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Research Article

Production, Physicochemical and Organoleptic Properties of African Breadfruit Yoghurt Samples

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Abstract

The physicochemical and organoleptic characteristics of yoghurt samples made from dried and fresh African breadfruit seeds were investigated. After cleaning, 5 kg of breadfruit seeds were parboiled for 30 minutes at 80°C to remove the hulls. The seeds were dehulled and weighed 2.5 kg apiece. One batch was immediately ground into flour, and the other was allowed to dry in the sun for 5 days before processing. Breadfruit milk extract was extracted from every batch by filtering the slurry through a 0.04 mm sieve. After being continuously stirred for 30 minutes, the milk was allowed to cool to room temperature. A commercial yoghurt starter culture (a 50:50 mixture of *Streptococcus thermophilus* and *Lactobacillus bulgaricus*) was mixed with African breadfruit milk to produce both fresh and dried African breadfruit yoghurt. The milk and yogurt samples were evaluated. The mean data were statistically analyzed using SPSS software version 23 and separated using One-Way ANOVA's Least Significant Difference at ($p \leq 0.05$) method. The physicochemical properties of the milk samples showed that the pH was 5.95 and 5.88; total titratable acidities were 0.34% and 0.31%; specific gravities were 1.013 and 1.011; viscosities were 244 cP and 352 cP of fresh and dried African breadfruit seeds respectively. The physicochemical properties of yoghurt samples showed that the pH were 5.24, 5.01, 4.71; total titratable acidities were 0.85%, 0.68%, 0.81%; specific gravities were 1.03, 1.04, 1.07 and viscosities were 417 cP, 473 cP, 495 cP of fresh and dried African breadfruit and cow milk respectively. The organoleptic properties show that the panelists preferred the commercial yoghurt to the yoghurt samples from African breadfruit seeds. Yoghurt samples from African breadfruit seeds can compete favourably in the market if the standards are maintained during and after processing.

Keywords: *pH; Titratable Acidity; Specific Gravity; Viscosity; Overall Acceptability*

Introduction

Plant-based product consumption has increased globally as consumers consider healthier dietary options. This development was also influenced by shifting consumer attitudes about dairy products as a result of lifestyle modifications, lactose intolerance, milk protein allergies, and cholesterol levels [1]. As a result, the market for dairy substitutes appeals to a developing market niche and is projected to reach USD 14.36 billion by 2022 [2]. Because functional foods like plant-based yogurt with probiotics have a high nutritional content and have positive health impacts when consumed, consumers are drawn to including them in their regular diets [3]. Studies on legumes, cereals, grains, fruits, and vegetables have also been done [3-5], although the most popular source for yogurt-like products is soybean [6,7]. Additionally, legumes may be a suitable source for making plant-based yogurt.

Food should include at least 6 log cfu/ml of probiotics before consumption, but 7 to 9 log cfu/ml is ideal for gastrointestinal health benefits [3,17]. Therefore, to enhance the growth and survival of the probiotics during storage, legumes must offer an ideal habitat. Thankfully, resistant starch found in legumes can function as a prebiotic, generating a mutually beneficial relationship with probiotics within the food matrix [3,4]. Because they contain little or no cholesterol and saturated fats, non-dairy yoghurts provide several nutritional advantages to cow over yogurt [18]. A common fermented milk product, yoghurt is made by fermenting milk with microorganisms like *Lactobacillus delbrueckii* subsp. *bulgaricus* and *Streptococcus thermophilus*. Human health, particularly the digestive system, must be taken into account when consuming food and liquids. Probiotic-containing food products are an alternative since they include lactic acid bacteria, which are healthy bacteria. According to Kumalasari., *et al*. [8], lactic acid bacteria generate antimicrobial compounds that function as natural antibiotics to combat harmful bacteria, support digestive health, fend off illnesses, and enhance digestibility in lactose-sensitive people. Since lactic acid bacteria are safe to use, antibacterial, and tolerant of stomach acid, they are categorized as probiotics. Probiotic lactic acid bacteria must be able to generate antimicrobial compounds that can inhibit the growth of harmful enteric bacteria. These compounds include bacteriocins, diacetyl, hydrogen peroxide, and organic acids [9,10].

A good source of protein, dietary fibers, carbohydrates, oligosaccharides, minerals, and vitamins, legumes are acknowledged as a sustainable foodstuff [11]. Few studies have used African breadfruit milk, while many have used legume milk from African yam beans [12], *Lupinus campestris* seeds [13], and peanuts [14] in yogurt compositions. Additionally, certain yogurt formulations contain dairy, dairy-derived, and/or animal-based components such as gelatin, lactose, whey protein, and sodium caseinate, which might undermine the authenticity of plant-based foods [15]. According to Hickisch., *et al*. [16], consumers' adoption of novel products is influenced not only by their health benefits but also by their flavor and feel. Ideal techno-functional qualities, such as emulsification and gelling capabilities, make legumes an important choice for making non-dairy yogurt. The synthesis of aromatic compounds and the formation of milk acid are facilitated by starter cultures [19]. Because of its high protein, vitamin, mineral, and calcium content, yoghurt offers numerous health advantages. Additionally, the inclusion of beneficial bacteria known as probiotic bacteria increases their health advantages [20,21]. Yogurt's probiotic bacterial component has been shown to strengthen the immune system and stave off illness. To enhance its health advantages, yogurt can be fortified with plant extracts or other nutrients to promote probiotic growth [22,23]. By using the probiotic activity of lactic acid bacteria (LAB) and their "generally recognized as safe" (GRAS) status, this advances our understanding of creating functional foods [24]. It is commonly consumed as a wholesome and nutritious food because of its sensory qualities. Based on its ingredients, yogurt is classified as either plain or flavored. Flavored yogurt contains additives, but plain yogurt simply comprises dairy ingredients [25,26].

