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Proximate Composition and Sensory Quality of Naturally Fermented Noni (*Morinda citrifolia*) Juice from Nigerian-Grown Fruit

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ABSTRACT

Traditional fermentation of noni (*Morinda citrifolia*) juice is a spontaneous process driven by indigenous microflora. This study is aimed at examining the proximate composition and sensory qualities of naturally fermented noni juice. Fully ripened fruits (300g) from Dilomat Farm, Rivers State University, were processed: for Day 0, 30 g were ground, and the juice was carefully strained through sterile muslin cloth to obtain fresh extract; 270 g was fermented in a sterile airtight container at 25–30 °C for 63 days. Samples collected on Days 14, 35, and 63 were first filtered through a sterile muslin cloth for proximate analysis. The remaining samples were then thermally treated at 90 °C for 60 seconds prior to sensory evaluation. Fermentation significantly increased crude protein (6.31 → 8.05 %), crude fibre (2.22 → 2.51 %), ash (2.06 → 2.27 %), and moisture (63.30 → 66.82 %), while carbohydrate content decreased (18.01 → 11.93 %), reflecting microbial utilization of fermentable substrates. Sensory evaluation using a nine-point hedonic scale showed a decline in all attributes at Day 14 relative to the control, followed by peak acceptability at Day 35 (appearance 7.6±0.9, aroma 7.7±0.5, taste 7.8±0.8, texture of mouth feel 7.6±0.7, overall acceptability 7.5±0.9), with scores remaining favourable through Day 63. Extended natural fermentation improved the nutritional and sensory quality of noni juice, offering baseline data for commercial Nigerian noni juice development.Further optimization of fermentation conditions is recommended to enhance the proximate and sensory quality of noni juice for potential commercial applications.

Keywords: Noni juice, *Morinda citrifolia*, fermentation, proximate composition, sensory evaluation.

Introduction

Noni (*Morinda citrifolia* L.) is a tropical fruit widely consumed across the Pacific Islands and other tropical regions as a functional beverage, owing to its reported antioxidant, antimicrobial, and anti-inflammatory properties (Ali *et al*., 2016; Bhatia *et al*., 2015). Traditional preparation of Noni juice typically involves a prolonged spontaneous fermentation process in which the fruit is sealed in containers and left at ambient temperature for periods ranging from several weeks to a few months. This fermentation is driven by the indigenous microflora naturally present on the fruit surface and is known to influence the juice's microbial composition, nutritional profile, and sensory characteristics (Wall *et al*., 2015).

Although Noni juice fermentation has been studied in several contexts, particularly in Asia and the Pacific (Kantachote *et al*., 2009; Wang *et al*., 2021), there is a notable scarcity of data on Noni fruit cultivated in Nigeria and the microbial and biochemical dynamics that occur during its natural fermentation (Amadi & Nwala, 2021; Saah & Adu-Poku, 2021). Given the increasing interest in functional and fermented beverages within local markets, understanding how fermentation duration affects the microbial succession, nutritional value, and acceptability of Nigerian-grown Noni juice is of practical importance for potential commercial development (Marco *et al*., 2017; Tamang *et al*., 2016).

This study therefore aimed to investigate the proximate composition and sensory quality of naturally fermented Noni juice over a 63-day fermentation period, with sampling at intervals selected to capture early, mid, and late fermentation stages. selected to capture early, mid, and late fermentation stages.

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Materials and Methods

Study Area

This study was conducted in Port Harcourt, Rivers State, Nigeria. Noni fruits (Morinda citrifolia) were harvested from Dilomat Farm, situated at latitude 4°48'N and longitude 7°01'E within the premises of Rivers State University, Nkpolu-Oroworukwo, in the Niger Delta region of southern Nigeria. All juice preparation, fermentation, and analytical procedures were carried out at the Microbiology Laboratory of the Department of Microbiology, Faculty of Science, Rivers State University, Nkpolu-Oroworukwo, Port Harcourt, situated at latitude 4°47'N and longitude 7°02'E.

