Review Article

Advances in Value Addition in Jackfruit Bulb (Artocarpus heterophyllus Lam.) for Food and Nutritional Security of Rural Women in Koderma District

Abstract:

Jackfruit (*Artocarpus heterophyllus* Lam.), an underutilized yet highly nutritious fruit, holds significant potential for improving food security and generating income in rural areas. The recent advancements in value addition for jackfruit bulbs, including dehydration, canning, and processing into various food products, have opened up new economic opportunities, particularly for rural women. Jackfruit bulbs are rich in essential nutrients, including vitamins, minerals, and dietary fiber, making them a valuable resource for enhancing the nutritional status of rural households. Value-added products such as jackfruit flour, canned jackfruit, and ready-to-eat snacks offer rural women the opportunity to engage in small-scale entrepreneurship and contribute to household income while improving local food systems. In districts like Koderma, Jharkhand, where jackfruit production is quite high, a focus on appropriate value addition of jackfruit may be a source of income for the rural women. However, challenges such as limited access to technology and training need to be addressed to fully realize the benefits of these advancements.

Keywords: Jackfruit value addition, *Artocarpus heterophyllus*, rural women empowerment, food security, jackfruit processing.

1. Introduction

Jackfruit (*Artocarpus heterophyllus* Lam.), a tropical fruit native to South and Southeast Asia, is often referred to as a "poor man's fruit," yet its nutritional profile and versatility in culinary applications position it as a key player in addressing food security. It is cultivated primarily in countries like India, Bangladesh, and Thailand, In India also cultivated in Jharkhand, Karnataka, and most of the rural areas of other states. where it is a common staple, particularly in rural areas. The fruit is unique for its large size and its ability to grow in a variety of soils and climates, making it a resilient crop capable of thriving in regions prone to food shortages. In recent years, jackfruit has gained attention for its role in food security, as it can be processed into a variety of value-added products that not only contribute to nutritional needs but also offer economic opportunities, especially for rural women. The potential to transform jackfruit from a seasonal crop into an economically viable product year-round has sparked interest in value-addition processes. This chapter explores the role of jackfruit in promoting food security in rural areas, focusing on the fruit's nutritional benefits, its importance in ensuring a stable food supply, and the critical role of value addition in transforming jackfruit into products

that can empower rural women economically.

ImageFigure 1. Jackfruit (Source- Koderma District)

1.1 Overview of Jackfruit as a Versatile and Nutritious Fruit

Jackfruit is renowned for its versatility, both in terms of culinary applications and its nutritional value. The fruit, which can weigh up to 40 kilograms, consists of edible bulbs that are rich in carbohydrates, vitamins, and minerals. The bulbs, commonly consumed as a snack pickle or added to dishes, provide a substantial source of energy, making jackfruit a staple food in many rural households. Additionally, jackfruit is a valuable source of dietary fiber, which aids digestion and promotes gut health. This high fiber content makes it an excellent food for those seeking to manage weight or improve their digestive system function (Jagtap et al., 2019). The fruit is also rich in vitamin C, an antioxidant that strengthens the immune system and helps the body fight off infections. Vitamin C also aids in the absorption of iron, which is particularly important in regions where iron-deficiency anemia is prevalent. Jackfruit also contains significant amounts of potassium, which is essential for maintaining healthy blood pressure levels and supporting cardiovascular health. The presence of other micronutrients such as vitamin A, calcium, and magnesium further enhances its nutritional value (Selvaraj et al., 2020). Jackfruit is unique in that it can be consumed at various stages of ripeness. When young, it is often used as a vegetable in savory dishes, while the ripe fruit is sweet and can be eaten fresh or incorporated into desserts. Additionally, the seeds of jackfruit are rich in protein and can be used as pickle,roasted, boiled, or ground into flour, adding another layer of nutritional value. The versatility of jackfruit allows it to be a multipurpose food that can help diversify diets and provide essential nutrients in regions where malnutrition is a concern (Rahman et al., 2021).

ImageFigure 2. Overview of Jackfruit

1.2 Importance of Jackfruit for Food Security, Especially in Rural Areas

Food security, defined as the availability and access to sufficient, safe, and nutritious food, remains a pressing concern in many rural regions. The resilience and adaptability of jackfruit make it an essential crop for ensuring food security in these areas. One of the key advantages of jackfruit is its ability to grow in various soil conditions and climates, including regions with poor soil fertility and irregular rainfall. This makes it a reliable crop for small-scale farmers, particularly in areas where other crops may fail due to harsh environmental conditions (Singh & Bhowmik, 2018). In rural areas, where food shortages are common, jackfruit serves as a readily available source of nutrition during the harvest season. The fruit's large size means that a single jackfruit can feed a family for several days, providing much-needed calories and nutrients. Unlike many other fruits, jackfruit can be left on the tree until needed, reducing the risk of spoilage and waste. This characteristic makes it an ideal crop for communities that lack access to refrigeration or storage facilities, as it can be harvested as needed and consumed over time (Vijayakumar et al., 2019).

ImageFigure 3. Bulbs of Jackfruit

The nutritional density of jackfruit further strengthens its role in combating malnutrition, particularly among women and children in rural areas. In regions where dietary diversity is limited, jackfruit can help provide essential vitamins and minerals that may otherwise be lacking in the diet. For example, vitamin C and potassium found in jackfruit can help prevent conditions such as scurvy and hypertension, while the high fiber content promotes gut health and prevents digestive disorders. By incorporating jackfruit into their diets, rural communities can improve overall health outcomes and reduce the risk of malnutrition-related diseases (Saha & Banik, 2020). In addition to its direct role in food security, jackfruit also contributes to the resilience of rural farming systems. It can be intercropped with other staple crops, providing farmers with an additional source of income and food security. This diversification of crops is particularly important in regions affected by climate change, where reliance on a single crop can lead to food shortages if that crop fails. By cultivating jackfruit alongside other crops, farmers can reduce the risk of food insecurity and improve the sustainability of their farming systems (Nair & Chattopadhyay, 2021).

