International Journal of Tropical Agriculture
Volume 42, Numbers (3-4) • 2024 : pp. 199-207
ISSN: 0254-8755

Jackfruit: A Nutritional Powerhouse, Cultural Icon, and Rising Global Treasure

Prof (Dr.) S N Tripathy*

**Former Professor of Economics, Gokhale Institute of Politics and Economics, Pune, currently at Berhampur, Odisha*

Abstract: Jackfruit (Artocarpus heterophyllus Lam.) is a tropical fruit renowned for its versatility in culinary and therapeutic applications. Widespread in tropical regions, jackfruit is consumed fresh, as a snack, or in processed forms such as flour and value-added products. Beyond its culinary uses, jackfruit has a long history in traditional medicine, with its various parts, seeds, and bark—providing health benefits. Rich in carbohydrates, proteins, vitamins, and essential minerals, jackfruit is particularly noted for its high content of bioactive compounds, including phenolic compounds and flavonoids, which contribute to its notable antioxidant, anti-inflammatory, antimicrobial, anticancer, and antifungal properties. The fruit's broad therapeutic potential is attributed to these bioactive compounds, which play a role in reducing oxidative stress and may aid in the prevention of chronic diseases. Moreover, jackfruit seeds, often overlooked, are also nutrient-dense and contribute to its health-promoting profile. The diverse applications and nutritional composition of jackfruit make it a valuable addition to health-focused diets and an interesting subject for further research in food science and nutrition.

Keywords: Jackfruit, bioactive compounds, antioxidant, therapeutic properties

INTRODUCTION

In India, where jackfruit holds cultural significance and is sometimes referred to as the "poor man's food," the tree is widespread, especially in the Western Ghats, a region renowned for its biodiversity. Besides India, jackfruit is widely cultivated in countries such as Sri Lanka, Bangladesh, Burma, the Philippines, Indonesia, Thailand, and Malaysia. Jackfruit has been cultivated since prehistoric times, has been introduced to many Pacific islands since post- European contact, and is particularly important in Fiji. The global interest in jackfruit is part of a more significant trend where fruits and vegetables are increasingly recognized for their bioactive compounds contributing to health benefits and disease prevention. Jackfruit is now cultivated beyond its native South Asian regions, including Africa, Brazil, Suriname, the Caribbean, Florida, and Australia. Jackfruit holds cultural and nutritional importance in Fiji and other Pacific islands, where it was introduced post-European contact. In India, jackfruit is extensively cultivated in states such as Assam, Bihar, Tripura, West Bengal, Uttar Pradesh, Kerala, Tamil Nadu, and Karnataka. As of 2022, jackfruit is cultivated over an area of approximately 1.87 lakh hectares, yielding an impressive 1.87 million metric tons. Known as the largest tree-borne fruit globally, jackfruit can reach up to 55 kg in weight, and each tree produces a prolific yield, with mature trees bearing hundreds of fruits annually. It is widely grown in tropical regions, including India, Bangladesh, Sri Lanka, and Southeast Asia (Wikipedia).

Besides India, jackfruit is commonly grown in home gardens of tropical and subtropical countries, especially in Sri Lanka, Bangladesh, Burma, Philippines, Indonesia, Thailand, Malaysia, and Brazil. In India, it is widely distributed in Assam, West Bengal, Uttar Pradesh, Maharashtra, Kerala, Tamil Nadu, and Karnataka and is considered the "poor man's food".

Article History: Received: 29 June 2024; Revised: 22 July 2024; Accepted: 29 July 2024; Published: 30 December 2024

It is a medium-sized tree, typically reaching 28–80 ft. in height, that is easily accessible for its fruit. The fruit is borne on the tree's side branches and main branches. The average weight of a fruit is 3.5–10 kg, and sometimes some fruit may reach up to 25 kg. The ripe jackfruits consisted of 29% pulp, 12% seeds, and 54% rind. The tree itself, which can reach heights between 28 to 80 feet, bears large fruits on its side and main branches, with each fruit typically weighing between 3.5 to 10 kilograms, although some can reach up to 25 kilograms. A mature jackfruit comprises approximately 29% edible pulp, 12% seeds, and 54% rind. The seeds, roughly 2-3 centimetres in length and 1-2 centimetres in diameter, are nutrient-dense and add further value to the fruit.

