MUST Journal of Research and Development (MJRD) Volume 6 Issue 1, March 2025
e ISSN 2683-6467& p ISSN 2683-6475

Sensory Evaluation of Butter and Milk Derived from Oyster Nut

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DOI: https://doi.org/10.62277/mjrd2025v6i10006

ARTICLE INFORMATION

Article History

Received: 11th November 2024
Revised: 06th February 2025
Accepted: 12th February 2025
Published: 31st March 2025

Keywords

Contamination
Pollution Sources
Shallow wells
Temporal Variations
Water Quality Index

ABSTRACT

This study explores the sensory evaluation of butter and milk made from oyster nuts (*Telfairia pedata*), a lesser-known but nutritionally rich seed. The evaluation involved a panel of trained assessors who assessed the products on the basis of key sensory attributes, such as appearance, texture, flavour, aroma, and overall acceptability. The oyster nut milk added with strawberry and oyster nut butter with cocoa, sugar, pumpkin seeds and chocolate had higher scores of 7.57 and 6.52, respectively, on overall acceptability. However, as a dairy-free product alternative, oyster nut milk and butter scored highly on sensory evaluations, suggesting a significant market potential and positive benefits for cardiovascular health. The two products exhibit potential, though further refinement in processing could enhance its acceptability. These findings suggest that oyster nut-derived products could serve as viable alternatives in the growing market for plant-based dairy substitutes, especially for consumers seeking unique and allergen-free options.

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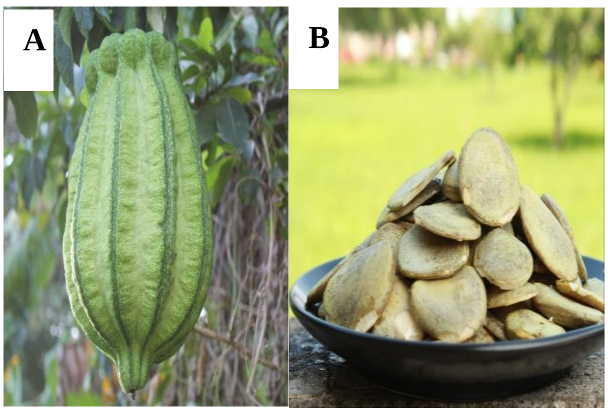
1.0 Introduction