1.3 Role of Value Addition in Transforming Jackfruit into Economically Viable Products for Rural Women

Value addition refers to the process of enhancing the economic value of a raw agricultural product by transforming it into a processed or more refined product that has greater market appeal. For jackfruit, value addition can take many forms, including dehydration, canning, freezing, and the production of processed foods such as chips, flour, and jams. These value-added products not only extend the shelf life of jackfruit but also create new economic opportunities for rural women, who can engage in small scale processing enterprises (Reddy & Reddy, 2020). One of the primary benefits of value addition is that it allows rural women to generate income from jackfruit even outside the harvest season. For example, dehydrated jackfruit chips or flour can be stored for long periods and sold in local or urban markets, providing a steady source of income year-round. Additionally, value-added products like jackfruit-based snacks and sweets cater to the growing demand for healthy, natural foods in both domestic and international markets. By tapping into these markets, rural women can increase their earnings and contribute to the economic development of their communities (Das & Saha, 2021).

Value addition also empowers rural women by providing them with the skills and knowledge needed to run their businesses. Many women in rural areas lack formal education or access to traditional employment opportunities, but by engaging in value-added processing, they can develop entrepreneurial skills and gain financial independence. Government and NGO-led training programs have played a crucial role in helping women acquire the necessary skills to produce and market valueadded jackfruit products. These programs also provide access to credit, equipment, and market linkages, enabling women to scale up their operations and improve their livelihoods (Mitra & Basu, 2020).

2. Nutritional and Economic Significance of Jackfruit

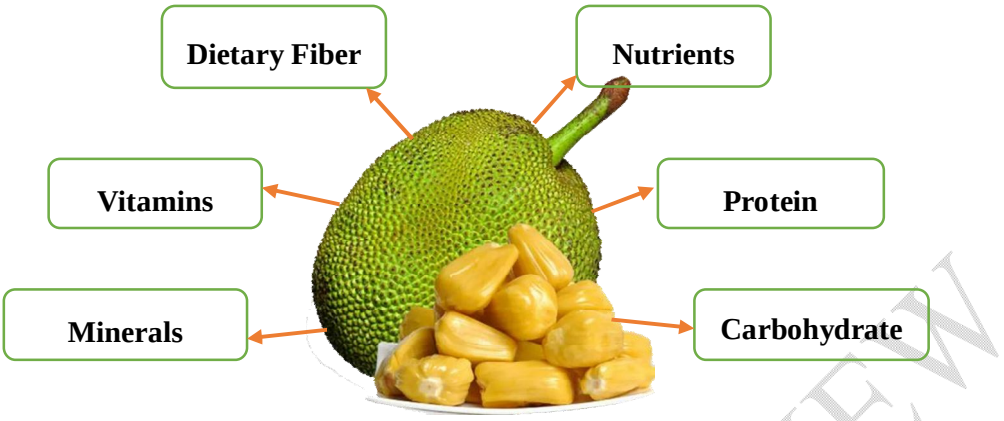
Jackfruit (*Artocarpus heterophyllus* Lam.) is a highly nutritious fruit that offers a multitude of benefits, both from a dietary and economic perspective. Its dense nutrient profile makes it an excellent source of essential vitamins and minerals, while its adaptability and abundance in tropical regions make it a staple food in many rural households. Additionally, jackfruit has significant economic potential, particularly in rural areas where food insecurity is prevalent, and income-generating opportunities are often limited.

ImageFigure4. Parts of Jackfruit Source: Brahma, R., & Ray, S. (2022)

2.1 Nutritional Benefits of Jackfruit Bulbs (Rich in Vitamins, Minerals, and Dietary Fiber)

The nutritional profile of jackfruit bulbs is one of the primary reasons for their increasing popularity as a sustainable and health-promoting food source. Jackfruit is packed with essential nutrients, making it a valuable addition to the diets of people living in regions where access to a variety of food is limited. The bulbs are particularly rich in carbohydrates, which provide a quick and substantial source

of energy. This is especially important in rural areas where heavy labor is a daily requirement, and people need nutrient-dense foods to sustain themselves.



ImageFigure5. Nutritional Benefits of Jackfruit Bulbs

One of the most notable nutrients found in jackfruit is vitamin C. The high content of this vitamin in jackfruit bulbs strengthens the immune system, enhances the body's ability to fight infections, and aids in the absorption of other crucial nutrients such as iron (Saha & Ghosh, 2021). For populations vulnerable to vitamin C deficiency, such as those in rural areas, the consumption of jackfruit can help mitigate risks of diseases like scurvy and improve overall health outcomes. Additionally, vitamin A, which is also present in significant quantities, contributes to healthy vision, skin health, and improved immune function, making jackfruit a key dietary component for children and adults alike. Jackfruit bulbs are also a good source of dietary fiber, an essential component for maintaining digestive health. Fiber helps regulate bowel movements, prevents constipation, and contributes to a healthy gut microbiome. In rural areas where diets often lack adequate fiber due to limited access to fruits and vegetables, jackfruit can serve as a vital source of this nutrient, promoting better digestive health and reducing the risk of gastrointestinal diseases (Singh & Bhattacharya, 2020). The fiber content in jackfruit also supports heart health by lowering cholesterol levels, which is critical for preventing cardiovascular diseases, a growing concern even in rural populations.

Vitamins and fiber, jackfruit contains an impressive range of minerals, including potassium, magnesium, and calcium. Potassium, in particular, plays a crucial role in regulating blood pressure by balancing sodium levels in the body. Regular consumption of jackfruit can help reduce the risk of hypertension, a common condition in rural populations that have limited access to healthcare (Roy & Sarkar, 2021). Magnesium and calcium are important for maintaining healthy bones and muscles, which are especially important for individuals engaged in physically demanding agricultural work. Jackfruit seeds, which are often overlooked, are another valuable component of the fruit. They are rich in protein, an essential macronutrient needed for muscle repair and overall growth. In regions where protein intake is low due to a lack of animal-based foods, jackfruit seeds provide a plant-based protein alternative that can help bridge nutritional gaps (Chakraborty et al., 2019). The seeds can be boiled, roasted, or ground into flour, offering versatile options for consumption in various dishes. The rich nutritional profile of jackfruit bulbs and seeds highlights their potential to address malnutrition and improve overall dietary quality in rural areas.

