenced with coverage 10X using the C-CAMP genomic facility**.**

Bioinformatics analysis

The prediction of the Single Nucleotide Polymorphism (SNPs) and InDels in the selected re-sequenced finger millet germplasm using Bioinformatics tools followed by Haplotype calling and the pedigree analysis was completed using the Genome analysis toolkit (GATK) (Figure 2.5 & 2.6). The pedigree lines were selected from the set and the pedigree analysis was carried out with respect to blast resistance and susceptibility traits.

A training on "Advanced Genomics tools for Crop Improvement" was organized successfully at TDU from November 25th to 29th 2019 in collaboration with ICRISAT. (Figure 2.7).

Team members

Dr. Malali Gowda, Dr. Lavanya Devi K, Dr. Prasanna S. Koti and Mr. Santhosh Hegde.

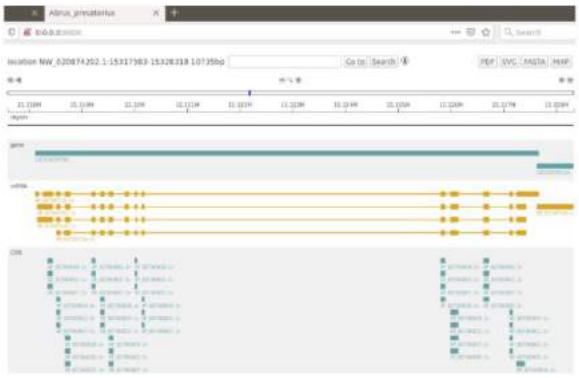


Fig 2.1 Genome browser page developed for the medicinal plants database

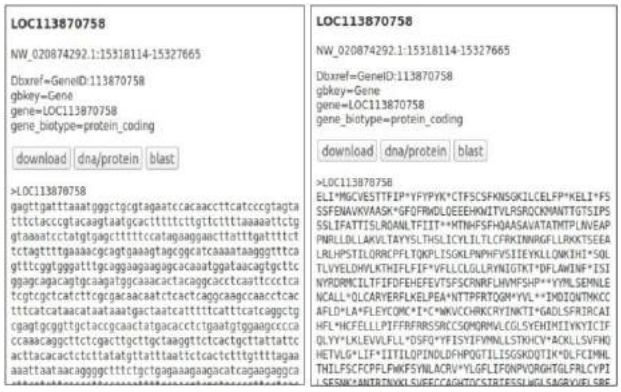


Fig 2.2 Nucleotide and protein sequence download window from the genome browser page

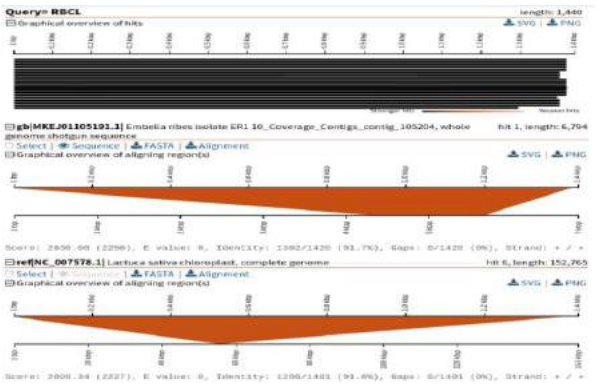


Fig 2.3 Sequence similarity search tool highlighting the query page

Fig 2.4 Result page generated as a result of sequence similarity search

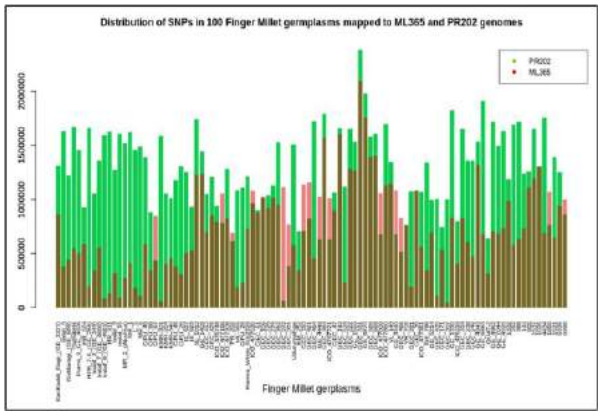


Fig 2.5 Distribution of SNPs in 100 Finger Millet germplasms mapped to ML365 and Pr202 genome assemblies

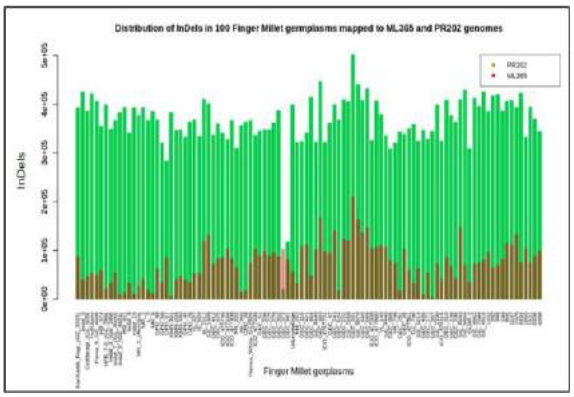


Fig 2.6 Distribution of InDels in 100 Finger Millet germplasms mapped to ML365 and Pr202 genome

Fig 2.7 Inauguration of Crop Genomics Training Program

From L to R: Dr. Krishnappa K., Former resident Scientist ICRISAT, Bangalore,Dr. Santosh Deshpande, Senior Scientist, ICRISAT, Hyderabad and Project Coordinator Finger Millet genome Consortium, Prof. Darshan Shankar, Vice Chancellor, TDU, Bangalore, Prof. M.V. Channa Byre Gowda, Former Project Coordinator for Small Millet scheme at UAS, Bangalore, Bangalore., Prof. Malali Gowda Dean and Professor, RUAS, Bangalore).

3. Centre for Local Health Traditions and Policy

3.1 Voluntary Certification Scheme for Traditional Community Healthcare Providers

Background

Traditional healers play a significant role in providing community-based health care service to rural community at no cost to public exchequer. These healers offer healthcare service based on locally available medicinal plants, which are easily accessible and affordable. VCSTCHP is a National scheme jointly launched by the Quality Council of India (QCI) with Foundation for Revitalisation of Local Health Traditions (FRLHT), to assess and certify healthcare workers as 'Traditional Community Healthcare Providers (TCHP)' through a competence- based model of personal certification as per ISO 17024.

Highlights of progress

Following are the highlights:

- TDU received provisional approval status as Personnel Certification Body (PrCB) under VCSTCHP scheme on 3rd July 2019. As per the scheme document, information on the scheme was made available to public through TDU website (http://tdu.edu.in/home/clhtp/) and newspapers in regional languages wherever feasible.
- A State level, TCHP advisory board consisting of 6 traditional healers and PrCB representatives was constituted for Karnataka and Kerala.
- Awareness programmes on minimum standards of competence (MSC), eligibility criteria to apply, evaluation methodology and process were conducted for orienting the advisory board members and traditional healers of Karnataka and Kerala

Name of program	Date	Venue	participants
TCHP evaluator training program-Karnataka	12th April 2019	TDU, Bengaluru	14
VCSTCHP in Ethno-Veterinary Practice (EVP)	26th June 2019	TDU, Bengaluru	10
TCHP Evaluator's training program	30-31st July 2019	TDU, Bengaluru	20
VCSTCHP awareness program	20th Aug 2019	Dharmawaram, Andhra Pradesh	50
VCSTCHP awareness program	30th Nov 2019	Goa	25
VCSTCHP awareness program	11th Oct 2019	Ramanagara, Karnataka	50
TCHP advisory board: Awareness program	2nd Jan 2020	Kannur, Kerala	20
TCHP advisory board: Awareness program	19th Jan 2020	Kannur, Kerala	20

Table 3.1 awareness program conducted during 2019-2020

Publications

Unnikrishnan PM, Hariramamurthi G, Sarin NS, Debjani R. Accreditation, Certification and self-regulation: An innovative approach for strengthening and reintegrating traditional community health care providers. In: Arima M, editor. Local Health Traditions: Plurality and marginality in South Asia. 1st ed. Orient Blackswan Private Limited, India; 2019. p. 54-75

Team members

Prof. Hariramamurthi G, Dr. Prakash BN and Dr. Amulya Kannan

3.2.Develop a Replicable Knowledge Resource for One Taluk in Karnataka (HD Kote) in the form of Geospatial Database of Populations, Distribution of Local Medicinal Plants and a Taluk Specific Herbal Pharmacopeia, on an ICT Platform

Background

Rural communities in India traditionally manage primary healthcare conditions first at the household level and what could not be solved in the home was taken to the community-based traditional healers. If at both these levels, a solution was not found, institutional (hospital) help was sought. However, in today's context, the household practices and the traditional community healthcare provider's services are slowly disappearing. This project examines the potential of household and community healthcare knowledge in dealing with primary healthcare related conditions.

Highlights of progress: The project was implemented in 30 selected villages from 5 hoblis of H D Kote taluk, Mysuru district, Karnataka, in collaboration with Swami Vivekananda Youth Movement (SVYM), Sargur.

Baseline and end line surveys were conducted among 650 households, before and after the health education intervention, to determine the status of knowledge, attitude and practice (KAP) of traditional healthcare practices for prevention and management of primary healthcare conditions. The survey covered, 86% of rural population and 14% of semi-urban population with 35% from ST and 26% from OBC. Majority of the participants (83.5%) were from below poverty line (BPL) income category.

The survey reported the following 10 most common ailments: Headache, cold, fever, cough, backache, acidity, conjunctivitis, joints pain, toothache, diarrhea.

The end line survey reported that, the knowledge level among the participants, on home remedies for treatment and prevention of primary health problems increased from 29% to 57% and from 15% to 53% respectively.

The endline survey reported that, the practice of home remedies for treatment and prevention of primary health problems increased to 48% and 43% as compared to 28% and 16% in the baseline survey respectively.

Appropriate IEC materials (brochure, ToT modules, short videos) on the use of locally available medicinal plants for primary healthcare were developed to educate the households, ASHA workers, Anganwadi workers, and school children of HD Kote. Following are the details.

Sl. No	Form	Focal theme	No. of disease covered
1	Brochure - 1	Primary Healthcare conditions / General health	10
2	Brochure - 2		10
3	Brochure - 3		10
4	ToT module-1		5:Fever, Headache, Cough, Cold, Acidity
5	ToT module2		5: Wounds, Skin disease, Mouth ulcer, Burns, White discharge
6	ToT module-3		5: Body ache, Jaundice, Toothache, Diarrhoea, To improve breast milk
7	ToT module-4		5: Menstrual disorders, Backache, Malnutrition, Anaemia, Constipation
8	ToT module-5		5: Piles, Indigestion, Asthma, To build immunity, To improve memory in children
9	ToT module-6		4: Worms, Eye disorders, Joints pain, Pain during menstruation
10	Short videos		30

Table 3.2 List of IEC materials developed for health education

Publications

Invited talk: Prakash BN visited Mbarara University of Health Sciences and Technology (MUST), Uganda for a series of talks on Ayurveda and yoga for MSc students during April, 2019 (2 weeks)

3.1 Assessment of a traditional healer by TCHP evaluators, Ayurveda physicians & QCI member

Team members

Dr. Prakash BN, Mr. Shivanand Savatagi, Dr. Mohan Kumar B. Thambad and team from SVYM
Dr. PS Sundar Rao, Senior Biostatistician, Dr. Nirmala Murthy and team, Foundation for Research in Health Systems (FRHS), Bengaluru.

4. Centre for Traditional Knowledge, Data Sciences & Informatics

4.1 Enhance the Indian medicinal plant database (IMPLAD) with Network pharmacology module

Background

Studying complex relationships between the bioactives, targets, diseases and genes is possible with Network Pharmacology which serves as a valuable tool for scientific understanding of Ayurveda in drug discovery (Chandran, 2015). Network pharmacology is reliant on the existence of open-source databases on bioactives from medicinal plants and their biological effects. This research is on "Development of In-silico Platform for Medicinal plants-based drug discovery using Network Pharmacology & Ayurveda database to study the Complexity of Ayurveda drug action".

Normally, drug discovery follows the one gene-one target-one drug track, while a multi-target, multi-ingredient formulation approach may be smarter. It is important to address multiple targets emanating from a syndrome-related, metabolic cascade so that holistic management can be effectively achieved. Thus, it is necessary to shift the strategy from a single target-new chemical entity as a drug, to one with multiple-target, synergistic, formulation discovery approach (Patwardhan & Chandran, 2015).

The objective is to leverage Ayurvedic pharmacopoeia using advanced research techniques and bioinformatics tools. This bioinformatics approach (Insilico) which can be used to design novel combinations by first validating the concept on a computer and validating scenarios. It solves many problems related to drug standardization, safety, and efficacy of the medicines (Monisha *et al*., 2018). Integrative network pharmacology is an effective computing tool to understand the intelligence behind traditional medicine through systematic data mining, information synthesis and collating bio actives, targets, pathways, and the associated indications. This may be a pragmatic application of system biology that connects complex etio pathology and targets with enriched photochemistry of natural products.

Highlights of progress

Network pharmacology analysis of Piper longum has offered new relationships between bio actives, targets and putative applications in new diseases. Such a Pharmacology network approach could be useful to rediscover the potential of traditional medicine, to obtain new drug leads from natural sources, to investigate unexplored molecular targets and to design experimental and clinical studies. The pharmacology network provides systems overview of pharma-omics of bio-actives with newer insights to expedite drug discovery, clinical research, and therapeutics. It further provides a comprehensive data-driven approach for natural product pharmacology where the whole is more than the sum of its parts.

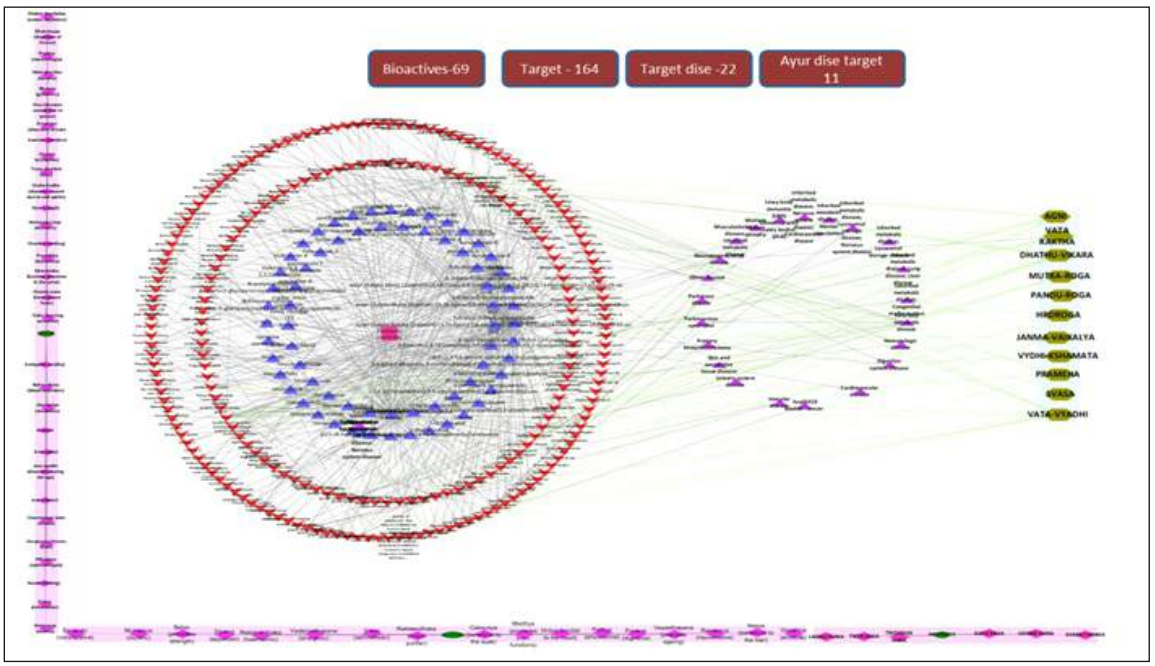


Fig. 4.1 An example of 69 bioactives of Tinospora cordifolia and their indications in Ayurveda

Species	Bioactive(BA)	Target(TR)	Disease
Tinospora cordifolia	69	164	22
Azadirachta indica	146	5398	531
Glycyrrhiza glabra	405	5306	104
Allium sativum	127	324	269

4.2 Visualisation and analysis done for the other species

To deepen the data on medicinal plants with respect to pharmacological aspects, some of the steps followed are:

- Phytochemical screening w.r.t. antimicrobial, antiviral, antibacterial potential of medicinal plants used in Ayurveda for combating pathogenic bacteria using In Silico approach.
- Compiling and translating traditional Ayurvedic uses from original Sanskrit references to English with supportive references International Classification Disease codes.
- Bio actives, target and disease pathways

References

- Chandran, Uma & Mehendale, Neelay & Tillu, Girish & Patwardhan, Bhushan. (2015). Network Pharmacology: An Emerging Technique for Natural Product Drug Discovery and Scientific Research on Ayurveda. Proceedings of the Indian Academy of Sciences. 81. 8. 10.16943/ptinsa/2015/v81i3/48229.
- Patwardhan B. and Chandran U., 2015. Network Ethnopharmacology Approaches for Formulation discovery, Indian Journal of Traditional Knowledge, Vol. 14(4), October, pp. 574-580
- Monisha M, Mishra AK, Ramesh NV, Pillai KU, Vineeth PK. In-silico studies in herbal drugs: A review. J Ayu Herb Med 2018;4(1):43-47.
- Chauhan, A., Semwal, D. K., Mishra, S. P., & Semwal, R. B. (2015). Ayurvedic research and methodology: Present status and future strategies. *Ayu*, *36*(4), 364–369. https://doi.org/10.4103/0974-8520.190699

Publications

- Venugopalan Nair S.N., Shilpa N., Vargheese T., Tabassum I.F. (2019) Neem: Traditional Knowledge from Ayurveda. In: Gowda M., Sheetal A., Kole C. (eds) The Neem Genome. Compendium of Plant Genomes. Springer, Cham, 1-12
- Venugopalan Nair S.N., D. K. Ved, K. Ravikumar, I. F. Tabassum ...et al. (2020) Indian Medicinal Plants Database (IMPLAD) and Threatened Medicinal Plants of India. In: Rajasekharan P., Wani S. (eds) Conservation and Utilization of Threatened Medicinal Plants. Springer, Cham. https://doi.org/10.1007/978-3-030-39793-7_3

Team members

Dr. Venugopalan S N., Dr. Tabassum Ishrath Fathima Dr. Shilpa Naveen, , Mr. Varuna Subramanya

4.2. Preparation of a Comprehensive Sanskrit – Kannada – English Dictionary of Ayurveda (in Print & Electronic Formats)

Background

Ayurveda is based on a highly evolved codified tradition of treatises in Sanskrit, such as Charaka Samhita, Sushruta Samhita and Ashtanga Hridaya. As far as the understanding of these texts is concerned, students and practitioners of Ayurveda are not so conversant with it, owing to insufficient orientation to Sanskrit language. This is despite the increase in the number of students and practitioners of Ayurveda in the recent decades.

The dictionary shall be available in the form of physically printed volumes with proper indexing etc., as well as in the form of a Web-app and Mobile app. When complete this Dictionary (both online and offline versions) will fill a great gap that currently exists and shall facilitate a very clear and precise understanding of the fundamental concepts of Ayurveda in a precise and versatile manner. In order to address this problem and facilitate proper understanding of the technical terms used in Ayurveda fraternity, this initiative was taken up in the form of Dictionary of Ayurveda (Sanskrit – English – Kannada) for the benefits of students, teachers, practitioners as well as interested laymen.

During the current year, the team gathered information about technical terms pertaining to 30 different fields, which forms the core of the dictionary. About 3,500 relevant technical terms out of about 5000 terms were gathered and classified under 23 categories of Ayurveda. Information under 31 fields for each term is included. Necessary collation and editing tasks completed.

Project on Jvara Manuscripts TDU has undertaken a programme to bring to light the most valuable ancient texts and manuscripts of Ayurveda in a systematic manner, by deciphering, editing, translating and publishing. As part of this program, 3 important manuscripts on 'Jvara' were taken up for the study, whose contents are not available in other recognized works. Jvara is the term in Ayurveda that is most commonly understood and translated as 'fever.' However, this term has several other connotations and holds the key to the understanding of several types of diseases.

The dictionary shall be available in the form of physically printed volumes with proper indexing etc., as well as in the form of a web-app and mobile app.

When complete this Dictioanry (both online and offline versions) will fill a gap that currently exists and shall facilitate a very clear and precise understanding of the fundamental concepts of Ayurveda in a precise and versatile manner.

