



Book of Abstracts

Virtual National Conference
on

Underutilized Horticultural Genetic Resources: Conservation and Utilization
(NCUHGR-2022)

(June 3-4, 2022)



Organized by
Andaman Science Association, Port Blair
ICAR-Central Island Agricultural Research Institute, Port Blair
Department of Biotechnology, Government of India, New Delhi

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BOOK OF ABSTRACTS

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Editors



Ajit Arun Waman

Pooja Bohra

D. Karunakaran

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Preface

India is known for its rich diversity of species of agri-horticultural significance. Due to the large geographical area distributed over diverse agro-ecosystems, the country probably has one of the most diversified agricultural systems in the world. The country is one of the largest producers of a number of horticultural crops including fruits, vegetables, flowers, spices, plantation crops and medicinal & aromatic plants. Besides the commercial crops, a number of underutilized species have been traditionally used for a variety of purposes such as food, medicine, fuel, natural colorants, sources of genes, artifacts, shelter, rootstocks *etc.* Often these species have limited territorial distribution and they are generally utilized based on indigenous technical knowledge associated with them. Such species have been generally termed as underutilized species, suggesting their potential for further utilization.

Commercial agriculture in the recent past has been facing multiple challenges including uncertainty of climate, surge of devastating pests/ diseases and unprecedented natural calamities such as cyclones, tsunami, rapid desertification *etc.* Lack of diversification and dependence on a few crops has contributed in worsening the situation resulting in huge losses to the farmers. Identification and promotion of locally adapted species with economic potential could not only give impetus for conservation of native diversity of a region but also provide alternative sources of income to the farmers. Further, many underutilized species are wild relatives of commercial crops and could hold potential as source of gene/ rootstock for combating long standing problems of cultivated species. Promotion of some of these species in challenged areas would also be beneficial considering the shrinking cultivable area in the country.

Research and awareness about such underutilized species is limited owing to various issues associated with them. However, the ecosystem services offered by such species make them most sustainable sources of livelihood, nutritional and ecological security. Keeping these things in mind, the National Conference on Underutilized Horticultural Genetic Resources: Conservation and Utilization (NCUHGR-2022) has been organized through virtual mode. The present abstract book is a compilation of the abstracts contributed by renowned keynote speakers, distinguished invited speakers and researchers working in different parts of our country. As a number of these species are not known to the masses, the idea of including a representative photograph of the abstract species/ aspect was introduced in this book. This would help the other researchers/ readers to understand the abstract and correlate with the species it deals with. We hope that the book will serve as a means of popularization of these underutilized species in other parts of the country as well.



(E.B. CHAKURKAR)

CONTENTS

Particular	Pages
National Advisory Committee	
National Organizing Committee	
Keynote Addresses	
Keynote Address 1	09
Keynote Address 2	12
Keynote Address 3	14
Theme I: Diversity, ethno-botany and conservation of underutilized horticultural species	
Theme I: Invited speaker	16
Theme I: Oral presentations	17
Theme I: Poster presentations	26
Theme II: Domestication and cultivation of underutilized horticultural species	
Theme II: Invited speaker	48
Theme II: Oral presentations	59
Theme II: Poster presentations	58
Theme III: Genetic improvement of underutilized horticultural genetic resources	
Theme III: Invited speaker	68
Theme III: Oral presentations	71
Theme III: Poster presentations	83
Theme IV: Postharvest management and marketing of underutilized horticultural species for improving nutritional and livelihood security	
Theme IV: Invited speaker	98
Theme IV: Oral presentations	100
Theme IV: Poster presentations	109
List of registered participants	119

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Keynote Address 1



Biodiversity, Ecosystem Services and Biosecurity for Sustainable Development of Andaman and Nicobar Islands under Climate Change

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Sustainable development, a UN millennium development goal, is seriously challenged by rapid climate change in intensity and direction. Global warming, rise in sea level and oceans, rapid increase in atmospheric carbon and increased risk from vector-borne diseases in plants, animals and humans are the four predicted cardinal effects of climate change. Unprecedented heat (49 °C in North India), rapid melting and disappearance of snow cover in the Himalayas, very late withdrawal of SW monsoon, repeated disasters in Uttarakhand, Chennai, Andhra Pradesh and many other parts of the country, violent cyclonic storms in Arabian sea are some of the manifestations occurring in the last 10 years. Andaman and Nicobar Islands are the true biodiversity representation of the bridge between Malayan and Indian peninsula. Located 92-94 °E and 6-14 °N in Bay of Bengal, covering 8,250 sq. km., (572 islands), with a mean precipitation of >3,100 mm, with a unique blend of forest, bioreserves, gardens, wildlife and tribes it is one of few truly untouched landscapes in the world. The unique positioning of these islands between the two major biodiversity areas endows it with an unmatched distribution of plants with representatives of the Indian, Myanmarese, Thai, Malaysian and Indonesian floras. The flora of the Andaman group of islands shows closer affinity to the Indo-Myanmarese-Thai flora, while the Nicobar groups of islands are closer to the flora of Malaysia-Indonesia.

Andaman Islands harbour nearly 200 endemic angiosperms, while Andaman Coconut, Nicobari Aloo, Khoon Phal, Neil mango, Noni are unique to the place. In mango, some species such as *Mangifera andamanica* – South Andaman, *M. camptosperma* - South Andaman, *M. griffithi* - South Andaman, *M. nicobarica* –Nicobar and *M. sylvatica* – North Andaman are unique and valuable. A very valuable *Musa indandamanensis* was described from Little Andaman, Bay Islands in 2013. Multiple spicata- A rare form of coconut in Andaman Islands, the *makapuno* type with soft endosperm, Long Island coconut with persistent petiole are some unique coconut types. Coconut is the lifeline of agriculture here. Furthermore, the region boasts of at least 18 species of *Garcinia*, 11 species of *Syzygium*, several species of *Annona*, *Artocarpus*, *Pandanus*, Khoon Phal - a rich source of beta carotene *etc.* Several leafy vegetables especially consumed by tribes, orchids, ginger and medicinal crops, *Amomum*, tuber crops *etc.* enrich the diversity of these Islands. Honey especially collected from wild bees is a part of food among the tribes. Several authors have reported various threats and impacts to the islands including impacts on the flora, fauna, indigenous tribal people and their reserves. The development of effective conservation strategies depends upon a sound understanding of the diversity, distribution, abundance and ecology of the islands' flora and fauna.

Climate change affects coastal regions, nations and cities and four key indicators of climate change are a) Greenhouse gas concentrations, b) Rise in sea level, c) Ocean heat and d) Ocean acidification set new record as per recent reports in 2021 as per the recent report of released on 'State of Climate'. The mean global temperature was warmer by 1.1° C in comparison to 1900 AD. One of the main reasons is fossil fuel pollution and inadequate progress in the use of renewable energy. Similarly, extreme weather events across the globe in on the rise and the loss was estimated to be \$100 billion in 2021 seriously impacting food security.

Another matter of concern for Island nations and regions is the rise in mean sea level which increased @4.5mm in the last 7-8 years. The data is a clear indication of the impact of global warming and a threshold of 1.5 °C is estimated

to be catastrophic. Data are also indicative of hotter, higher and more acidic in 2021. Melting of ice in the Arctic, Antarctic, and Himalayas due to global warming and the suicidal war in Ukraine is bound to further increase the sea level. While the focus is more on destruction due to floods and devastation to humans, the cost on other living forms, food chain and food web over time may have disastrous consequences to many lives on earth, biodiversity, ecosystem services etc. This year was witness to one of the warmest summers in India with Delhi touching 49 °C. Terminal heat impacts wheat productivity and India had to retreat its promise to feed the world under the conditions. The impediments in sustainable production of food, fruits, eggs, fish and other aquatic wealth puts generations at risk. Everyone has a role to play. The occurrence of drought and floods can be devastating but the impact on small Island nations and regions, needs immediate priority, Not much time is left. Landscape mapping, 3-dimensional simulation models on impact of rise in sea level, conservation of genetic resources, special focus on corals and mangroves and a better understanding of indicator species shall ameliorate and mitigate the impact. Central Island Agricultural Research Institute has a major responsibility in this direction. There is not much time left. Our focus should be need based, sustainable solutions and not mere academics.





Keynote Address 2

Importance of Certain Underutilized Horticultural Genetic Resources with Special Reference to Sea buckthorn (*Hippophae* sp.)

Prof. Brahma Singh

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Indian horticulture (fruits, vegetables, flowers, medicinal plants, spices, plantation crops, mushrooms and others), besides being blessed with diverse agro-climatic conditions, has remarkable genetic resources which are being used to progress this sector of agriculture continuously. Available plant genetic resources in different horticultural crops are being differently used to yield better both in off and main season, quantitatively and qualitatively. Despite enormous horticultural genetic resources utilization and exploitation, there are genetic resources in each category of crops in horticulture which are underutilized. Nature is very kind to horticulture to provide huge wealth of genetic resources. Research and awareness on certain plant species is limited owing to various issues associated with them. However, the ecosystem services offered by such species make them the sustainable sources of livelihood, nutritional and ecological security. The author had the fortune to work in cold desert, Union Territory, Ladakh which is known as barren land with no or less vegetation. But the area has rare useful horticultural genetic resources, which are underutilized. These genetic resources have been mentioned in presentation with details and useful utilization of sea buckthorn/*Brahmaphal* (*Hippophae* sp.). Enormous and huge natural sea buckthorn growth in cold deserts of Himalayas is mainly of *Hippophae rhamnoides*, *H. salisifolia* and *H. tibetana*. *Hippophae rhamnoides* is well studied but underutilized in India. Sea buckthorn shrubs have a remarkable lifespan of 100 to 150 years. Sea buckthorn is storehouse of nutraceuticals, phytopharmaceuticals and cosmeceuticals. Vitamin C requirement of world population can be met from natural growth of sea buckthorn. In the 1988 Seoul Olympics, sea buckthorn juice was the official team beverage for the Chinese team where it was studied in detail. It has several human health benefits. It is used in cancer therapy, cardiovascular health, immuno-modulation, dermal diseases, radio-protection, high altitude pulmonary edema *etc.* It has anti-oxidant property. It has antimicrobial, antiviral, antifungal and anti-inflammatory properties. Products of *H. rhamnoides* are used as preservatives or food additive, which increases the organoleptic and nutritional properties of food. Its juice has anti-freeze factor. Different foods and beverages made from out of fruits and leaves have been discussed. Feed enriched with *H. rhamnoides* has a positive impact on the nutrition and health of the animals, while improving their productivity. It is an ideal plant to check wind and water soil erosion in cold arid regions. Besides supporting rare fauna it fixes atmospheric 180 Kg Nitrogen per hectare annually. Other than sea buckthorn, certain horticultural underutilized genetic resources have been listed.



Keynote Address 3

Conservation and Utilization of Wild Relatives of Horticultural Crops, focusing on Climate Change

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The term wild relative denotes a plant species that is either closely or distantly related to domesticated/ crop species; it may be from the same or a related genus, and it shares a common ancestry but could have originated in the same area or distant lands. Several crop wild relatives (CWRs) have been contributing to the improvement of domesticated species, as they contain genes for tolerance to biotic and abiotic stresses, increased yield, novel cytoplasm, and for quality and other traits. At the same time, CWRs also face threats from climate change, development activities and by the expanding industrial agri-food systems. Hence, CWRs are international conservation and food-security priority. This highlights the need to conserve CWRs, either in *ex situ* or *in situ*, along with easily accessible documentation of all that is conserved. CWRs are important not only from the point of view of present use but also because they may contain genetic variability that may be crucial in the future, with the new demands placed by a changing climate. Since it is almost impossible to collect/assemble most of the diversity present in all horticultural crops, especially in the related species, they are best conserved in their natural habitat, supplemented by *ex situ* collections mainly for utilization in crop improvement programmes. Such *ex situ* conservation may be in the form of seed and field genebanks (depending on their seed storage behavior), cryo-conservation (tissues, pollen *etc.*) and other kinds of genetic material (DNA, sequence information *etc.*). Recognizing the value of native and exotic plants for crop improvement, including the wild relatives of horticultural crops, and providing for current and future food security, many countries around the globe, including India, have developed strategies for their conservation and use. Since some aspects of climate change have already been clearly predicted, our conservation and use strategies need to be modified or fine-tuned accordingly. The focus needs to be on adaptation, especially in the case of perennial horticultural species, as plant breeding may not be an option with species that requires long gestation periods.





Theme I

Invited Speaker

Status and Strategies for Conservation of Underutilized Horticultural Species

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Agriculture is under increasing pressure to produce greater quantities of food, feed and biofuel on limited land resources for the projected nine billion people on the planet by 2050. Vegetables and fruits are the key component of balanced human diet and also the main drivers in achieving global nutritional security by providing nutrient, vitamins and minerals. Spectacular growth in production of major vegetables has been witnessed due to development of improved varieties/hybrids, production and protection technologies through systematic research coupled with large-scale adoption. Diverse agro-climatic conditions of India allow growing more horticultural crops but many species are underutilized and lesser known in spite of having high nutritional and medicinal value and no concerted research and development efforts have been made to promote these crops. The base collection at ICAR-National Bureau of Plant Genetic Resources, New Delhi conserves ~ 41,786 accessions of different horticultural crop groups viz., Vegetables (28,269), Fruits and Nuts (300), Medicinal & Aromatics and Narcotics (9,017), Spices and Condiments (3,511), and Ornamentals (689) in the National Genebank. This includes trait specific registered germplasm (1,948 accessions) having resistance/tolerance to biotic and abiotic stresses, novel, unique and distinct value or of commercial importance. This vast gene pool is available to the breeders, but due to large size of the collection and lack of detailed information on unique traits, there has been minimum use of germplasm in breeding programmes to develop new varieties/hybrids. Moreover, there are many crops such as faba bean, lima bean, winged bean, jack bean, sword bean, velvet bean, tree bean, asparagus, amaranth, Indian spinach (*Chenopodium*), drumstick, curry leaf, *Momordica dioica*, *M. cochinchinensis*, *Coccinia indica*, *C. cordifolia*, *Melothria heterophylla* (dioecious), pointed gourd etc., which are grown, but no systematic research and development efforts have been made. Therefore, genetic diversity found in these crops is underutilized and offers a great opportunity for genetic improvement. The possible reasons for the low utilization of underutilized horticultural crops, in spite of their recognized importance are lack of availability of planting material, awareness on nutritional and medicinal importance and information on production techniques. The details of promising accessions as sources of specific traits are documented and conserved in National Genebank (NGB) for utilization are presented. However, there is a need to take up programme on target/crop specific exploration, management, utilization and improvement of underutilized horticultural crops to ensure food and nutritional security for future.





Theme I

Oral Presentations

Mapping the Climate Suitability Region using Ecological Niche Modelling Approach for an Underutilized Tuber ‘Soh-phlong’ (*Flemingia procumbens* Roxb.) Cultivation in India

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North East Region of India is endowed with rich vegetation with diverse vegetables, fruits, tubers and medicinal plants including underutilized species. *Flemingia procumbens* (Fabaceae) is a wild indigenous edible tuber patronized by Garo, Khasi and Jaintia tribes of Meghalaya, India. The juicy seasonal tuber is a highly valued in this region and possesses various ethno-botanical and nutritional properties. To facilitate domestication and conservation, ecological niche modelling approach was used to assess highly suitable regions for its cultivation in India and to assess worldwide distribution. Geographical coordinates recorded during an exploration for the collection of this important underutilized tuber crop by ICAR-NBPGR were used as presence points. It covered 18 villages in East Khasi hills, South West Khasi hills, West Khasi, West Jaintia hills and Ri Bhoi districts of Meghalaya. Maximum Entropy (MaxEnt) approach has been used to know the potential distribution of *Soh-phlong*. Bioclimatic variables viz. annual mean temperature, mean diurnal range, isothermality, temperature seasonality, maximum temperature of warmest month, minimum temperature of coldest month, temperature annual range, mean temperature of wettest quarter, mean temperature of driest quarter, mean temperature of warmest quarter, mean temperature of coldest quarter, annual precipitation, precipitation of wettest month, precipitation of driest month, precipitation seasonality, precipitation of wettest quarter, precipitation of driest quarter, precipitation of warmest quarter, precipitation of coldest quarter were also used to generate grid maps. The generated model indicates that the species is distributed in Chile, China, India, Myanmar, Nepal, Pakistan, Peru and Vietnam. Further it indicated that in India, climate suitable regions are distributed in parts of Assam, West Bengal, Uttarakhand, Gujarat and Jammu & Kashmir. Accordingly, strategies for on-farm conservation need to be developed.



Conservation Strategies for *Salacia chinensis* L.: an Anti-diabetic Medicinal Plant

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Salacia chinensis L., commonly called as *Saptarangi* or *Saptachakra* in *Ayurveda* and folk medicines, belongs to the family *Celastraceae*. Stem, roots and root bark of this plant contain salacinol, neokotalanol, mangiferin, kotalanol, salaprinol and neosalacinol as active principles. Primarily, it is used as an antidiabetic drug, apart from its use in rheumatism, fever, leucorrhoea, bronchitis, inflammation and venereal diseases. Unsustainable harvesting of its roots from natural sources has resulted in enlisting it as an RET species. This species is mainly propagated through seeds, which has low germination and vigour. Hence, the present work was taken up to develop seed germination and storage protocols, which could help in developing effective conservation and cultivation strategies of this species. Effect of different media (germination paper and cocopeat), pre-treatment (untreated, hydration for 48 h, 500 ppm GA₃ for 48 h and 0.1 % KNO₃ for 48 h) and temperature (20/30 °C, 20 °C and 30 °C) was studied. Results revealed that the seeds treated with 500 ppm GA₃, tested on germination paper and placed at 20/30 °C temperature showed the highest germination percentage (85%), seedling length (39.33 cm) and seedling vigour index (3345.50). The minimum values for all these parameters were recorded in the seeds tested in cocopeat treated with 0.5 % KNO₃ and placed at 20 °C. The 90 d storage studies on effect of packaging material (polythene bag and butter paper enclosed in polythene) and storage temperature (ambient temperature and refrigerated condition) were non-significant on germination for first 60 d of storage. But, after 90 d of storage, seed viability and vigour index were maximum, when the seeds were packed in butter paper, stored at ambient and refrigeration temperature (6.5 °C), respectively. This study will help in developing effective conservation strategies and production of quality planting material of this endangered medicinal species.



Review on Ethno-botany of Selected Plant Species of Andaman & Nicobar Islands, India

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There is a gradual increase in the demand of medicinal plants in the global market. On the other hand, their scarcity in future will become a significant hurdle in plant based traditional system of medicines. Since time immortal, plants are the prime component of our ecosystem and these plants have immense therapeutic potential because of which they have become popular among different ethnic groups around the globe. With social development and emergence of writing material, their systematic documentation took place. Similarly, folklore information from the native population of Andaman and Nicobar Islands about utilization of plants for remedial purpose has been documented by the researchers of different fields. Present is an attempt to systematically review the ethno-botanical uses of various plants by the settler communities and tribes of the Andaman and Nicobar Islands. There are more than 110 therapeutically potential plants species mentioned for about 50 disease conditions, of which abdominal pain, fever and headache are the most common conditions. It draws attention towards the age-old therapeutic knowledge about these plants with some sort of safety and efficacy. But, it is also necessary to conduct phytochemical, toxicological and pharmacological studies for drug development.



Diversity of Carambola (*Averrhoa carambola* L.) in Nagaland and its Ethno-botanical Benefits

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The North East region occupies 7.7% of India's total geographic area, supporting 50% of the biodiversity in the country. Wide range of underutilized fruits is grown in the North Eastern region of India. A large number of these underutilized species have been traditionally used for variety of purposes. However, limited efforts have been made for assessment of diversity available in most of the species. Further, documentation of traditional knowledge possessed by the native population is of utmost importance. Carambola is a small, bushy and evergreen fruit tree bearing fruits that are either sweet or sour depending on the cultivar and concentration of oxalic acid. The present study aimed at investigating the diversity of carambola in Nagaland and its ethno-botanical benefits. A total of 22 genotypes of carambola were collected from different locations of Nagaland and characterized based on plant morphological characters. Information regarding traditional or medicinal uses of the fruit was collected through interaction with the farmers/growers. The ethno-botanical benefits of carambola included use of fruits, seeds, leaves, bark and roots. Carambola fruits could be used to stimulate appetite. The fruit juice has also been known to counteract fever, lower high blood sugar and high blood pressure and treat diarrhoea, vomiting and dysentery. Leaves were also used to lower high blood sugar and high blood pressure.



