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CULTIVATING GROWTH AND COMPETITIVENESS OF BREADFRUIT (ARTOCARPUS ALTILIS) AS ALTERNATIVE FOOD DIVERSIFICATION AND STAPLE FOOD SUBSTITUTION IN INDONESIA

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Abstract

This qualitative research elaborates the potentials, obstacles, and challenges in cultivating breadfruit (*Artocarpus altilis*) or *sukun* as a staple food alternative in Indonesia. Data collections were conducted by in-depth interviews, field observation, and literature reviews.

Breadfruit serves a promising business potentials in Indonesia, since it can be processed into various products, such as flour, crackers, and many others such as brownies and fermented goods. Breadfruit is also a superfood which provides beneficial nutrients as a source of healthy food. No wonder that breadfruit, with its 80% of carbohydrate, is a very potential alternative for staple food in Indonesia, despite not yet very popular in replacing rice. For the Indonesian farmers, breadfruit is also convenient to grow, as it can be planted in various types of land, and it can be harvested twice a year. Research found that farmers only need 10 breadfruit trees to grow, and they can earn IDR 20 million / USD 1220 for each harvest.

On the other hands, this study identifies the obstacles in developing breadfruit in Indonesia, such as agricultural technical obstacle where breadfruit is prone to rottenness and damage due to containing high level of water (60-80%); the dependency to seasons and price fluctuations; the suboptimum marketing infrastructure; the agricultural institution in Indonesia which doesn't function optimally; and limited use of breadfruit among people.

In order to solve these problem, this research recommends several aspects to improve, such as management, marketing, and infrastructure; and specifically by implementing product innovation development, food processing quality improvement, and stronger institutional supports in food sector.

Keywords: breadfruit, *sukun*, food, staple, Indonesia

INTRODUCTION

Breadfruit (*Artocarpus altilis*) or *sukun* in Indonesian language, is one of traditional staple crops worldwide and an increasingly important component of Indonesian agrosystems. Out of various species of breadfruit, *Artocarpus altilis* species is horticultural plant (Rahmah and Waluyo, 2019). The fruit itself is often considered a superfood, due to its impressive nutritional profile and potential health benefits. This starchy fruit is rich in complex carbohydrates, fibre, as well as various vitamins and minerals, which making breadfruit a nutritious, healthy, and potentially beneficial food source. Whether fried, roasted, fermented, or eaten raw, breadfruit is a versatile food that's played an essential role in Indonesian cuisine for hundreds of years. Nowadays, as global climate continues to shift due to human actions, this fruit increasingly plays important role to address global hunger.

Unfortunately, regardless the abundant benefits of breadfruit, the amount of production of breadfruit in Indonesia has been decreasing over the recent years.

Table 1: Production of Breadfruit in Indonesia

Year	Production (in Tonne)
2020	190,551
2021	172,373
2022	165,032
2023	156,626

(Source: Statistik Pertanian, Ministry of Agriculture, Republic of Indonesia, 2020-2023)

This study aims to identify the potentials of breadfruit as an alternative food diversification and staple food substitution in Indonesia, to investigate further about the obstacles and challenges in cultivating breadfruit in Indonesia, and to propose several recommendations to overcome those obstacles.

Research Objectives

This objectives of this research is exploring the potentials of breadfruit as a staple food in Indonesia, as well as investigating the obstacles in hinders breadfruit become alternative staple food in Indonesia.

As a form of problem identification, this research is aimed to answer the following critical questions:

1. What are the **potentials** of breadfruits as an alternative food diversification and staple food substitution in Indonesia?
2. What are the **obstacles** and **challenges** in cultivating breadfruit that hinder breadfruit to become alternative staple food in Indonesia?
3. What **recommendations** to propose in order to overcome those obstacles and to make breadfruit a staple food alternative in Indonesia?

METHODOLOGY

This qualitative study adopts ethnobotany as the research method. Ethnobotanical research methods are approaches in studying the relationship between human and plants, in particular on how different cultures make use of native flora for many sorts of purposes, for instance food, medicine, and rituals (Fiveable, 2024). The ethnobotanical method in this research incorporates qualitative techniques, such as in-depth interviews and participatory observations in order to gather empirical primary data.