Animal milk is typically used to make yoghurt. However, animal milk lacks fiber and includes lactose. Accordingly, those with lactose sensitivity should avoid consuming yoghurt manufactured from cow milk [27]. Since vegetable milk is low in fat, includes fiber, and doesn't contain lactose, it can be used as a substitute basic component to make yoghurt [28]. Because plant milk is high in fatty acids and antioxidant activity, it can lower the risk of diabetes, cancer, and cardiovascular disease. Animal-based diets are increasingly being replaced with plant-based diets that consist of cereals, nuts, seeds, vegetables, and fruit for a variety of reasons, including environmental consciousness and the desire for a healthy lifestyle. Consuming animal products in excess can raise cholesterol and cause cardiovascular disease. As dietary sources of dietary fiber, vitamins, minerals, and antioxidants, cereals, legumes, whole grains, and nuts are categorized as functional and nutraceutical foods [29,30].

Consumer interest in fermented dairy products is growing as a result of new food processing methods, shifting social perceptions, and scientific proof of some components' health advantages [31]. In this study, the idea of diversification is based on enriching yoghurt with grains to increase the nutrients in the finished product and take advantage of resource usage through product diversity. Cereals and legumes allow for an increase in nutritious composition that yogurt cannot provide on its own. The nutritional perspective, customer acceptance, technology transfer opportunities through adaptive research, societal health advantages, and resource mobilization were all taken into consideration when choosing the new diverse yogurt product [32].

Health, animal welfare, and environmental issues have led to a greater focus on plant-based dairy products [26]. According to Aydar., *et al*. [29], these items contain a range of legumes, seeds, grains, nuts, vegetables, and fruits. One of the main concerns is food security, particularly the urgent need to reduce chronic malnutrition [33]. The use of plant-based proteins is growing among food producers, and pulses represent a high-quality, sustainable alternative [34]. Pulses, which have a protein level of 18.5 - 32%, are an inexpensive plant protein source. In developing countries like Nigeria, they are popular and are referred to as "the meat of the poor". According to Mehta., *et al*. [35], pulses have a bright future in the food sector because of their numerous advantages. Yogurt and food manufacturing are increasingly using plant-based milk, which can be made from peas, peanuts, lentils, almonds, corn, and soy [36].

Objective of the Study

The current study set out to design and develop yoghurt using African breadfruit seeds and evaluate its physico-chemical and sensory quality attributes, which are similar to those of cow milk yoghurt and influence consumer preferences before the final product is produced on a large scale and released onto the market. The findings of this study will improve and educate stakeholders in the non-dairy and dairy sectors regarding the implications and opportunities of diversifying the yogurt market in Nigeria.

Materials and Methods

Source of materials

Mature fruit heads of breadfruit were acquired from Olokoro in the Abia State local government area of Umuahia South. The Nigerian state of Abia's Umuahia main market is where the sugar, skim milk, and yogurt starter culture were bought. The regents of analytical grade were used.

Experimental site

The breadfruit seeds were dehulled and cleaned in Abia State, Olokoro, Umuahia South LGA. In the Department of Food Science and Technology's Food Processing and Analytical Laboratory at Michael Okpara University of Agriculture, Umudike, breadfruit milk was extracted, yoghurt was made, and the nutritional value of the yoghurt and breadfruit seed milk was examined [37].

Preparation of breadfruit seed meal

The breadfruit seeds were extracted from the fermenting breadfruit heads' pulp. The extracted seeds were cleaned and the pulp that adhered to them was removed using sand from the stream as an abrasive. After being washed, five kilograms of breadfruit seeds were parboiled for thirteen minutes at 80°C to remove the hulls (Figure 1). The dehulled seeds, each weighing 2.5 kg, were prepared in two batches. The first batch was immediately crushed into flour, and the second batch was allowed to dry in the sun for five days before being ground once again [38].

Preparation of breadfruit milk and breadfruit yoghurt

According to Onuorah., *et al.* [39], the traditional Chinese method was used to manufacture the breadfruit milk extract. After grinding, the fresh batch produced a smooth breadfruit slurry. After adding water, the slurry was passed through a 0.04 mm screen to yield

Figure 1: *Breadfruit seeds being dehulled.*

breadfruit milk. The dry sample underwent the same process. After 30 minutes of constant stirring, the filtrate was allowed to cool to room temperature. The flowchart for preparing African breadfruit yoghurt is shown in figure 2. The approach described by Agim-Ezenwaka., et al. [40] was employed. A prepared breadfruit milk batch of 250 ml was pasteurized at 82°C for 15 minutes. Next came the addition of skim milk and sugar (to taste). A temperature drops to 42°C was allowed, and the samples were homogenized using a Linsan standard mixer QF-3479. The samples were separated into fermentation plates and, after cooling to 42°C, inoculated with 1% commercial yoghurt culture (a 50:50 mixture of *Streptococcus thermophilus and Lactobacillus bulgaricus*). They were incubated at 32°C for 16 hours after being covered with foil. The mixture was placed in the refrigerator at 4°C at the end of the incubation period to stop the fermentation [38].