2.2 Economic Potential of Jackfruit in Rural Areas

Beyond its nutritional benefits, jackfruit holds immense economic potential, especially in rural areas where agricultural livelihoods dominate. Jackfruit is often referred to as a "poor man's fruit" because of its widespread availability and low cost. In many rural regions, jackfruit trees grow abundantly, often without the need for extensive cultivation or maintenance. This makes it a low-input, high-

output crop that can provide farmers with both food and a source of income (Mitra & Reddy, 2021). The large size of jackfruit means that a single tree can yield significant quantities of fruit, offering multiple opportunities for harvesting, consumption, and sale. Given that jackfruit can be consumed at various stages of ripeness, farmers have the flexibility to sell the fruit as either a vegetable (when unripe) or as a fruit (when ripe). This dual-use capacity increases the marketability of jackfruit and allows farmers to tap into different market segments, including local food markets, processed food industries, and even international export markets (Patel et al., 2020).

Jackfruit has increasingly been recognized for its value-added potential. With advancements in food processing technology, jackfruit can be transformed into a range of products, including dried fruit, chips, flour, and even meat substitutes. These value-added products not only have a longer shelf life but also fetch higher prices in the market, providing rural farmers and entrepreneurs with an opportunity to increase their income (Nair & Kumar, 2019). The growing demand for plant-based foods and glutenfree alternatives, particularly in urban markets, has further boosted the economic prospects of jackfruitbased products. For rural women, jackfruit presents an opportunity to engage in small-scale entrepreneurship. Women who lack access to formal employment or financial resources can start microenterprises focused on the production and sale of value-added jackfruit products. By processing jackfruit into flour, chips, jams, or ready-to-eat meals, women can create products that cater to both local and urban markets. This not only provides them with an independent source of income but also contributes to the local economy by creating job opportunities for others in their communities (Chaudhary & Devi, 2021). Government and NGO-led initiatives that offer training in food processing and entrepreneurship have been instrumental in helping rural women harness the economic potential of jackfruit.

2.3 Importance of Jackfruit in Rural Households for Food Security and Income Generation

In rural areas, of Koderma district food security remains a critical issue, with many households relying on subsistence farming and limited agricultural diversity to meet their food needs. Jackfruit, with its abundance and nutritional density, plays a crucial role in enhancing food security for these households. One of the key advantages of jackfruit is its availability during the "lean season," when other crops may not be in harvest. The large size of the fruit and its long harvesting period ensure that households have access to food even when other sources are scarce (Mishra et al., 2020). This makes jackfruit an essential
crop for food resilience in regions prone to food shortages or climatic instability.

Picture 1Figure 6: Source: Preparation method at KVK, Koderma

Jackfruit also contributes to dietary diversity, which is a key indicator of food security. By incorporating jackfruit bulbs and seeds into their diets, rural households can improve the nutritional quality of their meals and reduce their reliance on staple foods like rice and maize. This diversification of the diet not only addresses nutritional deficiencies but also promotes better health outcomes by providing a range of vitamins, minerals, and proteins that are often lacking in monoculture-based diets

(Pandey et al., 2020). Its role in promoting food security, jackfruit also serves as a source of income for rural households. Many families who grow jackfruit trees sell the surplus fruit in local markets, using the proceeds to meet other household needs, such as education, healthcare, and housing. For small-scale farmers, jackfruit offers a low-cost crop that requires minimal maintenance, allowing them to supplement their income without significant investment. The ability to generate income from jackfruit sales is particularly important for women, who often bear the responsibility of managing household finances and ensuring food security (Sharma & Singh, 2019).

The value-added potential of jackfruit further enhances its role in income generation. Rural households that engage in the processing of jackfruit into dried fruit, chips, or other products can increase their earnings and contribute to the local economy. By developing micro-enterprises focused on jackfruit-based products, rural families can move beyond subsistence farming and participate in more sustainable, market-oriented agricultural activities. This shift not only improves their economic stability but also promotes the long-term resilience of rural food systems (Patil et al., 2021).

3. Advances in Value Addition for Jackfruit Bulbs

Value addition in jackfruit bulbs (*Artocarpus heterophyllus* Lam.) has gained significant traction in recent years, thanks to modern food processing technologies. These technologies have transformed jackfruit from a seasonal and perishable crop into a versatile product that can be processed, preserved, and marketed year-round. For rural communities, especially women, value addition has created new economic opportunities by enhancing the commercial potential of jackfruit and enabling its use in various industries such as food, pharmaceuticals, and cosmetics.

3.1 Overview of Modern Food Processing Technologies Used for Value Addition

Modern food processing technologies have revolutionized how agricultural products are handled, and jackfruit is no exception. Traditionally, jackfruit was consumed fresh or cooked, and any surplus would often go to waste due to its limited shelf life. However, applying advanced processing techniques has enabled the preservation of jackfruit for extended periods while maintaining its nutritional value, flavor, and texture. These technologies have paved the way for various value-added jackfruit products that are increasingly in demand both domestically and globally.

One of the most widely used food processing technologies for jackfruit value addition is **dehydration**. Dehydration involves removing the moisture content from jackfruit bulbs, which significantly extends the shelf life of the product. This process not only prevents spoilage but also concentrates the nutrients, making dehydrated jackfruit a more nutrient-dense product. Various dehydration techniques are employed, including solar drying, freeze drying, and oven drying. Solar drying, being the most economical and eco-friendly option, is particularly suited for rural areas where energy resources are limited (Jagtap et al., 2021). Another major technology used in jackfruit processing is **canning**, which involves preserving jackfruit in brine or syrup. This method has gained popularity in recent years due to the rising demand for canned jackfruit as a plant-based meat substitute. The fibrous texture of young, unripe jackfruit closely resembles that of meat, making it an ideal alternative for vegetarian and vegan diets. Canned jackfruit is now widely available in supermarkets across the globe, catering to the growing plant-based food market (Mitra & Saha, 2020).