Genetic Diversity and Conservation of Endangered *Citrus indica*

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A study on characterization and conservation of endangered *Citrus indica* collected from different parts of Northeast Hill Region of India was carried out. Result showed wide variations among different genotypes of *C. indica*. Plants had ellipsoid tree shape with moderate vigour, high spine density and straight spines of 16-40 mm length. The tree is evergreen with vegetative life cycle exhibiting simple leaf division. There are no petiole wings and leaf attachment is sessile. Fruits showed early maturity (Nov.-Jan.). Wide variations were noticed for morphological parameters such as fruit weight (11.59 ± 0.94 - 33.88 ± 0.12 g); fruit length (21.12 ± 0.29 - 34.43 ± 2.27 mm); fruit diameter (25.85 ± 1.34 - 45.22 ± 1.18 mm) and rind thickness (1.46 ± 0.40 - 4.27 ± 0.53 mm). Biochemical characteristics of fruits such as fruit firmness (1.01 ± 0.21 - 4.73 ± 0.72 Kg/mm/sec), TSS (5.49 ± 0.24 - $10.80 \pm 0.95^\circ$ Brix), titratable acidity (3.33 ± 0.31 - $6.40 \pm 0.12\%$), total sugar (5.00 ± 0.11 - 38.01 ± 1.84 mg glucose/ml juice), Vitamin-C (8.44 ± 0.61 - 39.78 ± 0.24 mg/100 ml juice), total phenolic content (12.17 ± 0.19 - 63.85 ± 1.80 mg Gallic acid equivalent/100 ml), IC₅₀ (70.63 ± 0.68 - 359.63 ± 16.07 µg/ml) and FRAP (4.85 ± 0.21 - 22.92 ± 0.21 mM FeSO₄ equivalent/100 ml) also showed variations. Conservation of elite genotypes through standardization of propagation techniques using four different methods viz. wedge grafting, T- budding, cuttings and seeds was done. Result showed that wedge grafting had highest success (68.33% graft sprouts), minimum days to sprouting (18.6 d), highest plant survival (62.84%) and number of leaves (27.43).



Morpho-chemical Evaluation and Conservation of Ground Apple [*Smallanthus sonchifolius* (Poepp.) H. Rob.] - A Potential Tuberous Crop for Mid Hills of NW Himalaya

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The ground apple; yacon [*Smallanthus sonchifolius* (Poepp.) H. Rob.] is a species of the Asteraceae family, naturally grown in the Northern and Central Andes from Colombia to Northern Argentina. It is cultivated for its crispy, sweet-tasting, mildly resinous and spherical to oblong tuberous edible roots. In India, it was introduced from Nepal by the effort of progressive farmer, Sh. Satya Jeet Negi from Kinnaur district of Himachal Pradesh during 2014. The roots contain health-beneficial biomolecules and are widely used for the management of diabetes. But, very scanty information is available in the public domain about its economic, social and nutritional benefits. Present study was undertaken to assess the performance under N-W Indian mid-hill conditions. The average tuber yield per plant was found to be 3.5 kg along with 10-12 numbers of rhizomes, which can be used as propagating material. Total soluble solids content of edible tuber after harvest was found to be 15 °Brix. The biochemical study revealed that roots had higher accumulation of fructose (0.086 mg/g) as compared to glucose (0.041 mg/g). The roots also manifested the low phenol (0.061 mg/g), flavonoid (0.0093 mg/g), tannin (0.004 mg/g), alkaloid (1.193 mg/g) and saponin (0.25%) content, which makes it useful for raw consumption. The collection is being maintained as live plants at the field gene bank of ICAR-National Bureau of Plant Genetic Resources (NBPGR), Regional Station, Shimla apart from its in vitro conservation at Tissue Culture and Cryopreservation Unit of ICAR-NBPGR, New Delhi. Further efforts are necessary to generate more scientific data pertaining to its cultivation and assessment of inter-cropping potential with Himalayan cash crops (Pome and stone fruits) so that it could be promoted for doubling farmer income as well as meeting out nutritional needs.



***Ex situ* Conservation Studies in *Garcinia indica*: a Recalcitrant Seeded Indigenous Underutilized Fruit Tree**

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Garcinia indica(Thouars) Choisy is one of the important indigenous underutilized fruit species distributed in the Western Ghats of India and listed under vulnerable status by International Union for Conservation of Nature (IUCN). Its fruits, besides being of nutritional significance, have medicinal properties. The fruit rind is rich source of hydroxycitric acid (HCA), which has anti-obesity properties. Germplasm conservation in a conventional genebank is difficult in this species due to highly recalcitrant nature of the apomictic seeds. Reports on *ex situ* conservation using *in vitro* conservation are scarce and no report was available for its long-term conservation using cryopreservation technique. This paper discusses the development of protocols for medium-term *in vitro* conservation practices, as well as the use of new cryopreservation technique for long-term storage of *in vitro* derived apical shoot-tips. For medium-term storage, a media was formulated containing both BAP and NAA, where the explants could be stored for as long as 2 years with 36% survival and no loss in regeneration potential under standard culture room conditions. Long-term conservation technique was standardized using droplet vitrification (DV) resulting in better survival (80%) as compared to vitrification (V) technique, wherein shoot-tip explants failed to survive on all treatments. Apical shoot-tips (ca. 2 mm) collected from 24 w old explants after exposure to liquid nitrogen using DV showed regeneration rates of 40-60% after thawing. These protocols are being implemented for successful medium- and long-term conservation of *G. indica* germplasm at ICAR-NBPGR. A total of four accessions of *G. indica* were conserved in the *In Vitro* Active Genebank (IVAG) and 2 accessions in the *In Vitro* Base Genebank (IVBG) at Tissue Culture and Cryopreservation Unit of ICAR-NBPGR, New Delhi.



Diversity, Ethno-botany and Prospects of Underutilized Vegetables of Eastern India

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The Eastern states of India are rich reservoir of underutilized green vegetables. The underutilized vegetables are nutritionally rich and contribute as an integral part in the diet of tribal people. Various species of edible plants are growing as wild in the agricultural, non-agricultural fields and forests. Tribal or natives usually collected these plants from their immediate surroundings without any investment. Various parts of these wild plants like leaves, young shoots, young fronds, flower buds, flowers and stolon are consumed in fresh or dried form. These vegetables also serve as livelihood support to the tribal population through selling them in market. The local communities accumulated, conserved and passed the indigenous knowledge about medicinal properties of these plants from one generation to another traditionally. Though these plants have regional importance due to their ethno-botanical properties, unfortunately they lack recognition and appreciation by urban community and most of such species are considered as food for the poor. Keeping this in view a study was conducted to identify the potential underutilized vegetables of Eastern India. A total of 32 underutilized vegetables commonly consumed by the tribal were collected from Jharkhand, Odisha and West Bengal and identified. Information regarding the habit, availability and parts consumed were documented for each species. An ethno-botanical survey based on the traditional knowledge of local people regarding practical uses of these underutilized vegetables was conducted and it was found that almost all the species of underutilized vegetables consumed by local people have one or more ethno-medicinal uses. The study indicates that popularization of these under-exploited edible plants helps to add food diversity on the plate, ensure nutrition and contribute in the livelihood improvement of the resource poor tribal population.





Theme I

Poster Presentations

Exploring Wild Mushroom (*Trametes* spp.) in Andaman and Nicobar Islands for its Medicinal Value

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Andaman and Nicobar Islands, being tropical region, have high scope of identifying medicinal wild mushrooms. The warm and humid climatic conditions of the Islands with high rainfall (about 3,000 mm) and temperature ranging from 25 to 35 °C provides best conditions for wild mushrooms to sprout and bloom in the forests and plains. Although one fourth (*ca.* 27,000 species) of the formally reported fungi (above 1,00,000 species) are known from mainland India, only less than 2% are known from Andaman and Nicobar Islands. The present study aimed at identifying and documenting *Trametes* spp. available in Andaman and Nicobar Islands. Among many wild mushrooms spotted in the Islands, *Trametes* spp. are most commonly seen growing in cluster or rows on dead and decayed logs. These species are generally stalkless with a flat and semicircle cap. The size of the cap could grow up to 10 cm. The cap is generally observed to vary from white to brown in color, sometimes with black zones. Earlier studies revealed potential of *Trametes* spp. in many aspects of healing. Among the confirmed biological activities, antioxidant, antimicrobial, and anti-inflammatory are the most often mentioned in the literature. Studies have also revealed their role for therapies of cancers and neurodegenerative disorders. As many mushrooms belonging to *Trametes* spp. have been spotted, there are very high prospects for identifying, conserving and domesticating these mushrooms to explore their medicinal properties for betterment.



Assessing the Climate Suitable Regions using Ecological Niche Modelling for the Cultivation of Phalsa, an Underutilized Fruit in India

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Phalsa (*Grewia asiatica* L.) is indigenous to India and is mainly cultivated for its small drupaceous fruits having medicinal value. It has wide adaptability and is suitable for arid zone horticulture. About 40 species of *Grewia* are reported to occur in India, which are valued for their bark, fibre and edible fruits. Fruit is a rich source of calcium, iron, minerals, carotene and nutritively highly placed. It is reported to be cooling, digestive, tonic, aphrodisiac. Fruits are also known for curing inflammations, heart and blood disorders and urinary troubles. Root and bark are used in strangury, gleet, gonorrhoea, diarrhoea and dysentery. Leaves are used as an application to pustular eruptions and buds are also prescribed by native practitioners. In order to attain nutritional security in the country, cultivation area under such underutilized fruits need to be increased. Hence, an attempt has been made to assess the climate suitable regions for cultivation of this valuable fruit using ecological niche modelling approach. ICAR-NBPGR dataset and Maximum Entropy (MaxEnt) software were used along with climate grid files (Bioclim 2.5 arc min). Bioclimatic variables viz. annual mean temperature, mean diurnal range, isothermality, temperature seasonality, max. temperature of warmest month, min. temperature of coldest month, temperature annual range, mean temperature of wettest quarter, mean temperature of driest quarter, mean temperature of warmest quarter, mean temperature of coldest quarter, annual precipitation etc. were also used to generate grid maps. The generated model indicated that the species likely to occur in African countries (Angola, Chad, Mali, Nigeria, Sudan, Zimbabwe), Australia, Saudi Arabia, China, India, Pakistan, Myanmar, Russia, Laos, Cambodia etc. Further, it indicated that climate suitable regions for cultivation of phalsa are distributed in parts of Andhra Pradesh, Telangana, Karnataka, Goa, Maharashtra, Odisha, Bihar, Jharkhand, Rajasthan, Gujarat, Madhya Pradesh, Uttar Pradesh and West Bengal in India. Accordingly, strategies for *on-farm* conservation need to be developed.



Taxonomy and Ethnomedicinal Study of Plants used by Namasudra Bengali Community People in Port Blair Municipal Area

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The present investigation deals with documentation of traditional knowledge of Namasudra community in Port Blair Municipal area of South Andaman Island. A total of 50 numbers of medicinal plants belonging to 36 families were reported, which are being used by the traditional healers to treat various diseases and disorders of general public. For each species, local name, botanical name, status of occurrence, flowering season, flower colour, growth habit, habitat, distribution and traditional medicinal uses were documented. Of the species documented, *Catharanthus roseus*, *Plumeria alba*, *Thevetia peruviana*, *Allamanda cathartica*, *Allamanda blanchetii*, *Kopsia fruticosa*, *Abelmoschus esculentus*, *Ixora coccinea*, *Kyllinga nemoralis*, *Cucurbita maxima*, *Hibiscus schizopetalus*, *Basella alba*, *Moringa oleifera*, *Aegle marmelos*, *Citrus aurantifolia*, *Punica granatum*, *Morinda citrifolia*, *Hibiscus rosa-sinensis*, *Lilium candidum*, *Eryngium foetidum*, *Aloe vera*, *Musa balbisiana*, *Bryophyllum pinnatum*, *Datura stramonium*, *Psidium guajava*, *Carica papaya*, *Cleome viscosa*, *Ocimum sanctum*, *Sphagneticola trilobata*, *Mirabilis jalapa*, *Bauhinia acuminata*, *Nyctanthes arbor-tristis*, *Tinospora cordifolia*, *Ficus religiosa*, *Portulaca oleracea*, *Tradescantia zebrina*, *Torenia fournieri* and *Ipomoea nil* were common. Species such as *Tabernaemontana divaricata*, *Clitoria ternatea*, *Murraya koenigii*, *Euphorbia hirta*, *Costus igneus*, *Cucurma longa*, *Gardenia jasminoides*, *Quisqualis indica* and *Tecoma stans* were rare. The most common plant parts used in their formulations were leaves and barks. These species were used for treatment of various ailments like Type-2 diabetes, wound healing, hypertension, irregular menstruation, tumour, diuretic, loosening the bowels, cough, headache, snake bites, dysentery, liver problem, filariasis, diarrhoea, bronchitis, asthma, malaria, stomach pain etc. This information will be beneficial in public health.



Underutilized Vegetables: The Power House of Nutraceuticals

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Deficiencies in micronutrients, also known as hidden hunger, have become a serious nutritional issue affecting one-third of human population in developing countries of Africa, Asia and Latin America. According to global hunger index, India ranked 94th among 107 countries in 2020. Therefore, it is important to move beyond food security and achieve nutritional security in the country. Underutilized horticultural crops especially underutilized vegetable crops are known to provide a good balance between carbohydrates, protein, minerals, micronutrients and vitamins, which are crucial to achieve this. Leaves, flowers and tender stems of *Alternanthera sessilis* are used in Karnataka and Tamil Nadu. The greens are rich in protein, carbohydrate, fat, fibre, carotene, vitamin C, riboflavin, niacin and various minerals. One hundred grams of fresh *Portulaca oleracea* leaves contain about 300-400 mg of omega-3 fatty acids, 12.2 mg of alpha-tocopherol, 26.6 mg of ascorbic acid, 1.9 mg of beta-carotene and 14.8 mg of glutathione. Waterleaf, a nutritious antiscorbutic pot-herb, is used in preparation of soups, as a condiment in sauces or raw in salad. *Ipomoea aquatica* (Water spinach) contain high Fe, due to which it is recommended by the doctors to the anaemia patients. *Sauropus androgynus* is reputed for its high nutritive value and therefore it is popularly known as “multivitamin green”. *M. tuberosa* (kasarkaya) is an underutilized vegetable that contains carbohydrate (3.72%), protein (3.26%) fat (1.61%), Fiber (5.63%) and ash (1.25%). Tender green fruits of kasarkaya are used to prepare various recipes and pickles. It has been used extensively in folk medicine as a remedy for diabetes. *Nelumbo nucifera* (lotus) seeds are rich in proteins (10.6-14.8%). *Sechium edule* is a very popular vegetable with fruits rich in amino acids. *Vigna angularis* sprouts are used as a vegetable, which are excellent source of folic acid, vitamin A and vitamin B. Its seeds contain 19.9 g protein per 100 g of seed. Thus, underutilized vegetables, embedded with rich nutrients along with ability to withstand against adverse climatic conditions, may prove a boon to growers, consumers and environmentalists



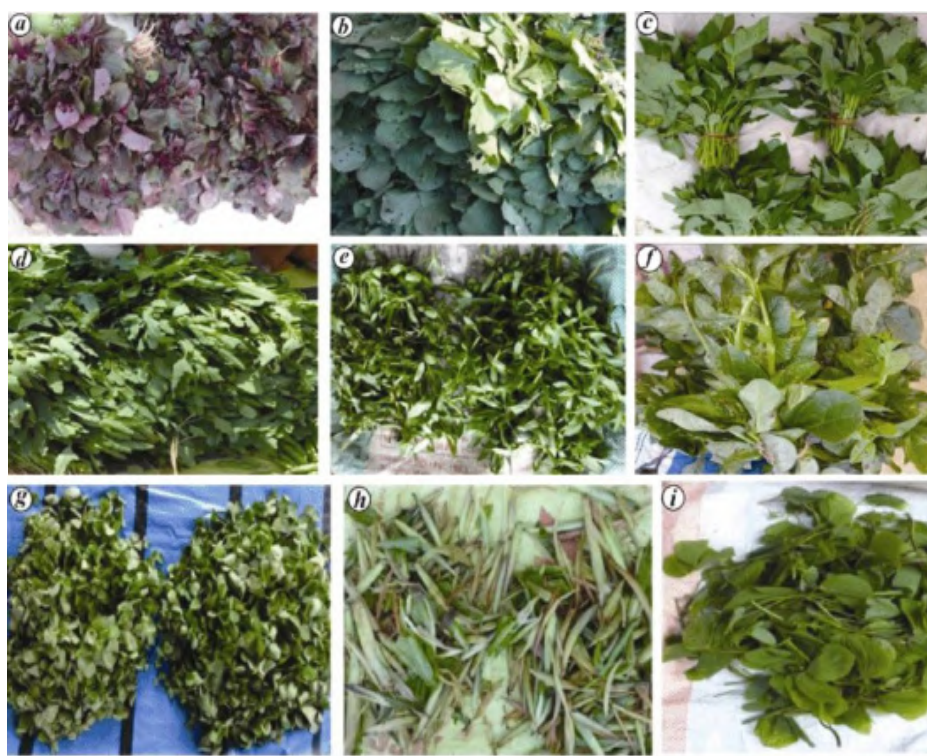
Underutilized Vegetables: a Boon to Farmers and Consumers

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Underutilized vegetables embedded with rich nutrient potentials along with ability to stand against adverse climatic conditions may prove boon to all concerns-growers, consumers and environmentalists, provided that they are tamed properly. Vegetables are the key component of balanced human diet and also the main drivers in achieving global nutritional security by providing nutrients, vitamins and minerals. This spectacular growth in vegetable production was possible due to development of improved varieties, production and protection technologies coupled with large scale adoption by the farmers. However, this was contributed by only few major vegetables. Although, diverse agro climatic conditions of India permit to grow more than 60 cultivated and about 30 lesser known vegetable crops, not much attention has been given on underutilized vegetables known. The possible reasons for the low utilization of underutilized vegetables, in spite of their recognized importance are due to lack of availability of planting material, lack of awareness on nutritional and medicinal importance and lack of information on production technique of these crops. In this context, there is an urgent need to take up programme on genetic resources exploration, management, utilization and improvement of underutilized vegetable crops to ensure food and nutritional security for future. The climate and soil of India are favourable for the production of different underutilized vegetables. Thus, the government of India has been taking some steps towards highlighting the underutilized vegetables. Finally, it can be concluded that, underutilized vegetable production will meet the shortage of per capita consumption availability there by solve the nutritional problems and at the same time it generates the employment and also increase the income of rural people and finally it could contribute the national economy.



Seed Desiccation and Freezing Tolerance: A Study on Wild Edible Fruit Tree Species from India

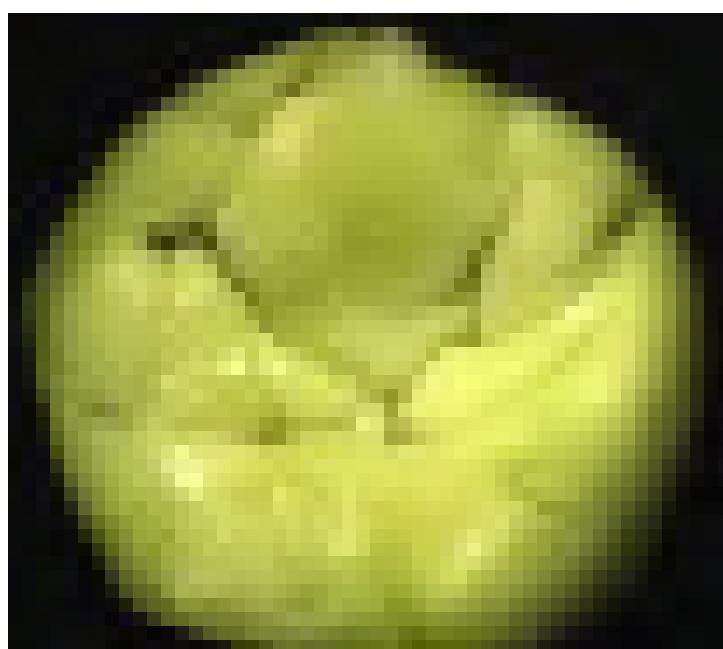
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Climate change and rapid urbanization have both resulted in significant biodiversity loss around the world. Indigenous wild fruit crops, which are a likely source of genes for some desirable traits, are the most vulnerable. These wild fruits are primarily adapted to a specific niche habitat, so their distribution in other areas is not observed, making research on these crops scarce or difficult. Several wild fruit crop species, including *Bursera serrata* (Te'kring), *Corylus jacquemontii*, *Garcinia gummi-gutta* (Malabar tamarind), *Limonia acidissima*, *Maclura cochinchinensis* (Damaru), *Prunus napaulensis* (Sohiong) and *Stixis suaveolens* (Thei ulluak) are still lesser known species to the researchers and farming community. Desiccation and freezing sensitivity studies in the seeds and embryonic axes of these species were conducted for their long-term conservation in the national cryobank housed in Tissue Culture and Cryopreservation Unit. Based on their sensitivity to desiccation and freezing, *B. serrata*, *G. gummi-gutta*, *P. napaulensis* and *S. suaveolens* were categorized as recalcitrant seeded species. Other species viz. *C. jacquemontii*, *L. acidissima* and *M. cochinchinensis* showed some tolerance to desiccation (critical moisture content: 7-10%) and thus, categorized as intermediate seeded types. As most of these fruit species exhibit non-orthodox (intermediate and recalcitrant) seed storage behavior, traditional seed conservation (seed genebank) methods are ineffective. Hence, protocols were standardized for long-term conservation at ultra-low temperatures (-196°C) in liquid nitrogen in these diverse species. Constant efforts to optimize the cryopreservation techniques in many such indigenous species, which are less studied for their storage behaviour is being done at the author's Institute.