Malnutrition has unintentionally increased in developing nations due to continuous population growth and insufficient protein supplies (Alozie & Udofia 2015). However, research is mainly focused on identifying substitute sources of protein from plant foods to meet the demand for protein in developing nations where animal protein is obviously inadequate and relatively expensive (Alozie & Udofia, 2015). Plant-based milks, also known by various names, including vegetable milk, non-dairy milk, dairy substitute, and imitation milk (Vanga & Raghavan, 2018), are recognised as a vital dietary supplement for people who are sensitive to any of the specified characteristics (Bernat *et al.,* 2014). Furthermore, it is impossible to accentuate the importance of having enough protein in the diet for effective body development and metabolism because it is an essential nutrient for both humans and animals. Milk has been described as an unavoidable component of our daily diet for the expecting mothers and growing children because milk is a balance of protein, fat, ash, lactose, nitrogen, and non-protein nitrogen and ash (Padma *et al.,* 2022). However, the demand for plant-based alternatives to cow's milk has surged globally due to issues including lactose intolerance and milk allergies (Maraş, 2020). Plant water extracts can serve as substitutes for milk, having other types of plant-based milk available, such as rice, soy, and coconut milk, which are mostly used (Rasika *et al.,* 2021). Additionally, there are several drawbacks to plant-based milks; some of these drawbacks include their difficult-to-accept flavour profiles and nutritional imbalance (Tangyu *et al.,* 2019). Plant seeds form an important part of the human diet, as they are a good source of proteins, edible oils, and fats in the diet, as well as prospective raw materials for local industries (Kumar et al., 2022). Plant milk is a general term for products similar to milk but made from plant sources that do not contain significant dairy products or milk fat (Alozie & Udofia 2015). Plant-based milks are recognised as essential food for people who are sensitive to the aforementioned characteristics because they are free of lactose, cholesterol, and animal protein (Vanga and Raghavan, 2018). These milk analogues could be utilised as animal milk substitutes because of their similar functional qualities, nutritional value, and sensory attributes (Kumar *et al.,* 2006). Actually, high interest exists in consuming foods that contribute to maintaining a healthy state, as well as preventing degenerative diseases (Bernat *et al.,* 2014). Among this type of food are nuts, which are nutritious, tasty, convenient, and easy snacks that contribute to a healthy lifestyle. They are typically consumed either raw, roasted, or salted or used as ingredients in various processed foods, especially in spreads, bakery, and confectionary products; crushed in a mortar to create a paste to add to vegetables or meat dishes and porridge (Tangyu *et al.,* 2019). In fact, there is a lot of interest in eating foods that contribute to maintaining health and preventing diseases (Donkor and Adebile 2007). Even epidemiologic studies have consistently demonstrated beneficial effects of nut consumption on coronary heart disease (CHD) morbidity and mortality in different population groups (Emelike *et al.,* 2015). The consumption of nuts in natural form is inadequate, as the elderly and children find it difficult to easily open and consume nuts. The development of new products, such as plant-based milk and nut butter, may expand the uses of nuts for food and introduce consumers to healthier options (Onweluzo & Nwakalor, 2009). Products with at least 90% nut ingredients are referred to as nut butter. They can be used for several purposes, but sandwich toppings are the most popular ones (Alozie & Udofia, 2015). The oyster nut [Telfairia pedata (Smiths ex Sim)] is a herbaceous vine known as Kweme or Itando, native to Tanzania, and is primarily found in the northern and southern highlands of Tanzania (Shayo *et al.,* 2021). Oyster nuts are considered underutilised and neglected oilseeds with significant potential for both food and industrial applications (Ajayi & Dulloo, 2015). It grows on tall trees that can reach the height of 20-30 meters, hedges, or wooden platforms for support (Musalima *et al.,* 2019). The long squash-like fruits are about the size of a watermelon and contain multiple seeds (Figure 1). The plant begins to produce fruits after one year and remains productive for up to 20 years. The oyster nuts produced in rainy areas are considered to be of a better quality than those from lowland plants (Nwonuala & Obiefuna, 2015). Oyster nuts can be eaten raw, cooked, or used for confectionery purposes and are a source of food for women during the lactating period, primarily due to their lactogenic properties (Emelike *et al.,* 2015).

Figure 1
Oyster Nut, A) Fruit and B) Unshelled Nuts



Mwakasege *et al.* (2019) elaborated that the nut possesses a series of functional properties that make it a good alternative for adequate nutrition. The oyster nut has a high content of protein (25%), fat (68%), ash (2%), fatty acids (mainly linoleic) (47%), and carbohydrates (5%). In addition, it is rich in vitamin D, copper, zinc, manganese, and omega-3 and omega-6, thus helping to prevent osteoporosis in elders. Emphasising healthy nutrition and healthy living has necessitated the consumption of functional food and a low-cholesterol diet. As interest in alternative and plant-based foods grows, the oyster nut offers a promising avenue for the development of new products, particularly butter and milk substitutes for conventional dairy products (Emelike *et al.,* 2015). This is due to the occurrence of health-related problems associated with the consumption of animal milk and its products, such as lactose intolerance, milk allergy, increased cholesterol, constipation, and flatulence, as well as the high cost of dairy milk (Henshaw *et al.,* 2009). However, recently there have been high demands by consumers for plant milk origin due to some problems of animal milk protein allergenicity and healthy life (Donkor & Adebile, 2007).

The decrease in the consumption of animal milk has stimulated several researchers to develop substitutes from different seeds and nuts. This has led to the development of milk and other dairy products from legumes, oil seeds, and nuts, such as coconut or natural milk, soymilk, peanut chocolate, flavoured beverages, and butter (Abuajah & Utuk, 2013). Dairy products from plant origin are known to be highly nutritious, beneficial to health, and relatively low-priced. They can be used to combat coronary heart and cardiovascular diseases as well as malnutrition in underdeveloped countries (Emelike *et al.,* 2015).

