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UNDER UTILIZED HORTICULTURAL CROPS

GUEST EDITOR

TASSO YATUNG

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EDITOR'S MESSAGE

In the realm of agriculture and food production, certain crops often take the spotlight, while others, equally valuable, remain in the shadows. This issue aims to shed light on those underappreciated gems of the horticultural world. Horticultural diversity is not only essential for food security but also for the preservation of agricultural heritage and the promotion of sustainable farming practices. It stands as a cornerstone of sustainable agriculture, offering a reservoir of genetic resources essential for adaptation to changing environmental conditions, pests, and diseases. While staple crops such as wheat, rice, and maize dominate global agriculture, the cultivation of underutilized horticultural crops holds promise for bolstering resilience and addressing nutritional deficiencies, particularly in marginalized communities. Many crops that we may consider underutilized possess unique nutritional profiles, environmental resilience, and cultural significance that warrant closer attention. In the pursuit of a more sustainable and resilient food system, it is imperative to harness the potential of underutilized horticultural crops, which are invaluable assets in the face of climate change and food insecurity.

Throughout these pages, you'll discover a wealth of information on a variety of lesser-known horticultural crops, ranging from indigenous vegetables to forgotten fruits and from niche herbs to resilient root crops. We delve into their culinary uses, nutritional benefits, agronomic characteristics, and potential for economic development. In exploring these underutilized crops, we celebrate the rich tapestry of biodiversity that our planet offers and recognize the importance of preserving and promoting these treasures for future generations. We hope that the current issue of the magazine serves as a catalyst for greater appreciation, research, and investment in underutilized horticultural crops, ultimately contributing to a more resilient and diverse agricultural landscape.

We extend our gratitude to the researchers, farmers, and enthusiasts who have contributed their knowledge and expertise to this publication. May it inspire new perspectives, spark curiosity, and foster a deeper connection to the wondrous world of horticulture.

Ms. Tasso Yatung
Guest Editor
Assistant Professor, Department of Horticulture, MTTC &VTC, Nakhu Nachibon, Central Agricultural University, District- West Kameng, Arunachal Pradesh, India

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Potential Uses of Indigenous Underutilized Fruit Crops

B. Manjula[1], R. Aruna[2], and P. Jayamma[2]
[1]Assistant Professor, Department of Processing and Food Engineering,
College of Agricultural Engineering, Madakasira,
[2]Assistant Professor, College of Food Science and Technology, Pulivendula,
Acharya N.G. Ranga Agricultural University, Lam, Guntur, 515 301 (A.P.).
*Corresponding Author: b.manjula@angrau.ac.in

Abiotic stresses caused by environmental factors are the most common yield-limiting factors globally, and they cause up to 70% of the yield losses in major fruit crops. In more detail, the individual potential yield losses induced by the different climatic adversities were reported to be the following: high temperature: 40–50%; salinity: 20%; drought: 17%; low temperature: 15%. Arid and semi-arid regions are considered the hotspot for abiotic stresses, such as extreme temperatures, intense solar radiation, salinity, drought and nutrient deficiency, where the commercial fruit crops either fail to grow or struggle to express their potential performance.

Under such climatic conditions, the integration of arid-zone underutilized fruit crops can be a better strategy to sustain the crop productivity under stress due to their typical morphological, physiological, anatomical and biochemical xerophytic characteristics that allow them to perform optimally under harsh climates. Therefore, adaptive traits such as those that increase the overall resilience and resistance to suboptimal environmental conditions do not necessarily result in a yield penalty. It is generally assumed that adaptive traits ensure yield stability in specific conditions, being fitness typically measured in terms of fertility, fruits and seeds.

In order to cope with abiotic stresses, the arid-zone underutilized fruit crops, such as ber (*Zizyphus* spp.), aonla (*Emblica officinalis*), bael (*Aegle marmelos*), jamun (*Syzigium* spp.) and wood apple (*Feronia limonia*), have modified and/or developed their organs to assure vital morpho-physiological functions (i.e., strong deep root system, a high root-to-shoot ratio for reaching into deeper moist soil layers and uptake more water and nutrients). Similarly, crops such asber, bael, lasora (*Cordia mixa*) and pilu (*Salvadora persica*) have round, thick and barked stems for easier water storage and reduced cuticle transpiration.

Indian Jujube (Ziziphus mauritiana L.)

The Indian jujube (ber) belongs to the family *Rhamnaceae,* and it is known as the king of arid-zone fruits or as poor man's apple. The ber tree is fast growing and has a spreading canopy and a short bole; branches are slender, downy, brown bold spines in pairs. The ber tree is extremely drought-hardy due to the deep taproot system and xerophytic characteristics, such as (a) dormancy (leaf shedding) during the peak period of hot summer preventing transpiration, (b) waxy and hairy leaves, (c) thick bark. It grows well even in marginal or poor soils where most other commercial fruit trees either fail to grow or have very poor performance. The jujube seeds contain saponins, jujubogenin and obelin lactone. Jujube wood is utilized as fuel or charcoal making and its leaves are used as fodder for sheep and goats.

The fruit has a spongy, sweet, tasty pulp and is an excellent source of vitamins C, A, B, carotenoids, protein, Ca, P, K, Rb, Br, La and sugars (fructose, glucose and galactose). The smoke of its burning leaves is also utilized to cure cutaneous, cough and cold. Ber fruit is mostly consumed as fresh within 4–5 days after harvest due to the short shelf life. Thus, it is necessary to develop a value-added product at a farmer-field or industry level, and there is the need to work on the diversification and popularization of jujube products. It is the only fruit crop that can give good returns even under rainfed conditions due to its wide adaptability under a large variety of soils, water availability conditions and climates (with the exception of heavy frosts) in arid and semi-arid regions. In addition to nutritional and economic health, some jujube cultivars, such as Dragon, Mushroom, So and Teapot, are known for their landscape values, such as unique fruit shape, fruit color and tree shape, and are planted in gardens and backyards due to their dwarf habit and compact canopy.

Bael [Aegle marmelos L. (Correa)]

Bael is the only species of the genus *Aegle*, which belongs to the family *Rutaceae*; it is one of the oldest indigenous fruits known by various names in different parts of India, such as billi, Bengal quince, stone apple, golden apple and Japanese bitter orange. Bael has a wide distribution in various ranges of edaphic-climatic conditions due to its ability to withstand heat, drought and low-temperature poor-nutrient soil. It is deciduous, medium-sized, slender, gum bearing with a cauliflorous fruiting habit, deep taproot system, bold thorny branches and trifoliate leaves. Its trifoliate leaves resemble a trident, so people offer them to Lord Shiva Lingam to get rid of worry and suffering. Bael can be used as avenue and ornamental trees (golden color ripen fruit); shells of the dried fruit after removing pulp are used as fashioned cups, small containers, ornamental pills, snuff boxes, etc.

The bael fruit is a rich source of riboflavin used to cure beriberi, and unripe fruit is suggested to treat diarrhea and dysentery, whereas the marmelosin in fruit has therapeutic properties being a good remedy for stomach ailments. However, all plant parts of bael contain various compounds with medicinal values, e.g., coumarins, alkaloids, sterols and essential oils, that have analgesic, antipyretic, anti-inflammatory, anti-antifungal, microfilaria, hypoglycemic, anti dyslipidemic, antiproliferative, wound healing, insecticidal and anti-fertility abilities. Bael fruit is consumed only in processed products, such as powder, preserve, nectar, toffee. These products have had high market demand during the COVID-19 pandemic period due to its ayurvedic medicinal values. Their current price in the market is high and for this reason, bael is becoming a remunerative crop for farmers of arid and semi-arid areas.

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Blooms Beyond the Ordinary: Embracing Diversity with Underutilized Flower Crops

Bhavanasi Sai Meghana[1*], Raja Naik. M[2], Vinod Kumar. N[3] and Asma Siddiq[4]
Department of Floriculture and Landscaping, Dr. Y.S.R. Horticultural University, College of Horticulture, Anantharajupeta, Railway Koduru (M), Annamaya (Dist.) – 516 105, Andhra Pradesh
*Corresponding Author: meghanarayana2000@gmail.com

The underutilized crops are those that have not yet had their full potential realized. They are also known as minor, orphan, neglected, underexploited, underdeveloped, lost, promising, alternative, local, traditional and niche crops. All these underutilized crops that were once extensively cultivated are now experiencing decreased usage due to various factors including agronomic, genetic, economic and cultural factors. Traditional knowledge of these species is quite known yet its scientific implementation is somehow limited. They are mostly found in wild habitats and have the potential to generate income through minor crop improvements. With consumer preferences shifting over time, the floriculture industry has been experiencing a rapid change with growing demand for ornamentals. The existence of enormous genetic diversity and varied agro-climatic conditions provide tremendous scope for diversification of novel ornamental crops, which fetch premium prices and possess a huge potential for the future global floriculture industry with their novelty and diversity. There are many promising ornamental plant species that remain unexplored and unexploited as they are cultivated mainly in rural communities and introduction of potential under-exploited crops helps to meet the ever-increasing demand of the global floriculture industry and contribute for increasing the national economy.

Importance of Underutilized Flower crops in the Floriculture Sector

- As local and international markets are saturated with traditional flowers, introduction of new crops helps to satisfy special market demands with their novelty in respect of their colour, form and texture.
- Reduce the risk of shortage of major flowers
- Relatively easy to cultivate with little care and less input requirements

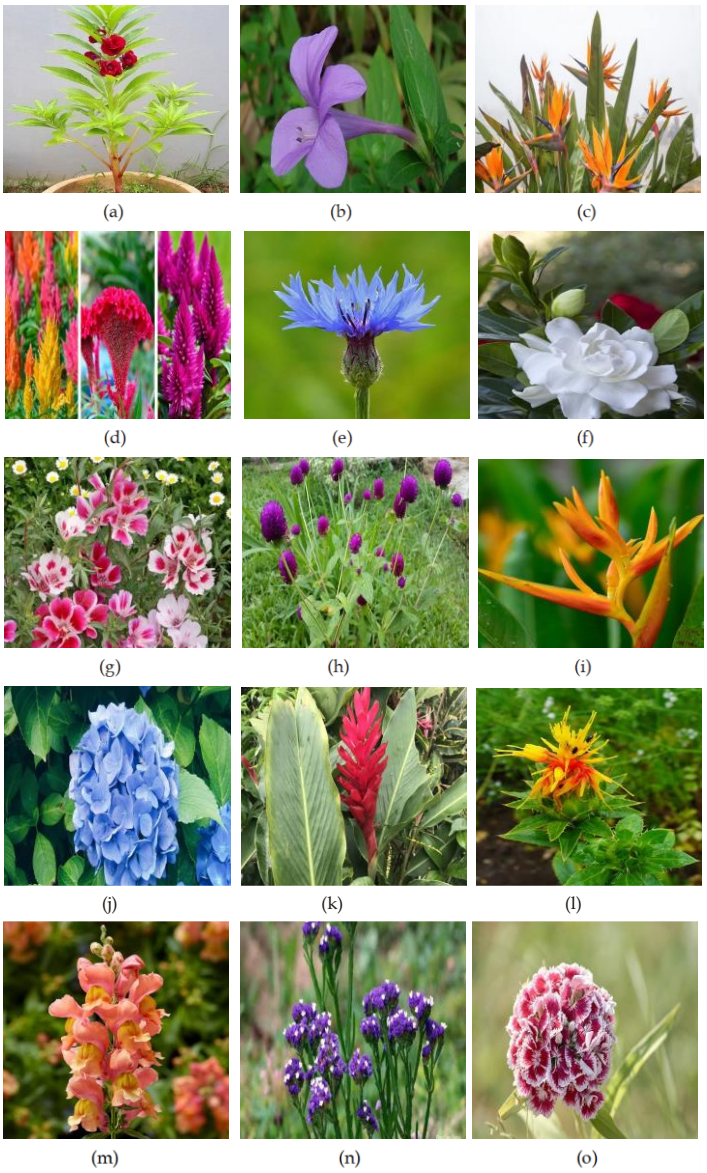

Fig. 1: (a) ***Impatiens balsamina*** **(b)** ***Barleria cristata*** **(c)** ***Strelitzia reginae*** **(d)** ***Celosia argenteta*** **(e)** ***Centaurea cynatus*** **(f)** ***Tabernamontana spp.*** **(g)** ***Pelargonium sp.*** **(h)** ***Gomphrena globose*** **(i)** ***Heliconia psittacorum*** **(j)** ***Hydrangea sp.*** **(k)** ***Alpinia purpurata*** **(l)** ***Carthamus tinctorius*** **(m)** ***Antirrhinum majus*** **(n)** ***Limonium sinuatum*** **(o)** ***Dianthus barbatus***

- Can be grown in India's wastelands and marginal areas to meet the country's growing demand for flowers
- Long-term production is feasible with year-round flower supply

- The conservation of unique flowers in a particular geographical area enriches cultural diversity
- Increases rural residents' income through eco-tourism
- Viable diversification from traditional crops during off-seasons can be achieved with the cultivation of underutilized flower crops
- Reduces over-dependency on a small number of major flowers
- Aid the underprivileged in generating revenue and sustaining themselves

Constraints pertaining to the implementation of underutilized flower crops

- Limited access to germplasm, especially on a national scale
- Insufficient knowledge of cultivation techniques and the post-harvest cold chain
- There is a lack of national policies to encourage underutilized crops research and development
- Interest by researchers, agriculturists, producers and extension workers is lacking.
- Although these crops are crucial to the local inhabitants' subsistence, they are nonetheless understudied and unrecognized by mainstream research and development initiatives

Prospective approaches to enhance the utilization of underutilized flower crops

- Exploration & exploitation of indigenous new ornamentals
- Support for research on new ornamentals is required
- Co-ordinated new crop research policies and initiatives ought to be given attention
- Train and assist farmers, floriculturists and business owners in the post-harvest handling, cultivation and value addition of underutilized flowers
- Events addressing the value and potential of underutilized flower crops on a regional, national and international scale should be held
- Encourage collaborations between local communities, NGOs, government agencies, research institutes and businesses to exchange knowledge and pool resources in order to promote neglected flower crops
- Data on consumer preferences that impact the purchase of flowers to be gathered

Conclusion

Floriculture In many regions of the world, floriculture has grown to be a profitable industry. The conventional, widely used decorative species and variants dominate the current flower market. However, there will always be a market for new goods and those who enjoy flowers will always be looking for something different. Significant opportunities exist for diversification and economic growth of underutilized flower crops. In this scenario, introducing potential underutilized flower crops aids in addressing the growing demand in the worldwide floral trade.

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Table 1: Details of Under-utilized flower crops

S. No	Under utilized flower crop	Scientific name	Family	Description
1.	Balsam	*Impatiens balsamina*	Balsaminaceae	Dwarf shrub good for ornamental hedges in sunny locations and mixed borders. Flowers are used as hair adornments and as offerings at temples. Can be propagated through seeds and cuttings. The flowering season spans from April to September.
2.	Barleria	*Barleria cristata*	Acanthaceae	Lilac, salmon, pink, orange, ruby, scarlet, rose or purple flowers can be single or double. Ideal for potted plants, borders and bedding. Easily propagated from seeds and cuttings.
3.	Bird of Paradise	*Strelitzia reginae*	Strelitziaceae	It's vivid orange and blue blossoms which are like an exotic bird bursting out from the broad leaves are making it more popular as cut flowers. Adaptability to full sun, semi-shade and many flowering seasons annually. Used in the landscape as indoor pot plant, specimen plant, shrub borders and water feature. Propagated through rhizomes.
4.	Cock's Comb	*Celosia argenteta*	Amaranthaceae	Yields tall, feathery spikes and big crested flower heads resembling combs. Beneficial for borders, bedding, potted plants and shrubbery cover plants. As they keep their colour for a long-time dried flower heads make the greatest decorations for tables and vases and are propagated by seeds.
5.	Corn flower	*Centaurea cynatus*	Asteraceae	Cut flowers, border planting, culinary additives containing anthocyanins extracted from petals and the use of dried petals to give colour to beverages are a few of the many uses of corn flower. Propagated by seeds.
6.	Cape Jasmine or Pin wheel flower	*Tabernamontana sp.*	Apocynaceae	Produces clusters of fragrant blooms that can be used for oil extraction or as cut flowers. They are propagated by cuttings and used as a border, hedge or as screening elements in landscaping.

7.	Geranium	*Pelargonium sp.*	Geraniaceae	Herbaceous perennials propagated through stem cuttings are grown as potted plants and excellent for window boxes and hanging baskets.
8.	Globe amaranth or Bachelor's button	*Gomphrena globosa*	Amaranthaceae	Propagated through seed and can be sown during February-March and May-June. Suitable for beds and borders, in rock gardens and very useful for cut flowers and dry flowers as they retain colour naturally
9.	Heliconia or False Bird of Paradise	*Heliconia psittacorum*	Heliconiaceae	Plants produce dark red or yellow-orange pendent inflorescence with spiralled bracts that alternate in a single plane and support the numerous small flowers which are best suited as cut flowers due to their vibrant hues, unique shapes, lengthy straight stems and outstanding qualities after being harvested. Can be grown as speciality cut flowers and are propagated through rhizomes.
10.	Hydrangea	*Hydrangea sp.*	Hydrangeaceae	pH indicator plant propagated through softwood cuttings. In acidic soils, this plant produces blue blooms and in alkaline soils, it produces red flowers. Hydrangeas can be grown in pots, gardens and as cut flowers.
11.	Red Ginger	*Alpinia purpurata*	Zingiberaceae	Long, fragrant inflorescences of vivid reddish-pink bracts that work well in floral arrangements as cut flowers. Suitable for hedging or screening purposes. All year long flowers are accessible and they are propagated by rhizomes, offshoots and seeds.
12.	Safflower	*Carthamus tinctorius*	Asteracae	Produces vivid yellow, orange or red flower heads that are globular in shape. In India, the blossoms are used as less expensive alternative of saffron, whereas in China, the leaves are used medicinally and as a vegetable.
13.	Snapdragon	*Antirrhinum majus*	Plantaginaceae	It yields extremely fragrant spikes of blooms that can be used as cut flowers or a decorative plant for flower gardens and borders. In addition, the flowers generate a green dye and are extracted for oil and are propagated through seeds and cuttings.
14.	Statice	*Limonium sinuatum.*	Plumbaginacae	Propagated by seeds, they have a variety of functions such as filler, dried flower and cut flower.
15.	Sweet William	*Dianthus barbatus*	Caryophyllaceae	Has Grown by seeds or terminal cuttings, they are used in flower beds, border areas, mass plantings, rock gardens etc.

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Underutilized Multipurpose Uses of Manilla Tamarind

Renuka Biradar, Vanishree S., and Aravind Rathod
Agriculture Extension Education Centre, Behind VCB College, Gudadanal road, Lingasugur-584122
*Corresponding Author: renubiradar456@gmail.com

In India there are quite a large number of indigenous and underutilized fruit and vegetable crops, which are used by the local inhabitants. In fact, these fruits and vegetables are the only source of protective food to meet the need of vitamins and minerals of people living in villages. Owing to curative properties, these fruits are used in Ayurvedic and Unani medicines since time immemorial. Apart from their nutritive and medicinal values, a few underutilized fruits and vegetables have excellent flavour and very attractive colour. They play a major role in the diversification of diet leading to more balanced source of micronutrients. Their cultivation is very restricted and they grow mainly as wild. Being tolerant to biotic and abiotic stresses, these crops are suitable for growing in the drought prone areas. Since India has a rich heritage of indigenous fruit types, some of them have already been recommended for commercial planting. These crops are known as underutilized but they are locally abundant and restricted to their geographical location owing to dearth of scientific knowledge. The major underutilized crops are viz., Manilla tamarind, bael, jamun, tamarind, khirni custard apple, karandas, etc

The Manila tamarind an underutilized and unexploited crop of the world, which has value in terms of food, fodder, fuel and green manuring. It also has high antioxidant potential, nutritive and medicinal value. Due to hardy, drought tolerant, it is a potential climate smart crop for agroforestry system in dry lands and it is one of the fast growing, hardy and evergreen, nitrogen fixing tree species which can resist drought and high temperature. In India, it grown in different forms such as wild, near road side, waste land plantations, farmlands, plateaus and in forests.

Manilla tamarind belongs to Fabaceae family and genus Pithecellobium. The word Pithecellobium is derived from geek language “Pithecos” meaning monkey and “ellobium” means earing. Hence it is known as monkey earrings due to resemblance with twisted pod. It has wide adaptability in terms of soil and climatic requirements. The plants can resist nutritionally poor and harsh sites, and can grow in sandy, loamy, clay, acid, neutral, alkaline and saline soils. due to wide adaptability, it grows well dry hot tropical and subtropical climates with maximum temperature tolerance limit of 48 °C and can grows well with annual rainfall of 700-1800 mm and survive in as low as 250 mm. It is a forest species whose full potential has not been utilized in terms fruit, fodder, green manure, production of lac and fuel purpose. Beside these it can also produce good quality honey from its flower due to sufficient amount of nectar.

It has a different name in different language. In English it’s called, Manila Tamarind, Monkey Pod, Madras Thorn, Blackbead Tree, Sweet Inga, Bread and Cheese Tree. In hindi VilayatiImli, Jangal Jalebi, Singri, Vilayati Babul, DakhaniBabul and in kannada SeemeHunase, Ilaichi Kai, D ora Hunase, Ilach-Hunchi Kai.

Table 1: Proximate composition

Sl.no	Nutrients present	Percentage of composition
1	Carbohydrate	18.2- 76.87g
2	Protein	12.47- 23.3 g
3	Fat	0.4-0.5 g
4	Fibre	1.1-1.3 g
5	Ca	13-21 mg
6	Fe	0.5-1.1 mg
7	Calories	78.8 K
8	Vitamins	Vitamin A thiamine, riboflavin, niacin & ascorbic acid
9	Essential amino acids	Valine, lysine, phenylalanine & tryptophan

In Karnataka its distribution is in Bengaluru, Davanagere, Mandya, Mysore. The plants are evergreenand can grow up to 10-15 m, The leaves are greenish, pinnate, the flowers are sessile, fragrant, greenish white in colour, The flower produces fleshy pods, which are constricted between two seeds and form spiral shape. The pods are initially green in colour which on maturity becomes light green to light pinkish. There are two types of Manilla tamarind *i.e.* white aril type and pinkish red aril type. The seed are shiny black in colour with circular and flat shape and usually on an average in one pod 4-5 seeds are present.

It has wide used and nutritional importance. Its pods and seeds are having high nutritive value. The aril contains different nutrients which are mentioned in the table 1. The seed contains 13.5 % moisture, 17.6 % protein, 17.1 % fat, 7.8 % fibre, 2.6 % ash, and 41.4 % starch.

Uses

- **Fodder:** Due to high nutritive value of leaves as it contains crude protein (29 %), ash, (5.6 %) calcium & phosphorus (1.14%, 0.35 %) hence they are used for fodder for goats, sheep's, horse and cattle.
- **Green Manure:** It can also use for green manure crop due to leguminous nature. It adds 4.9 % nitrogen, 0.78 % phosphorus and 2.67 % potassium in the soil.
- **Medicinal uses:** The different plant parts of Manilla tamarind such as leaves, bark, fruit, seed and roots have medicinal as well as traditional uses.

Thus, the increase in climate induced stress in present era had led to serious loss in plant and animal biodiversity. Due to huge yield losses and increased in the population pressure every year, it is impossible to feed to the population in coming era. Now days, due to harsh climatic conditions, the plants are unable to survive and to overcome this, it is become essential to introduce the new crops in our diet which can not only provide food but also give fodder and energy. The introductions of these under-utilized crops are not only having the wider adaptability to harsh climatic conditions but also have ability to fight against the malnutrition problems. Manila tamarind is one of the underutilized potential crop, hence need to be utilized fully in terms of food, fodder, fuel and green manuring.

Table 1: Medicinal uses of Manila Tamarind

Sl. No.	Plant parts	Medicinal use	Traditional use
1	Leaves	It can cure gall ailments and indigestion (leaves + salt) prevent miscarriage, convulsions, reduce inflammations (leaf paste)	Fodder
2	Bark	Used for treating the Astringent, antipyretic, dysentery, chronic diarrhoea, haemostatic, tuberculosis, gum ailments, toothache and haemorrhages.	Tannin extracted from the Bark is used to soften leather
3	Fruit/Aril	For prevention of gum ailments, toothache and boosting the immune system it staves off strokes and as it contains cancer-fighting antioxidants, reduce haemoptysis and haemorrhages	Used in the preparation of jam, beverage and squashes
4	Stem & branches	Combats dysentery	It used as avenue tree and topiary, wood of branches and stem used for furniture implements and also as fuel
5	Seed	For cleaning ulcers and it reduce chest congestion by inhaling the seed juice into the nostrils.	Seeds are edible & eaten in curries in India and the pressed seed is used to form seed cake and used as a seed meal for stock feed. MTSO Manila tamarind seed oil can be extracted and has anti-microbial and anti-inflammatory properties
6	Root	For curing the diarrhoea and dysentery.	-
7	Flowers	-	Excellent quality honey is produced from the high-quality nectar and pollen of flowers

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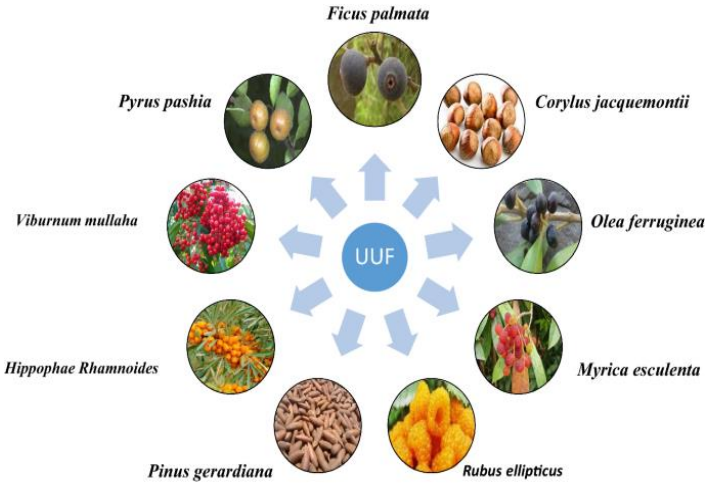
Current Status and Constraints Encountered in The Cultivation of Underutilised Fruit Crops in India

Niyati Thakur, Shilpa, Ajit Sharma and Sandeep
Dr. Yashwant Singh Parmar University of Horticulture and Forestry Nauni Solan HP India 173230
*Corresponding Author: thakniyati18ur@gmail.com

India holds a significant position on the global fruit cultivation map due to its diverse weather and climatic conditions, which favour the growth of various fruit varieties. Despite the abundance of these fruits, there is limited room for lesser-known fruit crops to expand, even though they offer high nutritional value in terms of nutrients, vitamins, and minerals. These less recognized crops, also known as underutilized crops, play a crucial role in providing livelihoods for economically disadvantaged individuals. Underutilized crops are plant species that receive minimal attention in marketing and research but exhibit strong adaptation to marginal and stressful conditions. Underutilized fruits can be described as those that are less accessible, utilized to a lesser extent, or rarely consumed, particularly in specific regions. In semi-arid areas, we encounter the oldest fruit tree crops, which have broad distribution and demonstrate adaptability to a wide range of soil and climatic conditions across India. In emerging economies and low-to-middle-income countries, it is vital to pay attention to every plant and its different parts to promote a varied and nutritious diet and address deficiencies in micronutrients, known as "Hidden hunger". Without acknowledging the value of each product, they remain underutilized. Many overlooked and underutilized species are rich in nutrients and well-suited to low-input agriculture. The decline of these species can have immediate impacts on the nutritional status and food security of impoverished communities.

Underutilised fruit crops in India:

Underutilised plant species are those which have characteristics beneficial to human activities but are not extensively cultivated or researched. These crops typically have specific traits that make them suitable for certain regions or environments rather than being widely distributed. Unlike mainstream crops that are grown on a large scale, underutilized crops are often cultivated in smaller quantities.



Source: https://link.springer.com/article/10.1007/s10722-022-01476-6

Despite their potential advantages, underutilized crops tend to receive less attention from researchers, farmers, and government officials. However, they often possess remarkable nutritional, therapeutic, and medicinal properties. For example, some underutilized crops may contain high levels of essential nutrients or exhibit medicinal properties that can be beneficial for human health. Integrating underutilized crops into agricultural practices offers several potential benefits. Firstly, it can contribute to increasing agricultural production by diversifying the range of crops grown. This diversification helps reduce dependence on a limited number of staple crops and enhances resilience against pests, diseases, and environmental changes. Additionally, cultivating underutilized crops can promote sustainable farming practices by utilizing resources more efficiently and preserving biodiversity.

Moreover, incorporating underutilized crops into agricultural systems can have positive social and economic impacts. It can provide alternative sources of income for farmers, particularly in regions where mainstream crop cultivation may be less viable. Furthermore, by promoting the consumption of diverse and nutritious foods, it can contribute to improving public health and nutrition outcomes. Recognizing the value of underutilized crops and integrating them into agricultural systems can have

wide-ranging benefits, including enhancing food security, promoting biodiversity, supporting sustainable farming practices, and improving human health and livelihoods. Therefore, efforts to research, conserve, and promote the cultivation of underutilized crops are essential for realizing their full potential in addressing global food and nutrition challenges. Main underutilised crops in India are: Aonla/Amalaki/Amla (*Emblica officinalis*), Ber/Indian Jujube (*Zyziphus mauritiana*), Fig (*Ficus carica*), Karonda (*Carissa carandas*), Dragon fruit, Star fruit, Blueberry, wild fruits etc.

Importance and limitations of underutilised crops

Underutilized crops possess distinct characteristics that make them deeply ingrained in local cultures, often forming an essential part of traditional culinary practices. Their adaptability to diverse climatic conditions and resilience against various stressors, both biological and environmental, underline their significance. Typically, these crops require minimal inputs and management efforts, yet they offer a wealth of essential nutrients and medicinal properties, flourishing even in marginal or neglected lands with little intervention. Furthermore, they play a vital role in post-harvest applications, contributing to the creation of diverse food products like pickles, jams, and jellies, thus adding value to agricultural outputs.

Moreover, the potential of underutilized crops extends beyond their immediate nutritional and cultural value. They hold promise in addressing broader challenges such as food and nutrition security, mitigating risks associated with market disruptions and climate variability, and promoting sustainable ecosystem functions. By diversifying agricultural production and utilizing marginal lands effectively, these crops offer avenues for enhancing resilience in food systems.

However, despite their inherent advantages, underutilized crops face a range of barriers to widespread adoption and utilization. These challenges include limited knowledge about their production and nutritional qualities, inadequate awareness of their economic potential, and insufficient infrastructure for processing and marketing. Additionally, the absence of supportive policies and investment further hampers their development and utilization.

Addressing these barriers requires concerted efforts from various stakeholders, including researchers, policymakers, farmers, and extension workers. Investments in research and development, as well as targeted interventions to improve awareness and infrastructure, are crucial steps towards unlocking the full potential of underutilized crops. By overcoming these challenges, underutilized crops can emerge as valuable assets in fostering resilient and sustainable food systems, contributing to broader efforts in achieving food security and promoting agricultural sustainability.

Current status of underutilised fruit crops in India

Over the past thirty years, there has been a notable surge in research endeavours dedicated to underutilized crops. While many of these research projects have been driven by the interests of individual researchers, significant programs have also emerged with the specific goal of promoting underutilized species within agricultural systems. These initiatives seek to highlight these crops as viable alternatives or potential sources of novel products, and they have been implemented in both developing and developed countries alike. This indicates a global recognition of the importance of diversifying agricultural practices to enhance food security.

Moreover, there is a growing acknowledgment of the necessity to consistently advocate for the cultivation and utilization of underutilized crops as a means to bolster food security worldwide. This recognition stems from an understanding of the potential benefits these crops offer, including their resilience in diverse environmental conditions, their nutritional value, and their potential to provide alternative sources of income for farmers. A seminal report authored by Williams and Haq in 2002 provided a comprehensive overview of ongoing research efforts and proposed initiatives aimed at fostering collaboration on underutilized crops. This report not only underscored the breadth and depth of research interests surrounding these crops but also emphasized the importance of enhanced cooperation

to unlock their full potential. By facilitating collaboration, sharing knowledge and resources, and promoting best practices, such initiatives have the capacity to significantly advance the utilization of underutilized crops in addressing global food security challenges.

Conclusion

Underutilized crops, previously extensively cultivated, are now witnessing a gradual decline in both cultivation area and production. This diminishing trend poses risks to various aspects including agronomic, genetic, economic, and cultural factors. These crops garner lesser attention from both farmers and consumers compared to more prominent crop species grown in the same agricultural setting. The overall reduction in the cultivation of underutilized crops may result in a depletion of genetic diversity, constraining the potential for utilizing distinct traits in crop enhancement and adaptation. Introducing novel fruit sources could integrate these underutilized and disregarded plants into mainstream consumption patterns.