However, despite its numerous advantages and potential as a commercial crop, jackfruit remains underappreciated, partly due to variability in fruit quality, long seed dormancy periods, and a traditional belief that consuming too much jackfruit may lead to digestive issues.

Regarding biodiversity, jackfruit demonstrates extensive variation, especially in the Western Ghats, where it grows in multiple forms. Different types of jackfruits can vary significantly in size, shape, rind characteristics, latex content, and even the pulp's sweetness, flavour, and texture. This diversity offers significant potential for crop improvement through selective breeding. However, high variability within the species, largely due to cross-pollination and seed propagation, has presented challenges in achieving standardization.

Despite numerous advantages, the popularity of jackfruit as a commercial crop is very poor owing to wide variations in fruit quality, the long seed dormancy, and the widespread belief that excessive consumption of jackfruit bulbs leads to specific digestive ailments. The jackfruit has innumerable types in the Western Ghats with varying fruit characteristics. The types differ in the shape and density of spikes on the rind, bearing, size, shape, latex, flake size, flake colour, quality, and maturity period. Innumerable variations in bulb sweetness, acidity, flavor, and taste are observed in jackfruit growing areas. Such a wide diversity among jackfruit types in the Western Ghats offers tremendous scope for improvement of this crop by selection. Due to cross-pollination and predominance of seed propagation over a long period, there is a high degree of variability within the species. Considering the above backdrop, the study has the following objectives:

OBJECTIVES OF THE STUDY

(1) The primary objective is to promote the conservation of unique jackfruit varieties in the Tumakuru district by recognizing and compensating traditional custodians, thereby fostering community engagement in biodiversity preservation.

(2) To explore jackfruit seeds' nutritional, medicinal, and functional properties, emphasizing their potential for flour production, health benefits, and applications in food and medicinal industries.

(3) To innovate and commercialize jackfruit-based products that highlight their nutritional benefits, providing economically viable alternatives for farmers while reducing food waste.

METHODOLOGY

The methodology relied on secondary data analysis, including existing research on jackfruit varieties and their nutritional properties. Case studies evaluated collaborations with farmers and organizations, and reports and surveys assessed market trends to understand consumer preferences.

MEDICINAL USES OF JACKFRUIT

Medicinally, jackfruit has been noted for its anti-inflammatory, antifungal, and antibacterial properties. Phenolic compounds in jackfruit have been shown to reduce inflammation, while prenylflavonoids exhibit strong antioxidant qualities, which may protect cells from oxidative stress. This antioxidant effect is further supported by resveratrol, a polyphenol known for its cardioprotective and anti-inflammatory actions, which is also naturally present in jackfruit (Baliga et al., 2011). Ayurvedic practices have traditionally utilized hot water extracts of jackfruit leaves for managing hyperglycemia and diabetes, with flavonoids in the extracts identified as critical components in its hypoglycemic action (Swami et al., 2012). The seeds contain lectins that display antifungal properties, while methanolic extracts from the bark and roots have demonstrated broad-spectrum antibacterial effects (Rahman

et al., 2020). Moreover, jackfruit seed starch is utilized in the pharmaceutical industry as a super disintegrant in the formulation of fast-dissolving tablets.

It is believed to have originated from the forests of the Western Ghats in India, after which its cultivation spread across the tropical lowlands of both the northern and southern hemispheres. The phenolic compounds isolated from jackfruit are reported to exhibit anti-inflammatory effects. The prenylflavonoids in jackfruit have strong antioxidant properties and are expected to act against lipid peroxidation of biological membranes. The hot water extract of mature leaves is utilized in Ayurvedic treatment for hyperglycemia and diabetes. The flavonoids present in the extract have been identified to be responsible for the nontoxic hypoglycemic action. Lectins present in the seeds have shown antifungal properties, while the crude methanolic extracts from root bark and stems have shown broad-spectrum antibacterial activity. Resveratrol is one of the polyphenols naturally present in jackfruit and is well-known for its health-promoting activities of antioxidant, cardio protection, and anti-inflammatory effects. Compounds that can inhibit angiogenesis have great potential for cancer treatment. Jackfruit seeds contain secondary metabolites that display anticancer effects, especially anti-angiogenesis and belong to the flavonoid group.