Edited version will contain the following key sections

1. Detailed scholarly Introduction
2. Abbreviations
3. Edited text – with variations in reading, provided in footnotes.
4. Translation provided under the text
5. The following Appendices are provided
    - Additional notes
    - List of quotation with sources and translations
    - List of works referred to in the course of text(in chronological order)

i. List of authors referred to (if any)
ii. List of technical terms with Kannada & English equivalents
iii. List of Dravyas along with their 'Gunas' in the alphabetical order
iv. Recipes / Ingredients for the preparation of different medicines
v. List of prescribed and forbidden medicines / foods with the perspective of individual health
vi. List of slokas in the alphabetical order. (wherever applicable)

Descriptive catalogues in different libraries with the palm-leaf and hand-made paper manuscripts all over India were verified and the list of manuscripts dealing with Jvara was prepared and finalized. The following unpublished manuscripts on Jvara have been taken up for critical edition and publication

- Jvaratrishati.
- Jvaratimirabhaskara.
- Sarvajvarasamuccayadarpana.
- Jvarankushakalpa
- Jvaradhikara
- Jvararoganidana

Currently, the two works namely, Jvaratrishati and Jvaratimirabhaskara have been deciphered, edited, translated.

Teammembers

Prof. M.A.Lakshmithathachar, Dr. S N Venugopalan, Dr. M.A. Alwar, Dr. Hemanth T. R, Dr. Anantha M A

5. Centre for Ayurveda Biology and Holistic Nutrition

5.1 RIST Holistic Nutrition Research & Outreach Program

Background

India is facing multiple health challenges stemming from nutritional deficiencies, infectious diseases and chronic diseases. As examples, nearly 50% of pregnant women and a third of the general population in India suffers from iron deficiency anaemia (WHO 2011)[1]. Nearly 80 million Indians suffer from type-2-diabetes, a chronic disease. And though we have a young population today, the Economic Survey of India points to the fact that India's population of over 60 years will double over the next few decades, which could potentially compound the chronic health challenges at societal level. Lancet's 2020 special issue on Global Disease Burden also points to the increasing contribution of chronic diseases to disability-adjusted life years.

It is difficult and expensive to meet the growing health needs through a 'curative' health system. The most low-cost solution for unmet health needs is food because it is the daily input consumed to sustain human life and it offers a preventive solution as well.

India has a strong heritage of local health traditions underpinned by food, which can be leveraged for finding solutions to India's present as well as the emerging health and wellness challenges. Through the RIST program, we are developing infrastructure to research food solutions and to translate our research into products of mass consumption and training programs for outreach. The goal of the RIST Holistic Nutrition program is to create a healthy India through 'food-first' solutions based on science-backed traditional knowledge of nutrition embedded into every kitchen of India.

The program has 3 focus areas

1. Development of an Integrative nutrition database,
2. Development of traditional knowledge inspired functional foods for nutrient deficiencies, metabolic health and brain health
3. Creating & executing outreach programs for training professionals & non-professionals in holistic nutrition principles & practices.

WHO. The global anemia prevalence in 2011. Geneva: World Health Organization; 2015.
Accessed from https://www.who.int/nutrition/publications/micronutrients/global_prevalence_anaemia_2011/en/

Highlights of progress

Integrative Nutrition Database

A beta-version of an integrative nutrition database was completed this year. The database has 1000 and odd ingredients curated from Ayurveda texts, FSSAI database & NIN database. The database includes details of Ayurveda pharmacology properties and nutritional composition of these ingredients. The database also includes 4000 recipes curated from 30 classical texts spanning nearly 3000 years.

Functional Foods

The team was also engaged in developing functional foods for iron-deficiency anemia, controlling blood glucose response and for mild-cognitive impairment. Following are the highlights:

- For Iron-deficiency anaemia: a prototype extruded, iron-rich snack (savoury) with superior bioavailability, based on a CaCo2 cell-line model, was attempted, having 15% RDA of iron in a serving. A pilot-scale process was set-up while scale-up studies for establishing the technology were initiated. The product will be tested for acceptance in a community trial in villages in Nilgiris jointly with Nilgiris Adivasi Welfare Association in the coming months.

- Control of Glucose Blood Response to food: A mix of amla & turmeric (Nishamlaki) has been shown to inhibit two key enzymes (amylase & glucosidase) responsible for breakdown of carbohydrates into simple sugars in lab assays. The mixture was standardized and further work on improving its activity using the lab assay was initiated. An exploratory study to know the effect of the pilot-plant prototypes was initiated using continuous glucose monitoring.

- Ghrita: analytical methods to evaluate fatty acid profile and aroma profile of ghrita's were established. Pilot scale process for manufacturing ghrita by different methods –cream ghee, ripened cream ghee & curd ghee, were also established. These ghrita's were tested for their biological efficacy in C. elegans & Drosophila model systems. A clinical study was initiated for Brahmi Ghrita for its effect on mild cognitive impairment.

- The laboratory took up studies with amla, turmeric and Ayurveda greens to develop value added ingredients from these superfoods of Ayurveda. Additionally, scoping working on protein deficiency with a focus on cost and quality of proteins from plant sources, was initiated.

Outreach Program

Adequate knowledge sharing about nutrition and dietary practices is integral to the RIST program. Accordingly, two pilots for outreach programs (one for training healers to reach rural population and another with dieticians to reach urban populations) were initiated. The healers outreach program focused on foods and habits to address iron-deficiency anemia (IDA) in tribal populations, and the dieticians outreach program focused on increasing awareness about Ayurveda dietetics amongst nutrition and dietetic professionals. Developing appropriate contents for the pilots was initiated, for subsequent field testing of the pilots in the field, incorporating the learnings and refining.

Traditional healers provide informal healthcare services to local communities by addressing primary healthcare challenges using ecosystem specific natural resources. It is estimated that about a million healers practice non-codified or folk traditions of healthcare across India. In this outreach program, efforts were made to build the capacity of traditional healers for management of Iron Deficiency Anaemia (IDA) based on knowledge generated and products developed in our laboratories. In our pilot, we collaborated with NAWA (Nilgiri's Adivasi Welfare Association) for training healers from the tribal communities of the Nilgiris. Four online programs were conducted in which 47 traditional healers from 19 villages of Kotagiri were trained on the understanding of IDA, its causes, diagnostic features, management methods, and sharing of information on products researched and developed under the RIST project at TDU. These sessions also provided an opportunity for the healers to exchange their own traditional knowledge on IDA. 10 healers were selected for phase 2 and will be given additional training to become 'trainers'. Each of these trained healers is expected to train 500 households on food habits for tackling anemia.

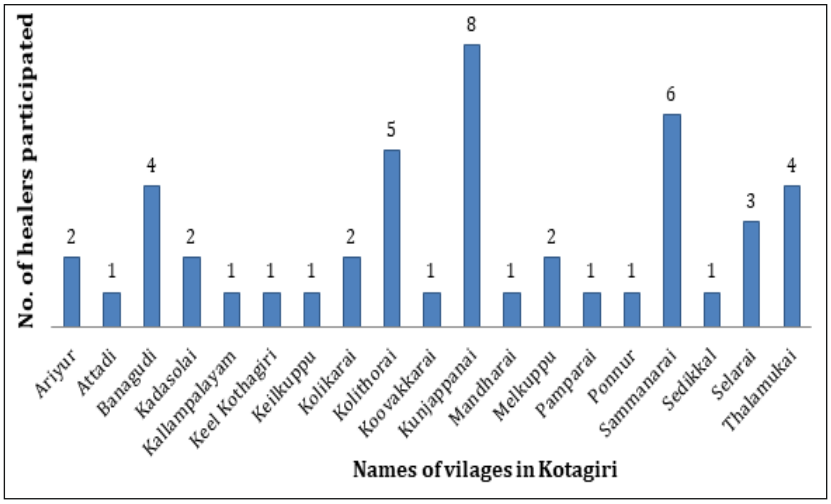


Fig 5.1 Village network of healers trained

Village wise distribution of healers who attended the awareness program on IDA

The training program for professional dieticians focused on integrative nutrition targeting the urban communities of India. Nine workshops on Ayurveda Dietetics were conducted, in which 600 people received certificates.

Laboratory Infrastructure for Holistic Nutrition Research

The Centre has 13 laboratories and pilot plants to research on the above. These include wet chemistry lab, food & Dravya analysis lab (with GC-MS, HPLC, LC-MS, HPTLC), Cell biology lab, C. elegans lab, Drosophila lab. These are supported with multi-omics, microbiology & microscopy labs. Pilot plants were setup for Ayurveda inspired food product design, post-harvest processing of botanicals, food extrusion, botanical extracts & powders. The laboratories and pilot plants give the Centre the capability to do end-to-end new product development for foods. The program included 7 PhD students and 1 MS by Research student.

The team delivered the following talks and webinars

- "Nutrition in Ayurveda and its application to modern dietary practises" one-day workshop for Indian Dietetic Association members (Bangalore chapter; 15 participants). August 2019.
- Iron-deficiency anemia awareness workshop with 35 traditional healers from Karnataka, October 2019.
- Workshop on "Ghee and buttermilk" in association with scientists from NDRI, Bangalore, November 2019 (~25 participants).
- Participated in CSIR Mission on Nutraceuticals at IHBT, Palampur. November 2019
- Thematic pre-conference session "Introduction to food concepts in Ayurveda and its potential for health" at the annual Indian Dietetic Association meeting in Ahmedabad. December 2019 (~120 participants).
- "Introduction to Ayurveda-based holistic Nutrition": a one-day workshop with Indian Dietetic Association, Mysore chapter. March 2020. (~120 participants).

Team members:

Gurmeet Singh, Subrahmanya Kumar, C. N. Vishnuprasad, Ashwini Godbole, Megha, Mohana Kumara Venkatraj Narayanan, Prakash B N, Varuna Subramanya, Hariramamurthi G, Venugopalan, Madhumitha Krishnan, Amulya Kannan

Fig 5.2 Talk by Professor Megha "Introduction to Ayurveda-based holistic Nutrition" at Indian Dietetic Association, Mysore

Fig 5.3 Attendees at Indian Dietetic Association, Mysore

5.4 Thin Film Evaporator

Fig 5.5 Freezer for finished products

Fig 5.6 Brabender TwinLab Extruder

5.7 Polarimeter

Fig 5.8 Electro Magnetic sieve Shaker

CTC Tea processing machine

Matcha grinder

Withering trough

Omega horizontal juicer

Stability chamber

Conveyor machine

Fig 5.9 Equipments

5.2. Scientific evaluation of marketed substitutes for medicinal plants facing conservation threat

Background

In the context of increasing demand for plant drugs from Ayurveda and herbal drug industry, the supply chain of medicinal plants needs to be enforced. There is also a need to establish substitutes that are bioequivalent for certain rare and endangered medicinal plant. In this project on *Abhava Pratinidhi Dravya* (substitutes), it was attempted to make use of tools from pharmacognosy, phytochemistry, molecular biology and pharmacology to evaluate bioequivalence of selected substitutes for rare and endangered medicinal plant. Pharmacological activity of compound Ayurvedic formulations prepared using substitute drugs and authentic herbs was compared.

Highlights of progress

Sarivadyasava, prepared with roots of *Hemidesmus indicus* is one of the commonly used medicinal products in Ayurveda to manage diseases of Pitta-dosha including gout, diseases of genito-urinary tract, diabetic carbuncle etc. However, since the availability of *H. indicus* is not meeting the demand, other species (*Ichnocarpus frutescens) are used* as Sariva to prepare Sarivadyasava (Lakshman et al., 2005)[2].

During the current year, five samples of Sarivadyasava prepared using different plant drugs such as *Ichnocarpus frutescens, Decalepis hamiltonii* and *Cryptolepis buchanani, that are* considered potential substitutes of *H. indicus* were studied using different pharmacological models. Cell based, *Drosophila melanogaster* and *Caenorhabditis elegans* based studies provided insights that, these substitutes were effective in place of *H. indicus,* especially for reducing inflammation, healing wounds, as well as for managing heat stress (activity related to aggravated *Pitta*).

The wound healing assay (scratch assay) on cell monolayer of several cell-lines was carried out to study the wound healing and lesion closure potential of Sarivadyasava. Cells were grown to form monolayer. This layer was scratched mechanically to mimic the skin lesion and the cell culture media was added with various samples of Sarivadyasava. Closure of the lesion and cell migration was observed at various time points. The pharmacology of Sarivadyasava in wound lesion closure proved similar mode of action of all 5 samples (figure 5.10 & 5.11). Similarly, all 5 preparations of Sarivadyasava exhibited comparable potential to palliate heat stress in *Caenorhabditis elegans.*

[2]Lakshman K, Jayaprakash B, Joshi H. Comparative anti-inflammatory activity studies of four species of Sariva. Indian Journal of Pharmaceutical Sciences 2005 (Jul-Aug), 481-2.

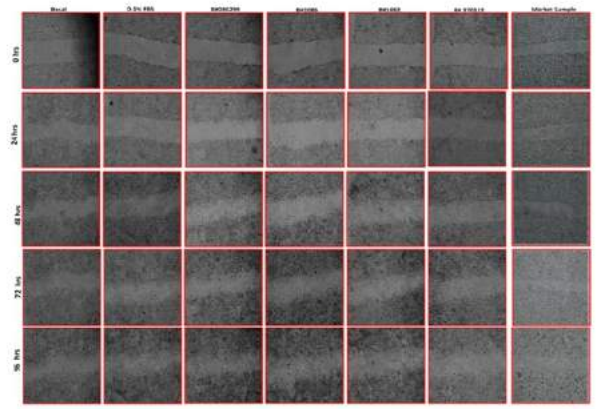


Fig 5.10 Scratch/wound healing assay on L929 subcutaneous adipose connective tissue – activity recorded at different time points (4x magnification) The lighter longitudinal patch in the centre of each quadrant is mechanical lesion created on cell monolayer. One can observe the gradual closure of the lesion as time advances.

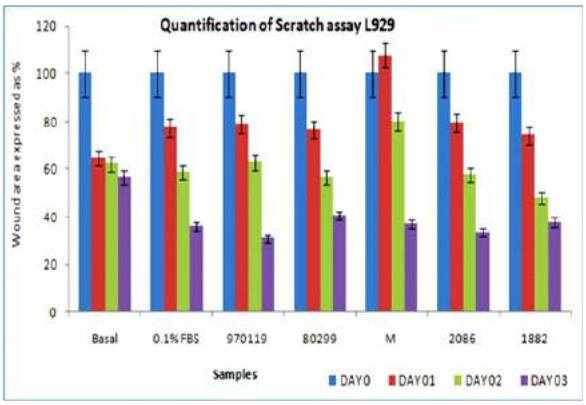


Fig 5.11 Quantitative result of wound healing assay with L929 Monolayer – showing similar activity by all five samples

As per the Ayurvedic Pharmacopoeia of India, Vidanga is *Embelia ribes*. experiments to study the anthelmintic activity of *Vidangarishta* using *Caenorhabditis elegans* (worm model) were carried out, wherein the nematodes grown in the laboratory were exposed to different samples of *Vidangarishta,* looking for their ability to kill the worms. Our studies showed that, Vidangarishta prepared using both species *are* equally potential in terms of anthelmintic, antilipidemic activities.

Publications

A poster titled '*In vitro* and *in vivo* evaluation of anti-obesity potential of Vidangarishta -an Ayurvedic poly-herbal formulation' was presented in the I*nternational Conference on* ***AYUSH for future health challenges, strengthening Trans-disciplinary research.*** Savitribai Phule Pune University (SPPU), Pune. 28-30th November, 2019.

Team members

Subrahmanya Kumar, C. N. Vishnuprasad, Ashwini Godbole, Ashwini Elango, Seema V, Kallolika, Arunava Choudhury

5.3. Ayurveda-Biology framework for integrative diabetes management

Background

Management of complex metabolic disease like diabetes and obesity requires a systematic approach. Diabetes research in TDU envisages creating a novel transdisciplinary 'Ayurveda-Biology' framework, combining holistic disease management principles of *Ayurveda* and the molecular perspective of modern biology, for the management of diabetes and glucose metabolism related disorders.

Gut or GIT is the first anatomic site that interfaces the ingested food (primary source of glucose and energy) and body's metabolic homeostasis. Gastro Intestinal mediated Glucose Disposal (GIGD), an orchestrated event regulated by various gut derived factors, is emerging as a systemic strategy in diabetes management. A deeper understanding of GIGD and its multi-targeted mode of action could open up novel holistic strategies for maintaining whole body glucose homeostasis and management of diabetes. The team studied 5 important Ayurveda formulations to understand their mechanism of anti-diabetic action, with a focus on GIGD.

Highlights of progress:

- The team showed *Vasanthakusumakara*, one of the anti-diabetic formulations used in Ayurveda, works through inhibiting digestive enzymes as well as reducing adipogenesis through down-regulating key molecular pathways of fat metabolism.

- The team conducted a multidimensional analysis of retrospective clinical data of patients treated at IAIM with these formulations using artificial intelligence and machine learning tools. The team proposed novel ways of analysing the clinical data of Ayurveda using these advanced tools.

- The team analysed the pharmacological networking of *Nishamalaki*, one of the first line formulations for diabetes management, for understanding novel pathways involved in its antidiabetic effect.

- Ms. Anjana and Ms. Sania attended the 'International conference on AYUSH for future health challenges - strengthening Transdisciplinary research' organized by Savithri Phule University, Pune 2019, the presentation mode of action of Ayurveda formulation won Second prize.

Publications/Research papers/ invited talks

a. Anjana T, Sania K, Subrahmanya KK, Vishnuprasad CN (2020). An '*Ayurveda-Biology*' platform for Integrative Diabetes Management. Journal of Ethnopharmacology (Manuscript under revision).

b. Nutan Nabar, Vaidya RA, Vishnuprasad CN, Raut AA, Vaidya ADB. (2020). Ayurvedic Dravyaguna (Pharmacological) Correlates With Biological Plausibility for Antidiabetic Activity of Eujenia Jambolana Linn. The Indian Practitioner, 73, 26-31.

c. Patra JK, Das G, Bose S, Banerjee S, Vishnuprasad CN, Rodriguez-Torres MP, Shin HS (2020). Star anise (Illicium verum): Chemical compounds, antiviral properties and clinical relevance. Phytother. Res. 1-20.

d. Vishnuprasad CN (2020). Scope of Ayurveda Biology in the future of integrative healthcare for global wellness. Ancient Sci Life; 38

Team members:

C. N. Vishnuprasad, Subramanya Kumar, Jaleel UC (Collaborator from OSPF), Anjana T, Sania Kouser

5.4. Effect of Ayurveda formulations on modulating fat metabolism

Background

Impaired fat metabolism leads to several metabolic disorders like Non-alcoholic fatty liver disease (NAFLD), obesity, insulin resistance, hyperlipidaemia, and other metabolic syndromes. It poses a significant health and economic burden to the patients and their families. The team at TDU explores the benefits of using Ayurveda formulations for managing fat metabolism related disorders.

Highlights of progress

- TDU team had shown the beneficial effects of *Lodhrasavam,* a fermented poly-herbal formulation in *Ayurveda* prescribed for obese diabetic patients. *Lodhrasavam* is a complex formulation prepared from 29 plant drugs and it is referred as a *medo-hara* formulation. Understanding the mechanism of action of *Lodhrasavam* will offer deeper insights into its therapeutic role in treating a complex disease like, obesity, NAFLD etc.
- The team had show protective effect of *Lodhrasavam* on steatosis (induced by sodium palmitate) in HepG2 (Human hepatocarcinoma) cell model. Palmitate induced cell toxicity was reduced when the cells treated with different concentrations of *Lodhrasavam*. Similarly, these concentrations also showed reduced lipid accumulation indicating the ability of *Lodhrasavam* to reduce lipotoxicity induced by palmitate.
- The team had also used *Drosophila melanogaster* (Fruit fly) model for studying the effect of *Lodhrasavam* on reducing hyperlipidemia. High fat fed obese flies when treated with Lodhrasavam showed reduction in body weight and triglyceride accumulation.

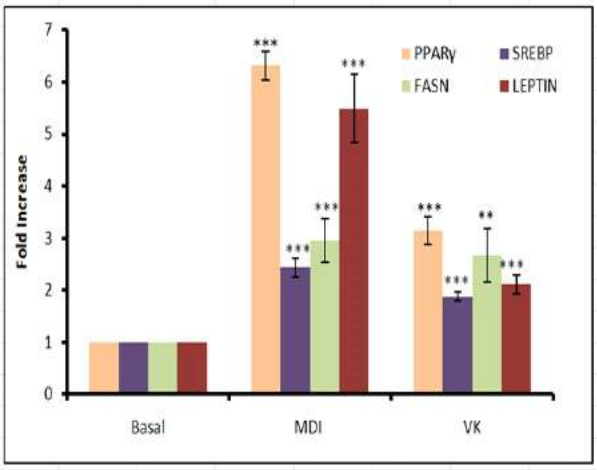


Fig 5.12 Effect of VK on expression regulation of adipogenesis related genes in 3T3-L1 adipocytes. VK down-regulates the expression of key adipogenesis genes.