Sherbet Berry- The Miraculous Fruit

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Fruit crops are classified as protective foods due to their phytochemical, mineral, nutrient, antioxidant and vitamin content. They are high in dietary fibers, which helps regulate bowel motions, lower cholesterol and fat levels, and improve the immune system. Underutilized crops are those that are neither cultivated at a commercial level nor traded significantly globally. *Grewia* species, which is also known as the sherbet berry is one such example of the underutilized fruit crop all over the world. This species is recognized to be source of bioactive compounds, which reduce the risk of both communicable and non-communicable illnesses. At the moment, phalsa is used to make a wide range of products, including jams, syrups, fruit juices, phalsa sherbet, squash and other drinks. Numerous metabolites, including polyphenols, flavonoids, anthraquinone, saponins, and coumarins, have been discovered as boosting phalsa's therapeutic efficacy. The plant has been utilized for thousands of years in the treatment of ailments ranging from diarrhoea to jaundice to various kinds of skin ailments. But one of the most significant drawbacks of these berries is that they are non-climacteric and highly perishable in nature. After being harvested, the berries remain in consumable stage for three to four days. As a consequence of this, both storage and long distance transportation are severely restricted. This presents a substantial challenge for use and commercial application of phalsa fruit. Research is starting to look at innovative scientific techniques to increase the viability of phalsa fruit, such as storing the fruit at low temperatures, covering it with edible substances, and drying it, as well as transforming phalsa fruit into value-added products. But a lot more studies investigating postharvest life needs to be done so that this valuable fruit can be utilized to its full potential.



Underutilized and Unexploited Edible Fruits and Vegetables of Tripura

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Tripura is one of the eight North Eastern States with a total geographical area of 10,491sq km of which 60% constitute forests and remaining 40% is available for cultivation. The state is characterized by subtropical, warm and humid condition, with fertile- acidic soil and abundant rainfall. This favors cultivation of various minor and underutilized horticultural crops. The North Eastern region is a reservoir of diverse minor and underutilized species; however, proper documentation and conservation efforts have not been made in most of these species. These species also play a vital role in providing nutritional, medicinal, economic and livelihood security to the small and marginal tribal and non tribal farmers in rural areas. These species help in employment and income generation to the rural dwellers; however, commercial importance and market value of these wild fruits is unknown to them. Nearly 90% of the farmers are small and marginal in Tripura; hence, many underutilized species are ideal for cultivation due to their low input requirement, less production cost, higher nutritive value and high yields. These species are easier to grow due to their hardy nature, producing a crop even under adverse soil and climatic conditions. The present work deals with underutilized fruits and vegetables used by the tribal people of Tripura. *Garcinia* spp., *Baccaurea* sp., *Flacourtia* sp., *Terminalia* sp., *Haematocarpus validus*, *Averrhoa bilimbi*, *Momordica* sp., *Dolichos* sp., *Eryngium foetidum*, *Dioscorea* sp. etc. are some underutilized fruit and vegetable species reported in this paper with emphasis on their identification, documentation and characterization using morphological and biochemical parameters.



Diversity of Wild Underutilized Edible Fruit Species in North-East India

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Nature in its generous abundance has bestowed the North-Eastern Himalayan region with a unique array of vegetation ranging from tropical and sub-tropical to temperate. With the diverse agro-climatic conditions coupled with varied soil type, abundant rainfall, rich forest cover and undulating topography of the region provides a variety of microclimates, ecological niches and offers immense scope for evolution and development of different wild fruit species. The paper reports on the survey and collection of wild underutilized edible fruit species found in the entire region of North East India covering 44 sites. A total of 44 underutilized fruit species represented by 21 families were enumerated in which rosaceae family represented the highest (six species) followed by Clusiaceae (five species), Anacardiaceae and Moraceae (four species each), Rutaceae and Euphorbiaceae (three species each), Lauraceae, Myricaceae, Burseraceae and Elaeagnaceae (two species each) and Dilleniaceae, Rhamnaceae, Eleocarpaceae, Combretaceae, Myrtaceae, Sapindaceae, Arecaceae, Menispermaceae, Fagaceae, Salicaceae and Caprifoliaceae with one species each. Consumption in its fresh form was the predominant form of use, while around 30 % were processed using simple traditional methods for off season consumption. Since yore, these fruits have helped the rural populace in mitigating the malnutrition by contributing food and nutritional security as well as in treatments of various ailments. However, with increasing population, deforestation and urbanization, diversity of these wild edible fruit species in the region is under threat and may soon be out of scenario unless proper identification, domestication, creation of awareness among people and conservation effort are initiated.



Underutilized Arid Fruit Crops: Genetic Diversity, Importance, Conservation and Utilization Strategies

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Underutilized crops are lesser-known plant species in terms of marketing and research, but well adapted to marginal and stress conditions. Being tolerant to biotic and abiotic stresses, these fruit species are suitable for growing in the disaster- and drought-prone areas. In addition, they are exceptionally rich in important phytochemicals and have medicinal value. Hence, their consumption may help to meet the nutritional needs of rural populations, such as those living in fragile arid and semi-arid regions around the world. There are around 30 plant species in arid zone known for their edible uses out of which some species are known for their edible fruits viz. *Cordia myxa*, *Ziziphus nummularia*, *Salvadora oleoides*, *Prosopis cineraria*, *Grewia subinaequalis*, *Aegle marmelos*, *Carissa carandas* etc. These underutilized fruits have many advantages in terms of ease in growing, hardy nature and good yield even under extreme weather conditions. The commercial production of these crops is restricted due to the shortage of desirable planting material. Micropropagation can play an important role in rapidly increasing new cultivars of these fruit crops. However, some of these fruits are not acceptable in the market in fresh form due to their acidic nature and astringent taste. Hence, there is a need to concentrate on research efforts in diversification and popularization of such underutilized fruit crops. Due to unsustainable market pressures and rapid urbanization, majority of these species have been threatened. A holistic approach is hence proposed, which includes both *in situ* and *ex situ* conservation strategies, as well as re-governance of the market chain.



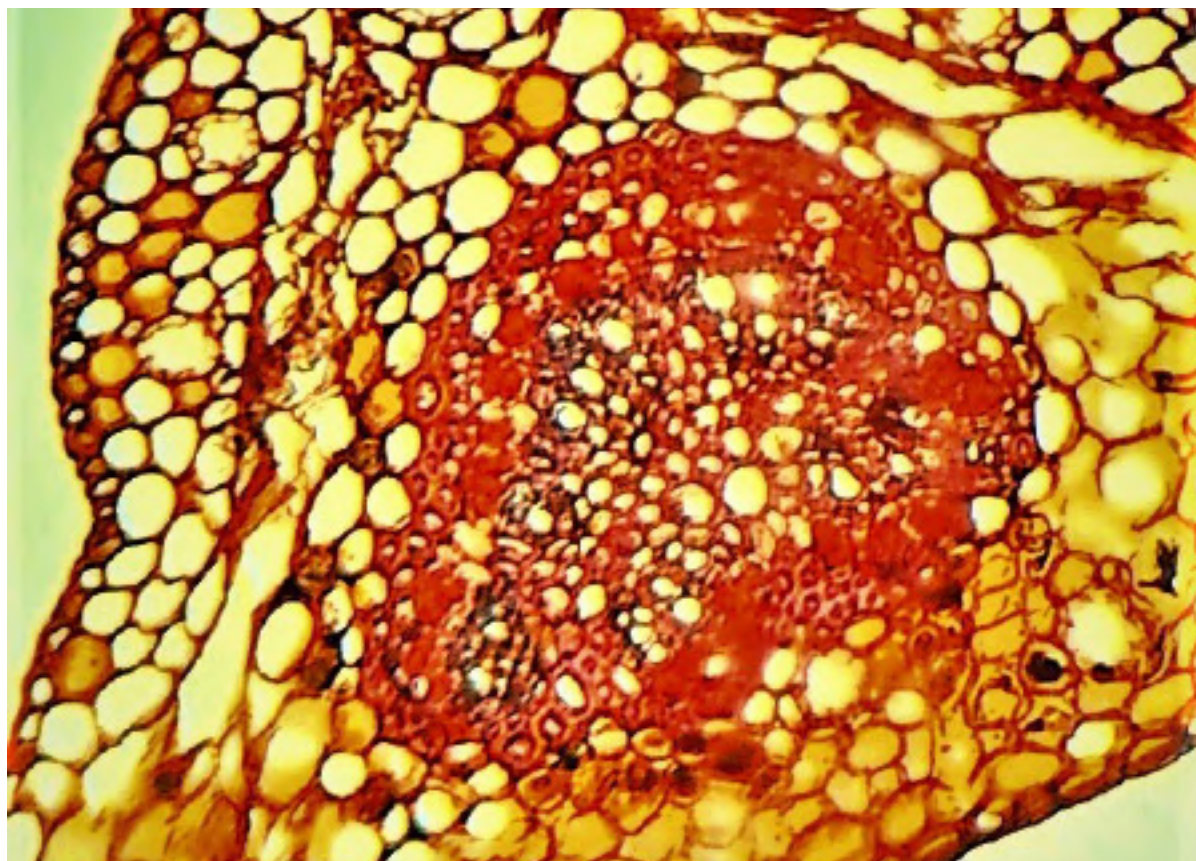
Anatomical Studies in *Garcinia dhanikhariensis* S.K. Srivastava (Clusiaceae)

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Garcinia is the largest genus in the botanical family Clusiaceae. As per the floral checklist of Andaman and Nicobar Islands, ca.17 species of genus *Garcinia* have been reported of which 7 species are endemic to the Islands. *Garcinia dhanikhariensis* is an endemic species reported from South Andaman Island. Such endemic species required to be studied in order to identify their role and potential in the ecosystem. Basic botanical studies are among the important pre-required steps before taking up any advanced level research in a species. However, so far no efforts have been made to systematically study its anatomical features. The aim of this paper is to study the anatomical characters of *G. dhanikhariensis*. A detailed anatomical description of leaves, petiole, stem and root of the species is reported for the first time in the present study. Result revealed that leaves have dorsiventral structure with a prominent midrib and thin lamina. The leaf is hypostomatous. Petiole vascular bundle appears in heart shape cells. It has a curved vascular strand with minute gap. Stem and root showed cellular differentiation, both as secondary growth. Calcium oxalate crystals and starch grains were widely distributed in stem, leaves and root of this species. Anatomical works on Clusiaceae family are limited and hence, the present work would form the basis for understanding this endemic species through further studies on phylogeny and physiology.



Makhana- an Untapped Aquatic Fruit from Bihar

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Gorgon nut or makhana is nothing but lotus seed and is the most promising aquatic cash crop with immense potential in Bihar. It accounts for more than 85% of the total production of India. Madhubani, Darbhanga, Sitamarhi, Saharsa, Katihar, Purnia, Supaul, Kishanganj and Araria districts are the major producers of Makhana in the state. The area under makhana cultivation in Bihar is about 13,000 ha and officially, around 25,000 MT of makhana is produced every year with an annual turnover of Rs. 300 Crores. Though makhana has potential, its value is mostly realized by local people only and hence it has remained underutilized and untapped. This fruit is getting unnoticed because of poor knowledge and awareness about its nutritional and therapeutic aspect and proper scientific management practices. The collection of gorgon nut (makhana) seeds from the bottom of ponds is cumbersome, tedious and drudgery prone. As this is specifically localized, no standardized infrastructure support exists. Further, non-remunerative marketing channels demotivate the makhana growers. Though Bihar has received Geographical Indication tag for this untapped low cost dry fruit, not many entrepreneurs are involved in its promotion. Considering high population of illiterate people (about 43% women and 27% men) and poor infrastructure facilities, agrobased enterprises focusing on value added products of makhana have been introduced. Makhana has high demand during religious functions and other social rituals. Keeping this in mind, Ready to Eat Makhana and Makhana Kheer Mix have been developed by author's University, which needs to be promoted to upscale on commercial basis. If appropriate scientific strategies are followed and the crop is included in horticulture based food production system, then this amazing fruit can acquire a prime position with measurable impact on the life and livelihood of the farming community.



Diversity and Conservation of Some Important Underutilized Fruit Crops

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Underutilized fruits are rich sources of vitamins and minerals and are known to have medicinal benefits. They may be well adapted to marginal lands and different stress conditions and may have ability to improve degraded habitats. There is need to document and popularize these crops in order to conserve their diversity for facilitating research and development programmes. Genetic diversity is the main basis for adaptation to future environmental uncertainty. Arid, semi-arid and tropical regions hold considerable genetic diversity of underutilized fruit crops such as *Annona atemoya*, *A. reticulata*, *A. muricata*, *Aegle marmelos*, *Phyllanthus emblica*, *Cordia myxa*, *Grewia asiatica*, *Artocarpus heterophyllus*, *Syzygium cumini*, *S. jambos*, *S. densiflora*, *Tamarindus indicus*, *Garcinia indica*, *G. gummi-gutta*, *G. cowa* etc. Genetic diversity can be effectively utilized for improvement of underutilized fruit crops. Improved varieties have been released in some of these species. Threats for genetic diversity of underutilized fruits include loss of habitats by competition with major fruits, extended farming, grazing forests and urbanization. Conservation of future fruits faces various challenges as majority of them have recalcitrant seeds. Hence, complimentary conservation strategies of *in situ* (on farm, biosphere reserves, national parks and gene sanctuaries) and *ex situ* (field gene banks, DNA bank, botanical gardens, *in vitro* conservation and cryopreservation) should be followed. At present, NBPGR and its collaborative centres, working on underutilized fruit crops are maintaining 1,717 accessions of underutilized fruit crops (1,127 accessions in field gene banks and 357 cryopreserved accessions).



***Momordica cymbalaria* - A Nutritionally Diverse Underutilized Vegetable Crop**

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Local/ tribal populations around the world rely on underutilized plants for food and nutrition. These plant products could be eaten raw or cooked, and their consumption adds variety to daily food intake by introducing new flavors to the diet. They are high in a variety of nutrients that can help to compensate for vitamin and mineral deficits in the human diet. In addition, neglected and underutilized species have an important role in maintaining diversity and hence more stable agro-ecosystems. *Momordica cymbalaria* originating from South East Asia and India is one among the underutilized Cucurbitaceous vegetable crops. It is commonly known as *Athalakkkai* or *Kakrol* or *Karchika* and *Kasarakayee*. Plants are found available in monsoon season. It is an annual or perennial climbing herb with branched, slender, striate and scandent stem. The fruits as well as the leaves of this species are consumed. *Momordica cymbalaria* is known for its immense nutritional and medicinal values. The fruits have hypolipidemic, hypoglycemic, nephroprotective, cardio protective and antioxidant properties. It is a rich source in calcium (72mg/100g), crude fibre (6.42mg/100g), vitamin C (290mg/100g), potassium (500mg/100g), sodium (40mg/100g) etc. Thus, increasing production and utilization of this crop would make it a candidate crop for nutritional security.



Diversity Spectrum of Tamarind Germplasm and their Geo-referencing using DIVA-GIS

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Tamarind (*Tamarindus indica*), an important leguminous tree, was studied for its distribution pattern and diversity using DIVA-GIS software. The experimental material comprised of 47 tamarind germplasm, which were collected and maintained in the field gene bank at ICAR-National Bureau of Plant Genetic Resources, Regional Station, Ranchi. DIVA-GIS software was used for studying the spatial distribution and richness of germplasm by using the geographical coordinates of collection sites. Grid maps were generated for analyzing diversity of important characters *viz.* fruit length, fruit weight, number of seeds per fruit and number of fruits per tree. It was observed that the genotypes used for study were collected from different blocks of Ranchi, Deoghar, Dumka and East Singhbhum districts of Jharkhand. Among them, majority of the accessions were collected from an altitude range of 500-750 m above mean sea level. It was observed that these tamarind germplasm exhibited wide range of variability for all the four characters studied. The grid map for fruit length revealed that high diversity index was observed in the collections made from Ranchi followed by East Singhbhum districts of Jharkhand. The highest diversity index for fruit weight was recorded in the collections from central part of Ranchi followed by East Singhbhum. The germplasm accessions collected from different parts of Ranchi had high diversity index for the characters *viz.* number of fruits per plant and number of seeds per fruit. This indicates that tamarind germplasm with high fruit length, fruit weight, number of fruits per tree and numbers of seeds per fruit are available in Ranchi and East Singhbhum districts of Jharkhand. Thus, these areas should be considered for future exploration programmes to capture maximum diversity for these characters.



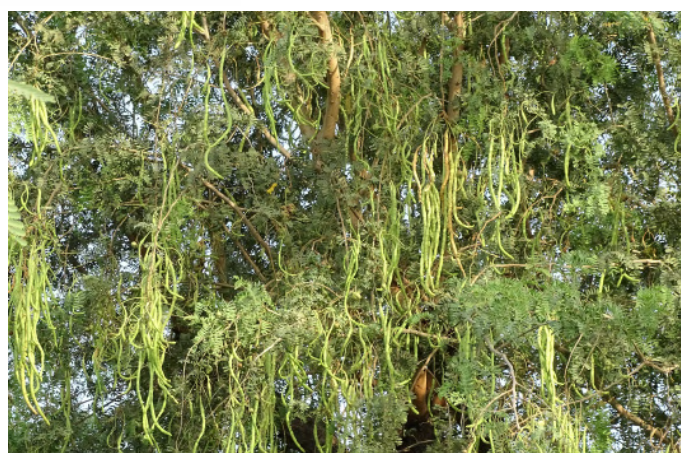
Underutilized Fruit Plant Species of Arid & Semi-Arid Regions of Rajasthan

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The fruit plant species, which are traditionally being used for food, oil, medicinal properties and other economic uses but their potential have not been fully utilized may be categorized as underutilized fruit plant species. Although, most of these underutilized fruits have remained integral part of traditional foods, especially in rural areas and among tribal communities, they have not received desired attention. These species are endowed with nutrients and antioxidants, and are known to exhibit ability to grow under adverse soil and climatic conditions. These underutilized plant species have potential to contribute to food security and nutrition. Arid refers to prolonged dryness, and is used with regards to the climate itself, and the land below it. In such regions, ability to produce agricultural crops is limited. Due to hardy plant types, these fruit plant species can thrive well under drought situations, which is common in arid and semi-arid regions. The recent awareness regarding potential of these ecologically fragile lands for production of quality horticultural produce has not only opened up scope for providing economic subsistence for the people of these regions, but also for bringing new areas to increase fruits production. Underutilized fruit species have wide scope of export for various processed products. The present study compiles scope, nutritive values and uses of underutilized fruits including ethno-botany of 25 species of arid and semi-arid regions of Rajasthan.



Sustentation of Local Novel Vegetables for Nutritional Security in Western Rajasthan

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Rajasthan has varying topographic features though a major part of the state is dominated by parched and dry region. Many grains and vegetable crops are still having a large number of landraces in this area. The available landraces in vegetable crops have different levels of tolerance to abiotic stresses like high temperature, low rainfall and biotic stresses like mosaic, blights, powdery mildew etc. The native communities have adopted a unique indigenous knowledge system of environmental conservation and sustainable management of these natural resources for food security. The system rely on preparation of processed vegetable by mixing dried fruits of four very common trees namely *Kair* (*Capparis decidua*), *Kumat* (*Acacia senegal*), *Khejri* (*Prosopis cineraria*), *Gonda* (*Cardia Myxa*) and an annual creeper *Kachri* (*Cucumis callosus*). This mixture is commonly known as *Panchkutta* i.e. mixture of five. As arid region has ample solar radiation for major part of year, these five vegetables are primarily processed, sun dried and then different proportion of these vegetables is mixed for *Panchkutta* preparation. *Panchkutta* is a balanced diet and is a readily available source of food and nutrient. This traditional preparation is locally available in every village of southern Rajasthan and it has been catering the food security of the native population in these regions. Further, a number of native people in this region are involved in the collection, processing and marketing of this formulation, which in turn is ensuring their livelihood security.



