Comparative Evaluation of the Physicochemical and Sensory Assessment of Selected Plant Milks

Okoroafor Clara Nneka[1], Nwachukwu Chijioke Nnaemeka[2], *Elemuo Godswill Kodili[3], Obinwa Ezinne Prisca[1], Salomi Onoriode Odehowho[4], Nwakanma Chidiebere Immaculata[4]

[1]Department of Human Nutrition and Dietetics, Ambrose Alli University P.M.B. 14, Ekpoma, Edo State, Nigeria

[2]Department of Food Science and Technology, Imo State University, Owerri, Imo State, Nigeria

[3]Department of Food Science and Technology, Federal University of Technology, Owerri, Imo State, Nigeria

[4]Department of Food, Nutrition and Home Science, University of Port Harcourt P.M.B. 5323, Rivers State

***Corresponding author**

DOI: https://doi.org/10.51584/IJRIAS.2025.1001043

Received: 18 January 2025; Accepted: 27 January 2025; Published: 24 February 2025

ABSTRACT

Soybeans, coconuts, tiger nuts and groundnuts were processed into natural fresh milk respectively. These milk samples were evaluated for their physicochemical and sensory qualities and for possible consumption as milk. Significant difference ($p < 0.05$) existed in sensory scores of texture, flavour, taste and general acceptability but there was no significant ($p > 0.05$) difference in appearance; although all the samples were generally accepted in terms of sensory quality. It was concluded that milk from coconut, groundnut, soymilk and tiger-nut be encouraged due to the high nutrient contents. It was also observed that tiger nut milk without sugar can be used by diabetic patients judging by their low carbohydrate content. The results from sensory evaluation revealed that the consumer acceptability of the plant milk samples varied based on the opinion of the panelists with soymilk and tiger nut milk recording the highest level of acceptability while groundnut milk recorded the lowest score for most of the parameters analyzed. These observations further support most of the earlier revelations on milk analogue from vegetable source as means of alleviating malnutrition in most developing countries such as Nigeria. It was observed that tiger nut milk without sugar can be used by diabetic patients judging by their low carbohydrate content.

Key words: Soymilk, Coconut milk, Tiger nut milk, Groundnut milk

INTRODUCTION

For more than 8000 years, cow milk has been an essential part of human nutrition. One of the most vital foods in the human diet is milk and its derivatives. When studies revealed that milk is high in nutrients, consumption started to rise more significantly (Kourkouta *et al.*, 2021). Countries recommend dairy products because of their high calcium, protein, and vitamin A, B2, and B12 content. For instance, South Africa and Benin offer quantitative recommendations (400–500 ml daily and 1-2 servings daily, respectively), whereas Kenya and Sierra Leone advocate for "daily" intake (FAO, 2021). Dairy is frequently acknowledged for its role in promoting varied and healthful diets. Nigeria and Sierra Leone, for instance, note the importance of dietary diversity and the role that dairy foods play in supporting this (Kevin *et al.*, 2023).

Dairy production or dairy farming creates considerable environmental impact due to greenhouse gas emissions. Livestock globally uses 70–80% of anthropogenic land and consumes approximately 35% of agricultural production (Ghosh *et al*., 2020). Thus, livestock generates environmental pollution and climate change (Singh *et al*., 2024). Dairy products have been considered as an essential food because of its nutritional value. However, the demand for plant-based milk alternatives increased over recent years due to lactose intolerance and allergies, as well as different lifestyles (Reyes-Jurado *et al*., 2021)

Plant milk is frequently promoted as a sustainable, healthful, and animal-welfare-friendly alternative. Plant milk, which comes from the water extraction of cereals, legumes, or nuts, is entirely devoid of any animal-based ingredients. Plant milk serves the same functions as conventional milk and has a similar look and flavour (Wenfan *et al*., 2023). Plant milk is becoming more and more popular due to dietary trends like flexitarianism and veganism. In some ways, plant milk has evolved into a lifestyle tool that many people use due to personal beliefs as well as dietary concerns (Singh *et al*., 2024).

Plant milk has been consumed as a regular drink and also as a substitute for diary milk. Additionally, vegans and vegetarians have actively promoted the benefits of plant-based substitutes for natural dairy milk-derived products, such as improved health by preventing cow's milk allergy and lactose intolerance due to the advantages of low-calorie, cholesterol-free, and lactose-free foods (Park, 2021). Plant milk is normally consumed for ethical reasons, health reasons including lactose intolerance, milk allergy etc. plant milks are used to make ice cream, vegan closes and yogurt (Pontonio *et al.,* 2022). Examples of plant milk includes hemp milk, soy milk, rice milk, almond milk, coconut milk, groundnut milk, tiger nut milk, etc.