As a super disintegrant, the jackfruit seed starch is suitable for preparing fast-dissolving tablets. Extracts of jackfruit pulp show considerable anti-inflammatory activity by suppressing the production of nitric oxide (NO) and prostaglandin E2 (PGE2), and its leaf extracts also give remarkable antioxidant activity and exhibit attenuation on hyperglycemia and hyperlipidemia. Its wood was reportedly used as an antioxidant, antiaging, anti-inflammatory, and skin care agent. The leaf, root, bark, and fresh fruit of this plant have been certified to contain various compounds like flavonoids, phenolic acids, organic acids, carotenoids, stilbenes, triterpenes, and sterols, especially prenylflavonoids. Freeze-dried, vacuum-fried, and cryogenic processing are new preservation methods for modern jackfruit-based products. Various parts of the jackfruit tree have been used in medicine, and its wood is an essential source in timber industries.

Currently, it is widely accepted that the beneficial health effects of fruits and vegetables in the prevention of disease are due to the bioactive compounds they contain. Research on jackfruit also extends to its bioactive properties. Phenolic compounds in Artocarpus species, including jackfruit, are associated with anti-angiogenic effects, which could have implications for tumour prevention. Angiogenesis, a process essential for tumour growth, is inhibited by flavonoids, saponins, and tannins, secondary metabolites in jackfruit seeds. These compounds are noted for their partial heat resistance at around 130 °C, which may preserve their activity even during specific food preparations (Subramaniam et al., 2012).

Furthermore, the jackfruit's ecological role is noteworthy as it is presumed to be a primary host plant for certain insect species, such as Alloiothucha artocarpi. While there is currently no evidence to suggest that this insect poses a threat to jackfruit crops, continuous monitoring of jackfruit plantations could help to preempt any adverse effects, given the crop's economic importance in tropical agriculture. Jackfruit, originating in the Western Ghats of India, is also a national fruit of Bangladesh and Indonesia, symbolizing both its cultural and nutritional significance within these regions.

Jackfruit is a multifaceted fruit valued for its culinary, nutritional, medicinal, and ecological contributions. Its role as a "poor man's food" and a "nutrient of giants" aptly captures its importance across a variety of contexts, making it an invaluable resource in both subsistence and commercial farming.

In recent years, consumers, researchers, and the food industries have shown increased interest in how food products can help maintain health, and the role that diet plays in the prevention and treatment of many illnesses has become widely accepted.

Recent advancements in processing have led to a broader array of jackfruit products, including jackfruit leather, chips, baby food, juice, jams, jellies, and bases for cordials. Innovations such as freeze-drying, vacuum-frying, and cryogenic processing have made it possible to extend the shelf life and diversify the range of jackfruit-based products available for consumer markets. This has allowed jackfruit, some fruit traditionally consumed fresh, to gain new relevance in food industries, where there is a growing demand for nutritious, functional foods. Jackfruit wood is also utilized for its durability and suitability for furniture and other timber products.

CULTURAL AND NUTRITIONAL SIGNIFICANCE OF JACKFRUIT ACROSS REGIONS

Jackfruit's culinary and cultural significance has spread beyond its native regions and is trendy in tropical countries. In Brazil, for instance, two distinct jackfruit cultivars have been identified based on the texture of their flesh. These cultivars are referred to as "soft" jackfruit, with tender flesh and perianth, and "hard" jackfruit, characterized by a firmer texture. This classification underscores the fruit's versatility in culinary applications, as both forms are used in traditional and contemporary dishes across different cultures (da Silva & de Souza, 2020).

Jackfruit is notable for its size, nutritional value, and phytochemical composition, which has garnered attention for potential health benefits. Jackfruit's edible portion is rich in carbohydrates, proteins, and essential fatty acids such as palmitic, oleic, stearic, linoleic, lauric, and arachidonic acids. It also contains vital micronutrients, including fibre, calcium, phosphorus, iron, vitamin A, and thiamine, making it a nutrient-dense option for tropical communities. The bracts of ripe jackfruit have exceptionally high mineral content, with levels of calcium ranging from 20.0 to 37.0 g per 100 g and potassium from 191 to 407 g per 100 g, which contribute to its appeal as a "nutrient of giants" and its reputation as a staple food source in areas where food security is a concern (Morton, 1987).