Tree Spinach (*Cnidoscolus aconitifolius*) - A Hidden Gem Hoarded with Nutrition and Medicinal Value

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Cnidoscolus aconitifolius, an underutilized leafy vegetable, is a tropical perennial euphorbiaceous shrub, native to Guatemala's Maya area, Belize, Mexico's Yucatan Peninsula, and sections of Honduras. It is commonly known as Chaya, Mayan keera, Cabbage Star, Tree spinach or Spinach tree. Ethnobotanical studies revealed that leaves are also used as live fence and fodder for animals of the Caatinga biome mainly during drought conditions. In terms of average nutrient value, leaves of tree spinach outperformed other green leafy vegetables including spinach, amaranth, Chinese cabbage and lettuce. Hydrocyanic glucoside, a poisonous chemical found in raw leaves, can make one sick. Cooked leaves, on the other hand, are safe to eat. The leaf is particularly high in protein (5.7%), crude fiber (1.9%), calcium (199.4 mg/100 g), potassium (217.2 mg/100 g), iron (11.4 mg/100 g), vitamin C (164.7 mg/100 g) and carotene (0.085 mg/100 g). There are lots of evidences on its therapeutic values in treating a number of disorders. It has ability to strengthen nails, colour grey hairs, cure alcoholism, sleeplessness, gout and can treat scorpion stings. It also improves brain and vision, apart from having anti-diabetic, antibacterial, hepatoprotective, anti-inflammatory, hypoglycemic, hypocholesterolemic and analgesic properties. Hence, tree spinach has potential as a new horticultural crop, which could expand beyond ethnic popularity to establish a global market both as a leafy green vegetable and herbal tea.



Wild Fagaceous Nuts from Mid-hill Forest Areas of Ri-Bhoi, Meghalaya

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Nuts are important part of human nutrition and health, as a source of protein, carbohydrate, vitamins, minerals, dietary fiber and phytonutrients. These are genetically very diverse groups and distributed throughout the world. In India, fagaceous nuts are mainly grown in the orchards and in wild throughout the Himalayas up to Assam and Meghalaya for its edible nuts. The utility of this crop has been minimal in the country as a whole. Even in the Kashmir valley, the profile of the fruit industry has long been dominated by apples. Diversifying fruit industry is a necessity for nutritional security and biodiversity conservation. Nowadays, it is important to develop local-based food habit, especially for the rural population. Meghalaya has rich biodiversity, but the potential of majority of this flora is still underutilized. Few wild fagaceous nuts have been identified with local names viz. *Soh ot langkraw* (*Castanopsis tribuloides*), *Soh ot saw* (*Castanopsis perpurella*), *Soh ot rit* (*Castanopsis indica*) and *Soh ot dieam* (*Lithocarpus fenetratus*) from the Kyrdemkulai forest area in Ri-Bhoi district, which showed distinctive variability for characteristics like burr, shell, leaves, nut shape and size. Locally, edible wild nuts are consumed fresh, sun dried and roasted. *Soh ot dieam* is not preferred for human consumption by the local people and solely eaten by wild animals in the forest areas. In the present day, nut-based products are gaining popularity among the global consumers and Meghalaya food processing sector has also entered a dynamic phase. Taking advantage of this, the existing underutilized species need to be brought to the lime light for economic sustenance, promotion of cultivation and conservation for environment restoration.



Nela Basale (Waterleaf): A Potential Nutritious Vegetable

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Nelabasale or waterleaf, is botanically known as *Talinum triangulare* ($2n= 48, 72$) is an edible leafy vegetable that belongs to the Talinaceae family. It is originated from West Africa and later spread to other parts of the world such as Asia and South America. Waterleaf is also known as Ceylon spinach, Bachalikura and Bombay basale. Its name is derived due to its high moisture content (about 90.8%). The leaves and shoots are soft and mucilaginous and are usually consumed as a cooked vegetable. It is also used as a salad and an alternative for purslane (*Portulaca oleracea* L.). Though waterleaf thrives well during rainy season, it can still tolerate drought conditions because of its Crassulacean Acid Metabolism (CAM) pathway. Waterleaf is a rich source of vitamin C, vitamin E, Omega -3 fatty acids, calcium, magnesium, soluble fibres (pectin), potassium, β -carotene, proteins and dietary fibre. It is a rich source of crude-protein (22.1%), crude fibre (11.12%) and ash (33.98%). All these vitamins and minerals contribute to high antioxidant values of waterleaf. Apart from its nutritional benefits, it also has medicinal importance due to the presence of tannins, alkaloids, saponins and flavonoids. This suggests its potential medicinal and dietary benefits. There are reports which suggest that waterleaf enhances cognitive ability, improves blood cells, promotes heart health, eliminates infections and diseases, repairs body tissues, strengthens bones and teeth, helps in digestion, aids in weight loss, improves blood clotting and eye health.



Underutilized Nannari Plant (*Decalepis hamiltonii*) for Health and Nutrition

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Decalepis hamiltonii is an endangered medicinal plant that grows mainly in dry deciduous forests of Deccan Peninsular of South India. It is a perennial, woody climbing shrub and its aromatic tuberous roots are generally used as a health drink and are very popular in Rayalaseema region of Andhra Pradesh as Nannari Sharbat and are well known for its nutraceutical and medicinal values. This species has been traditionally used in various systems of Indian medicines. Roots of this plant are being used in Unani, Siddha, Folk medicine as well as Ayurveda to stimulate appetite, relieve flatulence, skin diseases and as a general health drink. Moreover *D. hamiltonii* is a multipurpose plant and tubers of this have been identified as a traditional health drink owing to its nutritional value, besides its antioxidant, antimicrobial, antipyretic, antiulcer, insecticidal, chemo protective and neuroprotective activities. A number of systematic studies on this species have suggested these properties and hence, there has been an increasing awareness among the masses on its health benefits. However, indiscriminate exploitation of nannari plant, lower rate of seed germination and ecological and climatic conditions has lead to endangering this species in the natural ecosystem. Hence, there is an urgent need for conservation of this species for the present and forthcoming generations. Systematic research would not only help in its conservation but would also help in promoting the cultivation of this valuable genetic resource.





Theme II

Invited Speaker

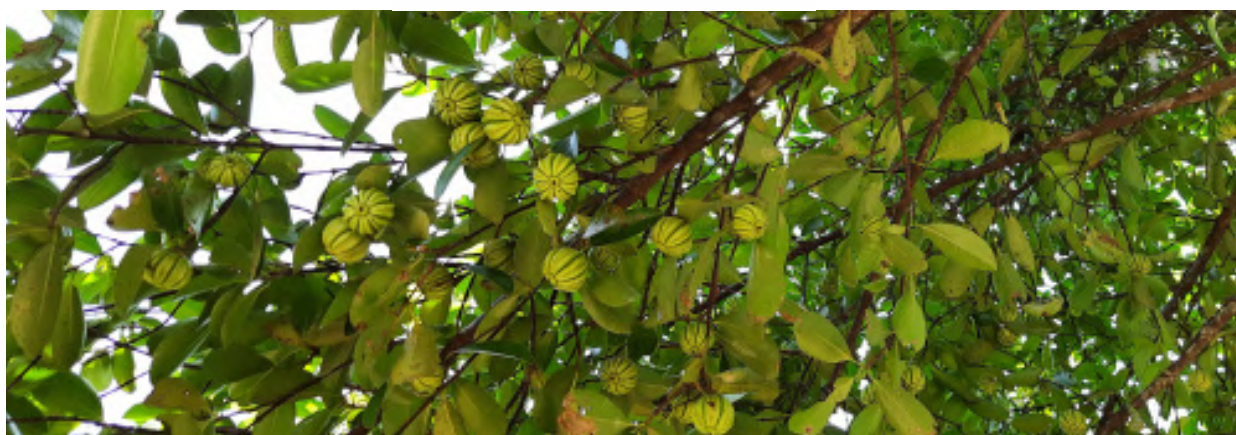
Prospects for Domestication of Lesser Known Fruit Species of India

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Indian region is a major centre of domestication and diversity of crop plants. About 33% of the cultivated plant species have their origin in this region. The Indian sub-continent is a centre of domestication and diversification of several economically useful plant species. As far as fruit yielding species are concerned, more than 500 species are found in different regions, which are being used for table purpose and various other purposes. The prominent indigenous fruit crop species of these regions are Jack fruit (*Artocarpus heterophyllus*), Aonla (*Emblica officinalis*), Star Gooseberry (*Phyllanthus acidus*), Bilimbi (*Averrhoa bilimbi*), Jamun (*Syzygium cumini*), Ber (*Ziziphus jujube*), Pummelo (*Citrus grandis*), Chalta (*Dillenia indica*), Tamarind (*Tamarindus indica*), Rose Apple (*Syzygium jambos*), Bael (*Aegle marmelos*), Wood apple (*Ferronia limbonia*), Governor's plum (*Flacortia indica*), Yellow mangosteen (*Garcinia xanthochymus*), Mahua (*Madhuca indica*), Indian almond (*Terminalia catappa*) etc. Some of the exotic minor fruits introduced in India are Rambutan, Avocado, Passion Fruit, Carambola, Java Apple, Soursop, Atemoya, Dragon Fruit, Malay Apple, Custard Apple, Surinam Cherry, Egg Fruit, Longan etc. Rich genetic diversity of wild and semi domesticated fruits is found in India. Some of the wild fruits found in different regions are *Myrica esculenta*, *Myrica farquhariana*, *Rubus ellipticus*, *Ficus palmata*, *Crataegus oxyacantha*, *Elaeagnus latifolia*, *Baccaurea sapida*, *Artocarpus hirsutus*, *Cordia dichotoma*, *Garcinia gummi-gutta*, *Garuga pinnata*, *Salvadora oleoides*, *Rubus biflorus*, *Hippophae rhamnoides*, *Diploknema butyracea*, *Berberis aristata*, *Pyrus pashia*, *Prunus undulata*, *Machilus edulis*, *Chrysophyllum roxburghii*, *Meyna laxiflora*, *Capparis deciduas* etc. Some of the wild species have been conserved by ICAR-National Bureau of Plant Genetic Resources, New Delhi, it's regional stations, ICAR institutes, State Agricultural Universities, Research stations and forest departments. Many wild fruits species are source of food for several tribes and forest dwellers since time immemorial. Some species are used as rootstocks for cultivated species, while some have potential to be used in breeding programmes. Wild pear (*mehal*, *Pyrus pashia*), *Kaith/pareu* (*Malus baccatta*) are used as rootstocks. There are some species such as *Pistacia integerrima* (wild pistachio, kakarsingi), Wild avocado (*Machilus edulis*), Palepan (*Chrysophyllum roxburghii*) etc., which have potential to be good rootstocks for Pistachio, avocado and sapota, respectively. Some of the wild species can be used as new species for crop diversification, some could be explored for their medicinal/ nutritional properties, whereas some could be used in processing. These lesser known fruits are sources of livelihood for the people of these regions. The domestication and promotion of these species would be helpful in employment generation and nutritional security.





Theme II

Oral presentations

Standardization of Grafting Time and Various Environmental Conditions in Jamun (*Syzygium cumini* Skeel)

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The present study was carried out to standardize most optimum season of grafting and environmental conditions for commercial scale multiplication of jamun in the Gujarat conditions. Treatments comprised of nine levels of grafting (G) time (from January 16 to May 16, at fortnightly interval) and three environmental conditions (E) viz. E_1 = open field, E_2 = net house and E_3 = polyhouse. The result indicated wide variations among the treatments studied for various parameters such as number of scions sprouted, grafting success, number of leaves per graft, graft length, graft diameter, rootstock length, rootstock diameter, root length, root diameter and root: shoot ratio. The lowest mortality (51.11 %) was observed in G_4 (March 1st) at 120 d after grafting. Among three environmental conditions, polyhouse grown grafts showed quickest sprouting with superiority in the grafting parameters studied. The lowest mortality was noticed in the polyhouse conditions (61.11 %) at 120 d after grafting. The interaction effect between grafting time and various environmental conditions was found in all parameters except graft diameter. The interaction effect between grafting time and various environmental conditions on graft diameter was found significant at 30 and 60 d after grafting. Maximum graft diameter (6.54 mm and 6.92 mm) was recorded in G_4E_3 (1st March + Polyhouse) at 30 and 60 d after grafting; whereas, the interaction effect between grafting time and environmental conditions was non-significant at 90 and 120 d after grafting. Therefore, the suitable season for softwood grafting of jamun is 1st March under polyhouse condition in order to get maximum success and survival percentage.



Tisal (*Zanthoxylum rhetsa* (Roxb.) DC): A Traditional Spice for Economic Prosperity of Coastal Farmers

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Tisal [*Zanthoxylum rhetsa* (Roxb.) DC.] belonging to Rutaceae family is found growing in wild in Western Ghats and other parts of India. The fruit has typical strong lemon skin aroma, because of which it has traditionally been used in culinary products like fish curry in Goa. It has preservative value that improves shelf life of the products in brine solutions. It could be utilized for extractions of essential oils and preparation of perfumes. It is anti-diabetic, anti-spasmodic, anti-diuretic, anti-inflammatory, anti-nociceptive, anti-diarrheal, anticestodal, antibacterial and anti-cancerous. This paper focuses on botany, traditional values, biochemical, morphological and cultivation hints of tisal. The tree grows tall (25 - 30m) with 80-100 cm DBH, with characteristic conical spines (1-5 mm size and density of 20-30 prickles/ 10 cm²) all over the stem. Leaf is imparipinnate type, tiny yellow coloured flowers are born in cymose of about 20 cm length at the terminal and axillary branches. Fruits are simple, true, follicles with smooth, globose, hard seeds. Morphological characterization of seven collections from various parts of Goa suggested distinct variations for seed morphology, essential oils and oleoresins. Variation for seed length (5.535 to 6.525 mm), seed width (4.835 to 6.376 mm), weight of 100 seeds (8.403 to 14.773g) was observed amongst the collections studied. The essential oil content varied from 6.0% to 8.4%, while oleoresin varied from 8.86% to 12.22% amongst the seven collections studied. Presently, it is found confined in the forests and only exploited by folk stakeholders at local level. However, it could be a potential spice for economical prosperity of coastal farmers as it has wide medicinal and traditional value.



Effect of Different Shades in Morphological and Biochemical Characters of *Eryngium foetidum*- An Underutilised Crop of North East India

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The ever increasing world population is putting a great pressure on agriculture to produce greater quantities of food, feed and biofuel on limited land resources. Current over-reliance on a handful of major staple crops has inherent agronomic, ecological, nutritional and economic risks and is probably unsustainable in the long run. Wider use of today's underutilized minor crops provides more options to build temporal and spatial heterogeneity into uniform cropping systems and will enhance resilience to both biotic and abiotic stresses. The aim of the experiment was to check the performance of an underutilized crop of the region with medicinal properties- culantro under different shade conditions and to develop cultivation practices for this underutilized herb. The plant was grown in different shade conditions of 25%, 50%, 75% and open condition in randomized block design. Various morphological and biochemical characters as influenced by the growing conditions were studied. It was found out morphological and biochemical characters of the crop differed with studied treatments. As a whole, performance of *Eryngium foetidum* was the best under 50% shade condition. Best shade conditions can be used for growing culantro for better yield and better biochemical contents.



Seed Germination in Blood Fruit as Influenced by Chemical Pre-treatments

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Blood Fruit (*Haematocarpus validus* (Miers.) Bakh. f. ex. Forman) is a tropical underutilized species naturally distributed in the North Eastern states of India. It grows wild in the forests and is considered a critically endangered species in the region. Fruit is rich in antioxidants and has been identified as a source of natural colourant. Seeds exhibit dormancy issues and pre treatments are required for obtaining large numbers of healthy seedlings for conservation and habitat enrichment. Very limited document is available regarding the seed germination and seedling growth. In present investigation, experiments on seed germination were initiated. Effect of seven seed pre-treatments viz. soaking for 24 h in water, KNO_3 (0.1% and 0.2%), GA_3 (250 mg/L and 500 mg/L) and thiourea (0.5% and 1.0%) was compared with untreated control under net house condition at Tripura. Results revealed significant differences among the studied treatments. Mean germination varied significantly (60.00 to 86.67%) amongst the treatments, the highest being in the seeds treated with GA_3 (500 mg/L). Mean germination time varied between 62.3 to 74.0 days. Soaking seed in KNO_3 (0.1%) and GA_3 (500 mg/L) significantly reduced the time taken for 50% germination. Germination index, time taken for first and final germination was also significantly influenced. Treatments with GA_3 (500 mg/L) and KNO_3 (0.1 %) showed significantly higher germination percent, mean daily germination, seedling vigour index-II and took minimum days to germination over untreated control. Except shoot length, all seedling growth parameters were significantly influenced by these treatments. Hence, treatment with KNO_3 and GA_3 could be recommended for obtaining healthy seedlings and mass multiplication of blood fruit for conservation.



Effect of Integrated Nutrient Management on Growth and Yield Attributes of Underexploited Vegetable Yardlong Bean (*Vigna unguiculata subsp. sesquipedalis* (L.) Verdc.)

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The present experiment was conducted during Kharif 2020-21 and 2021-22 to evaluate the effect of Integrated Nutrient Management on growth and yield of underexploited legume crop Yardlong bean cv. Arka Mangala under naturally ventilated polyhouse. The experiment was laid out in randomized complete block design with three replications and eight treatments viz. T1: 100 % Recommended Dose of Fertilizer (RDF), T2: 100 % RDF + Effective Microbial Consortia (EMC) + 5g/L Vegetable Special (VS), T3: 125% RDF, T4: 150% RDF, T5: 175% RDF, T6: 125% RDF + EMC + 5g/L VS, T7: 150 % RDF + EMC + 5g/L VS, T8: 175% RDF + EMC + 5g/L VS. Results from pooled data of two years revealed that, all the growth and yield traits were markedly affected by the integrated nutrient management practices. Among different treatments, significantly higher plant height (247.96 cm), number of primary branches (8.54), initiation of flowering (38.29 d), fifty percent flowering (43.48 d), days to first harvest (52.83 d), number of pods per plant (25.17), pod length (74.56 cm), pod girth (3.98 cm), average pod weight (35.54 g), yield per plant (664.17 g) and higher pod yield per 1000 m² (2171.96 kg) were recorded with treatment 150% RDF + EMC + 5g/L VS. Thus, integrated nutrient management practices with the said combination could be recommended for increasing growth and yield attributes in Yardlong bean.



Effect of Jeevamrutha and Panchagavya Biostimulants on Growth, Quality and Yield of Crossandra (*Crossandra infundibuliformis* L.)

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A field experiment was conducted at experimental block, Department of Floriculture and Landscape Architecture, College of Horticulture, Tamaka, Kolar, Karnataka during Rabi season of 2020-2021. The experiment was laid out in Randomized Complete Block Design with nine treatments and three replications. Among the treatments, application of panchagavya (6%) and jeevamrutha (3%) with 75% of NPK as soil application significantly improved the performance of the crop as revealed from the results recorded after 180 days of treatment. With this treatment, maximum number of primary branches per plant (18.02), secondary branches per plant (9.66), plant spread in East-West direction (42.54 cm) plant spread in North-South direction (42.17 cm) and leaf area (2885.87 cm²) were recorded. Quality parameters like maximum corolla tube length (28.98 mm) and flower diameter (27.13 mm), yield characteristics like number of spikes per plant (27.07), spike length (10.45 cm), number of flowers per spike (8.08) and cumulative flower yield per plant (46.75 g) were also significantly improved with this treatment.



Shortening the Germination Time through Seed Treatment in Palmyra Palm

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Borassus flabellifer belonging to the family Arecaceae is known as celestial tree and palmyra palm. It is native to tropical regions of Africa, Asia and New Guinea. Products from the palm have been used for food, wood, shelter and as the source of toddy. Apart from these, palmyra is having many medicinal properties and is being used to cure many ailments. Fabelliferin from the palm has potential to fight against lungs related diseases. Palmyra palm has a strong root system, due to which it has the ability to withstand drought, hurricanes and tsunami. Major problems faced by the growers are the slow growth of the palm and long germination time. The palmyra seeds require almost one year to reach transplantable stage. So, aim of the present study was to find the best seed treatment to shorten the germination time. In this study, eight treatment were tested viz. water soaking for 12 h, no treatment, soaking in GA_3 (500 ppm), vermiwash (10%), thiourea (1%), humic acid (2%), seaweed extract (1.5%) and $CaOCl_2$ (1%). The dehusked seeds were soaked in these treatments for 12 h and sown in the nursery beds. Results revealed that gibberellic acid (500 ppm) could shorten the germination time to 58 d and highest germination percentage was recorded in this treatment. This was followed by treatment of seeds with seaweed extract and water soaking. The hormone analysis suggested interesting results.