To tackle these challenges, immediate development of technologies is imperative to mitigate losses during post-harvest handling and to facilitate specific processing purposes, product development, and storage of fresh and processed items. This paper aims to offer comprehensive insights into the background, policies, international initiatives, current research, constraints for sustainable production, research methodologies, and potential strategies and action plans for the strategic advancement of underutilized crops. It is anticipated that these insights will steer efforts towards sustainable food and nutrition security and poverty alleviation.

In summary, recognizing the significance and potential of underutilized crops in India can significantly contribute to agricultural and rural development while reducing food and nutrition inadequacies. By leveraging the unique attributes of these crops and implementing strategic approaches, the challenges associated with underutilized crops can be effectively tackled, laying the groundwork for a more sustainable and resilient agricultural sector.

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Litchi: A Sub-Tropical Fruit Crop for Lower Pulney Hills of Tamil Nadu

C. Ravindran and R. Balakumbahan
Associate Professor and Head, Horticultural Research Station, Kodaikanal, Dindigul, Tamil Nadu, India
Associate Professor and Head, Horticultural Research Station, Thadiyankudisai, Dindigul District, Tamil Nadu, India
*Corresponding Author:

The Litchi (*Litchi chinensis Sonn*) an important sub-tropical evergreen fruit crop belonging to family *Sapindaceae*, is believed to have originated in China, where it has been grown in Southern Guangdong State for thousands of years. It is highly specific to climatic requirements and probably due to this reason its cultivation is restricted to few countries in the world. In India, Litchi was introduced in the 18th century through Burma, and from there, it spread to many countries. India and China account for 91 per cent of the world Litchi production but it is mainly marketed locally.

Climate and Soil

Since, flower bud differentiation, flowering, fruit set, fruit quality and flavour development in Litchi is influenced significantly by temperature and humidity, it has adapted well in the sub-tropics where summer months are hot and wet and winter months are dry and cool. Hot summers free from hot wind and winters free from frost are essential.

Litchi cultivation is highly successful in areas having minimum temperature of 10°C from December to February and 38°C from April to June. However, temperature of 32° C during these months is considered to be optimum. In Litchi growing areas in India the temperature varies from 21° C to 37.8°C during flowering and fruiting.In India, Litchi is grown successfully on a wide range of soil types, which include sandy loams, laterite, alluvial sand, and calcareous soil, but the best Litchi orchards are seen in alluvial sandy loam soils with good drainage and access to the water table. The performance of orchards is very poor on clay soil with poor drainage. The pH of soils ranges from 6.0 to 7.5.

Production of planting material

Litchi is generally multiplied by vegetative methods of propagation as plants raised through sexual method (by seed) grow slowly, have a long juvenile period and do not produce fruit true to the type. The most commonly practiced method of vegetative propagation is air-layering.

Table 1: Varietal Distributions of Litchi in Different States in India

States	Varieties
Bihar	Deshi, Purbi, China, Kasba, Bedana, Early Bedana, Late Bedana, Dehra Rose, Shahi, Manragi, Maclean, Longia, Kaselia and Swarna Rupa
Uttar Pradesh	Early Large Red, Early Bedana, Late Large Red, Rose Scented, Late Bedana, Calcuttia, Extra Early, Gulabi, Pickling, Khatti, Dehra Dun, Piyazi
West Bengal	Bombai, Ellaichi Early, China, Deshi, Purbi and Kasba
Haryana / Punjab	Early Seedless, Late Seedless, Seedless-1, Seedless-2

Air-layering

Air-layering, known as 'marcottage' in China and 'goottee' in India, is commercially practiced for large scale multiplication. For preparation of the air-layer a healthy terminal branch receiving good sunshine with a thickness of about 1.2-1.5 cm is selected and a 2.5 cm ring is made by removal of bark about 45-50 cm below the apical growth. The cambium layer is rubbed off and the woody portion is exposed. Rooting hormone (1000 ppm IBA) is used as paste or powder. A layer of moist sphagnum moss or coir pith is placed and wrapped with a piece (20 x 25 cm) of 400 gauge polythene sheet and tied properly at both ends to ensure supply of proper moisture which facilitates the development of roots. After about 50-60 days, the adequate root system develops from the upper end of the ring, which is visible through the polythene film. The layer is removed by making a sharp cut about 5 cm below the lower end of the ring, preferably in 2-3 stages. The detached layers are planted in partial shade. June is considered to be best time for air-

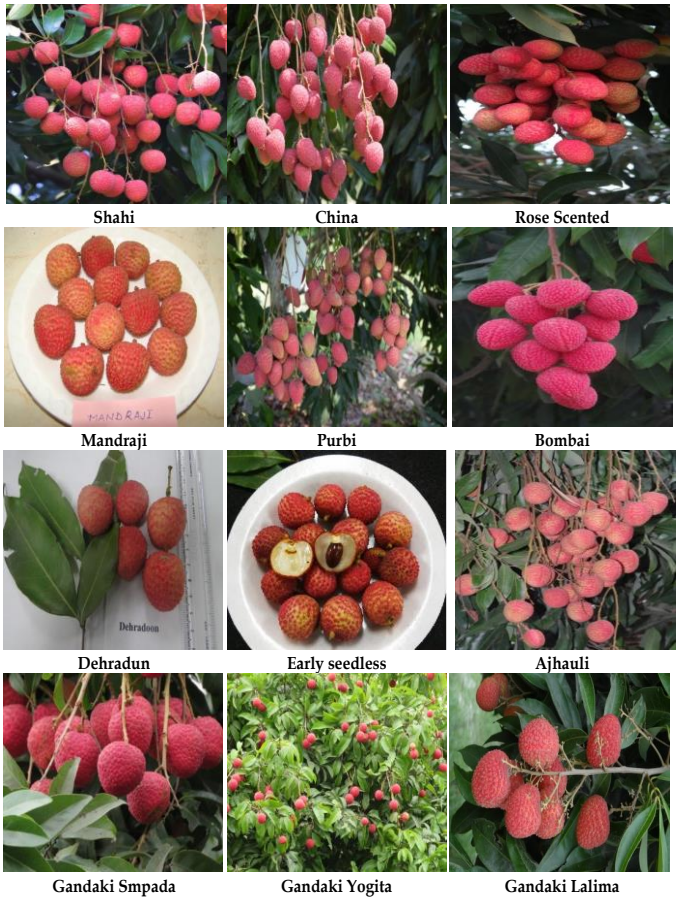
layering. In order to enhance the success of the detached layer, defoliation of leaves up to 50 percent is advocated.

Establishment of orchards

Orchard establishment is a highly specialized activity, which requires proper planning, selection of site, land preparation, layout, planting of saplings, as well as orchard protection and management.

Cultivars

Commercial Cultivars



Planting

Pits 90 x 90 x 90 cm in dimension are dug at the spacing decided for the orchard. Pit opening is normally recommended in April-May to have a sterilization effect for about 3 days. Before the onset of monsoon pits are filled with topsoil mixed with about 40 kg decomposed compost, 2 kg neem/karanj cake, 1 kg bone meal/single super phosphate and 200-300 g muriate of potash. Incorporation of about 2 baskets of soil from the root zone of old Litchi trees encourages the mycorrhiza growth. Planting is done during June to July. At the time of planting a hole the size of ball of earth is made in the centre of the pit at the marked point where the plant is fixed and the soil is pressed to remove air. Watering is done immediately after planting for proper establishment. Subsequently the plant is regularly irrigated till it is properly established.

Spacing and planting system

Square system at a distance of 9-10 m within and between the rows has been practiced. However, planting of Litchi in a double hedgerow system at a distance of 4.5 x 4.5 x 9 m accommodating 329 plants/ha has been found to be the best and gave higher yield of equally good quality fruits up to 16 years of plantation.

Training and pruning

Training of the plant in the initial stage is essential to provide the required framework. Three to four branches 60-75 cm from ground opposite to each other are allowed to form the proper frame of the tree. Non-fruiting unproductive branches inside the canopy in growing and mature trees should also be pruned. Dried, diseased and scissors-shaped branches should also be periodically removed. Light pruning after harvest has been found congenial for better growth, fruiting and yield. While harvesting the fruit the panicle is plucked along with 8-10 cm of twig to promote new flush and better bearing for the succeeding year.

Manure and fertilizer

Among the several factors associated with production of Litchi, balanced nutrition is considered to be the most important which determines productivity and quality. FYM: 60 kg. Application of FYM: 60 kg, 600-800 g N, 200-300 g P_2O_5 and 400-600 g K_2O per plant is recommended for 12–15-year-old trees. Nitrogen and Potassium should be applied in 2-3 splits and P_2O_5 in two splits. Excessive application of nitrogenous fertilizer before flowering should be avoided. Phosphorus application at the time of flower bud differentiation improves flowering and fruiting. In acidic soil application of 10-15 kg lime/tree once in 3 years has been found to increase the yield.

Irrigation, mulching and water conservation

Water requirement ranges from 600-800 mm. Litchi being an evergreen plant, the maintenance of optimum soil moisture is critical for growth, development and fruit production The young plants should be irrigated during dry periods and winter months at intervals of 3-5 days.

Physiological Disorder- Fruit Cracking

The splitting or cracking of fruits is quite common in almost all the Litchi growing areas of India, particularly under dry conditions. Excessive soil moisture aided by fluctuations in temperature and humidity may aggravate fruit splitting. Not much world has so far been done on this problem. However, the following measures are generally considered appropriate to minimize fruit splitting.

1. Regular irrigation in orchards helps in maintaining growth and expression in fruit.
2. In the absence of rain during summer, water spray proves useful in keeping the ambient atmosphere of the fruit unit, as moisture has a good local effect on the fruit against splitting.
3. The Litchi plants should be trained to keep them low headed. Such trained plants with dense foliage, withstand more heat and desiccating winds as compared to tall trees and thus fruit splitting is the list in their case.
4. Varieties which are less prune to splitting should be planted. Early varieties like Dehradun and Saharanpur split more than the mid-season of late varieties.
5. The plants can be guarded immensely against high temperature by sowing Jantar or Arhar along the tree rows or in the periphery of the plant basine. These helps to minimized splitting of fruits, beside protecting fruit trees from vagaries of hot weather.
6. NAA and 2,4,5-T (35-100ppm) are effective in checking fruit splitting and increasing fruit size.

Harvesting of fruits and yields

Maturity standard

Litchi being a non-climacteric fruit requires to be harvested after attaining full maturity on the tree. Studies have been conducted to determine the maturity standard for different cultivars under different agro-climatic conditions. The colour of fruit is an important criterion to decide the harvesting stage.

Harvesting

The fruits are harvested in bunches along with a portion of the branch and a few leaves. At the time of harvesting care is taken to harvest the selected bunch, which has attained the desirable maturity as determined by colour development and taste of the pulp. For distant market fruits are harvested when TSS attains 19° Brix and acidity 0.3 to 0.4 percent. The harvesting period is generally May-June, depending upon cultivar and location. However, in the hills of southern India Litchi is harvested in November-December.

Yield

The yield of Litchi varies according to the age of the tree, agro-climatic condition and maintenance of the orchard. Usually about 80-150 kg fruit/tree is obtained from 14–16-year-old trees. However, from a fully grown tree a yield of 160-200 kg/tree has also been recorded.

Table 2: Cultivars and their characteristic features

Cultivars	Cracking (%)	Estimated Fruit Yield (Kg/ plant)	Length (cm)	Shape Index	Fruit Weight (g)	Pulp (%)	TSS 00 Brix	Acidity (Citric Acid-100g)	Total Sugar (g/100g)
Ajhauli	27.58	72.42	3.48	1.15	15.29	63.13	20.22	0.3	12.53
Bedana	0.24	32.75	3.32	0.94	16.33	70.68	19.33	0.28	10.2
China	0.33	95.33	3.4	1.1	14.77	58.46	20.22	0.29	10.95
Dehra Dun	14.27	67	2.82	1.17	16.77	71.74	20.75	0.41	11.87
Dehra Rose	10.01	74.87	3.34	1.13	19.63	74.12	21.27	0.37	12.19
Deshi	13.63	83.03	3.5	1.18	15.94	66.65	22.82	0.37	13.48
Green	24.44	84.72	3.57	1.27	16.7	61.35	21.42	0.33	11.55
Kasba	0	37	3.78	1.12	25.93	72.23	20.23	0.4	11.24
Late Bedana	0	54.22	3.36	1.06	16.7	75.08	18.17	0.27	10.38
Longia	0	63.85	3.17	1.16	13.84	67.51	19.27	0.28	11.5
Purbi	0.95	80.65	3.31	1.07	20	71.73	20.1	0.29	11.04
Rose Scented	8.85	88.05	3.63	1.16	19.39	69.05	20.37	0.37	12.98
Shahi	12.25	100.3	3.4	1.21	19.47	74.78	22.3	0.38	12.97
Trikolia	12.03	42.37	3.37	1.14	17.35	70.83	22.43	0.36	12.7

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Potential of Winged Bean as Feed for Sustainable Livestock and Poultry Farming in North Eastern Region of India

Meena Das[1]*, Simardeep Kaur[1], Rakesh Kumar[2] and Jayanta Kumar Chamuah[3]
[1]ICAR Research Complex for NEH Region, Umiam, Meghalaya - 793103
[2]ICAR Research Complex for Eastern Region, Patna, Bihar - 800014
[3]ICAR-NRC on Mithun, Medziphema, Nagaland - 797106
*Corresponding Author: meenad3@gmail.com

The Northeast (NE) India is the eastern most region of India, comprising of Seven sister states (Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Tripura) and the Himalayan state, Sikkim. Physiographically the region is categorized into the Eastern Himalayas, Northeast hills (Patkai-Naga hills and Lushai hills) and the Brahmaputra and the Barak valley plains. The region

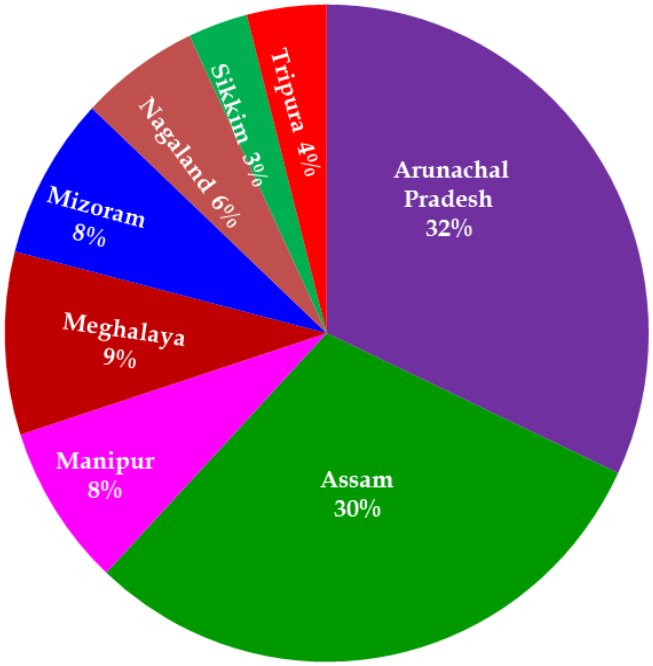

Fig. 1 Geographic area of North Eastern states (%)

lies within the latitude of 21°50′ to 29°34′ N and longitude 85°34′ to 97°50′ E with a geographical area of 2,62,179 km². It constitutes about 8% of India's size and its population is approximately 3.1% of the total Indian population (Census, 2011). About 90% of its entire border area is shared with China (southern Tibet) in north, Myanmar in the east, Bangladesh in the southwest and Bhutan to the northwest. The region has a predominantly humid sub-tropical climate with hot, humid summer, intense monsoon and mild to cold winter. The temperature of the region varies from 15°C to 36°C in summer and zero to 26°C in winter season. The region is endowed with all types of climatic conditions ranging from tropical to alpine and it receives rainfall ranging from 150-250 cm. However, most of the crops grown as a rainfed crop and irrigated area contributes < 20% of the net cultivated area. The southwest monsoon is responsible for bringing 90% of the annual rainfall to the region. April to late October are the months where most of the rainfall in Northeast India occurs with June and July being the rainiest months (https://en.wikipedia.org/wiki/Northeast-India). The region is also considered as a 'biodiversity hotspot' because of its high endemism in higher plants, vertebrates and avian diversity.

There is a decrease in livestock population in 2019 registering a decline of 10.19% in the total number of animals of various species in NER as compared to 2012 while in all India; a positive growth of 4.64 % is recorded during the same period (Table 2). On the other hand, there is an increase in poultry population in 2019 registering a positive growth of 62.57 % in the total number of birds of various species as compared to 2012, which is five times more than the national growth rate during the same period.

Demand-supply of milk, meat and eggs by 2030

The projection study on production and requirement of milk, meat and eggs in NER has been carried out to estimate the demand-supply gap of livestock products by 2030 (Table 3). The growth of livestock rate is based on the Livestock Census 2012 and 2019 (BAHS, 2019). Requirement of milk, meat and eggs is estimated by multiplying the recommended amount of per capita consumption with the population of 2018 and the projected population of 2030 in NER. The population of the region is estimated to be 57415800 by 2030 from 49758267 during 2018. The demand for livestock products is estimated to feed the growing population by 2030. The data shows that the demand is more than supply in all the three animal proteins by 2030. The projected milk, meat and egg production reveals that the region would have a deficit of 696.68 thousand MT, 259.44 thousand MT and

85200.90 lakh numbers by 2030 from 1033.71, 299.33 and 78207.94, respectively during 2018. However, the deficit percentage of milk, meat and eggs would be reduced from 41.54%, 54.94% and 87.31% during 2018 to 24.26%, 41.26% and 82.44% respectively by 2030 with the present livestock and poultry production system in the region. Therefore, to make this region self-sufficient in milk, meat and eggs a comprehensive approach should be under taken to accelerate the production and productivity of livestock and poultry birds in NER.

Agriculture is the major source of employment and livelihood for around 70% of the population in this region (Feroze *et al*., 2010). Animal husbandry is an important subsector of agriculture and it plays an important role in Indian economy. It is a major source of income for the landless and marginal farmers which directly influence their socio-economic status. They not only contribute to their income but also their best insurance against any natural calamity. The people of this region are confined to their traditional food habits with meat as an integral part and the meat consumption pattern and expenditure in this region are 2-3 folds higher when compared to the National level (Mahajan *et al*., 2015; Kadirvel *et al*., 2018). But the gap between the demand and supply of meat in the North East region is very high which may be due to traditional farming with indigenous breeds having low production potential. However, one important factor that affects the production and quality of the meat is feed. The high cost and, sometimes, the lack of availability of commercial protein supplements is one of the main limitations to efficient animal production by small holders. According to Longe (2006) and Bamgbose *et al.* (2011), the high cost of conventional feedstuffs has brought about the need to have alternative feedstuffs that can replace the expensive ones in order to reduce the cost of livestock production. Moreover, locally grown forages and grain legumes offer ecological benefits such as nitrogen fixation, soil improvement, and erosion control which contribute to improve cropping efficiency. Non-conventional feedstuffs offer the best alternatives in our environment for reducing feed cost and therefore a reduction in the cost of meat and animal products (Dafwang *et al*., 2001). The search for alternative sources of protein from legume crops in lieu of expensive ones has been advocated (Adebowale and Lawal, 2004; Ibe and Makinde, 2014).

Potential of winged bean as feed for livestock and poultry

Winged bean (*Psophocarpus tetragonolobus*) is an underutilized potential crop belonging to the family Fabaceae. Winged bean is popularly known as "One Species Supermarket" for its nutrient-dense green pods, immature seeds, tubers, leaves and mature seeds. It is known by many names such as Manila bean, Goa bean, princess pea, four-angled bean, asparagus pea, and Bepuithlanei or Bepuipawr in Mizo. It is believed to have originated from South-eastern Asia or Papua New Guinea (Bassal *et al*., 2020). It thrives well in the hot and humid climates and is distributed widely in the Southern and North-eastern regions of India. Winged bean is nutrient-rich, and all parts of the plant are edible. Leaves can be eaten like spinach, flowers can be used in salads, tubers can be eaten raw or cooked, seeds can be used in similar ways as the soybean (Khan, 1982). It is grown in pits and needs organic manure and fertilizers like other beans. To trail the branches it needs a Bower or trellis. It grows vigorously and flowering starts within three months. A robust, climbing herbaceous perennial plant, it can attain 5 metres in height. The flowers are of different colour; it may be blue, white or purple. Flowers have a sweet taste because of the nectar they contain. The pods are four sided with characteristic wings, and vary in length from 6- 36 cm (upto 50 cm) containing 5-20 seeds in each pod (Sahoo et al. 2002). The globular shaped shining seeds may be white, yellow, brown, black or mottled and vary in weight from 0.06-0.5g each. All parts of the plant, i.e., seeds, flowers, leaves, pods and tuber-like-roots are edible. The young tender pods can be stewed, boiled, fried, roasted or made into milk. The seeds contain 40% proteins and the roots contain about 20% proteins, which are supposed to be 10 times more than in potatoes or yams. Winged beans are also rich in carbohydrates and vitamin A (300 to 900 IU). Its tender leaves make good sauce and curry.

According to Ningombam *et al.* (2012), winged bean is a lesser known nutritious leguminous plant grown luxuriantly in Manipur. Highest crude fat (1.7%) was present in mature seed and crude protein (50.7%) was present in fully mature seed. The maximum amounts of total sugar (488.90 mg g-1), non-reducing sugar (415.95 mg g-1) and starch (420.60 mg g-1) were recorded in tuber. The plant was also found to have significant quantity of minerals. As regard to the mineral content, mature pod case showed the maximum amount of K (8.9 mg/g), Ca (8.06 mg/g) and Mg (5.72 mg/g). The tuberlike-roots are eaten after boiling or frying. The plant is a good fodder for cattle (Rai *et al*., 2005).

In Mizoram, winged bean is grown sporadically in jhum lands as the sole crop and mixed farming. It is generally consumed as a raw vegetable, soup, curry, chutney, and salad. This crop is abundant in natural antioxidants (Maimako *et al*., 2022), polyphenols and flavonoids (Kim *et al*., 2003; Bassal *et al*., 2020). The seeds have shown promising blood-pressure owering properties (Chay *et al*., 2018) and tuberous roots are highly protein-rich (Kortt and Caldwell, 1984) and hence can be used as a substitute for protein supplements (Soni *et al*., 2022). Additionally, substantial nodulation plays an important role for increasing soil fertility (Lepcha *et al*., 2017). Few reports are available on use of winged bean as feed for livestock and poultry. Nurpaidah *et al.* (2021) observed that there was effect of protease in diets containing winged bean seeds (*Psophocarpus tetragonolobus*) on performance of broiler chickens. The additive protease interaction with concentrations of 2.5% and 5% and level of winged bean seeds on the diet had a significant effect on the feed conversion ratio value ($P<0.05$). De Lumen *et al.* (1982) also studied the effects of replacing soybean meal with different varieties of winged bean meal on broiler performance. Similarly, Suntara *et al.* (2023) reported that the effects of the replacement of cassava chips with winged bean (*Psophocarpus tetragonolobus*) tubers (WBTs) on gas production parameters, in vitro degradability, and ruminal fermentation in ruminant diets. WBTs can be used effectively when combined with grass (Ruzi and Napier). The implementation of winged bean tubers as a novel alternative feed may effectively replace cassava chips without affecting rumen function. Thus, it can be concluded that as winged bean has excellent nutritional content and can flourish luxuriantly even in unfavorable climatic conditions, it can be used as an alternative feed for sustainable livestock and poultry farming in North Eastern region of India.

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Table 1: Livestock and poultry population of India vs North East

State	Cattle	Buffalo	Pig	Goat	Poultry
Arunachal Pradesh	3,39,221	6,379	2,71,463	1,59,740	1599575
Assam	1,090,239	4,21,715	2,099,000	4,315,173	46712341
Manipur	2,24,472	36,230	2,35,255	38,697	5897637
Meghalaya	9,03,570	15,714	7,06,364	3,97,503	5379532
Mizoram	45,701	2,109	2,92,465	14,820	2047810
Nagaland	78,296	15,654	4,04,695	31,602	2838944
Sikkim	14,8010	1,144	27,320	90,506	580864
Tripura	7,39,031	7,131	2,06,035	3,60,204	4168246
NER Total	13,387,540	5,06,076	4,242,597	5,408,245	69224949
All India	**1,93,462,871**	**1,09,851,678**	**9,055,488**	**1,48,884,786**	**851809931**

Source: 20th Livestock Census, 2019

Table 2: Change in livestock and poultry population (2012 – 2019)

	Livestock Population (in thousands)			Poultry Population (in thousands)		
	2012	**2019**	**% Change**	**2012**	**2019**	**% Change**
NER	27106.53	24343.18	-10.19	42580.47	69224.95	62.57
All India	512057.30	535828.88	4.64	729209.32	851809.93	16.81

Source: 20th Livestock Census, 2019

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Under-Utilised Floriculture Crops

Aswini.M.S.[1*] and Ananthu Rajagopal[2]
[1]Ph.D scholar, Department of Genetics and Plant Breeding, Kerala Agricultural University, Thrissur
[2]Ph.D scholar, Department of Genetics and Plant Breeding, UAS Bangalore
*Corresponding Author: aswinims89@gmail.com

The underutilized floriculture species are capable of developing as new cultivars through breeding programs targeting the flower colour, flower size, fragrance of the flowers, leaf size and number and plant structure etc. After developing into new species, they can be commercialized as potted ornamental plants. However, there are major gaps in knowledge and capacity to make the best out of these crops because agricultural research has so far paid little attention to these species. Research to increase the value of these crops and encourage them to be more widely cultivated would broaden the resource base and increase the livelihood options especially for smallholder farmers in marginal areas. Some of the under-utilised floriculture sp. are listed here.

Blue Mist/ Iron Wood

Blue mist is a perennial evergreen shrub or small tree reaching heights of 8–14 meters. Young branches display vibrant blue umbellate cymes, enhancing the plant's significance in floriculture. The clusters consist of small purple flowers that bloom once or twice annually, creating a stunning spectacle as their petals fall to the ground. Classified as an endangered species in Sri Lanka, it thrives in wet, dry, and montane zones across the island.

Propagation

This can be propagated through seeds and air layering. In some regions, vivipary has been observed in *M. umbellatum* seeds due to high moisture during heavy rainfall. An in-vitro multiplication protocol for *Memecylon umbellatum* showed a higher callus induction percentage with internodal explants than nodal explants. Rooted plants were successfully acclimatized in cocopeat media with a 56.66% survival rate.

Other Uses

Apart from landscaping, *Memecylon umbellatum*, and other species, are utilized for walking stick timber, decorative plant work, comb preparation, silk and cotton dyeing mordants, and constructing houses and boats. Beyond its floricultural value, *Memecylon umbellatum* is recognized for potential medicinal properties, extensively used by local healers. In vitro antioxidant activities in leaf extracts suggest its potential use against oxidative stress.

Possible Value Addition

Developing a dwarf structure makes this plant a potential potted ornamental.

Glory Lily

Glory lily, a climbing herb with a broad natural distribution, is cultivated as a garden ornamental in tropical regions. Found in forests, grasslands, and abandoned cultivated areas, it boasts glamorous yellow and red solitary flowers, contributing to its ornamental appeal. Classified as least concern in the flora red list.

Propagation

Propagation occurs through seeds or tubers, with flowering starting in 5 to 8 weeks for tubers. The branching pattern correlates with tuber weight, allowing for increased branches and flowers per vine. However, tuber-based vegetative propagation reduces vigour and stress tolerance. Seed propagation introduces new variability, crucial for conventional propagation.

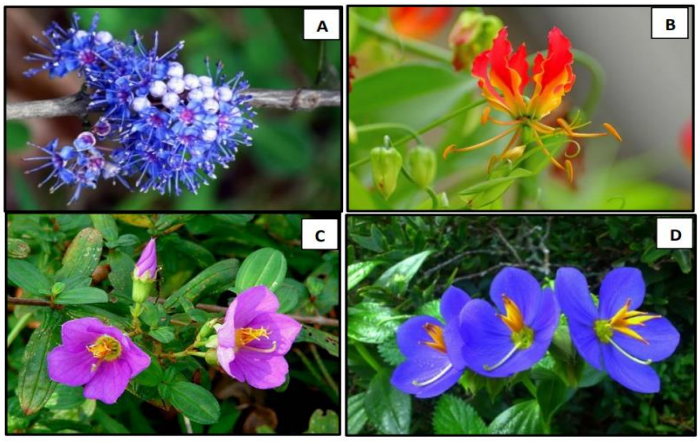

Figure 1: Few potential underutilized ornamental species. (A) *Memecylon umbellatum* Burm (EnglishIronwood tree, Family: Melastomataceae), (B) *Gloriosa superba* (English- Glory lily, Family: Colchicaceae), (C) *Osbeckia aspera* (English- Rough osbeckia, Family: Melastomataceae), (D) *Exacum trinervium macranthum* (Family: Gentianaceae)

Other Uses

Besides ornamental value, Glory Lily is a potential source of colchicine, exported for pharmaceutical industries. Despite its poisonous nature, it holds various traditional medicinal uses, such as asthma treatment and wound healing.

Possible Value Addition

Enhance ornamental value through cross-pollination for different flower colours and shapes. Growing as a potted ornamental plant with a dwarf stature and vibrant flowers presents commercial opportunities.

Rough Osbeckia/ Bovitiya

Osbekia aspera, a perennial montane shrub, showcases high floricultural potential, found in grasslands, open areas, and along the roadsides. Its free-flowering nature and contrasting flower colour against foliage place it under the least concern category in the red list.

Propagation

Simple propagation methods and adaptability to greenhouse conditions make it suitable for mass propagation. A protocol using single nodal cuttings on a specific medium has proven successful for shoot production.

Other Uses

Used in traditional medicine for its astringent properties, stress mitigation, detoxification, and treating cancer and inflammation. Chemical constituents include flavonoids, organic acids, and steroids.

Possible Value Addition

This ornamental flowering shrub holds great potential in the floriculture industry as a potted ornamental plant.

Binara

Binara, an endemic wild plant, can thrive in both low country and up-country wet zones on the island, growing to about 1 meter in height.

Marbled Jewel Orchids / Wanaraja

Wanaraja, an endemic orchid species, predominantly grows in tropical evergreen and subtropical montane forests in Sri Lanka. Thriving under tree shades and among leaf litter, its dark green to brownish purple leaves with red hearts and silvery vein patterns add to its ornamental value.

Figure 2. (E) *Anoectochilus reinwarddtii* (English-Marbled Jewel Orchids, Family:Orchidacea), (F) *Clitoria ternatea* (English- Blue butterfly pea, Family:Leguminosae), (G) *Ipsea speciosa* (English-Daffodil orchids, Family:Orchidacea), (H) *Jasminum angustifolium* (English- Wild jasmine, Family: Oleaceae).

Propagation

Anoectochilus spp. are typically propagated by seeds, but mass propagation through shoot tips and nodal explants is more efficient due to higher propagation rates.

Other Uses

Wanaraja is potentially rich in starch and alkaloids, holding medicinal importance.

Possible Value Addition

This orchid, with its distinctive leaf colour patterns, has the potential for commercialization as an ornamental potted plant.

Daffodil Orchids

A rare endemic terrestrial orchid found in highland grasslands, *I. speciosa* faces diminishing populations in central hills due to intentional burning and illegal harvesting for medicinal purposes. Easily distinguished by large bright yellow flowers, it blooms from September to February.

Propagation

Artificial propagation of seeds is successful for in vitro conditions while rhizome tips were suitable explant for mass propagation of Daffodil orchid.

Following that mass propagation protocol will ensure year-round production of this orchid species.

Other uses

Ipsea speciosa is an endangered orchid species with medicinal values.

Possible value addition

Developing the Daffodil orchid as a potted ornamental plant could enhance its appeal, especially since the plant does not bear leaves during the flowering season. According to Djordjević et al. (2016), factors such as temperature, altitude, and soil pH significantly impact the abundance of orchid species. Therefore, when introducing this species as ornamental plants, it is crucial to consider and adjust the basic requirements according to the plant's needs.

Blue Butterfly Pea

Clitoria ternatea is a versatile perennial leguminous twiner. The petals of its attractive flowers contain anthocyanin, imparting a stunning natural deep blue colour that adds ornamental value to the plant. Native to equatorial Asia and parts of Southeast Asia, it has also been introduced to Africa and Australia. It is a least concerned crop.

Propagation

The plant is typically propagated by seeds and readily self-seeds. Hand-harvested seeds require scarification before sowing. In vitro regeneration of *C. ternatea* is achievable using nodal explants.

Other uses

Aside from its floricultural value, numerous health-promoting functions have been attributed to this plant, including its anti-diabetic, anxiolytic, sedative, and anti-inflammatory properties. Butterfly pea is also utilized as a cover crop and green manure. Livestock find the crop highly palatable due to its non-toxic nature, thin stems, and large leaves.

Possible value addition

Improving the ornamental value of the plant can be achieved by developing medium-height Sergeants with deep violet, light pink, and velvety blue flowers and a reduced number of leaves.

Wild Jasmine

Wild Jasmine (*Jasminum angustifolium*) is a vine with a fragrant floricultural value, featuring prominently white flowers with a sweet fragrance. Endemic, it is classified as a least concerned crop that warrants more attention.