Generally, plant-based milk alternatives are claimed to have lower protein content, calcium availability, and higher GI values than cow's milk. However, these milks are rich in bioactive compounds, unsaturated fatty acids, and phenolic compounds (Aydar *et al.,* 2020). Since there are many methods used for butter and plant-based milk substitute production with many commonalities, a flowchart was prepared for general butter and plant-based milk substitute production in this study (Mäkinen *et al.,* 2016), Figure 1, and Leahu *et al.,* (2022), Figure 2.

The aim of this study is to evaluate the sensory properties of derived oyster nut butter and milk, contrasting them with conventional dairy products. By analysing the sensory characteristics, the study seeks to identify the strengths and areas for improvement in these novel products, contributing to the diversification of plant-based alternatives in the food industry. Therefore, if we increase their utilisation, farmers might be encouraged to cultivate them as an incentive for farmers on a large scale, thus enhancing their income.

2.0 Materials and Methods

2.1. Collection and Preparation of Experimental Materials

Oyster nuts, dates, pumpkin seeds, sugar, salt, cocoa powder, vanilla, and strawberry flavours were purchased from Mwanjelwa Market in Mbeya City, Tanzania. After purchasing, they were transported to the food laboratory at Mbeya University of Science and Technology for further processing.

2.2. Experimental Design and Method of Analysis

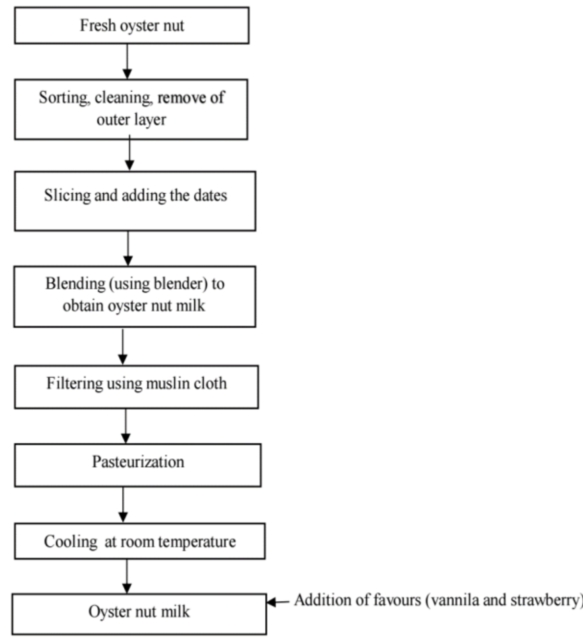
The experiments were laid out in a completely randomised design (CRD) with three replications and three formulations. Sensory evaluation of oyster nut products was done following the technique adopted by Heymann & Lawless (2013).

2.3. Products Developed from Oyster Nut

2.3.1. Oyster Nut Milk

The oyster nut milk processing is summarised in Figure 2, whereby purchased seeds were sorted to remove the spoilt and/or infested ones. The seeds were cracked open to obtain the kernel, washed, and sundried for four (4) days. The oyster nut kernels were washed with deionised water, grated, and added with dates with a ratio of 2:6:4, where two cups of oyster nut sample were mixed with six cups of water and four pieces of dates for blending to obtain oyster nut non-dairy milk. The blending was done using a kitchen blender (Kenwood, England) at maximum speed for eight minutes to obtain milk. After blending, oyster nut milk was filtered using muslin cloth, and then the milk sample was pasteurised to kill microorganisms. The milk was separated into three portions, whereby the first one was added with the vanilla flavour, the second with strawberry flavour, and the last one with no flavour added. All portions were kept in a container and stored at 4°C.