Experimental Design

This study was a longitudinal experimental laboratory study that adopted a time-series experimental design with repeated measures to evaluate changes in the proximate and sensory qualities of naturally fermented Noni juice over time. The independent variable was fermentation time, while the dependent variables included proximate composition and sensory attributes. Four sampling intervals were established: Day 0 (fresh, unfermented juice serving as the baseline control), Day 14 (early fermentation), Day 35 (mid-fermentation), and Day 63 (late fermentation). A total of approximately 300 g of Noni fruit was used per batch, with roughly 30 g reserved for Day 0 analysis and approximately 270 g committed to the fermentation process (Wang *et al*., 2021). All proximate composition analyses were conducted in triplicate at each sampling point, and sensory evaluation was carried out by a trained panel, to ensure reliability. Day 0 control, representing freshly extracted unfermented juice, served as the reference against which all subsequent fermentation stages were compared. The four sampling intervals were selected to capture three distinct stages of the fermentation process: early fermentation (Day 0–14), mid-fermentation (Day 14–35), and late fermentation (Day 35–63), providing a comprehensive temporal profile of proximate and sensory change (Wall *et al.,* 2015)

Sample Collection and Source

Ripe Noni fruits at the yellow-white maturity stage were harvested from Dilomat Farm, Rivers State University, Port Harcourt. Fruit ripeness was determined by three physical indicators: soft texture upon gentle compression, translucent yellowish-white skin coloration, and the characteristic mild odour associated with mature *Morinda citrifolia*, as described by Nelson and Elevitch (2006). Harvesting was carried out by hand during the early morning hours to minimise heat-induced deterioration of the fruit. Freshly harvested fruits were immediately placed into pre-labelled sterile polyethylene bags and transported on the same day to the Microbiology Laboratory of the Department of Microbiology, Rivers State University, for processing. From the point of harvest to laboratory arrival, all handling was conducted under conditions designed to preserve sample integrity and prevent contamination.

Juice Preparation and Fermentation

Harvested fruits were sorted, washed, and approximately 30 g of cleaned fruit was homogenised and filtered through a sterile muslin cloth to obtain Day 0 (fresh, unfermented) juice as a baseline control. The remaining approximately 270 g of fruit was placed in a sterile, airtight, wide-mouth plastic container and allowed to ferment naturally at ambient temperature (25-30°C) for 63 days. Samples were collected on Days 14, 35, and 63, and filtered through a sterile muslin cloth. The filtrate was then divided: one portion was used for proximate analysis, while the other was heat-treated at 90°C for 60 seconds prior to sensory evaluation. (Farhadi Chitgar *et al*., 2017).

Food safety throughout fruit selection, washing, juice extraction, fermentation, and sample handling was ensured through the application of Hazard Analysis and Critical Control Points (HACCP) principles, (Codex Alimentarius Commission, 2003). Key control measures included discarding fruits showing mould, lesions, or insect damage at selection; sterilizing extraction equipment and maintaining aseptic conditions during juice extraction; and subjecting samples to thermal treatment at 90°C for 60 seconds as the primary kill step to inactivate microorganisms prior to sensory analysis.

Proximate Analysis

Proximate composition, including crude protein, crude fat, crude fibre, moisture, ash, and carbohydrate content, was determined using standard methods of Association of Official Analytical Chemists (AOAC, 2005).

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Crude protein was determined by the micro-Kjeldahl method, involving acid digestion, distillation, and titration against standardized acid. Crude fat was extracted using the Soxhlet method with petroleum as solvent, while crude fibre was determined by sequential acid and alkali digestion followed by aching of the residue.

Moisture content was determined by oven-drying to a constant weight at 105°C, and ash content was determined by dry aching in a muffle furnace at 550°C. Carbohydrate content was calculated by difference, as the proportion of the sample not accounted for by moisture, protein, fat, and ash.