Henna (*Lawsonia inermis* L.): A Potential Underutilized Crop under Saline Arid Conditions

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Henna (*Lawsonia inermis* L.) is a small and hardy shrub dominating the agro-ecosystem of Pali district of Rajasthan, India. This species is known for its leaves, which have colouring compound. Presently, henna cultivation in the region is under 41,000 hectares, which is the largest area under this rainfed crop in the world at single location. It is dry land shrub, which can tolerate extreme dry and high temperature conditions. It survives well on problematic soils with high pH and saline water, wherein other crops cannot be grown. The development of henna cultivation and processing in Pali, Rajasthan is a blend of indigenous knowledge and people's innovations. In this crop generally, no fertilizers and plant protection measures are used and single leaf cutting is taken every year under rainfed conditions, while two cuttings are taken where water is available. Under rainfed conditions with dense planting, dried leaf yield in the first year is about 250 kg/ha and it keeps on increasing with time to about 2,000 kg/year. By following these measures, on an average farmers produce 15-20 q/ha dry henna leaves from their barren fields. It is a labour-intensive crop and its cultivation is dominated by women in every operation. The financial analysis indicated that henna farming is a profitable and attractive option for livelihood security of the farmers. Sustainable income from henna benefits the farmers of the district as it can tolerate high salinity, drought and incidences of pest and diseases.





Theme II

Poster Presentations

Studies on Effect of Storage and Container Treatment to Enhance Storage Life of Karonda Seeds

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An investigation on viability of karonda (*Carissa carandas*) seeds stored under two different storage conditions along with different container treatments was carried out at Department of Fruit Science, K.R.C. College of Horticulture, Arabhavi. The experiment was designed in factorial completely randomized design with two factors viz., storage condition (refrigerated and ambient) and container treatment (poly bag, poly bag + arappu leaf powder, poly bag + pongamia leaf powder, poly bag + bavistin, poly bag + *Trichoderma harzianum*, cotton bag) with three replications each. Stored seeds were sown at regular interval to assess their germination characteristics. Seeds stored in refrigerated condition showed maximum germination percentage. In case of container treatment effect, germination percentage was significantly high in seeds treated with *Trichoderma harzianum* kept in poly bag, which showed 85.00%, 75.00%, 65.00%, 48.33%, 40.00%, 33.33%, 25.00%, 18.33%, 13.33% and 5.00% germination at 15, 30, 45, 60, 75, 90, 105, 120, 135 and 150 days after extraction, respectively. In case of interaction effect, seeds treated with *Trichoderma harzianum* kept in poly bag and stored in refrigerated condition resulted in maximum germination of 90.00%, 80.00%, 73.33%, 56.66%, 50.00%, 43.33%, 36.66%, 26.66%, 16.66% and 10.00% at 15, 30, 45, 60, 75, 90, 105, 120, 135 and 150 days after extraction, respectively. The number of days taken for seed germination (days taken for initiation of germination, days taken for 50% germination and days taken for maximum germination) and seedling growth parameters such as root length, shoot length and seedling vigour index - I were also recorded the highest for the same treatment.



Studies on Orthodox Storage Behaviour of Passion Fruit (*Passiflora edulis* var. *flavicarpa*)

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Passion fruit is an underutilized fruit crop, in which round fruits are born on the vines. Studies have revealed that yellow passion fruit seeds exhibit orthodox as well as recalcitrant nature. Passion fruit seeds can present different forms and levels of dormancy. Such case, in which more than one type of dormancy occurs, is known as complex dormancy. During storage, seeds may lose their vigour, become more susceptible to stress during germination and lose their ability to produce normal seedlings. Hence, the studies with respect to determination of vigour potential and nature of dormancy are important. The viability of passion fruit at different seed storage period was studied and it was found that the seeds sown after 15 days of storage recorded significantly higher germination percentage (52.71%) and seedling growth parameters like seedling height (16.50 cm), shoot length (11.58 cm), root length (4.92 cm), fresh weight of the seedling (78.79 mg), dry weight of the seedling (8.27 mg), seedling vigour index-I (901) and seedling vigour index-II (458.96). These values were reduced with increasing storage duration. Irrespective of the seed storage period, seeds treated with thiourea (1%) for 10 min resulted in improved germination percentage and seedling quality parameters followed by seeds treated with GA3 (250 mg/L) for 10 min.



Viability and Vigour Studies in Passion Fruit (*Passiflora edulis* var. *flavicarpa*)

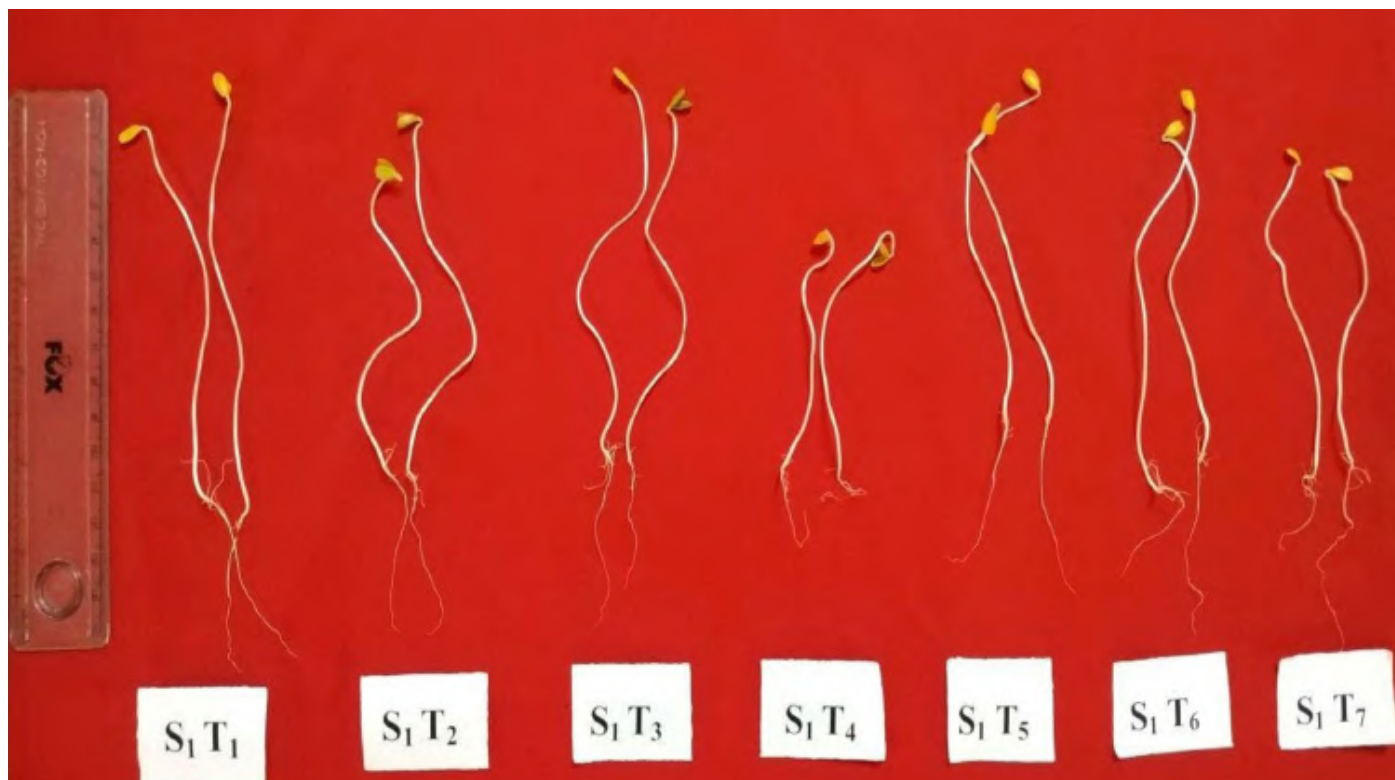
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An investigation on viability, vigour and storage studies in passion fruit (*Passiflora edulis* var. *flavicarpa*) seeds was conducted. The germination of passion fruit seeds is less and uneven, which may be due to physical (integument impermeability to water and gas), chemical (presence of inhibitory substances), physiological immaturity (mechanisms of germination inhibition) or embryo immaturity. Pre-treatments may enhance the germination potential of passion fruit seeds and hence, effect of seven pre-treatments was studied on germination and vigour characteristics. Among the pre-treatments studied, seeds treated with thiourea (1%) for 10 min recorded highest germination percentage (59.48%), which was followed by GA3 250 ppm (49.33%). Minimum number of days taken for initiation (18.33 d), days taken for 50% germination (28.33 d) and days taken for maximum germination (38.00 d) were recorded in seeds treated with GA3 (250 ppm) for 10 min. Vegetative growth parameters such as shoot length (26.54 cm), root length (15.91 cm), fresh weight of seedling (6.50 g), dry weight of seedling (1.38 g) were recorded the highest in seeds treated with thiourea (1%) for 10 min. Further, this treatment also exhibited superior seedling vigour index-I (1571) and seedling vigour index-II (82.38), while these parameters were the lowest in control. These results would help in large scale multiplication of passion fruit.



Kashi Manu: A Promising Variety of Water Spinach for Diversification and Economic Security

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Water spinach (*Ipomoea aquatica*) is commonly used as a food plant in several parts of the country. The leaves are good source of minerals and vitamins especially carotene. Leaves are heart-shaped and 20-30 cm long. ICAR-Indian Institute of Vegetable Research, Varanasi is maintaining several diverse forms of water spinach. Leaf biomass of Kashi Manu comes to harvest 20 days after sowing/ planting. The upper part of the main shoot, about 35- 40 cm long, is cut about 2.0 cm above ground level. About 90-100 t/ha leaf biomass can be harvested per cutting. Water spinach is commonly grown in waterlogged areas, which makes the plant protection practices and harvesting cumbersome. ICAR-IIVR, Varanasi has made efforts for cultivation of Kashi Manu water spinach in upland field condition and promising results were obtained for the same. This technology has proved to be simple and the crop could be cultivated round the year. Leaves are usually sold in the bunches of 500 g in the markets at the rate of ₹ 35- 40/Kg. In view of the importance, popularization of Kashi Manu water spinach on large scale under upland field condition could make significant contribution towards economic upliftment of the society along with ensuring nutritional security.



Scion Compatibility Behaviours of *Prunus* Species on Underutilized Local Rootstock

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A study on scion compatibility of *Prunus* species on underutilized local rootstocks was conducted at ICAR Research Complex for NEH Region, Umiam, Meghalaya to realize the potentiality of local fruit genetic resources. Two plum cultivars viz. Kala Amritsari and Satluj Purple and three peach cultivars viz. Partap, Flordaprince and Shan-e-Punjab were grafted on rootstock RC Peach-1 (IC-0632364) to test the rootstock scion compatibility behaviour. It was found that Shan-e-Punjab took minimum days for sprouting (23.33 d) followed by Kala Amritsari (25.67 d). Highest graft success and plant survival was recorded in Kala Amritsari (90.0% and 83.60%). Highest plant height was recorded in Kala Amritsari (1.19 m). The rootstock and scion diameter were recorded maximum in Flordaprince (8.43 and 7.24 mm). The number of functional leaves per plant was recorded highest in Kala Amritsari (232.0). Results indicated better compatibility of plum cv. Kala Amritsari followed by peach cv. Flordaprince on local RC Peach-1 rootstock.



Seed Germination Studies in *Eryngium foetidum* (L.)

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Culantro (*Eryngium foetidum* L.) is one of the important underutilized spices often cultivated for its culinary, pharmaceutical and medicinal use. It is grown commonly in the Andaman Islands and North Eastern States of our country. Due to the perishable nature and high market demand throughout the year, large quantity of culantro seedlings is required every year. Seed germination in the species is noticed from the mature seeds fallen from the plants. However, when seeds are harvested manually and sown, erratic germination is noticed. In order to improve the germination for producing large number of propagules, present study was taken up. Seeds were soaked in different treatments for 24 h. Effect of seed soaking in potassium nitrate (0.1% and 0.2%), GA₃ (500 ppm and 1,000 ppm), thiourea (1% and 2%) and water soaking were studied on seed germination and growth parameters under naturally ventilated low cost polyhouse condition. Seeds that were untreated served as control. Results indicated that higher seed germination (24.75%) was observed when seeds were soaked in GA₃ (1,000 ppm) followed by soaking in KNO₃ (0.1%), which exhibited (16.25%) germination. The lowest germination (6.75%) was reported in water soaked seeds. Thus, soaking of seeds with GA₃ (1,000 ppm) could be recommended for obtaining large number of plants.



Insect-pest Problems in Underutilized Fruit Crops

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Worldwide, many agricultural and horticultural crops are yet to be underutilized on commercial scale; of which, fruit crops such as, jack, fig, annona, ber, tamarind, West Indian cherry, bael, wood apple, jamun, bread fruit, avocado, star gooseberry, karonda and mulberry are being consumed by the local habitants and have potential for value addition in the near future. These underutilized fruit species offer promising export-oriented opportunities for income generation. An increasing endorsement at national and international level is being given to tap the potential of such valuable plant species with high genetic diversity. Such attention stems out from developments over the last decade that has contributed to change in the perception of people regarding the importance of such species. However, production of these fruit crops is sometimes hampered by pests and diseases, which are being less focused. Among the insect pests, shoot and fruit borer (*Margaronia caesalis*) is a major pest of jackfruit, which alone can cause up to 30% yield loss. Other less utilized fruit crops also suffer from pests viz. pink mealy bug (*Maconellicoccus hirsutus*) infests *Annona*, while fruit fly (*Carpomyia vasuviana*), fruit borer (*Meridarches scyroides*) and leaf roller (*Psorostichia zizyphi*) affect ber. Shoot and capsule borer (*Conogethes punctiferalis*) in wood apple, fruit fly (*Daccus correctus*) in jamun, scales (*Aspidiotus tamarindi*) in tamarind, leaf webber (*Diaphina pulverulentalis*), pink mealy bug (*M. hirsutus*) in mulberry and tea mosquito bug (*Helopeltis antonii*) in avocado have been reported. Hence, before strategies can be developed to promote the use of these underutilized fruit crops, careful analysis is necessary to monitor and document the precise impacts of pests and their management practices. Also, if it was possible to predict likely flare up of these pests before they evolve in the field, it might be feasible to have strategies to circumvent the problems.



Domestication and Cultivation of Underutilized Horticultural Species

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Millions of people in many developing countries do not have enough food to meet their daily requirements. Further many foods are deficient in one or more nutrients. In fact, considerable imbalances persist with respect to the calories, proteins, minerals and vitamins availability that will lead to malnutrition problems. The diversity in wild plant species offers variety in family diet and contributes to household food security. Today, most plant-derived human food is based on limited number of crops. However, it is clear that in many parts of the world, the use of wild plants is not negligible. In India, most rural inhabitants still depend on the wild edible plants as supplements to meet their food requirements. Among these, underutilized horticultural crops play an important role in food supplement especially during scarcity. Underutilized crops are those species with underexploited potential for contributing to food security, health, income generation, and environmental services. The possible reasons for the low utilization of these underutilized crop species, in spite of their recognized importance are due to lack of availability of planting material, lack of awareness on nutritional and medicinal importance and lack of information on production techniques. In this context, there is an urgent need to take up programmes on genetic resources exploration, domestication, management, utilization, conservation and improvement of underutilized horticultural crops to ensure food and nutritional security for the future. Synergistic interactions among improved technologies, institutional supports, favourable governmental policies and awareness among the farmers are necessary to encourage their cultivation. Underutilized horticultural crop production could meet the shortage of per capita consumption availability and at the same time contribute to the nation's economy.



Sword Bean: A Potential Underutilized Nutritious Vegetable

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Sword bean (*Canavalia gladiata* L.) is a tropical underutilized food legume which is rich in proteins and cultivated as a vegetable and fodder crop. It is also called as Jack bean or beach bean and was originated in India and China. Its fruits and immature seeds are used as vegetable in India, Sri Lanka, Indonesia, China, Korea and Japan. In Tanzania, the Swahili expression for 'eating sword bean' means 'being happy'. There are two types of sword bean. White seeded varieties are bushy in nature, while red seeded varieties are generally trailed over pandals. Tamil Nadu Agricultural University released a sword bean variety named SBS 1 in the year 1990. Sword bean matures in 110-120 d of sowing. Tender pods are ready for harvest from 75 days after sowing. It gives an average grain yield of 1,356 kg/ha and green pod yield of 7,500 kg/ha. The crop can also be grown as a border crop or intercrop.





Theme III

Invited Speakers

Genetic Resources and Crop Improvement in Underutilized Vegetables of Andaman and Nicobar Islands

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Underutilized vegetables or indigenous vegetables are the integral constituents in the traditional food system and serve as important sources of dietary micronutrients and health beneficial compounds for marginal communities. These crops are well accepted in food-based approaches to fight against micronutrient and vitamin deficiencies worldwide. Production, collection and marketing of these vegetables is a traditional source of livelihood for local people and is becoming the way for economic integration. These vegetables are vital for survival and health of marginal communities in remote areas particularly in underdeveloped and developing countries. Andaman and Nicobar Islands (India) have rich biodiversity of flora and fauna including vegetable crops. The present paper highlights the efforts made towards understanding the extent of genetic resources of underutilized vegetable crops available in the islands and also the attempts made for improvement of prioritized indigenous vegetables for the island ecology during the period 2008 to 2014. A total of 42 indigenous vegetables were documented and more than 200 local germplasm of these minor crops were collected and conserved by creating 'indigenous vegetable germplasm block' and in seed form at ICAR-CIARI, Port Blair. Out of these, ten were prioritized for breeding use. Five varieties were developed including CIARI Broad Dhaniya-1 (*Eryngium foetidum*), CIARI Poi Selection-1 (*Basella alba*), CIARI Shan (*Basella rubra*), CIARI Harita and CIARI Lal Marsha (*Amaranthus tricolor*). Also, CIARI Brinjal-1 (*Solanum melongena*), CIARI SP-1 and CIARI SP-2 (*Ipomoea batatas*) and CIARI Yamini (*Dioscorea alata*) were developed using local germplasm. High yielding elite genotypes were developed by improving the local germplasm of teasel gourd (*Momordica dioica*), *Centella asiatica*, *Hibiscus sabdariffa*, *Alternanthera* and Chilli. Genetic diversity analysis revealed a significant level of diversity in local germplasm and also a divergence from commercial varieties from mainland indicating for molecular changes during adaptation processes in the island ecology. Improved varieties showed a remarkable gain in yield, uniformity, and quality traits during the selection process. Breeding varieties for high yield and uniformity is essential for tapping the commercial potential of these potential crops and in achieving the nutritional and livelihood security of vulnerable population.





Theme III

Oral Presentations

Evaluation of Morphological, Biochemical and Molecular Diversity in Karonda (*Carissa carandas* L.) Germplasm

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An attempt was made to analyze the morphological, biochemical and molecular diversity in fifty-four accessions of karonda (*Carissa carandas* L.) maintained at ICAR- Indian Institute of Horticultural Research, Bengaluru, India. Morphological and biochemical traits were recorded and evaluated for variance and mean comparisons. Sequence Related Amplified Polymorphism (SRAP) molecular markers were used for generating information on genetic variation and relationships among the accessions. Significant variation was found in fruit related morphological characters. The germplasm lines showed high variations in individual fruit weight (g) and total soluble solids (°Brix) which ranged from 1.8 to 19.33 with a mean value of 6.16 and 1 to 18 with a mean of 13.3, respectively. The germplasm also exhibited diversity in parameters including fruit length, fruit width, seed weight, number of seeds per fruit, total sugars, antioxidant activity, phenol, flavonoid and anthocyanin content. Eleven SRAP markers were used and the PIC values ranged from the highest (0.39) obtained for Me3F-Em15R combination to the lowest of 0.28 for primer combination Me4F-Em3R. The mean PIC value for all markers was 0.30. The study on genetic diversity and relatedness using morphological, biochemical and molecular markers was successful in categorizing karonda accessions into different groups based on sweetness, colour of fruits and geographical origin. The combination of all the three systems of characterization provided important information about this minor fruit crop. The work will be useful for the breeders working on karonda for characterization, genotype identification and selection of parents.