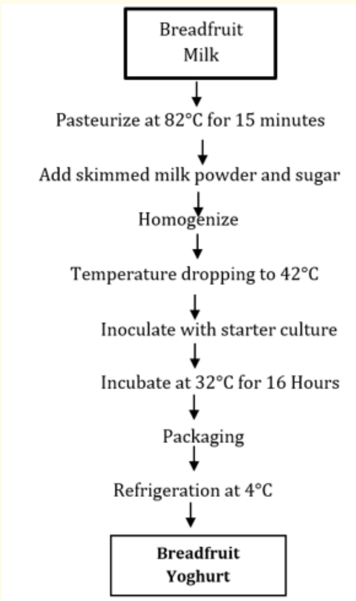

Figure 2: *Flow chart for production of yoghurt from breadfruit milk.*

Physicochemical analysis

pH

The laboratory pH meter (Hanna model HI991300) was used to measure the sample's pH electrometrically. After rinsing the pH electrode with distilled water and blotting it dry, a tiny amount of the sample was added to a small beaker. A suitable amount of the sample was added to a tiny beaker so that the electrode tips could be submerged at least 2 cm below the surface. The electrode was at least 1 centimeter from the beaker's bottom and edges. After activating the pH meter, the sample's pH was noted [15,18,26].

Titratable acidity

The approach outlined by AOAC [41] was used. One hundred milliliters of distilled water were combined with ten milliliters (10 ml) of yoghurt-like samples. After adding phenolphthalein (1%) indicator, 0.1N NaOH was used to titrate the mixture until a persistent pink hue was achieved. Using 1 ml of 0.1N NaOH = 0.0090g of lactic acid, the titratable acidity was expressed as a percentage of lactic acid by weight [18,26].

Viscosity

Approximately 30 ml of the sample was filled into a 50 ml beaker. Viscosity was measured using Oswald-type viscometer [8,31,42].

Determination of specific gravity

Specific gravity is the mass of a particular volume divided by the mass of an equivalent volume of water. For similar compositions, the specific gravity marginally reduces when viscosity drops and decreases with increasing temperature [43]. Using a weighing balance, ten (10) milliliters of distilled water were placed in a container with a specific gravity. The weight was noted as W_1. On the weighing balance, ten (10) milliliters of the yoghurt sample were likewise weighed, and the weight was noted as W_2. In triplicate, the yoghurt samples' specific gravities were determined [44]:

Specific Gravity = $\frac{W_2}{W_1}$

Sensory evaluation of samples

Taste, aroma, appearance, mouth feel, and overall acceptance were assessed for the breadfruit milk, dry milled yoghurt, and wet milled yoghurt samples. Each organoleptic trait was rated on a 9-point hedonic scale, with 9 representing "strongly dislike" and 1 representing "strongly like," by 50 panelists who were knowledgeable about the organoleptic properties of yoghurt [15,19]. The control was a commercial yoghurt beverage [8,45].

Statistical analysis

The acquired triple data was statistically analyzed using SPSS software version 23. Following the calculation of mean values and One-Way ANOVA, Fisher's Least Significant Difference was used to determine the separation of the means at ($p \leq 0.05$) [46].

Results and Discussion

Physio-chemical compositions of milk and yogurt from fresh and dried African breadfruit seeds

pH

Fresh and dried African breadfruit seeds yielded milk with pH values of 5.95 and 5.88, respectively (Table 1). The pH of two milk samples did not differ significantly ($p \leq 0.05$). Table 2 displayed the pH values of the yoghurt samples made from fresh African breadfruit seeds (YFABS, 5.24), dried African breadfruit seeds (YDABS, 5.01), and commercial yoghurt (CY, 4.71). The pH variations of the yoghurt samples were significant ($p \leq 0.05$). A necessary pH range for yoghurt is not stated directly in the Nigerian food law, more especially in the Milk and Dairy Products Regulations (S. I. No. 80 of 2021), which are issued by the National Agency for Food and Drug Administration and Control (NAFDAC). All milk and dairy products, including yoghurt, must, however, be registered with NAFDAC and adhere to the rules on composition, safety, and labeling. The bacterium *Lactobacillus acidophilus* is frequently used in the manufacturing of yogurt. Lactase, which converts lactose, a sugar present in milk, into lactic acid, is produced by the bacteria *Lactobacillus acidophilus*, which has a pH of 4. According to Ademosun., *et al*. [27], the conversion of lactose to lactic acid reduces the pH value of yoghurt, making it more acidic than milk. Lactose in the skim milk caused the commercial yoghurt sample's pH to drop [18]. The concentration of lactose that the enzymes in the starting culture can break down to make lactic acid rises when skimmed milk powder is added [47]. Thus, this acid naturally lowers the pH and makes the solution more acidic [42]. Since Elsamani., *et al.* [48] also found that the sample with the highest addition of skim milk powder had a lower pH, the presence of skim milk powder may be the cause of the lower pH of the commercial milk. The pH of yoghurt analogues including pectin, maize starch, and locust bean gum at both concentrations ranges from 4.00 to 4.7, according to Fazla., *et al.* [19]. This is in line with the Food and Drug Administration's (FDA) recommendation that yoghurt have a pH of 4.6 or lower [49]. Commercial yoghurt may become more acidic with the addition of citrus fruits and other acidulants, as well as with longer fermentation times. As a result, the pH level is not solely dependent on fermentation but can fluctuate [50]. According to Gibson., *et al.* [51], adding prebiotics can provide a source of energy to enhance probiotic growth during fermentation. Herbal plants are among the natural sources of prebiotics. Because of its useful qualities, including fibre and carbohydrates with sugar groups, particularly glucose, gotu kola leaf extract can be used as a prebiotic [52]. Lactic acid bacteria (LAB) will use available carbohydrates during fermentation to make lactic acid and organic acids, which lowers the pH value [53]. The kind of starter that was employed also had an impact on the pH value drop [8].