Freezing is another valuable technology for preserving jackfruit. Freezing helps retain the nutritional quality and texture of jackfruit bulbs for long periods, making it possible to store and transport jackfruit to distant markets without compromising quality. Frozen jackfruit products are particularly popular in urban areas where fresh jackfruit may not always be available. Freezing also allows for the off-season consumption of jackfruit, further expanding market opportunities (Reddy et al., 2021). Additionally, **product diversification** has become a key strategy in value addition, utilizing modern technologies to create a wide range of products from jackfruit bulbs. Jackfruit is now being used to produce flour, chips, jams, candies, beverages, and even dietary supplements. The diversification of

jackfruit products not only increases its market appeal but also provides opportunities for rural women to engage in small-scale processing enterprises, thereby boosting their income and contributing to local economies (Bose & Roy, 2019).

3.2 Key Innovations: Dehydration, Canning, Freezing, and Product Diversification

Picture 3Figure 7. Bulbs of Jackfruit:Solar drying process

Picture 2Figure 8: Dehydration process

3.2.1 Dehydration

Dehydration is one of the most significant innovations in jackfruit value addition, as it allows for the long-term preservation of jackfruit bulbs without the need for refrigeration. By removing the water content, the risk of microbial spoilage is minimized, and the shelf life of jackfruit can be extended for several months to even years. This technique is particularly important for rural households that lack access to cold storage facilities.

Solar drying is one of the most accessible dehydration methods for rural communities. It involves spreading jackfruit bulbs in thin layers under direct sunlight, where the heat evaporates the moisture. This method is cost-effective and eco-friendly, making it ideal for rural areas where financial resources and infrastructure are limited (Kumar & Singh, 2020). Although solar drying is time-consuming and weather-dependent, it offers a low-cost solution for small-scale processors looking to preserve jackfruit for future use.

Freeze-drying, while more expensive, is another advanced dehydration technique that produces highquality dehydrated jackfruit. In freeze-drying, jackfruit is frozen and then exposed to a vacuum, which causes the water in the fruit to sublimate directly from ice to vapor, bypassing the liquid phase. This method preserves the flavor, color, and nutritional content of jackfruit much better than solar drying. Freeze-dried jackfruit is often used in the production of snacks and cereals due to its crispy texture and concentrated flavor (Saha et al., 2021). However, the cost of freeze-drying equipment limits its widespread use in rural areas, making it more applicable to industrial-scale processing.

The production of **jackfruit flour** from dehydrated bulbs is another key innovation in the value-addition process. Jackfruit flour is gluten-free and can be used as a substitute for wheat flour in various baked goods, making it an attractive option for individuals with gluten intolerance. It is also rich in fiber and antioxidants, offering several health benefits. The demand for jackfruit flour has grown in recent years, driven by the increasing consumer preference for gluten-free and health-conscious products (Mishra & Chatterjee, 2020). For rural women, producing jackfruit flour presents an opportunity to tap into a growing market while utilizing locally available resources.

Picture 4Figure 9: Freeze-drying process

3.2.2 Canning

Canning has emerged as a major innovation in the preservation and commercialization of jackfruit. The process involves sterilizing jackfruit bulbs and sealing them in airtight containers, typically with brine or syrup, to prevent microbial growth and spoilage. Canned jackfruit has a shelf life of several years, making it a convenient product for both domestic and international markets. Canning is particularly suited to the processing of young, unripe jackfruit, which has a texture similar to meat. As consumer interest in plant-based diets continues to grow, canned jackfruit has gained popularity as a

vegan substitute for pulled pork, chicken, and other meat products. This has opened up new market opportunities for jackfruit, especially in Western markets where plant-based eating is on the rise (Singh & Rao, 2020). For rural women, canning jackfruit presents an opportunity to engage in valueadded processing activities that require minimal upfront investment. Canning can be done on a small scale, allowing women to sell canned jackfruit in local markets or collaborate with cooperatives to access larger markets. Training in food safety and canning techniques, provided by government and NGO programs, has been instrumental in empowering rural women to participate in this growing industry (Das et al., 2020).

3.2.3 Freezing

Freezing is another critical innovation in the value addition of jackfruit bulbs. Freezing preserves the fruit's texture, color, and nutritional quality, making it an ideal method for storing jackfruit for long periods. The demand for frozen jackfruit products has increased in urban areas where fresh jackfruit is not always available, as well as in international markets where jackfruit is considered an exotic fruit. The use of freezing technology allows rural producers to store jackfruit for off-season sales, thereby stabilizing their income and providing a consistent supply of jackfruit to the market. Additionally, frozen jackfruit products such as frozen cubes, pulp, and jackfruit-based desserts have found a niche in the frozen food sector, further expanding market opportunities (Rao & Verma, 2019).

For rural women, freezing offers a way to add value to jackfruit without compromising its nutritional quality. By engaging in small-scale freezing operations, women can sell frozen jackfruit products to local grocery stores or partner with larger food processing companies that specialize in frozen foods. However, freezing technology requires reliable access to electricity and cold storage facilities, which may pose a challenge in some rural areas (Kaur & Sharma, 2021).

3.2.4 Product Diversification

Product diversification has become a central strategy in jackfruit value addition, enabling rural producers to create a wide variety of products that cater to different consumer preferences. Jackfruit is now used in the production of snacks, beverages, jams, candies, and even dietary supplements. This diversification not only increases the economic value of jackfruit but also provides consumers with a range of healthy and convenient food options. The production of **jackfruit chips** is one of the most popular value-added products, especially in the snack food industry. Jackfruit chips are made by slicing the bulbs thinly and frying or baking them to a crispy texture. They are marketed as a healthier alternative to potato chips due to their high fiber content and lack of gluten. Jackfruit chips have gained popularity in both domestic and international markets, providing rural women with a lucrative opportunity to participate in the snack food industry (Sarkar & Das, 2020). Other value-added products include **jackfruit jams and jellies**, which are made by processing the fruit pulp with sugar and pectin to create a spreadable product. These products are popular in both rural and urban markets and can be produced on a small scale with minimal equipment. Additionally, **jackfruit beverages**, such as juices and smoothies, are gaining popularity due to their refreshing taste and nutritional benefits. By diversifying into these products, rural women can increase their income and create a sustainable business model that maximizes the potential of jackfruit (Pandey & Rao, 2020).