Propagation

Common methods of jasmine propagation include layering and cuttings. However, these methods limit the quantity of plants produced as they depend on season and climate.

Other uses

Wild jasmine is utilized to treat various ailments either alone or in combination with other medicinal herbs. Ethanol extracts of the plant exhibit anti-tumor effects.

Possible value addition

The vine can be developed into a dwarf potted wine with larger petals while enhancing its fragrance.

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Dragon Fruit (*Hylocereus* species): Anti-Inflammatory, Antioxidant, Anti-Lipidemic, Anti-Cancer Properties

Manjit M Khatal *[1] and Aniket A. Kale[2]

[1]PG Scholar, Department of Process and Food Engineering, [1]College of Agricultural Engineering and Technology, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Ratnagiri, M. S. (India)

[2] PG Scholar, Department of Irrigation and Drainage Engineering, College of Agricultural Engineering and Technology, Dr. Balasaheb Sawant Konkan Krishi, Vidyapeeth, Dapoli, Ratnagiri, M. S. (India)

*Corresponding Author: manjitkhatal18@gmail.com

The Dragon fruit plant *(Hylocereus spp.)* is an evergreen cactus with thin, leafless vine-like branches that grows quickly and can reach heights of 1.5 to 2.5 meters. It is an epiphytic or terrestrial cactus with succulent three-winged stalks.

Table 1. Nutrient content of Dragon fruit per 100 g

Name	Amount
Water	84 g
Energy	57 kcal
Protein	0.36 g
Total lipid (fat)	0.14 g
Carbohydrate, by difference	15.2 g
Fiber, total dietary	3.1 g
Sugars, total including NLEA	9.75 g
Calcium, Ca	9 mg
Iron, Fe	0.18 mg
Magnesium, Mg	7 mg
Phosphorus, P	12 mg
Potassium, K	116 mg
Sodium, Na	1 mg
Zinc, Zn	0.1 mg
Copper, Cu	0.082 mg
Vitamin C, total ascorbic acid	4.3 mg

(Source: USDA Food Data Central, 2022)

The stem has several branching segments and is mushy and vinelike. Three wavy wings, one to three spines, or occasionally no spines, are present on each segment. The plant's aerial roots grow on the underside of the stems, absorb water, and hold the stems firmly in place. Often white in colour, dragon fruits have a bell shape and are 25 to 30 cm long and 15 to 17 cm wide. The fruit is stunning, with bright red skin covered in green scales, and either red or white flesh that is filled with numerous tiny black seeds.

Antioxidant Effects

By Species Hylocereus. polyrhizus is rich in betalains and other bioactive compounds such as vitamins and phenolic compounds that exert relevant

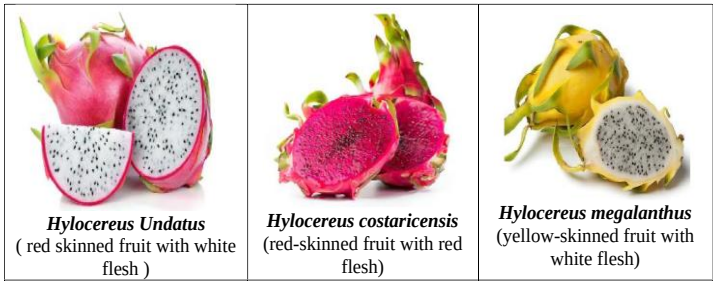

Figure 1. Types of Dragons Fruit

(Source: Nishikito et al., 2023)

antioxidant properties and, for these reasons, are related to the prevention of several human diseases. The oil results from the seeds, and the peel is also an essential source of antioxidant compounds. The peel of *H. undatus* possesses more flavonoids than the flesh. The antioxidant properties of dragon fruit extract were investigated. Total antioxidant status was reduced in pre-diabetic and normocholesterolemic subjects that consumed red pitaya.

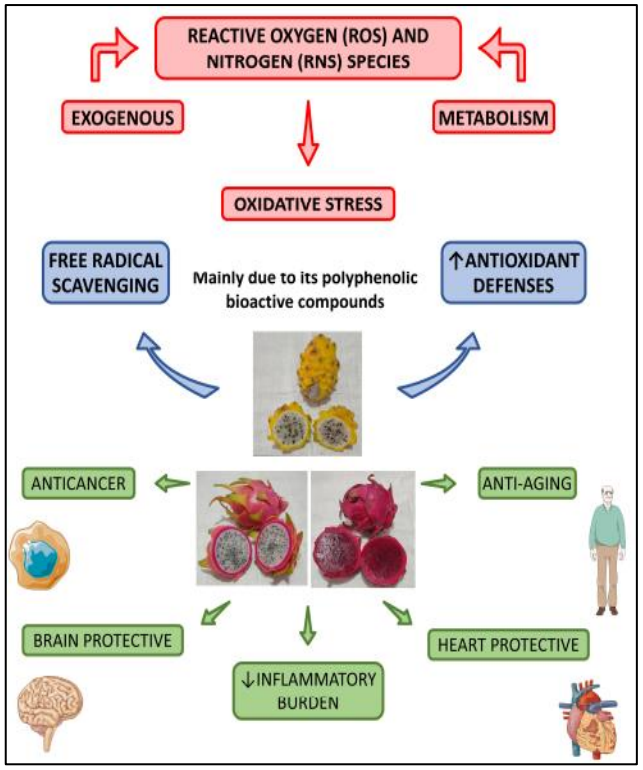

Figure 2. Main antioxidant effects of Hylocereus species and their health effects. ↑—increase; ↓—decrease (Source: Nishikito et al., 2023)

Anti-Inflammatory Effects

Besides the antioxidant actions, dragon fruit can also exert anti-inflammatory actions. anthocyanins (cyanidin 3-glucoside, delphinidin 3-glucoside, and pelargonidin 3-glucoside) in the pulp and peel of pitaya red. the first anthocyanin (cyanidin 3-glucoside) inhibited the synthesis of reactive oxygen and nitrogen species, cyclooxygenase-2 (COX-2), and inducible nitric oxide synthase (iNOS), in in vitro models and without resulting in cytotoxicity. the dragon flesh and peel extract and the isolated squalene led to the inhibition of pro-inflammatory enzymes such as cyclooxygenase-2 lipoxygenase and acetylcholinesterase and concluded that this fruit could produce a significant potential for the control and management of inflammatory processes through different pathways that may include, prostaglandin, leukotriene, and cholinergic pathways.

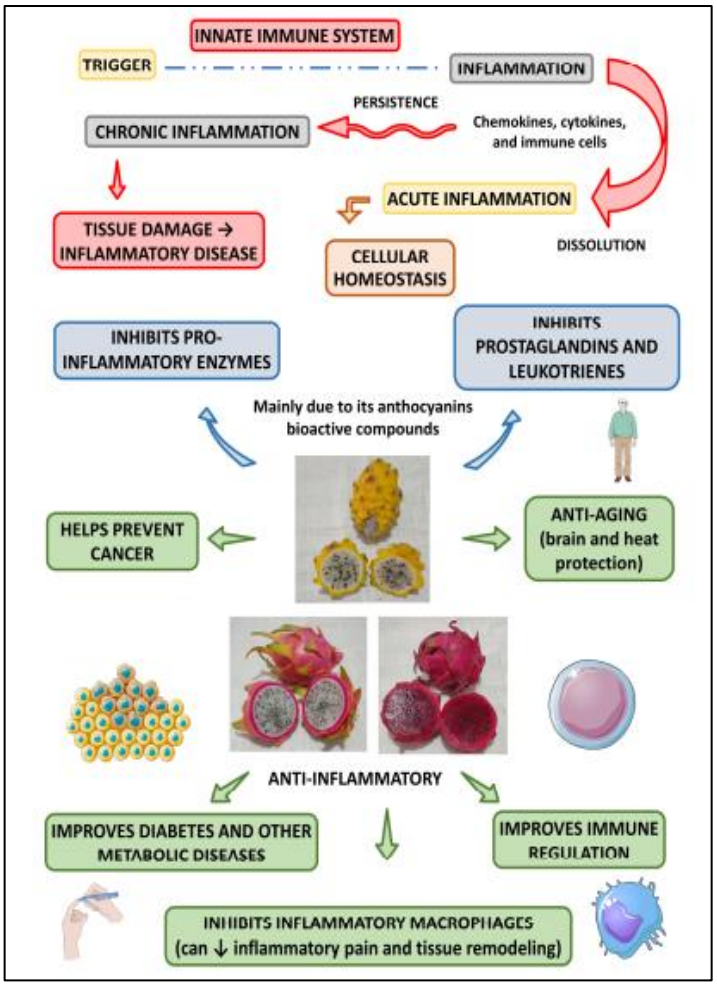

Figure 3. Main anti-inflammatory effects of Hylocereus species and their health effects. ↑—increase; ↓—decrease (Source: Nishikito et al., 2023).

Anti-Lipidemic Effects

The use of red pitaya can improve lipid profile, decrease total cholesterol, LDL-c, and triglycerides, and increase HDL-c levels in normocholesterolemic subjects, pre-diabetic, and type 2 diabetic patients. The consumption of red pitaya also showed benefits in lipid levels in dyslipidemic C57BL/6 mice, contributing to reducing cardiovascular diseases. the effects of the consumption of red pitaya skin extract on the lipid profile of male Wistar rats with diabetes and dyslipidemia and did not find a significant reduction in the lipid profile of these animals.

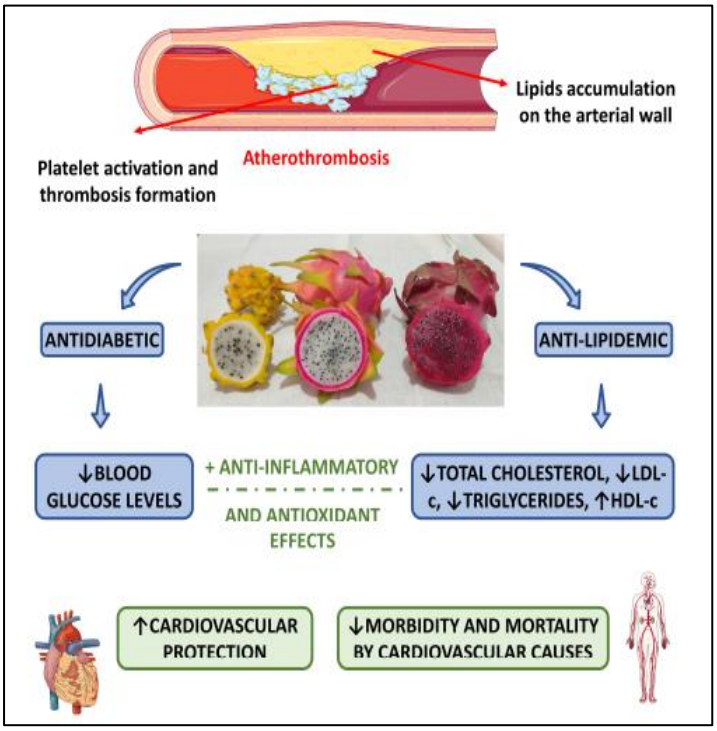

Figure 4. Cardiovascular protective effects of the Hylocereus species. ↑—increase; ↓—decrease; HDL-c—high-density lipoprotein cholesterol; LDL-c—low-density lipoprotein cholesterol (Source: Nishikito et al., 2023).

Anti-Cancer Effects

Some studies have shown the anti-cancer potential of dragon fruit. the ability of this fruit to produce nanoparticles and found they can significantly inhibit the growth of MCF-7 breast cancer cells. Another study showed that the fecal fermentation of pitaya oligosaccharides augmented the populations of Lactobacillus and decreased the populations of Bacteroides and Clostridium, and resulted in the production of lactic acid, acetic acid, propionic and butyric acids that can inhibit Caco-2

cells and has a potential for risk reduction in colon cancer. the anti-proliferative effect of red pitaya on B16F10 melanoma cells. They showed that the peel has stronger inhibition of the growth of these cancer cells than the flesh.

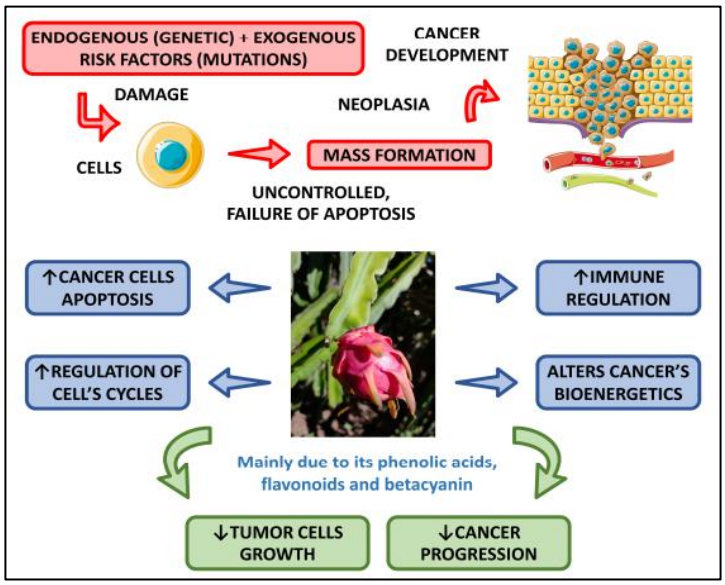

Figure 5. Main anti-cancer effects of Hylocereus species. ↑—increase; ↓—decrease (Source: Nishikito et al., 2023).

Conclusion

Studies show that Dragon fruit has beneficial potential for human health, having antioxidant, anti-inflammatory, antilipemic, anti-diabetic, anti-bacterial, anti-fungal, and anti-cancer effects. The consumption of this fruit can act on oxidative stress and anti-inflammatory processes and control or reduce the occurrence of conditions such as diabetes, dyslipidemia, metabolic syndrome, cardiovascular diseases, and cancer.

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Blood Fruit (*Haematocarpus Validus*): An Integrative Review of Its Nutritional Composition and Health Benefits

Robin Subba[1], Damchoo Dolma Bhutia[1], Radhakrishnan Kesavan[2] and Puja Das[2*]

[1]Dept. of Food Processing Engineering, College of Agricultural Engineering and Post-Harvest Technology, Ranipool, Sikkim

[2]Department of Food Engineering & Technology, Central Institute of Technology Kokrajhar, Kokrajhar, Assam, India

*Corresponding Author: pdas12994@gmail.com

The modern age has seen a growing demand for fruits rich in nutrients, benefiting human health both nutritionally and metabolically. A variety of lesser-known crops, which are not extensively cultivated or traded commercially, are mainly consumed locally. These fruits, though lesser-known and underutilized, have advantages such as easy cultivation, resilience to climate change, and hardiness, which set them apart from major commercially grown crops. Moreover, they are rich in essential phytochemicals and possess medicinal properties. Therefore, including these crops in diets can help meet the nutritional needs of rural populations, especially those living in vulnerable arid and semi-arid regions worldwide. The blood fruit, a tropical liana, bears underutilized edible fruits belonging to the Menispermaceae family. It grows in the wild across India, Indonesia, Bangladesh, Pakistan, Thailand and Singapore. In India, the species is naturally found in the Tripura, Andaman and Nicobar Islands, Arunachal Pradesh, Meghalaya, Assam, Sikkim, and parts of West Bengal. Although the fruits are known to be a rich source of vitamin C, phenols, flavonoids, iron, β-carotene, and minerals, including anthocyanins such as Pelargonidin and Cyanidin, they are particularly valued for their positive effects on various physiological disorders. Tribes in northeastern India have long utilized extracts from these fruits to treat conditions such as blood purification, jaundice, anemia, itching, and heart diseases. Fruits. The blood fruit not only holds nutritional value but also plays a crucial role in contributing to the economic and livelihood security of farmers in its native distribution regions. Despite being rich in polyphenols with high antioxidant properties, the blood fruit remains underutilized and has not been commercialized. This underutilization is due to factors such as the fruit's perishable nature, a lack of postharvest technology, and limited processing knowledge. Improving the nutritional value of various foods by incorporating blood fruits can lead to increased retention of phytochemicals, which can positively impact human health. This article provides a thorough analysis of the current understanding of the nutritional and physiological characteristics of blood fruit. It is essential to maintain its market presence and advance commercialization through effective value-added procedures that meet consumer demand for nutritional and functional benefits. The ultimate goals are to enhance livelihoods and achieve successful commercialization.

Blood fruit

The plant species recognized as blood fruit (*Haematocarpus validus*) belongs to the Menispermaceae family and the Haematocarpus genus. The fruit is derived from dark crimson specimens, characterized by dense fibers and ripe with copious amounts of blood-red liquid. Etymologically, the genus name Haematocarpus signifies "blood fruit," with "haem" referring to iron-containing compounds and "carpus" denoting fruit. These fruits are becoming more and more well-liked for their traditional therapeutic uses due to their abundance in different alkaloids. The blood fruit, which has iron-rich characteristics and is used by some long-time villagers, is widely recognized for its relevance and ethno-medical values. Even with this acknowledgement, not much research has been done on how to identify and use these fruits properly, and what is known about them is still mostly lacking. The fruit goes by different names in various communities, including Blood fruit (English), Khoon phal (Hindi), Roktogula/Lalgula (Bengali), Rosco (Chakma), Thoyphal (Tripura), Te.pattang (Garo), Theichhung-sen (Mizo), Ranguichi (Marma), Raktaphal (Tamil/Telugu/Malayalam), and Sohsnam (Khasi & Pnar).

Nutritive composition

Blood fruit's nutritional content suggests that it is high in a number of important vitamins and

minerals, including vitamin C, carotenoids, iron, copper, and potassium. Additionally, it has reasonable levels of fats, proteins, and carbohydrates, among other macronutrients. Nutritional value per 100 g of blood fruit is listed in Table 1. reported that blood fruit contain 90.12% moisture, 0.6% protein, 1.22% crude fiber, 1.23% ash, 1.44% fat, 6.99 % carbohydrate, 9.16 mg calcium, 39.50 mg phosphorus, 129.57 µg Copper, 0.14 µg Zinc, 152.04 µg Manganese, 6.86 mg Magnesium, 0.42 mg Sodium, 255.70 mg Potassium and 50 Kcal Energy.

Table 1: Nutritional value per 100 g of blood fruit

Parameter	Contents	Parameter	Contents
Moisture (gm)	90.12	Iron (mg)	0.57
Protein (gm)	0.6	Copper (µg)	129.57
Carbohydrate (gm)	6.99	Zinc (µg)	0.14
Fat (gm)	1.44	Manganese (µg)	152.04
Crude fiber (gm)	1.22	Calcium (mg)	9.16
Ash (gm)	1.23	Magnesium (mg)	6.86
Energy (Kcal)	50	Sodium mg (mg)	0.42
Vitamin C (mg)	13.15	Potassium (mg)	255.70
Carotenoids (µg)	1170	Phosphorus (mg)	39.50
		β-carotene (µg)	9.0

The fruit has an acidic pH of 2.77 and TSS (12.40%). Iron concentration in blood fruit is 0.57 mg/100 g, which is significantly higher than that of commercial fruit crops such as mango (0.2 mg/100 g), apple (0.1 mg/100 g), guava (0.3 mg/100 g), and cherry (0.3 mg/100 g) (Singh, 2013). Moreover, the seeds include 0.11 mg/100g. In order to treat iron deficiency and associated anemia diseases, blood fruit consumption may be helpful.

Phyto-chemical composition

The phytochemical constituent of blood fruit crude extract includes phenol (0.51%) (Sangma, 2016; Rahim et al., 2015), titratable acidity (5.08%), reducing sugar (6.90%), Carotenoids (1170 µg/100g) total sugars (27.232%), non-reducing sugar (26.67%), β-carotene (9.0 µg/100g), total polyphenol (400 GAE mg/100g), flavonoid (542 RE mg/100g), vitamin C (13.15 mg/100g) tannin (275.56 TAE mg/100g) and anthocyanin (203.77 C3GE mg/ 100g) as reported by Singh et al. (2014). The fruit's high carotenoid, β-carotene, and mineral content make it a natural antioxidant and a rich source of micronutrients like calcium, magnesium, potassium, and phosphorus.

Health benefits of Blood Fruit

Wild edible fruits, recognized for their abundant nutritional value, have been consumed by rural and tribal communities since ancient times as a remedy for various diseases. Tender shoots extract is used as a jaundice cure by the Chakma and Marma tribes of Chittagong, Bangladesh. They also apply a mash of the roots to relieve itching, and use fruits and seeds as medicinal remedies for anemia. Blood fruit is rich in many different phytochemicals with medicinal qualities, and consuming it in a well-balanced diet may have several health advantages. Regular eating of this fruit rich in nutrients has the ability to reduce the risk of a number of illnesses, such as diabetes, cancer, heart disease, neurological conditions, and ageing. Ingesting blood fruit can help address issues related to iron deficiency and anemia. In addition, it provides a greater concentration of vitamin C than fruits that are sold commercially, exhibiting higher antioxidant activity.

Food Uses

Blood fruit can be consumed both in its raw and ripened stages. The ripened fruit offers a sweet taste with a slightly acidic flavor, making it suitable for blending into beverages. The vibrant color of blood fruit serves as a natural coloring agent for processed foods, given its high content of anthocyanin pigment, making it a natural additive. The popularity of utilizing color extracted from blood fruit in soft drinks and desserts is increasing as a substitute for synthetic coloring agents, which pose health hazards. The Garo tribe in Meghalaya highly values the iron-rich blood fruit, which they use to heal blood-related diseases or anemia. They even consume the extract of ripe fruit slices that have been soaked overnight to obtain health benefits. Some tribes use ripening blood fruit to make

wine and other alcoholic drinks. These ripe fruits are used to create squash in Tripura, and the dye that is taken from them is used to color fabrics used in handicrafts. Blood fruit is processed domestically in several villages in northeastern India using methods including pickling and drying to produce chutneys, pickles, and dried fruits that can be consumed later.

Future prospects

Underutilized fruit crops offer therapeutic advantages due to their high nutritional and medicinal value. Their potential to become significant horticultural assets could help ensure food security and nutrition in countries. These crops are also important for the environment, society, and recreation. Their ability to thrive in severe dry and semi-arid settings, such as waste areas, marginal or saline soil and water conditions, and rocky terrains, makes them suitable for enhancing sustainable agricultural revenue. The value and importance of wild edible plants and *H. validus* receive less attention at various levels. Many neglected and underutilized species play a role in maintaining cultural diversity associated with food habits, health practices, religious rituals, and social exchanges. Focusing on neglected and underutilized species is an effective way to promote a diverse and healthy diet and to combat micronutrient deficiencies, known as 'hidden hunger,' and other dietary deficiencies, particularly among the rural poor and more vulnerable social groups in developing countries. Emphasis should be placed on identifying more areas to explore the potential pockets for cultivation, which can bring more economic benefits to local communities if properly harnessed. Research on the utilization aspect will help identify new uses and improve production, promoting the welfare of the local community. Information and research concerning crop improvement, propagation, utilization, agro techniques, nutrition, and conservation aspects, especially on this particular fruit species, are extremely scarce and need attention. Efforts should be directed towards better maintenance of their resource base, both through ex situ and in situ conservation methods, to ensure their development and sustainable use by present and future generations. To make the blood fruit more popular, it is important to morphologically screen populations from different geographical regions of the country. This endeavor can assist in identifying plants with edible and larger fruits, exhibiting wider adaptability, and tolerance to disease and insect pests, which can later be used for breeding purposes. Improving the acceptability and marketability of this fruit by making people aware of its nutritional qualities is also crucial. Improving the availability of information on underutilized crop species is one of the most important areas that demand immediate attention. Additionally, there is scope for studying the response of pruning, training, and other cultural practices. Standardization of harvesting and post-harvest techniques, including packaging and value addition, could also be pursued. Suitable procedures for the isolation of anthocyanins and their utilization as a natural colorant for preparing products also need to be standardized. Since traditional knowledge of this wild edible fruit is being eroded through acculturation and the loss of plant biodiversity along with indigenous people and their cultural background, promoting research on this wild fruit is crucial to safeguard this information for future generations and their conservation.

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Shirui Lily: An Indigenous and Endangered Flower

Alok Kumar[1], Ng Piloo[2] and Gayatri Khangjarakpam[3]
[1]Research Scholar, UBKV, Cooch Behar
[2]Professor, College of Agriculture, CAU, Imphal
[3]Assistant Professor, College of Agriculture, CAU, Imphal
*Corresponding Author: alokkr581996@gmail.com

Shirui lily is renowned as the "Jewel of Northeast India" which is a special gift from Manipur to the world's floral wealth. This flower is an Asiatic lily species, botanically called *Lilium mackliniae* which belongs to family Liliaceae. In 1946, botanist Frank Kingdon- Ward of the New York Botanical Society made the discovery of this species of Asiatic lily, which he named after his wife, Jean Kingdon-Ward (née Macklin). This lovely flower was awarded the renowned merit prize in 1948 at the Chelsea Flower Show, which was put on by the Royal Horticulture Society in London. It is a rare species of terrestrial lily which is an indigenous and endangered flower of India, growing naturally only in the Shirui Hill range of Ukhrul district in Manipur at an elevation of 1730 – 2590 metres above the sea level. Reputed for being Manipur's highest hill district, Ukhrul is located roughly 83 km east of Imphal, the state capital. The native habitat of the lily, which is spread across an area of 41 km², was designated as the Shirui National Park in 1982. Shirui lily is believed to be the daughter of goddess Philava, who resides in and guards the Shirui hills and on 21 March 1989, it was designated as the State flower of Manipur in recognition of its legacy and distinctiveness. This beautiful flower also symbolizes wealth and a contented existence and locally known as Kashong Timrawon, named after Timrawon, the daughter of mythical goddess Philava.

Travellers will find paradise when they visit the Shirui hill area in the blossoming season. It is a seasonal flower which blooms in the month of May and June and its height varies from 1 to 3 feet. The plant is shade tolerant in which the beautiful flower hangs downward resembling the modest and shy girl. The plant is perennial and herbaceous in nature, bulb is broadly obovoid in shapeand pale yellow or light pinkish in colour. The flower features 3–5 petals, lovely pink in colour that are 4-5 cm long, a 3 cm peduncle, an ovary 4 by 2 cm with a 2.5 cm lobe, a 3.5 cm style, 6 stamens in two rows, and an anther that is 0.9 mm long and basifixed in a brownish red colour. Leaves of the plant are long and narrow like other lilies and flowers are pale bluish pink in colour with bell shaped petals. The flower blooms solitary or upto 9 flowers per plant and during its blooming season, the flower infuses the air with a delightful smell.

Photo courtesy: Dr. Y. Rupert Anand,CAU, Imphal

Shirui lily is also used medicinally to treat stomach and skin problems due to its antibacterial and anti-anthelmintic properties. This unique flower has several distinctive features, one of which is that, when viewed under a microscope, it comprises of seven colours.

A postal stamp has been issued by the Indian Postal Department to memorialize the rare Shirui Lily flower. This plant cannot be replanted anywhere in the entire world, it is the most unique characteristics of this flower.

From 2017 onwards, Shirui lily festival is organized as a state festival in Manipur which is the second biggest tourism festival in the Manipur after the Sangai festival. The festival is organized by Department of tourism and Manipur state Government in order to give honor to this flower and

with a motto of conserving this endangered species of Lily. It attracts thousands of visitors from throughout the state, other regions of India and from entire world. Different cultural shows, traditional dances, folk songs, live music concerts, art and handicraft exhibitions, indigenous games and sports are organized on this occasion. The event is going to be observed every year at Ukhrul town as well as Shirui village in Manipur which help in spreading awareness about the endangered Shirui lily.

Climate change, global warming, unlawful tree-cutting, careless forest fires, unchecked plucking and uprooting, manipulative behaviour, and the introduction of foreign species are all contributing factors to the Shirui Lily's imminent extinction. Along with that a wild dwarf bamboo species' extensive root system has recently encroached over the lily habitat at Shirui Peak.In addition to having a negative effect on the stability of the lily population, this new rival will restrict conservation efforts by preventing in situ plant reproduction from bulbs and/or seeds. The head of Goa's Department of Environment and legacy, ShajinJinks, organized an expedition to the Shirui Hills on October 13, 2013, to raise awareness for the need to safeguard this endangered cultural legacy.

The population of lilies is on the verge of extinction due to changing climate conditions, human encroachment, and resource exploitation. Therefore, this vulnerable plant is listed in the "Red Data Book" of "Indian Plants Volume I". An important concern for the researchers is how to save this vulnerable species in the face of shifting climate conditions. The genetic resources of rare and endangered plant species can be conserved via techniques like tissue culture which provide useful tools for rapid mass propagation of the species in vitro condition. Micropropagation in bulbous plants is preferred over the traditional vegetative propagation method because it produces high-quality, disease-free planting materials and multiplies the rate of multiplication by many times. To ensure the long-term preservation of these uncommon bulbous plants, a high-throughout micropropagation technology must be developed for the generation of healthy clonal plants. A campaign to restore the Shirui Lily's habitat was started on February 19, 2015 by the National Institute of Bio-resources and Sustainable Development. The flowers are going to be grown in the lab and then sent to nurseries to be planted and grown.

The endangered lily flower is suffering from negligence of government still remains unexplored by the researchers. To save this flower from extinction, some important actions must be taken by the Government. And researcher should also focus for conserving the vulnerable plant from extinction. Both ex situ and in situ methods of conservation strategies should be used to preserve it.

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Swede: An Underexploited and Versatile Root Vegetable

Swagat Ranjan Behera[1], Riya Pandey[1], Vanshika[1] and Shaili[2]

[1]Department of Vegetable Science, College of Agriculture, G. B. Pant University of Agriculture and Technology, Pantnagar – 263 145, Uttarakhand, India

[2]Department of Vegetable Science, College of Agriculture, Odisha University of Agriculture and Technology, Bhubaneswar – 751 003, Odisha, India

*Corresponding Author: swgtbehera@gmail.com

The swede, scientifically classified as *Brassica napus* var. *napobrassica*, stands as a testament to the botanical intrigue that arises when turnip and cabbage come together in a harmonious union. Also known as "rutabaga" in certain regions, the swede boasts a distinctive blend of flavours, marrying the earthy sweetness of turnips with the robustness of cabbage. As a cruciferous vegetable with a bulbous, turnip-shaped root, the swede has not only carved a place in culinary landscapes but also holds a rich history that intertwines with the agricultural practices of bygone eras.

Originating from a natural cross-breeding event, likely in the 17th century Bohemia, now a part of the Czech Republic, the swede emerged as a product of nature's ingenuity. The turnip (*Brassica rapa* L.) and cabbage (*Brassica oleracea* L. var. *capitata* L.) found themselves in close proximity, allowing the magic of cross-pollination to unfold. What succeeded was the birth of a new hybrid, a vegetable that inherited the best traits of both of its parent plants.

The bulbous root of swede, adorned with a smooth, waxy skin, houses a flesh that ranges from yellowish to purple-tinged. Its flavour profile is a delicate dance between the mild sweetness characteristic of turnips and the slightly peppery, robust notes associated with cabbage. This unique combination not only makes the swede a culinary delight but also a versatile ingredient that adds depth to an array of dishes. Beyond its culinary prowess, the swede has etched its presence in agricultural history. Its journey involves the careful observation and selection by farmers and horticulturists who recognized the potential within this natural hybrid. Through generations of selective breeding, the swede evolved into a stable variety, its characteristics refined to meet the preferences of cultivators and consumers alike.

Fig. 1: Yellow-skinned swede

Fig. 2: Purple-skinned swede

Nutritional profile of swede

Swede is a nutritious root vegetable that offers a range of health benefits:

i. **Calories:** Swede is relatively low in calories, providing approximately 38 calories per 100 g. This makes them a good option for those looking to manage their calorie intake.

ii. **Carbohydrates:** It is primarily composed of carbohydrates, with around 9 g per 100 g. The carbohydrates in swedes include dietary fibre, which is essential for digestive health and helps maintain stable blood sugar levels.

iii. **Protein:** It contains a small amount of protein, approximately 1 g per 100 g.

iv. **Fat:** It is very low in fat, with less than 0.2 g of fat per 100 g serving. This makes swede a healthy option for those watching their fat intake.

v. **Vitamins:** Swede is a good source of vitamin C, providing about 25 mg per 100 g. Vitamin C is an antioxidant that supports the immune system and helps the body absorb iron.

vi. **Minerals:**

a) **Potassium:** Swede is a rich source of potassium, offering about 305 mg per 100 g. Potassium is crucial for maintaining proper fluid balance, nerve function and muscle contractions.

b) **Calcium:** It provides calcium, an essential mineral that plays a role in bone formation. It offers about 43 mg per 100 g.

vii. **Dietary fibre:** It is a good source of dietary fibre, contributing approximately 2.3 g per 100 g. Dietary fibre is essential for digestive health, helps regulate blood sugar levels, and contributes to a feeling of fullness.

viii. **Antioxidants:** Swede contains various antioxidants, including carotenoids and flavonoids, which help protect cells from oxidative stress.