Total titratable acidity (TTA)

The total quantity of acid in a sample as measured by titration with a standard solution in NaOH is known as titratable acidity. The freshness of yoghurt and other fermented beverages is also determined by this metric, which is based on how well the protein or salts in the yoghurt absorb hydroxyl ions [50]. Bacterial acidification and the release of fatty acid, which results from the degradation of fats and other lipids, raise the titratable acidity [27]. The TTA of Milk from Dried African Breadfruit Seeds, MDABS (0.31%) and Milk from Fresh African Breadfruit Seeds, MFABS (0.34%) differed significantly ($p \le 0.05$), according to table 1. Table 2 shows that the TTA of YFABS (0.85%) and YDABS (0.68%) differed significantly ($p \le 0.05$), although the TTA of YFABS (0.85%) and CY (0.81%) did not differ significantly ($p \le 0.05$). One important indicator of the fermentation process is the notable difference in TTA between milk and yoghurt samples. Since milk is fresh and unfermented, its TTA is low. Natural components and little microbial activity are mostly responsible for the acidity [26]. The yoghurt samples' lactic acid bacteria convert lactose to lactic acid, which significantly raises the TTA [15]. Akwasiam., *et al*. [18] reported anaerobic microbial activities must have contributed to the increase in the titratable acidity which results in the production of lactic acid; which also depends on the type of lactic acid bacteria employed [54]. So, the higher TTA in yoghurt samples is a direct result of microbial fermentation, and it is a key parameter used to monitor yoghurt quality and shelf life.

Specific gravity

There was no significant difference ($p \le 0.05$) between the specific gravities of MFABS (1.013) and MDABS (1.011) (Table 1). YDABS (1.04) and YFABS (1.03) had specific gravities that were considerably ($p \le 0.05$) different from CY (1.07), but not significantly ($p \le 0.05$) different from one another (Table 2). Protein, lactose, and minerals were among the dissolved particles in liquid form found in milk samples. Because of the synthesis of lactic acid and protein coagulation, which can marginally raise specific gravity, yoghurt samples had denser structures than milk samples. Nonetheless, the growth is typically modest and not abrupt. slight rises in yoghurt as a result of the production of protein gel and increased solid content. In line with the findings of Elsamani., *et al*. [48], who reported an increase in total solids of peanut milk-based yoghurt with the addition of skimmed milk powder [18,50], the commercial yoghurt's higher total solids value may be attributed to the skimmed milk powder from which it was produced. According to Obasi., *et al*. [50], *Lactobacillus bulgaricus* development would be significantly inhibited at a total solids concentration level of 24% and higher. However, yoghurt's low total solids content may cause the starting culture to malfunction [55].

Viscosity

Table 1 shows that the viscosity of MDABS (352 cP) and MFABS (244 cP) differed significantly ($p \leq 0.05$). As seen in table 2, there were also notable ($p \leq 0.05$) variations in the viscosity of the yoghurt samples YFABS (417 cP), YDABS (473 cP), and CY (495 cP). In the yoghurt samples (Table 2), the acidic pH causes the casein micelles to coagulate into a three-dimensional gel, increasing viscosity. In contrast, the milk samples had low viscosity (thin fluid) due to the scattered casein and whey proteins that do not form a gel network. Additionally, the thickness is increased by exopolysaccharides that certain bacteria make during fermentation. According to Kumalasari., *et al*. [8], yoghurt samples had viscosities ranging from 418.84 cP to 483.60 cP. As a result, all yoghurt samples were categorized as having high viscosities. Milk type, protein level, and total solids can all have an impact on the viscosity of yoghurt [56]. The carbohydrate content may be the reason for the high viscosity value in the yoghurts made from African breadfruit samples [37]. The viscosity value of African breadfruit yoghurt samples may rise as a result of this high carbohydrate content. The viscosity value generated is likewise impacted when skim milk is added to a commercial yoghurt sample [8]. Because skim milk increases protein levels and creates an acidic environment below the isoelectric point of milk protein, it can change the viscosity of yoghurt [57]. Proteins can aggregate and create gels in an acidic environment [58]. The pasteurization procedure used to make cowpea milk also had an impact on the viscosity of the yoghurt. High temperatures (80°C) and prolonged pasteurization might increase the solids, causing starch granules to bind the milk's water content and produce swelling [8]. Protein coagulation and gel network formation during fermentation cause a large increase in viscosity [26].

Sample	Parameters			
	pH	TTA	SG	VI (cP)
MFABS	5.95 ± 0.00^{a}	0.34 ± 0.00^{a}	1.013 ± 0.02^{a}	244 ± 0.1^{b}
MDABS	5.88 ± 0.02^{a}	0.31 ± 0.01^{b}	1.011 ± 0.02^{a}	352 ± 0.1^{a}
LSD	0.11	0.02	0.0022	72.44

Table 1: *Physico-chemical composition of milk from fresh and dried African breadfruit seeds.*

Means with the same superscripts in the same column are not significantly (p ≤ 0.05) different from each other.

MFABS = Milk from Fresh African Breadfruit Seeds; MDABS = Milk from Dried African Breadfruit Seeds; TTA = Total Titratable Acidity; SG = Specific Gravity; VI = Viscosity.