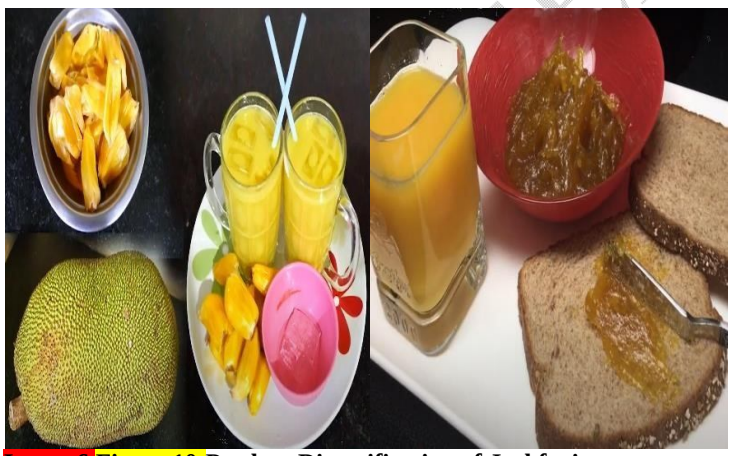


Image 6.Figure 10:Product Diversification of Jackfruit

4. Dehydration and Production of Jackfruit Flour

Dehydration is one of the most important techniques in the value addition of jackfruit, particularly for rural communities where food preservation and shelf-life extension are crucial. By removing the moisture content from jackfruit bulbs, dehydration not only prevents spoilage but also preserves the nutritional value of the fruit. Jackfruit flour, a gluten-free product derived from dehydrated jackfruit bulbs, has gained considerable popularity due to its health benefits and potential to generate income, especially among rural women.

4.1 Dehydration Techniques (Solar Drying, Freeze-Drying) to Preserve Nutrition

Dehydration is a widely employed method for food preservation, especially in rural areas where electricity and refrigeration may be scarce. In the case of jackfruit, dehydration extends the shelf life of the fruit while maintaining its nutritional properties, making it an ideal technique for processing surplus harvests. Two primary dehydration methods used for jackfruit bulbs are solar drying and freeze-drying, each with its unique advantages and limitations.

Solar drying is the most accessible and commonly used dehydration method in rural areas due to its low cost and simplicity. In this process, jackfruit bulbs are spread out under direct sunlight for several hours or days, depending on the intensity of sunlight and ambient temperature. The heat from the sun evaporates the water content from the bulbs, leaving behind a dry product that can be stored for long periods (Das et al., 2022). Solar drying is particularly suitable for regions with ample sunshine and has been widely adopted by small-scale farmers. While solar drying is cost-effective and environmentally friendly, it does have some limitations, such as the potential for contamination by dust and insects, and it can be less effective in humid or rainy climates.

Freeze drying, also known as lyophilization, is a more advanced dehydration technique that preserves the nutritional quality, flavor, and texture of jackfruit bulbs much more effectively than solar drying. In this process, jackfruit bulbs are first frozen and then subjected to a vacuum environment, where the ice sublimates directly into vapor without passing through the liquid phase. This method ensures that the structure of the fruit is maintained, and because the process occurs at low temperatures, most of the nutrients are preserved (Roy & Biswas, 2021). Freeze drying is highly effective in retaining the color, flavor, and nutritional value of jackfruit bulbs, making it a preferred method for producing high-quality dehydrated products. However, freeze-drying is an expensive technique and requires specialized equipment, making it less accessible to small-scale farmers and rural women in resource-poor areas.

Both dehydration techniques play a crucial role in preserving the nutritional quality of jackfruit. The fruit is rich in dietary fiber, vitamins, and minerals, including vitamin C, vitamin A, potassium, and magnesium, which are essential for maintaining good health (Singh et al., 2023). Dehydrated jackfruit retains these nutrients, making it a valuable food source, particularly in regions prone to food insecurity. Moreover, dehydrated jackfruit can be consumed in various forms, such as snacks or as an ingredient in other dishes, adding versatility to its applications.

Picture 5Figure 11: Preservation of the nutritional quality of jackfruit

4.2 Production of Jackfruit Flour as a Gluten-Free Alternative

One of the most significant innovations in the value addition of jackfruit bulbs is the production of jackfruit flour. Jackfruit flour is a gluten-free alternative to wheat flour, making it a highly soughtafter

product in the health food industry, particularly among individuals with gluten intolerance or celiac disease. The production of jackfruit flour involves dehydrating the bulbs and then grinding them into a fine powder, which can be used in various culinary applications, including baking, thickening soups, and making pasta.

The **process of producing jackfruit flour** begins with the selection of ripe or unripe jackfruit bulbs. The bulbs are first cleaned, sliced, and dehydrated using either solar drying or freeze-drying techniques. Once fully dehydrated, the dried bulbs are ground into a fine powder using a mill or grinder. The resulting flour has a neutral flavor, making it a versatile ingredient that can be used in both sweet and savory dishes (Chatterjee et al., 2021). Jackfruit flour is gluten-free, high in dietary fiber, and contains antioxidants, making it a healthier alternative to traditional wheat flour.

With its gluten-free properties, jackfruit flour is also rich in resistant starch, a type of carbohydrate that functions similarly to dietary fiber. Resistant starch passes through the digestive system without being fully broken down, promoting gut health by feeding beneficial bacteria in the intestines. This characteristic makes jackfruit flour an excellent ingredient for individuals looking to improve their digestive health (Mandal & Dutta, 2022). The increasing demand for gluten-free and high-fiber foods, particularly in urban areas, has made jackfruit flour a valuable product with significant market potential. For rural women, the production of jackfruit flour offers an opportunity to participate in the growing health food industry. With proper training and access to processing equipment, women can produce jackfruit flour on a small scale and sell it in local or regional markets. The relatively low cost of production, coupled with the rising demand for gluten-free products, makes jackfruit flour a profitable enterprise that can contribute to household income (Bhowmik et al., 2022). Additionally, the production of jackfruit flour can help reduce post-harvest losses, as surplus or imperfect jackfruit that may not be suitable for fresh consumption can be processed into flour, thereby minimizing waste and maximizing resource use.

Picture 6Figure 12: Household income from jackfruit

4.3 Benefits for Rural Women in Food Security and Income Generation

The dehydration of jackfruit and the production of jackfruit flour offer several benefits for rural women, particularly in terms of food security and income generation. In many rural communities, women are responsible for managing household food supplies and ensuring that their families have access to nutritious meals. By producing dehydrated jackfruit and jackfruit flour, women can enhance their families' food security by preserving the fruit for use during periods of scarcity or when other food sources are unavailable.