Development of the intergeneric hybrid vegetable

The development of the swede is a result of natural hybridization followed by selective breeding practices by farmers and horticulturists:

Natural hybridization

- The turnip and cabbage, both belonging to the Brassicaceae (Cruciferae) family, were cultivated in proximity to each other.
- Cross-pollination occurred naturally between the turnip and cabbage, resulting in a hybrid plant with characteristics from both parent species.

Human observation and selection

- Farmers and horticulturists observed the characteristics of the naturally occurring hybrid.
- Plants that exhibited desirable traits, such as a bulbous root, improved taste and disease resistance, were selected for cultivation.

Selective breeding

- Over successive generations, individuals with preferred traits were chosen for reproduction, creating a stable variety with consistent characteristics.
- This process involved careful selection and cultivation of plants that displayed the desired features, ensuring the stability of the new vegetable.

Cultivation and dissemination

- Once a stable variety of the swede was established, seeds were cultivated and disseminated.
- The cultivation of swedes spread across Europe and the vegetable became a widely cultivated and consumed crop.

Ongoing improvement

- As cultivation practices advanced, ongoing selective breeding aimed at improving traits like taste, size and disease-resistance likely continued.

While the specific historical details of the development of swede may not be extensively documented, the general process of natural hybridization followed by human selection and cultivation has been a common theme in the development of many crops.

Conclusion

In conclusion, the swede, with its roots deeply intertwined in the annals of agricultural history, emerges not merely as a vegetable but as a culinary marvel bridging the essence of turnip and the resilience of cabbage. The swede, with its rich flavour and storied past, invites us to continue exploring, experimenting and savouring the intricate tapestry of flavours that nature and human cultivation have woven together in this remarkable cruciferous delight.

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Less Known Aquatic Vegetables of Northeast Region: A Potential for Future Nutrition

Debiya Leitanthem[1], Neeruj Naorem[1] and Tasso Yatung[2*]

[1]Department of Vegetable Science, College of Horticulture and Forestry, CAU (I), Pasighat Arunachal Pradesh

[2]Department of Horticulture, MTTC & VTC, CAU (I), Pasighat Arunachal Pradesh

*Corresponding Author: tassoyatung@gmail.com

Underutilized aquatic vegetables refer to plant species that grow in aquatic or semi-aquatic environments and have the potential to be used as food but are not extensively cultivated or consumed. These plants can provide variability and sustainability to a diet, and they are frequently rich in nutrients. The underutilization of these aquatic vegetables could be due to various reasons, including limited awareness of their nutritional benefits, lack of culinary tradition, or challenges in cultivation and harvesting. These vegetables often have not received much attention in terms of research, development, or promotion compared to mainstream crops. Exploring and promoting the consumption of underutilized aquatic vegetables can contribute to diversifying diets, enhancing food security, and promoting sustainable agricultural practices. Examples of underutilized aquatic vegetables may include various types of water plants, algae, and other aquatic vegetation that have sufficient intake of nutrients for human consumption. Some of these plants may be rich in vitamins, minerals, and other beneficial compounds. Promoting underutilized aquatic vegetables is essential for various reasons. Firstly, these vegetables provide diverse nutritional profiles that supplement diets with a wide range of vitamins, minerals, and health-promoting components. Secondly, cultivating aquatic vegetables utilizes water resources efficiently, reducing pressure on land and promoting sustainable farming practices. Enhancing the range of our food sources makes us greater resilience, especially in regions where traditional crops might face hardships. From economic point of view, commercializing these crops creates new income streams for farmers and entrepreneurs, fostering local economic development. Moreover, popularizing underutilized aquatic vegetables contributes to the preservation and sustainable use of diverse plant species, supporting biodiversity. Aquatic vegetables can also contribute to water purification, ecosystem health, and environmental conservation. Promoting these vegetables helps preserve traditional culinary practices, ensuring the continuation of local food cultures. Certain aquatic vegetables might be more tolerant of environmental stresses, making them a dependable food source in areas susceptible to climate change.

A brief information of the popularly consumed underutilized aquatic vegetables in Northeast region of India; Manipur, Arunachal Pradesh, Meghalaya, Nagaland, Mizoram, Tripura and Sikkim are mentioned below.

Prickly Water Lily

Fig. 1: Makhana fruit

The major aquatic cash crop, Makhana or gorgon nut or fox nut (*Euryale ferox* Salisb.), is farmed mostly in eastern India. It belongs to the family Nymphaeceae producing vibrant purple blooms. Prickly spikes cover the surface of the leaves. The edible black nuts are popularly known as Thangjing in Manipur is consumed as raw, boiled, roasted and used in making chutneys (eromba and thangjing metpa). Typically, it grows in low-lying areas, lakes, ponds, and other stagna nt bodies of water. It is rich in carbohydrates (76.9%), protein (9.7%), phosphorous (0.9%), minerals (0.5%), fat (0.1%), Calcium (0.02%) and Iron (0.0014%). Both the raw and popped nuts have high calorific value of 362 and 328 kcal/100g respectively. Amino acids such as glutamine, cystine, methionine, and arginine having anti-aging property is present in high proportions in Makhana. It is used as a remedy for sickness like digestive, reproductive, stomachache and diabetes. It is available from October-November. For low-income

groups, its cultivation can bring in additional money which also has a huge scope of earning through

processing.

Fig 2: Makhana plant in pond

Manchurian Wild Rice

Fig 3: Wild rice tied in bundles

A well-liked vegetable in China, *Zizania latifolia* (Griseb.) Turcz. ex Stapf is a member of the Poaceae family. It is a special byproduct that is devoured like a vegetable that has been produced by a fungal parasite and p lant host. This perennial wet grass flourishes in swampy paddocks, roadside ditches, stagnant ponds, and riverbanks. In Manipur, it's described by the native term, kambong and the community' favorite wintertime dish. The infected gall forming culms of the plant are consumed raw or cooked. For the Brow-antlered deer acknowledged locally as Sangai, *Z. latifolia* is an integral source of nourishment food. After being charred, roasted, stir-fried in oil with potatoes, or teamed with cooked rice, it is devoured. It is loaded with fat, dietary fibers, vitamins, proteins, and carbohydrates. Ca, K, Na, Mg, Cu, Zn, As, phenolics, and flavonoids are plentiful in black smut. In pharmaceuticals, it is used as a remedy for dyspepsia, and its syrup is used to treat burn injuries, colds or flu, and coughs as well. It is accessible from January throughout April, during the fall to spring season.

Water Lily

In several communities in the northeastern region of India, families often raise the wild aquatic plant *Nymphaea rubra* Roxb. ex-Andrews in their backyard ponds. Being part to the Nymphaeaceae family, often referred to as "water lily." After being roasted or steam-cooked, the rhizome (locally called lemphu) is eaten, and it has a starchy, potato-like flavor. There is an immense amount of total carbohydrates (63.14%) in the rhizome along with protein, fat and fibre. The tender leaves, flower peduncles and seeds are also consumable. Numerous cosmetic items also contain the flower extract. Rhizome powder has been utilized for piles, loose stool, and dyspepsia. The majority of nymphaea plants are very nutrient-dense and have considerable medicinal value. The flower is almost available throughout the year. This plant may be a dependable source of protein owing to the substantial amount of protein it contains.

Fig 4: Starchy rhizome

Water Chestnut

Fig 5: Water chestnut Plant (Heikakyeli)

Water chestnut (*Trapa natans* L) is also known as singhara is one of aquatic vegetable of the family Trapaceae. The genus Trapa is an aquatic herb which is distributed in Central and South -East Europe and Temperate and Tropical Asia. The nutrient-rich waters of lakes, ponds, ditches, and streams are home to a variety of aquatic plant species, including water chestnut. Water chesnut is a floating herb aquatic plant with two types of leaves: undivided floating leaves carried in a rosette at the water's surface, and finely divided feather-like submerged leaves borne along the length of the stem. The floating leaves are rhomboid, fan-shaped, toothed along the edges, 2-6.5 cm in diameter, longer than wide, denticulate, denate, serrate, or incised along the entire base, apex acute, crimson, and thickly hairy or villous below. Anthocyanin pigments are mostly responsible for the red color of stems, the undersides of leaves, and bulbs. It can be consumed both raw and cooked. Fresh water kernels have the following composition: 81% moisture, 7.2% total soluble solids, 0.36% crude lipids, 1.87 % total proteins, and 5.6% total sugars. In Manipuri, Heikak refers to the fruit and Heikakyeli to the plant. The inhabitants of Manipur eat the fruit, leaves, and all other parts as well. It can be consumed both raw and cooked. The fruits are used `to make liniments that are applied to sunburns, sores, and rheumatism.

Fig 6: Fruit (Heikak)

Water Mimosa

Water Mimosa (*Neptunia oleracea* L.) is an aquatic vegetable of the family Leguminosae which is also known as puff, small leaf sensitive plant, dwarf sensitive plant, neptunia. It is called 'Eshing ekaithabi' in Manipuri. It is a little aquatic or creeping herb that either floats by producing spongy aerenchyma around the stem or grows prostrate along the water's edge. It thrives near slow-moving waterways but likes lakes, agricultural dams, ponds, and swamps. Tender shoots and leaves are eaten as vegetables. It is eaten both raw and cooked. It can be consumed by making stir fry,

Fig 7: Water Mimosa plant

salad. The nutritional composition of young shoots of water mimosa are as follows: 84 % moisture, 6.4 % protein, 0.8% carbohydrates, 1.8% fibre. The plant is used for the treating fever by applying the infusion of the whole plant, it is also used for the treatment of sores on tongue. It is available during the month of June-August.

Lotus

Fig 8: Lotus flower

Lotus (*Nelumbo nucifera* G) is a member of the family Nelumbonaceae. In Indian traditions, it is regarded as one of the auspicious flowers. In temples, it is used as an adornment and an offering. The pods are also used as an offering to God during festivals. *Nelumbo nucifera* is found in a variety of shallow wetland environments, such as floodplains, ponds, lakes, pools, lagoons, marshes, swamps, and the backwaters of reservoirs, in mild temperate to tropical

climates. Fresh lotus rhizomes have the following nutritional value: 83% moisture, 2.7% crude protein, 1.56% reducing sugar, and 0.80% fibre. It is known for its hypoglycaemic, antipyretic, anti-diarrhoea, anti-bacterial and anti-fungal activity. The entire plant such as young, unopened leaves, rhizomes, and pods are all consumed. Salad (Singju) is made from the opened delicate leaves. Rhizomes are consumed both in raw and cooked form. The pods are available in the month of June-July.

Fig 9: Lotus Pod

Conclusion

Popularizing underutilized aquatic vegetables will address the nutritional, environmental, economic, and cultural dimensions, contributing to a more sustainable and resilient food system in the Northeast region.

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Fox Tail Orchid: The Mystique Flower from Rain Forests of North East

A. Sumalatha[1], V. Bhargav[2] and T. Yatung[2]

[1]Scientist, ICAR- Indian Agricultural Research Institute, Gogamukh, Assam- 787034.

[2]Assistant Professor (Horticulture), MTTC & VTC, College of Agriculture, Pasighat, Arunachal Pradesh- 791102.

The Fox Tail Orchid, scientifically known as *Rhynchostylis retusa* (L.) Blume, originates from Southeast Asia, particularly Thailand, Malaysia, and the Philippines. The plant's habitat ranges from India, Sri Lanka and Bangladesh to the Philippines. In India it is native to Assam, Arunachal Pradesh, Manipur, Mizoram, Nagaland and Tripura. Belonging to the Orchidaceae family, it's renowned for its striking appearance, featuring clusters of fragrant, fox tail-like inflorescences.

Rhynchostylis retusa, identified as an endangered, epiphytic plant characterized by a sturdy stem measuring approximately 25 cm in length. Its pendulous inflorescences boast densely flowered clusters, extending up to about 60 cm in length (Sinha and Jahan, 2012). It has been historically utilized in traditional medicine across its native regions, with reported treatments for conditions such as paralysis, rheumatism, allergies, abnormal menstruation (Akhter et al., 2017), and malaria (Tiwari et al., 2012). The plant's dual significance in traditional medicine and ornamental horticulture has led to its rampant exploitation from natural habitats over centuries, ultimately resulting in its endangered status (Fonseka 2020). The Fox Tail Orchid holds significant cultural and ornamental value. It's highly prized in floral arrangements, especially in weddings, special occasions, and religious ceremonies. The orchid's vibrant colors and unique shape make it a favorite among florists and flower enthusiasts alike.

In Assam, the Fox Tail Orchid, known locally as "*Kopou Phool*," holds profound cultural and religious significance intertwining with traditions, celebrations, and spiritual beliefs hence referred as state flower of Assam. The flowering season of the Fox Tail Orchid coincides with the Assamese festival of Bihu, particularly during the spring festival known as "*Rongali Bihu*" or "*Bohag Bihu*," which typically falls in April. The Fox Tail Orchid symbolizes the onset of spring and the renewal of nature's bounty. During *Rongali Bihu*, the orchid's vibrant blooms adorn households, traditional attire, and cultural performances, adding to the festive atmosphere. In

Fig 1: Foxtail orchid in pot

Assamese culture, the *Kopou Phool* is considered a harbinger of prosperity, joy, and new beginnings. The orchid plays a central role in Assamese weddings and rituals, where it is used in bridal bouquets and ceremonial decorations, symbolizing purity, beauty, and marital bliss. Additionally, the Fox Tail Orchid holds significance in Assamese folklore and literature, often depicted as a symbol of love, longing, and the ephemeral nature of life. Beyond its cultural associations, the Fox Tail Orchid also has religious significance in Assam. It is revered in Assamese Hindu traditions, where it is offered to deities during prayers and religious ceremonies, seeking blessings for auspicious occasions and prosperity for the community.

In Arunachal Pradesh, the Fox Tail Orchid holds significant cultural and religious importance among the indigenous communities. Known locally as "*Nagee* or *Nageshor*" it is revered for its beauty and symbolism. In cultural contexts, the Fox Tail Orchid is often associated with festivals, traditional ceremonies, and rituals. It symbolizes purity, prosperity, and harmony within nature. The flowering season of the

Fox Tail Orchid in Arunachal Pradesh typically coincides with the region's monsoon season, which lasts from June to September. During this time, the orchids grace the lush forests and mountainous landscapes with their spectacular blooms, adding to the region's natural splendor and hence the state of Arunachal Pradesh had given status of state flower to fox tail orchid.

Propagation

Primarily propagation of fox tail orchid occurs through division or through tissue culture techniques. These methods ensure genetic stability and allow for mass production of desirable cultivars.

Cultivation

Cultivation of the Fox Tail Orchid requires specific conditions mimicking its native tropical habitat. It thrives in warm, humid climates with ample indirect sunlight and well-draining soil. In cultivation,

Fig 2: Potting media

it's often grown in orchid houses or greenhouses where environmental factors can be controlled. Being an epiphytic orchid, it doesn't soil and can be grown on trees and coconut husks or shells. For commercial cultivation epiphytic orchids require a potting medium that provides good drainage, aeration, and moisture retention.

Common potting media for epiphytic orchids include:

Fir bark: Chunks or chips of fir bark provide excellent drainage and aeration, mimicking the orchid's natural habitat in the trees.

Sphagnum moss: Long-fibered sphagnum moss retains moisture well and is suitable for orchids that prefer consistently moist conditions.

Coconut husk chips: Coarse coconut husk chips provide good drainage and aeration, similar to fir bark.

Perlite or charcoal: These materials can be added to potting mixes to improve drainage and prevent compaction.

Cinder: Provides excellent drainage and aeration, promoting healthy root growth and preventing water logging.

Potting the Orchids

When potting epiphytic orchids, select a pot with ample drainage holes to ensure proper water drainage. Gently remove the orchid from its old pot and carefully inspect the roots for any signs of damage or disease. Trim away any dead or rotting roots using sterilized scissors or pruners.

Place a layer of potting mix at the bottom of the pot, then position the orchid in the center, spreading out the roots evenly. Fill the pot with the potting mix, ensuring that the roots are securely nestled but not buried too deeply.

After care

Light: Provide bright, indirect sunlight for epiphytic orchids, avoiding direct sunlight which can cause leaf burn.

Watering: Water the orchids thoroughly when the potting mix begins to dry out, typically every 7-10 days. Allow excess water to drain away to prevent waterlogging.

Humidity: Maintain humidity levels between 50% to 70% to replicate the orchid's natural environment. Place a humidity tray filled with water and pebbles beneath the orchid pot, or use a room humidifier.

Temperature: Keep temperatures consistent between 15 to 29°C, avoiding extreme fluctuations.

By providing the appropriate potting media and following proper cultivation techniques, you can successfully grow and care for epiphytic orchids, allowing them to thrive and bloom beautifully in your home or garden.

Looking into the future market, the Fox Tail Orchid is poised to have a significant impact on the floriculture industry. As consumer demand for unique and exotic flowers continues to grow, the orchid's distinct appearance and cultural significance position it as a desirable choice for both domestic and international markets. With advancements in cultivation techniques and global trade networks, the Fox Tail Orchid holds promising potential for increased commercial production and market expansion within the floriculture industry. As consumer preferences evolve towards sustainable and ethically sourced products, there's also an opportunity for the orchid to lead initiatives promoting responsible cultivation and conservation efforts.

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Nutritional Importance and Medicinal Properties of Burmese Grapes

Shubham Maurya[1], Tasso Yatung[2] and Rampreet Singh[3]

[1]Research Scholar, Department of Vegetable Science, College of Horticulture and Forestry Pasighat, Arunachal Pradesh, India

[2]Department of Horticulture, Multi Technology testing Centre and Vocational Training Centre, Pasighat (CAU), Arunachal Pradesh, India

[3]Research Scholar, Department of Fruit Science, College of Horticulture and Forestry Pasighat, Arunachal Pradesh, India

*Corresponding Author: shubhammauryaup44@gmail.com

Abstract

The goal of this article is to examine the underutilized Burmese grape (*Baccarea ramiflora*), which is an excellent food crop cultivated in the northeast of India. In spite of having these berries is used in a variety of culinary dishes and regional specialties. It stands out for having a wealth of naturally occurring bioactive compounds that have a variety of health advantages. These naturally occurring compounds have shown cytotoxic, anti-inflammatory in nature anti-obesity, and antidiabetic effects. Due to the fruit's high mineral content and antioxidant qualities, many non-communicable diseases can be effectively eradicated at a relatively low cost. Omega-9 fatty acids and other commercially significant fatty acids are present in seed oil. Therefore, it is necessary to draw attention to and promote the economic potential of this underappreciated fruit. Through research and development, it can help create wealth and reduce poverty in areas with abundant biodiversity.

Introduction

Burmese grape (*Baccaurea ramiflora* Lour.) is an underutilized fruit crop growing primarily in backyard plantations and as a forest plant in the Euphorbiaceae family (Raghavan and Ramjan 2018). *B. ramiflora* is grown in the foothills of the Himalayas (Nepal to Sikkim), the northeastern states of India (Assam, Tripura, and Arunachal Pradesh), and the southern part of the country (the Andaman and Nicobar Islands). It is also found in neighboring nations, mostly in tropical moist forests, such as Bhutan, Tibet, Burma, Thailand, Peninsular Malaysia, Vietnam, Laos, and Cambodia. (Sundriyal & Sundriyal, 2003). The hard, long-lasting timber of *B. ramiflora* is frequently used to make furniture, and its fruit is one of the most valuable nutritional sources for humans. It is a short to medium-sized, evergreen plant with slow growth. The fruit is referred to locally as "Latka," "Latkan," "Lotko," or "Notko." It is primarily consumed as fresh fruit and has a mild acidity. The tree is an evergreen, dioecious plant that prefers shady situations.

Its approximate contents are as follows: 35.6% water, 51.9% carbohydrates, 5.58% protein, and 20.4% fibre. For every 100g of fruit pulp, the fruit contains an abundance of magnesium (504 mg), potassium (730 mg), phosphorous (132 mg), and iron (100 mg). It contains a significant amount of ascorbic acid, which contributes to its antioxidant properties.

Health Benefits of Burmese grapes

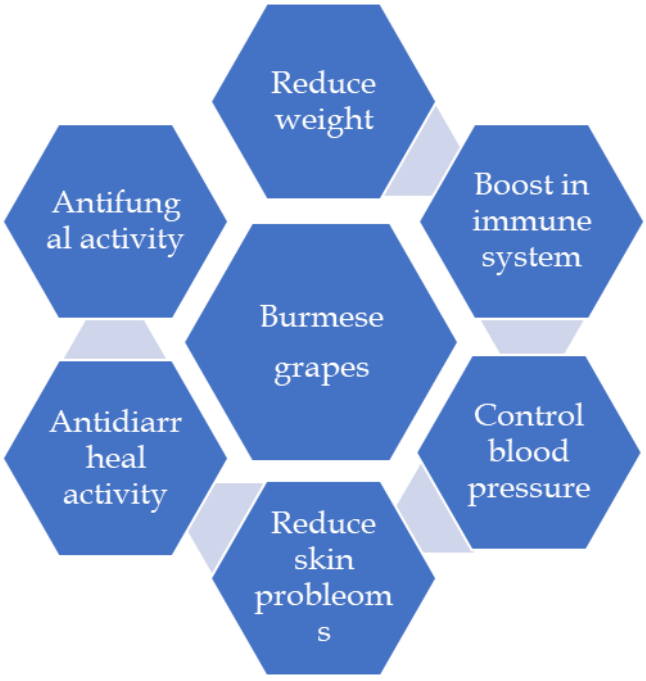

Fig 1: Health benefits of Burmese grapes

1. Boost immune system: It has excellent antioxidant qualities and is abundant in different phytochemical substances, such as phenolic compounds. By lowering low-density lipids (LDL) and raising high-density lipids (HDL) cholesterol, which help prevent the buildup of plaque in arteries that can result in a heart attack or stroke, omega-9 fatty acids can help lower the

chance of cardiovascular disease and stroke. The fruit

are rich in ascorbic acid.

Fig 2 & 3: Fruit of B. Grapes and Seed of B. Grapes

2. Control blood pressure: *B. ramiflora* is a rich source of numerous vital macro- and micronutrients that support and sustain a typical, healthy lifestyle. Potassium contains a significant mineral in a very high concentration (730 mg). Clinical studies have shown that potassium is a very useful mineral for reducing blood pressure and managing heart-related issues like cardiac arrest (Rohilla, S. 2023).

3. Glowing skin: Burmese grapes are incredibly high in vitamin C content. Fruits naturally contain acid. One of the most potent antioxidants is vitamin C. These goods give you really glossy skin.

4. Reduce weight loss: Burmese grapes are low in calories and can help people lose weight. It reduces the urge to eat and makes your stomach feel fuller. To treat baldness, apply leaf juice to the scalp for 21 days. The plant's leaf juice works wonders for treating febrifuge, edema, alopecia, and subacute liver enlargement cases.

5. Antifungal activity: After three picrotoxin sesquiterpenes were extracted from the berries, antifungal activity was demonstrated by all three compounds, with the lowest inhibitory concentrations being 12.5, 12.5, and 50 mg/ml. (Pan *et al*., 2015). This fruit's pulp has a good amount of vitamin C (178 mg/100 g), which is well-known for its antifungal and anti-browning properties (Haque *et al*., 1970).

6. Antidiarrheal activity: Burmese grape seeds and pulp can lower the test animal's risk of diarrhoea by 63.03% and 59.7%, respectively, of the extracts. Over the course of four hours, there is a decrease in the test animals' feces.

Conclusions

Fruit pulp has a sour and sweet combination that the food processing and brewing industries can market. The fruit is high in minerals and a good source of vitamin C, which has been shown to have antioxidant properties. These qualities can help eradicate many non-communicable diseases in a very economical manner. Seed oil can also be extracted and commercially exploited due to the presence of omega-9 fatty acids as well as other commercially important fatty acids in it. As a result, it is necessary to promote and highlight the economic potential of this underutilized fruit, as well as to aid in the conservation of bio resources.

Future prospects

Burmese grapes are very nutritious underutilized fruit and rich in bioactive compounds. These fruits are highly potential to medicinal properties. In future development of a proper package and practices of fruits because North eastern region is rich in diversity and very valuable fruit crops.

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Parkia roxburghii - A Potential Solution for Global Food Security and Beyond

Siddhartha Singh, Athikho Kayia Alice, Shubranil Das, Tabalique Yumkhaibam and Amit Kumar Singh
College of Horticulture & Forestry, Central Agricultural University (I), Pasighat, Arunachal Pradesh
*Corresponding Author: siddharthasingh786@gmail.com

Various plant species that have been neglected and underutilized, yet are rich in nutrients and well-suited for low-input agriculture, hold significant potential in bolstering global food security (Dansi et al., 2012). These underutilized resources boast higher nutritional content compared to commonly produced and consumed species or varieties on a global scale (Ebert, 2014). By harnessing the potential of such species, there is a possibility to improve nutrition and combat hidden hunger. *Parkia roxburghii* G. Don, also known as tree bean, is a swiftly growing leguminous plant found across Southeast Asia and the Pacific region. It is prevalent in India's Northeastern states, where it is referred to by various vernacular names such as Manipur-Urohi, Khorial in Assamese, Manipuri seems in Bengali, Zawngtah in Mizo, Yongchak in Manipuri, Aoelgap in Garo, Unkamn-pinching in Naga, and Bairethai in Dimasa (Firake et al., 2013).

This medium-sized tree, ranging from 10 to 20 meters in height, is commonly cultivated in home gardens, jhum fallows, and marginal lands alongside roads in northeastern India (Angami et al., 2018). Its flowers, tender pods, and seeds are edible and offer a rich source of carbohydrates, vitamins, minerals, and proteins compared to other legumes (Seal, 2011). Considered an underutilized plant with diverse utility and benefits, this species holds significant potential (Firake et al., 2013). While *P. roxburghii* has garnered attention for its nutritional value and biological properties (Singh et al., 2020), there remains a dearth of information regarding its role in environmental management. Hence, this article seeks to present updated insights into the diversity, distribution, traditional uses, and its significance in food security.

Diversity, Distribution and botanical description

Parkia, a genus widely distributed across the tropics, encompasses approximately 35 species, predominantly found in tropical America, notably within the Amazon basin. Among these, the African locust bean plant (*Parkia biglobosa*) stands out as a significant species of South Africa, representing one of the 34 recognized species within the Parkia genus (Amusa et al., 2014). Across Asia, Parkia's presence extends from northeastern India and Bangladesh eastward through Southeast Asia, with additional species occurring in Micronesia and Fiji (Hopkins, 1994). Detailed taxonomic descriptions of Parkia species from both the New and Old World have been meticulously documented (Hopkins, 1994). Notably, *Parkia roxburghii* G. Don. (Syn. *Parkia timoriana* (DC.) Merr.) emerges as the most widely distributed species across the Indo-Pacific region (Hopkins, 1994). In India, this species is observed in various regions including Arunachal Pradesh, Cachar hills of Southern Assam, Garo and Khasi Hills of Meghalaya, Lushai Hills, Kolasib–Bukpui, and Sialsuk road in upper Thenzawl area of Mizoram, Imphal, Kangpokpi, and Pachao of Manipur (Angami et al., 2018). It is also documented in Chittagong and Sylhet of Bangladesh, Myanmar, and the Malay Peninsula.

Parkia trees typically reach medium size, featuring grayish-brown bark and reaching heights of 15–25 meters. Flowering occurs from September to October, with fruits maturing approximately four months after flowering, available for harvest from January to March. Pods develop in clusters of 10–15, suspended on elongated stalks measuring 25–40 cm in length and 2–4 cm in width. Leaves are compound bipinnate, spirally arranged or alternating, hosting anywhere from 500 to 3500 leaflets per leaf. Inflorescence is terminal, arranged in a racemose fashion, with flowers clustered at the end of a peduncle up to 45 cm long. Flowers are white and yellow, measuring approximately 1 cm in length. *Parkia roxburghii* follows an annual phenological cycle, marked by a brief period of leaflessness succeeded by the emergence of new, light green, shiny leaves (Thangjam et al., 2020). Notably, *P. roxburghii* exhibits remarkable complexity within the genus, with only 9-17 fruits produced from its numerous fertile flowers in a capitulum (Hopkins, 1994).

Nutritional Status

The green pods serve as a valuable reservoir of crude proteins and energy (Rocky et al., 2004).

Notably, the tender pods exhibit elevated levels of diverse minerals such as Na, Ca, K, and P, whereas the mature pods are characterized by a higher concentration of Mg, Fe, Mn, and Cu (Table 1). The mineral distribution within the pods follows the sequence of pulp > testa > cotyledon (Salam et al., 2009). Furthermore, the protein fractionation analysis of the seeds reveals a lower globulin to albumin ratio (1.6), suggesting improved protein digestibility and nutritional value when utilized as a vegetable (Salam et al., 2009). Moreover, the seeds contain relatively lower levels of anti-nutritive and toxic components such as phytate, phosphorus, trypsin inhibitors, and saponins, which can be effectively eliminated through conventional processing and cooking methods (Salam et al., 2010). Given the challenges of achieving sustainable development in countries like India, where feeding a population of 1.3 billion remains a pressing concern despite economic growth, the nutritional profile of this species emerges as a crucial asset for enhancing food security (Salam et al., 2010).

Table 1: Nutritional variation in tender pod, mature pod and mature kernel of *Parkia roxburghii*

Nutritional Parameters	Tender Pod	Mature Pod	Mature Kernel
Moisture (%)	8.4	6.7	10.0
Protein (%)	12.1	18.8	28.8
Fat (%)	1.0	15.5	33.5
Ash (%)	7.4	6.1	5.7
Carbohydrate and Fabre (%)	71.1	52.9	22.0
Energy (kcal)	342	426	505
Phosphorus (mg/ 100 g)	320	298	270
Magnesium (mg/ 100 g)	520	480	420
Calcium (mg /100 g)	176	172	180
Iron (mg/100 g)	8.8	9.1	13.3
Manganese (mg/ 100 g)	2.8	2.4	2.9
Zinc (mg/ 100 g)	3.1	3.3	5.6
Copper (mg/ 100 g)	0.6	0.6	0.7
Chromium (µg /100 g)	74.0	71.0	79.0

Source: Roy et al., 2016

Role in food and nutritional security

Parkia, a significant edible legume in South Asian countries, plays a crucial role in ensuring food security, ecosystem maintenance, and supporting farmers. With low fat and high fiber content, it offers health benefits (Roy et al., 2016). Parkia pods are available in markets annually from December to March, with consumption ranging from tender light green pods, approximately 30 cm in length, to maturity. These pods are consumed fresh, raw, or sundried during off-seasons, serving as a supplementary food source (Longvah & Deosthale, 1998). This multifunctional crop not only enhances food and livestock provision but also serves as a dependable income source for growers and users. Parkia's mature seeds boast high-quality proteins with no limitations in essential and semi-essential amino acids, distinguishing it among legumes (Longvah and Deosthale, 1998). Furthermore, chemical analysis by revealed that mature kernels have notable moisture (10.0%), protein (28.8%), fat (33.5%), energy (505 kcal), iron (13.3mg/100g), manganese (2.9 mg/100g), zinc (5.6 mg/100g), and chromium (7.9 µg/100g) content compared to tender and immature pods. However, tender pods exhibit higher carbohydrate and fiber (71.15%) content (Roy et al., 2016).

Tribal communities have a diverse array of culinary uses for tree beans. These beans, marketed as vegetables, feature prominently in various dishes. In Manipur, for instance, they're a key ingredient in 'Singju,' a traditional salad. Additionally, the scraped and sliced skins are combined with fish to prepare 'eromba,' a distinctive curry. Pickling the pods is a popular method of consumption, while tribes like Garo, Khasi, Reang, Naga, and Mizos incorporate them into their cuisine as well. Furthermore, both the flowers and mature seeds find their way into tribal diets, either raw or cooked alongside meat. Though bitter, the seeds become palatable after roasting or boiling. Notably, the characteristic pungency of Parkia derives from thioproline, a cyclic sulfur-containing amino acid, with demonstrated anticancer properties. This species enjoys culinary and medicinal use across India and beyond, particularly in Northeastern states like Manipur, Mizoram, and Nagaland, where various

tribal communities utilize different parts of the plant in salads, curries, and even diabetes treatment through bark decoction. Moreover, minor tribes such as Kacharis, Dimasa, Mikir, and Garos employ bark paste as a remedy for eczema (Rathi et al., 2012).

Application in traditional Medicine

The medicinal properties of the bark of *P. roxburghii* have been well-documented. It serves as a lotion for treating cancer and various skin ailments (Angami et al., 2018). Additionally, even the dry seeds of the plant are utilized in non-seasonal culinary dishes. Traditional healers utilize tender pods and bark from sacred groves to address intestinal disorders such as piles, dysentery, and diarrhea (Khumbongmayum et al., 2005). Moreover, a decoction made from the bark, fruit skin, and leaves is employed to manage diarrhea and dysentery. In Northeast India, the Dimasa and Kachari tribes apply a paste made from the bark as a plaster for eczema treatment. Not only does the bark contain antioxidants, but it also possesses therapeutic properties that enhance children's cognitive abilities (Angami et al., 2018). Furthermore, a lotion crafted from the bark and leaves is utilized for treating skin diseases and ulcers. Ethnobotanical studies have highlighted the effectiveness of seeds and pods from *P. roxburghii* in alleviating stomach disorders and regulating liver functions (Roy et al. 2016). In some practices, pods are crushed in water and used for facial and scalp cleansing.