MATERIALS AND METHODS

Materials

Soybean, coconut, tiger nut and groundnut seeds used for this study were purchased at Relief Market, Owerri, Imo State. Chemicals and laboratory equipment used for the analyses were obtained from the Department of Food Science and Technology, Imo State University, Owerri.

Methods

Production of soymilk

The method as described by Okwu and Ndu (2006) was adopted little modification. The flow chart for the production of soymilk is presented in Figure 1. The dry soybean was sorted to remove stones, dirt and metallic pieces. It was weighed and soaked in water for 4 hours to soften the soybean seeds. It was washed with clean water and dehulled to remove the skin of the soybean seeds. It was further milled with water in order to form slurry. The slurry was heated at 110^0C to 140^0C for about 40 minutes and further filtered to remove the solid particles of the slurry. The slurry was bottled and then cooled.

Production of coconut milk

The method as described by Okwu and Ndu (2006) was adopted little modification. The flow chart for the production of coconut milk is presented in Figure 2. The freshly gotten coconut was first deshelled. It was then washed with clean tap water and grated or milled with a hand grater or a blender. Water was added to the grated coconut to enable the milk content to be pressed. It was then filtered using a muslin cloth to separate the milk from the solid particles. It was then heated at 110 to 140 ºC for 40 minutes and then bottled. Then the coconut milk was cooled.

Production of tiger nut milk

The tiger nut milk was produced by modifying the method of Adgidzi *et al*. (2011). The flow chart for the production of tiger nut milk is presented in Figure 3. Tiger nut was sorted to remove stones, dirt and metallic materials. The tiger nut seeds were further weighed and washed with clean water and soaked for 4 hours to soften the seed. Tiger nut seed was milled with enough water to enable its extraction. It was then filtered using

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume X Issue I January 2025

a muslin cloth to remove solid particles from the slurry; it was then heated at 110ºc to 140ºc for 40 minutes and bottled. The milk was later cooled.

Production of groundnut milk

The method as described by Okwu and Ndu (2006) was adopted little modification. The flow chart for the production of ground nut milk is presented in Figure 4. Groundnut was sorted to remove stones, dirt and foreign materials and it was then weighed and then soaked for 4 hours to soften the groundnut seed. It was washed and dehulled to remove the skin of the seed. It was milled with enough water to enable filtration. It was filtered using muslin cloth to remove solid particles. It was heated at 110 to 140 ºC for 40 minutes. It was bottled and then cooled.

Chemical analysis

Determination of pH

This method was carried out by the method of AOAC (2012). The electrode was thoroughly rinsed with clean water and reading adjusted to zero mark. The electrode was dipped into a beaker containing 15ml of the different samples and the reading recorded as it stabilizes. The meter was standardized with a buffer solution.

Determination of titratable acidity

Titratable acidity was determined using the method of (Onwuka, 2018). Ten millimeters of the milk sample was titrated against 0.1N NaOH (Sodium hydroxide) solution and 3 drops of phenolphthalein indicator was added. The titration was continued until the appearance of a pink colour which marks the end point was being observed. The acidity was expressed as percentage lactic acid.

Total acidity (%) = $\frac{(V_1 \; x \; N_1 \; x \; 90 \; x \; 100)}{(1000 \; x \; V_2)}$

Sensory evaluation

The product samples were evaluated using hedonic method for sensory characteristics and overall acceptability by a panel of 40 judges selected randomly. They were served coded samples of milk and asked to compare the samples by testing for taste, aroma, mouthfeel, appearance and overall acceptability. All tests were performed and rated on a 9 – point hedonic scale described by Iwe (2014).

Statistical analysis

The data obtained from different analyses was subjected to various statistical analyses which include simple descriptive mean, standard deviation and analyses of variance (ANOVA), while turkey's test was used to separate the means among the samples attribute examined using SPSS 20.0 Software Inc. USA.

RESULTS AND DISCUSSION

Physicochemical properties of the selected milk samples

The result of the physicochemical analysis of the milk samples is presented in Table 1. The pH of the milk samples ranged from 6.40 to 6.80. The highest pH value (6.80) was recorded in coconut milk (Sample B) while the lowest pH value (6.40) was recorded in groundnut milk (Sample D). Samples differed significantly ($p> 0.05$) from each other. These values were higher than that reported for tiger nut milk products by Ukwuru and Ogbodo (2011) but were found to be comparable to the pH of melon seed milk (6.25), cowpea milk (6.79) and soymilk (6.6) reported by Onweluzo and Owo (2005).