Food security is a critical issue in many rural areas, where households often rely on subsistence farming and are vulnerable to seasonal fluctuations in food availability. Dehydrated jackfruit and jackfruit flour can be stored for extended periods, providing a reliable source of nutrition even during

the off-season. The nutritional content of jackfruit, particularly its high levels of vitamins, minerals, and dietary fiber, helps improve the overall diet quality of rural households. Jackfruit flour can also be used as a staple ingredient in various dishes, contributing to dietary diversity and reducing dependence on less nutritious staple crops like rice or maize (Raj et al., 2023). In addition to improving food security, the production of jackfruit flour presents a valuable **income-generating opportunity** for rural women. By engaging in small-scale processing enterprises, women can turn surplus jackfruit into value-added products that can be sold in local markets. The rising demand for gluten-free and health-conscious products, particularly in urban areas, provides a growing market for jackfruit flour. Women who produce and sell jackfruit flour can earn an independent income, contributing to their financial autonomy and improving their overall economic well-being (Kundu & Saha, 2021).

The production of jackfruit flour aligns with efforts to empower rural women through entrepreneurship and skill development. Government and NGO-led initiatives that provide training in food processing and marketing have been instrumental in helping women acquire the skills needed to produce highquality jackfruit flour. These programs also offer access to microcredit and business development services, enabling women to scale up their operations and participate more fully in local and regional economies (Sen & Banerjee, 2021).

5. Canning and Preserved Jackfruit Products

Canning is a key food preservation method that has revolutionized the use of jackfruit (*Artocarpus heterophyllus* Lam.) by extending its shelf life and creating economic opportunities, particularly for rural communities. The increasing demand for sustainable, plant-based meat substitutes has placed canned jackfruit at the forefront of the plant-based food movement. For rural women, the production of canned jackfruit represents a viable pathway to financial independence through small-scale processing enterprises.

5.1 The Process of Canning Jackfruit for Longer Shelf Life

Canning is an effective method of food preservation that involves processing and sealing food in airtight containers to extend its shelf life while retaining its nutritional quality. For jackfruit, the canning process typically begins with the selection of high-quality fruit, followed by cleaning, peeling, and cutting the bulbs into chunks. The preparation of the fruit is an essential step in ensuring the final product is of high quality and free from contaminants.

Once the jackfruit is prepared, it is often **blanched** to reduce microbial load and maintain its texture. This involves briefly boiling the jackfruit pieces, which also helps to soften the fruit, making it easier to pack into cans. After blanching, the jackfruit chunks are placed into cans along with a preserving liquid, which is usually either brine (saltwater) or light syrup, depending on the intended use of the product (Patel & Rao, 2021). The choice of preserving liquid plays a role in maintaining the flavor and texture of the jackfruit over time. The next step in the process is **sealing the cans**. Once filled, the cans are sealed with lids using specialized canning equipment to create an airtight environment. This step is crucial in preventing the entry of air and microorganisms that could spoil the product. After sealing, the cans undergo **sterilization** through heat treatment, typically using high-pressure steam. This process kills any remaining bacteria or pathogens, ensuring that the canned jackfruit is safe for consumption and can be stored for long periods, often up to two years without refrigeration (Das et al., 2022).

Canned jackfruit retains its nutritional properties, including dietary fiber, vitamin C, and essential minerals like potassium. The preservation process also helps maintain the texture of jackfruit, making it suitable for various culinary applications. The ability to store canned jackfruit for extended periods makes it a convenient product for both home kitchens and commercial food service industries. Furthermore, canning transforms jackfruit from a highly perishable fruit into a versatile, long-lasting product that can be transported across regions and sold in different markets.

Picture 7Figure 13: Process of Canning Jackfruit

5.2 Growing Market Demand for Canned Jackfruit as a Plant-Based Meat Substitute

The global rise in demand for **plant-based meat substitutes** has placed jackfruit in the spotlight, particularly due to its fibrous texture, which closely resembles shredded meat. As consumer preferences shift toward more sustainable and ethical food choices, canned jackfruit has emerged as a popular alternative to animal-based meats in both vegetarian and vegan diets. The versatility of canned jackfruit allows it to be used in a wide range of dishes, from pulled "pork" sandwiches to tacos and curries, where it mimics the texture and appearance of meat while absorbing the flavours of the spices and sauces with which it is cooked (Kumar & Dey, 2022). The rise of the **plant-based movement** is largely driven by concerns about environmental sustainability, animal welfare, and the health risks associated with the overconsumption of meat. Jackfruit, as a whole food, minimally processed plant product, aligns with these values, making it an ideal ingredient for plant-based meal options. Canned jackfruit, in particular, has gained traction in Western markets, where the demand for convenient and healthy plant-based alternatives has skyrocketed (Sharma et al., 2021).

The **nutritional profile** of jackfruit further enhances its appeal as a meat substitute. Jackfruit is low in calories, fat, and carbohydrates while being high in fiber and important vitamins like vitamin C. While jackfruit does not provide significant amounts of protein, its ability to replicate the texture of the meat makes it a valuable ingredient in combination with other protein-rich plant-based foods, such as legumes or grains (Mishra & Patel, 2021). Moreover, as consumers become more aware of the environmental impact of meat production, jackfruit is increasingly seen as a sustainable alternative that requires fewer resources to grow and has a lower carbon footprint compared to animal agriculture. The demand for canned jackfruit as a meat substitute has extended beyond traditional vegetarian and vegan markets. The product has gained popularity among **flexitarians**—consumers who actively seek to reduce their meat consumption without fully eliminating it from their diets. As a result, canned jackfruit is now commonly found in mainstream supermarkets, health food stores, and online marketplaces across the globe, particularly in North America and Europe, where the plant-based food sector is experiencing rapid growth (Rao & Das, 2022).