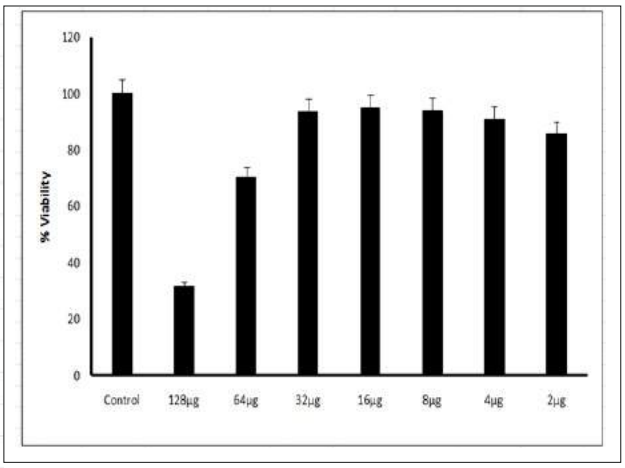


Fig 5.13 Lodhrasavam reduced the lipotoxicity induced by 1% palmitate on HepG2 cells

Team members

C. N. Vishnuprasad, Subramanya Kumar, Sania Kouser, Ashwini Elango, Seema

General CABHN related activities of Dr. C.N. Vishnuprasad.

- Participated in a workshop conducted by Open Source Pharma for discussing an Ayurveda trial in the cancer domain on 23.11.2019 at World Trade Centre, Center 1, 31st Floor, Committee Room, Cuffe Parade, Mumbai- 05, and presented TDU work on clinical data analysis.
- Participated in the 2nd Indian-French Symposium Plants with health benefits and Biomolecules of interest from the plantlets to the tablets, University of Bordeaux, Agora du Haut Carré, Talence Campus France, 27th – 29th November, 2019

Best Poster Award recognizing CABHN works

Vishnuprasad CN (2019, November), Transdisciplinary research approaches for studying the poly-herbal formulations of *ayurveda* for enhanced bio-assimilation of food and medicine**,** 2nd Indian-French Symposium Plants with health benefits and Biomolecules of interest From the plantlets to the tablets, University of Bordeaux, Agora du Haut Carré, Talence Campus France, 27- 29 November, 2019.

5.5. *Drosophila* model for Environmental Enteric Dysfunction

Background

The Global Nutrition Report 2020 estimates that over 50% of Indian children under 5 suffer from some form of malnutrition. The causes include several socio-economic circumstances as well as environmental conditions which lead to inadequate diets and frequent diarrheal diseases. Together, malnutrition and recurrent enteric infections have been proposed to cause a syndrome called "**Environmental Enteric Dysfunction"** characterized by a deteriorated state of the intestinal tissue architecture, ultimately resulting in poor digestion. This further negatively impacts growth and development of a growing child.

Animal research models serve as a means to understand the causes, pathology and treatment for environmental enteric dysfunction. To this end, we are characterizing a *Drosophila melanogaster* (fruit fly) model. In humans, environmental enteric dysfunction includes gut inflammation, systemic inflammation, increased intestinal permeability and poor digestive capacity. Our first goal is to develop a protocol for early-life malnutrition and enteric infection that reflects the biomarkers seen in humans. On this model we can then perform two types of studies: investigate molecular and cellular properties of intestinal tissue, which is currently difficult in humans and explore dietary interventions that ameliorate environmental enteric dysfunction pathology, to generate pre-clinical evidence for diet-based remedies.

Highlights of progress:

- A protocol for early life malnourishment and later-life diarrheal disease was optimized. Flies were acutely exposed to a low-protein diet in the last stages of development and as adults, exposed to a mild enteric infection with *Erwinia cartovora*, a gram-negative bacterium. These are referred to as "stunted" flies due to their smaller size (Figure 5.14).

- The stunted flies exhibited impaired engagement of innate immunity as assessed by antimicrobial peptide expression, lower intestinal permeability (Figure 5.15) and altered systemic immunity. This suggests that our protocol and model have potential use to study environmental enteric dysfunction.

- Intestinal tissue architecture was observed by immunohistochemistry on intestinal stem cells and enteroendocrine cell numbers.

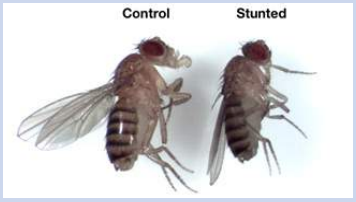


Fig 5.14. “Stunted” flies are exposed to acute low-protein diet during development and are smaller as compared to control flies.

Fig 5.15. “Smurf” assay to measure intestinal permeability. Flies are fed blue-coloured food and the appearance of blue colour is observed. If the entire body appears blue (left), poor intestinal permeability is suggested. In case of retention of the dye in gut (right), intact intestinal permeability is concluded.

Publications/Research papers/ invited talks:

Poster titled “**Drosophila model for Environmental Enteric Dysfunction”** was presented at the 5th Asia-Pacific Drosophila Research Conference, 6 -9 January, 2020 , Pune.

Team members:

Oviya T S, Sushmitha Sekar, Vaishali Rao (former member)

5.6. DESI-MS/ MALDI-MS tissue metabolite imaging of key medicinal plant *Dysoxylum binectariferum*: from metabolite imaging to gene discovery

Bacgkround

Diverse plant species worldwide produce important medicinal compounds which are used for curing major diseases, including cancer. Often the availability is limited, due to low levels *in planta* and/or coming from biodiversity hotspots. Furthermore, their commercial chemical production is frequently difficult because of: a) synthesis of their complex skeletal structures are not economic, and b) metabolic pathway engineering is currently not feasible because of lack of information on biosynthetic machinery involved.

A new approach is urgently needed to overcome these longstanding biotechnological bottlenecks and ultimately gain sustainable production of such key medicinal metabolites. In this current program, cutting edge technology and approaches were used to determine cellular "phytochemical factory" location(s) of key medicinal pathway metabolites using DESI-MS/MALDI-MS tissue imaging and for identification of the remaining missing pathway genes in order to have new means for their production, including use of synthetic biology.

Highlights of progress

DESI MS imaging of different seed developmental stages of *D. binectariferum* was done. Rohitukine accumulation increased with seed development and its distribution was largely restricted to cotyledonary tissue. Analogues of Rohitukine such as Rohitukine acetate, glycosylated rohitukine and rohitukine methoxylated are reported for the first time. Further, tissue specific localization of metabolites during different developmental stages of seedling growth have been identified.

- *De novo* transcriptome analysis of *D. binectariferum* leaf and root samples revealed 5 partial genes could be involved in the biosynthesis of chromone alkaloid, rohitukine. Chalcone Synthase is one of the important genes shortlisted. Currently, orthology analysis of chalcone synthase gene is ongoing using the available SRA data.
- Collection of some *D. binectariferum* and *D. malabaricum* seedlings was done from *Dysoxylum* hotspots near Jog, Sirsi, Kathgal, and Benegav.
- TLC profiling was done for all the collected samples. The leaf and root of *D. binectariferum* and *D. malabaricum* were subjected for transcriptome analysis. Simultaneous analysis of SRA dataset using free web servers is ongoing.

- Extraction of Rohitukine from the samples was initiated and two hundred milligrams of the sample were subjected to extraction in methanol using sonication. The extracts were initially subjected to TLC, to confirm the presence of Rohitukine. Further, the samples were filtered through 0.2 µm syringe filters and subjected to HPLC and LC/MS. Optimization of the methods and quantification of rohitukine from different samples is currently ongoing.

The following are the identified putative genes possibly involved in biosynthesis of chromone alkaloids in *D.binectariferum*

1. Cinnamyl alcohol acyltransferase
2. Phenylalanine ammonia lyase
3. Phenylalanine hydroxylase
4. Cinnamate 4-hydroxylase
5. 4-hydroxyphenylpyruvate dioxygenase
6. Phosphoethanolamine N-methyltransferase
7. Chalcone synthase belongs polyketide pathways

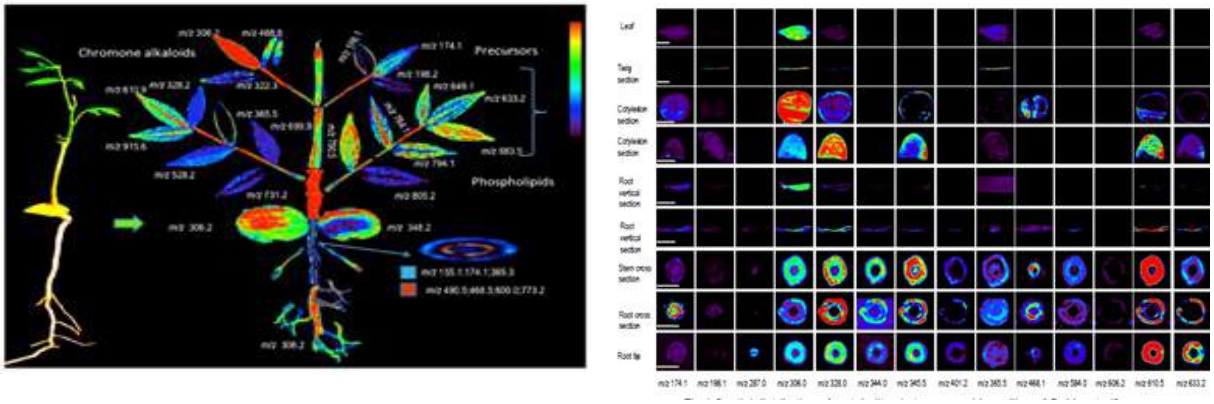


Fig 5.16. Spatial distribution of metabolites in different section of *Dysoxylum binectariferum* one year old seedling

Fig. 5.17. Equipments procured during the reported duration.

Publications/Research papers

- Mohana Kumara P, Uma Shaanker R and Pradeep T, 2019. "UPLC and ESI-MS analysis of metabolites of *Rauvolfia tetraphylla* L. and their spatial localization using desorption electrospray ionization (DESI) mass spectrometric imaging Mass spectrometry imaging; metabolic pathways" Phytochemistry Vol. 159, 2019, 20-29.

Team members:

Mohana Kumara P, Renuka, Amitava Srimany, Ravikanth G, Uma Shaanker R, Pradeep T

5.7. Functional molecules in honey for the management of diabetes

Background

Honey is a natural product obtained from the nectar of flowers, collected by bees. It is considered as a functional food and one of the finest sources of heat and energy. It is rich in sugars, minerals, enzymes and functional phytochemicals. Among these, the major constituents are glucose (30%), fructose (40%) and water (17%). The nature and composition of minor components like functional molecules (flavonoids, terpenes, enzymes, peptides, rare sugars etc.) are basically determined by the floral diversity and nectar source from which it is collected. Biological effects, composition and acceptability of honey are largely determined by the local floral diversity, geographical locations and the species of *Apis*, which collects the honey. While the major components of honey like sugars and water remain constant, the functional molecules will vary depending on the quality determining factors.

In order to overcome the variability, the present study intends to use honey obtained from single plant species (such as Jamun, Eucalyptus, Ficus, etc - monofloral honey). The study focuses on identifying the chemical constituents of the monofloral and multifloral honey using advanced analytical tools and elucidate the biological properties (anti-diabetic and anti-obesity) using various in-vitro model systems.

Highlights of progress: Multifloral and monofloral honey was collected from authentic sources. Extracts of multifloral honey showed higher percentage of inhibition of enzymes (Alpha-Amylase and Alpha-Glucosidase) than monofloral honey. This could be because of possible synergistic effect of phyto-constituent's presence in the honey collected from many plants. Studies also indicated that when honey mixed in lukewarm and water at room temperature, high percentage of inhibition of enzyme was observed in honey mixed with water with room temperature. This indicates that honey in room temperature water shows anti-diabetic property. Phytochemcial analysis of honey using GCMS showed the presence of more than 30 different metabolites.

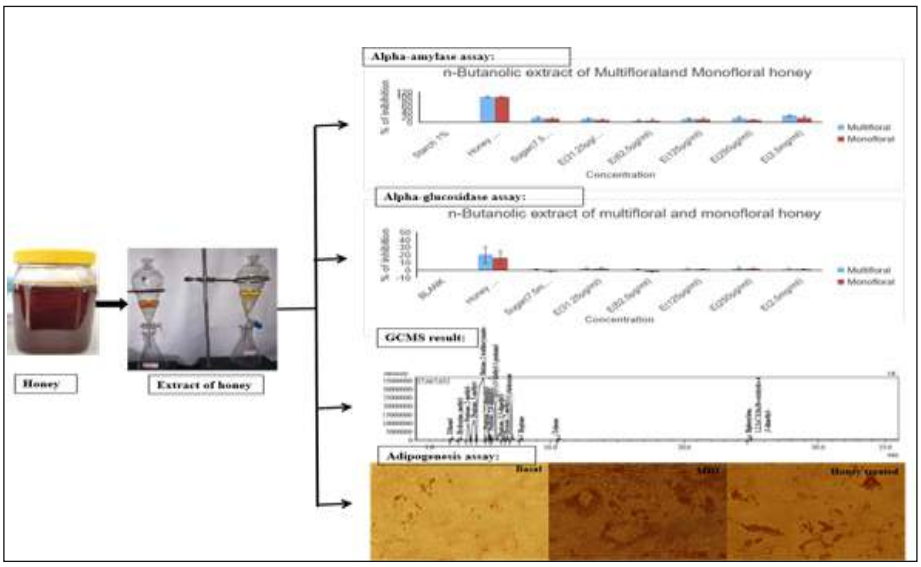


Fig 5.18 Effect of honey extracts on alpha- amylase and alpha glucosidase enzymes and GCMS chromatogram showing presence of different metabolites.

Training/ Symposium/Workshop attended:

- Mohana Kumara P attended the EMBO-EMBL Symposium on " Multiomics to Mechanisms: Challenges in data integration. September 2019
- Renuka attended the training on "transcriptome analysis" conducted by IBAB. October 2029
- Ashwini S attended the LCMS and flow cytometry training.

Team members:

C. N. Vishnuprasad, Mohana Kumara P, Ashwini, Renuka Joshi

5.8. Understanding biological effect of Ayurvedic Nootropics

Background

Nervous System Health

Optimum development, function and structural integrity of nervous system are of high importance for good quality of life. Good sensory and motor functions as well as high cognition are indication of healthy nervous system. Aging is the most common factor which leads to decline in cognitive health, but stress, unwholesome life style and injuries can also affect the nervous system health and cognition. Maintenance and enhancement of cognition is very vital not only for fulfilling all the required mental and physical tasks at all ages, but also for reducing risk of getting age-related neurodegenerative disease (Blagosklonny.et al 2009) and enhancing quality of life.

Paucity of effective and safe nootropic drugs

Function of nervous system is an important topic of bio-medical research. Scientific research in recent past has come up with detailed understanding of structural details of normal and diseased nervous system, brain in particular (Bossy-Wetzel et al 2004). However, very few well researched solutions are available for enhancement and maintenance of health of the nervous system.

Ayurveda has concepts and elaborate description of different aspects of nervous system health and disease (Susruta Sutrasthana 2/3, Charaka Samhita VS 8/8). It describes many concepts and suggests many practices, diet, herbs and formulations for enhanced cognition, sensory and mechanical abilities. However, both the concept and practices from Ayurveda are largely not backed up by contemporary scientific evidence (Singh and Rastogi 2012). This has led to limited acceptability and use of potentially very effective health solutions from Ayurveda.

Transdisciplinary Research in Neurobiology

Neurobiology research at CABHN-TDU stems from Ayurvedic knowledge and concepts sourced from classical texts and Ayurveda clinical practice. The research is mainly focused on developing scientific evidence for efficacy and mode of action at clinical and pre-clinical level respectively.

Mode of Action studies: *Caenorhabditis elegans* models

1. Correlation of aging and nervous system function. Effect of Ayurvedic anti-aging formulation
2. Study of mode of action of Ayurvedic Nootropic formulation on protein homeostasis and neurodegeneration in Alzheimer's and Parkinson's Disease models of *C elegans*
3. Effect of different dosage forms of Brahmi on neuronal health and Disease
4. Molecular and cellular insights in correlation of sugar and lipid homeostasis with nervous system function

Clinical studies: Effect of Brahmi ghrita on memory

1. Age-related Mild Cognitive Impairment (MCI): A community based clinical research done in collaboration with a team from NCBS-TIFR
2. Chemotherapy Induced Cognitive Impairment (CICI) in breast cancer patients: In collaboration with HCG, Bangalore

highlights of progress:

- Mandookaparni swarasa (fresh juice) (Figure 1) and Bala in the form of Ksheerabala 101 protects PD models of *C. elegans* against MPP+ iodide induced neurodegeneration (Figure 5.19).
- Plain Ghrita (cow ghee) and Brahmi Ghrita reduced percentage of Amyloid beta protein aggregation induced paralysis in AD models of *C. elegans*. The molecular biology related experiments (quantitative RT-PCR) indicated that ghee-based formulation and some fat rich food protect AD phenotypes in the transgenic worms by enhancing expression of protein homeostasis and anti-aging genes (Figure 5.20)
- Milk supplementation of food increased life span of *C. elegans*

Team members:

Ashwini Godbole, Anjaneyulu J, Varghese Thomas, Ashwini Thakare, Prasanna K Simha, Pushpendra Jat, Swathi G H, Arman Deep Singh, Bhaktee Dongaonkar (NCBS-TIFR)

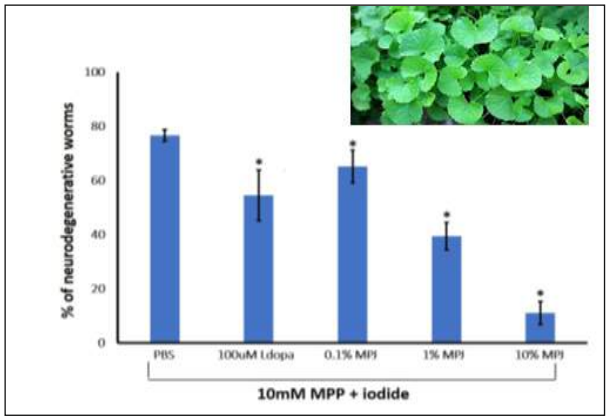


Fig 5.19 Mandookaparni (*Centella asiatica*) Swarasa Mitigates MPP+ Iodide Induced Neurodegeneration in PD models of *C.*

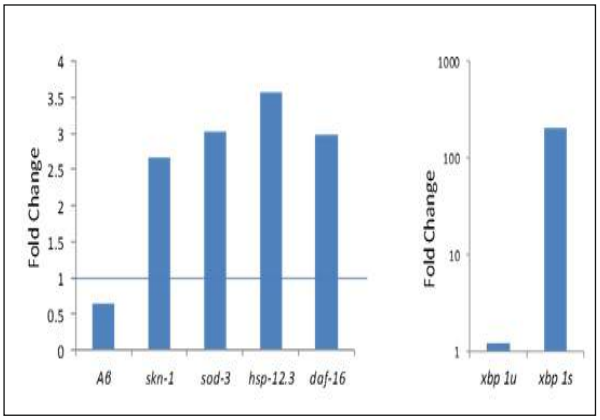


Fig 5.20 Ayurvedic nootropic foods reduce A and higher expression of anti-aging, anti-oxidative, protein homeostasis enhancers and ER stress related genes in AD models of *C elegans*.

6. Centre for Conservation of Natural Resources

6.1 Assessment of medicinal and aromatic plants species (including collection, usage, demand, market, price trends & life cycle) focusing on landscapes, with special reference to RETs

Background

Biodiversity resources, particularly medicinal and aromatic plants, are usually harvested in an unorganized manner by many local communities to address health concerns, as well as for meeting their livelihood. However, with increasing demand, the intensity of harvesting from the wild increases year by year and can result in degradation of extent and availability of bioresources in a landscape. The assessment of availability, sustainable harvesting methods and compliance of statutory provisions of Biological Diversity Act on Access and Benefit Sharing therefore become critically important for optimizing benefits to the communities to ensure adoption of concepts of sustainable harvesting/ use, thereby conservation.

In this context, The Ministry of Environment, Forest and Climate Change (MoEF & CC), Government of India along with UNDP is implementing a new GEF funded project: SECURE Himalaya (Securing livelihoods, conservation, sustainable use and restoration of high range Himalayan ecosystems) in the states of Jammu and Kashmir, Himachal Pradesh, Uttarakhand and Sikkim, which aims to support the Government of India to effectively promote sustainable land and forest management in alpine pastures and forests in high range Indian Himalayan ecosystems that secure sustainable livelihoods and community resilience and ensures conservation of globally significant biodiversity and threatened species.

Under this initiative, FRLHT/TDU was awarded a study for Khangchendzonga – Upper Teesta Landscape, Sikkim, to identify suitable forest sites for establishing MPCDAs.