Fieldwork is one critical aspect of an ethnobotanical research, which requires researchers to immerse themselves in the communities they study in order to build trust, as well as to gather accurate data (Balick and Cox, 2020). For the primary data, in-depth interviews were conducted with breadfruit farmers and scholars in breadfruit agriculture (Weller and Romney, 1998). The second primary data was gathered by participatory observation, which was conducted in several breadfruit plantations in Central Java.

For the secondary data, literature study is conducted by collecting relevant information from various documents, such as academic journals, books, online news, social media, and other relevant media. This multifaceted qualitative approach helps to document the indigenous uses and traditional ecological knowledge of breadfruit in Indonesia, while augmenting the understanding and comprehension of both biodiversity and cultural practices. This article organizes reviews several published and unpublished documents on breadfruit in Indonesia, with foci on ethnobotanical data recorded the most current survey conducted on several islands in Indonesia during 2024-2025. This research has compiled a database of 12 cultivars. For the future outlook, some suggestions for future research within the scope of the social and agricultural sciences are proposed.

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RESULTS AND DISCUSSIONS

Profile of Breadfruit

Breadfruit has been a staple food in many tropical regions in the world, particularly in the Caribbean, the Pacific Islands, and some parts of African continent, but unfortunately not a staple in Indonesia. Its high yield, climate resilience, and nutritional values make it a promising food for the future, particularly in the encounter of climate change. Richard Schiffman (2024) emphasizes that breadfruit is more than just another crop; it is a powerhouse which can revolutionize food systems and agriculture worldwide. Schiffman also underscores that globally incorporating breadfruit into diets can help alleviate hunger and malnutrition, as well as provide sustainable food source which supports healthy living.

Table 2. Nutrient Content Comparison of Breadfruit and White Rice (in every 100 gram of edible portions)

	KCal	Fibre (g)	Cal-cium (mg)	Iron (mg)	ß-Carotene equivalents* (µg)	Niacin (mg)	Thiamine (mg)	Vitamin C (mg)
Unseeded flesh mature, boiled 1	103	2.5	18	0.2	30	0.7	0.08	22.0
Unseeded flesh ripe, boiled 3,4	n.a.	n.a.	n.a.	n.a.	8–157	n.a.	n.a.	n.a.
Seeded flesh ripe, raw 2	122	1.1	24.5	1.4	n.a.	1.9	0.12	34.4
Seeded flesh ripe, boiled 3,4	n.a.	n.a.	n.a.	n.a.	145–939	n.a.	n.a.	n.a.
Preserved, fermented 2	130	2. 4	18.8	0.6	n.a.	0.9	0.02	3.2
Preserved, dried paste 2	283	5.1	134.0	0.8	n.a.	7.4	0.14	n.a.
Seeds 1	155	3.0	69	0.7	0	6.0	0.34	6.1
Rice, white, boiled 1	123	0.8	4	0.3	0	0.6	0.03	0

1 Dignan et al. 2004; 2 Murai et al. 1958; 3 Englberger et al. 2003(a); 4 Englberger et al. 2003(b); n.a.= not available.
*Energy expressed as kilocalories; †provitamin A carotenoids expressed as the sum of the ß-carotene plus half of the ß-carotene. Note: 1 cup of breadfruit is equivalent to 250 grams.

The fruit itself is a nutritious and versatile food source, can be consumed both ripe and unripe, all of which can be prepared in various ways, including frying, roasting, baking, and boiling. Ethnobotanist Diane Ragone who heads the National Tropical Botanical Garden's Breadfruit Institute said "You can eat breadfruit at any stage. When it's small and green, it tastes like an artichoke. When it's starchy and mature, it's the equivalent of a potato. When it's soft and ripe, it's dessert." (Gross, 2016)

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Table 3. Breadfruit Nutrient Composition per 100 gram of Ingredients