High pH which indicates low acidity which enhances the growth of spoilage bacteria thereby reducing shelf life. This implies that these milk samples need proper preservation to extend its shelf life. Titratable acidity of

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume X Issue I January 2025

the milk samples ranged from 0.15% to 0.24%. The highest titratable acidity (0.24%) was recorded in tiger nut milk sample (Sample C) while the lowest titratable acidity (0.15%) was recorded in Soymilk sample (Sample A).

Results of the Sensory evaluation of the selected milk samples

The result of the sensory evaluation of the milk samples is presented in Table 2. Sensory scores obtained from this result showed significant difference ($P<0.05$) on the characteristics of the plant milk samples evaluated. The colour of the different plant milk samples analyzed showed that the colour of tiger nut milk was most preferred whose score (7.50) did not differ significantly ($p<0.05$) from that of soymilk (7.40). It was noted from this study that the mouth-feel values for soymilk milk and tiger nut milk were significantly ($p< 0.05$) higher than that for groundnut milk and coconut milk. This is similar to the findings of (Onweluzo and Nwakalor, 2009). Similarly, significant mean difference was discovered on the aroma, taste and general acceptability of the plant milk samples. The 7.40 and 7.10 mean scores for the aroma and taste recorded for soymilk respectively was the highest rated among the plant milk samples by the opinion of panelists. Generally, soymilk and tiger nut milk samples had the highest mean scores and the best among the plant milk samples analyzed while groundnut milk recorded the lowest score for almost all the parameters analyzed.

The significant ($p<0.05$) difference observed in the characteristics of the milk samples and the other plant milk samples may be caused by the variation of the inherent chemical properties and the nature of the raw material used. However, the results obtained further indicated the potential of plant materials in the development of acceptable milk analogue.

CONCLUSION

This study showed that non-dairy milk produced from coconut, groundnut, soybean and tiger nut with improved nutritional and acceptable quality was obtained from this work. The physicochemical and sensory evaluation samples analyzed shows that it will give good nutritional quality and palatability, most especially in rural communities in developing countries where accessibility and cost of dairy products is a challenge of the people. It will also provide a healthy alternative for people that are lactose intolerance. The result further revealed that milk prepared from soybean, coconut, tiger nut and groundnut could be used as a beverage for both the young and old persons due to the high nutrient contents.

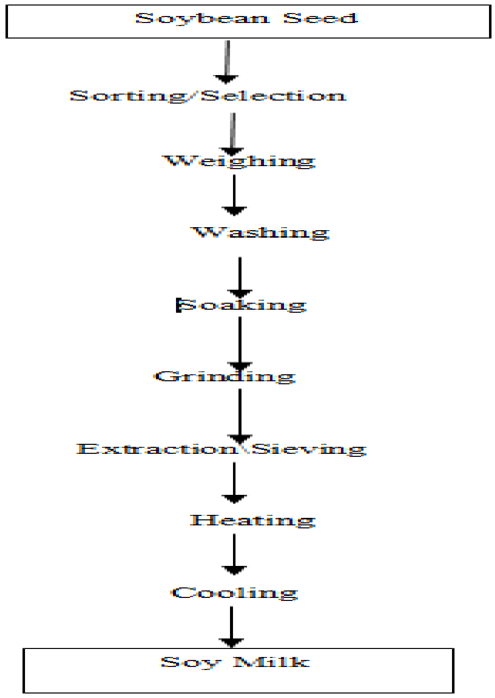

Fig 1: Flow Chart for Production of Soymilk.