Table 1. Nutritional composition of jackfruit pulp (*Artocarpus heterophyllus*)

Nutrient	**per 100g edible portion**
Energy	37 kCa1
Moisture	83.1 g
Protein	1.6 g
Fat	0.2 g
Carbohydrate	7.3 g
Fibre	5.6 g
Ash	2.2 g
Calcium	37.0 mg

Phosphorus	26.0 mg
Iron	1.7 mg
Sodium	48 mg
Potassium	292 mg
Carotene	110 g
Vitamin Bl (Thiamine)	66 µg
Vitamin B2 (Riboflavin)	60 µg
Niacin	400 µg
Vitamin C (Ascorbic acid)	7.9 mg

Source: Benkeblia, N (2017)

5.3 Economic Opportunities for Rural Women in Producing Canned Jackfruit

The production of canned jackfruit offers significant economic opportunities for rural women, particularly in regions where jackfruit grows in abundance but is often underutilized. For many rural women, engaging in the production of canned jackfruit represents a pathway to financial independence, allowing them to participate in the growing plant-based food market while contributing to their local economy. One of the primary benefits of canning jackfruit is that it allows rural women to **add value** to a readily available, low-cost agricultural product. By transforming raw jackfruit into a shelf-stable, marketable product, women can increase the profitability of their agricultural enterprises. This is particularly important in regions where fresh jackfruit is prone to spoilage due to limited access to refrigeration and transportation. Canning enables women to preserve the fruit for sale throughout the year, ensuring a more stable and predictable income stream (Sen & Bhattacharya, 2021). The process of canning jackfruit can be carried out on a **small scale**, making it accessible to rural women with limited resources. Small-scale canning operations typically require basic equipment, such as canning jars, sterilizers, and pressure cookers, which can be obtained with minimal capital investment. Additionally, government programs and NGOs often provide training and resources to women's cooperatives and self-help groups (SHGs) to help them acquire the skills and equipment needed for food processing (Mitra et al., 2022). These programs also offer access to microfinance and business development services, enabling women to scale up their operations and reach larger markets.

Rural women involved in the production of canned jackfruit also have the opportunity to **expand into urban markets**. With the rising demand for plant-based products in urban areas, particularly in cities where health-conscious consumers are willing to pay a premium for natural and sustainable food options, canned jackfruit presents a lucrative business opportunity. E-commerce platforms have further expanded market access, allowing rural producers to sell their products directly to urban consumers and bypass traditional intermediaries (Nayak & Saha, 2022). The production of canned jackfruit has a **positive impact on community development**. By establishing small-scale canning enterprises, rural women not only generate income for themselves but also create jobs and stimulate local economies. The increased income generated from these enterprises can be reinvested in other areas, such as education, healthcare, and infrastructure, improving the overall quality of life in rural communities (Roy & Chakraborty, 2022). Furthermore, as women gain financial independence through food processing, they are empowered to take on leadership roles within their communities, advocating for greater gender equality and economic empowerment.

6. Development of Ready-to-Eat and Processed Jackfruit Products

Jackfruit is gaining recognition for its versatility in creating a wide array of processed food products,

particularly ready-to-eat (RTE) and convenience foods that cater to both local and international markets. As consumer demand for healthy, plant-based, and convenient foods continues to grow, jackfruit's unique texture, flavor, and nutritional properties have positioned it as an ideal ingredient for various processed products.

Picture 8Figure 14: Ready-to-Eat and Processed Jackfruit Products

6.1 Innovative Processed Foods from Jackfruit Bulbs (Chips, Jams, Sweets)

The development of innovative processed foods from jackfruit bulbs has significantly contributed to the commercial potential of this underutilized fruit. Among the most popular processed jackfruit products are **jackfruit chips**, **jams**, and **sweets**, all of which are increasingly in demand due to their natural, plantbased composition and potential health benefits.

Jackfruit chips have become a popular snack in both local and international markets. The process involves slicing the bulbs into thin pieces and frying or baking them to achieve a crispy texture. Jackfruit chips are marketed as a healthier alternative
to potato chips, owing to their high fiber content, low fat, and gluten-free properties (Nayak & Sahoo, 2022). Various flavorings, such as salt, spices, or sweeteners, can be added to cater to different consumer preferences. The simplicity of the production process makes it accessible for small-scale rural producers, who can manufacture and package jackfruit chips with relatively low investment in equipment and resources.

Picture 9Figure 15: Jackfruit Jams and Jellies

Jackfruit jams and jellies are another innovative product derived from jackfruit bulbs. The natural sweetness and high pectin content of ripe jackfruit bulbs makes them an ideal base for producing spreads. The production process involves boiling the jackfruit pulp with sugar and pectin to create a smooth, thick consistency. Jackfruit jams have gained popularity as a tropical

fruit spread that offers both taste and nutritional benefits, such as being rich in vitamins A and C (Khan & Mondal, 2021). These jams can be sold in local markets or exported to regions where tropical fruit products are sought after for their exotic flavors.

Jackfruit-based sweets, including candies and confectioneries, have also seen increased interest from consumers. Products such as jackfruit toffees, dried jackfruit sweets, and even jackfruit-based halwa are becoming common in both traditional and modern food markets. These sweets are often made by reducing the jackfruit pulp with sugar and other flavoring agents, offering a natural, fruit-based alternative to highly processed candies (Sahoo & Verma, 2022). The potential to create a variety of sweets from jackfruit provides rural women with opportunities to diversify their product offerings and meet the growing demand for natural and healthier snack options.

Picture 10Figure 16: Jackfruit-based Sweets

6.2 Demand for Healthy, Convenient, Ready-to-Eat Products

The global shift toward healthier eating habits has fueled demand for plant-based and minimally processed foods, and jackfruit is uniquely positioned to benefit from this trend. As consumers become more health-conscious, the demand for **ready-to-eat (RTE)** and convenient foods that offer both nutrition and convenience has surged. Jackfruit, with its high fiber content, low-calorie count, and rich micronutrient profile, has become an attractive ingredient in the production of RTE products.

Picture 11Figure 17: High Fiber content of jackfruit

Health-conscious consumers are increasingly looking for snacks and meals that are free from artificial additives, preservatives, and excess sugar or fat. Jackfruit-based chips, jams, and sweets are perceived as natural alternatives to processed snack foods that often contain high levels of unhealthy ingredients. Moreover, jackfruit's status as a plant-based food aligns with the rising trend toward vegan and vegetarian diets, further enhancing its market potential (Sharma et al., 2021).