Conclusion

Exploration of neglected and underutilized plant species, particularly *Parkia roxburghii* G. Don, underscores a significant opportunity in addressing global food security challenges. Despite being an underutilized resource, *P. roxburghii* offers a rich source of nutrients and holds immense potential for low-input agriculture. Its widespread distribution across Southeast Asia and the Pacific region, coupled with its nutritional richness, makes it a valuable asset in combating hidden hunger and improving nutrition. Furthermore, the multifunctional nature of *P. roxburghii* extends beyond its role in food security to encompass environmental management, traditional medicine, and income generation for local communities. The study of *P. roxburghii* exemplifies the untapped potential of underutilized plant species in addressing multifaceted challenges, including food security, nutrition, and health. Further research and investment in harnessing the capabilities of such species are essential for promoting sustainable agriculture, improving livelihoods, and enhancing human well-being on a global scale.

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Averrhoa bilimbi: A Repertory of Ethnomedical Benefits

Chandhni P.R[1*] and Lakshmipriya P.R[2]

[1*]Assistant Professor, Department of Food technology, TKM Institute of Technology, Kollam, Kerala

[2] Ph.D Scholar, Faculty of Fisheries Engineering, Kerala University of Fisheries and Ocean Studies (KUFOS), Ernakulam, Kerala

*Corresponding Author: chandhnipr189@gmail.com

Averrhoa bilimbi is commonly known as bilimbi. It is a fruit-bearing tree of the genus Averrhoa also known as tree sorrel which belongs to *Oxalidaceae* family. It is an underutilized crop mainly cultivated in home gardens. Bilimbi cultivation prefer warm and moist conditions with a proper rainfall but its flowering is initiated by dry season. It bears small flowers which are slightly fragrant. Fruits are oblong shaped flesh berry with a smooth shiny surface and juicy extremely acidic in nature. Bilimbi is reported to have many health beneficial properties like fighting against microbes, as an antioxidant, improving liver health, healing of wounds, lowering blood sugar levels, cholesterol and improving heart health. Since this crop is having many medicinal uses it can be utilized as a flavouring agent, for preparing tasty dishes like Bilimbi toffee, squash, curry, wine vinegar, pickles, etc and as a substitute for tamarind in recipes. They are also frequently consumed raw.

Bilimbi as an Antimicrobial Agent

The widespread development of antimicrobial resistance in recent years had led to a renewed search for newer antimicrobial agents for the treatment of infectious diseases. According to reports, the ethanol extract from the leaves of *A. bilimbi* demonstrates significant antibacterial action against six pathogenic pathogens, including Gram-positive and Gram-negative bacteria. The younger fruits were found to be effective against *E. coli* whereas mature fruits against *S. aureus*. The chloroform extracts of bilimbi's leaves and fruits have showed positive antibacterial activity against many important pathogenic bacterias like *Staphylococcus aureus*, *Staphylococcus epidermis*, *Bacillus cereus, Salmonella typhi,* etc (Astillo *et al*., 2022). It was also used as a natural method of decontaminating shrimps just before its preparation and consumption by reducing the microbial load especially *L. monocytogenes* and *S. typhimurium.* Additionally, it has been found that the leaf extracts exhibit modest antifungal activity against *Candida albicans*, *Cryptococcus neoformans*, and *Blastomyces dermatitidis*.

Bilimbi for lowering cholesterol

The three major types of lipids found in the body are phospholipids, triglycerides, and cholesterol. The main risk factors for the onset of peripheral vascular disease, coronary artery disease, cerebrovascular disease, and cardiovascular disorders are elevated blood lipid levels. Heart attacks and strokes are frequently caused by these disorders. In addition to having an impact on the brain, hypercholesterolemia can constrict the blood vessels in the kidneys, heart, and eyes (Alhassan *et al*., 2016). Atherosclerosis in the heart leads to a stroke and coronary artery disease. Bilimbi contains bioactive substances such as terpenoids, tannins, phenols, and flavonoids which helps in lowering bad cholesterol (LDL, VLDL) and raise good cholesterol (HDL).

Bilimbi for Antidiabetic activity

Diabetes is a multifactorial illness that can cause a number of problems. There are several disadvantages to the current pharmacological regimens for managing diabetes. There is a need for safer, more effective natural medications with strong antidiabetic effects. *Averrhoa bilimbi* is said to have hypoglycemic properties. The reason for this is because bilimbi extracts are found to have flavonoid chemicals that have the ability to reduce blood glucose levels by blocking the intestinal absorption of glucose and inducing the release of insulin by pancreatic beta cells via the control of calcium metabolism. Additionally, flavonoids provide antioxidant qualities that help shield from free radicals.

Bilimbi against Hypertension

Hypertension is sometimes referred to as a "silent killer" as the people not experience any noticeable symptoms to the condition. Eventhough there is a greater chance of serious health issues with uncontrolled hypertension, most people are less concerned about taking the medication on a regular basis. Bilimbi's flavonoids are found to have blood pressure-lowering effects. It's possible that the flavonoids will widen blood vessels and lessen blood

flow resistance (Melania *et al*., 2018). Volatile components, including oxalate compounds, phenol, flavonoids, and pectin, amino acids, citric acid, phenolics, and potassium ions are all present in *Averrhoa bilimbi* which contributes to lowering blood pressure.

Bilimbi as Biopesticide

Researchers were especially interested in Averrhoa bilimbi because of its flavonoid and saponin levels, which might be tested against insects. Numerous investigations have been carried out to manage termites, cockroaches, and mosquitoes. For vegetable species, *Averrhoa bilimbi* is employed as a biopesticide to manage armyworm. This insecticide has a single active ingredient that performs multiple roles, including insect repellant, antifertility toxin, etc. for larvae, the alkaloid, saponin, and phenol are poisonous substances. This substance can irritate the mitochondria's ability to transport electrons, which prevents the larval cells from activating and ultimately leading to their death.

Future potential as value added products from bilimbi

Bilimbi is abundant in bioactive chemicals and it has the potential to be used as an antibacterial, pest control in agriculture and also as liver medicine. Even though it is a rich source of many beneficial components, it is a fruit that isn't utilized much. The fruit serves as a preservative and flavouring. Another possible product developed is bilimbi-coconut water jam created with enhanced flavor and optimized nutritional qualities (Swedha *et al*., 2022). Simple and inexpensive juices can also be made from this readily accessible fruit by optimizing the color, flavor and other ingredients. Chutneys can be made with bilimbi in place of raw mango and tamarind. Since it is usually found in home gardens, bilimbi fruits are made to pickle by adding salt and spices like cinnamon, cardamom, cloves, and black pepper. Moreover, it has high commercialization and marketability potential due to its long storage life and low cost.

Conclusions

Bilimbi's leaves and fruits can be used to cure a variety of illnesses, such as microbial infections, diabetes, and hypertension. It has been shown to be beneficial in complementary medicine and has been clinically verified for pharmacological procedures. Bioactive chemicals are abundant in bilimbi like flavonoids and phenols so the fruit syrup is used to cure internal haemorrhoids, stop rectal bleeding, and treat inflammations. Leaves are used as a paste to fought itchiness, mumps, rheumatic swellings, skin eruptions etc. Advanced research in the field of bioactive compounds contained in this plant will open up many opportunities to bring out the potential benefits and utilize bilimbi for many health issues in the form of novel food preparations.

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Unlocking the Potential of Underutilized Horticultural Crops

Gunja Thakur
[1]Ph. D. (Hort.), Research Scholar, Department of Fruit Science, COA, Raipur
IGKV, Raipur (C.G.) – 492012, India
*Corresponding Author: gunju1696@gmail.com

Underutilized horticultural crops, often referred to as neglected or minor crops, are a diverse group of plant species that have the potential to significantly contribute to global food security, nutrition, and sustainable agriculture. These crops, which are not widely traded or grown on a large scale, are rich in nutrients, adaptable to various agroecological conditions, and can help improve the resilience of farming systems in the face of climate change.

Nutritional and Economic Benefits

Underutilized crops are valued for their high content of vitamins, minerals, and proteins, making them important components of a balanced diet. They are also tolerant to harsh environmental conditions, which can make them more resilient to climate change. By incorporating these crops into farming systems, rural communities can improve their food security and nutrition, while also generating income from the sale of these crops.

Research and Development

Recent years have seen a shift in policy and research efforts towards harnessing the benefits of underutilized horticultural crops. The use of omics approaches, such as genomics, proteomics, and metabolomics, has provided valuable insights into the biology of these crops, helping to improve their production and nutritional qualities.

Challenges and Opportunities

Despite their potential, underutilized horticultural crops face several challenges, including a lack of availability of planting material, limited awareness of their nutritional and medicinal importance, and a lack of information on production techniques. However, these challenges also present opportunities for research, development, and policy interventions to promote the cultivation and consumption of these crops.

Government Initiatives

Governments around the world are taking steps to address the challenges associated with underutilized horticultural crops. For example, the Indian government has launched initiatives such as MIDH (Mission for Integrated Development of Horticulture), MEIS (Merchandize Export from India Scheme), and a national coordinated project to promote research on underutilized crops.

Some other important highlights on Underutilized Horticultural Crops

Underutilized horticultural crops offer numerous benefits and play an important role in global food security, nutrition, and sustainable agriculture. Some of the key importance of underutilized crops include:

1. Nutritional value: Underutilized crops are rich in vitamins, minerals, and proteins, making them important components of a balanced diet.

2. Adaptability: These crops are often adapted to harsh agro-climatic conditions, making them more resilient to climate change.

3. Diversification: Underutilized crops can help diversify crop rotation, improving soil health and reducing the incidence of pests and diseases.

4. Food security: By expanding the range of crops grown, underutilized crops can contribute to food security, particularly in regions where traditional crops are not sufficient.

5. Income generation: Underutilized crops can provide income for rural communities, helping to alleviate poverty.

6. Cultural biodiversity: These crops are linked to the cultural heritage of their places of origin, and their cultivation helps to preserve cultural biodiversity.**7. Medicinal properties:** Many underutilized crops have medicinal properties, making them valuable for traditional medicine and pharmaceutical industries.

8. Environmental services: Underutilized crops are adapted to marginal soil and climate conditions, and their cultivation can help to mitigate environmental problems.

Despite their potential, underutilized crops face several challenges, including a lack of availability of planting material, limited awareness of their nutritional and medicinal importance, and a lack of information on production techniques. However, these challenges also present opportunities for research, development, and policy interventions to promote the cultivation and consumption of these crops.

By addressing the challenges associated with underutilized horticultural crops, researchers, policymakers, and farmers can work together to unlock their full potential and contribute to a more resilient and equitable global food system.

Characteristics and Potential Uses of Indigenous Underutilized Fruit Crops

Abiotic stresses caused by environmental factors are the most common yield-limiting factors globally, and they cause up to 70% of the yield losses in major fruit crops. In order to cope with abiotic stresses, the arid-zone underutilized fruit crops, such as ber (*Zizyphus spp.*), aonla (*Emblica officinalis*), bael (*Aegle marmelos*), jamun (*Syzigium spp.*) and wood apple (*Feronia limonia*), have modified and/or developed their organs to assure vital morpho-physiological functions (i.e., strong deep root system, a high root-to-shoot ratio for reaching into deeper moist soil layers and uptake more water and nutrients.

Similarly, crops such asber, bael, lasora (*Cordia mixa*) and pilu (*Salvadora persica*) have round, thick and barked stems for easier water storage and reduced cuticle transpiration.

Some crops such as kair (*Capparis decidua*), lasora, aonla and pilu have synchronized flowering and fast fruit development during the season characterized by larger moisture availability. Crops such as ber, phalsa and bael exhibit leaf shedding/dormancy for reducing water loss in summer and for protecting the plants from frost in winter.

Similarly, other underutilized crops possess numerous morphological characters, such as spines instead of leaves (ber), scanty foliage (kair), spiny cladodes (prickly pear), mucilaginous sap for reduced transpiration loss (kair, lasora, pilu, bael, etc.), small-sized and thick leaves, fur/hairiness and waxy coating on the leaf surface and sunken and deep stomata, for water saving through the reduction in transpiration rate and heat shocks (ber, phalsa, lasora, fig), and selective or reduced absorption of cation and anions. These characteristics are also associated with the accumulation of osmolytes, compatible organic and inorganic solutes (proline, phenolics, flavonoids, soluble sugars, glycine, betaine, etc.), and biosynthesis of enzymatic and non-enzymatic antioxidants, heat shock proteins and drought-responsive genes to maintain cell turgor, allowing better survival under the adverse conditions of arid and semi-arid environments.

In addition, the genetic basis of the adaptive traits deserves to be studied because this information could be used in future breeding programs that may also involve novel tools, such as genome editing. These underutilized fruit crops may represent the next generation of futuristic crops, which could enhance the farmer's income through sustainable production systems even under a climate-change scenario.

Some examples of underutilized horticultural crops include

Fruits and Nuts

Citrus grandis	Pummelo
Cornus mas	Cornelian Cherry
Anacardium occidentale	Cashew
Annona cherimola	Cherimoya
Annona muricata	Soursop
Annona squamosa	Sugar apple
Artocarpus heterophyllus	Jackfruit
Averrhoa carambola	Star Fruit

Kair

Wood apple

Aonla

Ber

Bael

Vegetable Crops

Amaranthus spp.	Amaranth
Asparagus officinalis	Asparagus
Lactuca sativa	Lettuce
Apium graveolens	Celery
Allium porrum	Leek
Cynara scolymus	Globe Artichoke
Amorphophallus campanulatus	Elephant Foot Yam
Brassica oleracea var. gemmifera	Brussels Sprouts
Brassica oleracea var. gemmifera	Brussels Sprouts
Brassica oleracea var. acephala	Kale
- Brassica compestris spp.	Chinese Cabbage
- Psophocarpus tetragonolobus	Winged Bean
- Canavalia ensiformis	Jack Bean
Cucumis anguria	Pointed Gourd

Kale

Pointed gourd

Winged bean

Brussels Sprouts

These crops are considered underutilized due to a variety of reasons, including lack of availability of planting material, limited awareness of their nutritional and medicinal importance, and lack of information on production techniques. By addressing these challenges, researchers, policymakers, and farmers can work together to unlock the full potential of underutilized horticultural crops and contribute to a more resilient and equitable global food system.

Conclusion

Underutilized horticultural crops offer a wealth of opportunities for improving food security, nutrition, and sustainable agriculture. By addressing the challenges associated with these crops, researchers, policymakers, and farmers can work together to unlock their full potential and contribute to a more resilient and equitable global food system.

Underutilized horticultural crops are a diverse group of plant species that have the potential to contribute significantly to global food security, nutrition, and sustainable agriculture. While they are not widely traded or grown on a large scale, they offer valuable nutritional and medicinal benefits, as well as adaptability to various agroecological conditions.

Underutilized horticultural crops offer a wealth of opportunities for industrial applications, as well as for improving food security, nutrition, and sustainable agriculture. By addressing the challenges associated with these crops, researchers, policymakers, and farmers can work together to unlock their full potential and contribute to a more resilient and equitable global food system.

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Custard Apple An Economically Significant Major Arid Fruit Crops: Its Recent Varieties and Other Species

Bharti Choudhary[1] and Rahul Dongre[2]

[1]Technical Officer, AICRP-AZF, Department of Horticulture, CoA, JNKVV, Jabalpur (M.P.)

[2] Scientist, Department of Forestry, CoA, JNKVV, Jabalpur (M.P.)

*Corresponding Author: bharati.choudhary06@gmail.com

Custard apple is one of the important topical fruit crops in India. The Annonaceous fruits originated in tropical America and are widely distributed in tropics and sub tropics. Among annonaceous fruits, custard apple is the most popular in India. It's distributed in Andhra Pradesh, Assam, Bihar, Karnataka, Maharashtra, Madhya Pradesh, Orissa, Rajasthan and Tamil-Nadu as a scrub or hedge plant. Other annonnas are cultivated on a limited scale. Bullock's heart is more commonly found in south India than in north India. It is usually associated with gardens and compounds and not commercial orchards. *Cherimoya* is mostly restricted to Assam and hills of south India. *Atemoya* and sour sop are cultivated in some gardens as miscellaneous fruits. Custard apple (*Annona squamosa* L.) t is commonly found in India and cultivated in an area of 47 thousand ha. with production of 407 thousand MT (NHB, 2020-21).

Custard apple, (genus *Annona*), of about 170 species of small trees or shrubs of the family Annonaceae. The number of genera and species in the family Annonaceae is still debated.

Edible species of custard apple is cherimoya (A. Cherimola Mill.), sugar apple (A. squamosa L.) hybrid between the two, atemoya, which has been assigned horticultural species status (A. atemoya Hort.) are the most popular ones.

The other annona species also producing edible fruits are bullock's heart (A. reticulata L.), Ilama (A. diversifolia Staff), and sour soup (A. muricata L.). The identification of Annona among botanically similar are very difficult and quite confused at times. Atemoya (Cherimoyax Custard apple) was mistakenly called custard apple for many years (Morton, 1987); custard apple is also frequently confused with A. glabra (Pinto et al., 2005)

Some of the Importance Species of Annona

1. **Annona squamosal:** English name custard apple, sweet soup, sugar apple; Indian name sitaphal, sharifa, ate. It is widely cultivated species in India. The plant is deciduous, tall, woody shrub or small tree of about 5 to 6 meters in height with irregular spreading branches. The greenish yellow flowers arise at an extra axillary position, usually in clusters and rarely solitary. Fruits 250-300g; globular; green skin; sweet (20% sugar); non acidic; pulp creamy white; distinct segment, 60-80 seeds /fruit.
2. ***Annona cherimola*:** English Name Cherimola and Cherimoyar, Indian Name- Hanuman phal. The name cherimoya derives from the Quechua name 'chirimuya', which means 'cold seeds. Cherimoya is the only species adapted to subtropical or tropical highland conditions. It is a small, erect and spreading, deciduous tree, rarely reaching a height of more than 7.5 m. It was domesticated in the mid-elevation Andes of South America. The fruits are large green conical or heart-shaped compound fruit with 10-20 cm long with skin that gives the appearance of having overlapping scales or knobby warts. The ripened flesh is creamy white and contains numerous hard, inedible, brown or black, beanlike and glossy seeds. Fruits weight 250-300g, sub-globose, pine like aroma, 18% sugar, segment fused, 10-15 seeds /fruit. The fruits have fused ariols, non-gritty, sub acidic pulp with very good taste and flavour.
3. ***Annona muricata* (Sour Sop):** It is called as sour sop and prickly custard apple because the tree produces fruits that are slightly acidic taste when ripe. *A. muricata* tree is a native of the Caribbean and Central America. The tree is an evergreen with an erect growth habit to about 4 meters (13 ft) tall and cannot stand frost. The fruit is dark green, prickly (or bristled) fruits are egg-shaped and can be up to 30 cm long. The seed contains an average oil content of 24%. Fruits weight 500-750 g, heart shaped; dark green; fleshy pines, pulp is white; fibrous, juicy with mango like flavour; 11-14 %sugar

4. ***Annona reticulata*** **(Bullock's heart):** English name Bullocks Heart; Indian Name Ramphal. Bullock's heart is native of the Caribbean or South America. Leave is alternate, oblong or narrow-lanceolate. Flower is slender, with 3 outer fleshy, narrow petals 2-3 cm long; light-green externally and pale-yellow with a dark-red or purple spot on the inside at the base, borne in drooping clusters, fragrant and never opening fully. Fruit is compound, 8-16 cm in diameter, symmetrically heart-shaped, lopsided or irregular or nearly round or oblate with a deep or shallow depression at the base; rind thin but tough, may be yellow or brownish when ripe, with a pink, reddish or brownish-red blush and faintly, moderately or distinctly reticulated; pulp thick, cream white, custard-like, somewhat granular and sweet. Fruit is large (350-400g); smooth rind with hexagonal markings, pulp pale, gritty, flavored, 12.5% sugar and few seeds (30-40).
5. ***Annona glabra*** **(Pond Apple):** It is also known as Alligator-apple, Swamp apple, Corkwood, Bobwood, and Monkey-apple. The tree is native to Florida in the United States, the Caribbean, Central and South America, and West Africa. It is a known allopolyploid species. It grows in swamps, tolerant to saltwater, and cannot grow in dry soil. The trees grow to a height of around 10–12 m. They have thin, gray trunks and sometimes grow in clumps. The leaves are ovate to oblong with an acute tip, 8–15 cm long and 4–6 cm broad. The fruit is oblong to spherical and apple-sized or larger, 7–15 cm long and up to 9 cm diameter; the immature fruit is green on ripening it turns to yellow. While the grafts initially appear to be effective, a high percentage of them typically fail over time. Sour sop on Pond-apple rootstock has a dwarfing effect.
6. ***Annona senegalensis*** **(wild Sour Sop):** Wild sour sop also called as African custard-apple and wild custard apple. *Annona senegalensis* occurs in the form of shrub or small tree of height 2-6 m and rarely grows up to 11 m. The bark is smooth or coarse texture of gray-silver or gray-brown. The leaf is nearly round; flaking, showing lighter-hued spaces of under bark. Mature flower reaches up to 3 cm in diameter on a 2 cm stalks, either singular, or two to four, ascending from the leaf axils. \It is a traditional food plant in Africa, the fruits of A. senegalensis have the potential to improve nutrition, boost food security, foster rural development and support sustainable land care is well known. Where it grows naturally, it is largely unheard of elsewhere (NRC, 2008).
7. ***Annona atemoya*****:** *Atemoyas* are hybrids between *A.squamosa X A. cherimoya,* Indian Name - Lakshaman phal. The plant is semi-deciduous, sub-tropical tree being tolerant to frost; large spreading tree, 5m height. Fruit weight 500 g, globular green; white smooth pulp is very juicy with excellent sugar acid blend; large segments 10-15 seeds/ fruit. It is a hybrid with distinct improvement over custard apple in respect of seedlessness, fruit size, percent pulp and fruit quality. However low fruit set and yield are its drawbacks.
8. ***Annona diversifolia*** (Ilama): It is a tropical fruit tree found in Central America. The tree is erect at about 7.5m and often the branches begin at ground level. The leave is obovate or oblanceolate. The tree produces long and solitary flowers of maroon color. The fruit is cone-shaped, heart-shaped, or ovular similar to cherimoya. The fruit is 15 cm long and weight about as high as 900 gm. Ilama are of two types, viz., green and pink type.

Varieties of Custard apple

Introduced variety

- Mammoth: introduction from West Indies
- Barbados: This is also a introduction from West Indies,
- British Guiana: This is also a introduction from West Indies,

Exotic Varieties of Custard Apple in India

- **Thai Lessard:** It is one of the most important cultivars in tropical and subtropical areas. Pulp is sweet custard like. The fruit diameter is 7.5 to 12.50 cm with a lumpy green skin. At maturity the fruit colour turns to bluish or white blush and has

custard like white pulp with small black seeds. The sweet flesh is eaten fresh or used for milk shakes and ice creams. Older trees may continue fruiting into January during warm winter.

- **Kampong Mauve: The** fruit is round in shape or heart-shaped or ovate or conical, 2 to 3 inches in diameter, yellowish green, green, pink or purple in colour with attractive nature. The surface is a tuberculate and covered with a whitish bloom. The pulp is white, sweet and a little acidulous in flavor. The carpels, both of which normally contain a brown seed the size of a small bean, go together loosely or not at all. The distinction of custard apple from cherimoya is that it is difficult to distinguish capillary divisions in the flesh.
- **Israeli Selection:** Fruits are less seeded.
- **Israeli Hybrid:** Fruits are less seeded
- **Pink's Mammoth**: The tree produces commercial crops at the age of 6-7 years. Its fruit are large, ranging from 800 g to 2000 g.
- **KJ Pinks**: It is a bud sport of the custard apple 'Pink's Mammoth'. It is a high yielding variety and now being grown commercially. It is being used in the breeding program. This variety naturally sets fruit at 41 per cent, compared to less than three per cent for other varieties. It is very suitable for higher density training systems such as the Maroochy-V trellis and hedge row systems.
- **African Pride:** It was introduced into Australia from South Africa. It is a precocious and high yielding variety. Fruits are small to medium in size.
- **Bradley:** The tree bears small sized fruits having relatively smooth and thin skin.
- **Page :** It is a Florida cultivar which produces medium-sized fruit with prominent skin segments
- **Gefner:** It is an Israel cultivar, where it was introduced into Australia. Fruit are small to medium size, similar to 'Page'.

The Varieties Developed by Selection

- **Balanagar:** The selection was identified at Fruit Research Station, Sangareddy, Andhra Pradesh. This is a good variety mostly grown in South India. It is also becoming popular in farmers of Gujarat. The variety is performing well in West Bengal. The tree produced average number of fruit (51.4) with fruit weight (137.0 to 264.0 g) and seed weight (5.7 g/fruit).
- **Red Sitaphal:** It is a distinct cultivar which probably originated in India as a chance seedling (Venkataratnam,1965). Trees are dwarf, leaves have purplish mid rib. Fruits and floral parts are light reddish-purple colour. (Thakur and Singh, 1967). Number. of flowers /shoot 243, percent fruit set 3.97, with average number of fruits per tree 22.0, fruit weight 119 to 156.0 g, seeds / fruit was 50 and seed weight 5.2 g.
- **Gujarat Junagadh Custard Apple-1 (GJCA-1):** This variety was developed with clonal selection from Sindhan cultivar by the Department of Horticulture, Junagadh Agril. University, Junagadh (Gujarat) and released during 2009. It has higher plant height and plant spread as compared to local. The GJCA-1 produced higher fruit yield (27 kg/tree) with 45.86 per cent higher than Sindhan. The fruit is attractive, green colored, oblong with medium size. The pulp is in higher quantity with white, agreeable flavour with sweet taste. It is recommended for Saurashtra region of Gujarat.
- **AKP-CA-1:** It is a clonal selection from a high yielding type in the State Horticultural farm, Courtallam, Tamil Nadu released in 2003. It bears higher yield in rainfed vertisol (black soil). It is a drought tolerant variety which bears sweet fruits with TSS of 24.5 Brix and acidity of 0.2%. The tree gives mean fruit weigh of 207.5 g and 72 fruits per tree per year. It yields about 7300 kg fruits / ha (14.90 kg / tree which are 30.7 percent higher than 'Balanagar'). The first bearing commences in a graft/budded plant is 3-3 ½ years. It is suitable for cultivation in plains of Tamil Nadu especially in semi-arid regions and marginal soils of both vertisol and alfisol in dry tracts. It is also suitable for both rainfed and irrigated conditions.
- **NMK 1:** It is a selection made by Shri N.M. Kaspate in his orchard. 'NMK-1', is suitable for all

types of soils for plantation with a distance of 10 feet x 15 feet. The tree bears 100-125 fruit/tree, the yield and productivity of this selection is about 15-19 t/ha with 70-80% grade-1 fruits. Fruits of this selection are very attractive in colour and in size, have a smaller number of seeds per fruit and berry is quite big. The unique feature of this variety is that the fruit remains in the plant itself in good condition (un-ripped) for at least 20-25 days. This feature may help in adjusting the harvesting time based on market demand and cargo facilities. The harvesting of 'NMK1' can be done 2-3 times within 20-25 days as per the market convenience.

- **Annona -2:** The variety is developed by a farmer in Solapur district of Maharashtra. The fruits have less seeds and fruit size ranges from 500 to 750 g; fruit yield 16 to 19 tonnes per hectare, with revenue of Rs. 6 to 8 lakhs
- **Washington PI 98797:** It bears fruit number per tree (21.0), fruit weight ranged from 146 to 161g, seeds / fruit was 48, seed weight 6.9g /fruit, the pulp content is 38.1% with TSS 20.8 B, acidity 0.28%, reducing sugar 12.7% and total sugar 17.9%. Fruit yield / plant was 10.58 kg (Anon., 1987).

Variety Developed by Hybridization

- **Arka Sahan:** It is a hybrid of 'Island gem' (*Annona atemoya* Hort.) x 'Mammoth' (A. squomosa L.) The hybrid yields very sweet, fragrant, low seeded fruits having longer shelf life. The fruits are harvested during September-October. The average fruit weight is 210 g and normally takes about 6-7 days to ripe. The average fruit yield per plant is nearly 17 kg and 12 tonnes/ha. The creamy white colour flesh is juicy with mild pleasant aroma and tender with less number of seeds (9/100 g fruit) and large segments. Mesocarp color white, edible pulp 48.6%.
- **Mammoth:** This hybrid is resistant to drought. Though there is profuse flowering, fruit set was negligible. The fruit set can be improved by hand pollination with the pollen of *Annona squamosa* only. Hand pollination with *A. squamosa* improved fruit set to 83%, while natural set was just 1.2%.

Some other important varieties of custard apple

- **British Guinea:** The tree given average number of fruits per tree 35.0, fruit weight 151.0 g and seed weight 8.4 g. The pulp content is 37.9% with TSS 23.30 B, acidity 0.27%, reducing sugar 15.0% and total sugar 17.9%.
- **Barbados Seedling:** The tree bears an average fruit number per tree 35.0, fruit weight 154.0 g and seed Weight 8.0 g. The fruit pulp content 41.2% with TSS 22.30 B, acidity 0.22%, reducing sugar 13.7% and total sugar 16.5%.
- **Local Sitaphal:** The traditional Sitaphal growing wild in the forest of India. Number of flowers /shoot236.3, percent fruit set 16.34, number of fruits / tree 31, fruit weight 127 to 137 g, seeds / fruit was 48, seed weight 9.2 g /fruit. Fruit yield / plant was 20.7 kg (Anon., 1987).The performance of the variety is the best under semi-arid rainfed condition, only disadvantage is more number of seeds / fruit.
- **Island Gem:** Number of flowers /shoot was 257, percent fruit set was 1.21, and fruit weight 195 to235 g, seeds / fruit was 31 and seed weight 6.5 g /fruit, pulp percent 51.7, TSS 26.6 0Brix, acidity 0.26%, reducing sugar 11.8%, total sugar 15.3%. Yield / plant 2.64 kg and lowest yield / plant was recorded in this variety.
- **Sindhan:** It is very old and indigenous variety of Saurashtra region of Gujarat. It is more popular not only in farmers but in consumers also. Earlier it was naturally grown in forest of Gir and Gir nar as well as waste land of the region. However, now-a-days it is started Cultivation systematically due to its pleasant characteristics. The maximum area and Production of Sindhan goes to Bhavnagar and Junagadh districts of the state. The fruits of this variety are very attractive, green colored, big sized with higher fruit length and girth. The average weight of fruit is 150 to 200 g. The sugar content and TSS in fruit are 16.48% and 23.78%, respectively.

- **Seedless Atemoya:** Percent fruit set 6.34, fruit weight ranged from 186 to 215 g and yield / plant 8.29 kg.
- **Atemoya x Balanagar:** One of the highest yielders due to high fruit set. Number of flowers /shoots 44.0, percent fruit set 49.23, fruit weight ranged from 216 to 255 g, seeds / fruit was 55 and seed weight 11.5 g /fruit, pulp percent was 44.5, TSS 20.00 Brix, acidity 0.26%, reducing sugar 12.7%, total sugar 16.5% and yield / plant was 26.8 kg

The other varieties grown in different parts of India are 'NLD-5', 'NLD-8', 'NLD10', 'MMR-9', ' Bellary', 'Phythota-3, 'MMR-8', 'MMR-9', 'MMR-10' and 'Y. Palli-12'.

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Underutilized Horticultural Crops

Prajwal P.
[1]M. Sc. Research Scholar, College of Horticulture, Mudigere
*Corresponding Author: prajwalpmdg@gmail.com

India is one of the most populous countries of the world and accounts for about one fifth of the world's population with more than 70% of the farming households. The annual population growth rate is around 1.8 percent, whereas, the overall demand for food is expected to grow by 3% or more per annum in the near future. 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. Underutilized crops/plant species as "those species with underexploited potential for contributing to food security, health (nutritional/medicinal), income generation, and environmental services".

What do you mean by underutilized crops?

Neglected and underutilized crops are domesticated plant species used for food, medicine, trading, or cultural practices. They are significant within their local communities but are not widely commodified or studied as part of mainstream agriculture. Such crops may be in declining production. They are considered underutilized in scientific inquiry for their perceived potential to contribute to knowledge regarding nutrition, food security, genetic resistance, or sustainability. Other terms to describe such crops include minor, orphan, underused, local, traditional, alternative, minor, niche, or underdeveloped.

Underutilized crop species as crops whose potential contribution to the national economy have not been adequately explored due to the decreased attention to their production, consumption and utilization (Aboagye et al., 2007).

Features, importance and scope of underutilized horticultural crops

Features of underutilized horticultural crops to be considered a crop as an 'underutilized horticultural crops', it must have the following features:

- The underutilized horticultural crops crop must have scientific proof of food value.
- They must have been cultivated in a specific geographical region or natural habitat and have indigenous uses in localized areas.
- Crop must have less or no proper supply of planting materials.
- Crop must be currently cultivated less than other conventional crops.
- Received little or no attention from consumers, farmers, researchers and policy makers.
- May be highly nutritious and have therapeutic or medicinal properties or other multiple uses.
- Most of the underutilized horticultural crops are hardy and thus resistant to adverse climatic conditions, biotic and abiotic stress.