Nutrient/100g	Breadfruit Population		
	Unripe Breadfruit	Ripe Breadfruit	Breadfruit Flour
Water	87.10	69.10	0.00
Carbohydrates (g)	9.20	28.20	78.90
Fat (g)	0.70	0.30	0.80
Protein (g)	2.00	1.30	3.60
Vit. B1 (mg)	0.12	0.12	0.34
Vit. B2 (mg)	0.06	0.05	0.17
Vit. C (mg)	21.00	17.00	47.60
Calcium (mg)	59.00	21.00	58.80
Phosphorus (mg)	46.00	59.00	165.20
Iron	0.00	0.40	1.10

Source: FAO (1972)

Breadfruit in Indonesia

Indonesia is a global breadfruit champion. Not only one of the native homes of breadfruit, Indonesia is also the largest producer of breadfruit by quantity. In this country, breadfruit trees are commonly found in rural farms, home gardens, and agroforestry systems, which contributes to both regional markets and subsistence farming (Pune-Okayama, 2025). Indonesia's tropical and humid climate, as well as its fertile volcanic soils create ideal environments for cultivating breadfruit. Breadfruit fields in Indonesia is usually integrated into traditional agriculture alongside bananas, coconuts, and cassava. Both fresh and dried breadfruit products in Indonesia are consumed locally and also exported to neighbouring countries.

The fruit's cultural and economic value in Indonesia makes it an important crop, and oftentimes incorporated into Indonesian daily meals as roasted, fried, or boiled delicacies (Pune-Okayama, 2025). The key producing regions in Indonesia are South Sumatra, Jambi, Lampung, East Kalimantan, West Java, Central Java, Yogyakarta, East Java, East Nusa Tenggara, and South Sulawesi (Ditjen Hortikultura, 2020). According the Ministry of Agriculture data, the breadfruit fields in Indonesia spread up to approximately 50,000 hectares in 2020 (Ministry of Agriculture, 2020). The production of breadfruit in West Java reached 21,853 tons in year 2019, and increased to 24,251 tons in year 2020. The centres of breadfruit in West Java are in the towns of Kuningan, Indramayu, Garut and Tasikmalaya (BPS, 2020).

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Table 4. Amount of Breadfruit Production in Indonesia in 2023 (in quintal)

No.	*Provinces*	*Breadfruit Production (in Quintal)*
1	Aceh	10862.73
2	Sumatera Utara	14030.88
3	Sumatera Barat	33999.55
4	Riau	20305.17
5	Jambi	29252.13
6	Sumatera Selatan	45483.66
7	Bengkulu	3381.88
8	Lampung	140267.84
9	Bangka Belitung	4884.27
10	Riau	3114.29
11	DKI Jakarta	3400.32
12	Jawa Barat	431495.37
13	Jawa Tengah	357021.57
14	DI Yogyakarta	94636.34
15	Jawa Timur	166216.12
16	Banten	71197.1
17	Bali	2028.97
18	Nusa Tenggara Barat	5409.9
19	Nusa Tenggara Timur	26550.49
20	Kalimantan Barat	22497.95
21	Kalimantan Tengah	22642.3
22	Kalimantan Selatan	10402.82
23	Kalimantan Timur	36724.9
24	Kalimantan Utara	20738.32
25	Sulawesi Utara	5339.93
26	Sulawesi Tengah	9868.24
27	Sulawesi Selatan	121733.63
28	Sulawesi Tenggara	27023.34
29	Gorontalo	100.2
30	Sulawesi Barat	22459.15
31	Maluku	33143.57
32	Maluku Utara	4808.78
33	Papua Barat	2365.13
34	Papua Barat Daya	2227.2
35	Papua	4579.1
36	Papua Tengah	3.2
37	Papua Pegunungan	1322.04
38	**Indonesia**	1811518.38 quintals / 199685.72 tonnes

(Source: Agricultural Statistic for Horticulture SPH, Badan Pusat Statistik/BPS-Statistics Indonesia, 2024)

Breadfruit has a great potentials and opportunity to become an alternative food which can support the food diversification in Indonesia. The nutritional contents of

breadfruits are not inferior to the nutritional contents of other crops or tubers. The development of breadfruit cultivation in Indonesia will starken the level of food availability nationwide, particularly carbohydrates, as well as can add the source variety of food and menus. The final aim of breadfruit production in Indonesia is to increase the availability of carbohydrates sources, in attempts towards food self-sufficiency and the country's food security stability (Histifarina & Purnamasari, 2022)

Potentials of Breadfruit

There are some advantages of breadfruit that makes it a good source of staple food.