Sensory Evaluation

Sensory evaluation of the fermented juice samples was conducted using a nine-point hedonic scale (Lim, 2011; Lim & Fujimaru, 2010), assessing appearance, aroma, taste, texture of mouth feel, and overall acceptability, with a commercial noni juice as control used for comparison (Cardello & Schutz, 2004).

Statistical Analysis

Data were expressed as mean ± standard deviation. Differences across sampling time points were assessed for statistical significance at $p \leq 0.05$.

Results

The results of proximate composition changes during fermentation are presented in Table 1. It revealed that, fermentation resulted in a significant increase ($p \leq 0.05$) in crude protein content from 6.31±0.04% to 8.05±0.02%, crude fibre from 2.22±0.02% to 2.51±0.02%, ash content from 2.06±0.02% to 2.27±0.01%, and moisture content from 63.30±0.04% to 66.82±0.02% between Day 0 and Day 63. Crude lipid content remained comparatively stable, increasing only slightly from 8.09±0.03% to 8.42±0.01%. Conversely, carbohydrate content decreased substantially from 18.01±0.02% to 11.93±0.02% over the same period, reflecting the utilization of fermentable substrates by the microbial community (Table 1).

Table 1: Proximate Composition of Noni Juice during Fermentation

Proximate Parameter	Day 0	Day 14	Day 35	Day 63
Moisture (%)	63.30±0.04	65.23±0.02	66.41±0.02	66.82±0.02
Ash (%)	2.06±0.02	2.15±0.03	2.26±0.02	2.27±0.01
Crude Protein (%)	6.31±0.04	7.64±0.05	7.99±0.02	8.05±0.02
Crude Lipid (%)	8.09±0.03	8.16±0.03	8.38±0.03	8.42±0.01
Crude Fibre (%)	2.22±0.02	2.35±0.02	2.45±0.02	2.51±0.02
Carbohydrate (%)	18.01±0.02	14.47±0.04	12.51±0.03	11.93±0.02
p-value	0.000	0.000	0.000	0.000

Note: Values are mean ± standard deviation. $p \leq 0.05$ was considered statistically significant.

Sensory evaluation using the nine-point hedonic scale revealed a decline in all attributes at Day 14 relative to the control, with aroma recording the lowest mean score (5.7±1.6) and taste scoring 6.0±1.5, corresponding to ratings between "like slightly" and "like moderately".

All attributes then peaked at Day 35, with appearance (7.6±0.9), aroma (7.7±0.5), taste (7.8±0.8), texture of mouth feel (7.6±0.7), and overall acceptability (7.5±0.9) corresponding to ratings between "like moderately" and "like very much". By Day 63, scores remained comparatively high, ranging from 7.0±1.3 for aroma to 7.6±0.9 for texture, and stayed above Control values (6.9±1.4 to 7.2±1.0) for most attributes.

All five sensory attributes differed significantly across sampling points ($p=0.001$) (Table 2). Aroma and taste showed the most pronounced improvement at Day 35 relative to the control.

Overall, the control (commercial juice) consistently demonstrated high acceptability, but the Day 35 sample was nearly comparable, highlighting that fermentation can improve the sensory profile of fresh noni juice to a level close to commercial standards.

The relatively higher sensory scores obtained for the Day 35 sample indicate that fermentation duration influences the balance of flavor, aroma, and taste attributes in noni juice (Figure 1).

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Table 2: Mean Sensory Evaluation Scores of Noni Juice at Different Fermentation Times

Sensory Attribute	Control	Day 14	Day 35	Day 63
Appearance	7.2±1.0	6.6±1.1	7.6±0.9	7.5±1.1
Aroma	6.9±1.4	5.7±1.6	7.7±0.5	7.0±1.3
Taste	6.9±0.9	6.0±1.5	7.8±0.8	7.3±0.9
Texture of Mouth Feel	7.2±0.9	6.4±0.9	7.6±0.7	7.6±0.9
Overall Acceptability	7.1±0.8	6.6±1.1	7.5±0.9	7.4±1.2
p-value	*0.001*	*0.001*	*0.001*	*0.001*

Note: Scale: 1 = dislike extremely … 9 = like extremely (nine-point hedonic scale). Values are mean ± standard deviation.