The team at TDU was involved in this unique initiative during the year and made significant progress. Following are the highlights.

Identification of sites is a cumulative outcome, is based on at least 3 activities completed previously. These are: a) understanding the natural distribution of the focal MAP species, b) locating sites having sizable population of the focal MAP species, within their distribution range, c) current threats and population status of the focal MAP species at these select sites. These three activities would be carried out first based on review of literature, and followed by discussion with different stakeholder groups such as Sikkim FD, local communities, and finally by ground truthing.

- The team initiated a rigorous literature review from published sources and >130 publications (scientific papers, books, technical reports, forest working plans, online resources) related to diverse topics of Sikkim landscapes (Biodiversity resources, ethnobotany and medicinal uses, folk traditions, rapid vegetation surveys, ecology, threats and conservation status, climate change), were gathered and a gap analysis was carried out to understand the status of MAPs of the study area.
- The team identified 10 focal species of medicinal plants (5 species with high degree of threats, 5 species that witness high volume trade), as its focal species for the study. These include: Allium wallichii, Gymnadenia orchidis, Neopicrorhiza scrophulariifolia, Panax sokpayensis, Polygonatum verticillatum, Aconitum ferox, Nardostachys jatamansi, Paris polyphylla, Podophyllum hexandrum and Rheum nobile.
- Subsequently, botanical survey was undertaken to understand the population status of these species in different locations of Sikkiim: Yuksom (Koungtay, Mangtabong, Dubdi Monastery forests), Sachen, Bakhim - Tshoka trail, Tshoka – Dzongri trail, Dzongri - Tshoka trail, Tshoka - Yuksom trail. The team could locate a small population of Polygonatum verticillatum.
- Ecogeographic maps were generated for 6 focal species using the published and the field data.
- Market surveys were conducted during June-July 2019 to understand the intensity of trade of these medicinal plants. Starting from local markets in Sikkim to retail, regional and wholesale markets in Siliguri and Delhi were consulted and necessary information was gathered from traders. It was found that, the high-altitude medicinal plants are sourced from across different states in the Himalayan region, and a complex network of collectors, agents, small traders and big traders operate.
- The team further visited select EDCs and JFMCs to understand the livelihood dependency of local communities on medicinal plants. It was found that, main source of family income is from MGNREGA jobs, farming and tourism related activities. The team gathered information on traditional knowledge related to harvesting and post harvesting practices of medicinal plants being followed by local communities.
- A thorough literature search was carried out to gather relevant data on distribution, population status of focal MAPs, and ideal locations for MPCAs, based on High Conservation Value (HCV) principles. Various publications, (including research papers, technical documents, forest working plans and project reports from different agencies and govt. departments) were consulted. Available information on suitability of landscapes for conservation reserves and conservation values was processed and we found that there is a dearth of significant data. Additional information was sought from two other agencies working in the landscape (ATREE and WETLNADS international). Supporting data related to principles of Important Biodiversity Areas (IBA), Protected Area networks (PA), Important Plant Areas (IPA) for Medicinal plants, were gathered.

- The available data on distribution, population status of the focal MAP species shows the following sites with significant presence of focal MAP species: Lachen, Yumthong, Thangu, Lachung, Dzongri, Uttarey, Yuksom, Kapup, Tamzey. These were shortlisted as possible candidate sites for MPCDAs.
- A comprehensive medicinal plant cultivation manual was prepared on the basis of available state reports, literature and field observation. The manual encompasses with habitat, environmental suitability aspects, propagation techniques, seed collection methods, seed treatment and germination techniques, water management, weed control, post-harvest techniques and micro-propagation.
- The findings and project progress status were presented to state forest department of Sikkim, during the two review meetings at Gangtok in June 2019 and November 2019, as well as to the National review committee, UNDP at New Delhi, during December 2019.

6.2. Impact of Climate Change on wild populations of Medicinal Plants of Conservation Concern (Endemic, Niche-specific & Red Listed): A Futuristic Scenario

Background

Climate change, as a global challenge to the scientific fraternity has sparked a recent surge of interest world over in investigating its impact on forests and biodiversity. However, in India research to study the impact of climate change on forests and biodiversity is quite limited, as it is confined to certain temperate plant species, leaving behind a gap in respect of tropical species. Understanding the effects of climate change on medicinal plants in India becomes a priority, since majority of high volume traded medicinal plants are currently sourced from wild tropical landscapes, which are vulnerable to climate change as per the projected climate scenarios.

This study is thus an attempt to fill this gap by way of developing an overview of the impact of climate change on wild populations of medicinal plants, based on published research literature and data from climate change studies in India.

Highlights of progress

The team during the year, engaged in the following activities and successfully completed them.

a) Literature Review: The team focused on selected 18 medicinal plant species from the tropical landscapes of Western Ghats of India. These are major NTFP species which currently witness high volume trade (>100 MT) in the raw drug markets. Appropriate climate change research datasets for the period 1990-2018, corresponding to these species from India, and similar biogeographic zones in S.E. Asia were gathered through a rigorous literature search. Major online information portals (Scopus, Google scholar, Inflibnet, Shodhganga, Krishikosh, India Biodiversity Portal, Western Ghats Biodiversity Portal) were consulted.

This search resulted in pooling >400 datasets, (peer reviewed research papers/ study reports/ chapters/ references) which was further filtered to ~200 for the current synthesis.

Table. 6.1 Focal species considered for Climate change impact-future scenarios study

Medicinal plant Species	Niche specificity	Whether NTFP	Trade	Red list status
Artocarpus lakoocha	*Riparian spp.*	*NTFP*	*Regional*	
Artocarpus gomezianus	*Evergreen spp.*	*NTFP*	*Regional*	
Calophyllum apetalum	*Riparian, swamp*	*NTFP*	*Local*	*Vulnerable*
Calophyllum ionophyllum	*Riparian, swamp*	*NTFP*	*Local*	
Cinnamomum macrocarpum	*Evergreen sp.*	*NTFP*	*High volume trade*	*Vulnerable*
Cinnamomum riparium	*Riparian spp.*	*NTFP*	*High volume trade*	*Endangered*
Garcinia gummi-gutta	*Evergreen sp.*	*NTFP*	*High volume trade*	*Near Threatened*
Garcinia indica	*Evergreen sp.*	*NTFP*	*High volume trade*	*Vulnerable*
Garcinia morella	*Riparian, Swamp*	*NTFP*	*regional*	*Vulnerable*
Garcinia xanthochymus	*Evergreen sp.*	*NTFP*	*regional*	
Holigarna arnottiana	*Riparian, Swamp*	*NTFP*	*High volume trade*	
Hydnocarpus macrocarpum	*Riparian spp.*	*NTFP*	*High volume trade*	*Vulnerable*
Hydnocarpus pentandra	*Riparian spp.*	*NTFP*	*High volume trade*	*Vulnerable*
Mesua nagassaricum	*Evergreen sp.*	*NTFP*	*High volume trade*	
Myristica malabarica	*Swamp*	*NTFP*	*High volume trade*	*Vulnerable*
Myristica fatua magnifica	*Swamp*	*NTFP*	*High volume trade*	*Endangered*
Saraca asoca	*Riparian spp.*	*NTFP*	*High volume trade*	*Endangered*
Vateria indica	*Evergreen sp.*	*NTFP*	*regional*	*Vulnerable*

- These datasets were processed and "annotated data digests" were prepared. This information was further used to develop a draft synthesis of the futuristic scenario of the impact of climate change on medicinal plants. Following are the key findings.
- Available information from the review, brings to light the impact of climate change on medicinal plants in the form of: a) change in species distribution, b) change in population/ forest structure, and c) altered phenology of plants.
- The projected futuristic scenarios of climate change indicate that, the forests in India especially in Western Ghats, Himalayas and north eastern India are going to be greatly affected by 2050 and 2070. This would mean much of the tropical landscapes would face the challenges of climate change.
- The available studies, though limited, have projected a significant shift and reduction in the distribution range of 217 endemic flora in the Western Ghats, of which 67 medicinal species are feared to face local extinction, due to reduction of suitable habitable by 2050 (species such as Garcinia indica, Myristica dactyloides, Piper nigrum, Saraca asoca, which are major NTFP species) would completely disappear by 2070.
- The tropical Dipterocarp forests are projected to be altered, which would mean that, the populations of medicinal plants such as Vateria indica, and many swamp species, including Myristica dactyloides, Myristica malabarica, Calophyllum apetalum, Calophyllum ionophyllum, Cinnamomum spp., Syzigium spp., Garcinia Morella, Holigarna arnottiana, and Hydnocarpus pentandra, would be adversely affected.
- The Synthesis, though in its interim version, offers a collective picture of different trends in respect of 3 kinds of changes due to climate change, as below. The Synthesis further attempts to offer detailed profiles of these changes based on limited equations.

Table. 6.2 Impact of climate change on wild medicinal plants-emerging trends

Species	Altered distribution	Altered population	Altered growth	Altered yield
Artocarpus lakoocha	#		#	#
Calophyllum apetalum	#	#	#	
Calophyllum ionophyllum		#	#	
Cinnamomum macrocarpum	#	#		
Cinnamomum malabathrum	#	#		
Cinnamomum sulphuratum	#	#		
Garcinia gummi-gutta	#			#

Species	Altered distribution	Altered population	Altered growth	Altered yield
Garcinia indica	#	#		#
Garcinia morella	#			
Holigarna arnottiana	#	#	#	
Hydnocarpus pentandra	#	#	#	
Knema attenuata	#			
Mesua ferrea	#		#	
Myristica fatua magnifica	#		#	
Myristica malabarica	#		#	#
Saraca asoca		#	#	
Shorea roxburghii	#			
Vateria indica	#	#	#	

6.3 Study on Phenological Response of Endemic Plants of Western Ghats to Climate Change: Based on Herbarium records, Historical datasets & Ground truthing

Background

Phenological datasets have become extremely important for understanding the impact of climate change as they reveal variations in flowering patterns. However, there is a dearth of long-term data about flowering of medicinal plants in India, especially the perennials.

This study is thus an attempt to strengthen the current understanding of the impact of climate change on medicinal plants in tropical landscapes. In the absence of sufficient scope for generating long term data, this study aims to examine the trends in phenological response of select endemic medicinal plants of the Western Ghats, by relying on relevant historical data, viz., a) herbarium specimens collected during the last century and housed at different herbaria in India, b) published research literature and research reports, c) forest working plans and other forest records from the previous decades, d) anecdotal qualitative data by NTFP collectors and community groups about the recent changes in flowering patterns and harvest cycles of selected medicinal plant species, through their recollections of harvesting episodes.

The team engaged in consulting herbarium data for the following species, and subsequently carried out ground truthing.

Medicinal plant Species	Niche specificity	Whether NTFP	Trade	Red list status
Calophyllum apetalum	*Riparian, swamp*	*NTFP*	*Local*	*Vulnerable*
Cinnamomum macrocarpum	*Evergreen sp.*	*NTFP*	*High volume trade*	*Vulnerable*
Garcinia indica	*Evergreen sp.*	*NTFP*	*High volume trade*	*Vulnerable*
Myristica malabarica	*Swamp*	*NTFP*	*High volume trade*	*Vulnerable*
Saraca asoca	*Riparian spp.*	*NTFP*	*High volume trade*	*Endangered*
Vateria indica	*Evergreen sp.*	*NTFP*	*regional*	*Vulnerable*
Dysoxylum malabaricum	*Evergreen sp.*	*NTFP*	*Local*	
Kingiodendron pinnatum	*Evergreen sp.*	*NTFP*	*Local*	
Mammea suriga	*Evergreen sp.*	*NTFP*	*High volume trade*	
Shorea roxburghii	*Deciduous*	*NTFP*	*Local*	

Herbarium data: The team gathered historical data related to flowering phenology of these species from different herbarium records. The team visited, the herbaria at Botanical Survey of India, Coimbatore; French Institute, Pondicherry; Institute of Forest Genetics & Tree Breeding (IFGTB), Coimbatore; Jawaharlal Nehru Tropical Botanic Garden and Research Institute (JNTBGRI), Trivandrum; Kerala Forest Research Institute (KFRI), Peechi and Shivaji University, Kolhapur. Herbarium specimens of the focal species found in the collections of these herbaria were examined, and gathered altogether 285 herbarium records (date & place of collection, latitude-longitude, phenology) for the period 1950-2015. These include 172 records with flowering data and 113 records with fruiting data.

The 285 herbarium records were further examined to study the peak flowering month (PFM). Data on the PFM of a species identified from the different herbarium records, was combined under every decade and examined for flowering patterns. We found that the peak flowering phase in all the species, was gradually drifting in the recent years (2000-2015) from the corresponding regular flowering period in the previous decades. This drift appears to indicate the emergence of at least 3 altered flowering patterns:

- Flowering onset advanced-earlier than usual: (seen with Calophyllum apetalum, Mammea suriga, Dysoxylum malabaricum, Myristica malabarica, Saraca asoca and Vateria indica);
- Flowering onset delayed-later than usual: (seen with Cinnamomum macrocarpum);
- Overall Flowering duration reduced: (seen with Garcinia indica and Shorea roxburghii).

Ground truthing: We subsequently attempted to brace up these observations, with ground truthing in select localities along the Western Ghats. It was found that, in the wild populations too, a slight drift in the flowering cycle (bud burst and flowering) has been noticed in the recent years, with three patterns as below:

- Flowering onset delayed-late than usual (seen with Mammea suriga, Myristica malabarica, Saraca asoca and Vateria indica)
- Flowering onset delayed but duration reduced (seen with Garcinia indica, Shorea roxburghii);
- Overall flowering phase reduced (seen with Calophyllum apetalum).

Phenological data based on qualitative observations by the local communities: Subsequently, we interviewed select NTFP collectors from 8 different villages in Uttara Kannada, Mandya and Tumkur districts, to probe into whether they have noticed any changes in the flowering patterns of these species. These collectors too confirmed such drifts in the recent years, in the form of unusual delay in the onset of flowering especially in respect of Mammea suriga, Garcinia indica, Vateria indica, Myristica malabarica and Shorea roxburghii.

The study brought to light many interesting observations and trends about the impact of climate change on medicinal plants in tropical landscapes. Undoubtedly, climate change appears to be affecting the tropical endemic medicinal trees in the recent two decades (2000-2015), and as evident from Herbarium records from 1950-2015.

However, more comprehensive datasets for different species, corresponding to longer time periods are needed to strengthen the understanding further.

6.4. TDU- HD Kote Herbal Pharmacopeia Portal & collaborative portals with KSRSAC & IBP (Funded by AYUSH, Govt of Karnataka)

Background

TDU HD Kote Herbal Pharmacopeia portal was developed to provide relevant information required to manage primary health care by the local communities of HD Kote, students, teachers, health workers and trainers ayurvedic practitioners and policy makers, with geospatial capabilities. In view of the need for wider dissemination of the information to larger user groups, two collaborative efforts have been realized with Karnataka State Remote Sensing Application Center (KSRSAC), Bangalore, and India Biodiversity Portal (IBP).

In this direction, an exclusive module for HD Kote database has been incorporated as Health GIS module under the KGIS portal which has built in resources with remote sensing and geospatial features. Secondly the data has been shared with IBP portal, Bangalore team which has unique geospatial information on Biodiversity aspects.

Highlights

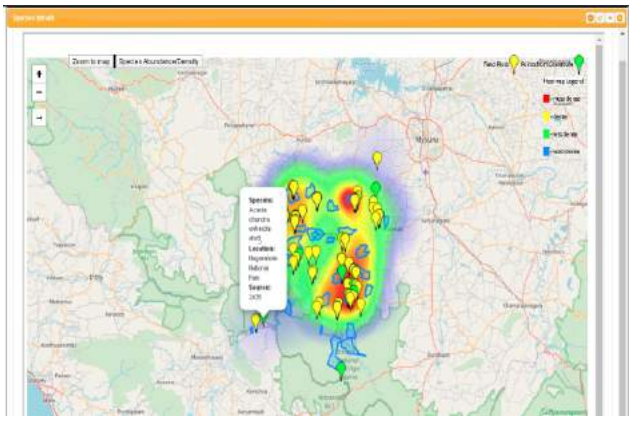
The TDU HD Kote geospatial portal has both static and dynamic pages with textual, pictorial, chart/graphs and dynamic map outputs. The method of retrieving the above outputs involved programming with simplified and optimized query interfaces with regular expression detection capabilities, sanitized form elements for secure data retrieval, localized interface description and data outputs, automated user registration approval/feedback alert systems, facility to view and download training modules and videos for environment education and health education.

The site has been mobile optimized to the extent of static pages and dynamic pages involving search interfaces and data tabs except for the map interfaces. The portal incorporates geospatial features for added visualization and information query effectiveness.

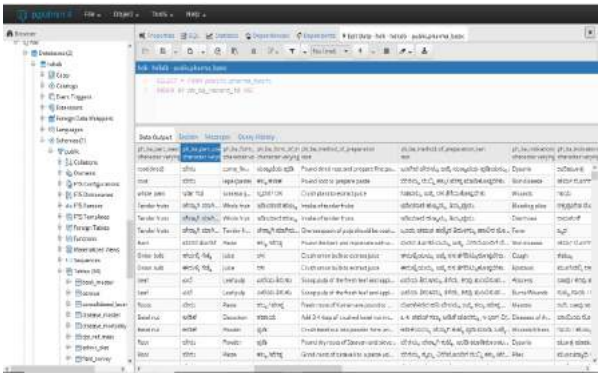
The interfaces/modules that serve dynamic content are the Medicinal Plant Resources module that allows query of botanical details, vernacular details and village profiles in terms of the medicinal plant species, pharmacopeia details and disease details. The Health Resources module helps in visualizing validated primary health care practice details, dravyaguna profiles in terms of medicinal plant species, the formulations and the diseases with their remedies. All the dynamic data query modules have the ability to visualize the queried data in geographic context using web based geospatial frameworks.

The map interfaces have been provided with standard zoomin/zoomout tools, zoom to full extent, distance measure, feature selection functions like marker and village boundary-based data query, radial / buffer area query of data, density heat maps, zoom to selected features. The data queried through geospatial interfaces display medicinal plant resource details like botanical information, species images, slokas associated with the species, single drug remedies related to the species, the field survey plot details village wise, literature references, usage details, trade information, red list status, village profiles, with location boundary and information, generic census information.

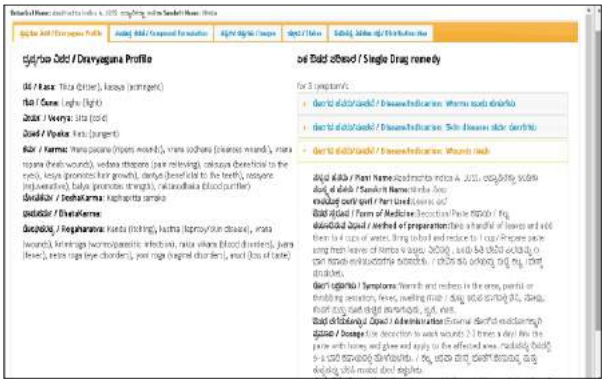
Fig. 6.1 Opening page of TDU HD Kote Herbal Pharmacopeia Portal & collaborative portals



6.2 Plot density and Heat map of the species queried



6.3 Screenshot of the HD kote geospatial Database on a Postgresql platform



6.4 Dravyaguna Profile page Image

6.5 Primary healthcare management information in Kannada

6.5 Development of Geospatial Database for HD Kote Taluka

Background

A Geospatial database for HD Kote taluk, has been developed as a multifaceted diverse information source on health conditions, medicinal plant resources and uses. It is designed to be a model reference source on medicinal plants for rural communities, health workers, school teachers and students, and decision makers in HD Kote taluk of Mysuru district, to build self-reliance in respect of primary health care management using medicinal plants in their neighbourhood.

The team worked on developing the database, and in this direction, a physical functional database was loaded into the Postgres Database of TDU server.

Following are the salient features:

- Entity Relationship diagram of the complete database
- Design Plan for Web portal with the technical flow diagram which depicts the structure of the database, tables, fields, the relationships among the tables and the constraints / validations governing these tables
- Software requirement System (SRS) document for Websites for the feature required on the website as per the data generated and the user groups.
- Updated Database dump provided to KSRSAC portal and India Biodiversity Portal

6.6 H D Kote Pharmacopoeia Project: Environmental Education initiatives in Govt High Schools of H D Kote Taluk

Background:

School based environmental education initiatives offer excellent scope for orienting students and teachers to the various environmental issues, while also introducing them to different topics related to biodiversity, its sustainable utilization and conservation, which are otherwise not included in the regular class room curriculum. Thus, in the context of H D Kote taluk Pharmacopoeia project, environmental education activities constitute an important component.