1. Nutritional Values

Breadfruit is naturally rich in nutrients. This fruit is one good source of complex carbohydrates which provides sustained energy. It is also a source of protein, containing all 9 essential amino acids, making breadfruit a complete protein source. Breadfruit is also high in dietary fibre that promotes satiety and aids digestion. Last but not least, breadfruit is a good source of minerals and vitamins, which includes calcium, potassium, and vitamin C. Not to be worry for those with celiac disease or gluten sensitivities, breadfruit is also naturally gluten-free (Ransome-Washington, 2025

Table 3. Nutrient Contents of Breadfruit in Indonesia (per 100 gr)

Nutrient/100g	Breadfruit Population							
	Kediri	Madura	Yogyakarta	Banten	Bone	Lombok	Gowa	Pulau Seribu
Water (%)	68.59	62.85	74.03	64.18	72.29	72.46	70.45	72.58
Ashes (%)	1.19	1.29	1.03	1.03	1.11	0.75	1.54	0.88
Fat (%)	0.28	0.35	0.23	0.33	0.21	0.30	0.21	0.27
Protein (%)	2.06	2.13	1.74	1.93	1.93	1.60	2.22	1.78
Carbohydrate (%)	27.88	33.37	22.96	32.53	24.46	24.89	25.58	24.5
Starch (%)	19.41	22.50	15.68	24.12	14.25	6.51	15.07	5.52
Vitamin C	11.60	14.59	14.07	11.89	16.86	44.19	22.02	36.37
Phosphor (mg)	50.72	60.52	50.01	55.94	54.61	28.90	60.77	33.97
Calcium (mg)	52.90	47.09	45.15	53.66	38.72	40.17	48.72	29.07
Raw Fibre (%)	1.80	2.14	1.39	1.87	1.56	1.30	1.97	1.31
Calories (Cal)	115.1	136.4	94.89	132.8	102	102.4	106.1	101.23

Source: Adinugraha and Kartikawati (2012)

2. Culinary Versatility

For unripe breadfruit, they are typically cooked in many ways before consumption, such as to be boiled, roasted, baked, or fried. When ripe, breadfruit can be consumed raw when soft, though is often cooked as well with various preparations. Breadfruit can be

cooked and prepared in a wide array of dishes, including stews, curries, porridge, and even as a substitute for flour or potatoes in baked goods. In some cultures in Indonesia, breadfruit is traditionally preserved, such as being fermented and can be stored for later use.

3. Climate Resilience

Breadfruit trees are heat tolerant. Those trees can thrive in warm and humid climates, which makes them well-suited to the tropics like in Indonesia. Breadfruit trees has a high yield, where one single tree can produce a large amount of fruit annually, which makes it a productive source of food. Breadfruit trees are also drought tolerant, as those trees can withstand several periods of drought, which makes them a reliable crop in an everchanging climates.

4. Cultural Significance

Breadfruit has been a snack food in the Indonesia for thousands of years, playing quite a vital role in the diets and cultures of the Indonesian people. In the traditional practice dimension, various traditional methods of preparing and preserving breadfruits are still practiced until today. Due to breadfruit's nutritional value, climate resilience, and high yield, breadfruit is now perceived as potential solution to food security challenges in encountering climate change.

Obstacles and Challenges in Cultivating Breadfruit

Breadfruit, despite being a nutritious and climate-resilient crop, encounters several obstacles in becoming a widely adopted staple food. These obstacles include the historical perceptions, its short shelf life, harvesting challenges, and challenges in propagation and distribution and limited processing and distribution infrastructure.