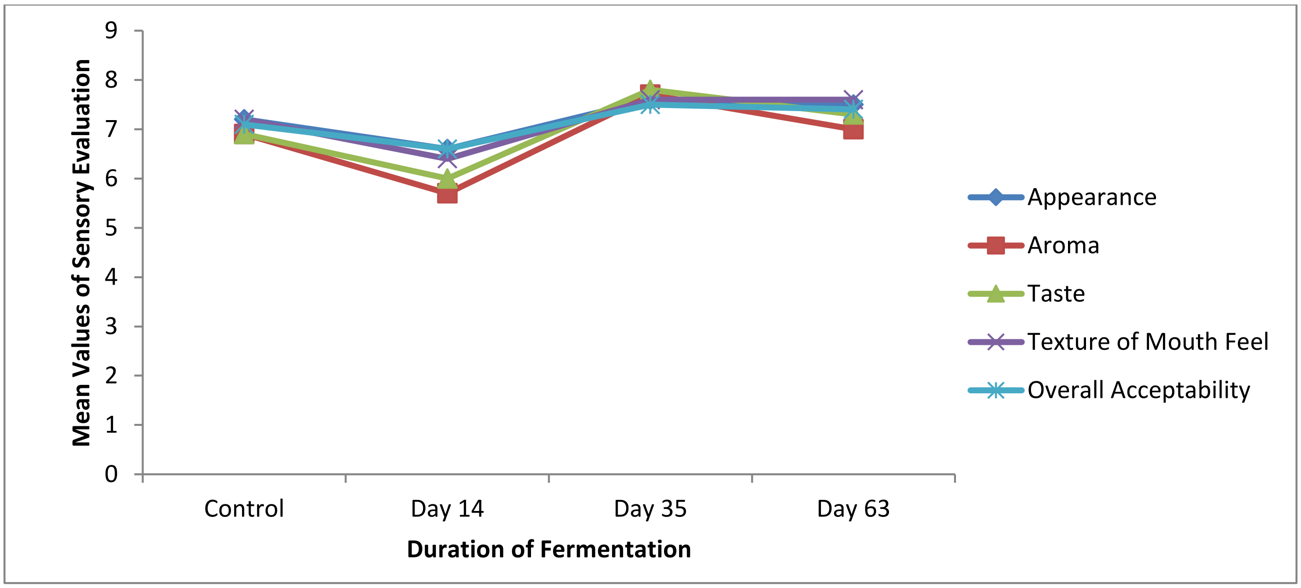

Fig. 1: Trends showing the sensory evaluation qualities during the fermentation process

Discussion

The observed increase in moisture, crude protein, crude fibre, and ash contents, together with the reduction in carbohydrate content, reflects the biochemical changes associated with microbial metabolism during spontaneous fermentation. The increase in moisture content may be attributed to the enzymatic degradation of fruit tissues and the release of bound water during fermentation, a trend consistent with the findings of Amadi and Nwala (2021).

Conversely, the progressive decline in carbohydrate content indicates the utilization of fermentable sugars by fermentative microorganisms as their primary energy source, corroborating the observations of Wang *et al*. (2021) and Cheng *et al*. (2021), who similarly reported carbohydrate depletion during noni fermentation.

The increase in crude protein content is likely associated with microbial growth and the accumulation of microbial biomass during fermentation and agrees with the findings of Amadi and Nwala (2021), who reported enhanced protein levels in fermented noni juice. Likewise, the slight increases in ash and crude fibre contents reflect the relative concentration of mineral and structural components as carbohydrates are metabolized, consistent with reports on fermented fruit products by Terefe *et al*. (2021) and Hassan *et al*. (2021).