Sample	Parameters			
	pH	TTA	SG	VI (cP)
YFABS	5.24 ± 0.03^{a}	0.85 ± 0.04^{a}	1.03 ± 0.11^{b}	417 ± 4.78^{c}
YDABS	5.01 ± 0.11^{b}	0.68 ± 0.07^{b}	1.04 ± 0.02^{b}	473 ± 6.39^{b}
CY	4.71 ± 0.12^{c}	0.81 ± 0.04^{a}	1.07 ± 0.03^{a}	495 ± 8.4^{9}a
LSD	0.22	0.13	0.021	21.44

Table 2: *Physico-chemical composition of fresh and dried African breadfruit yoghurt.*

Means with the same superscripts in the same column are not significantly (p ≤ 0.05) different from each other.

YFABS = Yoghurt from Fresh African Breadfruit Seeds; YDABS = Yoghurt from Dried African Breadfruit Seeds; CY = Commercial Yoghurt (Control); TTA = Total Titratable Acidity; SG = Specific Gravity; VI = Viscosity.

Organoleptic properties of fresh and dried African breadfruit yoghurt samples

Table 3 displays the average organoleptic property scores for the various yoghurt samples. Their general acceptability, taste, texture, scent, and appearance are among the organoleptic qualities that were assessed.

Appearance

The commercial yoghurt sample's mean appearance score (6.42 = liked slightly) was substantially ($p \leq 0.05$) higher than that of YDABS (5.67 = approximate liked slightly) and YDABS (4.79 = approximately neither liked nor disliked), according to table 3. According to Uzoukwu., *et al.* [59], this has to do with the yoghurt samples' general physical appearance. The commercial yoghurt sample showed no phase separation and a consistent, glossy surface with a bright, creamy hue. The YDABS and YFABS showed a little sedimentation and looked a little drab or less shiny. Consumer approval of the two African breadfruit seed yoghurts is better measured by commercial yoghurts [15]. There may have been a few reasons why the panelists were neither particularly fond nor distasteful of the yoghurt samples' look.

Aroma

This is a measurement of the characteristic, all-encompassing odour of yoghurt or fermented milk. Table 3 shows that the commercial yoghurt's scent (6.88 = roughly liked moderately) was substantially ($p \leq 0.05$) stronger than that of YDABS (5.64 = roughly liked slightly) and YFABS (5.43 = roughly neither liked nor hated). Different amino acids and organic acids may contribute to the higher CY aroma score by producing more lactic and aromatic molecules [60,61]. Low ratings for aroma qualities for YFABS and YDABS suggest that the panellists did not approve of them [15]. Uzoukwu., *et al*. [59] claim that the different volatile chemicals that the fermenting lactic acid bacteria release during their metabolism are what give yoghurt samples their characteristic scent. Legumes will produce volatile organic molecules during fermentation, which could affect how their scent is released [62]. Lactic acid is the main contributor to the aroma of yoghurt, although there are additional components that also contribute to its aroma. According to Ifediba and Nwafor [61], acetaldehyde and diacetyl are essential aroma compounds of typical yoghurt, and *S. thermophilus* and *L. bulgaricus*, the most common lactic acid bacteria cultures used in yoghurt manufacturing, work together and synergistically to provide volatile metabolites that determine the flavour of yoghurt. In order to ensure that the yoghurt meets the standard scent quality that is generally acceptable, particularly to the ultimate consumer, it is crucial to determine the yoghurt's aroma using the nose [63].

Taste

This analysis will help determine whether the yoghurt has a sweet, salty, bitter, sour, or umami taste by measuring its distinctive flavour using the sense of tongue where the taste buds are located [59]. The yoghurt's unique taste is attributed to compounds such as acetaldehyde, diacetyl, and acetic acid. The taste values ranged from 6.33 to 7.53, with the commercial yoghurt having a mean taste value of 7.53 (approximately liked very much), the YFABS sample having a mean taste value of 6.33 (approximately liked slightly), and the YDABS sample having a mean taste value of 6.67 (approximately liked moderately). Furthermore, the greater taste score may have been influenced by CY's increased fat content [37]. Although the taste of YDABS was greater than that of YFABS, there was no discernible difference between the tastes of YFABS and YDABS. The commercial yoghurt had a much higher taste than YFABS and YDABS. This guarantees that the yoghurt meets the required standards for taste quality, which are often regarded favourably, particularly by the end user.

Mouthfeel

Table 3 shows the mean mouthfeel values for the commercial yoghurt, which was 7.11 (approximately liked moderately), the YFABS sample, which was 6.23 (approximately liked slightly), and the YDABS sample, which was 5.87 (approximately liked slightly). While there was no significant difference between the mean values of YFABS and YDABS, the mouthfeel value for CY was considerably higher than the mean values for YFABS and YDABS. According to Ifediba and Nwafor [61], fat has been shown to improve mouthfeel, which may have improved the commercial yoghurt's mouthfeel. Because of the difference in gel consistency, the panelists might have liked the texture of the commercial cow milk yoghurt more than the breadfruit yoghurt samples. A number of variables, including composition and production procedures, influence the gel network's structural configuration, which establishes the textural properties of coagulated dairy products [61]. According to Akalin., *et al*. [64], non-dairy yoghurts are notorious for having a decreased water-holding capacity, which results in excessive syneresis and a poor texture. These factors may have contributed to the improved texture of the CY [61]. Other factors that have been reported to impact the final product's body include the amount of fat and total solids in the milk, heat treatment of the milk before inoculation, homogenization, the presence of stabilizers, and incubation conditions [65].