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume X Issue I January 2025

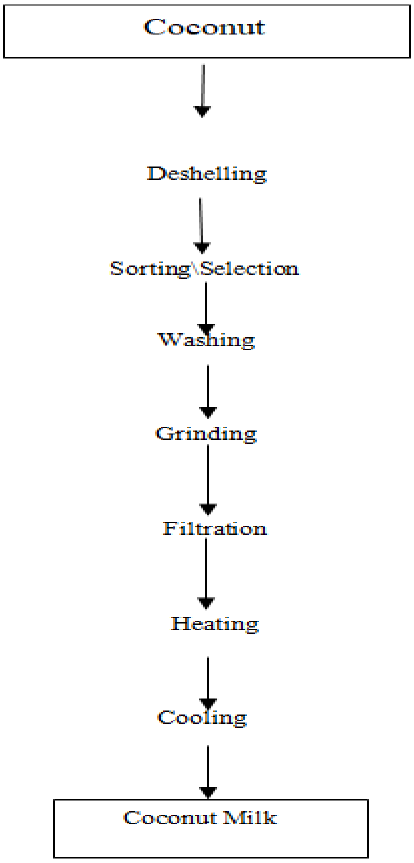

Fig 2: Flow Chart for Production of Coconut Milk

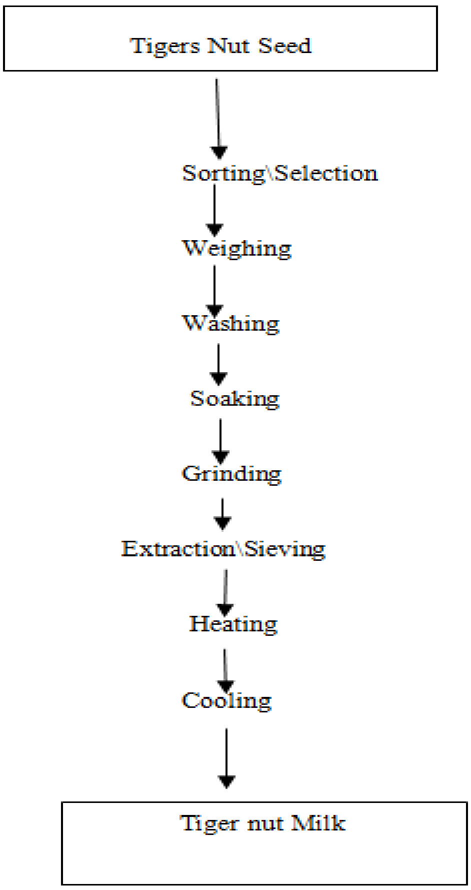

Fig 3: Flow chart for production of tiger nut milk

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume X Issue I January 2025

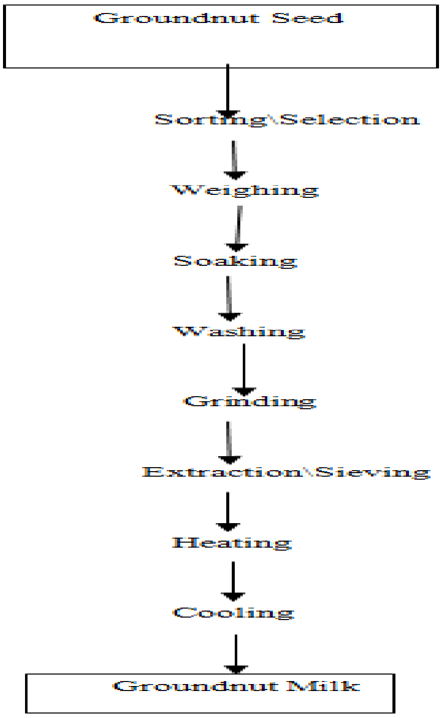

Fig 4: Flow Chart for the Production of Groundnut Milk

Table 1: Physicochemical properties of the selected milk samples

Sample	Parameters pH	Titratable Acidity (%)
A	$6.70^{ab}\pm0.10$	$0.15^{c}\pm0.04$
B	$6.80^{a}\pm0.05$	$0.18^{bc}\pm0.05$
C	$6.60^{b}\pm0.04$	$0.24^{a}\pm0.08$
D	$6.40^{c}\pm0.06$	$0.20^{ab}\pm0.02$
LSD	0.15	0.05

Values are means ± SD. Values on the same column with different superscripts are significantly different.

Key:

A - Soymilk

B - Coconut milk

C - Tiger nut milk

D - Groundnut milk

Table 2: Sensory scores of the milk samples

Sample	Appearance	Taste	Parameters Mouthfeel	Aroma	General Acceptability
A	7.40 ± 0.11^{a}	7.10 ± 0.08^{a}	7.20 ± 0.11^{a}	7.40 ± 0.06^{a}	7.70 ± 0.08^{a}

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume X Issue I January 2025

B	7.05 ± 0.08^{b}	6.15 ± 0.14^{b}	6.20 ± 0.08^{b}	6.15 ± 0.11^{c}	6.20 ± 0.18^{c}
C	7.50 ± 0.15^{a}	7.00 ± 0.12^{a}	7.10 ± 0.08^{a}	6.10 ± 0.08^{c}	7.05 ± 0.04^{b}
D	7.00 ± 0.06^{b}	5.30 ± 0.10^{c}	5.05 ± 0.10^{c}	6.50 ± 0.10^{b}	5.40 ± 0.06^{d}
LSD	0.25	020	0.18	0.28	0.32

Values are means ± SD. Values on the same column with different superscripts are significantly different.