Under this initiative, science teachers and students of 8th, 9th and 10th class from 32 Govt schools of H D Kote taluk in Mysore district, are considered as the focal audience. Four illustrated participatory learning modules were developed to introduce to them different salient aspects of medicinal plants diversity of HD Kote landscapes. Key themes (Medicinal plant diversity of H D Kote, their usage in primary healthcare, current threats to medicinal plants and need for conservation) constituted the key topics for the modules. These were used as the learning resources for the EE initiatives during the year.

The environmental education team, successfully implemented the following activities in the Schools of H D Kote taluk, during the year 2019-20.

Highlights of the Progress:

a) Participatory Environmental Education programs in 32 Higher Secondary Schools of H D Kote

i) School based EE activities: 4 participatory learning modules were introduced in 32 higher secondary schools of HD Kote. These were:

- Medicinal plants of H D Kote taluk-diversity and identification
- Medicinal plants for Primary healthcare in the households
- Current threats to medicinal plants and their conservation
- Student based learning activities: House hold remedies for common ailments; traditional stories around medicinal plants; collection medicinal plants seeds for School Science lab

Sixteen teams of 26 Master trainers were drawn from among the Community education field staff of Swamy Vivekananda Youth Movement (SVYM), Saragur (who were earlier trained to deliver these modules). These sixteen teams visited the 32 schools on a select day, over 4 consecutive weeks (spread during July-September 2019), and introduced one module each during their visit. Two Master trainers in every team would take turn to introduce the module in each school. A typical learning session focusing on a given module would last ~120 minutes, while adopting a participatory mode. Each session would typically include an ice breaking exercise, followed by simple games and dialogues with students, further delivering the focused lessons and finally ending with question-answers.

All the school-based series of programs witnessed an overwhelming participation by the students, who intently participated in these sessions. Altogether >2400 students from 8th, 9th and 10th class from 32 schools were oriented in this this series of Environmental education activities.

Fig 6.6 An open air learning session in progress

ii) Nature walks for Science Teachers: As an addition to the school-based activities, two nature walks were conducted for the science teachers from these schools during August 2019 and December 2019. Altogether 40 teachers took part in these two nature walks conducted around the forest areas of Chikkadevammana betta and S Hosahalli of Saraguru. The teachers were introduced to the skills of field identification of local medicinal plants, and hands on activities around the topics icluding co-evolution, plant-animal associations, pollination-seed dispersal mechanisms, and other local ecological issues.

These nature walks served as open-air class rooms for the teachers, allowing sufficient scope for keen observations to recognize morphological features of medicinal plants, peer-group learning and information sharing about uses of medicinal plants and traditional ecological knowledge.

b) Field testing of Environmental Education Modules

The 4 illustrated learning modules, which were developed and peer reviewed by the subject experts during the previous year, were field tested during the school-based programs as above. Necessary Participant observations were made while the master trainers introduced these modules in the schools. Different variables related to the nature of the subject delivery, content clarity, content completeness and comprehensiveness, use of relevant examples, ease of understanding, use of visuals and the language were observed.

Fig 6.7 During a field learning session

6.8 A Master trainer displays her prize catch during the nature walk-a garland like medicinal plant

The review and monitoring returned many insights and re-assured that the modules were well received due to their appropriateness, novelty and comprehensive nature of the content. The feedback by school teachers and students highlighted the following:

- Module contents are quite novel, meet the learning needs and are relevant.
- They offer very interesting and engaging learning sessions
- Local examples included in the modules, are quite appropriate and have increased the value of the contents, while many of these are hitherto unknown and hence the modules increase the scope for fresh and new learning.
- The learning sessions have redirected the students' attention to look for such local examples in the neighboring landscapes and thereby help in enriching their class room-based learning.
- Students have very well appreciated the contents and have found them quite useful.
- The modules have really supplemented the textbook learning, especially on those lessons related to environment, local biodiversity, forests and wildlife.

Team members:

- Somashekhar B S., Scientist-F, TDU, Co-PI
- Mohan Kumar Thambad, Project Coordinator, SVYM, Saraguru and 26 field educators, who served as Master trainers
- Kollegala Sharma, Senior Scientist, CFTRI, Mysore- External Consultant and Subject Expert on Science communication, who reviewed the ToT modules.
- S Tukaram, Director, Centre for Social Justice, Administrative Training Institute, Mysore- External Consultant and Subject Expert on Community education, who reviewed the ToT modules.

6.7 Strengthening of National Herbarium, Raw Drug Repository and multidisciplinary databases of Medicinal Botanicals of India.

Background

The National Repository of the medicinal plants of India, housed at TDU is the only medicinal plants herbarium in the country, with an exclusive focus on medicinal plants. It brings together a range of information related to medicinal plants of the country (vernacular names, currently accepted botanical names, specific location of its occurrence on the Indian territory, including -latitude, longitude, altitude details). It also involves collection of morphological variations of select species.

The herbarium and raw drug repository serve as one stop centre for the information related to medicinal plants used in Indian Systems of Medicine. The traded botanical in raw drug repository is a referral collection for research for authentication of botanicals traded in the country.

Highlights

- A total of 3276 voucher specimens were collected, processed, mounted and labelled during the year. These plant specimens were from different locations in southern India, Andaman & Nicobar Islands and North East India.
- The collections include: Manipur: 220 species (261 voucher specimens); Nagaland: 215 species (385 voucher specimens); Rajasthan: 80 species (150 voucher specimens), West Bengal: 1865 species (100 voucher specimens); Andaman and Nicobar Islands: 200 species (350 voucher specimens), and Tamil Nadu (Hosur and Dharmapuri): 70 species (80 voucher specimens).
- 200 raw drug samples were carefully identified and curated, and added to the raw drug repository.

6.8 Revisiting of 7 Medicinal Plants Conservation Areas in West Bengal

Background

The study involves re-visiting 7 MPCAs in West Bengal, which were established during 2000-05. The field work focused on studying the wild populations of threatened medicinal plants, and short listing of species for threat assessment at the State level and conducting CAMP exercise, followed by ground truthing.

Highlights

The team carried out botanical studies, in which 182 species were recorded and collected in Dhotrey MPCA, and 91 species were recorded and collected from Tonglu MPCA in the hills of North Bengal

The team carried out community studies in 7 villages (Dhotrey, Seliembong, Chot Hatta, Dilpa, Tonglu, Magma and Tumling) adjacent to Dhotrey and Tonglu MPCAs. Of the 315 households 87 were interviewed to understand the communities' perceptions of medicinal plants conservation in the MPCAs and their involvement in monitoring the MPCAs. The respondents were 62% male and 38% female.

It was found that among the interviewed households, majority was not aware of medicinal plants and MPCAs around their villages. Major Threats reported were grazing inside the Tonglu MPCA.

6.9 Development of an electronic database on medicinal plants of Andaman and Nicobar Islands

The database of medicinal plants of Andaman and Nicobar Islands will be useful to understand the available medicinal plant resources for the purposes of research and conservation action programs.

Highlights

The team, prepared the inventory of 700 medicinal plant species by sourcing the data from 10 floras, 50 scientific papers and FRLHT database on Indian Medicinal Plants. Information on ethnomedicinal uses of 300 plant species, information on plant distribution of 240 species was added. A web browser was developed, which can do the search based on botanical name, synonym, vernacular name, distribution and medicinal uses of the plants. About 200 plant photographs were added to the database.

6.10 Plant Wealth of Lalbagh Botanical Garden

Background

Lalbagh Botanical Garden, is an old botanical garden in Bengaluru, commissioned by Hyder Ali, the then ruler of the erstwhile princely state of Mysore in 1760 AD. It is spread on an expanse of 240 acres (0.97 km2) and is known as mecca of plants-both exotic and native, among the plant lovers. The inventory prepared by the Lalbagh Botanical garden needed an updation of information related to taxonomic identity, origin of the living collections in the garden, and other information on educational signages. This project aims to provide updated checklist of the flora of Lalbagh.

Highlights

Field visits to Lalbagh Botanical Garden were made during different seasons and 400 voucher specimens (in flowering and fruiting stage) corresponding to 150 plant species were collected. Information on the local names, use in medical system, photographs, distribution data of these species was appended.

6.11 Baseline survey of MPCAs in Karnataka

Background

Karnataka Forest Department with technical support from TDU-FRLHT has established 17 Medicinal plants Conservation Areas (MPCAs). A baseline survey was carried out to develop long term monitoring strategies for management and conservation of medicinal plant species in these MPCAs.

Highlights of progress

- The baseline survey in the 17 MPCAs helped document the physical status of MPCAs, disturbance level, human interventions (if any) and community participation in conservation and management of the MPCAs.
- A long term MPCA management strategy was developed to address in situ conservation, resource augmentation, support to JFMCs/ BMCs, training and capacity building programs and home herbal gardens.

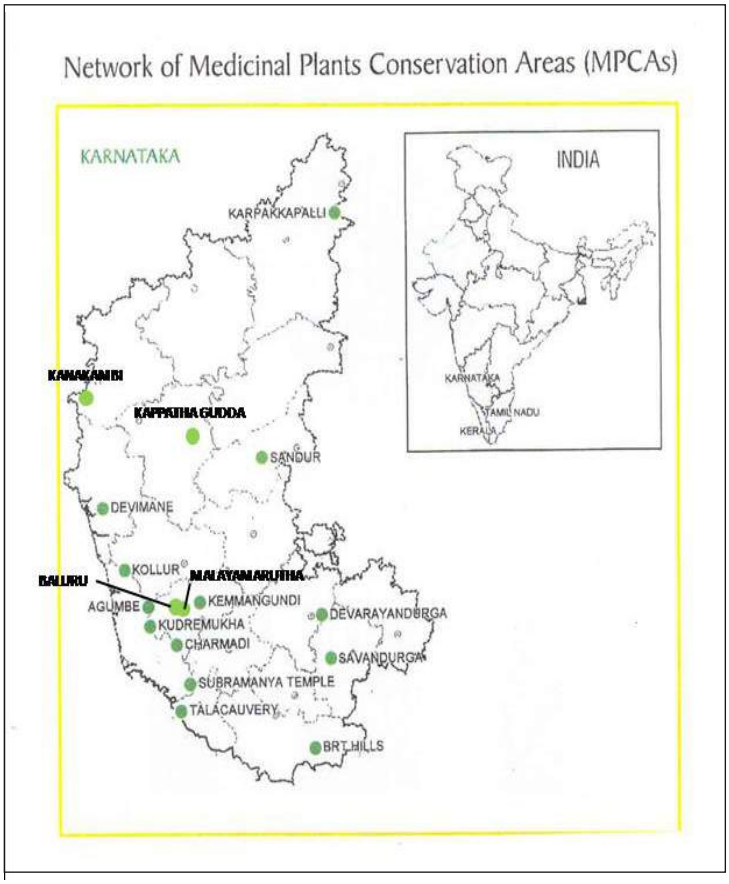


Photo 6.9 Location map of 17 MPCAs in Karnataka

Sl. No.	Name of JFMC	Forest Division	Species targeted
1.	Jodukatte	Ramanagara	Decalepis hamiltonii
			Asparagus racemosus
2.	Agumbe	Shimoga	Garcinia gummi-gutta
			Cinnamomum sulphuratum
3.	Illemani	Shimoga	Ailanthus triphysa
			Myristica dactyloides
4.	Honnasagadde	Shimoga	Terminalia chebula
			Phyllanthus emblica
5.	Hasirumane	Shimoga	Artocarpus lakoocha
			Garcinia gummi-gutta
6.	Siragunjji	Honnavar	Salacia chinensis
			Embelia tjserium-cottam
7.	Kaduboranalli	Tumkur	Terminalia chebula
			Pongamia pinnata
8.	Baadenahalli	Tumkur	Tamarindus indica
			Pongamia pinnata
9.	Chandaguli	Yallapur	Garcinia indica
			Embelia tjserium-cottam
10.	Panchavati	Koppa	Terminalia bellirica
			Murraya koenigii
11.	Mallikarjuna	Koppa	*Acacia concinna*
			Garcinia gummi-gutta
12.	Nidle	Mangalore	*Acacia concinna*
			Piper nigrum
13.	Talageri	Honnavar	*Garcinia indica*
			Sapindus emarginatus
14.	Aluru	Haliyal	*Terminalia chebula*
			Phyllanthus emblica

Sl. No.	Name of JFMC	Forest Division	Species targeted
15.	Kalave	Sirsi	*Sapindus emarginatus*
			Phyllanthus emblica
16.	Mahadevanagar	Mysore	*Gloriosa superba*
			Asparagus racemosus
17.	Basavanahalli	Madikere	*Phyllanthus emblica*
			Acacia concinna
18.	Balagunda	Belgaum	*Syzygium cumini*
			Pongamia pinnata
19.	Bandur	Dharwad	*Syzygium cumini*
			Terminalia bellirica
20.	Ayajhapura	Raichur	*Azadirachta indica*
			Pongamia Pinnata
21.	Shamatabad	Bidar	*Buchnania axillaris*
			Azadirachta indica
22.	Agrahara	Bellary	*Annona squamosa*
			Syzygium cumini

Highlights of Progress:

- Regular field visits were organized to facilitate maintenance of the plantations.
- Coordinated the evaluation of the project by Ministry of AYUSH, Govt. of India.
- Integrated Management Plans were prepared for the forest area under 22 JFMCs which were reviewed by the Deputy Conservators of Forests of the respective forest divisions.

6.10 Review team at the plantation area at Gubbi, Tumkur, Karnataka

6.12 Development of sustainable harvesting methodologies for selected medicinal plant species in Medicinal Plants Conservation Areas (MPCAs), Chhattisgarh.

Background

Chhattisgarh Medicinal Plants Board has established 21 MPCAs in Chhattisgarh. Sustainable harvesting techniques were implemented in 2 MPCAs viz., Katghora and Keshkal. This project was aimed at developing sustainable harvesting techniques for 13 medicinal plants and imparting training to different stakeholders (medicinal plants collectors, folk healers, self-help group members and JFMC members).

Sl. No.	Botanical Name	Part harvested
1	*Aegle marmelos*	Fruit
2	*Andrographis paniculata*	Whole plant
3	*Asparagus racemosus*	Tubers
4	*Buchanania lanzan*	Fruit/ Seed
5	*Celasrus paniculatus*	Fruit/ Seed
6	*Chlorophytum tuberosum*	Tubers
7	*Embelia tsjerium-cottam*	Fruit
8	*Gloriosa superba*	Tubers, Seed
9	*Holarrhena antidysenterica*	Bark, Seed
10	*Phyllanthus emblica*	Fruit
11	*Pueraria tuberosa*	Tubers
12	*Terminalia arjuna*	Bark
13	*Terminalia chebula*	Fruit

Highlights of the progress:

The team organised a Community-To-Community Training (CTCT) program on sustainable harvesting techniques for the stakeholders during 6-7th March 2020 at Keshkal. Fifty-two participants including front line forestry staff took part in the training. The training sessions included multi-media presentations, field visits, demonstrations and group discussions. Program report with participants' feedback was prepared and submitted to the funding agency.

Sustainable /good collection practices for Terminalia arjuna bark

Part harvested: Bark

Time of harvest: January end to March 2nd week

Method of harvest

- Above 1 m girth trees should be selected- Remove the bark from above breast height of the tree, it can also extract from the big branches of the tree.
- Removal of bark - superficial peeling of bark in small pieces (5 – 10 cm wide, depending on the girth of the tree) with short vertical strips (up to 1 foot length) in different portions on the trunk using a knife/Blade, use axe if the bark is very thick.
- Maintain a gap of 2 feet between the strips - if the tree is very tall and big (clear bole height & girth), collection can be made at different heights.
- Maintain a rotation cycle- should not remove the bark from the same tree from which bark has been removed earlier, until the wound is healed / and exposed portion is covered by the new growth.
- Avoid removing the bark from the tree trunk which is exposed to direct sunlight - this will lead to further dryness of the exposed wood, and may adversely affect the healing process.
- Do not practise ring barking or any other method of complete debarking - which will adversely affect the growth of the tree, healing would be delayed and rejuvenation of bark may not be effective.

6.11 Demonstration of sustainable harvesting of bark from *Terminalia arjuna*

6.12 Application of cow dung to facilitate wound healing in *Terminalia arjuna* after bark harvest

6.13 Development and standardization of semi-processing technology to enhance the quality and market value of selected medicinal plants in Peechi Wildlife Sanctuary and Silent Valley National Park, Kerala.

Background

The objective of this project is to explore the prospects of semi-processing and value addition for 14 medicinal plant species, and honey at 9 Eco Development Committees (EDC) in Silent valley and Peechi Forest Development Agencies in Kerala. Develop and standardize semi-processing and packaging methods to improve the quality of herbal products to supply to herbal industries.

Highlights of progress:

- The team successfully designed and developed species-specific semi-processing and packaging technologies for 14 medicinal plant species viz., Canarium strictum, Acacia concinna, Garcinia gummigutta, Piper longum, Hemidesmus indicus, Nilgirianthus ciliates, Salacia fruiticosa, Baliospermum montanum, Asparagus racemosus, Acacia pennata, Psuedarthria visicida, Balanophora fungosa, Rauvolfia serpentine, Desmodium gangeticum and honey.

- Organized interactive meetings with community members at 5 EDCs in Silent valley and 4 EDCs in Peechi and documented the traditional processing practices.

- Organised two consultative workshops: a) with 32 officials of Kerala Forest department on 11th January 2020 at Thiruvananthapuram, and b) with representatives of 18 herbal industries on 13th January 2020 at Peechi. The workshops aimed at finalising semi processing and packaging technologies, and marketability of these produces.

6.13 Meeting with Uppukulam EDC members to document the traditional processing practices

6.14 Discussion with Forest Department officers on opportunities for implementing various semi-processing technology

6.14 Training of Biodiversity Management Committees and Preparation of People's Biodiversity Registers in Manipur State

Background

Biological Diversity Act 2002 provides for the establishment of Biodiversity Management Committees (BMCs) and preparation of People's Biodiversity Registers (PBRs) in all local bodies (Panchayats or Municipalities) throughout the country. The preparation of PBR involves participatory documentation of local biodiversity, traditional knowledge, and local practices. These documents are seen as key legal documents in ascertaining the rights of local people over the biological resources and their associated traditional knowledge.

The project's focus was to document involving the local communities, the baseline data of local biodiversity (local names, uses, management, traditional knowledge related to wild and domesticated biodiversity) using a standard documentation template by the National Biodiversity Authority and state biodiversity Boards. The project focused on Manipur, Chhattisgarh, and Karnataka states.

Highlights

The team finalised the Model PBRs For 10 divisions of Manipur State (viz. Modi, Haokha Sorarel, B Hounveng, Nachou, Phayeng, Rangkung –II, Nongdam Tangkhul, Dailong, Makhel and Makhan villages) and the PBRs were submitted to the Govt. of Manipur.

The team also carried out different activities leading to Sensitization of public about the study, survey and management, c) Training of BMC members, Panchayats and folk healers and local communities in identification and collection of data on biological resources and traditional knowledge, d) Collection of PBR data.

The activities included review of literature on the natural resources of the districts, Participatory Rural Appraisal (PRAs) at village level, housel hold interviews, individual interviews with village leaders and knowledgeable individuals, household heads, key actors of the panchayat raj institutions and NGOs and direct field observations. Analysis and validation of data in consultation with technical support groups and BMC, preparation of PBRs, computerization of information. Documentation of PBRs was complete in 7 villages and PBRs were submitted to the State Biodiversity Board.

6.15 Training of BMCs and preparation of Peoples Biodiversity Registers for Districts, Taluks and Urban areas of Chikkaballapur and Mysuru districts in Karnataka State:

The project was implemented in two districts and the team was involved in capacity building of 105 BMC members on the importance of Biodiversity Act and their role in PBR preparation.

Highlights

The team successfully completed the following activities:

- Sensitization of the public about the study, survey and possible management, and training of BMC members, Panchayats and folk healers and local communities in identification and collection of data on biological resources and traditional knowledge,
- The activities in Chikkaballapura district, brought to light the presence of 300 species of flora (including local cultivars of rice, crops, medicinal plants and weeds), and 200 species of fauna (birds, butterflies, spiders, mammals, livestock and soil micro-orrganisms).
- Likewise, the activities in Mysuru district, brought to light the presence of 500 species of flora (including local cultivars of rice, crops, medicinal plants and weeds), and 300 species of fauna (birds, butterflies, spiders, mammals, livestock and soil micro-orrganisms
- The team completed the following PBRs and submitted:
- Chikkaballapur District (Gowribidanur and Gudibande taluks, CMCs of Bagepalli, Chintamani, Chikkaballapur, Gowribidanur and Sidlaghatta CMCs, Gudibande TMC).
- Mysuru District (Mysuru, T Narasipura, K.R Nagar, Nanjangud, H D Kote, and Chamarajnagar Taluks). The team additionally completed selected PBRs of Bangalore rural district too (Devanahalli TMC and Doddaballapur CMC).