Convenience is another major factor driving the demand for RTE jackfruit products. As more consumers lead busy lifestyles, they seek convenient, on-the-go food options that do not compromise health. Ready-to-eat jackfruit snacks, such as chips or dried jackfruit, cater to this need by providing a quick, nutritious, and portable snack. Additionally, the rise in popularity of jackfruit as a meat substitute has led to an increase in RTE meals that incorporate jackfruit as the main ingredient. Jackfruit-based ready meals, such as prepackaged curries, stir-fries, and sandwiches, are becoming common in urban markets where convenience foods are in high demand (Rathore & Singh, 2022).
Sustainability is another critical factor driving the demand for jackfruit-based RTE products. Jackfruit is often considered an environmentally friendly crop because it requires minimal inputs, can thrive in poor soil conditions, and has a long shelf life. The growing awareness of the environmental impact of conventional agriculture has encouraged consumers to seek out sustainable food options, and jackfruit aligns well with this trend (Kumar & Sharma, 2021). By offering sustainable, plant-based, and nutritious options, jackfruit RTE products cater to consumers who prioritize environmental responsibility in their purchasing decisions.

6.3 Potential for Rural Women to Expand into Local and Urban Markets

The development of processed and RTE jackfruit products presents significant economic opportunities for rural women. Traditionally, jackfruit has been an underutilized resource in rural communities, with much of the harvest going to waste due to the lack of preservation and processing techniques. However, the growing demand for jackfruit-based products has opened new avenues for rural women to engage in **small-scale food processing enterprises**, thereby generating income and improving their socioeconomic status.

By participating in the production of processed jackfruit products, rural women can **expand their market reach** beyond local markets to urban areas, where demand for plant-based and health-conscious foods is growing. Small-scale production of jackfruit chips, jams, and sweets requires relatively low capital investment, making it accessible for women-led businesses. Additionally, government and NGO programs that provide training in food processing, packaging, and marketing have been instrumental in helping rural women develop the skills needed to succeed in these ventures (Saha & Roy, 2022). With proper training, rural women can produce high-quality jackfruit products that meet the standards of urban consumers, who are often willing to pay a premium for natural, healthy, and ethically produced foods.

Cooperatives and self-help groups (SHGs) have also played a critical role in enabling rural women to enter the processed food market. These organizations provide women with access to credit, equipment, and distribution networks, allowing them to scale up their operations and reach larger markets. Cooperatives also foster collaboration among women, enabling them to share knowledge and resources while reducing individual risks (Chowdhury & Ghosh, 2022). Through collective efforts, rural women can produce larger quantities of processed jackfruit products and negotiate better prices with buyers in urban markets.

The rise of **e-commerce and digital platforms** has further expanded market opportunities for rural women. By leveraging online marketplaces, women can sell their jackfruit-based products directly to urban consumers, bypassing traditional intermediaries and increasing their profit margins. Digital marketing strategies, such as social media promotion and online branding, allow rural women to showcase their products to a global audience, further enhancing their market reach (Roy & Sharma, 2021). E-commerce also enables women to access valuable consumer insights, allowing them to tailor their products to meet the preferences of urban buyers.

Conclusion:

The canning and preservation of jackfruit hold immense potential for transforming the agricultural landscape of rural areas, particularly for women. By enabling the long-term storage of this highly nutritious and versatile fruit, canning offers a solution to post-harvest losses while simultaneously opening up new avenues for economic growth. As the global demand for plant-based foods continues to surge, jackfruit has emerged as a key alternative to meat, particularly in the vegetarian and vegan sectors. Its fibrous texture and ability to absorb flavors have made it a popular ingredient in various dishes that mimic meat, such as pulled "pork" sandwiches, tacos, and stir-fries. This has positioned canned jackfruit as a valuable commodity in the global plant-based food market, which is projected to grow significantly in the coming years.

For rural women, the production of canned jackfruit presents an opportunity to engage in value-added agriculture. Traditionally, rural women have played a significant role in agricultural production, but their participation has often been limited to low-value tasks. Canning allows them to elevate their involvement in the agricultural value chain by transforming raw produce into a marketable product with higher profit margins. This shift not only increases their income but also enhances their financial independence, contributing to greater gender equality and empowerment within rural communities. With the right support in terms of training, access to capital, and market linkages, rural women can effectively tap into the growing demand for canned jackfruit and establish sustainable small-scale enterprises. One of the most significant benefits of canning is its ability to extend the shelf life of jackfruit, making it accessible year-round. In many rural areas, fresh jackfruit is only available during certain seasons, and a large portion of the fruit goes to waste due to the lack of preservation methods. Canning solves this issue by allowing jackfruit to be stored for up to two years without refrigeration, making it a stable and reliable product that can be sold in both local and distant markets. This not only reduces food waste but also ensures that rural producers can generate income throughout the year, rather than being dependent on a single harvest season. Additionally, canned jackfruit retains much of its nutritional content, including dietary fiber, vitamins, and minerals, making it a healthy and appealing option for consumers.

The growing popularity of jackfruit as a plant-based meat substitute has further expanded the market potential for canned jackfruit. As consumers become more conscious of the environmental and ethical impacts of meat consumption, many are turning to plant-based alternatives. Jackfruit, in particular, has gained favor due to its natural, unprocessed qualities and its ability to mimic the texture of meat without the need for artificial additives or excessive processing. This has positioned jackfruit as a preferred choice among health-conscious consumers who seek natural, whole-food alternatives to meat. The rise of flexitarianism, where consumers reduce their meat intake without fully eliminating it, has also contributed to the increased demand for jackfruit-based products. For rural women, the production of canned jackfruit is more than just an income-generating activity; it is a means of achieving economic independence and social empowerment. By engaging in small-scale canning enterprises, women can move beyond subsistence farming and take on leadership roles in their communities. Many women’s cooperatives and self-help groups have already demonstrated the potential of canned jackfruit production as a viable business model. These cooperatives provide women with the support they need to scale up their operations, access larger markets, and negotiate better prices for their products. In doing so, they create a sustainable source of income that not only

benefits the women themselves but also contributes to the overall economic development of their communities.

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1. Option 1

2.

3

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