1. Short Shelf Life and Harvesting Challenges

In harvesting breadfruit, its tall tree (50-60 feet) makes harvesting quite challenging. Oftentimes it potentially leads to falling and squashed from its tall tree, or fruit damage during harvesting (Caribbean Agribusiness, 2015). Once ripe, breadfruits usually deteriorate relatively quickly, due to its high rate of respiration. Breadfruit contain high water (60-80%), hence is perishable and once cultivated, it is easier to go spoiled. Fresh breadfruit lives a short shelf life, making it complicated to transport particularly for long distances, and to store for extended periods in regions with no or limited refrigeration. This circumstances

causes higher expenses in transportation, handling, and storage costs. Preserving breadfruit through certain methods like fermenting or drying can extend its usability, but unfortunately those traditional methods are not always extensively known or practiced in Indonesia.

2. Climate Variability

Despite relatively resilient to climate change, some research highlight the need to identify specific cultivars which are best suited to specific or different climate conditions. Breadfruit is a seasonal fruit, thus resulted in high fluctuation of price. There is also a problem of decreasing production of breadfruit due to climate change, deforestation, less farmers, and changes in land use. The current trends toward climate changes, deforestation, and the inclusion of non-traditional cuisines has decreased breadfruit dependency in many regions and impact either the breadfruit nutrient or content productivity (Erland et al., 2023). As dependency on bread fruit reduces, the threat of genetic erosion will increase, and numerous geographically confined cultivars may encounter extinction. It requires agroforestry land uses for sustainable breadfruit production. As a matter of fact, recent land use change has also caused the speedy growth of deforestation because of the settlement development, which become a threat and has declined the available land for the practices of breadfruit agroforestry (Munjeb et al., 2020; Shapla et al., 2022).

3. Historical and Cultural Perceptions

In some regions, particularly in Java island, breadfruit's association with snack has created a less-significant perception. This perception, while changing, can hinder the adoption of breadfruit as a staple food source.

4. Low Diversification in Food Processing

The lack of widespread infrastructure throughout Indonesia for processing breadfruit into more storable forms or more convenient goods (such as flour, noodles, or pre-packaged products) limits breadfruit's accessibility and appeal. For instance, pre-packaged roasted breadfruit can be one good alternative food for those without having the means to roast it themselves, but unfortunately this is not widely available in Indonesia.

The use of breadfruit as an alternative foods can also be found in the various forms, such as breadfruit noodles, cookies, breadfruit flour, and other processed food ingredients. Breadfruit flour can replace the function of wheat flour as a raw material for baking and

making other processed foods. In addition, processing breadfruit into breadfruit flour or noodle can extend the shelf life.

5. Propagation Challenges

Traditional or conventional methods of propagating breadfruit trees are considered slow and inefficient, which hinders large-scale production and distribution. Furthermore, microbial contamination and associated import restrictions have also limited the international distribution of breadfruit (Roberts-Nkrumah, 2012).

6. Suboptimum Marketing Infrastructure

Marketing issues are also become obstacles in developing breadfruit agriculture. Despite the high potentials as an alternative staple food source, the lack of wide distribution channel makes breadfruit products harder to be sold. The distribution and marketing institutions of breadfruit in Indonesia are not as good as rice's. This issue makes the selling price of breadfruit becomes low, and decreases the incentives received by farmers in cultivating breadfruits. Therefore, efforts are needed to build partnerships among farmers, processors, and distributors in order to make breadfruit more easily accessible by consumers (Maulana, 2025).

7. Other Considerations

Despite being is a good source of carbohydrates, fibre, and some minerals and vitamins, breadfruit is not a complete protein source. Moreover, most Indonesians may have preference for other staple foods, which is rice, due to cultural and dietary habits, particularly in many regions in the country where rice is one significant part of its local cuisine.

In conclusion, although breadfruit has significant potentials as a sustainable and nutritious food source, yet overcoming its limited shelf life, historical perceptions, harvesting challenges, and limited infrastructure is crucial for breadfruit's wider impacts and adoption.