Sample	Attribute				
	Appearance	Aroma	Taste	Mouthfeel	Overall Acceptability
YFABS	5.67 ± 0.11^{b}	5.43 ± 0.13^{b}	6.33 ± 0.21^{b}	6.23 ± 0.20^{b}	5.92 ± 0.31^{b}
YDABS	4.79 ± 0.12^{c}	5.64 ± 0.14^{b}	6.67 ± 0.21^{b}	5.87 ± 0.2^{1}b	5.74 ± 0.3^{0}b
CY	6.42 ± 0.11^{a}	6.88 ± 0.14^{a}	7.53 ± 0.21^{a}	7.11 ± 0.20^{a}	6.99 ± 0.3^{2}a
LSD	0.52	0.43	0.48	0.42	0.51

Table 3: *Mean score of organoleptic properties of fresh and dried African breadfruit yoghurt samples.*

Mean values within a column with the same superscript are not significantly (p ≤ 0.05) different.

YFABS= Yoghurt from Fresh African Breadfruit Seeds; YDABS = Yoghurt from Dried African Breadfruit Seeds; CY = Commercial Yoghurt (Control); LSD = Least Significant Difference.

Overall acceptability

The subjective metric of acceptability is based on hedonics, which is impacted by the food's sensory qualities. Consumer perception of a food product as a whole is known as overall acceptability. It includes all of the food product's sensory attributes [59]. The panelists' preference for the CY sample over the YFABS and YDABS samples was 6.99, indicating that it was moderately liked. In contrast, YFABS received a score of 5.92, indicating that it was somewhat liked, and YDABS also received a score of 5.74, indicating that it was somewhat liked. Therefore, the overall acceptance of the yoghurt samples was not significantly impacted by the drying of African breadfruit.

Conclusion

Yoghurt can be produced at a minimal cost utilizing simple processing techniques from breadfruit milk, a plant protein that is readily available to rural populations. While the pH and specific gravity of the milk samples were unaffected, the TTA and viscosity of the milk extracted were significantly impacted by the freshness and drying of African breadfruit seeds. The TTA, specific gravity, and viscosity of the yoghurt samples also increased, while the pH significantly decreased. The specific gravities of the YFABS and YDABS samples were unaffected by the freshness and drying of the African breadfruit seeds, but they did significantly alter the pH, TTA, and viscosity of the two samples. The African breadfruit seed's varying moisture content is the cause of the effect. The results of the yoghurt samples' organoleptic characteristics showed that the panelists preferred commercial yoghurt over trials made with African breadfruit seeds and were familiar with yoghurt made from cow's milk. It was shown that compared to African breadfruit yoghurt samples, the commercial yoghurt sample's organoleptic qualities were noticeably superior. The only notable distinction between the African breadfruit yoghurt samples was their appearance; everything else, including taste, aroma, texture, and overall acceptance, was identical. In comparison to cow milk yoghurt, the inclusion of sweeteners, flavour enhancers, and stabilizers will improve the physicochemical properties and organoleptic acceptability of breadfruit yoghurt.

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The authors do not have any conflict of interest.

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- Nwakodo C S: Methodology.
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- Onwukwe C E: Analysis.
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Ethics Statement

This research did not involve human participants, animal subjects, or any material that requires ethical approval.

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Bibliography

1. Granato D., *et al*. "Functional foods and nondairy probiotic food development: trends, concepts, and products". *Comprehensive Reviews in Food Science and Food Safety* 9.3 (2010): 292-302.
2. Markets and Markets. "Dairy alternatives market by type (soy, almond, coconut, rice, oat, hemp), formulation (plain and sweetened, plain and unsweetened, flavored and sweetened, flavored and unsweetened), application (food, beverages), and region - global forecast to 2022" (2017).
3. Martins EMF., *et al*. "Products of vegetable origin: A new alternative for the consumption of probiotic bacteria". *Food Research International* 51.2 (2013): 764-770.
4. Mridula D and Sharma M. "Development of non-dairy probiotic drink utilizing sprouted cereals, legume and soymilk". *LWT-Food Science and Technology* 62.1 (2015): 482-487.
5. Russo P., *et al*. "*Lactobacillus plantarum* strains for multifunctional oat-based foods". *LWT-Food Science and Technology* 68 (2016): 288-294.
6. Cruz N., *et al*. "Ultra-high-pressure homogenization of soymilk: Microbiological, physicochemical and microstructural characteristics". *Food Research International* 40.6 (2007): 725-732.
7. Ferragut V., *et al*. "Physical characteristics during storage of soy yogurt made from ultra-high pressure homogenized soymilk". *Journal of Food Engineering* 92.1 (2009): 63-69.
8. Kumalasari ID., *et al*. "Physicochemical, microbiological and organoleptic properties of cowpeas (*Vigna unguiculata*) yoghurt with the addition of Gotu Kola Leaf (*Centella asiatica* (L.) urban) extract". *Sains Malaysiana* 53.1 (2024): 123-134.
9. Melia S., *et al*. "Characterization of the antimicrobial activity of lactic acid bacteria isolated from buffalo milk in West Sumatera (Indonesia) against *Listeria monocytogenes*". *Pakistan Journal of Nutrition* 16.8 (2017): 645-650.
10. Weerathilake WADV., *et al*. "The evolution, processing, varieties and health benefits of yoghurt". *International Journal of Scientific and Research Publications* 4.4 (2014): 1-10.
11. Tiwari BK., *et al*. "Pulse foods: Processing, quality and nutraceutical applications". Academic Press (2011).
12. Amakoromo ER., *et al*. "Shelf-life study of a yoghurt-like product from African Yam bean". *Nature and Science* 10.5 (2012): 6-9.
13. Jiménez-Martínez C., *et al*. "Production of a yogurt-like product from *Lupinus campestris* seeds". *Journal of the Science of Food and Agriculture* 83.6 (2003): 515-522.
14. Bansal S., *et al*. "Optimization of process conditions for developing yoghurt like probiotic product from peanut". *LWT-Food Science and Technology* 73 (2016): 6-12.
15. Jamalullail NA., *et al*. "Nutritional, physicochemical stability, microbial survivability and sensorial evaluation of legume yogurts". *Journal of Microbiology, Biotechnology and Food Sciences* 12.4 (2023): e5141.
16. Hickisch A., *et al*. "Influence of lupin-based milk alternative heat treatment and exopolysaccharide-producing lactic acid bacteria on the physical characteristics of lupin-based yogurt alternatives". *Food Research International* 84 (2016): 180-188.
17. Bernat N., *et al*. "Development of a non-dairy probiotic fermented product based on almond milk and inulin". *Food Science and Technology International* 21.6 (2015): 440-453.