Figure 2
Flow Diagram of Oyster Nut Milk Processing

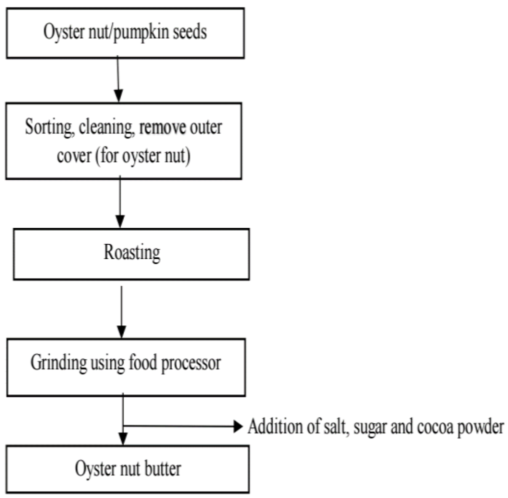


2.3.2. Oyster Nut Butter

The amount of nuts used for each butter sample was a constant of 250 g of kernels. The nut was roasted while regulating the temperature to avoid burning of the oil seeds. This was done to both oyster and pumpkin seeds. For a few minutes until the nuts are lightly brown and smell nutty, and they were left to cool until they were handled. The temperature used to heat the oyster nuts was 100°C for 25 minutes, while the pumpkin seeds were baked at 60°C for 15 minutes.
The roasted oyster nut and pumpkin seeds were added in a bowl of a food processor as shown in Figure 3.
The mixture was processed for five minutes, and a spatula was used to scrape the sides of the bowl and reprocessed for five minutes to form a shiny and smooth texture and appearance of the oil seed combination. The desired amount of salt was added when it was thick enough, and the consistency was checked to achieve the desired

smoothness. Control samples consisted of oyster nut butter without any mixture. The addition of cocoa powder and sugar was done and then processed for some minutes until the mixture was blended and shiny, and it was checked for consistency.

Figure 3
Flow Diagram of Oyster Nut Butter Processing



2.4. Sensory Evaluation
Trained a group of 75 consumers (20–45 years), young adult students, and university staff volunteers (who regularly consume peanuts and nut kernels) (Kim *et al.,* 2020) and assessed the butter and milk samples using a defined sensory language (taste, texture, colour, aroma) and overall acceptability on a 9-point hedonic scale, where 1 is extremely dislike and 9 is extremely like, to understand consumer acceptance of butter and milk-based plants (Pladma *et al.,* 2023).

The samples were three-digit coded and were presented in a randomised manner to the panelist. Moreover, the panelists were provided with warm water to rinse their mouths in between tastings. All the treatments of each product were evaluated based on the scores given by the panelists. The panelists recorded their preferential comments in the supplied questionnaire. The results were presented both in percentage figures and in acceptability scores figures and in acceptability scores.

2.5. Data Analysis
Data were analysed using the Statistical Package for the Social Sciences (SPSS) statistical software version 21 and Analysis of Variance (ANOVA). Statistical comparisons were performed with a one-way analysis of variance, and p values <0.05 were regarded as significant. The mean differences were analysed using the least significant difference (LSD) test.

3.0 Results and Discussion

3.1. Sensory Evaluation of Processed Products From Oyster Nut

3.1.1. Oyster Nut Milk

The ANOVA results had shown mean hedonic scores in each sensory attribute, which was analysed, and the level of testing was at the significance level ($p < 0.05$). The results for mean hedonic scores of milk samples from oyster nut are in Table 1.

Table 1

Mean Hedonic Score of Oyster Nut Milk

Sample	Attributes				
	Color	Texture	Aroma	Taste	Overall Acceptability
Oyster nut milk	6.95 ± 1.03^{a}	6.67 ± 1.21^{a}	7.03 ± 1.09^{a}	6.76 ± 1.06^{a}	7.11 ± 0.89^{a}
Oyster nut milk with vannila	6.87 ± 1.08^{a}	6.56 ± 1.00^{a}	6.88 ± 1.11^{b}	7.11 ± 1.24^{b}	7.17 ± 0.95^{a}
Oyster nut milk with strawberry	7.69 ± 1.07^{b}	6.93 ± 1.22^{a}	7.32 ± 1.19^{a}	7.27 ± 1.26^{b}	7.57 ± 1.00^{b}

Values are presented as mean ± SD, means having different superscripts within the same column are significantly different at p<0.05.

The mean hedonic scores of the sample attributes were analysed as follows; control oyster nut milk sample had a low score of 6.95 ± 1.03 in colour compared to other sensorial attributes followed by texture, having mean hedonic score of 6.67 ± 1.21, followed by aroma having 7.03 ± 1.09, followed by taste having 6.76 ± 1.06, and the overall acceptability of the sample had a mean score of 7.11 ± 0.89.