Exploring the Morpho-genetic Diversity of Unique *Capsicum* Landraces of North-East India

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North-East India harbours rich diversity of *Capsicum* landraces, with *Capsicum chinense* and *Capsicum frutescens* being privileged with geographical indicator status recently. The information about genetic diversity among germplasm and within geographical boundaries is the first and foremost requirement for germplasm collection, maintenance, conservation and breeding in any commercial crop species. The present study was based on morphological and molecular characterization of 96 *Capsicum* landraces from seven states (Assam, Arunachal Pradesh, Nagaland, Manipur, Mizoram, Meghalaya and Sikkim) of North East India. Significant variations were recorded in the morphological and reproductive traits of these landraces. Principal component analysis (PCA) based on morphological characters revealed that seven PCs accounted for 69.5% of total variation. Genetic diversity of *Capsicum* landraces was analyzed using 20 simple sequence repeat (SSR) markers. A total of 72 alleles were detected with an average of 3.6 alleles per SSR locus. The polymorphism information content (PIC) values of SSR markers varied from 0.08 to 0.69, with an average of 0.46. The model-based population structure analysis showed that the *Capsicum* landraces were clustered into two broad groups. The geographic distribution and cultivars grouping of *Capsicum* were compared with genetic clusters. The results confirmed the presence of interesting and yet unexplored genetic variability having potential for use in *Capsicum* breeding programmes.



Assessment of Genetic Variability and Character Association in Kalingada (*Citrullus lanatus*), an Indigenous Vegetable of Hot Arid Zone of India

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Indigenous vegetables have enormous potential to contribute in nutritional security of geographically challenged regions. Watermelon, popularly known as ‘Kalingada’ and regarded as an important vegetable, supports the livelihood of desert dwellers in Indian hot arid zone. A study was conducted on eleven Kalingada genotypes for six qualitative (fruit shape, fruit rind color, fruit grooves, fruit stripes, color of flesh and seed coat color) and twelve quantitative traits (days to fruiting, days to maturity, no of vines per plant, length of vine, fruits per vine, fruits per plant, fruit diameter, fruit weight, fruit length, fruit width, 100seed weight and fruit yield) for analyzing the correlation and path coefficient under hyper arid conditions of RRS, Jaisalmer, ICAR-CAZRI, Rajasthan during *kharif* of 2019-2020. Significant genotypic differences were observed for all the studied characters indicating considerable amount of variation among the genotypes. The estimates of genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were high for fruit yield (23.76, 28.71) and fruit weight (22.35, 22.60). Broad sense heritability estimates were high for fruit weight (97.73) followed by days to fruiting (88.63), fruit width (83.92), fruit length (82.22), days to maturity (70.60) and fruit yield (68.46). The characters also indicated high values of genetic advance except fruit width and days to maturity. Number of branches per vine showed positive and significant correlation with fruit yield (0.39). Fruit length showed significantly high positive correlation with fruit weight (0.59) and number of branches per vine (0.37). Path coefficient analysis revealed that number of branches per vine showed highest positive direct effect on fruit yield (0.51) followed by fruits per vine (0.37), vine length (0.29) and fruit length (0.23). These results suggest that use of these traits would help in selecting higher yielding genotypes and supplementing empirical breeding approach.



Winged Bean (*Psophocarpus tetragonolobus*): a Wonder Legume Vegetable for Food Security

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Winged bean has assumed considerable importance as a protein rich multipurpose crop. Winged bean is a short-day climber, cultivated as an annual with indeterminate growth. Best time for sowing is June to July. Flowering commences after 50 to 60 days of sowing. The leaves are trifoliate and deltoid or lanceolate. Extensive root system helps plant to grow in nitrogen poor soils, reflecting its ability to obtain fixed nitrogen via its root nodules. The fibrous roots of certain genotypes form tubers also. The inflorescence is an axillary, erect raceme which bears 3-12 bluish or white flowers. Pod formation is visible after 5 to 7 days of anthesis. The length of four-winged, slightly bent pod varies from 10-40 cm and the seed number 5 to 15 per pod. The leaves contain 5 to 15% protein and high amount of vitamins. Its tubers contain higher crude protein than many other tuber crops. The green tender pods also have high protein content (1.9- 2.9%), carbohydrates (3.1- 3.8 %), are rich in calcium, iron, phosphorus and vitamins but low in fat which accords to potential health benefits. Considering the importance of the crop, an initiative has been taken at ICAR-IIVR, Varanasi, India by adopting winged bean as a new underexploited vegetable crop. In this regard, diverse germplasm lines were evaluated during 2016-21 for their morphological and biochemical characters. Observations were recorded on different horticultural traits, which suggested wide variability. Antioxidant analysis was also performed for some of the promising lines for edible pods and tubers. It was found that winged bean green pods had higher antioxidant activity than the raw tubers. Popularization of its cultivation techniques and augmenting the potential of this wonder legume vegetable can play an important role for crop diversification and food security under the changing climatic conditions.



Collection and Evaluation of Wild Accessions of *Capsicum frutescens* L. under Hill Zone of Karnataka

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Chilli is a major vegetable cum spice crop highly valued for pungency and colour. *Capsicum frutescens* L. (bird's eye chilli) is a semi-wild species of chilli known for the small yet highly pungent fruits. The species is found growing wild in the forests and coffee ecosystems in the Malnad region of Karnataka. In this study, an effort was made to collect and evaluate local accessions of the species from wild. Thirty-five accessions of bird's eye chilli were collected from the wild and evaluated for growth, yield and quality traits at College of Horticulture, Mudigere under hill zone of Karnataka. The design adopted was Randomized Complete Block Design with three replications. Analysis of variance for various growth and yield characters were statistically tested. Significant differences were observed among the genotypes for all the traits under study. Among the genotypes, Acc.15 was found to be superior in terms of growth parameters viz. plant height (79.81 cm), number of primary branches (7.17) and plant spread (46.46 cm²). Acc. 160 (12.14 kg per plot) and Acc.158 (11.39 kg per plot) were found to be higher yielders of green chilli, while Acc.18 (26.67 d) was early maturing type. Acc.133 (120.17 mg per 100g) and Acc. 164 (2.16%) recorded high ascorbic acid and capsaicin content respectively. All the yield traits under study had high GCV and PCV indicating the presence of wide variability in the genotypes. High heritability coupled with high GAM was noticed for most of the yield traits. Out of 19 characters studied, 16 showed direct positive effect on yield per plant. Accessions were grouped into six clusters with inter cluster D2 values ranging between 172.33 and 1275.15.



Genetic Variability in Vegetable Type Roselle (*Hibiscus sabdariffa* L.) Germplasm

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Malnutrition or hidden hunger is a major issue responsible for poor health status and resultant mortality in India. It is estimated that about 25% of Indian population is malnourished, most of which belong to poorer sections of society that cannot afford quality food. Strategic inclusion of low cost locally available vegetables, containing high amounts of mineral nutrients and immune-boosting bioactive compounds, in our regular diet is a priority that needs to be addressed through social awareness. Roselle is one such species, which is primarily cultivated in India as a cash crop for making coarse fibres but also has the potential for supplementing the nutrition system. The knowledge of health benefits from roselle has perpetuated from ancient civilizations. Various parts of the roselle plant have been used in traditional medicine to treat colds, toothaches, urinary tract infections and hangovers. Despite several health benefits, its consumption as food is limited only to the fibre growing belts and no standalone cultivation belt of roselle as a vegetable is present. One of the reason is unavailability of roselle cultivars specifically for vegetable purpose. Hence, the present study was undertaken to generate baseline information about the pattern of genetic variability in vegetable type roselle genotypes. Agglomerative Hierarchical Clustering based on Euclidean distance method grouped 13 genotypes into three broad groups. Cluster I was largest with eight genotypes followed by cluster II with four genotypes and cluster III harboring only one genotype. Promising genotypes identified for each trait could be successfully utilized in future breeding program for the development of dual purpose high yielding cultivars.



Exploitation of Germplasm for Drought Tolerance in Yard Long Bean: an Underexploited Leguminous Vegetable

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Yard long bean (*Vigna unguiculata* subsp. *sesquipedalis*) is an underutilized vegetable in India that has potential to address malnutrition and food insecurity due to its high nutritional content and low management requirement. Being a leguminous crop, it enriches soil and is an integral part of sustainable agriculture. Moisture stress is a major abiotic constraint that limits its extension to non-traditional areas of cultivation. Yard long bean has been in cultivation in Kerala since ancient times, resulting in a rich and diverse local germplasm. Collection, conservation and utilization of this native diversity is crucial for broadening the genetic base and exploiting this genetic wealth in developing climate resilient cultivars. Research was conducted in this context to identify new sources of moisture stress tolerance among the available germplasm and to use the tolerant lines in breeding programmes to develop drought tolerant cultivars. Hundred yard long bean genotypes were evaluated for drought tolerance both in field and polyhouse under imposed water stress condition. Seven drought tolerant genotypes selected through germplasm screening were genetically analyzed for combining ability and heterosis using a $L \times T$ mating design. Twenty one hybrids generated through this were evaluated for twelve morphological and physiological parameters for drought tolerance. All the hybrids manifested a significant amount of dominance variance for commercial exploitation. The identified genotypes and the transgressive segregants from the identified crosses can be used for the development of drought tolerant high yielding cultivars in future. The utilization of these genetic resources would encourage its cultivation in drought prone areas and wastelands with minimal consequences of climate change. This would facilitate the fight against malnutrition and help in improving farmers' income and food security of the nation.



Evaluation of Jamun Genotypes for Seed Mineral Content

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In spite of their high nutritional and medicinal properties, commercial cultivation of underutilized fruits is lacking in India. Most of the underutilized fruits like jamun are in the core recipes of many ayurvedic formulations. Jamun seed powder has been used for centuries to maintain the healthy blood sugar level. An experiment was conducted to determine the mineral elements such as Cu, Mn, Zn, Fe, Mg, Ca, and K in jamun (*Syzygium cumini*) seeds through atomic absorption spectrophotometer. Twenty eight genotypes under the present investigation were from different regions of India. The calcium and magnesium content in jamun seed powder ranged from 35 mg/100g (Collection-13) to 349mg/100g (Collection-6) and 31.47mg/100g (Collection -13) to 328.10mg/100g (Collection-6), respectively. The iron, manganese, zinc and copper content in jamun seed powder ranged from 23.80ppm (Collection-8) to 50.73 ppm (Selection-58), 4.17ppm (Collection-10) to 7.33ppm (Collection-5), 5.10ppm (Savadatti) to 15.20 ppm (Collection-9) and 3.38ppm (Collection-10) to 22.69ppm (Selection-45). Potassium content was found to be the lowest in Collection-12 (0.211%) and the highest in DMS-2 (0.346%). These findings concluded that there was a significant difference among the genotypes for seed mineral content and overall, genotypes Collection-6, Selection-45 and S-58 were found to perform better than the others.



Bael (*Aegle marmelos* Correa)- Diversity of Wild and Cultivated Types for Yield, Fruit Quality and Nutraceutical Attributes

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Bael (*Aegle marmelos* (L.) Correa) is an indigenous underutilized fruit crop found growing naturally across different states in India and has religious, cultural and spiritual significance. Wild bael trees produce small, hard-shelled fruits, which are not fit for fresh consumption due to high astringency. Fruits of this type are extremely important in Ayurveda for medicinal uses. Improved varieties are cultivated on limited scale in some states of North India. They are sweet and the fresh ripe pulp is used for processing into several products such as squash, jam, candy and syrups, which have enough demand. Due to its numerous food, pharmacological, and other value added applications, it could be considered as a promising fruit tree species for large-scale cultivation. With this background, an investigation on the performance of seedling progenies of improved varieties *vis-a-vis* wild types was carried out at ICAR- Indian Institute of Horticultural Research, Bengaluru to identify superior genotypes with desirable quality and nutraceutical traits. Fruits were analyzed for physicochemical attributes and comparative studies on phytonutrients showed wide variations. Fruit weight ranged from 80.00-1548.10 g, number of fruits from 9 to 210/plant and yield 4.31-73.5kg/plant. Variability was also observed for fruit length (3.50-10.60 cm), fruit width (3.25-11.60 cm), pulp weight (15.00-894.30 g), total seed weight (10.00-105.20g/fruit), shell weight (44.00-534.10g), shell thickness (0.17-1.30 cm), TSS (27-36 °Brix). High levels of variability was observed for antioxidant activity using FRAP and DPPH assays. The carotenoids and antioxidant values were higher in progenies of improved varieties compared to the wild types. This work resulted in identifying few superior genotypes with higher content of bioactive compounds as pre breeding lines for further use in bael improvement.



Unraveling Genetic Variability in Teasel Gourd (*M. subangulata* subsp. *renigera* (Wall. ex G.Don) W.J.de Wilde)

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Teasel gourd is a widely cultivated vegetable in Eastern India, North-eastern hills and Andaman Islands. Being devoid of bitterness, highly nutritious and with unique flavour and taste, it could be a good choice for diversifying the vegetable basket in non-traditional cultivation areas like the West coast, the Western Ghats and Nicobar Islands of India. Owing to its wider climatic adaptability, the crop is now being popularized for homestead cultivation in humid Peninsular tract of the country. Over hundred farmers in the West coast were supplied with the sprouted male and female tubers for cultivation in their homesteads. In order to identify superior accessions for wider adoption, genetic variability was assessed in thirty-six germplasm collected from Assam, Mizoram, Nagaland, Odisha and Tripura. The accessions were grown in plastic barrels of 30 cm × 75 cm size to protect them from the attack of wild boars. The characterization data were taken for six stem, 14 leaf, six flower and seven fruit characters. Variability was absent with respect to tendril characters and shape of stem (quadrangular) at nodal region. With respect to the quantitative characters, significant differences were observed in most of the characters except petal length and width. Accession IC641652 developed female flower setting at 6th node from base, an indication of earliness in bearing. Fruit length of 8.88 cm was exhibited by IC641646, a collection from Tripura. The accession IC641667, also from Tripura, was found to be a promising one as it recorded maximum values for weight (93.00 g), width (4.94 cm), circumference (16.76 cm) and flesh thickness (0.54 cm) of the fruit. Progeny of cross between IC597084 and IC553771 was found to give fruit weight (130 g), when grown in fertile soil under optimum field conditions. Maximum coefficient of variation was exhibited for the trait- node number of first flower appearance, followed by fruit width. As the crop faces the problem of lack of pollinators visit (insect recognition), requirement of hand pollination outside its home range is a constraint for its popularization. To overcome this, efforts are underway to combine high vegetative propagation efficiency, bigger fruit size, prolificacy and extended harvest period of teasel gourd and entomophily of spine gourd, by tetraploidization of two related species; *M. dioica* and *M. sahyadrica* (both 2n=28) using 1% colchicine on the growth primordia of tuber sprouts at two leaf stage. Bulged collar region of the survived plants was taken as an indication of polyploidization and male flowers from such plants were used as pollinizers for teasel gourd. The developed crosses will be evaluated for selecting natural insect pollinated segregants.



Study on Extent of Variation in Jackfruit [*Artocarpus heterophyllus* Lam.] Genotypes from Northern Tripura

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The experiment was undertaken during 2019-21 for the purpose of studying the extent of variation existing for different quantitative and qualitative traits among various locally available jackfruit germplasm in northern Tripura. Fair amount of variations was observed for yield attributes such as weight of flakes per kg fruit (g), weight of fresh flakes with seed (g) and without seed (g), number of flakes/fruit, fruit core weight (g), individual fruit weight (kg), number of fruits/tree/year, fruit productivity (kg/m²) and fruit yield (kg/tree/year). High magnitudes for GCV, heritability, genetic advance and genetic advance as percentage of mean were observed for yield, fruit productivity, fruit stalk length and fruit core weight, which indicated scope for improvement of these traits through proficient selection process. Comparatively low genetic advance with high heritability estimates for some of the traits like seed width, seed length and total sugar content of ripe fruit could be indicating towards the fact that direct selection based on these characters would be less effective. Characters such as number of fruits per cluster and shelf life of fruits exhibited wide range of differences between GCV and PCV. Hence improvement of these traits by means of selection may not be effective at all. In Principle Component Analysis (PCA), the component loading plots for various parameters clearly showed that the parameter-yield per tree per year was located or loaded with near proximity of fruit core weight, fruit weight, number of fruits per cluster, flake width, flake length, fruit stalk length *etc.*





Theme III

Poster Presentations

Evaluation of Arrowroot (*Maranta arundinacea* L.) Genotypes for Growth, Yield and Quality Attributes

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Arrowroot (*Maranta arundinacea* L.) is a starchy vegetable grown in India, used both as food and for nutraceutical purposes. A study was conducted at RHREC, Dharwad (Karnataka), India during 2020-2021 with seven genotypes of arrowroot. The results showed that the genotypes significantly differed for all the sixteen characteristics studied. Plant height varied from 103.97 to 119.54 cm with a mean of 109.45cm. In case of number of tillers per plant, it ranged from 6.21 to 9.15 with a mean of 7.71. Number of leaves per plant ranged from 38.78 to 56.00, while leaf area varied from 115.03 to 161.74cm². Number of rhizomes per plant ranged from 9.66 to 12.66 with a mean value of 10.93. Rhizome length and girth varied from 13.83 to 15.69cm and 2.21 to 2.75cm, respectively. Rhizome yield per plant ranged from 187.81-276.54g, while total rhizome yield was 27.14 t ha⁻¹ and it ranged from 20.87 to 30.73tha⁻¹. In case of dry matter, starch, reducing sugar, carbohydrate, crude protein and crude fibre content, the values ranged between 73.09-78.77%, 14.33-18.39%, 2.14-2.64%, 30.44-32.56%, 3.58-4.37% and 17.47-21.29%, with mean values of 76.37%, 16.52%, 2.36%, 31.79%, 4.03% and 19.93%, respectively.



Evaluation of *Chenopodium album* Genotypes under North Eastern Transition Zone of Karnataka

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An experiment was carried out at College of Horticulture, Bidar, University of Horticultural Sciences, Bagalkot, Karnataka to study the performance of 23 genotypes of an underutilized leafy vegetable- *Chenopodium album*. Pooled data of three years (2017-18, 2018-19 and 2019-20) on various growth and yield parameters was analyzed. The results revealed that the plant height varied significantly among the studied genotypes. Collection HUB-6 recorded the maximum plant height of 80.03 cm, while HUB-8 recorded minimum height of 43.91 cm. Significantly higher number of leaves per plant (108.17) were recorded in collection NIC-22517 whereas lowest number of leaves (47.05) were recorded in collection IC-109235. Stem diameter varied from 1.70 mm in NIC-22506 to 2.76 mm in HUB-7. Significantly maximum number of branches (13.54) was recorded in NIC-22492, while lowest number (6.77) was recorded in case of IC-109235. Significantly maximum foliage yield was observed in HUB-6 (2.74 kg per plot and 18.15 t ha⁻¹).



Genetic Studies in Portulaca (*Portulaca oleracea* L.)

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Portulaca is a potential leafy vegetable crop known for its richness in nutraceuticals. However, in India, it is largely treated as a weed and information on its cultivation practices is scarce. Estimation of genetic diversity in any species is essential for its genetic improvement. Hence the study on genetic plasticity in portulaca accessions collected from different location of Karnataka was undertaken. The present experiment was conducted at Kittur Rani Channamma College of Horticulture, Arabhavi, UHS, Bagalkot during the year 2018-19. The experiment was laid out using randomized block design (RBD) with three replications. Observations were recorded on various yield and yield contributing characters. Analysis of variance indicated highly significant differences among the genotypes for all the characters indicating the presence of wide range of variability. The PCV was invariably higher than their corresponding GCV for all the traits. High GCV and PCV values were observed for plant height (21.81% and 22.71%), number of leaves (29.95% and 32.59%), leaf area (30.31% and 33.10%), number of branches (25.20% and 26.37%), foliage yield per plant (43.51% and 44.60%), foliage yield per plot (34.77% and 36.34%), foliage yield per hectare (34.73% and 36.31%) and for biochemical contents including calcium, magnesium, iron, oxalates, nitrates and chlorophyll. It indicated existence of broad genetic base. High heritability coupled with high genetic advance over percent mean was observed for the traits, viz. plant height, number of leaves, leaf area, number of branches, number of inflorescence per plant, secondary branches, plant spread, stem girth, number of nodes, number of flowers, 1000 seed weight, fresh weight of plant, dry weight of plant, foliage yield per plant, foliage yield per plot, foliage yield per hectare, vitamin A, vitamin C, protein, calcium, magnesium, iron, zinc, oxalate, nitrates and chlorophyll contents. This shows predominance of additive component for these characters and hence direct selection would be more effective in improving these traits.