Key:

A - Soymilk

B - Coconut milk

C - Tiger nut milk

D - Groundnut milk

REFERENCES

1. Adgidzi, E. A, Ingbian, E. K. and Abu, J.O. (2011). Effects of Hot Water and Steam Blanching on the Quality of Aqueous Extract from Tiger nuts (Cyperus esculentus) PAT; 7(1): 90 –102.
2. AOAC (2012). Official Methods of Analysis of the Association of Official Analytical Chemists, 15th ed., AIAC, Arlington,Virginia, USA. Science and Technology.pp:31-33.
3. Food and Agriculture Organization of the United Nations. Food-based dietary guidelines: Africa. FAO (2021). Available online at: http://www.fao. org/nutrition/education/food-dietary-guidelines/regions/africa/en/ (accessed December 5, 2021)
4. Ghosh, A., Misra, S., Bhattacharyya, R., Sarkar, A., Singh, A. K. and Tyagi, V. C. (2020). Agriculture, dairy and fishery farming practices and greenhouse gas emission footprint: a strategic appraisal for mitigation. Environ. Sci. Pollut. Res. 27: 10160–10184.
5. Iwe, M.O. (2014). Handbook of current trends sensory evaluation of foods. Enugu: Rojoint Communication Services Ltd.
6. Kevin, B.C., Gregory, D.M., Amy, C.B., Stephanie, N.M.S., Janice, C.G. and Katie, A.B. (2023). Global review of dairy recommendations in food-based dietary guidelines. Front. Nut, 11(2): 1 – 10.
7. Kourkouta, L., Frantzana, A., Koukourikos, K., Iliadis, C. Papathanasiou, V. and Tsaloglidou, A. (2021). Milk Nutritional Composition and Its Role in Human Health. Journal of Pharmacy and Pharmacology, 9: 10 – 15.
8. Okwu, D. E. and Ndu, C. U. (2006). Evaluation of the phytonutrients, minerals and vitamin content of some varieties of yam (Discorea spp). Int. J. Molecular of Medicine and Advances in Sci.pp.22:199-203.
9. Onwuka G. I (2018). Food analysis and instrumentation (theory and practice). 2nd Ed., Naphtali prints, Lagos, Nigeria. Pp. 348
10. Onweluzo JC, OS Owo. (2005) Stabilization potential of water-soluble polysaccharide from two legumes (Deterrummissocarpum and Mukuraflagellipes) in vegetable milk: effects on selected quality characteristics. J. Home Econ. Res., 6:39–44.
11. Onweluzo, J. C. And Nwakalor, C. (2009). Development and evaluation of vegetable milk from Treculia Africana (Decne) seed.Park. J. Nutr., 8: 233-238.
12. Park, Y. W. (2021). The impact of plant-based non-dairy alternative milk on the dairy industry. Food Science of Animal Resources, 41(1): 8.
13. Pontonio, E., Marco, M. Cinzia, D., Michele, R. Domenico, C., Vito, E. C. and Carlo, G. (2022). Design and characterization of a plant-based ice cream obtained from a cereal/legume yogurt-like. Food Science and Technology, 161: 1 – 7.

14. Reyes-Jurado, F., Soto-Reyes, N., Dávila-Rodríguez, M., LorenzoLeal, A.C., Jiménez-Munguía, M.T., Mani-López, M. and López-Malo, A. (2021). Plant-based milk alternatives: Types, processes, benefits, and characteristics, food reviews international, DOI: https://dio.org/10.1080/87559129.2021.1952421
15. Singh, A.B., Bhakar, V., Gaurav, G., Khandelwal, C., Sarkar, P., Singh, H. and Dangayach, G.S. (2024). Environmental sustainability of milk production: a comparative environmental impact analysis and sustainability evaluation. Front. Sustain., 5: 1 – 15.
16. Ukwuru M. U. and A.C. Ogbodo, A. C. (2011). Effect of Processing Treatment on the Quality of Tiger nut Milk. Pakistan Journal of Nutrition, 10: 95-100.
17. Wenfan, S., Yu, Y.Z., Songhan, L. and Jiping, S. (2023). Consumers' preferences and attitudes towards plant-based milk. Foods, 13(1): 2.