Importance of underutilized horticultural crops

- The underutilized horticultural crops played a major role in diversification of diet and more balanced form of nutrition there by eliminating malnutrition in rural areas.
- They played a role in keeping alive the cultural diversity through food habits, religious rituals, social exchange and constitute essential biological assets of the rural poor.
- They are effectively deployed to address poverty through employment and income generation
- They provide crop diversification and a hub of genetic resources in conservation and crop improvement.
- Some sections of underutilized horticultural crops are effectively employed in manufacturing traditional herbal medicines, decoctions and drugs in treating several health issues or directly consumed as food to boost the immune system of human body.

Scope of underutilized horticultural crops

The underutilized horticultural crops being hardy and adaptable to adverse climate and soil with India being a diverse climatic country, it is possible to explore the untapped potential of a particular region with a scientific approach and subsequently extend the area under horticultural crops. The increasing demand from consumers in developed and

developing countries for diversity in diets and novelty in foods is creating new market niches for underutilized horticultural crops. These can create opportunities to generate additional income and employment for poor farmers in rural areas. A startup among the unemployed youths can be established to generate income through processing and other value-added products of underutilized horticultural crops. Apart from nutritive value, underutilized horticultural crops are particularly more important for their medicinal values and famous in Ayurvedic medicine. Mostly the local people are familiar with the infusion preparations and used in the treatment of particular ailments.

List of Underutilized Vegetable Crops

***Alternanthera sessilis* (Ponnanganni Greens, Gudrisag)**

The leaves are eaten as potherb and used for cool down the body useful in diarrhoea, fever, anaemia etc. In Karnataka and Tamil Nadu, the leaves, flowers and tender stems are consumed as vegetables. Ponnanganni greens are rich in protein, carbohydrate, fat, fibre, carotene, vitamin C, riboflavin, niacin and various minerals. Leaves and tender shoots are used as vegetables. It is mainly propagated by seed.

***Sesbania grandiflora* (Agathi)**

Leaves, flower and tender fruits are valued as vegetables or mixed into curries or salads in many countries due to their high nutritious value particularly vitamin A and minerals. Leaves and flowers have nutritional and medicinal properties. However, it is not grown large scale for vegetable purpose. It is mainly propagated by seed. In T.N grown around banana as a wind break, around coconut seedlings as a shade plant. It has also ornamental, food and fodder values. Agathi is a folk remedy for bruises, catarrh, dysentery, eyes, fevers, headaches, smallpox, sores, sore throat, and stomatitis (Duke and Wain, 1981.)

***Sauropus androgynus* (Chekurmanis)**

The plant is reputed for its high nutritive value and therefore it is popularly known as "multivitamin green" and "multi mineral packed leafy vegetable". Chekkurmanis is a rich source of carbohydrate, vitamins and minerals. In Malayalam, this plant is known as 'Madhurakeera" and in Tamil it is "Thavarai Muringai". It is mainly propagated by Semi hard wood stem cuttings. Juice of leaves of chekkurmanis is pounded with roots of pomegranate and leaves of jasmine are used against eye troubles. The tender shoots and leaves are used for vegetable in Tamil Nadu and Kerala. Leaves are very rich in protein, minerals and vitamin A, B, C and also used to give light green colour to pastry and to fermented rice in Dutch East Indies, preparation of soup in java. It is planted as live fence in garden beds and provides shade to vegetables.

***Ipomoea muricata* (Clove bean)**

Tender fruits are used for cooking. It is used as vegetable in mostly in Kerala. The fruits contain fibre, vitamin C, potassium and calcium. Powdered clove bean are known remedy to fever. Plants juice is sprayed to kill bugs.

***Dioscorea bulbifera* (Aerial yam, Air potato)**

The bulb is eaten on peeling off the hard back after cooking Aerial yam has been used as a folk remedy to treat conjunctivitis, diarrhoea, and dysentery, among other ailments. Useful in syphilis, gonorrhoea, hydrocele. Goitre, piles, dysentery. It is used as vegetable in South Indian states. It is propagated by bulbil.

List of Underutilized Fruit Crops

Bayberry (*Myrica esculenta spp.*)

Bayberry is a perennial fruit tree originated in Southern China. It comprises of more than 50 species distributed throughout tropical, subtropical and temperate climates (He et al., 2002). Some of the species are distributed throughout the NE hill region in India. It is a tall plant up to 20 m height with dark green and glossy leaves. The plant exhibit four different types of flowers depending upon the presence of male and female flower (Miao and Wang, 1987) viz., only male flowers, only female flowers, female flowers > male flowers and male flowers > female flowers. The catkins arise axially from shoots as a racemose inflorescence with pollination carried out by wind. Upon ripening, the fruits turned greenish white, purple, red or greenish yellow from unripe green colour depending on species and has a pleasant combination of sweet (sugar) and tart (acid) tastes. It is rich in vitamin C, carbohydrate, organic acid, thiamine, riboflavin, carotene and antioxidants. (Wang et al., 2002). It can be propagated sexually through seeds and asexually through cuttings and suckers arising from layering.

Monkey jack (*Artocarpus lakoocha*)

Monkey Jack fruit (*Artocarpus lakoocha* Roxb., Moraceae) is a tropical fruit and originated from India. It is mostly found in Asian countries like Bangladesh, Bhutan, Nepal, Myanmar, Sri Lanka, Thailand, Malaysia, Singapore, Vietnam, Cambodia and Laos. It is usually propagated through seeds. The seeds are recalcitrant and loses its viability within a week of harvest.

Khirni (*Manilkara hexendra L.*)

Khirni/rayan belongs to the *Sapotaceae* family, and it is a native to India, evergreen, medium-sized, slow-growing fruit plant with a spreading canopy. It is a wild plant found in the arid and semi-arid to tropical climate as an avenue tree and can be used as bonsai due to the evergreen, dense foliage and dwarf habit. It bears flowers in February–March, whereas fruit ripen in May–June, and it is commercially used as rootstock for sapota to exploit its tolerance to salinity and drought. Khirni fruit and bark are used for numerous medicinal purposes, such as curing fever, flatulence, stomach disorder, leprosy, ulcers, opacity of the cornea, dyspepsia, urethrorrhea and bronchitis.

Manila tamarind (*Pithecellobium dulce (Roxb.) Benth.)*

Manila tamarind is commonly known as Madras thorn Monkey pod and Jungle jalebi and belongs to the *Fabaceae* family. It is a multipurpose, fast-growing, medium-sized thorny tree used as live fencing, animal fodder, hardwood timber, windbreak and a potential source of lac culture. Its fruit has a sweet acidic taste and high content of dietary fibre, proteins, Ca, Fe, P, unsaturated fatty acids and antioxidants. Manila fruit is used to treat toothaches, mouth ulcers, sore gums, dysentery, chronic diarrhoea, stress, aging symptoms and dark skin spots.

Constraints in cultivation of underutilized horticultural crops:

- Lack of awareness among the farming community about the nutritional and medicinal values of underutilized horticultural crops.
- Lack of research and extension work.

- Lack of proper documentation of these crops.
- Lack of cultivation technique and practices.
- Lack of desirable planting materials among the farmers for large scale cultivation.
- Lack of post-harvest management practices in increasing the shelf life.
- Limited and inadequate marketing supports & infrastructure facilities for transportation, storage and processing.
- Limited participation of financial Institutions in setting up of agro industries.

Strategies for the development of underutilized horticultural crops

- A detailed research and extension of targeted potential underutilized horticultural crops
- should be taken up through various national programs focusing on their conservation and uses.
- As the underutilized horticultural crops mostly occur naturally in the forest, domestication through homestead cultivation should be encouraged to avoid overexploitation from their natural habitat.
- Production of quality seeds and other vegetative planting materials should be focus.
- Awareness campaign on the nutritional and medicinal properties of underutilized horticultural crops among the producers as well as consumers.
- Proper documentation and ethnobotanical studies of underutilized horticultural crops should be done.

Conclusion

India is bestowed with different agro-climatic regions for the production of under-exploited horticultural crops. Apart from the fresh produce, production of quality seeds including hybrids and varieties of underutilized horticultural crops can be developed and exported. Similarly, desirable genes present in these crops can also be exploited in breeding programmes. It can also generate income and create employment opportunities in agro-based industries, packaging, storage, preservation, canning and transportation. Thus, safeguarding and conservation of these crops should be given a prior importance to avoid over exploitation in the future.

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Underutilized Fruit Crops: A Boon for Climate Resilient Agriculture

Chethan T., Ravi Pujari and Mahantesh M. T.
Assistant professors, University of Agricultural Sciences, Raichur
*Corresponding Author: chetan.hortico@gmail.com

The impacts of climate change on different sectors of society are interrelated. It is one of the major challenges of our time. From shifting weather patterns, that threaten food production and human health. Most countries have been facing crises due to disasters and conflicts; food security, however, is adversely affected by inadequate food stocks, basic food price fluctuations, high demand for agro-fuels, and abrupt weather changes.

Climate change can reduce agricultural income by 15-25 per cent; it is high time that rationale of climate-resilient agriculture (CRA) is valued and implemented more rigorously. Climate-resilient agriculture (CRA) is an approach that includes sustainably using existing natural resources through crop and livestock production systems to achieve long-term higher productivity and farm incomes under climate variabilities.

There are crucial to address the climate change and achieve sustainable development goals (SDG) in India. Among those the intervention of underutilized fruit crops will fit more effectively. The details of crucial steps to be parted with underutilized fruit crops are as follows according to the problem to be mitigated.

Strategies and technologies for climate change adaptation with underutilized fruit crops

- **Conservation of soil structure and nutrients**: Different farm management practices can increase soil carbon stocks and stimulate soil functional stability. Conservation agriculture technologies (reduced tillage, crop rotations, and cover crops), soil conservation practices (contour farming) and nutrient recharge strategies can refill soil organic matter by giving a protective soil cover.

  In that way, underutilized fruit crops are hardy in nature and they are deep rooted which plays major role in conservation of soil organic carbon and microbial functioning by shedding their own leaves during stress period or off period. This helps to conserve soil moisture led to build soil organic carbon and to build congenial environment for microbial function, soil carbon and manure management. Example: Jamun, Custard apple, Sapota, Karonda, Ber, Aonla, etc

- **Adaptation to overcome the climate stress:** Patterns of drought may need various sets of adaptive forms. To reach deficient downpour conditions, these underutilized fruit crops are well adopted to local climatic condition and have tolerant breeds for mitigation of biotic and abiotic stresses. Example: Custard apple, Jamun, Bael fruit, Aonla, etc.

- **Water management:** At present condition, there is huge fluctuation among the rainfall during the season. Sometimes, it may be neither drought condition nor flood situations this will affect the crop growth greatly. To mitigate this, locally adopted underutilized fruit crops like Karonda, Guava, Aonla, Fig, Ber, Tamarind, etc impart for efficient productivity, resource utilization and returns.

- **Agro-advisories for timely crop monitoring:** Response farming is an integrative approach; it could be called farming with advisories taken from the technocrats depending on local weather information. The success of response farming, viz., decreased danger and enhanced productivity.

  This will be achieved easily and more effectively in underutilized fruit crops. Because, these crops will come up well under

minimal agronomic practices and with less management compare to commercial crops. This may help farmers to reach satisfactory crop yields, even in deficit rainfall and warmer years.

- **Nutritional security:** Nowadays human beings are suffering from many illnesses due to poor nutrition. Neglected and underutilized fruit crops are domesticated plant species used for food, medicine, trading, or cultural practices. They are significant within their local communities. These will definitely helps to overcome nutritional deficiencies among the society leads to wellness.

In this way, Underutilized fruit crops have the potential to contribute to climate-resilient agriculture by diversifying crop options, enhancing food security, reducing vulnerability to climate change induced stresses. These crops often have inherent resilience to local environmental conditions, requiring fewer inputs such as water and pesticides. Additionally, they can offer nutritional benefits and economic opportunities for farmers, while also preserving biodiversity. Promoting the cultivation and consumption of underutilized fruit crops can play a crucial role in building more resilient agricultural systems in the face of climate variability and change.

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Avocado: A Health Trustworthy Powerful Superfood

Anjana M[1] and BP Pushpa[2]*
M. Tech Scholar, Dept. of Dairy Chemistry, DSC, KVAFSU, Bengaluru, Karnataka[1]
*Assistant Professor, Dept. of Dairy Chemistry, DSC, KVAFSU, Bengaluru, Karnataka[2]
*Corresponding Author: pushpadc819@gmail.com

Avocado (*Persea americana*) is a tropical fruit originated from the Aztec word "Ahuacatl". Ancient Aztec, Olmec and Maya cultures praised avocado as one of the gifts of God among many fruits. The more easily pronounced name of avocado is created by Sir Henry Sloane in 1669. It is believed that 12,000 years ago (7,000 and 5,000 B.C.) avocado appeared in Puebla (Central America) and Southern Mexico. Several millennia before this wild variety was cultivated and Archaeologists in Peru found domesticated avocado seeds buried with Incan mummies dating back to 750 B.C. and there is evidence that avocados were cultivated in Mexico as early as 500 B.C. Fast forward to 1871, when Judge R.B. Ord of Santa Barbara successfully introduced avocado to the U.S. with trees from Mexico. 'Hass' variety was discovered in the late 1920s and Rudolph Hass patented in 1935. American Dietetic Association (ADA) in 1999 considered *P. americana* as an effective food due to its high nutritional value that has an important role in human health.

Avocado was introduced by the American missionary, residing in Bangalore between the years 1906 and 1914 was from Royal Botanical Gardens, Ceylon. More than a dozen varieties of Avocado are grown in many parts of the hill stations near Nilgris, Palani, Kodaikanal, Yercaud, Coorg, etc. The influx of Americans in very large numbers soon after the Second World War, renewed interest in the propagation of avocados. In the meantime, the Government of Mysore opened a research station for non-citrus fruits at Hessaraghatta, Bangalore and about 150 avocado seedlings of different species were introduced by the research station in different parts of Karnataka, Kerala, Tamil Nadu, Sikkim and other states. There are three main production regions of avocado in India, the Kodaikanal area, Ooty area of Tamil Nadu, Gundlupet and Kodagu region of Karnataka and a minor area in North Eastern India.

Production of avocado

The avocado cultivation has gained an overwhelming popularity during last one decade due to nutrition value of the fruit. Avocado production of the world was 10.27 million tonnes in 2023 with CAGR (Compound Annual Growth Rate) of 6.10 %. Mexico is the largest producer of Avocado in the world followed by Colombia, Dominican Republic, etc. Mexico supplies 45 % of the international avocado market. USA is the number one importer in the world, followed by the Netherlands, which plays an important role as transit country in the international trade. The top-ranking export countries are Mexico, Peru, Colombia and Chile.

'Arka Supreme' is a high yielding hybrid developed from Central Horticultural Experiment Station (IIHR), Chettalli in 2020. A fully-grown tree yields about 175-200 kg/plant, with an average fruit weight of 367-428 g. In 2021, Indian market reached nearly 2.5 million US Dollars in 2021. The value of avocado market in India reached nearly 5000 tonnes. With the advent of the COVID-19 pandemic, the demand for avocado-based products has witnessed a staggering rise as an immune boosting fruit or super food.

Plant morphology of avocado

Avocados can be grown on a wide range of soils, but they are extremely sensitive to poor drainage and cannot withstand waterlogging. They are intolerant to saline conditions. Optimum range of pH is from 5 to 7. The tree avocado is evergreen all over the year with a height of 40-80 feet from the ground and has a lot of long branches. The shape of the leaves is round oval and ovate and about length in 3-10 inches. The size of the avocado flower is small and greenish. The shape of avocado fruit may be round, ovate or pear-shaped and the skin of the fruit is different in colour and appearance in all varieties. The skin may have more flexibility, smooth to scratchy and yellow-green, purplish-red or black in appearance. The pulp colour of the avocado fruit is yellow-greenish to bright-yellowish and it is oily in texture when ripped, but the inner surface will be fibrous. Avocado fruit contains one large seed i.e. ovate or

oval-shaped and it makes the weight of the fruit about 10 to 25 % of the total weight.

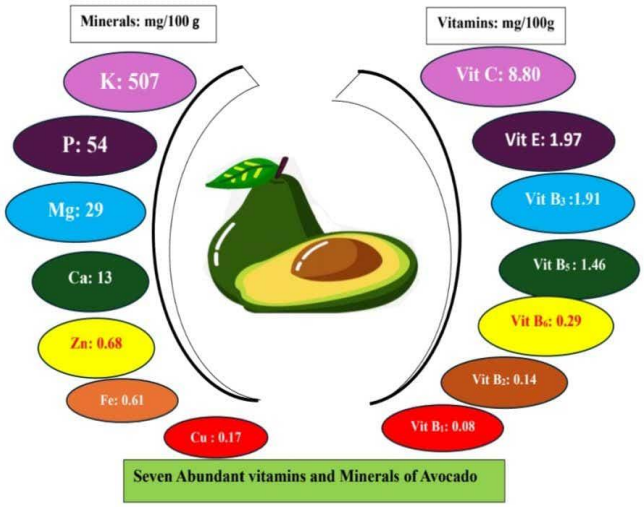
Picture of Avocado Tree, Flower, Seed.

Avocado is a member of the flowering plant group belongs to the kingdom; *Plantae*, family: *Lauraceae*, order; *Laurales*, genus; *Persea*, and species; *P. americana*. Avocado is the most important and only edible fruit of the family *Lauraceae* and has a high nutritional and commercial value. Mexico is the leading producer of avocado due the main climatic requirements of the tree are related to the temperature and rain fall, and the varieties behave differently according to their race. The organoleptic quality of the fruit being very smooth buttery texture with mild flavour (less sweet) and is gaining popularity worldwide and is recognised as "superfood" because of the nutraceutical and therapeutic properties. It has potential applications in the nutrition field and the byproducts of the fruit are used in preparation of starch and pharmaceutical industries etc.

Nutritional status

Avocado has been recognized for its higher nutritional value and health benefits. A whole avocado provides 140 to 228 kcal (~585–1000 kJ) of energy. This fruit has a lipid content approximating 25% of the edible portion with an energy density like chicken breast. Avocado pulp is rich in MUFA (Mono-unsaturated fatty acids) 9.8 mg/100 g. Oleic acid is the principal fatty acid in avocado, comprising 45 % of its total fatty acids. In terms of its total fat content and fatty acid composition, avocado oil is similar to olive oil. Other fatty acids present include palmitic and palmitoleic acids with smaller amounts of myristic, stearic, linolenic, and arachidonic acids. A single serving can provide about 2 g protein and 2 g of fiber with a glycemic index of 1±1. Most of the lipids (77-80 %) in the seeds are neutral lipids, whereas glycolipids and phospholipids represent the 7.4 and 10.9 %, respectively.

Fiber constitutes most of its carbohydrate content (~9 g of fibre and 12 g of carbohydrate per avocado) and can reach up to 13.5 g in larger avocados. Fiber prevents constipation and lowers the risk of colon cancer, regulating the immune system and inflammation, lower blood cholesterol, improve the



Seven Abundant vitamins and Minerals of Avocado

microflora of the intestines by working as a prebiotic etc.

Avocado is notable for their higher potassium content (507 mg/100 g of fresh weight), and it provides 60 % more than an equal serving of banana. Potassium intake helps to maintain cardiovascular health and muscle function by regulating the blood pressure through the modulation of liquid retention in the body. Carotenoids, including lutein, zeaxanthin, and α- and β-carotene found in the pulp of the avocado are potent free radical scavengers. It protects the skin from ultraviolet radiation, keeps the eyes healthy by providing antioxidant protection to help minimize any kind of damage even from the ultraviolet light. Xanthophylls suppress the damage of blood vessels by decreasing the amount of oxidized low-density lipoproteins (LDL). The 68 g serving of Hass avocado contains about 57 mg of phytosterols, which is significantly higher compared to other fruits. Avocado phytosterols have been reported to reduce the risks of coronary heart disease. Vitamin C in avocado helps in reducing skin inflammation, promotes wound healing and soothes the dry skin. The fruit contributes to a healthy-looking skin and healthy hair due to the presence of Vitamin E. Folate helps in reducing the risk of miscarriage and neural tube defects in babies.

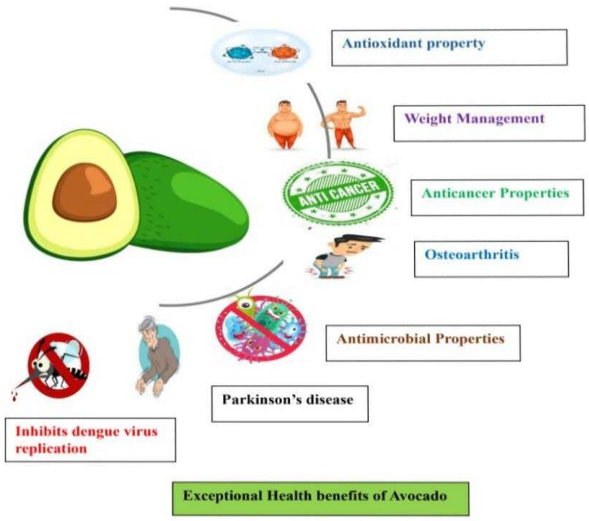
Surprising therapeutic/functional properties of Avocado

Antioxidant property: Procyanidins, flavonols, hydroxybenzoic, condensed tannins, phenolic acids are the polyphenolic compounds responsible for antioxidant properties of fruit pulp, peel and seed of avocado.

Anticancer Properties: Avocado pulp, peel, seed, leaf and root bark have anti cancerous property. Scopoletin is a aromatic chemical compound (plant coumarin and phytoalexin) reduced the carcinogens-induced toxicity and the size of skin papilloma in vivo. Various key cell cycles for cancer cell replication, apoptotic and tumor invasion markers are modulated by scopoletin compound present in the fruit.

Osteoarthritis (OA): Avocado–soybean unsaponifiable (ASU) combination represents one of the most commonly used treatments for symptomatic OA. It has anti-inflammatory effects attributed to many phytosterols and isoflavones, which suggests its possible role in the prevention of osteoarticular, autoimmune, and menopausal disorders.

Antimicrobial Properties: Antibacterial activity of the extracts derived from different parts of avocado (peel, seed, and pulp) was found against *Bacillus cereus, S. aureus, L. monocytogenes, E. coli, Pseudomonas spp*., and *Yarrowia lipolytica*. The highest inhibitory activity against the Gram-positive bacteria- *B. cereus* and *L. monocytogenes* was observed, while *E. coli* was the most sensitive among the tested Gram-negative bacterial species.



Parkinson's disease (PD): Polyphenols of avocado have demonstrated antioxidant properties, anti-infammatory, and regulation of autophagy which is important in human neurodegenerative disorders including PD.

Inhibits dengue virus replication: Natural product (2R,4R)-1,2,4-trihydroxyheptadec-16-yne (THHY), extracted from unripe avocado (*Persea americana*) fruit, can inhibit DENV-2 replication in a concentration-dependent manner and efficiently suppresses replication of all DENV serotypes (1–4). Further revealed that the NF-κB-mediated interferon antiviral response contributed to the inhibitory effect of THHY on DENV replication.

Weight Management: Analysis of the 2001–2012 NHANES (national Health and Nutritional Examination Survey) dataset reported avocado consumers were 33% less likely to be overweight or obese and 32% less likely to have an elevated waist circumference compared to non-consumers.

Conclusion

Avocado pulp and by-products such as peel, seed, and leaves obtained from industrial processing of avocado contain bioactive compounds (phytochemicals) such as polyphenols, carotenoid, and tocopherols. These bioactive compounds have acquired a greater interest in the scientific society due to their Anti-oxidant, Anti-cancerous, Anti-Inflammatory, Anti-microbial properties as well as dermatological uses. Avocado and their byproducts can be used effectively in the food, nutraceutical, pharmaceutical and cosmetic industries. The avocado can be made popular by increasing its organoleptic quality by incorporating into compatible foods and by increasing the volume of cultivation to reduce the market prize. Utilisation of the fruit can be enhanced by use of advanced technologies to extract the valuable micronutrients and bioactive compounds present in it.

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Imperative Role, Nutritive Value, Constraints and Schemes Associated with Underutilized Horticultural Crops in India and Global Scale

Ganesha B. H., Rajath Kumar, Jagadish M. R. and Inamati S. S.
Department of Silviculture and Agroforestry
College of Forestry, Sirsi, Uttara Kannada
University of Agricultural Sciences, Dharwad, Karnataka
*Corresponding Author: ganeshforicofcp@gmail.com

Domesticated plant species with significant nutritional and functional values that are not widely used for a variety of reasons are known as underutilised horticultural crops (Ebert 2014). Pseudocereals and millets, grain legumes, roots and tubers, leafy vegetables, and wild vegetables are the five main categories into which these crops can be grouped. In their local contexts, neglected and underutilised crops are important for food, medicine, trade, or cultural practices. Drumstick, red cabbage, avocado, beetroot, turmeric, passion fruit, jamun, and bael are a few examples of these crops. Because of their diverse genetic backgrounds, these underutilised crops are frequently tolerant of challenging agroclimatic conditions. To assess their potential and incorporate them into agricultural systems, a methodical effort should be made. Moreover, neglected crops are becoming new sources of vital bioactive ingredients and are abundant in naturally occurring pigments with medicinal qualities (Sagar *et al.*, 2018). Neglected horticultural crops have a lot of potential for cultural practices, medical applications, and nutritional security. More resilient and varied food systems may result from their incorporation into agricultural systems.

The significance of neglected horticultural crops

Plant species that have not yet been fully utilised for their potential advantages in economic development, agriculture, and nutrition are referred to as underutilised horticultural crops. These crops frequently have important qualities like high nutritional content, resistance to pests and diseases, climate adaptation, cultural significance, and resistance to diseases. Acknowledging and advocating for the significance of underutilised horticultural crops can yield numerous noteworthy advantages.

Conservation of Biodiversity: Underutilised horticultural crops maintain genetic diversity within agricultural systems, which aids in the conservation of biodiversity. Numerous of these crops are indigenous to particular areas and offer distinctive genetic resources that could be crucial for upcoming breeding initiatives. Food and Nutrition Security: Underutilised crops can supply vital vitamins, minerals, and other nutrients that are absent from conventional diets. They also frequently have high nutritional value. In areas where malnutrition is a problem, encouraging their production and consumption can help diversify diets and enhance food and nutrition security.

Climate Resilience: Drought, low soil fertility, harsh temperatures—all of these local environmental conditions are well-suited to certain underutilised crops. Farmers can lessen their reliance on conventional crops, which might be more susceptible to environmental stresses, and increase their resilience to climate change by diversifying their agricultural systems with these crops.

Income Generation and Livelihood Improvement: Smallholder farmers and rural communities can benefit economically from the cultivation of underutilised horticultural crops. There may be specialised markets for these crops both locally and abroad, providing greater costs in comparison to common commodities. Furthermore, underutilised crops can be used to create value-added products like jams, juices, and herbal remedies, which can increase income potential even more.

Cultural Preservation: A lot of neglected horticultural crops are important to the local way of life and have a long history of use in food preparation. Encouraging their production and use can aid in the preservation of the traditional knowledge and cultural legacy connected to these crops. Sustainable Agriculture: Compared to conventional crops, underutilised crops frequently require fewer inputs, such as water, fertilizer, and pesticides. Through the reduction of chemical inputs, mitigation of soil erosion, and promotion of agro-ecological principles, their cultivation can support sustainable agricultural

practices. Market Diversification and Innovation: Growing the market for horticulture crops that aren't being used to their full potential can lead to innovative approaches to farming, processing, and marketing (Ebert 2014). This may open doors for investment and entrepreneurship in rural areas, promoting development and economic growth.

Underutilised horticultural crops' nutritional value

High in Micronutrients: Vital vitamins and minerals can be found in abundance in a number of underutilised crops. Moringa leaves, for example, are an excellent supplement to diets in areas where certain nutrients are deficient because of their exceptionally high levels of vitamin C, vitamin A, calcium, potassium, and iron.

Diverse Antioxidants: Underutilised crops frequently have a wide range of antioxidants that lower the risk of chronic illnesses like cancer and heart disease and help fight oxidative stress. For instance, amaranth contains a lot of flavonoids and phenolic compounds, both of which have antioxidant qualities.

Healthy Fats and Oils: Some underutilised crops provide healthy fats and oils that contribute to overall health. Sacha inchi, for instance, is a seed rich in omega-3 fatty acids, which are important for brain function, heart health, and reducing inflammation. High protein content: Plant-based proteins can be found in abundance in a number of neglected crops. For instance, quinoa is a vital component of vegetarian and vegan diets since it is a complete protein that includes all of the essential amino acids.

Dietary fibre: Underutilised crops frequently have high dietary fibre content, which helps prevent diverticulosis and constipation by promoting digestive health. Ethiopian-native teff grain has a high fibre content that promotes gut health and fullness.

Low Glycemic Index: Certain underutilised crops raise blood sugar levels more gradually and steadily because of their low glycemic index. Controlling weight and diabetes may benefit from this. Millet and Fonio are two examples.

Gluten-Free Options: Underutilised crops like teff and fonio provide gluten-free options to traditional grains like wheat, barley, and rye for people with celiac disease or gluten sensitivity. Adaptability to Adverse Environments: A lot of underutilised crops can withstand adverse environmental factors like drought, poor soil, or extremely high or low temperatures. In areas where conventional crops have difficulty thriving, the cultivation of these crops can increase food security.

Issues related to underutilised crops in horticulture

Plants that have not been fully utilised for their potential benefits are referred to as underutilised horticultural crops. This can be because of a variety of factors, such as a lack of research and development, limited commercial interest, or cultural preferences for other crops. A number of issues are linked to underutilised horticultural crops, including:

Limited Market Demand: One of the main issues is the market's limited appetite for underutilised crops. These crops may be unknown to consumers, or they may prefer more widely accessible options. **Lack of Research and Development:** Compared to major crops, underutilised crops frequently lack thorough research and development. This covers post-harvest handling methods, agronomic techniques, pest and disease management plans, and breeding programmes for improved varieties.

Poor Infrastructure and Distribution Networks: Inadequate infrastructure, such as storage facilities, transportation networks, and market linkages, can hinder the efficient distribution of underutilised crops from production areas to consumers.

Limited Access to Inputs and Technology: Farmers growing underutilised crops may have limited access to quality seeds, fertilisers, pesticides, and other agricultural inputs. Additionally, they may lack knowledge about modern farming technologies and practices that could improve crop productivity.

Risk of Genetic Erosion: Underutilised crops often possess valuable genetic diversity that could be lost over time due to neglect. This genetic erosion reduces the resilience of agricultural systems to environmental stresses such as climate change and pest outbreaks.

Marginalisation of Indigenous Knowledge: Traditional knowledge related to underutilised crops may be marginalised or lost as communities transition

to more commercially viable crops. This can lead to a loss of cultural heritage and ecological wisdom associated with these crops.

Food Security and Nutrition: Neglecting underutilised crops limits dietary diversity and resilience to food insecurity. Many of these crops are rich in essential nutrients and have the potential to contribute to improved nutrition and food security, especially in marginalised communities.

Policy and Regulatory Constraints: In some cases, regulatory barriers, such as certification requirements or trade restrictions, may impede the production and marketing of underutilised crops, limiting their economic viability.

Underutilised horticultural crops in India

Here are some examples of underutilised horticultural crops from various regions around the world:

1. Moringa: Known for its high nutritional value, moringa is grown in many tropical and subtropical regions but is still underutilised in many places (Bennett et al., 2013).
2. Jicama: also known as Mexican turnip or yam bean, is a root vegetable native to Mexico and Central America. It has a crunchy texture and a slightly sweet flavour.
3. Okra: Commonly grown in tropical and subtropical regions, okra is a nutritious and versatile vegetable that is underutilised in some parts of the world.
4. Chayote: Chayote, also known as vegetable pear or mirliton, is a squash-like fruit native to Mesoamerica. It is grown in many tropical and subtropical regions but is often underutilised.
5. Amaranth: Amaranth is a highly nutritious pseudocereal that is grown in many parts of the world but is considered underutilised compared to other grains such as wheat and rice.
6. Bamboo shoots: Bamboo shoots are edible young shoots of bamboo plants and are commonly used in Asian cuisine. They are underutilised in many parts of the world outside of Asia (Rana *et al.*, 2022).
7. Winged bean: A tropical legume indigenous to Papua New Guinea, winged bean is also referred to as goa bean or asparagus pea. It yields edible flowers, leaves, pods, and tuberculate roots.
8. Celeriac: A root vegetable closely related to celery, celeriac is also referred to as celery root. Compared to other root vegetables, it is underutilised and has a distinct flavour.
9. Taro: Grown extensively in tropical regions, taro is a starchy root vegetable. Even though it is a staple food in many parts of the world, some areas still don't use it enough.
10. Yacon: A native of South America's Andes, yacon is a tuberous root vegetable. It is becoming more and more popular as a low-calorie sweetener because of its crunchy texture and sweet flavour.