The results of vanilla oyster nut milk sample on Table 1 above, had shown that color had 6.87 ± 1.08, followed by texture had 6.56 ± 1.00, followed by aroma had 6.88 ± 1.11, followed by taste had 7.11 ± 1.24, and for the overall acceptability had 7.17 ± 0.95. Whereby,for the analysis scores of color of strawberry oyster nut sample had high score of 7.69 ± 1.07 compared to other samples, for texture score had 6.93 ± 1.22, followed by aroma score had 7.32 ± 1.19, followed by texture score had 7.27 ± 1.26, and for the overall acceptability had 7.57 ± 1.00.

Furthermore, the oyster nut milk was noted for its slightly thicker consistency and nutty flavor, though some panelists identified a subtle earthy aftertaste and slight grittiness in texture.

3.1.2. Oyster Nut Butter

The ANOVA results had shown mean hedonic scores in each sensory attribute which was analysed and the level of testing was at the significance level ($P < 0.05$). The results for mean hedonic scores of butter processed from oyster nut are shown on Table 2.

The following analysis was done on the mean hedonic ratings of the sample attributes: Compared to other sensory attributes, the taste of butter made with oyster nuts and pumpkin seeds had a low score of 5.31±1.17. This was followed by overall acceptability, which had a mean hedonic score of 5.52±1.30, aroma, which had a score of 5.58±1.18, color, which had a score of 5.59±1.37, and texture, which had a mean score of 5.69±0.98.

The results of the oyster nut, salt, and pumpkin seed butter are shown in Table 2. According to the results, the color, texture, aroma, taste and overall acceptability are 6.27±0.91, 5.89±1.19, 5.77±1.12, 5.73±1.06, and 5.87±1.01, respectively. For general acceptability, the product received a higher score.

However, butter prepared from cocoa, sugar, pumpkin seeds, oyster nuts, and chocolate had higher color scores (6.59±0.75), while the scores for texture, aroma, and overall acceptability were 6.54±0.69, 6.25±0.95, 6.54±0.69, and 6.52±0.84, respectively.

Additionally, oyster nut butter exhibited a creamy texture, pale yellow color, and a mild, nutty flavor, which was well-received by the panelists, indicating its potential as a plant-based butter alternative.

Table 2

Mean Hedonic Score of Oyster Nut Butter

Sample	Attributes				
	Color	Taste	Aroma	Texture	Overall acceptability
Oyster nut with pumpkin seed	5.59±1.37^a	5.31±1.17^a	5.58±1.18^b	5.69±0.98^b	5.52±1.30^b
Oyster nut with salt and pumpkin seed	6.27±0.91^b	5.73±1.06^a	5.77±1.12^b	5.89±1.19^b	5.87±1.01^b
Oyster nut with salt, chocolate and pumpkin seed	6.59±0.75^b	6.58±0.84^a	6.25±0.95^a	6.54±0.69^a	6.52±0.84^a

Values are presented as mean ± SD, means having different superscripts within the same column are significantly different at p<0.05.

4.0 Conclusion and Recommendations

These study results show that oyster nuts have great potential in developing processed products, of which oyster nut milk and butter were involved. Moreover, the products showed good sensory qualities, proving that oyster nuts are valuable in processing and a promising raw material for milk and butter making.

Therefore, the present study is a sign of the bright prospect of processing oyster nut products to minimise postharvest loss. Moreover, processed products can be sold at a high price in the off-season by adding preservatives in both local and foreign exchange, which will enrich our national economy. But further investigation is necessary to study the economic aspects of the products before recommending them for commercial production.

5.0 Funding Statement

The authors received no financial support for this study, authorship, and/or publication of this article.

6.0 Acknowledgements

The authors are grateful to Mbeya University of Science and Technology for the opportunity to conduct this study.

7.0 Conflict of Interest

The authors declare no potential conflicts of interest.

8.0 Research Involving Human Participants

Written informed consents were obtained from each participating individual.

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