18. Akwasiam BU., *et al*. "Physiochemical study of yoghurt-like product from breadfruit, coconut and soybean extracts stored at different temperature". *South Asian Journal of Research in Microbiology* 15.4 (2023): 46-56.

19. Fazla SNM., *et al*. "Physicochemical, microbiological, and sensorial properties of chickpea yogurt analogue produced with different types of stabilizers". *Discover Food* 3 (2023): 19.

20. Benmeziane F., *et al*. "Lentil (*Lens culinaris*) flour addition to yoghurt: Impact on physicochemical, microbiological and sensory attributes during refrigeration storage and microstructure changes". *LWT* 140 (2021): 110793.

21. Zare F., *et al*. "Probiotic milk supplementation with pea flour: Microbial and physical properties". *Food and Bioprocess Technology* 6.5 (2013): 1321-1331.

22. Mohamed Ahmed IA., *et al*. "Physicochemical quality attributes and antioxidant properties of set-type yoghurt fortified with argel (*Solenostemma argel* hayne) leaf extract". *LWT* 137 (2021): 110389.

23. Sarker A and Siddiqui RA. "Effects of ultrasonic processing on the quality properties of fortified yoghurt". *Ultrasonics Sono Chemistry* 98 (2023): 106533.

24. Yankey S., *et al*. "Optimized fermentation conditions for dragon fruit yogurt". *Food and Humanity* 1 (2023): 343-348.

25. Li R., *et al*. "Impact of milk fortification on the microbiological and physicochemical properties of set-type skimmed yogurt using three commercial soluble prebiotics". *Foods* 8.6 (2019): 181.

26. Zahir A., *et al*. "Evaluation of physicochemical properties of yogurt fortified with four verities of common bean whey (*Phaseolus Vulgaris)*". *Asian Journal of Dairy and Food Research* 43.4 (2024): 708-715.

27. Ademosun OT., *et al*. "Physico-chemical, microbial and organoleptic properties of yoghurt fortified with tomato juice". *Journal of Food and Nutrition Research* 7.11 (2019): 810-814.

28. Aswal A., *et al*. "Preparation and evaluation of polyherbal cosmetic cream". *Der Pharmacia Lettre* 5.1 (2013): 83-88.

29. Aydar EF., *et al*. "Plant-based milk substitutes: Bioactive compounds, conventional, and novel processes, bio-availability studies, and health effects". *Journal of Functional Foods* 70 (2020): 103975.

30. Sebastiani G., *et al*. "The effects of vegetarian and vegan diet during pregnancy on the health of mothers and offspring". *Nutrients* 11.3 (2019): 557.

31. Stanton C., *et al*. "Market potential for probiotics". *American Journal of Clinical Nutrition* 73.2 (2001): 476S-483S.

32. Admassu SE. "Nutrient dense dairy product diversification and quality evaluation". *East African Journal of Sciences* 13.2 (2019): 195-206.

33. Pradeepkiran JA. "Aquaculture role in global food security with nutritional value: A review". *Translational Animal Science* 3.2 (2019): 903-910.

34. Bessada SM., *et al*. "Pulses and food security: Dietary protein, digestibility, bioactive and functional properties". *Trends in Food Science and Technology* 93 (2019): 53-68.

35. Mehta KA., *et al*. "Breadfruit (*Artocarpus altilis*): Processing, nutritional quality, and food applications". *Frontiers in Nutrition* 10 (2023): 1156155.

36. Emkani M., *et al*. "Effect of lactic acid fermentation on legume protein properties: A review". *Fermentation* 8.6 (2022): 244.

37. Nwakodo CS., *et al*. "Production and nutritional evaluation of African breadfruit yoghurt". *Journal of Probiotics and Food Sciences* 1.1 (2024): 1-13.

38. Nwabueze TU. "Kernel extraction and machine efficiency in dehulling parboiled African breadfruit (*Treculia africana* Decne) whole seeds". *Journal of Food Quality* 32.5 (2009): 669-683.

39. Onuorah CE., *et al*. "Comparative physico-chemical evaluation of soymilk and soya cake produced by three different methods". *Nigerian Food Journal* 25.2 (2007): 28-38.