Plans, laws, and regulations from the government for underutilised horticultural crops

Around the world, a number of governments have put plans, laws, and regulations into place to encourage the growth and use of underutilised horticultural crops. These programmes frequently target nutritional issues, biodiversity conservation, increased farmer incomes, and food security. Here are a few instances:

India's National Horticulture Mission (NHM) is a government-sponsored initiative designed to encourage the comprehensive development of the horticultural industry. It encompasses programmes for the advancement of neglected crops in addition to common horticultural crops.

United States Specialty Crop Block Grant Programme: Underutilised horticultural crops and other specialty crops are among the projects that this programme funds state departments of agriculture to support in order to increase their competitiveness. It seeks to address problems with these crops, including marketing, research, and education.

The Canadian government funds research, development, and adoption of innovative agricultural practices, such as the production and use of

underutilised horticultural crops, through the Agri-Innovation Programme.

National Horticulture Policy, Kenya: Kenya has developed a National Horticulture Policy that aims to promote the production, marketing, and consumption of diverse horticultural crops, including those that are underutilized. The policy provides a framework for supporting smallholder farmers and improving access to markets.

The European Union launched the European Innovation Partnership for Agricultural Productivity and Sustainability (EIP-AGRI) to encourage innovation in agriculture. It consists of initiatives to encourage the production and use of underutilised crops, with an emphasis on resource efficiency and sustainability.

CGIAR ie Conservation and Sustainable Use of Crop Genetic Resources in Developing Countries. It is an international collaboration that funds agricultural development research. Programmes aimed at conserving and utilising crop genetic resources, particularly underutilised horticultural crops, are included.

Initiatives supported by the United Nations Food and Agriculture Organisation (FAO): As part of its efforts to improve food security and nutrition globally, FAO supports a number of initiatives aimed at promoting underutilised crops, including horticultural crops. This covers policy advocacy, research support, and capacity building.

Conclusion

Acknowledging the value of underutilised horticultural crops and promoting their production, application, and commercialization can help with a number of sustainability-related issues, such as food security, climate resilience, biodiversity preservation, and economic growth. Through policy support, research and development, capacity building, and market linkages, governments, research institutions, non-governmental organisations, and the private sector can all play significant roles in encouraging the adoption of these crops.

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The Rise of Dragon Fruit Farming in India: A Tropical Wonder

Vennela V
M.Tech (Food Processing Technology), Dept. of Food Science and Technology, College of Agriculture, Hassan.
University of Agricultural Sciences, Bangalore;
*Corresponding Author: vennelav17102001@gmail.com

Dragon fruit, also known as pitaya, is a stunningly vibrant fruit that has been gaining popularity worldwide for its unique appearance and array of health benefits. Let's delve into what makes this exotic fruit so special. Dragon fruit is visually striking, with its bright pink or yellow skin adorned with green scales resembling those of a mythical dragon. There are three main types of dragon fruit: white-fleshed with pink skin, red-fleshed with pink skin, and yellow-fleshed with yellow skin. Each variety has its own distinct flavor profile, ranging from mildly sweet to subtly tangy.

Despite its exotic appearance, dragon fruit is surprisingly low in calories and packed with essential nutrients. It's rich in antioxidants, vitamins, and minerals, making it a nutritious addition to any diet. The fruit is particularly high in vitamin C, which boosts immunity and promotes healthy skin. Additionally, it contains several types of antioxidants that help fight inflammation and protect against chronic diseases.

Dragon fruit offers a plethora of health benefits. Its high fiber content aids digestion and promotes gut health, while its low glycemic index makes it suitable for individuals with diabetes or those looking to manage their blood sugar levels. Moreover, the fruit's rich antioxidant content may reduce the risk of heart disease and certain types of cancer. Dragon fruit's mild flavor and visually appealing appearance make it a versatile ingredient in both sweet and savory dishes. It can be enjoyed fresh on its own, blended into smoothies, added to fruit salads, or used to garnish desserts. In Asian cuisines, dragon fruit is often paired with seafood or incorporated into refreshing beverages like juices and cocktails. One recent trend in dragon fruit is its growing popularity as a plant-based ingredient in various food and beverage products. From dragon fruit-flavored snacks and beverages to dragon fruit-infused skincare products, there has been a surge in consumer interest in incorporating this exotic fruit into everyday items.

In India, the success story of dragon fruit cultivation has gained momentum in recent years, particularly in states like Gujarat, Maharashtra, Andhra Pradesh, Telangana, and Karnataka. Here's an example of a successful dragon fruit farming venture in India:

Table – 1 Nutrient composition of dragon fruit

Nutrient	Amount per 100g	Daily value (%)	Comment
Water	87g	NA	Very high-water content
Protein	1.1g	2.1	-
Fat	0.4g	NA	Contains practically no fat
Fiber	3g	3.4	Very good source of dietary fibre
Carbohydrates	11g	12	-
Vitamin B1 (Thiamine)	0.04mg	2.7	-
Vitamin B2 (Riboflavin)	0.05mg	2.9	-
Vitamin B3 (Niacin)	0.16g	0.8	-
Vitamin C (Ascorbic acid)	20.5g	34.2	Contains more than 3 times the amount of Vitamin C found in carrot
Calcium (Ca)	8.5mg	0.9	-
Iron (Fe)	1.9mg	10.6	A good source of iron
Phosphorus (P)	22.5mg	2.3	-
Zinc (Zn)	NA	NA	-

(Source: https://www.healwithfood.org)

In Gujarat, a farmer named Rajesh Patel decided to diversify his traditional farming practices by venturing into dragon fruit cultivation. Facing challenges such as water scarcity and fluctuating market prices for his existing crops, Patel saw dragon fruit as a lucrative alternative due to its high demand and potential for profitability. Starting with a small

plot of land, Patel meticulously researched dragon fruit cultivation techniques, including soil preparation, irrigation methods, and pest management strategies. With the help of agricultural experts and government support programs promoting horticultural practices, he established his dragon fruit farm. Despite initial setbacks and the steep learning curve associated with a new crop, Patel's dedication and hard work paid off. His dragon fruit farm thrived, yielding high-quality produce that garnered attention from local markets and wholesalers. As demand for dragon fruit soared, Patel expanded his operations, leveraging innovative farming practices and technology to increase efficiency and productivity.

Today, Patel's dragon fruit farm serves as a shining example of agricultural entrepreneurship in India. His success has not only improved his family's livelihood but also inspired other farmers in the region to explore new avenues for agricultural innovation and diversification. The success of farmers like Rajesh Patel highlights the immense potential of dragon fruit cultivation in India and underscores the importance of adaptive farming practices in addressing contemporary agricultural challenges such as water scarcity and market volatility.

Dragon fruit cultivation in India has gained momentum across various states, including Gujarat, Maharashtra, Andhra Pradesh, Telangana, and Karnataka. Farmers like Rajesh Patel from Gujarat are leading the charge, recognizing dragon fruit's potential to thrive in arid conditions and its ability to fetch high prices in local and export markets. The rise of dragon fruit farming is not only transforming individual livelihoods but also contributing to the broader economy. With increasing demand for dragon fruit in domestic and international markets, farmers are experiencing enhanced income opportunities and improved socio-economic conditions. Additionally, the expansion of dragon fruit cultivation is generating employment opportunities along the value chain, from farming to processing and distribution.

As dragon fruit continues to gain popularity, the future of farming in India looks promising. With ongoing research and development initiatives, coupled with supportive government policies, the dragon fruit industry is poised for further growth and diversification. As more farmers embrace this lucrative crop, India's agricultural landscape is undergoing a transformation, driven by innovation, entrepreneurship, and a commitment to sustainability. The rise of dragon fruit farming in India represents a compelling narrative of agricultural resilience and adaptation to changing market dynamics. With its potential to generate economic prosperity, promote sustainable practices, and empower farming communities, dragon fruit farming is not just a crop but a catalyst for agricultural innovation and prosperity in India.

In conclusion, dragon fruit is not only a feast for the eyes but also a nutritional powerhouse with a wide range of health benefits. Whether enjoyed on its own or incorporated into various culinary creations, this exotic fruit is sure to delight taste buds and nourish the body. So next time you're looking to add a tropical twist to your diet, consider reaching for the vibrant allure of dragon fruit

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Faba Bean- A Future Smart Food

Puja Mandal[1*] and Subhradeep Pramanik[2]
[1]Department of Genetics and Plant Breeding, TNAU, Coimbatore-641003
[2]Department of Education, Vinaya Bhavana, Visva-Bharati, Santiniketan, West Bengal, India-731235
*Corresponding Author: pujaman@gmail.com

Feeding the flourishing population in a sustainable way is a global challenge. Industrialization along with the growing population is reducing the per capita land availability thus exerting pressure on arable land to produce more. Climatic stresses like increased temperature, asymmetric changes in night temperature, untimely rainfall are curbing crop yields. In addition to that, shift in population growth of pathogens and pests in relation to the change in climatic factors, is also clutching the yield. Land clearing for crop cultivation is not a sustainable option as it disrupts the ecological balance. In order to provide more food from farm to fork there is urgent need for augmenting the yield of crops on the same unit of lands available and strengthening the existing crop production systems or developing alternative ones. Systematic endeavors are being made to assess the viable alternatives for achieving the balance between the ever-growing population and food production. One of the tactics is to utilize the wide range of neglected and underutilized crop species. Faba bean has been listed as "Potential Future Smart Food" in South Asia and South East Asia under the 'Future Smart Food' initiative by Food and Agriculture Organization (Li and Siddique, 2018).

Origin and Botany

The genus Vicia belongs to the family of nitrogen-fixers, Fabaceae. Most probable origin of Faba bean is the Near East or Mediterranean region while China is the secondary center of origin. The commonly grown genotypes of *Vicia* faba are of three major categories: (a) *Vicia faba* var. *major* (large seeds) (b) *Vicia faba* var. *equine* (medium-sized seeds) (c) *Vicia faba* var. *minor* (small seeds). Large-seeded varieties (broad beans) are extensively being used for food, as a fresh vegetable or (dehulled) dry seeds. Small- to medium-size seeded varieties are mostly used for animal feed purposes.

Faba bean is a diploid (2n=12), annual leguminous crop, which exhibits partial out-crossing. The plant has a straight, sturdy, unbranched stem growing between 0.1 to 2 m tall. It has indeterminate growth habits, and shows susceptibility to lodging. The leaves are alternately pinnate in structure, with two to six leaflets. The flowers exhibit typical papilionaceous pattern, common to all pulse crops, typically white, sometimes with anthocyanin pigmentation on all petals, often the wing petals have black spots. Seeds vary in size and shape, with wide range of colors from yellow, green, brown, black, to violet and sometimes spotted. The plants possess a robust and strong taproot system with profuse lateral root branching, hosting nitrogen-fixing nodules containing rhizobia on both tap and lateral roots. The plant lacks tendrils on the leaves for climbing. Its pods are characterized by being green, wide, and tough, turning blackish-brown with a dense, fuzzy texture when fully mature.

Fig 1: Bud to pod development of faba bean

Benefits of faba bean

Faba bean, a versatile crop with manifold applications ranging from fodder to culinary delights, boasts an impressive array of medicinal properties. The verdant pods of this legume are commonly enjoyed post-cooking, while its seeds find their way to markets fresh or frozen. Renowned for its role as a cornerstone in high-protein, high-energy diets that remain economically accessible, faba bean stands out nutritionally due to its favorable protein-to-carbohydrate ratio compared to its pulse counterparts. Additionally, its amino acid profile aligns closely with the adult nutritional requirements, further enhancing its dietary appeal. Faba bean proteins are mainly

globulins, majorly, legumins and vicilins (Boye et al., 2010).

Fig 2: Faba bean plant in reproductive stage

Within its humble exterior lies a treasure trove of nutritional constituents: protein, starch, fiber, minerals, vitamin C, lysine, arginine, isoflavones, and an array of antioxidants and phenolic compounds. Beyond mere sustenance, faba bean serves as a canvas for culinary innovation, with its functional components offering foaming, emulsifying, and gelling properties. These attributes make it a prime candidate for the development of value-added foods and alternatives to traditional meat and dairy products. But the virtues of faba bean extend far beyond the realm of gastronomy. Its medicinal potential is vast, with applications in treating hypertension, cancer, renal failure, anorexia, and a host of other ailments. Particularly noteworthy is its role in combating Parkinson's disease, owing to the presence of L-3,4-dihydroxyphenylalanine (L-DOPA), a precursor to the neurotransmitter catecholamine. This compound, found abundantly in faba bean, has demonstrated efficacy in improving motor function in Parkinson's patients. Furthermore, traditional medicinal practices in regions like Turkey employ faba bean leaves as a remedy for Alzheimer's disease, underscoring its multifaceted therapeutic utility.

Beyond its medicinal and culinary prowess, faba bean plays a pivotal role in agricultural and horticultural systems. Its remarkable ability to fix atmospheric nitrogen surpasses that of other winter pulses, making it indispensable in sustainable cropping practices. Moreover, its robust germination capability endures cold soil temperatures better than most legumes, further solidifying its status as a resilient staple crop. Faba bean thereby transcends its humble origins to emerge as a powerhouse of nutrition, culinary innovation, and medicinal efficacy. From enriching diets with its protein-rich goodness to serving as a potent ally in the fight against debilitating diseases, this unassuming legume continues to leave an indelible mark on both the agricultural landscape and the realm of human health and well-being.

Challenges

Despite being copious in nutraceutical and functional benefits, its use is restricted due to the presence of anti-nutritional factors like vicin, covicine, trypsin inhibitors and condensed tannin. These accumulate in the cotyledons of the beans and on ingestion, they get hydrolyzed into their aglucones, which are the antinutritive and cause favism (hemolytic anemia) (Khamassi et al., 2013). The primary techniques employed to decrease the levels of these compounds in faba bean seeds include soaking, removing hulls, boiling, pressure-cooking, autoclaving, and extrusion cooking.

It also faces a multitude of challenges from both biotic and abiotic sources, which contribute to yield instability. Biotic stresses, diseases including ascochyta blight, chocolate spot, rust, gall disease, orobanche infestation, faba bean necrotic yellow virus, and insect pests such as the black bean aphid, stem borer, pea leaf weevil and broad bean weevil infestation, pose significant threats to crop health and productivity. These pathogens and pests can cause extensive damage to faba bean crops, leading to reduced yields and economic losses. In addition to biotic stresses, faba bean is also susceptible to various

abiotic stresses such as waterlogging, drought, heat, and frost. These environmental factors can disrupt normal growth and development, affecting key physiological processes and ultimately impacting yield potential. Waterlogging and drought conditions can hinder nutrient uptake and water absorption, while extreme temperatures, both hot and cold, can cause physiological stress and reduce crop vigor.

Future prospect

Faba bean germplasm, like many other important crop species, is conserved in gene banks around the world to ensure its genetic diversity is preserved for future agricultural use (Karkanis et al., 2018). The International Center for Agricultural Research in Dry Areas (ICARDA) is one of the key institutions involved in conserving and distributing faba bean germplasm, particularly focusing on varieties adapted to dryland agricultural systems. By leveraging the vast diversity within the faba bean gene pool, opportunities for innovation, resilience, and progress in faba bean research, breeding, and agriculture can be unlocked, ultimately benefiting farmers, consumers, and the environment.

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Spider Lily: A Novel Loose Flower

D. Mahesh Reddy[1] and V. Bhargav[2]

[1]Ph.D. Scholar, Department of Floriculture and Landscaping, College of Horticulture, Dr. Y.S.R. Horticultural University, Anantharajupeta, Annamayya district, Andhra Pradesh.

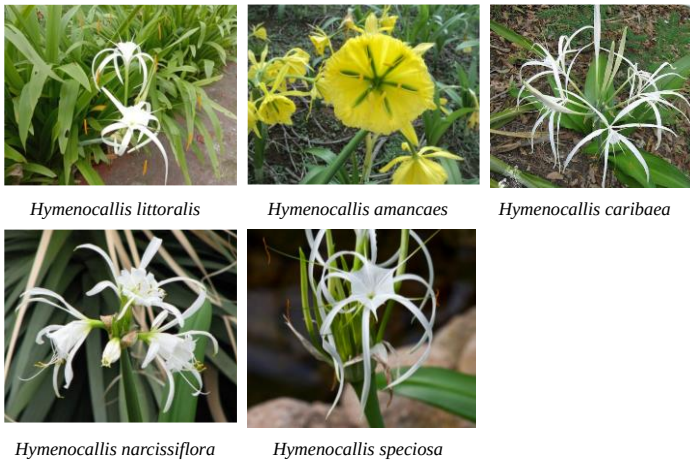
[2]Assistant Professor, Department of Horticulture, College of Agriculture, Central Agriculture University, Pasighat, Arunachal Pradesh.

*Corresponding Author: bhargavhorti12@gmail.com

Spider lily (*Hymenocallis* sp.) belongs to family Amaryllidaceae, is a perennial bulbous flower plant and is native to Southern United States and South America. It is grown as a important loose flower crop in Southern Gujarat of India.The genus name *Hymenocallis* is derived from the Greek word *hymen* meaning 'membrane' and *kallos* meaning 'beauty' (beautiful membrane), in reference to the membrane that unites and forms the staminal cup. These are most suited as border plants in the greenhouse, beside the walls and water channels, in herbaceous borders and walkways, beside the grass, and in garden beds; nonetheless, they prefer sunny locations. It is used as loose flowers for garlands, veni, gajra making and decoration of stages in marriages. It has medicinal properties which is used in traditional medicine to treat various ailments such as gastric ulcers, wounds, and respiratory problems.

Species

- *Hymenocallis amancaes*: These are deciduous Peruvian species, leaves are 30 cm long and strap shaped, flower stalk is up to 50 cm height producing 8 yellow fragrant flowers.
- *Hymenocallis caribaea*: It is an evergreen species, distributed in West Indies, leaves are 50 cm long strap shaped, spike is 60 cm with about 8 white fragrant flowers.
- *Hymenocallis narcissiflora*: These are deciduous species from Peru, leaves are 50 cm long, flower stalk is 50 cm long with white fragrant 3 to 4 flowers.
- *Hymenocallis pedunculata*: These are deciduous species from Peru, leaves are 22 to 45 cm long strap shaped, flower stalk of 40 to 60 cm with 2 to 6 white scented flowers.
- *Hymenocallis speciosa*: It is an evergreen species from west indies, leaves are 60 cm long, flower stalk is 30 to 40 cm tall with 5 to 7 white fragrant flowers.
- *Hymenocallis littoralis*: These is a potential loose flower crop in western India. It flowers throughout the year and continues up to 5-6 years from single planting. These species possess some anti-viral activity lycorine, an antifeedant activity against desert locust.
- *Hymenocallis ovata:* It is native of West Indies, leaves strap shaped and 25 cm long, flowering in September-October, flowers white, fragrant with greenish tube and on a 30 cm long stalk.



Hymenocallis littoralis *Hymenocallis amancaes* *Hymenocallis caribaea*

Hymenocallis narcissiflora *Hymenocallis speciosa*

Fig 1: Some important species of Spider lily

Soil and climate

Well drained, medium black soils and rich organic soils with pH of the soil having 6 – 7.5are ideal. It requires tropical climate (warm temperature and sunny situations). Low temperatures below 15°C and dry climatic conditions can inhibit growth and quality of flowers. The plant is hardy and drought tolerant and grows well in full sun or partial shade.

Propagation

It is commercially propagated by bulbs. Bulblets and seeds are also used but ripe seeds are stored for utilising in next sowing season. Bulbs of 4 – 6 cm diameter planted at 5-10 cm depth of the soil are best for growth and yield. Best planting time is May – June months. Bulbs are planted in 90 cm apart between lines and 60 cm in plant-to-plant distance.

Water management

First irrigation should be given after planting of bulbs. Adequate water is needed during growing season and flowering. Frequent irrigation of 5-7 days interval should be followed.

Manures and fertilizers

During final ploughing of soil 25-30t/ha of FYM should be incorporated into soil. Fertilizers are 300 kg N, 225 kg P and 200 kg K per hectare should be applied every year. Phosphorus and potash should be given as basal dose whereas, nitrogen should be given in four split doses, *i.e*. June, September, December and March.

Intercultural operations

Earthing up: It should be done when plants attain some 20 cm height and in perennial cropping every year at the start of the growth to cover the exposed roots. This helps in conserving the moisture for healthy growth of the bulbs and plants.

Weeding: It should be done during early stages of growth which helps in minimising crop weed competition against nutrients.

Harvesting: A matured unopened flower bud started turning white just to open the next day should be harvested during early morning hours. It is perennial crop and gives economical production up to 7-8 years. Maximum yield is obtained in summer compared to both winter and rainy seasons. It produces 27 to 30 lakh buds per ha yearly.

Postharvest management

Grading: Two grades of buds are created based on the length of the buds, and bundles of 50 buds each are created. The bundles are placed inside plastic or gunny bags and secured with rubber bands and transported to markets.

Storage: Spider lily buds can be kept in cold storage for a week if they are pulsed with 250 ppm 8-HQC and 2% sucrose for 45 minutes before being packaged in tissue paper at a temperature of 2 ^{o}C.

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Unveiling the Potential of Moringa: An underutilized Horticultural Gem in India

Lakshmipriya P R[1*], Chandhni P R [2], Parameswari P L[3] and Malavika Manoj[4]

[1*] Ph.D Scholar, Faculty of Fisheries Engineering, Kerala University of Fisheries and Ocean Studies (KUFOS), Ernakulam, Kerala

[2] Assistant Professor, Department of Food technology, TKM Institute of Technology, Kollam, Kerala

[3] Food safety Officer, Ettumanoor, Govt. of Kerala

[4] MSc student, Department of Home Science, ST. Teresa's College Ernakulam

*Corresponding Author: lakshmirajendran716@gmail.com

Moringa oleifera (Family: Moringaceae), the plant known as drumstick sometimes referred to as the "Miracle Tree" or the "Tree of Life." has been shown to have strong hypoglycemic, hypolipidemic, nootropic, and anti-inflammatory properties (Mukherjee *et al.*, 2022). Moringa is a nutrient-dense superfood. It contains a wide range of vital phytochemicals in its pods, leaves, bark, roots, and seeds. Minerals like potassium, calcium, iron, copper, zinc, and magnesium are abundant in moringa leaves. M. oleifera leaves also include vitamins A (β carotene), B (folic and nicotinic acid), C, D, and E, as well as phytochemicals such sterols, tannings, alkaloids, and flavonoids, as well as anti-cancerous compounds like glucosinolates and isothiocyanates. Vitamins B6 and C, potassium, magnesium, and dietary fiber are all abundant in moringa pods. Moringa oleifera is therefore a useful treatment for malnutrition (Samarawickramaa *et al.*, 2023). This underutilized crop possesses remarkable qualities that make it a valuable addition to sustainable agriculture. This tree has several sections that are excellent providers of antioxidant chemicals, calcium, iron, protein, and ascorbic acid. As a result, its exceptional qualities aid in the battle against human illnesses, nutritional deficiencies etc. (Jattan *et al.*, 2021).

Nutritional powerhouse

Moringa stands out for its nutritional richness, boasting high levels of vitamins, minerals, and antioxidants. Exploring its potential as a source of essential nutrients could address malnutrition and enhance public health. Moringa which has a great attention because of the presence of bioactive components. Its leaves, pods and seeds have a major biological effect on people. Moringa is a paradigm of continuous nourishment since it is rich in essential nutrients like vitamins, minerals, and proteins. Beta-carotene and vitamin C are two of the rich antioxidants found in moringa, which give the body powerful protection against oxidative stress and free radicals (Srivastava *et al.*, 2023).

Drought-Resistant Marvel

Amidst growing concerns about water scarcity, moringa shines as a drought-resistant crop. Its ability to thrive in challenging conditions makes it a resilient choice for farmers, contributing to food security and climate-resilient agriculture. It is a sustainable and environmentally beneficial resource due to its quick growth and low water requirements. Furthermore, its importance in agroforestry systems is increased by its capacity to fix nitrogen in the soil.

Culinary Versatility

Beyond its traditional use in Indian cuisine, moringa offers culinary versatility. From leaves and pods to seeds and roots, exploring various culinary applications could spark innovation in the kitchen and create new market opportunities.

Medicinal Marvel

Moringa's medicinal properties have been recognized in traditional medicine. Investigating its potential in modern healthcare may uncover valuable compounds with therapeutic benefits, opening doors for pharmaceutical and wellness industries. Moringa is known to treat for diabetes and cancer.

It contains various anti-cancerous substances like including, glucosinolates, glycoside compounds, isothiocyanates, glycerol-1-9-octadecanoic and phytochemicals such as tannins, terpenoids, sterols, , saponins, alkaloids, flavonoids etc. Leaf extracts are used to treat malnutrition and increase breast milk production in nursing mothers. Moringa is a potent Neuroprotectant and good antimicrobial agent has been used in various treatments (Gopalakrishnan *et al.*, 2016). It has been used to treat problems such as anemia, anxiety, asthma, bronchitis, skin infections in different cultures of the world.

Economic Empowerment

According to reports, the moringa tree is a miracle plant with numerous applications, including water purification, bio-gas production, cosmetics, and sustenance for humans and animals. Its potential as a tool to increase the revenue of its producers is highlighted by empirical evidence on the economics of its production. However, the degree of knowledge about its applications and proof of its effectiveness among farmers were limited (Omotesho *et al.*, 2013). Promoting moringa cultivation can lead to economic empowerment, especially for small-scale farmers. With increasing global demand for health-conscious products, moringa presents an opportunity for income generation and rural development.

Conclusion

Despite its potential, moringa faces challenges such as limited awareness, market access, and processing techniques. Addressing these hurdles through education, infrastructure development, and research can unlock the crop's full potential. Moringa, the underutilized horticultural gem, holds the key to a healthier, more sustainable future. By recognizing and harnessing its nutritional, economic, and environmental benefits, India can elevate moringa from an underappreciated crop to a cornerstone of agricultural innovation.

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Cultivating Diversity: Exploring Chhattisgarh's Underutilized Horticultural Crops

Maneesh Sonkar
M.Tech Scholar, SV College of Agricultural Engineering and Technology and Research Station, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh-492012
*Corresponding Author: sonkarmaneesh54@gmail.com

Chhattisgarh, a state located in central India, is endowed with rich agricultural diversity and fertile lands that support the cultivation of a wide variety of crops. While traditional crops like rice, wheat, and pulses dominate the agricultural landscape, there exists a treasure trove of underutilized horticultural crops in Chhattisgarh that hold immense potential for both farmers and consumers. These lesser-known crops, often overlooked in mainstream agriculture, offer unique benefits in terms of nutrition, sustainability, and market value.

The underutilized horticultural crops in Chhattisgarh presents an opportunity to diversify agricultural practices, enhance food security, and promote sustainable farming methods. These crops, which include indigenous fruits, vegetables, herbs, and seeds, have the potential to thrive in the region's agro-climatic conditions and contribute to the overall agricultural economy of Chhattisgarh. With increasing consumer awareness about health and nutrition, there is a growing demand for exotic and nutrient-rich foods in the market.

Furthermore, these underutilized horticultural crops offer a range of benefits that make them valuable additions to the agricultural landscape of Chhattisgarh. Many of these crops are rich in essential nutrients, antioxidants, and medicinal properties, making them not only nutritious but also beneficial for overall health and well-being. Additionally, their cultivation can contribute to biodiversity conservation, soil health improvement, and sustainable farming practices.

Despite their numerous benefits and market potential, underutilized horticultural crops in Chhattisgarh often face challenges related to awareness, availability, and promotion. Farmers may lack knowledge about the cultivation techniques, market opportunities, and value-added products associated with these crops. Moreover, limited access to quality seeds, technical support, and market linkages may hinder the widespread adoption of these crops.

In this context, it is essential to explore the untapped potential of underutilized horticultural crops in Chhattisgarh and highlight their significance in promoting agricultural diversity, enhancing nutrition security, and boosting rural livelihoods. By shedding light on the marketing potential, benefits, and availability of these crops, this study aims to create awareness among stakeholders, policymakers, and farmers about the untapped opportunities that lie within the realm of underutilized horticultural crops in Chhattisgarh.

Some of the Underutilized Horticultural Crops available in Chhattisgarh

Chhattisgarh has a diverse agro-climatic condition that is suitable for growing a variety of horticultural crops. Some of the underutilized horticultural crops in Chhattisgarh that have the potential for cultivation and promotion include:

1. **Mahua (*Madhuca longifolia*):** Mahua is a traditional tree crop native to central India, including Chhattisgarh. The flowers of the Mahua tree are used to produce liquor and the seeds are used in edible oil and traditional medicine. Mahua is rich in sugar content and vitamins and minerals such as Vitamin C, Calcium, and Phosphorus. It is used to produce a fermented drink and edible oil, and its leaves and seeds are used for medicinal purposes. Mahua seeds can contain up to 50% oil as a major component.

Fig. 1 Mahua Seed

Fig. 2 Mahua Seed

2. **Sal Seed *(Shorea robusta)*:** Sal seed is another important tree crop found in Chhattisgarh. The seeds are rich in valuable fat (12-14%) and protein and can be used for oil extraction and as a food source. Sal seed is rich in healthy fats and contains fatty acids such as Palmitic acid, Stearic acid, Oleic acid, and Linoleic acid. It is used to extract oil, which is used in cooking and in the treatment of skin ailments and rheumatism.

Fig. 3 Sal Seeds

3. **Chironji *(Buchanania lanzan)*:** Chironji, also known as Charoli, is a nut-like seed that grows in the wild in Chhattisgarh. It is rich in protein, fat, and minerals and has various culinary uses.

Fig. 4 Chironji Seeds

4. **Karonda (*Carissa carandas)***: Karonda is a small, sour berry that grows well in the climate of Chhattisgarh. It is used in pickles, chutneys, and traditional medicines. (%) Karonda is rich in Vitamin C and contains other vitamins and minerals such as Calcium, Iron, and Phosphorus. It helps in digestion, boosts immunity, and helps in managing diabetes.

Fig. 5 Karonda Fruit

5. **Ghevda:** Ghevda, also known as Indian guar bean, is a leguminous crop that is drought-tolerant and grows well in Chhattisgarh. The seeds are used for food and fodder.

Fig. 6 Ghevda

6. **Ber *(Eugenia jambolana):*** Ber, also known as Indian plum or Jujube, is a small fruit tree that thrives in the arid regions of Chhattisgarh. The fruits are rich in Vitamin C, antioxidants and minerals. Ber is rich in Vitamin C and contain other vitamins and minerals such as Calcium and Iron. They help in digestion, boost immunity, and promote heart health.
7. **Amla *(Phyllanthus emblica)***

Fig. 7 Amla

Amla (Indian Gooseberry): Amla is a rich source of Vitamin C (%) and antioxidants (%). It is traditionally used in Ayurvedic medicine and has various culinary applications. Amla is high in Vitamin C and contains other vitamins and minerals such as Vitamin A, Calcium, and Iron. It boosts immunity, helps in digestion, promotes hair growth, and helps in managing diabetes.

8. **Jamun *(Eugenia jambos)*:** Jamun is a seasonal fruit with medicinal properties. It is rich in antioxidants (%) and has anti-diabetic properties. Jamun is rich in Vitamin C and contains other vitamins and minerals such as Iron and Calcium. It helps in managing diabetes, boosts immunity, and promotes heart health.

Promoting the cultivation and utilization of these underutilized horticultural crops in Chhattisgarh can help diversify agricultural production, improve farmers' income, and contribute to food security and nutrition in the region. Government support, research initiatives, and market

linkages can play a vital role in encouraging farmers to grow these crops and creating awareness among consumers about their nutritional benefits.