6.16 Training of Biodiversity Management Committees and Preparation of People's Biodiversity Registers in 949 Gram Panchayats and 15 Municipal Council, City Council and District councisl in Haryana State.

Highlights

The team was involved in the activities of PBR preparation and completed draft PBRs of 949 gram panchayats of Palwal, Mewat, Kaithal and Kurukshetra districts, and draft PBRs of 15 municipalities of Kaithal, Palwal and Mewat districts. Students and interns from local educational institutions were involved in gathering the basic PBR information related to the BMCs. The team conducted 5 online webinars to orient the students and to familiarise them with the biodiversity of Haryana and steps for PBR preparation. Teams of students with a mentor were formed and the teams were guided to collect and solicit the information from literature search, publications and secondary sources. Draft PBRs were developed based on such information in the first step.

6.17 Creation of Herbal Gardens and landscaping with Medicinal plants:

The team was involved in establishing herbal gardens in different parts of the country.

Following are the highlights:

Completed the establishment of thematic gardens (alongside developing information for signages) for "Ecozone" project for Toyota-Kirloskar Motors, Bidadi, Bengaluru.

- Established Medicinal garden at Bidar, for State Forest Department.
- Established two gardens at Army School Campus and Parachute Regiment Campus, Bengaluru.
- Took up landscaping with native plants, including pollination meadow, at Lingambudhi Botanical Garden, Mysuru (under the supervision of Lal Bagh Botanical Garden, State Horticulture Dept., Govt. of Karnataka, Bengaluru).
- Completed establishment of various thematic sections including "Rain Forest for Rain" at Kanha Shanti Vanam, Hyderabad.
- Designed the Medicinal garden and supervised the planting at Rail Wheel Factory, Govt. of India, Yelahanka Campus. Also established Herbal Garden at GE Research, White Field.
- Helped the teams from Rishi Valley School, Anantapura, Andhra Pradesh and The Valley School, Kanakapura, Bengaluru, Karnataka, in identification of medicinal plants on campus and planning of herbal gardens.
- Successfully completed the 3rd annual maintenance program of "Green-belt developed by planting Red listed Medicinal Plants of India", at Sports Centre, Jindal Steel Works, Vidya Nagar, Bellary.

6.18 Academic Programs - M.Sc. Conservation Future by Research

Background

Any knowledge domain pertaining to any facet of nature is essentially about change in nature. To understand the change is therefore of primary importance in all knowledge domains. Hence, the Conservation Future course's curriculum is designed to focus on assessing those 'changes in nature'. The foundational courses design around mainly four axes (i.e., Observe, Categorize, Causality, and Mitigation), and besides students will undergo modern tools (viz. computer skills, remote sensing & GIS, biostatistics) which can help to explore those four axes scientifically.

Highlights

- Five students enrolled for MSc Conservation Future by Research program, of which four completed during 2019-20 and one in 2020-21.
- The team offered 2 credits Ethnobotany course and 60 students MES College, Bangalore, enrolled in this course and completed successfully.

6.19 Others

- The team organised a National Consultation on medicinal plants and human wellbeing on 19-20th September 2019 at Aranya Bhavan, Bangalore. Stakeholders' feedback was invited on the four themes viz. citizen knowledge portal, Insitu conservation including genetic and microbiome studies in medicinal plants conservation areas (MPCAs), National herbarium, and medicinal plant extract library, transdisciplinary R & D strategy on development of star products for health and livelihood security.
- The team was engaged in developing a draft protocol on genetic and microbial diversity documentation of wild populations of threatened and endemic medicinal plant taxa to locate their genetic hotspots, to guide conservation action.
- The team was engaged in developing a draft R&D protocol on Trans-disciplinary product development for poly-herbal drugs.
- The team on a regular basis, worked on consolidating the checklist of medicinal plants from published literature/reports/ TDU data base on botanical name, local name, threat status, trade status with tags of endemic plants, high volume traded plants were prepared for the two aspirational districts of West Sikkim (137 species) and Raichur (133 species).

Trainng Programs, Publications, Talks, Lectures

Research Papers:

- Abidah Parveen, John S. Adams, Vijayasankar Raman, Jane M. Budel, Jianping Zhao, Ganesh N.M. Babu, Zulfiqar Ali Ikhlas A. Khan. Comparative Morpho-Anatomical and HPTLC profiling of Tinospora species and Dietary Supplements. Planta Medica 10.1055/a- 1120-3711. 2020.
- Balachandran N., Dhatchanamoorthy N. and Gastmans W.F. 2019. Carallia borneensis Oliver (RHIZOPHORACEAE) - New Record to India from Andaman Islands. The journal of the Bombay Natural History Society. Vol. 116: pp 17-18. doi: 10.17087/jbnhs/2019/v116/105941.
- Chetan, H. C., R. Ganesan, and T. Ganesh. 2020. Seed and seedling establishment in the abandoned tea plantations, southern Western Ghats, India. Tropical Ecology 1-17.
- Chetan, H.C & B.C. Nagaraja. 2020. Vegetation dynamics and its dispersal syndrome across size class of tropical montane (shola) forest, Kudremukh, Western Ghats, India. International Journal of Ecology & Development 35:1.
- Dhatchanamoorthy N. and Balachandran N. 2019. Phyllanthus simplex var. gardnerianus (Wight) Müll. Arg. (Phyllanthaceae): New Record for the Eastern Ghats, India. Indian Journal of Forestry, 42(2): 199-200.
- Dhatchanamoorthy N.,Raja S., Anbarashn M. and Ravikumar K. 2019. A New Record of Crotalaria wightiana: A Rare Legume of Western Ghats, from Karnataka, India. Indian Forester, 146(7): 309-314.
- Dhatchanamoorthy N., Ravikumar K., Noorunnisa Begum S. and Mayur D Nandikar. 2019. Lectotypification of Dicliptera beddomei (Acanthaceae): A strict endemic species to the Eastern Ghats of Andhra Pradesh, India. Annals of Plant Sciences, 8.5: 3551-3552.
- Ganesh Babu N.M. and Ravikumar K. Red Listed Medicinal Plants of India. In: Invited articles of Two-Day National Conference on "Dravyaguna Prabodhini– Compendium on Dravyaguna, PG Syllabus oriented theme with research updates" organized by Post Graduate Dept. of Dravyaguna, Government Ayurveda Medical College, Bengaluru. pp. 79-98. February 7-8, 2019.
- Munisamy Anbarashan, Anbarashan Padmavathy, Ramadoss Alexandar & Narayanasamy Dhatchanamoorhty. 2019. Survival, growth, aboveground biomass, and carbon sequestration of mono and mixed native tree species plantations on the Coromandel Coast of India. Geology, Ecology, and Landscapes, pp 1-10. . ISSN: (Print) 2474-9508.
- Noorunnisa Begum S., Patturaj R. and Ravikumar K. 2019. Comparative pharmacognostical and histochemical studies on the three different species of Tinospora on stem and leaf. J. of Pharmacognosy and Phytochemistry, 219 (8) 2: 650-655.
- Ravikumar K., Dhatchanamoorthy N., Arisdason W. and Saha D. 2019. Distributional records for three little-known and rare flowering plants from West Bengal, India. Pleione, 13(1): 198-202.

- Samudhyatha R and Dhanya B. 2020. Trees for life: Role of wood resources in artisanal livelihoods in Channapatna, Karnataka"- Voice of Environment newsletter; Vol-03, Issue 01, Pages 82- 85.

Books and Chapters in Books

- Bawa, K. S., Nawn, N., Chellam, R., Krishnaswamy, J., Mathur, V., Olsson, S. B., & Shankar, D. (2020). Opinion: Envisioning a biodiversity science for sustaining human well-being. Proceedings of the National Academy of Sciences.
- Chetan H.C 2019. Ecological restoration of abandoned tea plantations: Challenges and Prospects in Southern India. Edu creation Publishing 144 pp. (ISBN:978-93-88S910-09-5)
- Deepa G.B., Jagannatha Rao R. and Arthur Selwyn Mark. 2019. Resource Augmentation Techniques Developed for Three High Traded Medicinal Trees: Ailanthus triphysa, Cinnamomum malabatrum and Sapindus emarginatus. In: Amruth M., Raghu AV., Raveendran VP., Md. Kunhi KV., and Viswanath S. (eds.). Medicinal Plants: Cultivation and Conservation. KSCSTE-Kerala Forest Research Institute, Peechi, Kerala. Pg 69-80. ISBN: 81-85041-90-3.
- N.M. Ganesh Babu, Vandana Krishnamurthy, et al. "Plant combinations for Stunning Gardens" published by Ministry of Environment, Forests and Climate Change, Govt. India.
- Noorunnisa Begum S., Ravi Kumar K., and Divakara B. N. 2019. Threats and Conservation, In: T. Pullaiah, S. Balasubramanya , M. Anuradha (Eds.). Red Sanders: Silviculture and Conservation, pp. 153-172. Springer Nature Singapore Pte Ltd.

PBR documents

- B Hounveng, Jiribam district People's Biodiversity Register (PBR), Manipur Biodiversity Board, Manipur, 60 pages.
- Haokha Sorarel Village, Thoubal district People's Biodiversity Register (PBR), Manipur Biodiversity Board, Manipur, 80 pages.
- Modi Village, Chandel district People's Biodiversity Register (PBR), Manipur Biodiversity Board, Manipur, 56 pages.
- Nongdam Tangkhul Village, Kamjong district People's Biodiversity Register (PBR), Manipur Biodiversity Board, Manipur, 59 pages.
- Orientation program by Dr. A. K Gupta, Registrar, TDU, Dr.Abdul Kareem, Head, CCNR, TDU, Dr. Souravi Karpakkal and Mr. Nishanth Gurav, JRF, TDU
- Phayeng Village, Imphal West district People's Biodiversity Register (PBR), Manipur Biodiversity Board, Manipur, 77 pages.
- Rangkung –II Village, Noney District People's Biodiversity Register (PBR), Manipur Biodiversity Board, Manipur, 70 pages.

Training, Awareness programmes, Exhibitions and outreach activities

The team conducted the following training programs.

- 2-days training on Plant identification and herbarium techniques for 50 BAMS students of RAMC College, Bengaluru, 2-3rd May 2019.
- Hands on Training on Plant Anatomy for 10 students of Vidya kshetra Home, 11-12th May 2019
- Training on Plant Anatomy for students of NPS school, 2nd August 2019.

Internships: Following students completed the internship successfully.

- Bishop Heber College (Autonomous) Tiruchirappalli: Ajitha. A and Priya Dharshini V.,
- Christ University, Bengaluru: C. M. Manasvi
- MVIT college, Bengaluru: K. Preksha Machaiya and Yashika B
- St. Joseph College, Bengaluru: Parvathy Sumam, Sherin S K, Sharmila S N, Gandhimathi V J, Shashi Shekhar, Abhiram Suresh and Shishira Rao H S.

International Presentation

Dhanya B and Samudyatha R.2019. Wood use in traditional toy-making in Channapatna- resource conservation and livelihood implications"- Abstract accepted for oral presentation at the International Union for Forest Research Organizations, XXV IUFRO World Congress, Brazil, 2019.

Invited Lectures/ Talks Delivered

Deepa G.B. gave a lecture on "Conservation and sustainable use of medicinal plants", in DST sponsored training program on medicinal plants for the students of higher secondary schools on 26th November 2019, 7th January 2020 and 14th January 2020, at M.S. Ramaiah Institute of Technology, Bengaluru Jagannatha Rao gave a lecture on "Sustainable harvesting, value addition and marketing of wild medicinal plants – Designing participatory methods and the process of field implementation" in one week refresher training course on 'Conservation and Development of Medicinal Plants and Benefit sharing with Local Communities' for officers of Indian Forest Service, on 23rd October 2019, at KSCSTE-Kerala Forest Research Institute, Peechi, Thissur, Kerala.

Jagannatha Rao presented a talk on "Medicinal Plants Trade and Policies", DST sponsored training program on medicinal plants for the students of higher secondary on 29th November 2019, at M.S. Ramaiah Institute of Technology, Bengaluru.

Noorunnisa Begum S presented a talk on plant Taxonomy and Herbarium, at MES College, Bengaluru. on 29th July 2019

Somashekhar B S, served as an invited Resource person for the State level Refresher training course for CEOs of Zilla Panchayat and senior officers, Govt of Karnataka (6 batches), jointly organised by Administrative Training Institute, Mysuru, and Centre for Social Justice and Equality, Mysuru during October 2019-March 2020, and delivered 6 lectures on Forest Right Act 2006 and traditional knowledge of local communities. The Training courses included the officers from the depts of Forest, Revenue, Agriculture, Horticulture, Fisheries, Irrigation, Social Welfare, Rural development & Panchayat Raj, and Collegiate Education, Govt of Karnataka,

Somashekhar B S, served as an invited Resource person at the National level Brainstorming on "Science communication in Kannada: Today and Tomorrow", on 30 July 2019, organised by Vigyan Prasar, Govt. of India, at Indian Academy of Sciences, Bengaluru.

Somashekhar B S, served as an invited Resource person at the National level consultation on "Science communication in Kannada: Today and Tomorrow", on 21 September 2019, organised by Vigyan Prasar, Govt. of India, at CFTRI, Mysuru, and delivered a talk on "Environmental Communication in Kannada: some reflections".

Somashekhar B S, served as an invited Resource person at the National level Science Drama Festival-Seminar on 1 March 2020, organised by Vigyan Prasar, Govt. of India, at CFTRI, Mysuru, and delivered a talk on "Traditional Ecological Knowledge of Indigenous communities: some glimpses".

Radio Science talk:

Somashekhar B S. delivered a Radio science talk in Kannada, on Climate change and its impact on forest resources, on All India Radio, Bangalore on 26 December 2019. The talk was on state hook up and received rave reviews and eventually witnessed 4 repeated broadcasts during January 2020, and February 2020 due to listeners' demand.

Community outreach:

- Somashekhar B S delivered a public lecture on "Local communities' indigenous climate knowledge and Climate change", on 28 December 2019 at Chitradurga, organised by Chitradurga District History Association, Chitradurga.
- Suma TS gave a lecture on "Floral and medicinal plants diversity of Kappatha Gudda", during the "Kappatha Gudda Utsava 2020", Gadag, Karnataka on 1.02.2019, organized by State Forest Department. The program was attended by around 700 participants from different local schools, colleges (including Forestry, agriculture, medicine, AYUSH) and general public. Useful web resources such as www.homeremedy.in, and related Apps on medicinal plants were shared.

- Suma TS delivered a lecture on Neighborhood Medicinal Plants for health care to 60 OIKOS Club members at BMSIT College, Yelahanka.
- The team also initiated Popularization of e-resources in public forum. During the lock down period due to COVID-19 pandemic, during February-March 2020, the team was involved in promoting several online resources through social media, and received >3000 contacts.

Member/ representation in technical committees

Ganesh Babu served as a member of the Expert Committee for the eradication of invasive species and planting native plants in Tamil Nadu State, constituted by Honourable High Court of Madras (Madurai Bench). He participated in 2 committee meetings and took up 2 field visits (Nilgiri Biosphere and Mudumalai Tiger reserve) for assessing the degree of spread of invasive species and the remedial measures for the same. He subsequently provided his inputs for 2 interim reports which were submitted to the Honourable High Court of Madras (Madurai Bench).

Ganesh Babu served as a member of the Expert Committee, participated in the executive meeting conducted by the Ayush Dept., Belgaum to plan and promote the cultivation of medicinal plants in the lands owned by Ayush Belgaum and also on farmers' field.

Ganesh Babu presented the final progress report of ABG Scheme, MoEF, Govt. India in the Review Meeting of all the on- going Botanic Garden projects under ABG program on 8th May, 2019.

Team Members:

Abdul Kareem, Ravi Kumar K, Somashekhar BS, S Noorunnisa Begum, Suma Tagadur, Chetan H, M Sathya Sangeetha, Jagannatha Rao R, Ganesh Babu N.M, Deepa GB, Amrita G, Arthur Selwyn, Ganesh Babu NM, Revathi B P, Nandini D, Hanumantharayappa, Manjunatha, Umesh, Vijay Srinivas, Dhatichinamoorty, Patturaj, Arun, Nishanth, Bhagyalakshmi K.B, Naresh NK

Consultants/ External Team members associated in different programs

- Mohan Kumar B. Thambad and field staff of SVYM, Saraguru, Mysore
- Mahesh, Balasubramaniam, Nancy, Kumar, Deshworjit Singh Ningthoukhongjam Tombi Raj, Hirom Dolendro Singh
- Manjunatha Naik, Veeresh Gowda,
- Shiva Subramanya. B.V. Suresh, A.S. Rajashekhar,
- Nandini, Prabhakar, Thomas Vattakavan.

7. Centre for Clinical Research and Education

7.1 Evaluation of Ayurvedic Management of uncomplicated urinary tract infections (UTI) in adult females-using modern biochemical tests– A Pre-post, Pragmatic Clinical Pilot Study.

Background

Urinary Tract Infections are commonly seen in women worldwide with symptoms like dysuria, burning micturition, and increased frequency of urination sometimes associated with pain in the abdomen. UTI causing bacteria have become resistant even to highly potent antibiotics. Antimicrobial resistance results in recurrent infections. Ayurveda doctors have noticed improvement in UTI symptoms (pain, burning sensation, and discomfort during micturition) due to the use of single herb or formulations, while these observations are supported by research-based evidence of late. However, our understanding says that, there are no studies which have documented the effect of whole systems Ayurveda with long term follow-up.

Whole systems black box approach includes customized medications, therapies along with diet and lifestyle advice (particularly, disease-condition based on Ayurveda algorithm), in which a homogenous group of UTI affected females are classified based on dosha involvement and treated. The positive results of this study are expected to convince the scientific world to avoid using antibiotics for UTI patients, all of which can be considered as a boon for the present day world, where Antibiotic resistance is raising concerns.

During the year 2019-2020, we focused on participant recruitment and follow-up treatments from a sample of 45 patients, along with systematic documentation. Preliminary data analysis and statistical interpretation were completed.

Highlights of progress

- The study was conducted on 45 adult female participants with uncomplicated UTI. (in the age group of 18-60 years), 34 participants have completed the study.
- After confirming the presence of UTI causing bacteria through urine culture report, the "Ayurveda whole systems black box approach" was used to treat these individuals based on the analysis according to Ayurveda. The participants were given the treatment for 3 months, along with 6 months observation without medications.

- Medication was prescribed based on the individual participant's condition. The combination of drugs was modified as per patient symptoms. The treatment was assessed every 15 days by questionnaires and biochemical evaluations and modified accordingly. Common medicines included Gokshuradi guggulu, Chandarprabha vati, and Punarnava paneeya intake along with lifestyle advice (not to withhold the urge for micturition) and sit bath was advised.
- All the patients reported significant **reduction** in the common symptoms (burning micturition, increased frequency, pain in abdomen and dysuria) of UTI irrespective of culture reports.
- It was observed that, within 7-15 days of treatment, the pain during micturition was relieved in 70% of patients, 24% noticed complete relief from the pain during subsequent follow-ups, while 6% of the patients had significant reduction. Burning sensation and discomfort was relieved within 15 days in 97% of the patients. Remaining 3% of patients observed reduction in these parameters during the subsequent follow-ups.
- Out of 14 recurrent UTI cases, 97% of the study subjects (13 out of 14 patients) reported no recurrence after treatment. The urine routine also showed average reduction in pus cells by 41% from the baseline value. Erythrocyte sedimentation rate had average reduction (18%), average C-Reactive protein range decrease (34%), and neutrophils had a mean reduction (5%). Other parameters (nausea, vomiting, supra-pubic discomfort) were completely resolved. After the treatment, 55% showed negative for bacterial culture, 21% showed reduced bacteria load, and 24% showed presence of bacteria in urine culture. Only 1 patient out of 14 recurrent UTI cases had recurrence when observed for 9 months follow-up while the other participants reported no recurrence of infection after 9 months of treatment. That is a significant outcome especially for recurrent UTI.

  Further statistical interpretation of data for correlation continued

- **Presentation:** A flash talk was presented by Dr Poornima, on ***Management of UTI without antibiotics***, during the Indo-UK summit on **Emerging innovations in Antimicrobial Resistance** at National Institute of Advanced Studies (NIAS), IISc, Bangalore on 7 June 2019. The presentation helped generate awareness about Ayurveda management of UTI, amongst the audience.

  Team members:
  Dr Neelambika, Dr Poornima, Dr Raschel, Dr Sanjeev Tonshal, Ms. Bhavya

7.2. Evaluation of biomarkers among the patients undergoing Ayurvedic management of uncomplicated urinary tract infections in adult females

Background

The observations from the UTI clinical study demonstrated that, irrespective of the bacterial presence in few cases, there was highly significant reduction in all the clinical symptoms along with significant reduction in recurrence rate. This finding, lead to an inference-based thought that, Ayurveda might be acting through immunomodulatory route, which gave rise to this present study.