Characterization of Indigenous Mango Cultivars of Coastal Districts in Andhra Pradesh Using RAPD Markers

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A study was conducted at Horticultural research station, Venkataramannagudem (Andhra Pradesh) for evaluating the variability of indigenous mango cultivars to conserve the elite ones and to identify the superior genotypes using molecular markers for future crop improvement. Genetic variation and relationship among 34 traditional mango cultivars were analyzed using Random Amplified Polymorphic DNA (RAPD) markers. Fifteen out of the twenty primers screened were informative and 177 amplified DNA bands with size ranging from 100 - 5000 bp were selected as RAPD markers. The number of amplified fragments varied from 3 (OPG 13) to 20 (OPX 04) with an average of 11.8 polymorphic fragments per primer. Specific RAPD markers for some mango cultivars were identified. Unweighted Pair Group Method using Arithmetic means (UPGMA) cluster analysis grouped all the cultivars into two clusters with a genetic similarity coefficient range of 0.67 to 0.88. The cultivars Panukula Mamidi and Rajamamidi were closely clustered since these two cultivars are native to Vizianagaram district. Similarly, the cultivars Nuzividu Tiyya Mamidi and Nuzividu Rasalu occurred in the same cluster indicating that these cultivars also originated from same geographical area. Hence, it could be concluded that they cultivars were separated into the clusters based on their geographic origins. This study indicated the potential of indigenous mango diversity of coastal areas of Andhra Pradesh for the identification of mango germplasm for breeding purposes

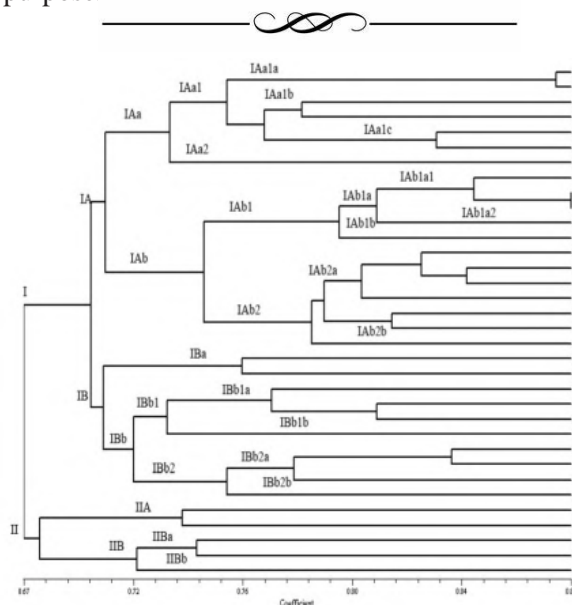


Fig. 1. Dendrogram of mango germplasm based on RAPD markers

- | | | |
|-------------------------|---------------------------|---------------------|
| 1 : Banganapalli- 1 | 13: Jalal | 25: Paparao Goa |
| 2 : Banganapalli- 2 | 14: Jehangir | 26: Peddarasam |
| 3 : Banganapalli- 3 | 15: Kolanka Goa | 27: Panukula Mamidi |
| 4 : Banglora- 1 | 16: Kottapalli Kobbari | 28: Royal special |
| 5 : Banglora- 2 | 17: Kowsuri Pasand | 29: Rajamanu |
| 6 : Baramasi | 18: Nalla Andrews | 30: Sora Mamidi |
| 7 : Cherukurasam | 19: Nalla Rasalu | 31: Suvarnarekha |
| 8 : Chinnarasam | 20: Navaneetham | 32: Tella Gulabi |
| 9 : Chinna Suvarnarekha | 21: Nuzividu Tiyya Mamidi | 33: Tella Rasalu |
| 10: Elamandala | 22: Nuzividu Rasalu | 34: Rajamamidi |
| 11: Hyder | 23: Panchadara Kalasa | |
| 12: Imam Pasand | 24: Pandurivari Mamidi | |

Performance of Ajwain (*Trachyspermum ammi* L.) Genotypes in Different Locations

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Ajwain (*Trachyspermum ammi* L.), also known as the Bishop's weed, is an annual herbaceous plant belonging to the family Apiaceae and produces grayish brown fruits. The major ajwain producing countries are India, Persia, Iran, Egypt, Afghanistan, Pakistan and North Africa. Thirteen ajwain genotypes were evaluated for various plant growth, seed yield attributing traits and essential oil content during 2016-17 to 2018-2019 at six centres of All India Coordinated Research Project on Spices including Hissar, Guntur, Jobner, Jagudan, Faizabad and Ajmer. Significant differences were obtained for all the parameters studied. Plant height ranged from 118.8-121.1 cm, number of primary branches 18.0-18.8, umbels per plant 265.6-298.8, umbellate per umbel 24.0-27.4 and seeds per umbellate 19.0-19.5. On the basis of pooled data for three years, maximum mean seed yield (1652.45 kg/ha) was recorded in genotype AA-73 showing an increase of 88.06 and 57.03% in seed yield over Ajmer Ajwain -2 and Ajmer Ajwain -1 (checks), respectively. Seeds of AA-73 contain 9.15% total oil and 6.38% essential oil, which is higher (39.26% and 17.27%, respectively) as compared to Ajmer Ajwain-2, the national check.



Diversity Analysis of Growth and Fruit Characteristics in Kokum for Crop Improvement

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Garcinia indica, commonly known as ‘kokum’, belonging to the family Clusiaceae, is an underutilized tree spice native to the Western Ghats in India. Owing to its cross pollination behavior and propagation through seedlings, it exhibits huge natural variability. Considering the potential and medicinal properties of this crop, systematic surveys were conducted in major growing areas of Goa, Karnataka and Kerala during 2017-2020 for documentation of its diversity. Different natural populations of kokum were studied and various tree morphological and fruit characters were documented. Wide variations were observed in tree crown shape (pyramidal, conical and drooping), fruit shape (pyriform, oblate, spherical, bell shape with or without pointed tip), leaf and seed characters. Among 89 kokum accessions, higher fruit yield was recorded in Karekhazana-1, Kurcherium-9, Ambulim-P1 and Kasarpal-5 accessions, while thicker rind was recorded in Ambaulim-115. Accession Bhandarwada-3 had better fruit quality parameters than other accessions. This information would be useful in further crop improvement programs for developing varieties targeting different uses of this crop.



Biochemical and Morphological Analysis of Two Minor Fruit Species from Meghalaya

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A study was carried out in the Department of Horticulture, Assam Agricultural University, Jorhat on *Calamus meghalayensis* (Becc.) A.J. Hend and *Haematocarpus validus* (Miers) Bakh.f. ex Forman. Fruits were collected from four different locations of Tura region of West Garo Hills District viz. Tura Bazaar (L₁), Hawakhana (L₂), Araimile (L₃) and Chandmari (L₄). Slight variations were observed in *C. meghalayensis* fruits with maximum fruit weight observed from L₁ (3.4g) and fruit volume (5cc), TSS (18.4°Brix), reducing sugars (11.7%) and non-reducing sugars (24.3%) in L₃. In case of *H. validus*, maximum fruit weight (25g) and volume (15cc) were observed from L₂, while TSS (12.8 °Brix), reducing sugars (16.6%) and non-reducing sugars (29.7%) were the highest in L₁. From the study, it was noted that variability exists for both *Calamus meghalayensis* and *Haematocarpus validus* fruits in their natural habitats. Further, these species have extensive scope for research in near future as they are important native foods that can supply good nutrition and other health benefits to the consumers.



Characterization of fruit quality and genetic diversity among natural populations of *Averrhoa carambola* from North East India

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Carambola (*Averrhoa carambola* L.) is an underutilized, attractive fruit of the family Oxalidaceae. It is a rich source of reducing sugars, ascorbic acid and minerals such as K, Ca, Mg and P. Although wide variability is present in cultivated or wild form, no specific recommended variety is available for this crop. The present study was carried out to characterize fruit biochemical and genetic diversity of 20 natural populations of carambola from different regions of North- East India. Parameters such as total soluble solids (TSS), oxalic acid content, titratable acidity, ascorbic acid content, pH, total sugars and shelf-life were evaluated. The result showed considerable variations among the genotypes, wherein TSS varied between 4.8 and 14.5 °Brix, oxalic acid 0.01% and 0.06%, ascorbic acid 28.00 and 65.00 mg/ 100g, acidity 0.13% and 1.32%, total sugars 4.1% and 12.50% and shelf life 11 and 14 days. For RAPD analysis, 20 primers were used, in which 15 primers generated 92 bands including 64 polymorphic bands with a mean of 4.26 bands per primer and 69.34% polymorphism. The findings illustrated the usefulness of fruit quality characterization for screening of genetic diversity. The information generated would be useful for further crop improvement through selection in this crop.



Morphological Evaluation of Bhringaraj (*Eclipta alba* L.) Accessions

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Bhringaraj (*Eclipta alba* L.), is one of the important traditional medicinal plants traded in India. It is an annual herb belonging to the family Asteraceae and is commonly known as the false daisy. In Ayurveda, *Eclipta* is said to be the best drug for the treatment of liver ailments. The estimated annual trade of bhringaraj is 2000-5000 MT but the plant material is generally collected from the wild. Hence, there is lot of scope for its cultivation due to the increasing demand in the herbal market. Thirty accessions collected from different places were evaluated for their morphological traits. Among these, four collections exhibited erect growth habit, 15 semi-erect and 11 prostrate. Maximum variation was recorded in traits like internodal length, leaf length and width, number of leaves and stem diameter at 90 days after transplanting. The internodal length ranged from 2.51 cm (Accession 8 and 20) to 7.31 cm (Accession 3). Leaf length in morphotypes ranged from 1.60 to 5.65 cm, while leaf width ranged from 0.3 to 1.5 cm. The number of leaves per plant ranged from 75 (Accession 6) to 154 (Accession 13). Stem thickness also varied among the accessions. The maximum girth was recorded in accession 43 (2.65 cm), whereas minimum girth was recorded in IC 370450 (1.50 cm).



Horticultural Characterization of Bird's Eye Chilli (*Capsicum frutescens* L.) Germplasm of West Garo Hills, Meghalaya

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The present investigation was carried out at the Research Farm of Department of Horticulture, NEHU, Tura Campus, Meghalaya during 2019. Ten bird's eye chilli germplasm lines collected from different location of West Garo Hills were evaluated for 14 quantitative horticultural traits. The experiment was laid out in a randomized block design with three replications. Data pertaining to plant height (cm), plant canopy spread at the time of maturity (cm), number of flowers per axil, days to 50% flowering, days to 50% fruiting, number of fruits per plant, fruit length (cm), pedicel length (cm), placenta length (cm), fruit width (cm), fruit weight (g), 1000 seed weight (g), number of seeds per fruit and fruit yield per plant were systematically recorded. Maximum plant height (64.06 cm) and plant canopy (60.60 cm) were recorded in collection T-8, while the highest number of flowers per axil was exhibited by T-9 (3.10). Minimum days to 50% flowering and fruiting were observed in T-6 (48.20) and T-8 (53.9), respectively. Highest number of fruits per plant, placenta length and 1000 seed weight were recorded in T-6 (169.3), T-4 (1.02 cm) and T-5 (3.4 g), respectively. Maximum fruit length (T2.7 cm) and fruit weight (1.74 g) were observed in T-1. The germplasm T-8 recorded the highest pedicel length (1.89 cm), fruit width (0.44 cm), maximum number of seeds per fruit (22.7) and fruit yield per plant (65.1 g).



Genetic Improvement of Faba Bean (*Vicia faba* L.) for Yield and Quality through Biotechnological Approach

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Faba Bean (*Vicia faba* L.) is a temperate annual legume crop in high altitude areas and is grown on a limited extent in the north eastern region of India. Plants are erect, reaching 60-125 cm in height, very leafy with robust stems. The protein content of seeds is high (about 20-25%). It can excel under wide range of soil conditions (pH 4.5 to 9.0). In India, it is still treated as a minor legume. Major faba bean breeding challenges include its mixed breeding system, unknown wild progenitors, and genome size of ~13 GB, which is one of the largest among the diploid field crops. The crop presently benefits from synteny-based genetic maps in conjunction with next generation sequencing and high throughput genotypic advance that pave way to marker assisted selection. Several random amplified polymorphic DNA (RAPD) markers linked to a gene determining hypersensitive resistance to race 1 of the rust (*Uromyces viciae-fabae*) have been reported. Molecular breeding for resistance to broomrape, *Ascochyta* blight, rust, and chocolate spot has been attempted. The use of marker assisted selection (MAS) can complement conventional breeding by speeding up the selection of desirable traits and increasing selection efficiency. Recently, markers linked to a gene controlling growth habit or to select against traits affecting the nutritional value of seeds have also been reported. Developing a reference genome and eventually a pan genome will give a foundational asset for molecular breeding. New techniques such as protoplast fusion, regeneration, and embryo-rescue assisted interspecific crossing could probably be introduced in faba bean breeding to improve yield and quality.



Analysis of Growth Traits and Quercetin Content in *Houttuynia cordata* Thunb. Collected from Different Geographic Regions of Sikkim

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Houttuynia cordata Thunb. is a herbaceous perennial native to the South East Asia. The plant has a wide range of culinary usages, wherein it is cooked as a vegetable or used as salad, *chutney*, herbal tea *etc.* It has high medicinal value and is used in the Chinese traditional system of medicine for treating different disorders and ailments. The herb is found growing wild in Sikkim, a Himalayan state in India. Quercetin is reported to be one of the important constituents found in *Houttuynia* spp. The present study aims at understanding the growth traits and quercetin content in wild collections of *H. cordata*. During the study, plants were collected from different ecological conditions and were grown at five different geographic regions of Sikkim. Growth traits and morphological characters were observed and quercetin content was analysed. While the growth traits like number of leaves and number of secondary branches showed significant differences among different growing regions, no significant variations were observed among the genotypes. The Pearson's correlation coefficient suggested strong correlation between number of leaves, altitude and latitude of growing place. Plant height was positively correlated with number of leaves and geographical latitude, whereas number of branches was significantly correlated with altitude. Though the content of quercetin was neither significantly associated with the morphology or geographic region nor with the growth traits, genotypic differences were observed.



Genetic Improvement of Underutilized Pointed Gourd (*Trichosanthes dioica* Roxb.)

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Pointed Gourd (*Trichosanthes dioica* Roxb.) is a perennial, dioecious, tropical cucurbitaceous vegetable crop. The fruits are easily digestible and diuretic in nature and have anti-ulcerous property. The stem and leaves also contain many bioactive compounds. It also invigorates the heart and brain and lowers the blood sugar and serum triglycerides. The crop gives continuous production for about 7-8 months in a year. Average yield of pointed gourd is very low (7.8 t/ha) in our country. Lack of high yielding varieties is one of the main reasons for this. Improvement of any crop depends on the magnitude of its genetic variability. Knowledge of the available variability within the species and diversity in plant genetic resources for the desired characters enables the breeder in determining the most potential genotype which include both farmer-preferred traits and breeder preferred traits. In the present study, DUS descriptors were used to characterize the pointed gourd genotypes. The experiment was conducted at BCKV, West Bengal under the All India Coordinated Research Project on Vegetable Crops during Rabi season of 2021-22 and Summer of 2022. Fruit quality analysis was also carried out to identify the elite types. The genetic variability parameters are being analyzed for important growth and fruit characters influencing yield, their interrelationships and their direct and indirect effects on fruit yield.



Diversity of Some Underutilized Eggplant Species from Northeast India

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In the Northeastern region of India, different cultivars, wild and indigenous germplasm of various plant species are reported to occur naturally or cultivated by the tribal communities and local farmers of the region. Brinjal (*Solanum melongena*) or eggplant is an important solanaceous vegetable crop in many countries of Asia and Africa. Since time immemorial, the tribal communities of Northeast India are using both the unripe fruits and leaves of different brinjal germplasm as vegetables and in traditional medicines. Various species of *Solanum* are considered to have good source of phenols and flavonoids with high antioxidant activities. In spite of the presence of high level of glycoalkaloids, many wild species of *Solanum* are consumed by various tribal communities in the region. The present study focused on assessing the genetic diversity and taxonomic relationships among different eggplant species grown in Northeast India. The information generated would not only facilitate their utilization in crop improvement programs but also improve the food and nutritional security in the region through the direct use of elite selections.





Theme IV

Invited speakers

Postharvest Management of Underutilized Horticultural Species with Special Emphasis on Kokum (*Garcinia indica*)

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Kokum (*Garcinia indica* Choisy.) is one of the important tree spices remained under- exploited and commercially neglected so far. It is native of the Western Ghats in India. It is mostly found in Konkan region of Maharashtra, Goa, Coastal Karnataka, Kerala, forests of Assam, Khasi- Jaintia hills, West Bengal and Surat district of Gujarat. It is found mainly in the evergreen and semi-evergreen forests. It is also grown as a home garden tree and cultivated at a limited scale as a (rain-fed) crop, usually mixed with other fruit trees. The fruits of Kokum are commercially exploited for making traditional products such as Kokum Syrup (Amrit Kokum), which is used to prepare an excellent sherbet, kokum agal (salted syrup) and amsul (dried rind). Oil is extracted from the seeds, which is edible and remains solid at room temperature. Many therapeutic effects of kokum fruit are well known, which include its usefulness as an infusion in skin ailments such as rashes caused by allergies; treatments of burns, scalds and chaffed skin and to relieve sunstroke. It is also used as a remedy for dysentery and mucous diarrhea apart from use as an appetizer and liver tonic. It is known to allay thirst; function as a cardio-tonic and has been useful for bleeding piles, dysentery, tumours and heart diseases. One of the ingredients of kokum, hydroxycitric acid (HCA), has been patented for use as anhypocholesterolaemic agent. HCA is a potential anti-obesity agent. It suppresses fatty acid synthesis, lipogenesis, food intake and induces weight loss. Garcinol, a poly-isoprenylated benzophenone purified fruit rind, displays antioxidant, anti-cancer and anti-ulcer properties. Apart from HCA and garcinol, kokum contains abundant anthocyanins and other compounds with potential antioxidant properties. Apart from traditional value added products, novel products such as rind powder, sherbet mix, solkadhi mix, wine, honey, beverage dip bags etc. are recently prepared from Kokum. In future, emphasis needs to be given on economic exploitation through organized plantations of elite types, development of value chain management and development of novel value added products.





Theme IV

Oral presentations

An Economic Analysis of Elephant apple (*Dillenia indica*) for the NTFPs Collectors of Tripura

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In recent years, there has been rising interest in the contribution of non-timber forest products (NTFPs) to rural lives, development, and poverty reduction. The livelihoods of people living near forest regions are strongly reliant on NTFPs. The research was carried out in Tripura to study the significance of non-timber forest products in the rural livelihoods of Tripura, elephant apple (*Dillenia indica*) being one of them. The objective was to study the socio-economic status of NTFPs collectors and analyze the economic profitability of Elephant apple. For the study, multistage sampling approach was used to choose a representative sample of 200 households. The results of primary survey were examined using descriptive statistics. The data revealed that tribes in the studied region not only relied upon various NTFPs for family usage and subsistence, but the activity also accounted for a considerable portion of household revenue. These findings also suggested that elephant apple played an important role in sustaining the livelihoods and, as a result, provided a necessary safety net income for households. The findings suggested increased emphasis on technical and financial assistance programmes for conservation, value addition and commercialization of elephant apple in order to improve the quality of life of NTFPs collectors.



Utilisation of Fishtail Palm (*Caryota urens* L.) in Tribal Area of Andhra Pradesh – Present Status and Scope

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Fishtail palm (*Caryota urens*) is a well-known landscaping plant having widespread distribution in peninsular India and Sri Lanka. It is a multipurpose species with a variety of applications. Also known as *Jirika* in Andhra Pradesh and *Giraka* in Telangana, it is a native rainforest species of tropical Asia. Fishtail palm or sago palm is traditionally tapped for its inflorescence sap, which is used in preparation of alcoholic beverages. Tapping the palms is the domain of tribal people in Andhra Pradesh who have been traditionally involved in it. This study focused on documentation of traditional knowledge available with tappers pertaining to management of palm, its uses and tapping activities. The potential economic value of fishtail palm is also assessed. Though the palm yields throughout the year, the best quality sap flows during the dry season. However, the supply of sap increases during high humidity and rainy season. While men climb the palms and tap flowers, women are involved in its processing and sale in neighborhood or road side. The freshly collected sap is sweet, but in the course of a few hours, it begins to ferment and becomes cloudy becoming completely sour in 24 h. Alternatively, when alcoholic beverages are the desired end product, the nectar may be allowed to ferment to the mildly alcoholic “Toddy” or distilled further for production and sale of homemade liquor called *Arrack*. Unfermented sap, however, could be converted to jaggery, nector, jaggery powder *etc.* to diversify the product range and improve the marketing prospects.