Historically, the name "jackfruit" is thought to derive from the Greek terms artos (meaning "bread") and carpets (meaning "fruit"), reflecting its cultural and dietary importance as a food that has sustained many generations in the tropics. Jackfruit has achieved significant acclaim in traditional medicine, particularly within the ethnopharmacological domain, where it has been applied to treat ailments such as inflammation, diarrhoea, and diabetes mellitus. Several bioactive compounds within the jackfruit, including flavonoids, benzofurans, and lectin jacalin, are linked to these therapeutic effects and contribute to its prominence in folk medicine (Rahman & Nahar, 2013).

Moreover, jackfruit has been a prominent subject in recent studies focused on sustainable food sources and plant-based diets. With the rising interest in plant-based meat alternatives to mitigate the environmental impact and health risks associated with meat consumption, jackfruit has found a place as a favorable substitute due to its meat-like texture when cooked and its nutrient profile. This increasing demand for jackfruit-based meat analogues highlights its role as a culturally significant fruit and an environmentally friendly food option with health benefits (Selvamuthukumaran & Shi, 2020).

JACKFRUIT VARIETY

Jackfruit seeds, comprising around 10–15% of the fruit's total weight, are highly nutritious, particularly rich in carbohydrates and proteins, and each fruit contains approximately 100–500 seeds. While often discarded, they are sometimes steamed and eaten as snacks or used in local dishes, although fresh seeds cannot be stored long-term. Processing them into seed flour offers a sustainable alternative, with the flour usable in various food products. Jackfruit seeds are notable for their starch content, at around 22%, and dietary fibre, at 3.19%, making them a valuable source of energy and beneficial for digestive health. Beyond nutrition, jackfruit seeds are packed with phytonutrients, including lignans, isoflavones, and saponins, which offer diverse health benefits, such as anticancer, antihypertensive, antioxidant, antiaging, and antiulcer effects. Their unique composition also includes two lectins, jacalin and artocarpin, with jacalin playing a role in assessing immune function in HIV patients. With an amylose content of 32%, jackfruit seed starch has lower swelling properties but demonstrates excellent resistance to heat and mechanical shear, making it a stable ingredient in food formulations. Fat absorption and organic acid content in jackfruit seeds further enhance flavour, mouthfeel, and health impacts, making them a promising component in nutritional and medicinal applications.

Jackfruit seeds are nutritious and possess health-enhancing properties, partly due to their organic acids, which interact with other compounds to influence the acetic-alkali balance within the body. These organic acids contribute to improved overall health by creating an alkalizing effect. Their role in digestion is also significant, as they stimulate the stomach and pancreas while enhancing intestinal motor function. Among these organic acids, oxalic acid, which naturally occurs in the blood at a mean concentration of 288 micrograms per 100 millilitres,

is crucial for supporting immune responses, as it aids the body in combating conditions like cancer and viral, bacterial, and vascular diseases. When oxalic acid levels fall below optimal, the immune system may weaken, allowing abnormal or radical cells to proliferate, potentially leading to detectable tumours. Another essential component of jackfruit seeds is their amino acid content, which plays a fundamental role in protein synthesis. Proteins, the building blocks of life, are constructed as cells interpret DNA's (Deoxyribonucleic Acid) instructions to bind specific amino acids in precise sequences. This synthesis process relies on RNA (Ribonucleic Acid), which transfers DNA instructions, gathers necessary amino acids, and arranges them into chains. Each amino acid's unique chemical structure dictates the protein's final shape and function. Moreover, jackfruit seeds contain amino acids like tryptophan, which is known for synthesizing serotonin- a neurotransmitter that regulates mood—and melatonin, a hormone essential for sleep. The amino acid profile of food proteins in jackfruit seeds varies, containing both essential and nonessential amino acids, making them a rich dietary source for supporting cellular functions and neurological health.