40. Agim-Ezenwaka OA., *et al*. "Proximate composition and organoleptic attributes of legume-yoghurt samples fermented by lactic acid bacteria". *Journal of Nutrition and Food Sciences* 2 (2020): 016.

41. AOAC. Official Methods of Analysis, Association of Official Analytical Chemists, Washington D.C. 18.1 (2006): 831-835.

42. Ifediba DI and Ozoh CN. "Effects of storage on physicochemical properties and microbiological qualities of African breadfruit-corn yoghurt". *European Scientific Journal* 14.6 (2018): 172-191.

43. Akinola FF., *et al*. "Physico-chemical properties of palm oil from different palm oil local factories in Nigeria". *Journal of Food, Agriculture and Environment* 8.3 (2010): 264-269*.*

44. Nwakodo CS., *et al*. "Effect of processing methods and storage time on chemical properties of palm oil". *Research Journal of Food Science and Nutrition* 4.2 (2019): 37-47.

45. Zare F., *et al*. "Microbial, physical and sensory properties of yogurt supplemented with lentil flour". *Food Research International* 44.8 (2011): 2482-2488.

46. Landau S and Everitt BS. "A handbook of statistical analyses using SPSS". Chapman and Hall/CRC (2003).

47. Kpodo FMK., *et al*. "Nutritional and sensory characterization of full fat and partially defatted peanut soymilk yoghurt". *International Journal of Nutrition and Food Science* 3.3 (2014): 187-193.

48. Elsamani MO., *et al*. "Physico-chemical characteristics and organolepitic properties of peanuts milk-based yoghurt fortified with skimmed milk powder". *Journal of Research in Applied Sciences* 4 (2014): 78-82.

49. Rezaei R., *et al*. "Effect of inulin on the physicochemical properties, flow behavior and probiotic survival of frozen yogurt". *Journal of Food Science and Technology* 51.10 (2014): 2809-2814.

50. Obasi BC., *et al*. "Assessment of the quality of different brands of commercial yoghurt sold in Wukari Metropolis, Taraba State-Nigeria". *Open Access Research Journal of Life Sciences* 03.01 (2022): 039-045.

51. Gibson GR., *et al*. "Dietary prebiotics: Current status and new definition". *Food Science and Technology Bulletin: Functional Foods* 7.1 (2010): 1-19.

52. Kusuma YD. "Pemberian ekstrak daun pegagan dengan prebiotik *Lactobacillus acidophilus* terhadap persentase lemak abdominal dan karkas itik hibrida". Surabaya: Universitas Airlangga (Unpublished) (2020).

53. Bucker JR., *et al*. "Lactic acid fermentation of peanut milk". *Journal of Food Science* 44.5 (2008): 1534-1538.

54. Hidayat IR., *et al*. "Total bakteri asam laktat, nilai pH, dan sifat organoleptik *drink yoghurt* dari susu sapi yang diperkaya dengan ekstrak buah mangga". *Animal Agriculture Journal* 2.1 (2013): 160-167.

55. Adubofour J., *et al*. "Comparative studies on the qualities of seven brands of vanilla-flavoured stirred yoghurt produced within the Kumasi metropolis of Ghana". *International Food Research Journal* 21 (2014): 1243-1248.

56. Edy Permadi., *et al*. "Kualitas yoghurt susu kambing PE dengan suplementasi ekstrak buah lakum terhadap viskositas, total asam dan total padatan terlarut". *Jurnal Sains Peternakan* 9.1 (2021): 40-47.

57. Ivan Sugianto., *et al*. "Pengaruh penambahan susu skim dan yoghurt plain terhadap sifat organoleptik yoghurt sari jagung". *JTB* 9.2 (2020): 829-837.

58. Yulian C S., *et al*. "Nilai pH, viskositas, dan tekstur *yoghurt drink* dengan penambahan ekstrak salak pondoh (*Salacca zalacca*)". *Jurnal Aplikasi Teknologi Pangan* 3.3 (2014): 110-113.

59. Uzoukwu AE., *et al*. "Impacts of palm bunch ash and brine solutions on the microbial and organoleptic properties of "Ugba" (*Pentaclethra macrophyll* Benth)". *Journal of Food Chemistry and Nanotechnology* 10.2 (2024): 40-48.

60. Routrary W and Mishra HH. "Scientific and technical aspects of yoghurt aroma and taste: review". *Comprehensive Reviews in Food Science and Food Safety* 10.4 (2011): 208-220.

61. Ifediba DI and Nwafor EC. "Nutritional and sensory evaluation of African breadfruit corn yoghurt". *African Journal of Food Science* 12.4 (2017): 73-79.

62. Coda R., *et al*. "Manufacture and characterization of functional emmer beverages fermented by selected lactic acid bacteria". *Food Microbiology* 28.3 (2011): 526-536.

63. Igbabul B., *et al*. "Physico-chemical, microbiological and sensory evaluation of yoghurt sold in Marudi Metropolis". *African Journal of Food Science and Technology* 5.6 (2014): 129-135.

64. Akalin AS., *et al*. "Microstructural, textural and sensory characteristics of probiotic yoghurts fortified with sodium calcium caseinate or whey protein concentrate". *Journal of Dairy Science* 95.7 (2012): 3617-3628.

65. Kumar P and Mishra HH. "Mango soy fortified set yoghurt: effect of stabilizer addition on physicochemical, sensory and textural properties". *Food Chemistry* 87.4 (2004): 501-507.

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