The sensory evaluation scores of the noni juice samples revealed significant differences across fermentation stages ($p<0.05$). The commercial noni juice (control), which served as the benchmark, was rated highly across all attributes, with appearance (7.2±1.0), aroma (6.9±1.4), taste (6.9±0.9), texture (7.2±0.9), and overall acceptability (7.1±0.8).

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By comparison, the Day 14 fermented juice received lower ratings, particularly in aroma (5.7±1.6) and taste (6.0±1.5). This decline is consistent with the persistence of sharp acidic volatiles and the incomplete breakdown of bitter compounds at early fermentation, which often results in reduced consumer preference (Chan-Blanco *et al*., 2006).

Improvement was observed by Day 35, where appearance (7.6±0.9), aroma (7.7±0.5), taste (7.8±0.8), and overall acceptability (7.5±0.9) all surpassed the Day 14 values and approached the ratings of the commercial control. This increase aligns with findings by Pino *et al*. (2010), who reported that mid-fermentation coincides with the accumulation of fruity esters and a reduction in harsh-smelling fatty acids, enhancing aroma and flavor perception.
At Day 63, ratings remained favorable (appearance 7.5±1.1, taste 7.3±0.9, overall acceptability 7.4±1.2), though slightly lower than at Day 35. This trend suggests that while prolonged fermentation preserves acceptable sensory quality, optimal flavor intensity may peak around mid-fermentation.

Overall, the control (commercial juice) consistently demonstrated high acceptability, but the Day 35 sample was nearly comparable, highlighting that fermentation can improve the sensory profile of fresh noni juice to a level close to commercial standards. The relatively higher sensory scores obtained for the Day 35 sample indicate that fermentation duration influences the balance of flavor, aroma, and taste attributes in noni juice. This improvement is likely associated with the combined effects of sugar utilization, acid production, and the formation of volatile aroma compounds during fermentation, as reported in previous studies on fermented noni juice (Pino *et al*., 2010; Chan-Blanco *et al.,* 2006).

Conclusion

This study demonstrates that natural fermentation of Nigerian-grown Noni juice over 63 days results in significant improvements in proximate composition, with increases in crude protein, crude fibre, ash, and moisture content, and a corresponding decline in carbohydrate content, reflecting active microbial utilization of fermentable substrates. Sensory evaluation revealed that fermentation enhanced the appearance, aroma, taste, texture, and overall acceptability of the juice, with peak acceptability observed at Day 35 before settling to values still comparable to the commercial control by Day 63. The findings provide novel baseline data for the natural fermentation of Noni juice in Nigeria and support further investigation into controlled fermentation approaches to optimize the nutritional quality, sensory appeal, and consumer acceptability of noni juice for commercial development.

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Conflict of Interest

The author declares no conflict of interest.

References

Ali, M., Kenganora, M., & Manjula, S. N. (2016). Health benefits of Morinda citrifolia (Noni): A review. *Pharmacognosy Journal*, 8(4), 327-328.

Amadi, L. O., & Nwala, H. (2021). Preliminary investigation on microflora associated with fermentation of noni (*Morinda citrifolia*) fruit and its nutritional components. *International Journal of Biotechnology and Microbiology*, 3(2), 01-04.

AOAC -Association of Official Analytical Chemists. (2005). *Official methods of analysis (15th ed.)*.

Bhatia, R., Thapliyal, K., & Kumar, D. (2015). Phytochemical and therapeutic aspects of *Morinda citrifolia* L (Noni plant): A review. *Research Journal of Pharmacognosy and Phytochemistry*, 7(3), 167-174.

Cardello, A. V., & Schutz, H. G. (2004). Research notes numerical scale-point locations for constructing the LAM (labeled affective magnitude) scale. *Journal of Sensory Studies*, 19(4), 341-346.