Across the diverse regions of India, a wide range of jackfruit varieties can be found, each with distinct characteristics and uses. Recently, four unique varieties of jackfruit, primarily from the Malenadu region of Karnataka, have been officially registered under the Protection of Plant Varieties and Farmers' Rights Authority (PPFRA), marking a significant step towards their conservation and commercial potential. The registration of unique jackfruit varieties under (PPFRA) and the development of innovative jackfruit-based products underline the fruit's economic and nutritional potential. This authority in India is responsible for registering unique plant varieties, safeguarding plant breeders' rights, and protecting farmers' rights over traditional varieties they have developed. These efforts safeguard biodiversity and offer new opportunities for farmers to benefit financially. The varieties Haladi Rudrakshi, Orange-RPN, Kempu Rudrakshi, and Red were studied in a comprehensive study that spanned more than four years. Upon the conclusion of this rigorous examination, the necessary documentation was submitted to the PPFRA for registration. Following the submission, experts appointed by the authority conducted site visits and thoroughly inspected the varieties, eventually recommending them for registration.

One notable variety is the Lalbagh jackfruit, which is believed to have originated in Bengaluru. Well-suited for dry regions, this variety yields fruit twice a year. The Lalbagh jackfruit is characterized by its large size, with individual fruits weighing between 20 and 25 kilograms, an oblong shape, and bright yellow, crispy flesh. The taste is notably sweet, making it suitable for various uses, including preparing jams, jellies, chutneys, and pastes, and as a flavouring agent in ice creams and beverages. Following the required procedures, the registration processes for these varieties were completed, and the respective certificates were issued.

The protection and conservation of these unique jackfruit varieties are expected to benefit farmers substantially. Once commercial production begins, farmers who have obtained these certificates will enjoy financial advantages as the demand for these specialized varieties grows. Moreover, if farmers of these protected varieties suffer any losses, they are entitled to compensation under government regulations, ensuring both economic protection and sustainability for those engaged in their cultivation.

THE RISE OF KARNATAKA'S UNIQUE RED JACKFRUIT

For generations, a select few households nestled in the Tumakuru district of Karnataka have meticulously safeguarded a hidden treasure- an exceptional variety of jackfruit that yields exquisitely flavorful bulbs, characterized by a delightful aroma and vibrant hues that range from copper red to bright orange. Until approximately a decade ago, the existence of these plants and their devoted custodians remained largely unknown to those beyond the village borders, with only occasional sightings of vendors peddling the succulent bulbs, locally known as chandra halasu in Kannada, along the roadside during the height of the summer season, yet even these vendors were reticent to disclose the identities of the growers. Consequently, it took considerable effort and many years of persistent visits to various households throughout Tumakuru for Ganesan Karunakaran, a principal scientist at the Indian

Institute of Horticultural Research (IIHR) in Bengaluru, to elevate this remarkable jackfruit variety to the public's attention. Currently, this prized plant is being cultivated across an impressive expanse of approximately 2,000 hectares in the states of Karnataka, Tamil Nadu, Kerala, and Odisha, serving as a compelling testament to how biodiversity can be effectively conserved when communities and traditional custodians of biological resources can reap the benefits. Over the ensuing three years, IIHR scientists, in collaboration with enthusiastic jackfruit advocates and non-profit organizations, diligently identified a total of 125 varieties from the Tumakuru region, and through careful evaluation based on parameters such as the richness of colour, flavor, crispness, and nutrient profile, ultimately selected ten varieties that stood out as the best among them.

In an unprecedented move, the Indian Institute of Horticultural Research (IIHR) took a significant step by releasing jackfruit varieties named after their custodian farmers, with the Siddu variety being released in 2017 and the Shankara variety following in 2019; additionally, IIHR entered into memoranda of understanding (MOUs) with these custodian farmers, stipulating that they would receive 75 per cent of the proceeds from graft sales, thereby ensuring that the benefits of this endeavour would directly support those who have long cared for and cultivated these unique varieties. To further protect these valuable resources, the varieties were registered under the Protection of Plant Varieties and Farmers' Rights Authority (PPV & FRA), guaranteeing that no unauthorized individuals could propagate or sell them without the farmers' consent. Over the years, Siddappa's son, Paramesh, and Shankarayya's son, Kemparaj, have diligently acquired grafting techniques and established their nurseries, with Paramesh having earned a remarkable royalty of ₹40 lakh from IIHR, and he currently produces approximately 25,000 saplings annually.