Urinary tract infections are associated with inflammation in the urethra due to the bacterial adhesion to epithelial cells. This activates a number of inflammatory pathways as explained in many research studies, which have reported the involvement of cytokine markers such as IL-6 and IL-8 during the infection. With reference to this, in this study, we evaluated the above cytokines and its changes during the treatment. It is hypothesized that Ayurveda treatment undertakes immunomodulatory mechanisms to tackle the infection. To explore the outcomes of the treatment in effective management of UTI, cytokine assay was conducted to determine the molecular roles of the intervention.

This study was planned to explore any 'Immune-modulation' pathway of Ayurveda treatment against uncomplicated UTI. IL-6 and IL-8 are cytokine pro-inflammatory immune markers predominantly identified in cases of UTI. The molecular and supra-molecular changes of these IL-6 and IL-8 biomarkers from blood serum of the patients receiving Ayurvedic treatment were quantified to map the molecular pathway of recovery. The serum biomarkers of baseline, before interventions were compared with the biomarkers changes after the treatment. The impact of treatment was correlated with the molecular outcomes of the biomarker assay. It was observed that there is correlation between IL6 and clinical symptoms of UTI like pain, burning sensation, discomfort as well as lab parameters like neutrophils, lymphocytes and ESR values in this study. This correlation points towards the molecular changes in immune markers through Ayurveda intervention for UTI. Further studies are required with larger sample size to establish the mechanism of Ayurveda intervention for UTI.

Highlights of progress: Cytokine ELISA assay was conducted on 10 samples selected based on the sample availability of the experiment. The test was conducted to assess the immunomodulatory effects of Ayurveda treatment by correlating the clinical and biochemical outcomes to observable molecular outcomes of cytokines

- The study was conducted on cytokines (IL-6 and IL-8) using serum samples.
- The outcomes showed correlations of clinical outcomes to molecular data in IL-6, while IL-8 did not report any correlations. The comparison of the laboratory outcomes with IL-6 and IL-8 was evaluated using spearman rho correlation.

The study is the first report directing the molecular correlations with UTI Ayurveda treatment. With the lead from this study, further systematic studies can be designed to explore potential pathways of disease-drug interaction in future.

Team members:

Ms. Bhavya, Dr Satish Rao, Dr Poornima, Dr Neelambika

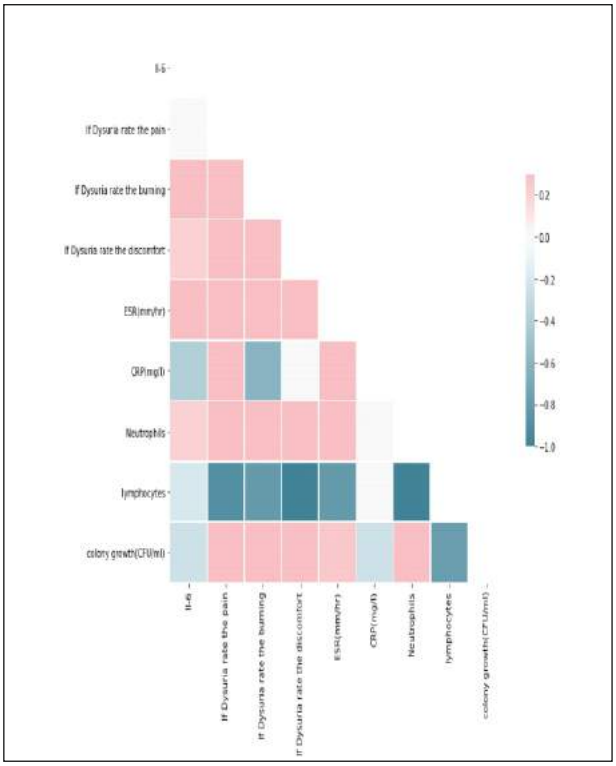


Fig 7.1 Heatmap of spearman correlation between IL-6 and clinical parameters

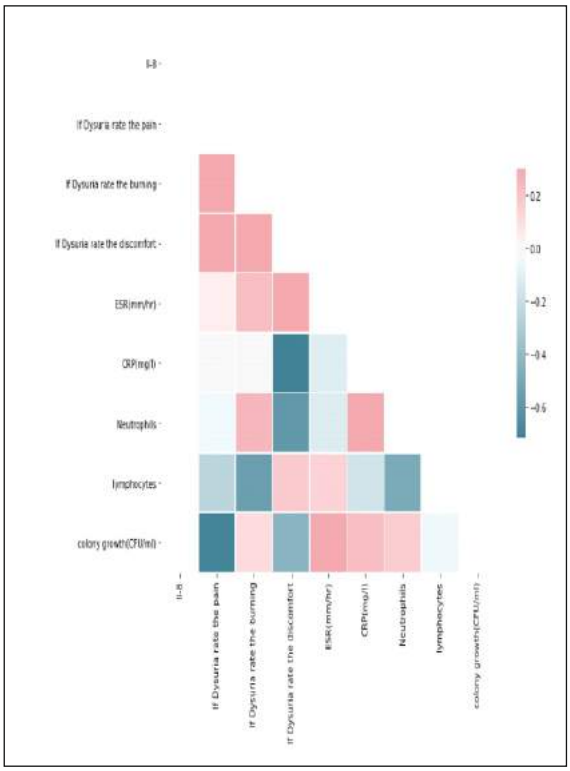


Fig 7.2 Heatmap of spearman correlation between IL-8 and clinical parameters

7.3. Identification of biomarkers of Ayurveda obesity treatment

Background

Obesity and its metabolic complications are major health problems worldwide, and increasing evidence implicates the microbiota in these important health issues. Ayurveda suggests various diet and lifestyle advice along with medicaments and therapeutic measures for obesity. Medicated enema (Lekhana basti) is one of the prime recommendations for reduction of obesity.

Although the outcomes of the Ayurveda basti treatment are known to be impactful in obesity treatment, the molecular understandings of the treatment are limited. To explore the potential mechanism of obesity management, this study aimed at finding the biomarker changes from the patients who underwent Lekhana basti treatment for obesity. Before and after treatment urine samples were collected from the patients who underwent basti treatment. Exosomes extracted from urine were used as the source of biomarkers. The study intended to compare the expression patterns of proteins before and after the basti intervention for obesity. Following this, obesity related well-known proteins were targeted to identify changes. This was intended to explore a potential mechanism followed in basti treatment.

This study was planned to identify the exosomal biomarker signatures of the Ayurveda treatment for Obesity. Samples were collected from the patients who had undergone medicated enema (Lekhana basti) treatment for obesity at IAIM. Clinical results were highly significant in reduction of weight, BMI, body circumference and lipid profile after the therapy.

Highlights of progress

Urine samples from the participants undergoing Lekhana basti were collected periodically. Ten selected samples (before, during and after treatment) were subjected to exosome isolation and mass spectrometric analysis. The outcomes revealed the top 10 biomarker pathways viz., protein digestion and absorption, glycolysis, thyroid synthesis, pancreatic secretion, metabolic pathways were dysregulated in obesity. The markers referenced in literature as predominant (such as heat shock protein-HSPA5, glyceraldehyde 3 phosphate dehydrogenase-GAPDH, kininogen-KNG1 observed during obesity) were seen to be expressed significantly in this study as well with expression changes in the participants from before and after treatment samples.

The study shows that 7 out of 10 genes highly responsible for obesity related gene expressions were significantly altered in our study. The data were compared to literature and the results show correlations of biomarkers with the existing obesity markers. This study explored the molecular pathways and routes involved in Ayurveda obesity treatment and is the first potential lead for exosomal biomarker study for Ayurveda obesity management.

Team members:

Dr Satish Rao, Ms. Bhavya, Dr Poornima

7.4. Efficacy of Chandraprabha Vati and Punarnava in the Chronic Kidney Nephropathy (CKD) model in Mice

Background

Chronic Kidney Disease (CKD) is a global healthcare issue increasing at an alarming rate in India. The renal replacement therapies in the form of dialysis and / or transplantation are highly invasive and expensive, necessitating an alternative.

Ayurveda is managing CKD with herbal and herbo-mineral formulations along with some therapies. Chandraprabha vati (CP vati) and Punarnava are two such common medications used in Ayurveda for CKD. This study was planned to evaluate the synergetic effect of these medications as they are usually prescribed together in Ayurveda, through evaluating the biochemical parameter changes and tissue histopathological observations of the treatment in mice model, in which they were given separately and also together to evaluate their efficacy both independently and synergistic action compared with the standard drug, Hydroxybetacyclodextrin (HBCD). This study also planned at evaluating organ and molecular level alterations/changes before and after treatment of CKD with these formulations, and is expected to throw light on mechanism of selected Ayurveda formulations that are commonly used in the Ayurveda practice.

Highlights of progress

Nephropathy was induced in BALB/c mice with Adriamycin(ADM) and test formulations along with standard were administered. Twenty-four hours post nephropathy induction, animals were treated subcutaneously Hydroxybetacyclodextrin [HBCD] standard drug, Ayurvedic medicine doses of CP vati at doses 200, 400 mg/kg, CP vati (200 mg/kg) + Punarnava extract (200 mg/kg), CP vati (400 mg/kg) + Punarnava extract (200 mg/kg) and Punarnava extract 200 mg/kg, orally, daily for 10 weeks. From the study outcomes, it was observed that Ayurveda formulations were as good as the standard drug HBCD in reducing CKD parameters like serum creatinine, Blood urea nitrogen.

ADM+ mice with Punarnava extract, 200 mg/kg once daily for 10 weeks showed significant reduction of **serum creatinine** when compared to the vehicle control as shown in figure 8. The combination of CP vati and Punarnava formulation showed significant reduction in **mesangial expansion** when compared to the ADM control. **Blood-urea-nitrogen** values showed considerable reduction when compared to control and the standard treatment. Standard drug showed efficacy in reducing **Albumin-Creatinine ratio** (ACR) when compared to the control groups. Similar to this, test formulations with CP vati (200 mg/kg) + Punarnava extract (200 mg/kg) and CP vati (400 mg/kg) + Punarnava extract (200 mg/kg) and group with only Punarnava extract (200 mg/kg) also showed significant reduction of ACR when compared to the ADM +vehicle control as shown in figure 7, 8 and 9. The effect of test formulations was comparable to standard drug HBCD with no significant difference. **Thus, proving the efficacy of Punarnava and Chandraprabha Vati equivalent to that of HBCD, the positive control Nephroprotective Agent.**

Team members:

Dr. Satish Rao, Dr. Poornima, Ms. Bhavya

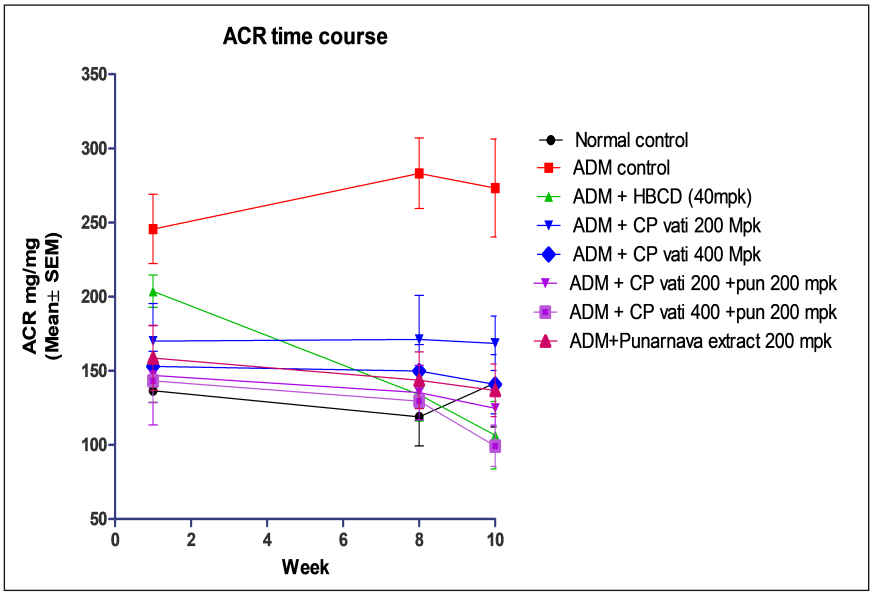


Fig 7.3 The graphical comparisons of the treatment on biochemical parameters

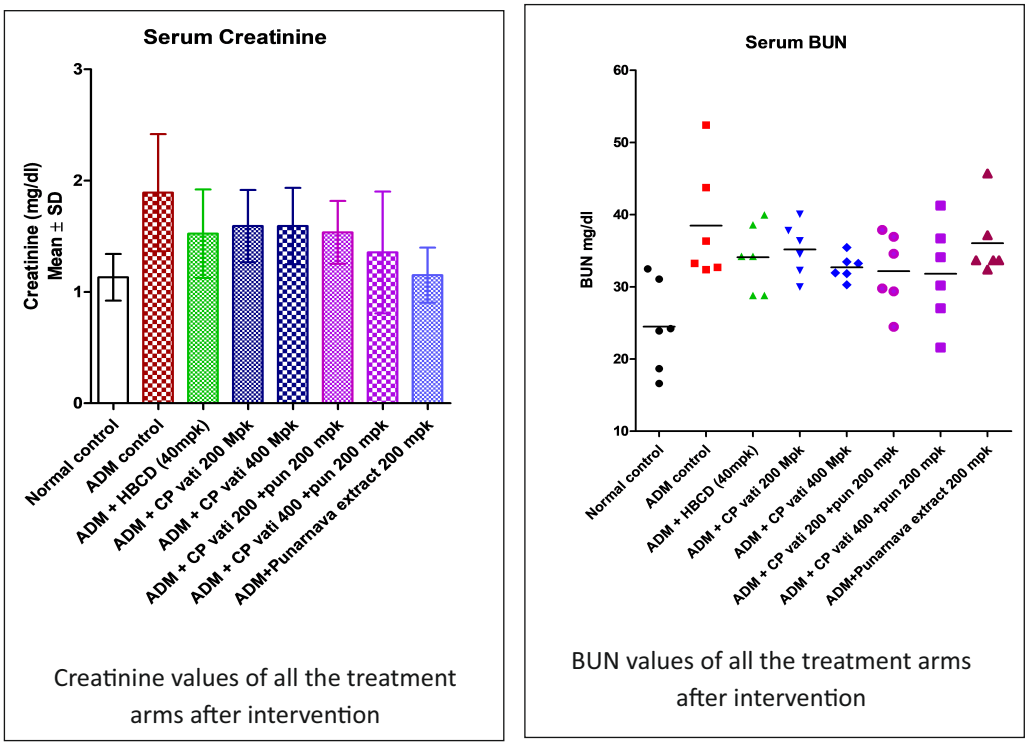


Fig 7.4 Albumin-to-Creatinine ratio from week 1, 8 and 10.

7.5. Effect of Brahmi ghrita and Brahmi extract on cognitive functions in mild cognitively impaired (mci) population - a randomized controlled study

Background

The ability to maintain high levels of cognition in humans is considered to be an indicator of a healthy nervous system and a protective factor for neurodegeneration. Thus, promotion of cognition, prevention, and reversal of its decline is of great bio-medical interest. Mild Cognitive Impairment (MCI) is one of the most common clinical manifestations affecting the elderly population. It defines a transitional stage between normal ageing and dementia.

Conversion rate from MCI to dementia varies from 8 to 14% as reported by both Indian and western studies. Timely intervention is extremely important in these cases. Limitations and adverse effects of modern medications for MCI suggest the need for alternative medications for the same. Ayurveda has detailed about medhya rasayana which are specific to brain and nervous system. Bramhi is one of the herbs that is being used as ***medhya rasayana***. It is preferred as ghee form in Ayurveda. Hence this study was planned to evaluate the effect of Brahmi ghee in MCI patients.

Cognitive assessments including spatial memory, auditory verbal memory and logical memory were assessed in participants who underwent the intervention.

Highlights of progress

The project is ongoing - Number of participants screened -71. Number of cases completed the trial- 17

Preliminary observations: Brahmi Ghee enhanced spatial memory, auditory verbal memory and logical memory in participants who completed the intervention. It was also observed that the quality of sleep was improved.

Presentation:

Dr. Ashwini gave a lecture on ***Medhya rasayana under microscope*** during VIVEK TALKS – a lecture series on Ayurveda concepts, during the International conference - AYUSH for Future health challenges, at Savithribhai Phule University, Pune on 27th November 2019.

Team members:

Dr Vivekanand, Ashwini Godbole, Bhaktee dongaonkar, Dr Poornima, Arman Singh, Dr Swathi BH, Krishnendu Vyas

7.6. Ayurveda management of acne (Mukhadooshika/ youvnapidika) – A retrospective study

Background

Acne vulgaris is a disease of the pilosebaceous unit, afflicting >80% adolescents and young adults and can last into adulthood. It ranks second to dermatitis in terms of global burden of skin disease. The mainstay of acne therapeutics is topical and /or oral modalities comprising mainly comedolytics and antibiotics.

Ayurveda recommends various internal and external medications along with some therapies for the management of acne. Though clinical experience of Ayurveda physicians suggests the potential of Ayurveda management of acne, there are still lacunae in terms of systematic evaluation of whole system Ayurveda in acne management. We would like to address this lacuna by developing a protocol for documentation and evaluation of the same. Whole systems protocol involves Ayurveda medications, therapies along with diet and lifestyle modification advice.

As a first step towards developing a whole systems study protocol for a prospective study on acne, we plan to conduct a retrospective study of the acne cases treated at IAIM. This would guide to develop a prospective study protocol by helping us to understand the effect of Ayurveda in acne treatment along with medications and ingredients that have shown positive effect in treatment of acne.

Highlights of progress

After IEC approval**,** Phase 1 systemic documentation of retrospective data from nearly 200 acne patients has been completed. Preliminary analysis with medicine frequency chart showed the use of 107 internal medicines and 81 external medicines for therapies. A total of 66 male participants and 169 female participants with Acne reported for the study. The participants in the age group of 21-30 years had higher rates of Acne, while those in the age group of 41-50 had least count of acne cases. The findings from the retrospective analysis would be published and used for designing further clinical studies.

Team members

Dr. Poornima, Dr. Sahana, Dr. Satish Rao, Ms. Bhavya

7.7. Workshops: on "Real World Evidence and its role in Ayurveda clinical practice and basic research – A data science perspective" during 13-14th June 2019 under the guidance of Sri Darshan Shankar, Vice chancellor, TDU

Background

The rationale for the workshop stemmed from the recent understanding that, while reputed Ayurveda hospitals in India are treating various health conditions with extraordinary success, however, when their retrospective data is examined, many lacunae are found in data capturing and more importantly in analysis of the cases. It is more and more being realised that, globally it is being recognized that *real life clinical data* from hospital systems can be interpreted in structured but simple ways and the resulting analysis can guide improvement in clinical practice, safety, provide leads for basic science and drug development. The workshop was designed to generate awareness about the importance of documentation and means of analysis of various types of data that emerges during real time clinical practice.

Highlights

The 2-day workshop on 13th – 14th June 2019 was led by Dr Ashwini Mathur, Head, Data Sciences and Artificial Intelligence, Novartis, Ireland along with other renowned speakers like Dr Kishore Patwardhan, Professor, Banaras Hindu University, Mr Vinay Mahajan, NOVARTIS, Dr Narendra Pendse, Senior Ayurveda Physician, Hon Medical Director, IAIM, Mr Shivaram, Director, CURL analytics. About 50 participants from CCRAS, KLE, Belgaum, SDM Ayurveda college Hasaan, Savithribhai Phule University, Amrita school of Ayurveda, Kerala and many others including people from IAIM and TDU took part in this workshop.

Some of the key concepts of discussion were 'Glimpses of data capture at OPD and IPD and solutions to improve data generation at hospital levels' - by Dr. Narendra Pendse, 'Application of Data Science in Ayurveda' – by Mr. Shivaram, 'Guidelines applicable for reporting clinical studies in Ayurveda and Good practices of publishing Ayurveda research' – by Dr. Kishore Patwardhan, 'Software to capture clinical trends from hospital HMIS systems and need for set theory and pattern recognition for interpretation' – by Mr. Vinay Mahajan and a master class on 'Real World Evidence, its role in Ayurveda clinical practice and basic research – A data science perspective' by Dr. Ashwini Mathur.

This workshop was successful in sensitizing the participants about the importance of systematic documentation in the real-world clinical practice and its benefits especially for Ayurveda field.

Team members:

Dr Poornima Ms. Bhavya, Dr Satish Rao, Dr Girish and IAIM doctors

Fig 7.5 Inauguration by Sri Darshan Shankar, Vice chancellor and other dignitaries, TDU

Fig 7.6 Dr. Ashwini Mathur from Novartis, key speaker presenting at the workshop, TDU

7.8. "Panchakarma Therapist" training program for youth across the country as a Model Bridge support from unemployment to first employment- TDU-BOSCH CSR sponsored study.