Chan-Blanco, Y., Vaillant, F., Perez, A. M., Reynes, M., Brillouet, J. M., & Brat, P. (2006). The noni fruit (Morinda citrifolia L.): A review of agricultural research, nutritional and therapeutic properties. *Journal of Food Composition and Analysis*, 19(6-7), 645-654.

Cheng, Y., Li, P., Hu, B., Xu, L., Liu, S., Yu, H., ... & Qian, H. (2021). Correlation analysis reveals the intensified fermentation via Lactobacillus plantarum improved the flavor of fermented noni juice. *Food Bioscience*, 43, 101234.

Codex Alimentarius Commission. (2003). Hazard analysis and critical control point (HACCP) system and guidelines for its application. *Codex Alimentarius Food Hygiene Basic Texts (3rd ed.)*. FAO/WHO.

Farhadi Chitgar, M., Aalami, M., Maghsoudlou, Y., & Milani, E. (2017). Comparative study on the effect of heat treatment and sonication on the quality of barberry (*Berberis vulgaris*) juice. *Journal of Food Processing and Preservation*, 41(6), e13254.

Hassan, A. B., Al Maiman, S. A., Mohammed, M. A., Alshammari, G. M., Alkhudhayri, D. A., Alhuthayli, H. F., ... & Osman, M. A. (2021). Effect of natural fermentation on the chemical composition, mineral content, phytochemical compounds, and antioxidant activity of *Ziziphus spina-christi* (L.) “Nabag” seeds. *Processes*, 9(7), 1228.

Kantachote, D., Kowpong, K., Charernjiratrakul, W., & Pengnoo, A. (2009). Microbial succession in fermenting wild forest noni (*Morinda coreia* Ham) fruit plus molasses and its role in producing a liquid fertilizer. *Electronic Journal of Biotechnology*, 12(3), 9-10.

Lim, J. (2011). Hedonic scaling: A review of methods and theory. Food Quality and Preference, 22(8), 733-747.

Lim, J., & Fujimaru, T. (2010). Evaluation of the labeled hedonic scale under different experimental conditions. *Food Quality and Preference*, 21(5), 521-530.

Marco, M. L., Heeney, D., Binda, S., Cifelli, C. J., Cotter, P. D., Foligné, B., ... & Hutkins, R. (2017). Health benefits of fermented foods: Microbiota and beyond. *Current Opinion in Biotechnology*, 44, 94-102.

Nelson, S. C., & Elevitch, C. R. (2006). Noni: the complete guide for consumers and growers. PAR.

Pino, J. A., Márquez, E., Quijano, C. E., & Castro, D. (2010). Volatile compounds in noni (*Morinda citrifolia* L.) at two ripening stages. *Food Science and Technology*, 30(1), 183-187.

Saah, S. A., & Adu-Poku, D. (2021). Phytochemical, proximate, and vitamin C content in *Morinda citrifolia* (Noni). *Journal of Tropical Pharmacy and Chemistry*, 5(3), 182-187.

Tamang, J. P., Watanabe, K., & Holzapfel, W. H. (2016). Diversity of microorganisms in global fermented foods and beverages. *Frontiers in Microbiology*, 7, 377.

Terefe, Z. K., Omwamba, M. N., & Nduko, J. M. (2021). Effect of solid state fermentation on proximate composition, antinutritional factors and *in vitro* protein digestibility of maize flour. *Food Science & Nutrition*, 9(11), 6343-6352.

Wall, M. M., Nishijima, K. A., Sarnoski, P., Keith, L., Chang, L. C., & Wei, Y. (2015). Postharvest ripening of noni fruit (*Morinda citrifolia*): The microbial and chemical properties of its fermented juice. *Journal of Herbs, Spices and Medicinal Plants*, 21(3), 294-307.

Wang, Z., Dou, R., Yang, R., Cai, K., Li, C., & Li, W. (2021). Changes in phenols, polysaccharides and volatile profiles of noni (*Morinda citrifolia* L.) juice during fermentation. *Molecules*, 26(9), 2604.

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