During a festive event in June 2024 in Mangalore, a farmer associated with the Toobugere Jack Growers Association was seen peeling red jackfruits for sale, which garnered considerable attention due to the recently discovered category of red jackfruits, resulting in the association receiving invitations to all jackfruit festivals organized in coastal Karnataka, where these unique fruits were sold for ₹250 each. In the years 2014-15, two scientists from the state Kumar KK from Government First Grade College in Devanagari and Bharathi TR from the University of Mysore in Mysuru—assessed the nutritional value of the fruit, concluding that the orange-flake jackfruits contain higher levels of phenols and flavonoids compared to their yellow counterparts, indicating a more excellent antioxidant activity in the former. Grafting expert Gururaja Balthillaya, hailing from Athradi village in the Udupi district, emphasized that the primary allure of this fruit lies in its vibrant colour, describing it as having a sort of addictive quality, noting that while it may be less sweet than yellow jackfruits, it compels people to consume more. Furthermore, Shashi Bhushan Choudhary, the chief of the National Bureau of Plant Genetic Resources in Ranchi, has been conducting research on the fruit for the past five years and has expressed admiration for its genetic diversity, revealing that until recently, it was believed that a Brix value of 26 was the highest achievable in this category. However, a new variety has emerged with an impressive Brix value of 31, which indicates superior sugar content and, consequently, better resistance to pests and diseases. He also pointed out that when examining the gene pool of jackfruit varieties in India, red fruits have not been reported from the country's northern or northeastern regions.

Whether due to its exotic appeal, impressive nutritional content, vibrant colour, or delightful taste, the demand for red jackfruits-encompassing both the saplings and the fleshy bulbs-has increased exponentially in recent years, reflecting a significant surge in interest from consumers and growers alike, as a result of this heightened demand, the fruits are now commanding prices that are two to three times higher than those of the more commonly known yellow jackfruit, highlighting not only the shifting preferences of the market but also the potential economic benefits for farmers who cultivate these sought-after varieties.

EMPOWERING COMMUNITIES FOR SUSTAINABLE JACKFRUIT CONSERVATION

Community-based conservation is increasingly viewed as a promising approach for biodiversity protection, offering a model that addresses the needs of local ecosystems and empowers communities, fostering a sense of stewardship over natural resources that is essential for long-

term environmental protection. This model integrates the knowledge and involvement of local communities into conservation efforts, aiming for sustainable impacts that can be adapted across various cultural and geographic settings. Community-based conservation is particularly effective because it prioritizes the people most intimately connected with the land, encouraging a participatory approach that ensures their voices and insights are central to the process. Consequently, this approach has proven to be both environmentally sound and cost-effective, allowing for broad application in diverse settings and strengthening the foundation for sustainable biodiversity management.

The fundamental principle of community-based conservation is powerful: it emphasizes collaborative efforts between scientists and the local community, wherein both groups work in tandem to protect local species and their habitats. This cooperative approach supports wildlife conservation and brings substantial social benefits, as community members feel a heightened sense of responsibility and pride in preserving the biodiversity around them. Furthermore, the participatory nature of this model enables local knowledge to be integrated with scientific expertise, creating ecologically sound and culturally relevant conservation strategies. This blending of traditional knowledge and modern science is crucial in developing context-specific conservation practices that are both realistic and achievable over the long term.

Fruits play a crucial role in these community-based efforts, as they provide nutritional security, contribute to food diversity, and promote climate resilience through low-carbon production systems. Indigenous fruits, such as jackfruits, are an invaluable resource in rural diets, rich in essential vitamins and minerals that support overall health. Despite their high nutritional value and potential medicinal benefits, many indigenous fruit species remain underutilized in global markets and local economies. Increasing awareness, capacity-building initiatives, and adopting innovative post-harvest technologies can help improve the conservation and utilization of these fruit species. Community-based conservation efforts encourage local farmers to cultivate, preserve, and promote indigenous fruit trees on their lands, thereby shortening the food supply chain and supporting local biodiversity while providing a sustainable livelihood.