Background

The program aimed at training the unemployed youth across the country for first employment under Bridge model[1] of BOSCH.

[1] Bridge model program is a BOSCH CSR initiative, aimed at facilitating first employment for unemployed potential youth through specific skills that attract immediate job opportunities.

Rural youth who have passed 10th grade and are interested in paramedical work inter are the potential candidate for the program. The selected candidate will be trained with Panchakarma therapy skills for 6 months. Successful candidates are facilitated for placement at various Ayurveda institutes and hospitals in the country.

Fig 7.7 Group photo of all the participants of the Workshop at TDU

Highlights of progress

- Selection of candidates was based on qualitative assessment of different parameters to grade/ score the potential candidate's eligibility to enter the training course. Combination of educational qualification, socio-economic background, age, physical fitness, personality trait, Prakriti body type, communication skills, etc were individually scored
- Two batches of 25 students each were trained. Subsequent to the training the trainees were placed at various Ayurveda institutes in the country, thus proving 100% job placement for the students.

Team members

Dr. Girish Kumar V., Dr. Sreeja, Dr. Sreedevi, Dr. Aayush, Dr. MNB Nair, Dr. Abdul kareem, Ms. Amrutha, Dr. Yashaswini, Dr. Udaykumar, Ms. Tarika, Senior Therapists of I-AIM, Mr. Indrajit

7.9. “Panchakarma Therapist" training for youths of Odisha state- sponsored by Orissa Skill Development Authority (OSDA)

Background

The program is sponsored by OSDA, Government of Odisha and aimed at identifying potential unemployed youth with 10th grade across Odisha state, seeking placement-linked-training-programs, especially interested to work in paramedical-field. In the training each student is individually trained with skills on Panchakarma therapy for 6-months. They will be placed in various Ayurvedic establishments across the country.

Fig 7.8 Class room training for Panchakarma therapy

Highlights of progress

- Selection of candidates was based on qualitative assessment of different parameters to grade/ score the potential candidate's eligibility to enter the training course. Combination of educational qualification, socio-economic background, age, physical fitness, personality trait, Prakriti body type, communication skills, etc were individually scored
- Two batches of students 21 and 20 students completed the training. Out of them 36 students got job placement at various Ayurveda establishments. 5 students completed the training but returned to their native because of personal reasons.

Fig 7.9 Bridge module on Soft skill & Communication training

Fig 7.10 Two batches of ODSA sponsored Panchakarma therapy students

Team members

Dr. Girish Kumar V, Dr. Sreeja, Dr. Sreedevi, Dr. Aayush, Dr. MNB Nair, Dr. Yashaswini, Dr. Udaykumar, Ms. Tarika, Mr. Indrajit, Mr. Prashanth acharya, Mr. Eso gamango, Mr. Venkatesh Das

7.10. Developing Innovative educational programs based on Ayurveda and allied integrative medical sciences for students from abroad

Background

This program is aimed at developing Innovative educational programs that is customer specific for various knowledge seekers from abroad in the area of Ayurveda & allied integrative medical sciences.

Highlights of progress

Developed & Conducted Workshop on Dinacharya based on Ayurveda, for South East Asian participants during December 2019 for 5 days. 11 participants from Malaysia & Singapore participated in the program. The workshop used to start at 6 am in the morning and guided every participant for self-experiencing the regimes of Dinacharya advocated by Ayurveda for health & wellness, like Dantadavana using herbs, Jihwanirlekhana, Kaval-Gandusha, Nasya, Anjana, Abhyanga Udwarthana, etc and guidance on Ayurveda principles of customised diet and lifestyle that also included prayers.

Internship program (6 months) for one foreign student (Mr. Michael Link) from University of Redlands, USA and conducted classes on Fundamentals of Ayurveda & its applied aspects**.**

Short training on "Introduction to Ayurveda" was delivered for International patients at I-AIM. The event was conducted on 1st February, 2020 for 15 participants from Europe, Australia & India. This training covered topics on basics of Ayurveda like the concept of dosha, Dhatu, panchamahabhoota, Prakruti, diet and lifestyle choices based on Prakriti, seasons and health status.

Team members: Dr. Girish Kumar V., Dr. Prasanna Kulkarni, Dr. Aayush, Dr. MNB Nair, Mr. Ravikumar G., Mr. Indrajit

Fig 7.11 Eleven participants from Malaysia & Singapore in the inauguration ceremony

7.11. Medicinal Plants & Primary Health Care teaching

Background

This program is being regularly executed for more than 10 years at various public & community centres. The learning groups are sensitized about having self-reliance in primary health care management and using medicinal plants grown in backyard & kitchen culinary items as home remedies for early management of PHC.

Fig 7.12 Theory & Demonstration classes, talk by Dr. Satish Rao

Highlights of progress

The team conducted a 1-day workshop on Medicinal plants & Primary health care for College teachers & Dieticians on 19th October 2019 at TDU campus and demonstrated 4 medicine preparations using about 10 medicinal plants. Eight participants took part in the program. The team also delivered guest lectures on Medicinal plants & Primary health care at Mount Carmel college for Graduate students as a part of their Community Development Program, during July-October 2019.

Team members Dr. Girish Kumar V., Dr. Megha

Fig 7.13 Identification of Medicinal plants as a part of Workshop on Medicinal plants

8. Accounts and Financial Statement

THE UNIVERSITY OF TRANSDISCIPLINARY HEALTH SCIENCES & TECHNOLOGY
74/2, Jarakabande Kaval, Post Attur, Yelahanka, Bangalore 560 064

BALANCE SHEET AS AT MARCH 31, 2020

CORPUS FUNDS, CAPITAL FUNDS & LIABILITIES	SCH REF	As at 31st Mar 2020	As at 31st Mar 2019	PROPERTIES & ASSETS	SCH REF	As at 31st Mar 2020	As at 31st Mar 2019
		Rs.	Rs.			Rs.	Rs.
General Fund	A	2,75,07,924	1,15,23,526	**Property, Plant & Equipments**	F	1,06,74,719	1,03,48,797
Reserves	B	37,62,748	29,82,431	**Investments**			
				Fixed deposits / Bonds	G	3,33,99,953	2,03,41,000
Project Grants	C	2,96,19,005	3,16,86,469				
				Assets, Loans and Advances			
Current Liabilities	D	18,19,702	20,42,317	Cash on hand	-	6,302	30,968
				Bank balances	H	2,37,75,320	1,52,76,502
Non-Current Liabilities	E	1,07,92,185	-	Other Current Assets	I	33,15,201	12,23,479
				Advances	J	23,30,069	10,13,997
Total		**7,35,01,564**	**4,82,34,743**	Total		**7,35,01,564**	**4,82,34,743**

Notes A) to J) referred to above and Notes to the accounts (Note No. O) form an integral part of this Balance Sheet

For The University of Trans-Disciplinary Health Sciences & Technology

Place: Bangalore
Date : 19/11/2020

(Professor Darshan Shankar)
Vice-Chancellor

(Dr. A.K. Gupta)
Registrar

(Mr. Suresh Hegde)
Joint Registrar - Finance & Accounts

As per our report of even date attached

For LAWRENCE TELLIS & ASSOCIATES
CHARTERED ACCOUNTANTS
(FIRM REGISTRATION NO. 001857S)

(Rohan Miranda)
Partner
ICAI M. No. 022772

Place: Bangalore
Date : 19/11/2020

THE UNIVERSITY OF TRANSDISCIPLINARY HEALTH SCIENCES & TECHNOLOGY
74/2, Jarakabande Kaval, Post Attur, Yelahanka, Bangalore 560 064

STATEMENT OF INCOME AND EXPENDITURE FOR THE YEAR ENDED 31ST MARCH 2020

(Amount in Rs.)

Income	Grants/Project Income (Schedule K)	University Income (Schedule L)	Total Income	Previous Year's Total (FY 18-19)
Consultancy Income	58,76,610	1,99,933	**60,76,543**	**1,20,24,001**
Donations	30,00,000	2,82,76,412	**3,12,76,412**	**11,87,41,793**
University Course Fees	-	27,68,100	**27,68,100**	**33,44,251**
Training Income	52,05,222	1,11,44,015	**1,63,49,237**	**79,45,985**
INCOME FROM OTHER SOURCES				
-Hostel & Guest House Charges	19,89,000	28,66,587	**48,55,587**	**23,74,125**
-Miscellaneous Income	1,05,700	2,19,384	**3,25,084**	**1,32,347**
-Transport & Other Recoveries	-	7,35,061	**7,35,061**	**9,55,521**
INTEREST EARNED				
-Interest on Fixed Deposits	2,47,094	17,62,197	**20,09,291**	**10,54,261**
-Interest on Savings Bank Accounts	1,45,085	7,54,806	**8,99,891**	**5,03,529**
Fees on Projects (Contra)	-	44,46,327	**44,46,327**	**50,10,728**
TOTAL INCOME A]	**1,65,68,711**	**5,31,72,822**	**6,97,41,533**	**15,20,86,541**

Expenditure	Grants/Project Expenses (Schedule M)	University Expenses (Schedule N)	Total Expenditure	Previous Year's Total (FY 18-19)
Books, Periodicals & Other Literature	7,464	14,310	**21,774**	**68,133**
Communication Costs	31,505	5,89,087	**6,20,592**	**7,41,893**
Consultants & Outsourcing Services	37,98,601	22,07,557	**60,06,158**	**1,07,75,718**
Consumables	22,96,672	3,39,889	**26,36,561**	**25,37,245**
Field Work & Trials	1,25,187	1,90,682	**3,15,869**	**1,53,616**
Gratuity Expenses	-	2,48,616	**2,48,616**	**30,41,587**
IT Hardware, Software & Services	28,183	1,26,385	**1,54,568**	**2,18,857**
Maintenance, Utilities, Repairs & Improvements	64,591	1,16,50,628	**1,17,15,219**	**1,13,53,069**
Meeting, Conferences & Workshops	1,92,706	5,24,822	**7,17,528**	**14,23,760**
Other Overheads & Contingencies	22,10,795	11,09,687	**33,20,482**	**15,82,506**
Printing & Stationery	1,88,118	2,31,499	**4,19,617**	**4,40,317**
Salaries Including Fellowships	1,59,44,334	1,50,63,976	**3,10,08,310**	**3,38,89,966**
Travel & Conveyance	24,83,781	20,54,920	**45,38,701**	**36,54,359**
Fees on Projects (Contra)	30,12,159	14,34,168	**44,46,327**	**50,10,728**
SUB TOTAL B-1]	**3,03,84,096**	**3,57,86,226**	**6,61,70,322**	**7,48,91,754**
Depreciation (**Schedule F**) **B-2]**	-	21,90,172	**21,90,172**	**23,17,718**
TOTAL EXPENDITURE B] = B-1] + B-2]	**3,03,84,096**	**3,79,76,398**	**6,83,60,494**	**7,72,09,472**
EXCESS / (DEFICIT) OF INCOME OVER EXPENDITURE FOR THE YEAR C] = A] - B]	**(1,38,15,385)**	**1,51,96,424**	**13,81,039**	**7,48,77,069**

I & E A/C (PAGE .....1)

LAWRENCE TELLIS & ASSOCIATES * CHARTERED ACCOUNTANTS * BANGALORE FRN : 001857S

THE UNIVERSITY OF TRANSDISCIPLINARY HEALTH SCIENCES & TECHNOLOGY
74/2, Jarakabande Kaval, Post Attur, Yelahanka, Bangalore 560 064

STATEMENT OF INCOME AND EXPENDITURE FOR THE YEAR ENDED 31ST MARCH 2020

(Amount in Rs.)

Income	Grants/Project Income	University Income	Total Income	Previous Year's Total (FY 18-19)
Excess / (Deficit) of Income over Expenditure for the year b/d	(1,38,15,385)	1,51,96,424	**13,81,039**	**7,48,77,069**
			-	-
Appropriations:			-	-
Project income transferred to the respective **Project (Grants) Funds (Schedule C)**	1,65,68,711		**1,65,68,711**	**1,26,78,306**
Project Income Recognition (to the extent of project funds / grants utilised as in **Schedule C**)	(3,03,84,096)		**(3,03,84,096)**	**(3,43,41,783)**
Depreciation for the year on assets acquired through project funds transferred to **Reserves for Fixed Assets (Schedule B)**		(7,87,974)	**(7,87,974)**	**(6,55,723)**
Excess of Income over Expenditure for the year transferred to **General Fund (Schedule A)**		1,59,84,398	**1,59,84,398**	**9,71,96,269**
TOTAL	**(1,38,15,385)**	**1,51,96,424**	**13,81,039**	**7,48,77,069**

Schedules A, B, C, F, K, L, M & N referred to above and Notes to the Accounts (Schedule O) form an integral part of this Statement of Income and Expenditure.

For The University of Trans-Disciplinary Health Sciences & Technology

Place: Bangalore
Date: 19/11/2020

(Professor Darshan Shankar)
Vice-Chancellor

(Dr. A.K. Gupta)
Registrar

(Mr. Suresh Hegde)
Joint Registrar - Finance & Accounts

As per our report of even date attached
For LAWRENCE TELLIS & ASSOCIATES
CHARTERED ACCOUNTANTS
(FIRM REGISTRATION NO. 001857S)

(Rohan Miranda)
Partner
ICAI M. No 022772

Place: Bangalore
Date : 19/11/2020

LAWRENCE TELLIS & ASSOCIATES
Chartered Accountants
No. 44/45, 2nd Floor, Vinayaka Complex
Residency Cross Road, Bangalore - 560 025
Ph.: 41514791/92/93
(FIRM ICAI REGN. No. 001857S)

END OF I & E A/C (PAGE .....2)

THE UNIVERSITY OF TRANSDISCIPLINARY HEALTH SCIENCES & TECHNOLOGY
74/2, Jarakabande Kaval, Post Attur, Yelahanka, Bangalore 560 064

RECEIPTS AND PAYMENTS ACCOUNT FOR THE YEAR ENDED 31ST MARCH 2020

(Amount in Rs.)

Receipts	Grants/Project Receipts	University Receipts	Total Receipts	Previous Year's Total (FY 18-19)
OPENING BALANCES AS ON 01/04/2019			-	-
Bank Balances (**Schedule G**)	39,60,000	1,13,16,502	**1,52,76,502**	**2,24,33,846**
Cash Balances	-	30,968	**30,968**	**57,368**
RECEIPTS DURING THE YEAR				
Consultancy Income	56,60,502	1,99,933	**58,60,435**	**1,20,24,001**
Donations	30,00,000	2,82,76,412	**3,12,76,412**	**3,63,62,290**
University Course Fees	-	27,68,100	**27,68,100**	**33,44,251**
Training Income	52,11,847	1,09,05,435	**1,61,17,282**	**78,75,921**
INCOME FROM OTHER SOURCES				
-Hostel & Guest House Charges	19,89,000	27,44,062	**47,33,062**	**23,74,125**
-Miscellaneous Income	1,05,700	2,19,384	**3,25,084**	**1,21,097**
-Transport & Other Recoveries	-	7,35,061	**7,35,061**	**9,55,521**
INTEREST EARNED				
-Interest on Fixed Deposits	1,24,953	17,62,197	**18,87,150**	**10,59,222**
-Interest on Savings Bank Accounts	1,45,085	7,54,806	**8,99,891**	**5,03,529**
Project Grants received	1,34,02,475	-	**1,34,02,475**	**1,28,50,691**
OTHER RECEIPTS DURING THE YEAR				
Refundable Credits received	-	14,624	**14,624**	**2,22,222**
Refund of Deposits paid	-	-	**-**	**52,000**
Refund/Settlement of Advances	2,08,677	59,119	**2,67,796**	**6,65,346**
GST/other Statutory Liabilities Collected and to be remitted	16,233	1,27,923	**1,44,156**	**5,32,588**
Advance from Foundation for Revitalisation of Local Health Traditions	-	1,07,92,185	**1,07,92,185**	-
Fees on Projects (Contra)	-	44,46,327	**44,46,327**	**50,10,728**
Inter-Unit Transfers (Contra)	36,85,108	-	**36,85,108**	**1,49,46,095**
TOTAL RECEIPTS	**3,75,09,580**	**7,51,53,038**	**11,26,62,618**	**12,13,90,841**

Payments	Grants/Project Payments	University Payments	Total Payments	Previous Year's Total (FY 18-19)
PAYMENTS DURING THE YEAR				
Books, Periodicals & Other Literature	7,464	14,310	**21,774**	**70,013**
Communication Costs	31,505	5,89,087	**6,20,592**	**7,54,502**
Consultants & Outsourcing Services	37,98,601	22,07,557	**60,06,158**	**1,07,75,718**
Consumables	22,96,672	3,39,889	**26,36,561**	**25,37,245**
Field Works & Trials	1,25,187	1,90,682	**3,15,869**	**1,53,616**
Gratuity Expenses	-	2,48,616	**2,48,616**	**30,41,587**
IT Hardware, Software & Services	28,183	1,26,385	**1,54,568**	**3,01,445**
Maintenance, Utilities, Repairs & Improvements	64,591	1,10,56,608	**1,11,21,199**	**1,10,96,070**
Meetings, Conferences & Workshops	1,92,706	5,24,822	**7,17,528**	**14,23,760**
Other Overheads & Contingencies	22,10,795	10,80,887	**32,91,682**	**15,06,946**
Printing & Stationery	1,88,118	2,31,499	**4,19,617**	**4,40,317**
Salaries Including Fellowships	1,58,63,694	1,50,04,776	**3,08,68,470**	**3,71,95,898**
Travel & Conveyance	24,83,781	20,54,920	**45,38,701**	**36,54,359**
Advances for Purchases	12,98,577	2,38,814	**15,37,391**	**10,04,675**
Refund of un-utilised Project Grants	86,263	-	**86,263**	**95,004**
Purchase of Fixed Assets	15,68,291	9,47,803	**25,16,094**	**46,65,256**
c/fd	**3,02,44,428**	**3,48,56,655**	**6,51,01,083**	**7,87,16,411**

R & P A/C (PAGE .....1)

LAWRENCE TELLIS & ASSOCIATES * CHARTERED ACCOUNTANTS * BANGALORE FRN : 0018575

THE UNIVERSITY OF TRANSDISCIPLINARY HEALTH SCIENCES & TECHNOLOGY
74/2, Jarakabande Kaval, Post Attur, Yelahanka, Bangalore 560 064

RECEIPTS AND PAYMENTS ACCOUNT FOR THE YEAR ENDED 31ST MARCH 2020

(Amount in Rs.)

Payments	Grants/Project Payments	University Payments	Total Payments	Previous Year's Total (FY 18-19)
b/fd	3,02,44,428	3,48,56,655	6,51,01,083	7,87,16,411
OTHER PAYMENTS DURING THE YEAR				
Loans & Staff Advances	-	2,29,099	2,29,099	4,323
Refund of Caution Deposits received	-	3,00,000	3,00,000	1,50,000
TDS/TCS recovered during the year	-	15,25,138	15,25,138	4,66,940
GST paid	1,64,914	3,70,374	5,35,288	874
Investments during the year	40,84,953	89,74,000	1,30,58,953	67,88,000
	-	-	-	
Fees on Projects (Contra)	30,12,159	14,34,168	44,46,327	50,10,728
Inter-Unit Transfers (Contra)	-	36,85,108	36,85,108	1,49,46,095
CLOSING BALANCES AS ON 31/03/2020				
Bank Balances **(Schedule G)**	3,126	2,37,72,194	2,37,75,320	1,52,76,502
Cash Balances	-	6,302	6,302	30,968
TOTAL PAYMENTS	3,75,09,580	7,51,53,038	11,26,62,618	12,13,90,841

For The University of Trans-Disciplinary Health Sciences & Technology

Place: Bangalore
Date: 19/11/2020

(Professor Darshan Shankar)
Vice-Chancellor

(Dr. A.K. Gupta)
Registrar

(Mr. Suresh Hegde)
Joint Registrar - Finance & Accounts

As per our report of even date attached
For LAWRENCE TELLIS & ASSOCIATES
CHARTERED ACCOUNTANTS
(FIRM REGISTRATION NO. 001857S)

(Rohan Miranda)
Partner
ICAI M. No 022772

Place: Bangalore
Date: 19/11/2020

END OF R & P A/C (PAGE .....2)

LAWRENCE TELLIS & ASSOCIATES
Chartered Accountants
No. 44/45, 2nd Floor, Vinayaka Complex
Residency Cross Road, Bangalore - 560 025
Ph.: 41514791/92/93
(FIRM ICAI REGN. No. 001857S)

The University of Trans-Disciplinary Health Sciences and Technology

No.74/2, Jarakabande Kaval, Post Attur, Via Yelahanka, Bengaluru - 560064

www.tdu.edu.in

Ph: 080 28568000 | Fax: +91 80 28567926