Conclusion

Chhattisgarh is a home to a variety of known underutilized horticultural crops that offer unique advantages in terms of nutrition, sustainability, and market value. These crops, such as Mahua, Sal Seed, Chironji, Karonda, Ghevda, Kusum, Ber, Amla, and Jamun, are packed with essential nutrients, antioxidants, and medicinal properties, making them not only nutritious but also beneficial for overall health. Encouraging the growth and utilization of these underutilized horticultural crops in Chhattisgarh can help diversify agricultural output, boost farmers' earnings, and enhance food security and nutrition in the area. Despite their many benefits and market potential, these crops often struggle with issues like awareness, availability, and promotion. Therefore, it is crucial to uncover the untapped potential of underutilized horticultural crops in Chhattisgarh and emphasize their importance in fostering agricultural diversity, improving nutritional security, and supporting rural livelihoods

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Table 1: Nutritional properties and benefits of underutilized horticultural crops

Crop	Nutritional properties	Health Benefits/Uses
Mahua	- High sugar content (sucrose, glucose, fructose, arabinose, few amounts of maltose and rhamnose) - Vitamins and minerals such as Vitamin C, Calcium, and Phosphorus	- flowers are used to produce a fermented drink and seeds are used for edible oil - Leaves and seeds are used for medicinal purposes - Provides an alternative source of income for forest-dependent communities - Can help to conserve forests and biodiversity - Can be used as a sweetener in various dishes
Sal Seed	- Rich in healthy fats - Contains fatty acids such as Palmitic acid, Stearic acid, Oleic acid, and Linoleic acid	- Used to extract oil - Oil is used in cooking and in the treatment of skin ailments and rheumatism
Amla	- High in Vitamin C - Contains other vitamins and minerals such as Vitamin A, Calcium, and Iron	- Boosts immunity - Helps in digestion - Promotes hair growth - Helps in managing diabetes
Karonda	- Rich in Vitamin C - Contains other vitamins and minerals such as Calcium, Iron, and Phosphorus	- Helps in digestion - Boosts immunity - Helps in managing diabetes
Jamun	- Rich in Vitamin C - Contains other vitamins and minerals such as Iron and Calcium	- Helps in managing diabetes - Boosts immunity - Promotes heart health
Ber	- Rich in Vitamin C - Contains other vitamins and minerals such as Calcium and Iron	- Helps in digestion - Boosts immunity - Promotes heart health
Lasoda	- Rich in Vitamin C - Contains other vitamins and minerals such as Calcium and Iron	- Helps in digestion - Boosts immunity - Promotes heart health

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Exploring Chayote: An Underutilized Vegetable with Potential for Snack Food Industries

Sajesh Chettri*, Sujata Jena, Said Prashant Pandharinath and Hijam Merina Devi
Department of processing and Food Engineering, College of Agricultural Engineering and Post Harvest Technology, Sikkim, Central Agricultural University Imphal, Manipur, India
*Corresponding Author: sajeshchettri20@gmail.com

Abstract

Chayote, an underutilized vegetable with immense potential, remains largely overlooked in the world of agriculture despite its nutritional benefits and versatility. This article explores the characteristics of chayote and its potential as a raw material for the snack food industry. Widely cultivated in India, particularly in the northeastern hill region, chayote offers various nutritional benefits, including vitamins, minerals, and dietary fibre. While the nutritional composition of its fruits is well-known, information about chayote roots and leaves is limited but promising. With its mild flavour, crunchy texture, and longer shelf life, chayote presents an ideal raw material for snack food production. Various snack applications, such as chayote chips, snack bars, crackers, and sweet snacks, highlight its versatility and potential to cater to diverse consumer preferences. Additionally, chayote cultivation offers environmental and economic benefits, contributing to food security and income generation for farmers. By harnessing the full potential of chayote as a raw material for the snack food industry, we can create healthier snack options and stimulate local economies, benefiting both consumers and agricultural communities

Introduction

In the world of agriculture, certain crops often go unnoticed despite their immense potential. One such underutilized vegetable is the chayote. While commonly consumed in some regions, chayote remains largely overlooked in others. However, this humble vegetable holds great promise, particularly as a raw material for the snack food industry. In this article, we will delve into the characteristics of chayote and explore its potential for snack food production.

Sechium edule, commonly known as chayote (Fig. 1a), mirliton, or chocho, belongs to the gourd family, Cucurbitaceae. It is a perennial vine cultivated primarily for its delicious fruits. While typically grown as an annual plant in temperate regions, chayote is known for its rapid growth and distinctive tendrils. The fruits are pear-shaped, green, and ridged, with tiny white flowers that are unisexual. Each fruit, ranging from 7.5 to 10 cm (3 to 4 inches) in length, contains a single seed within its green to green-white flesh. Certain varieties may have spines or hairs on the fruits. Despite containing sap that may irritate the skin of some individuals, the peel of chayote can be eaten raw. Additionally, the young tuberous roots (Fig.1b) of the plant can be prepared similarly to potatoes.

Fig: (1a) Chayote, (1b) Chayote Tuber

Chayote cultivation is widespread in India, particularly in the northeastern hill region, including states like Tamil Nadu, Karnataka, West Bengal, Himachal Pradesh, and Mizoram, which stands out as the top producer. Mizoram alone produces 10,985 metric tonnes of chayote from approximately 845 acres of land. In the northeastern states of Meghalaya, Mizoram, and Sikkim, chayote is grown in various

forms. Despite its widespread cultivation in India, chayote is believed to have originated from Guatemala and Mexico. Chayote goes by different regional names in India, including squash (Assamese), quash (Bengali), chow chow (Hindi), dashkush (Manipuri), seemakattirikkai (Tamil), seemebadane (Kannada), phuti kakudi (Oriya), and iskush (Sikkim).

Nutritional Profile of chayote, its tubers and edible leaves

Despite its understated reputation, chayote fruit, tuber and edible part of its leaves packs a nutritional punch. The fruit is low in calories and rich in dietary fiber, vitamins C and K, as well as minerals such as potassium and manganese. Moreover, chayote contains antioxidants and bioactive compounds that offer various health benefits, including improved digestion, enhanced immune function, and reduced risk of chronic diseases. Table 2 show the complete nutritional profile of Chayote fruit.

Table 2 Nutritional Profile of chayote fruit (Sanwal *et al.*, 2007)

Nutrient	Quantity (per 100g)
Moisture content % (w.b.)	94.240
Energy	80,000 kJ
Protein	0.820 g
Total Lipid	0.134 g
Ash	0.300 g
Carbohydrates (by difference)	4.510 g
Dietary fibre	1.700 g
Sugars (total)	1.660 g
Calcium	17,000 mg
Magnesium	12.0 mg
Phosphorus	18.0 mg
Potassium	125.0 mg
Vitamin C (total ascorbic acid)	7.7 mg

Information about the nutritional composition and uses of chayote roots is limited compared to that of chayote fruits. On average, 100 g of dried chayote root contains approximately 17.8–85.5g of carbohydrates, 13.6–72.8g of starch, 0.17–0.40g of fiber, 2.00–10.4g of protein, and 0.20–0.33g of lipids Starch, constituting around 67%, and total soluble sugars, about 2%, contribute to approximately 50 kcal/100g of available energy (Vieira et al., 2019).

The edible part of Chayote leaves contains notable amounts of protein (2.69–4.88 g/100 g), pectin (0.45 g/100 g), and lipids (0.40–2.32 g/100 g), with approximately 40.2% of the lipids being non-polar, 30.8% glycolipids, and 29.0% phospholipids. The primary fatty acids found in chayote leaves are linolenic (42.1–76.7%), palmitic (13.7–38.5%), and linoleic (5.7–15.3%) acids. Compared to fruits or seeds, chayote leaves have higher levels of amino acids, except for aspartic acid. Chayote stems contain fiber (1.20–21.70%), protein (4%), and are particularly rich in niacin (1.10 mg/100 g), vitamin A (615 UI/100 g), and vitamin E (90 mg/100 g) (Rao et al., 1990).

Potential for Snack Food Industries

A snack, also known as snack food, is a type of food that is not meant to be eaten as a primary meal such as breakfast, lunch, or dinner. Instead, snacks are consumed to satisfy hunger between these main meals and to provide the body with a rapid source of energy. Chayote has huge potential to be a raw material for snack food industry and converted to varies snack. The unique texture, mild flavour of chayote, longer shelf life and low cost of chayote fruit makes it an ideal raw material for snack food production (Pineda-Vargas et al., 2020). With the rising demand for healthier snack options, the snack food industry is constantly seeking innovative ingredients that offer nutritional value without compromising taste and texture. Chayote fits the bill perfectly, offering a crunchy, refreshing base for a variety of snack products.

Potential Snack Food Applications

Chayote can be transformed into a wide range of snack foods, catering to diverse consumer preferences. Thinly sliced and dehydrated and chayote chips (Raleng et al., 2021) offer a healthier alternative to traditional potato chips, boasting a satisfying crunch and subtle flavor. Chayote can also be incorporated into snack bars, Papad, crackers (Sakung et al., 2020), and savory granola mixes, adding nutritional value and textural interest. Furthermore, its neutral flavor makes chayote a versatile ingredient for sweet snacks such as Chayote Dodol (Arief et al., 2021), fruit crisps, muffins, and energy balls. The process flow chart for preparation of

some common snacks from chayote and its tuber is shown in fig. 2.

Fig 2: Process flow chart for Preparation of chayote chips, Dodol, Papad and Crackers

Sustainability and Economic Benefits

Beyond its culinary attributes, chayote cultivation offers environmental and economic benefits. The plant is relatively easy to grow, requiring minimal inputs and thriving in various soil and climate conditions. Its prolific yield potential and fast-growing nature make chayote a sustainable crop option for farmers, contributing to food security and income generation through value addition. Additionally, incorporating chayote into snack food production can create new market opportunities for farmers and stimulate local economies.

Conclusion

Chayote represents a hidden gem in the world of agriculture, offering immense potential for the snack food industry. With its nutritional benefits, versatility, and sustainability credentials, chayote is poised to become a sought-after ingredient for healthy snack products. By raising awareness of its culinary possibilities and investing in research and development, we can unlock the full potential of chayote as a raw material for snack food industries, benefiting both consumers and agricultural communities alike.

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Gooseberry: The Forgotten Fruit

Neetu[1]*, Urvashi Nandal[1] and Bishnupriya Rout[2]
[1]Department of Foods and Nutrition, CCSHAU, Hisar (125004)
[2]Department of Nutrition and Dietetics, GD Goenka University, Sohna (122103)
*Corresponding Author: neetuhr75@gmail.com

In the vast tapestry of horticultural diversity, certain fruits have captured the imagination of cultures worldwide, while others languish in obscurity. Among these overlooked treasures is the gooseberry, a tart fruit with a rich history and a myriad of untapped potential. Gooseberry refers to the fruit produced by various species of plants in the Ribes genus, primarily *Ribes uva-crispa*. These plants belong to the Grossulariaceae family and are native to Europe, Asia and North Africa. Gooseberries are small, round or oval-shaped berries that typically range in color from green to yellow to red, depending on the variety and ripeness. The gooseberry plant is a deciduous shrub that produces clusters of berries along its branches. The leaves are usually lobed and have a distinctive scent when crushed. Some varieties of gooseberry bushes have thorns, while others are thornless.

Historical Background

Gooseberries have a rich and fascinating history that dates back centuries, with mentions found in ancient texts and folklore from various corners of the globe. Native to Europe, Asia and North Africa, gooseberries were cherished by ancient civilizations for their versatility and medicinal properties. In medieval Europe, they were cultivated in monastery gardens and prized for their high vitamin C content, which helped prevent scurvy during long winters. They were a common ingredient in pies, preserves and sauces, enjoyed by nobility and commoners alike.

Current Status

Despite its illustrious past, gooseberry's popularity has waned in modern times. In many regions, it has become a forgotten fruit, overshadowed by more commercially viable crops. The decline of gooseberry cultivation can be attributed to changing dietary preferences, limited awareness among consumers and the dominance of mainstream fruits in the market.

Nutritional Value and Culinary Uses

One of gooseberry's most remarkable attributes is its nutritional density. These small fruits pack a powerful punch of vitamins, minerals and antioxidants, making them a valuable addition to any diet. Gooseberries are rich in vitamin C, potassium, fiber and phytochemicals, which contribute to their numerous health benefits.

Beyond their nutritional value, gooseberries are prized for their culinary versatility. They can be enjoyed fresh, with their tart flavor adding a refreshing twist to salads and desserts. Additionally, they can be transformed into jams, jellies, sauces and chutneys, enhancing both sweet and savory dishes with their unique flavor profile.

Challenges and Opportunities

Despite its potential, gooseberry cultivation faces several challenges in the modern agricultural landscape. Limited awareness among consumers, lack of infrastructure for processing and marketing and competition from mainstream fruits pose significant obstacles to the revival of gooseberry cultivation.

However, there are also opportunities waiting to be seized. With growing interest in sustainable agriculture and culinary diversity, there is a renewed appreciation for underutilized crops like gooseberry. By promoting awareness, investing in research and development and exploring niche markets, unlocking the full potential of gooseberry and reintroducing it to the culinary mainstream.

Health and Environmental Benefits

Beyond its culinary appeal, gooseberry offers a host of health benefits. Studies have shown that the

antioxidants found in gooseberries may help reduce inflammation, lower cholesterol levels and improve heart health. Additionally, their high vitamin C content boosts immunity and promotes skin health, making them a valuable addition to a balanced diet.

From an environmental perspective, gooseberry cultivation offers several advantages. These hardy plants require minimal inputs, making them well-suited for organic and sustainable farming practices. Furthermore, their deep roots help prevent soil erosion, improve soil structure and enhance biodiversity in agricultural landscapes.

Promotion and Advocacy

To fully realize the potential of gooseberry, concerted efforts are needed to promote its cultivation and consumption. This includes raising awareness among consumers about the nutritional and culinary benefits of gooseberry, supporting farmers with technical assistance and market access and fostering collaborations between researchers, growers, chefs and policymakers.

By advocating for the reintroduction of gooseberry into our diets and agricultural systems, we can not only diversify our food sources but also promote environmental sustainability, support local economies and preserve cultural heritage. It's time to rediscover the forgotten fruit and celebrate the rich tapestry of horticultural diversity that it represents.

Conclusion

In conclusion, gooseberry have been overlooked in recent times, but its potential to contribute to our health, environment and culinary traditions is undeniable. Despite the challenges it faces in today's agricultural landscape, including limited awareness and competition from mainstream fruits, gooseberry offers a wealth of nutritional, culinary and environmental benefits. With its rich history, packed with mentions in ancient texts and folklore and its remarkable nutritional density, gooseberry deserves a place of honor in our diets and agricultural practices. By recognizing and embracing the value of underutilized crops like gooseberry, we can cultivate a more resilient and vibrant food system for generations. By promoting awareness, supporting farmers, fostering collaborations and advocating for its cultivation and consumption, we can ensure that the gooseberry regains its rightful place in our culinary traditions and agricultural landscapes.

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Production Technology for Successful Cultivation of Manila tamarind (*Pithecellobium dulce* (Roxb. Benth)

Udhayakumar K[1*], Muthulakshmi S[2], Aneesha[3], Sangeeth Shyam Sundar[4] and C. S. China Samy [5]

[1,4&5]Research Scholar, Department of Fruit Science, Horticulture College and Research Institute, Periyakulam, TNAU

[2] Professor, Department of Fruit Science, Horticulture College and Research Institute, Periyakulam, TNAU

[3]Research Scholar, Department of Vegetable Science, Horticulture College and Research Institute, Periyakulam, TNAU

*Corresponding Author: udhayakumar1077@gmail.com

Manila tamarind (*Pithecellobium dulce (Roxb. Benth*) comes under family of Fabaceae (2n = 26). It's a very hardy and robust thorny tree. It is basically a forest species which is also recommended for plantation as border plant or wind break around the orchard. It produces edible fruits and therefore can be planted in the back yards. Plants of jungle jalebi growing naturally on the waste lands or being planted at community lands were main source of edible fruits. The fruits are relished by children and local habitats as fresh. It can also be used for developing some value-added products.

Nutrient composition

The fruits of jungle jalebi were rich in various nutrients and anti-oxidant properties. The various chemical constituents of fruits have been observed due to location, genotype and maturity stage. The aril (Outer covering of the seed) was the only edible portion of fruit which constitutes about 60 per cent of the fruit weight. It contains approx. 22° Brix TSS at full maturity.

Constituent	Amount (per 100g edible pulp)
Calories	78.00
Moisture(g)	77.80
Protein(g)	3.0
Fat(g)	0.40
Total carbohydrate(g)	18.20
Fibre(g)	1.20
Ash(g)	0.60
Calcium(g)	13.00
Phosphorus(g)	42.00
Iron(g)	0.50
Sodium(g)	19.00
Potassium(g)	222.00
Thiamine(mg)	0.24
Riboflavin(mg)	0.10
Niacin(mg)	0.66
Ascorbic acid(mg)	133.00

Uses

- Manila tamarind contains a rich source of Vitamin C.
- Manila tamarind is used in various traditional medicines ranging from bronchitis, hemorrhage, sores and liver problems.
- Manila tamarind fruit exhibited strong antiulcer activity comparable to the standard drug, omeprazole.
- Its high thiamine content promotes the body converts sugars into energy, which stabilize stress levels.
- Works as an antiseptic.
- Boost the immune system and reduces phlegm.

Origin and distribution

It is native to Mexico, South America, and Central America. It is common in India, Malaysia and Thailand. In India, it widely grown in different parts of India i.e. Andhra Pradesh, Bihar, Chhattisgarh, Gujarat, Jharkhand, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, Tamil Nadu, Telangana, Uttar Pradesh, West Bengal, Delhi, Goa, and Andaman Island

Soil and Climate

The plants can resist nutritionally poor and harsh sites, and can grow in sandy, loamy, clay, acid, neutral, alkaline and saline soils. It can grow at altitudes up to 1550 m. Wide adaptability it grows well dry hot tropical and subtropical climates. Maximum temperature tolerance limit of 48 °C. It can grow well with annual rainfall of 700-1800 mm and survive in as low as 250 mm. It can tolerate shade and drought conditions but susceptible to severe frost.

Botanical description

It is a very hardy and thorny tree and is small to medium sized semi evergreen tree which can be grown up to 20 m height. The crown is spreading but

irregular and trunk is short (about 1 m height) with crooked branches and somewhat shiny branchlets. Bark exudes reddish brown gum when injured. Leaves are bipinnately compound with a pair of pinnae, each with two leaflets that are kidney shaped and dark green in colour. Spines are present in pairs at the base of the leaf.

Flowering

Flowers whitish, raceme like panicles 10 to 20 cm in length. Each branch has around 15 - 20 white flower in round heads. Each flower is 0.3 to 0.5 cm long with hairy corolla and calyx. Fruit is a pod, 10 to 15 cm long, 1 to 1.5 cm wide, curled up tightly and reddish brown in colour. Each pod has five to ten shiny black coloured seeds, which are surrounded by thick, spongy, dry pulp. Sweet tamarind may first produce flowers when trees are 2 years of age. Some workers suggested that seedling plant starts bearing six year after planting. Flowering generally occurs between December to May and fruits can be obtained on tree from February to August.

Varieties

Importance of varietal selection in jungle jalebi at Southern parts of our country mentioned that attempts were being made to identify and select the promising genotypes on the basis of bearing potential, fruit colour and pulp content. Mainly two types of jungle jalebi *i.e.,* red aril and creamy aril types were common in most parts of the country.

PKM 1

It is an open pollinated seedling selection from Soolakkarai at Virudhunagar district. The best season was June – September and can tolerate saline and alkaline soils. It is a regular bearer. The spirally twisted fruits with clear constrictions, pale yellow pods and white attractive aril were found in clusters (2-3). The skin of fruits turns yellow at maturity and seeds turn black. It yields about 79 kg/tree/year which is 30.0% increase over local type. The highest yield obtained from this variety is 125 kg / tree / year (11.85 t/ha).

PKM 2

It is a clonal selection from local collection, Horticultural College and Research Institute, Periyakulam. It is an ever-green tree with semi branching and spreading growth habit. It is a regular bearer with cluster bearing (3-4 fruits /cluster) type. The individual fruit weight is 40.25 g with fruits yield of 90 kg/tree/year (13.50 t/ha).

Planting

For hedge, seed are sown in 2 - 3 rows at 15 cm distance which develops an impenetrable fence after regular training and pruning. To develop a shelter belt, seedlings are transplanted at 3 - 4 m spacing around the orchard. For fruit production seedlings of Inga are planted in square system at 8 x 8 m spacing. Vegetative multiplied plants are planted at 6 x 6 m spacing. July - August is the best time for planting when the saplings are planted in the well prepared and filled pits of 60 x 60 x 60 cm. In problematic soil, pits size can be enhanced as per need.

Propagation and Rootstock

It is commonly propagated by seed. Freshly harvested seed germinate easily in 1 to 2 days after

sowing while dried seeds take 30 - 35 days for germination. Seed remains viable in storage for approximately 6 months. Replanting after 4 - 6 months.

Propagation by vegetative method

It can be propagated through hardwood cuttings. The best time for taking cutting is in July - August and treatment with 1000 ppm IBA improves rooting. Budding, grafting and layering are also successful at limited scale.

Training and Pruning

Training is essential at initial stage to provide better frame work to jungle jalebi tree. As avenue plant, the tree trunk was kept clean up to 3-4 m height and then branches were allowed in all the directions. *Pithecellobium* tree has fast growth rate and vigorous coppicing capacity and therefore can withstand any amount of pruning, lopping or browsing by animals. For hedge, regular pruning is necessary.

Water Management

Jungle jalebi was a hardy tree and grows well even without irrigation. At initial stage irrigation is required to establish the young plants. Irrigation during summer improves fruit size and yield.

Mulching

Sweet or manilla tamarind is hardy and drought tolerant plants, however, paddy straw, dry banana leaf etc. can be used as mulch beneath the tree canopy. Black polythene mulch is very effective to conserve soil moisture.

Intercropping

Inter crops such as coffee, tea, cacao, cardamom can be taken under humid tropical conditions and other seasonal inter crops like cow pea, brinjal, can be grown at initial stage of manila tamarind.

Nutrient Management

To a bearing tree, application of 50kg FYM during monsoon improves fruit set, fruit size and yield. Application of 40-50 kg FYM and 500g phosphatic fertilizer per tree has been found beneficial. Fertilizers should be applied during February- March and July-August.

Flowering, fruiting and yield

A seedling plant of jungle jalebi starts bearing six years after planting. Small, white flowers of 1 cm diameter having dense globular heads appear on one year old twigs during February. The fruit matures about 3-4 months after flowering. *P. dulce* (Akasa Kainan) matures by April-June in Orissa and most of the Northern states. Immature green pods are astringent while the ripe fruits are sweet. Ripening of fruit does not have any association with the colour of aril. Similarly, colour of aril does not have definite relation with astringency. On an average, a well-developed tree produces 40 to 50 kg fruits per year.

Harvesting and

Ripe fruits are manually harvested when peel colour turns from green to pink or when pulp becomes pinkish in colour. However, climbing on the tree is a risk because tree has thorny stem and branches. To harvest the fruits from a tall (10 - 15 m) tree, thin and long bamboo poles having a sharp pruning knife (skeel) fixed at the top of it, is used for harvesting.

Post-harvest management

Harvested pods are packed in bamboo baskets and wooden basket for marketing. Fruit can be stored for a few days at room temperature. The pulp is extracted from the pods by removing the peel and seeds. The fruits are used for making paste, mixed fruit jam, beverage, etc. Coloured varieties are used for making jam and squashes.

Future research needs

Jungle jalebi was a hardy fruit yielding species which has not been exploited commercially. Owing to its high nutritive value, antioxidant property and multipurpose nature of the tree, this species need special research attention in National Agricultural Research System of the country. The full potential of the species can only be exploited after,

1. Development of high yielding, dwarf statured, probably thorn less variety with high quality and palatability of fruits.
2. Development of commercial protocol for production of quality and true-to-type plant material.

3. Standardization of complete agronomical practices for fruit production under various ecological regions.
4. Development of various value-added products and diversification of its present use pattern.
5. Popularization of this fruit from neglected fruits to health food in the society.

Conclusion

The Manila tamarind have highly commercial as well as nutritional value. It can be grown successfully in backyard and at large scale that give high economic return. Manila tamarind can be used as a fresh table purpose as well as in processed form. Manila tamarind was used for weight loss and as a healthy light snack.

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Cultivation Technology of Dragon Fruit

P. Vasudev Naik, Mahantesh Y. Jogi and Chethan T.
ICAR - Krishi Vigyan Kendra, Kalaburagi-II (Raddewadagi),
Tq: Jewargi, Dist: Kalaburagi
*Corresponding Author: vasudevhort@gmail.com

According to the Indian Council of Agricultural Research (ICAR), the fruit can be sold between Rs. 150-200 per Kg and thus can fetch a huge profit for the farmers. With crop diversification, an important part of Government's strategy is to increase farmers income crops like Dragon fruit will surely being new hope for the Indian farmers that to especially Karnataka farmers.

Dragon fruit demand is very high and many people are showing interest in dragon fruit cultivation in Karnataka and neighboring state also. Among lot of exotic fruits now a days the dragon fruit is commercially grown in India. The Indian climatic conditions are highly favorable and suitable for its cultivation.

Climatic Condition

This fruit is best suited for the tropical climate with an annual rainfall 40 - 60 cm and Temperature ranging from 20° C to 40° C is considered suitable to grow.

Soil requirement

This can be grown on almost any soils however sandy soils that have good irrigation are generally preferred. The pH value of the soil should be in the range of 5.5 to 6.5 for a better crop.

Dragon fruit varieties

Mainly 3 varieties

1. Pink variety: Epicarp, as well as the edible endocarp, is pink in colour with black seeds.

2. Red white variety: Upper epicarp is pink and the edible portion is the white colour with black seeds.

3. Yellow variety: Upper part seems to be yellow and the edible portion is white colour with black seeds.

Planting

There are 2 methods of growing dragon fruit, the first is the use of seeds and the second is using cuttings from the plants. Seed method will consume more time. So, farmers opt for the cutting method and its commercial one. The length of cutting (sapling) should be 20 cm and it should be cut from the mother

plant and left in the shade for one week before being planted in the field. The distance between the plants depends on whether the support used is vertical or horizontal. In vertical support, the distance between the plants should be 2-3 meters while in horizontal support the distance reduced to almost 50 cm and allows for intensive farming. The vertical support should be in between 1 to 1.20 meter high while the horizontal support should be 1.40 to 1.60 meter for appropriate growth.

Irrigation

Since the plant requires less water irrigation is recommended once a week and drip irrigation should be used for better efficiency.

Flowering

The flowers start with on small spiral button type attract structures at the stem margins. These develop to flower buds in 10-15 days. The beautiful hermaphrodite nature flowers length (25-30cm), white inside and greenish yellow with purple dyes on the outside. They are scented and only blooming at night and last one only night. Flower production generally takes place during May - August and fruit harvest 30-40 days after fruits set.

Harvesting of Dragon fruit

The fruit requires 27 -30 days to fully grow. The fruit should be picked as soon it is fully grown as even

a delay of 4-5 days can cause it to rot. The expected yield per acre may vary from (1st year to 4th year) 04 to 12 metric tons depending on the conditions and techniques used.

The main advantage part of this fruit is that no requirement of either huge manure or regular medication etc. With less effort, get more profit.

Pests

Aphids: Prune to avoid dense canopy, do not intercrop with alternate hosts, enhance natural enemies by incorporating natural habitats of agro-forestry and flowers strips around field. Spray Lambda Cyhalothrin, Cypermethrin, Imidacloprid, Acetamipride, etc. are recommended, at the rate of 1m/ litre of water.

Thrips: Destroy all plant residues and volunteer plants during field preparation by turning them under while ploughing, apply mulch to reduce pupation. Spray insecticides like Deltamethrin at the rate of 1ml/1litre of water.

Mealybug: Spray acephate 75 SP @ 1 g/l or Quinalphos 25 EC 2 ml/l or Chlorpyriphos 25 EC 2ml/l or Profenophos 50 EC @ 2 ml or Thiodicarb 75 WP 2gm/l.

Diseases

Anthracnose: Pre-harvest spraying of Mancozeb 2g/lit or Carbendazim 1g/lit or Thiophanate methyl 1g/lit or Chlorothalonil 2 g/lit, 3 times at 15 days interval will control anthracnose.

Brown Spot: Field sanitation (collection and disposal of fallen diseased fruits, leaves and vines). Pruning vines to reduce density and thereby reducing humidity within the crop. Timely sprays with copper-based fungicides.

Soft rot: Control includes pruning out dying stems and spraying with copper sulfate White washing before onset of the problem Timely sprays with copper-based fungicides. Copper oxy chloride (at 0.2%) can be used for managing this disease.

Fruit rot: Maintain a weed free planting and remove and discard diseased plants (i.e. stems, fruits, and flowers) promptly when symptoms occur.

Reference

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Enhancing Efficiency: Underutilized Horticultural Crops and Their Post-Harvest Management

Shubham Gangwar[1], Rohit Kumar[1] and Dharmendra Kumar Ram[2]

[1]Ph.D. Scholar, Department of Post Harvest Technology, Banda University of Agriculture and Technology, Banda (Uttar Pradesh)

[2]Assistant professor, Sai Nath University, Ranchi (Jharkhand)

*Corresponding Author: rohitgautam958@gmail.com

Horticultural crops play a crucial role in providing diverse and nutritious food options, contributing to global food security and economic development. However, amidst the plethora of cultivated crops, there exists a category often overlooked and undervalued - underutilized horticultural crops. These are plant species with potential nutritional, economic, and ecological benefits, yet they are marginalized in agricultural systems and often neglected in research and development efforts. Underutilized horticultural crops encompass a wide range of species, including fruits, vegetables, herbs, and spices, which have not received adequate attention in terms of cultivation, promotion, and utilization. Despite their potential, factors such as limited awareness, insufficient research investment, market constraints, and cultural preferences have hindered their integration into mainstream agricultural practices.

The post-harvest phase of underutilized horticultural crops is particularly critical, as it directly influences their quality, marketability, and shelf-life. Post-harvest processes encompass activities from harvesting to consumption or storage, including handling, transportation, processing, and marketing. Efficient post-harvest management can mitigate losses, enhance product quality, extend shelf-life, and unlock economic opportunities for farmers and stakeholders along the value chain.

Importance of underutilized horticultural crops

Underutilized horticultural crops hold significant importance for several reasons

Biodiversity Conservation: Underutilized horticultural crops often represent a diverse array of plant species, including indigenous varieties and wild relatives of cultivated crops. By promoting the cultivation and conservation of these crops, agricultural biodiversity is preserved, contributing to ecosystem resilience and adaptation to environmental changes.

Nutritional Diversity: Underutilized horticultural crops offer a wide range of nutrients, flavours, and textures, enhancing dietary diversity and nutrition security. Incorporating these crops into diets can help combat malnutrition and address deficiencies in essential vitamins, minerals, and antioxidants.

Adaptation to Climate Change: Many underutilized horticultural crops are resilient to environmental stresses such as drought, pests, and diseases. By diversifying cropping systems with these resilient species, farmers can mitigate the impacts of climate change and improve agricultural resilience.

Cultural Heritage Preservation: Underutilized horticultural crops often have cultural significance and traditional uses within local communities. Preserving and promoting the cultivation of these crops helps maintain cultural heritage, culinary traditions, and indigenous knowledge systems.

Economic Opportunities: Underutilized horticultural crops have the potential to generate income and livelihood opportunities, particularly for smallholder farmers and marginalized communities. By diversifying crop production and value chains, farmers can access niche markets, specialty food sectors, and high-value products.

Food Security: Underutilized horticultural crops can contribute to food security by providing alternative sources of food during times of scarcity or crop failure. Their resilience to environmental stresses and adaptability to diverse agro-ecological conditions make them valuable assets for food production in challenging environments.

Innovation and Research: Studying underutilized horticultural crops can lead to the discovery of novel traits, genetic resources, and breeding opportunities. Research and innovation in these crops can drive agricultural advancements, improve crop resilience, and enhance food system sustainability.

Challenges in Cultivation and Harvesting

Despite their potential benefits, underutilized horticultural crops face several challenges in cultivation and harvesting, including:

- **Limited Research and Extension:** Compared to mainstream crops, underutilized crops often lack comprehensive research, breeding programs, and extension services, leading to a scarcity of high-yielding varieties, best agronomic practices, and pest management strategies.
- **Market Access and Awareness:** Marketing underutilized crops can be challenging due to limited consumer awareness, inadequate infrastructure for storage and transportation, and market preferences for familiar or exotic produce.
- **Seasonality and Perishability:** Many underutilized crops have short harvesting seasons and perishable nature, requiring efficient post-harvest management to minimize losses and maintain quality.

Strategies for Effective Post-Harvest Management of Underutilized Crops

Effective post-harvest management is essential for preserving the quality, safety, and marketability of underutilized horticultural crops. Key strategies include:

- **Harvesting at Optimal Maturity:** Timing is crucial in harvesting underutilized crops to ensure peak flavour, nutritional content, and shelf life. Farmers should be trained to recognize signs of maturity and employ proper harvesting techniques to minimize damage.
- **Handling and Storage Facilities:** Investing in infrastructure such as cold storage, drying facilities and packaging materials can extend the shelf life of underutilized crops, reducing spoilage and post-harvest losses.
- **Value Addition and Product Diversification:** Processing underutilized crops into value-added products like jams, juices, sauces, and dried snacks can enhance their marketability, prolong shelf life, and generate additional income for farmers.
- **Quality Assurance and Market Access:** Implementation of quality assurance measures, including grading, sorting, and packaging, to meet market standards and consumer preferences. Development of market linkages and value chain to improve market access and facilitate the commercialization of underutilized horticultural crops. Promotion of branding, labelling and certification scheme to enhance product visibility, credibility, and market competitiveness.
- **Policy and Institutional Support:** Strengthening of institutional support mechanisms, including extension services, research institutions, and farmer cooperatives, to promote knowledge dissemination and technology adoption. Collaboration between governments, private sector actors, non-governmental organizations, and research institutions to address systemic challenges and promote sustainable post-harvest management practices.

Conclusion

Underutilized horticultural crops represent a valuable yet underexploited resource in global agriculture. By promoting their cultivation and addressing challenges in post-harvest management, stakeholders can unlock their full potential to contribute to food security, nutrition, biodiversity conservation, and economic development. Empowering farmers with knowledge, resources, and market linkages is essential in harnessing the power of underutilized crops and building resilient food systems for the future.

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