One of the essential components of community-based conservation is the active participation of community members in monitoring natural resources, which makes the conservation process more inclusive, contextually relevant, and often less dependent on costly external inputs. Monitoring initiatives can vary in structure, from simple data collection efforts involving local men and women to fully participatory approaches where community members are responsible for designing, collecting, and analyzing data. Each approach has strengths: Expert-led models may offer higher precision. In contrast, community-led models foster faster decision-making and a stronger sense of ownership among community members, ultimately leading to more sustainable outcomes. Community-based monitoring of local resources can be especially valuable for conserving fruit species like jackfruit, as it allows communities to keep track of tree health, yields, and ecological interactions, creating a direct link between biodiversity conservation and food security.

Participatory monitoring initiatives also foster a sense of responsibility and connection to natural resources, encouraging communities to develop adaptive management strategies that align with local ecological and economic needs. Community-based Forest management, for instance, has empowered many rural communities to address food insecurity and income poverty through the sustainable harvesting of non-timber forest products (NTFPs), which include indigenous fruits. This approach supports livelihood diversification and promotes the conservation of forest resources, as communities can develop local markets for sustainably harvested products, further enhancing their resilience. By focusing on NTFPs such as jackfruit, community-based conservation efforts can bring significant economic benefits while preserving traditional knowledge and practices contributing to sustainable resource use.

Global climate change mitigation efforts have also fueled the rise of community-based forest monitoring approaches, as these initiatives align with broader goals to protect, restore, and manage forests effectively. Such initiatives can provide jobs and income for community members who act as data collectors, although they often depend on external funding tied to international carbon accounting systems. However, this reliance on external funding can sometimes hinder the long-term sustainability of these projects, as the data needs may

not always align with local conservation priorities. Ensuring that monitoring results are integrated into local resource management plans is crucial to prevent unintended impacts and maintain ecological integrity, especially when the monitoring data pertains to critical resources like jackfruit, which holds both economic and cultural significance for many communities.

Guidelines are needed to assist facilitators in selecting suitable approaches that meet specific conservation objectives to optimize the effectiveness of community-based monitoring. A balanced approach integrating data collection with social learning is often ideal, as it leverages community knowledge while fostering a deeper understanding of environmental changes. Such guidelines may include practical tools for participatory biodiversity data collection and aim to engage local stakeholders across social groups in decision-making processes. Participation in monitoring initiatives enhances the capacity of local communities to respond to environmental uncertainties, encouraging adaptive management practices that are both transparent and accountable.

Although community-based monitoring is often focused on forest biodiversity, which includes species diversity, genetic resources, and ecosystem services, this framework is adaptable to other natural resources, such as water or traditional ecological knowledge. Community-based monitoring of forest biodiversity is vital because it directly supports the livelihood of forest-dependent communities, who rely on diverse forest products for food, medicine, and income. Relevant issues for monitoring might include the impact of resource extraction, climate change, or forest conversion on tree species diversity, population health, and ecosystem resilience. Furthermore, community-led monitoring can reveal valuable insights into local ecological practices, such as the traditional management techniques that contribute to forest health and productivity.

One of the most valuable aspects of community-based conservation is its inclusivity, allowing even marginalized groups—such as ethnic minorities and landless households, often the most dependent on forest resources—to participate actively in conservation efforts. This inclusion enriches the data collected and promotes equity in resource management. Through community-based monitoring (CBM) initiatives, these groups can gain a voice in decision-making processes and benefit-sharing arrangements, fostering more equitable management of natural resources and strengthening their roles within the community. By involving these diverse user groups, community-based conservation ensures that the benefits of biodiversity protection are shared more widely, contributing to social cohesion, ecological sustainability, and the long-term conservation of essential resources like indigenous jackfruit varieties. Through sustained commitment to community involvement, conservation efforts can build a resilient framework that safeguards biodiversity and meets the evolving needs of local communities, paving the way for an integrated approach to sustainability.