Effect of *Garcinia gummi-gutta* on the Quality Improvement of *Pampus chinensis* During Chilled Storage

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The underutilized fruit species Malabar tamarind (*Garcinia gummi-gutta*) is valued as an acidulant in parts of Kerala and Karnataka. Aqueous extract of dried rind of *G. gummi-gutta* was evaluated for its efficacy at two different concentrations during the chilled storage of the fish Roopchanda (*Pampus chinensis*). Hydrogen peroxide (1%) served as the positive control, while untreated sample (C) was the negative control. During the initial days of storage, the untreated sample was observed to have higher peroxide value and volatile base compounds which are the major biochemical spoilage indicators in fish. However, during the course of storage up to 15 d, distinct variations for peroxide value, free fatty acid values and TVBN values were noticed among the treatments studied. Microbial load of all the treated samples including the positive control was lower than the control during the entire storage period. Based on the findings of this preliminary study, it could be concluded that the Malabar tamarind possessed antimicrobial properties thereby maintaining the microbial safety of chilled stored fresh water fish produce 15 days of storage.



Nutrient Profiling of Important Underutilized Fruit Crops of North-East Region

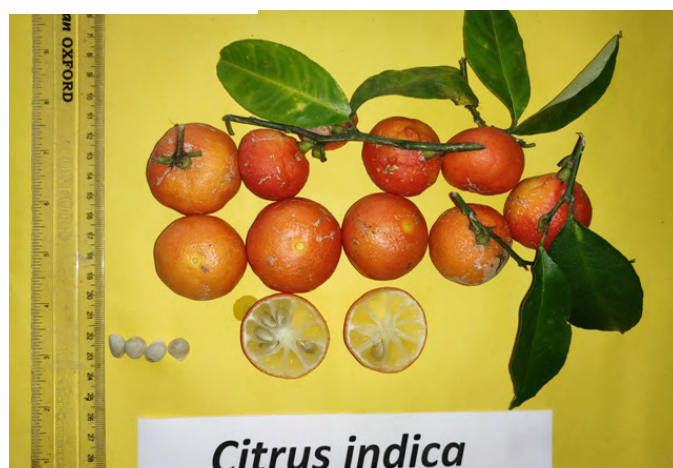
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The present investigation was carried out to determine the nutritional and anti-nutritional composition of forty-four underutilized fruit species found in the North-East India. *Elaeagnus umbellata* was found to be high in TSS content (24.5 ± 0.41 °Brix), free fatty acids (67.8 ± 1.75 mg KOH/g) and vitamin A (4536.0 ± 48.07 IU). *Calamus tenuis* exhibited the highest amount of titratable acidity ($14.4 \pm 1.05\%$). *Terminalia chebula* was a good source of reducing sugars ($8.4 \pm 0.07\%$) and total flavonoids (445.2 ± 1.18 mg/100 g). *Spondias pinnata* was rich in total carbohydrates ($12.5 \pm 0.22\%$) as well as vitamin C (74.2 ± 5.33 mg/100 g) contents. *Castanopsis hystrix* was found to exhibit highest starch (1764.8 ± 8.85 mg/100 g) as well as cellulose content (711.6 ± 7.68 mg/100 g). Total free amino acid (206.7 ± 8.22 mg/100 g) and crude protein ($9.9 \pm 0.29\%$) were found to be maximum in *Viburnum foetidum*. Maximum chlorophyll, carotenoids and anthocyanins were found in *Phoebe cooperiana* (0.57 ± 0.01 mg/g), *Rhus semialata* (19.10 ± 0.29 mg/100 g) and *Prunus nepalensis* (269.01 ± 5.23 mg/100 g), respectively. Highest vitamin B1 (0.22 ± 0.01 mg/100 g) and vitamin E (52.53 ± 0.51 mg/100 g) contents were recorded in *Rubus rosifolius* and *Garcinia lanceifolia*. *Artocarpus lakoocha* exhibited the highest antioxidant activity ($84.58 \pm 2.38\%$) closely followed by *S. pinnata* ($84.09 \pm 0.62\%$). *Machilus edulis* possessed highest fat content ($36.44 \pm 1.23\%$) and energy (372.71 ± 9.92 Kcal/100 g). Anti-nutritional factors were also studied in these species.



Value Addition of Medicinal and Aromatic Plants for Health Security and Entrepreneurial Opportunity

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In India, the use of different medicinal and aromatic plants (MAPs) to cure ailments has been in vogue since ancient times. However, there are some inherent constraints in their cultivation and utilization such as their regional specificity, seasonal availability, post-harvest losses, lack of interest to consume them due to bitterness. Hence, value addition of MAPs needs to be done to improve consumer acceptability and create diverse avenues for livelihood security and entrepreneurial opportunity. Value addition of MAPs could be done at two levels. Low level value addition could be accomplished at rural level by unskilled rural people with little investment and simple, eco-friendly technologies. Examples include primary processing, cutting, drying and packing, grading, powdering, organic production of herbs *etc.* High level value addition requires equipment, technology and considerable investment and includes preparation of herbal extracts, formulations, phytochemicals, consumer products *etc.* Value added products from medicinal plants include certified good quality seeds, plant parts containing specified concentration of active principles or chemicals (leaf, bark, root, seed *etc.*), grading, powders, herbal candies, murabba, pickles, ready to serve juices, herbal teas, herbal juices, sherbets, herbal chocolates, sweets, herbal extracts, extracted phytochemicals, plant drugs, herbal cosmetics/ cosmeceuticals, nutraceuticals, functional foods, herbal pesticides, by product utilization *etc.* Value added products from some aromatic plants are essential/aromatic oils, concrete, which are extensively used in the cosmetics, fragrance, flavour and aromatherapy industries. India, with its natural wealth of MAPs offers excellent scope for establishing enterprises at both rural as well as urban locations for manufacturing and trading their value added products.



Studies on Preparation of Guava Blended Wood Apple Jelly Cubes

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Preparation of value added products is among the most efficient means of improving the availability of the produce during off-season. It also facilitates marketing of the produce in distant markets. Wood apple is one of the popular underutilized fruit species, which has good potential considering its nutritional importance. An experiment was conducted during the year 2021 to standardize the combination of wood apple and guava pulp for preparation of jelly cubes. The experiment was laid out in randomized block design with nine treatments. Pulp blends were prepared using various proportions of wood apple and guava viz. 100:0, 95:5, 90:10, 85:15, 80:20, 75:25, 70:30, 65:35 and 60:40. The blended jelly cubes were evaluated for physicochemical and sensory quality parameters during 90 days of storage. Significant variations were observed in the storability of jelly prepared from different combinations. Treatment T6 (75% wood apple: 25% guava) recorded superiority in attributes viz., total soluble solids, pH, moisture, titratable acidity, ascorbic acid, reducing sugars, total sugars, non-reducing sugars and calcium content, while treatment T2 (95% wood apple: 5% guava) showed minimum values for these parameters. Treatment T6 also performed superior to other treatments and exhibited storage stability of three months under ambient storage conditions. These results would help in value addition of this underutilized fruit, thereby facilitating its popularization.



Postharvest Quality and Shelf Life of Custard Apple var. 'Arka Sahan' After Storage Treatments

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The effect of postharvest application of various concentrations of calcium chloride (2%, 4% 6%), benzyl adenine (50 ppm, 100 ppm, 150 ppm), chitosan (0.5%, 1.0%, 1.5%) and their combinations was studied on the storage life of fruits of custard apple hybrid 'Arka Sahan'. The study was conducted at the Department of Fruit Science, KNK College of Horticulture, Mandsaur. The experiment was designed in completely randomized design with three replications. Various physico-chemical parameters like physiological loss in weight (PLW), specific gravity, spoilage, storage life, acidity, total soluble solids (TSS), ascorbic acid, reducing sugars and non reducing sugars were estimated at an interval of 2 d during storage. Treatment of fruits with calcium chloride (6.0%) + benzyl adenine (150ppm) + chitosan (1.5%) was found to be the best as it resulted in minimum PLW, maximum fruit volume, specific gravity, ascorbic acid, TSS, total sugars, reducing and non reducing sugars with a shelf life of 12 d. These results would help in extending the marketable life of the produce; thereby reduce the postharvest losses in this crop. Further, this could also give advantage to the traders for long distance transportation of the produce, which is generally restricted due to the low shelf life of such perishable fruits.



Utilization of Palmyra Fruit Husk and Cotton Stalk Waste as Media for Marigold

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Palmyra palm (*Borassus flabellifer*) is utilized in every aspect except the husk. However, there lies the possibility of using the fibers of palmyra husk similar to coir obtained from the coconut husk. India being the largest producer of cotton also generates lot of crop waste after harvest. These cotton stalks with reserves of nutrients could be composted and utilized. The present study was carried out to utilize these by-products for cultivation of marigold. In this study, marigold was grown in eight different combinations of potting media namely, T₁ - Control (local soil), T₂ - Soil + Farmyard manure (1:1), T₃ - Soil + Cotton Compost (1:1), T₄ - Soil + Palmyrafruit husk fibers (1:1), T₅ - Soil + Farmyard manure + Cotton Compost (1:1:1), T₆ - Soil + Farmyard manure + Palmyra fruit husk fibers (1:1:1), T₇ - Soil + Cotton Compost + Palmyra fruit husk fibers (1:1:1) and T₈ - Soil + Farmyard manure + Cotton Compost + Palmyra fruit husk fibers (1:1:1:1). Germination percentages as well as various plant growth parameters were studied at fortnightly intervals up to 60 days after transplanting. Highest germination percentage (82.54%), early flowering and maximum number of flowers per plant were recorded in T₈. Individual flower weight was better in T₆ and T₄ when compared to all other treatments. T₁ and T₃ showed delayed vegetative and reproductive growth. The study thus showed that palmyra fruit husk and cotton stalk wastes are potential resources for commercial utilization. These organic wastes that are generated in large scale without being recycled could be cheaper alternatives for costly substrates being used in commercial floriculture.





Theme IV:

Poster Presentations

Promotion of Marketing of Underutilized Horticultural Crops – Challenges and Opportunities for Sustainability

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‘Underutilized crops’ is a broad term for any plant species that has potential for utilization and contribution to food security, nutrition, health, income generation, and agro-ecological or environmental services. It could be through area expansion under cultivation, increased productivity, better marketing or consumption. The importance of underutilized crops in poverty alleviation is widely acknowledged. Promoting underutilized crops not only contributes to the stability and risk management of farming systems, but also aids in the conservation of agrobiodiversity and strengthening of cultural identity and local empowerment of farmers. Many of these species have lot of potential to penetrate domestic, regional, and even international markets. Building stronger ties with the private sector and civil society, particularly in the commercialization of underutilized crops for and by smallholder farmers, integrating the three dimensions of sustainability – People, Planet, and Profit (social, ecological, and economic sustainability) is desired to realize this potential. However, there are only a few successful examples and considerable scope exists for more effective promotion of cultivation and utilization of these underutilized



Preparation of Roselle Wine from Different Fruit Blends

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Roselle (*Hibiscus sabdariffa*), a minor vegetable of India, originated in Africa and belongs to the family Malvaceae. It was introduced in India in 20th Century. It is generally consumed in fresh form and information on processing is scanty, though it is highly nutritive and medicinally valued. The present experiment was conducted with an objective to study the blending effects of roselle with compatible fruit juices to exploit the medicinal benefits of roselle in the wine prepared from these. Roselle juice was blended with papaya juice (1:1) and ginger juice (1:0.5) for preparation of sweet wines. One set was kept for roselle dry wine without blend. The pH and total soluble solids content of must were maintained for all the samples. Samples were, then, inoculated with the yeast-*Saccharomyces cerevisiae* and placed for fermentation. The samples were racked periodically during fermentation. After 30 days of fermentation, wine samples were analysed for different biochemical compositions and organoleptic parameters using established procedures. Among all the wines, papaya blended roselle sweet wine was found to be the most suitable for wine making as it scored maximum points for overall acceptability (16.4) and was categorized as good quality wine followed by sweet roselle wine as medium quality wine. Based on the biochemical parameters also, the wine prepared from roselle-papaya blend recorded the highest contents of total soluble solids, reducing sugars, non-reducing sugars, total sugars and alcohol.



Demographic Variables and Usage of *Diploknema butyracea*

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Underutilized fruits play an important role in human health besides being traditionally associated with cultural heritage and help to improve the economic status of rural communities. North Eastern states of India are home to a number of underutilized and lesser known species, which are commonly utilized by the native population for meeting various requirements. Chuiiri, or butter fruit, is one of the most prominent underutilized fruits (*Diploknema butyracea*) in the Indian Himalayan region. It is a multipurpose species because each part of the plant is used for different purposes ranging from medicine to valuable wood. It has high seed fat content, which is valued for both food and non-food uses especially in the regions of its distribution. A detailed demographic field survey was conducted using semi-structured interviews for documenting the information about this species. Localities were chosen based on the availability and use of fruits by the respondents. Further, processed products from *D. butyracea* like candy and juice were also prepared from its fruits. Sensory evaluations revealed that the prepared products were well received in terms of flavour, aroma, colour, and appearance. Thus, the species holds good potential for its diverse uses in food industry..



Profiling of Phenolics in *Zanthoxylum rhetsa* (Roxb.) DC Fruits: an Underutilized Spice of the Western Ghats

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Indian prickly ash (*Zanthoxylum rhetsa* (Roxb.) DC.), an underutilized spice, is commonly found growing wild in the Western Ghats region of India. It has been reported for having multiple medicinal, food, preservative and other properties. However, commercial exploitation of these properties is rare. The edible fruits are locally used to improve the flavor and shelf life of culinary products in Goa especially in fish curry preparations. Phenolic compounds are known to contribute to the antioxidant properties of a species. As a number of spices are known to have high antioxidant properties, systematic studies in the lesser known spices such as Indian prickly ash are desirable. Present study was conducted to profile and quantify different phenolic compounds from the pericarp of *Z. rhetsa* using LC-MS/MS. Major phenolic compounds observed were Ferulic acid (2,100 µg/g), Caffeic acid (404.60 µg/g), Sinapic acid (247.24 µg/g), p-Coumaric acid (177.56 µg/g), t-Cinnamic acid (119.20 µg/g) and Gentisic acid (104.24 µg/g). Ferulic acid and Caffeic acid contributed 64.27% and 12.38%, respectively to the total of 18 identified phenolic compounds. Pericarp being the major economic part of the species, this study would help in better understanding of its biochemical composition for further utilization at commercial scale.



Sensory Quality of Moringa Leaf Powder as affected by Different Drying Methods and Packaging Material

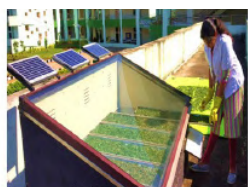
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Drumstick (*Moringa oleifera*) is an underexploited, perennial vegetable species of Moringaceae family, native to the Sub-Himalayan tracts of India, Pakistan, Bangladesh and Afghanistan. This fast growing tree is also known as the moringa, the horseradish tree, the benzolive tree, or the ben oil tree. It is a softwood tree species and it has various medicinal and industrial uses. The present experiment was conducted at the Post Harvest Technology of College of Horticulture, Dr YSR Horticultural University, Andhra Pradesh in a factorial completely randomized design with two factors at unequal levels and replicated thrice. Moringa leaves were dried using different methods viz., sun drying, solar drying, tray drying, vacuum drying and freeze drying. These dried powders were, then, packed in three different types of packaging materials viz., PET bottles, aluminium pouches, LDPE pouches of 200-gauge thickness to assess their suitability in retention of nutrients. The moringa leaf powder obtained from different drying methods was used for preparation of moringa tea, which was evaluated for sensory qualities up to 90 days of storage period. Sensory scores were obtained for colour, aroma, taste, mouthfeel and overall acceptability.



Sun drying



Solar drying



Tray drying



Vacuum drying



Freeze drying



PET Bottles



Aluminium pouches



LDPE 200 gauge polybags

Packaging Materials

Need for Value Addition of Underutilized Fruits for Nutritional Security

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The country's varied agro-climatic conditions provide an ideal environment for growing a wide range of fruits. But the number of commercial fruit crops is very limited in our country and the other species are under limited cultivation at regional level only. Fruit crops such as bael, cape gooseberry, carambola, dragon, durian, rambutan, rose apple, water apple, wax apple, and wood apple are examples of these. These fruit crops are the main sources of livelihood for the poor and play an important role in overcoming the problem of malnutrition. Several such indigenous fruit crops with therapeutic characteristics have been used in indigenous systems of medicine such as Ayurveda, Unani, and Homoeopathy for centuries. Additionally, most of these may be produced without much care even in the wastelands. Though most of these are rich sources of antioxidants and minerals, they are less preferred as fresh fruits in market due to astringency or highly acidic taste. Therefore, value addition of these crops is desired as it could improve the palatability besides improving the nutritional and livelihood security of the stakeholders involved. There is a need to create demand for underutilized fruit crops in both domestic and international markets. This could be accomplished in part by creating appropriate processing and marketing techniques for these underutilized fruits.



Marketing Strategies for Underutilized Horticultural Crops to Improve Livelihood Security and Sustain Agrobiodiversity

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In the marketing sector, processed foods, fruits and vegetables, and beverages are classified as fast-moving consumer goods (FMCG). Major firms involved in the FMCG sector spend substantial amount on marketing, the average being 24% of revenue. Besides, great emphasis is also given on packaging and labeling to attract the customers. However, farmers, that grow underutilized horticultural crops such as jackfruit and kokum, often devote lesser time and resources to value addition and marketing. One of the advantages for farmers in the case of underutilized horticultural crops is that the major FMCG firms are not involved to a larger extent in marketing of these crops. The reasons for the same are localized production, seasonality, demand limited to local areas and lack of availability of the uniform quality of produce in sufficient quantities. This offers an opportunity to undertake low scale processing and value addition as these products already possess unique characteristics and help the product stand out in the market. Besides, farmers can also harness innovative marketing strategies through social media platforms which are relatively cheaper and offer wider reach. Digital payments enabled by unified payments interface are also gaining popularity even in the rural sector and provide opportunities for direct selling to the consumers. Hence, if farmers are incubated for value addition, marketing and branding, there is ample scope for underutilized crops as these products are already distinguished due to their uniqueness. These measures would help to improve the livelihood security of underutilized crops farmers and also help in sustaining agrobiodiversity and preserving cultural identity.



Underexploited Vegetables: Crops for Nutritional and Economic Security

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Minor vegetables are increasingly being recognized as important for food and nutrition security. These species have the potential to reduce rural poverty and diversify the agriculture. These species are good sources of genes for pest and disease resistance. Despite these advantages, researchers, policymakers, and funding agencies have long disregarded these species due to various reasons. As the nutritional security revolution begins, now is the moment to recognize the immense potential of these magnificent vegetables in reducing hunger and malnutrition while also increasing their production and consumption among stakeholders. Crop diversification using these species would address several long pending issues. Underutilized vegetable production will address the lack of per capita consumption availability, thereby resolving nutritional issues. Its cultivation will also help in creating jobs and increasing rural people's income. Focusing investments on indigenous and minor vegetables will improve smallholder farmers' economic prospects as well. This, in turn, will contribute to the national economy.



Development and Standardization of Oyster Mushroom Soup Powder Blended with Locally Available Ingredients

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Oyster mushrooms have been extensively utilized for human consumption for generations and valued for their texture, flavor and medicinal values. The present study was conducted to develop and standardize healthy mushroom based instant soup powder supplemented with locally and readily available ingredients. Tree tomato (*Solanum betaceum*), Burmese coriander (*Eryngium foetidum*), Sichuan pepper (*Zanthoxylum piperitum*), ginger (*Zingiber officinale*), garlic (*Allium sativum*) and tapioca (*Manihot esculenta*) were used for the purpose. Mushroom and all vegetable ingredients were cut into small pieces and dried in cabinet drier at 50 °C and grinded into powder form. To prepare 1 kg of mushroom soup powder, 250 g of dried mushroom, 250 g of tapioca powder, 16.6 g of black pepper, 6.6 g of Sichuan pepper powder, 25 g ginger powder, 25 g of garlic powder, 83.3 g of tree tomato powder, 166.6 g of milk powder, 10 g of Burmese coriander, 100 g of salt and 25 g of sugar were mixed, homogenized, packed and labeled. Organoleptic evaluation using hedonic scale of 0 to 10 indicated average score of 8 which was considered as highly acceptable in terms of flavor, taste and overall acceptability. This convenient healthy soup mix has great potential, as the development of foods from locally and readily available ingredients is increasingly gaining importance. The instant soup mix could be a great source of nutrition in fast food and alternative of animal proteins in food. It can also be a potential candidate for commercial scale production.



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