CONCLUSION

Having combined historical and ethnobotanical data from various sources and followed by critical analysis, this study concludes that breadfruit has potential future growth and opportunities. Breadfruit is very feasible to be a staple food substitution in Indonesia. Breadfruit is present everywhere in the archipelago, but it appears particularly important

only on the certain regions in Java. In order to solve the obstacles, breadfruit needs to processed further in order to extend the shelf life. It also needs more socialization that breadfruit is more than snack, but also staple food. Digital channels of distribution and marketing need to be optimized. By leveraging its nutritional benefits, environmental resilience, and economic potential, breadfruit can plays a central role in creating sustainable and resilient food systems and thus this fruit can address some of the most daunting challenges of our time (Schiffman, 2016). Breadfruit stands as a sign of hope in our quest for more sustainable and secure future. Embracing breadfruit is not just about adopting a new crop and staple food. It is also about reimagining our relationship with the motherland of Indonesia, promoting national biodiversity, and ensuring that the future generations have access to sustainable, healthy, and resilient food sources.

RECOMMENDATIONS

In attempts to make breadfruit a staple food, it would be better to focus on diversifying its uses, addressing barriers to its wider adoption, and improving supply consistency. Breadfruit can be prepared in numerous ways (baked, boiled, fried, etc.) and used in a variety of dishes, from traditional meals to processed products like flour and chips. Efforts to standardize cultivars, improve harvesting techniques, and extend shelf life are also crucial.

In diversifying uses and recipes of breadfruit, there are several efforts than worth to try. The first is to explore more on its culinary versatility. Breadfruit can be prepared in numerous and various ways, including frying, baking, boiling, and roasting. Breadfruit can be a substitute for cassava, potatoes or other starchy fruits in diverse dishes, or to be cooked in breads, desserts, and even beverages. Second attempt is developing more variety of processed products of breadfruit. Breadfruit can be also processed by drying and grounding into flour. Breadfruit can also be processed into crackers, chips, and other types of snacks. This can expands breadfruit's market reach, as well as allows for longer storage. Second attempt in diversifying breadfruit is to promote breadfruit-based recipes. Breadfruit deserved encouragement in its development and sharing of breadfruit recipes that showcase the versatility of this superfood, from simple side dishes to more complex meals.

In addressing supply and harvesting challenges of breadfruit, several attempts can be conducted. First is to improve harvesting techniques. Breadfruit trees' height can be very tall, which makes their harvesting quite tricky and difficult. Identifying cultivars with shorter growth habits or developing more accessible harvesting methods can improve supply. Since breadfruit has a relatively short shelf life, we need extend shelf life by research into preservation methods such as freezing, drying, or vacuum packing, which can help extend its availability.

Standardizing cultivars can also be a good step, by identifying and promoting breadfruit varieties which are more suitable for processing. Meanwhile, more extensive consumption will help ensure a more consistent supply of this fruit.

To increase awareness and adoption of breadfruit, it takes few efforts. First is by education and promotion, by highlighting the culinary versatility and nutritional benefits of breadfruit through educational campaigns and sales or promotional efforts. Second attempt is by supporting local economies, by encouraging the development of local breadfruit-based industries in several provinces in Indonesia, as well as providing income opportunities for local communities who grow and process the breadfruit.

To address negative perceptions about breadfruit, emphasize can be put in its nutritional value and delicious taste when prepared properly. By addressing these major issues, breadfruit can be transformed from a local staple into a widely adopted and globally recognized staple food source.

Future Research Outlook

Further in-depth studies on the cultural and social aspects of breadfruit are required to understand better how the planting material circulate among landscape features, among islands, and among people in Indonesia. There is a lack of detailed studies on several aspects of current management practices which appear to vary from province to province. Additional surveys should be conducted to expand country coverage. Morphological and ethno-botanical descriptions of breadfruit cultivars should be supplemented with some genetic characterizations. For instance, one genotype may have multiple names in different languages in Indonesian provinces, and distinct genotypes may share the same breadfruit diversity within the country, management

practices, and uses deserve to be better documented and promoted in Indonesia to allow for adaptation to environmental and economic change, as well as for food security and sustained human health.

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