INNOVATIVE JACKFRUIT PRODUCTS: NUTRITION AND SUSTAINABILITY

The Indian Council of Agricultural Research's Indian Institute of Horticultural Research (ICAR-IIHR) in Bengaluru has introduced innovative jackfruit-based products, highlighting this underutilized fruit's versatility and nutritional value. Among these, Arka Halasuras stands out as a pioneering enzyme-clarified ready-to-drink jackfruit beverage, developed by liquefying jackfruit pulp using a special enzyme cocktail, followed by serum separation. This naturally sweetened drink, free from added sugars, acids, or preservatives, boasts a shelf life of six months and provides essential nutrients, including 15-18 mg of vitamin C per 100 ml and antioxidant properties. Meanwhile, Arka Jackolate combines jackfruit seed powder and mushrooms into a chocolate that not only appeals to all age groups but also harnesses the health benefits of jackfruit seeds, which are often discarded. This chocolate contains significant starch content and potential antibiotic properties. Moreover, Arka Jackies offers a healthier alternative in the form of cookies made with blanched jackfruit seed powder, replacing up to 40% of refined wheat flour, resulting in a product rich in fibre, minerals, and antioxidants. These products exemplify sustainable food innovation and jackfruit's potential to enhance nutrition and reduce waste.

CONCLUSION

In many developing countries, there is a growing recognition of the need to commercially utilize

jackfruit, a crop rich in vitamins and bioactive compounds, as it offers a potential natural alternative to supplement various nutrients essential for human health. Jackfruit contains phytochemicals with antioxidant properties that play a crucial role in neutralizing free radicals and reactive oxygen species, elements linked to numerous human disorders, making it a beneficial dietary choice and a potential functional food. Furthermore, jackfruit and its derived products are promising in diets due to their pleasant taste and immediate energy source. In traditional Ayurveda, jackfruit serves multiple medicinal purposes, such as cooling and pectoral effects; its roots are used in treatments for diarrhoea and fever, while its leaves stimulate milk production in lactating women and animals. The ash from jackfruit leaves is applied to ulcers, and its warmed leaves are known to aid in wound healing, highlighting the fruit's therapeutic potential. Given its abundant natural metabolites, jackfruit shows promise for incorporation into food and pharmaceutical industries. This vastly underutilized crop could represent a significant economic opportunity for producers, who might otherwise overlook its value.

Jackfruit's role in nutrition, medicine, and industry highlights its adaptability and importance as a sustainable crop. Its high nutritional value and wide range of bioactive compounds make jackfruit an excellent candidate for promoting health and wellness. Although it is still overcoming challenges in its commercial cultivation, the jackfruit tree holds promise for food security, particularly in tropical and subtropical regions. Due to its health benefits and versatility in food processing, it has the potential for expanded utilization in global markets.

The growing demand for diverse jackfruit varieties reflects shifting consumer preferences. These preferences emphasize the importance of supporting traditional custodians and advancing sustainable agricultural practices. This ensures that the environment and local economies thrive through the conservation of indigenous resources.

REFERENCE

Baliga, M. S., Shivashankara, A. R., & Haniadka, R. (2011). Phytochemistry, nutritional and pharmacological properties of Artocarpus heterophyllus Lam (jackfruit): A review. Food Research International, 44(7), 1800-1811.

da Silva, F. R., & de Souza, V. S. (2020). Characterization and uses of jackfruit (Artocarpus heterophyllus) in Brazil. Journal of Tropical Fruits, 8(2), 45-52.

Morton, J. F. (1987). Fruits of Warm Climates. Creative Resource Systems Inc.

Padre, S. (2024). Taste it red. Down to Earth, 16-30. Retrieved from https://downtoearth.org.in

Rahman, A. U., & Nahar, L. (2013). Medicinal Plants and Their Bioactive Compounds. Springer.

Rahman, M. M., Islam, M. B., & Haque, M. A. (2020). Antibacterial activity of jackfruit (Artocarpus heterophyllus) leaf extract and its application in food preservation. Journal of Food Processing and Preservation, 44(9), e14592.

Selvamuthukumaran, M., & Shi, J. (2020). Utilization of jackfruit (Artocarpus heterophyllus) as a sustainable ingredient in plant-based meat alternatives. Sustainable Food Systems, 12(1), 33-44.

Subramaniam, P., et al. (2012). Heat resistance of bioactive compounds in jackfruit seeds and implications for health. Journal of Food Composition and Analysis, 25(1), 100-107.

Swami, S. B., Thakor, N. J., Haldankar, P. M., & Kalse, S. B. (2012). Jackfruit and its many functional components as related to human health: A review. Comprehensive Reviews in Food Science and Food Safety, 11(6), 565-576.

Wikipedia contributors. (2023, September 18). Jackfruit. Wikipedia. https://en.wikipedia.org/wiki/Jackfruit