Effect of Fermentation Duration on the Nutritional Composition, Physicochemical Properties, and Consumer Acceptability of Aliha: A Traditional Ghanaian Fermented Maize Beverage

Rita Akosua Nimo[1], Gilbert Owiah Sampson[2]

[1]Department of Hospitality and Tourism Education, University of Skills Training and Entrepreneurial Development, Kumasi, Ghana

[2]Department of Hospitality and Tourism Education, University of Skills Training and Entrepreneurial Development, Kumasi, Ghana

DOI: https://doi.org/10.47772/IJRISS.2026.100700324

Received: 06 July 2026; Accepted: 11 July 2026; Published: 31 July 2026

ABSTRACT

Aliha is a traditional non-alcoholic fermented maize beverage consumed predominantly by the Ewe ethnic group in Ghana's Volta Region and neighboring communities. Although Aliha remains culturally significant and is increasingly recognised as a potential nutrient-rich alternative to sugar-sweetened beverages, its production is still largely artisanal, inconsistent, and unstandardized. This study investigated the influence of fermentation duration on the sensory acceptability, proximate composition, and physicochemical properties of Aliha, with the aim of identifying an evidence-based fermentation window that supports both consumer preference and product quality. Aliha samples were produced from malted maize and fermented for five different durations: three days (TDFMD), four days (FDFMD), five days (FIDFMD), six days (SDFMD), and seven days (SEDFMD). Proximate composition and physicochemical parameters were determined using standard laboratory procedures, while sensory evaluation was carried out using a consumer panel and assessed on a 9-point hedonic scale. The results showed that fermentation duration influenced both acceptability and quality attributes of Aliha. Sensory scores across colour, taste, aftertaste, aroma, mouthfeel, and overall acceptability were generally above the neutral point, indicating that all samples were acceptable to consumers. Overall acceptability ranged from 6.07 ± 2.28 to 6.69 ± 1.57, with the three-day fermented sample recording the highest overall acceptability, closely followed by the four-day and six-day fermented samples. Proximate analysis revealed high moisture contents (84.83–86.52%), reflecting the beverage nature of Aliha and processing steps such as soaking prior to fermentation. Crude protein content ranged from 0.16 ± 0.00% to 0.48 ± 0.00%, with the four-day fermented sample recording the highest value, indicating improved nutrient composition at this fermentation duration. Physicochemical properties further confirmed that all samples remained consistently acidic (pH ≈ 3.71–3.77), which supports product stability and potential microbiological safety. Vitamin C levels were appreciable in all samples, ranging from 52.13 ± 0.00 to 63.95 ± 1.02 mg/100 ml, with the six-day fermented sample recording the highest vitamin C concentration. Overall, the findings indicate that moderate fermentation durations, particularly between three and six days, yield Aliha with favourable consumer acceptability and improved compositional qualities. These results provide a practical foundation for optimising and standardising Aliha production while preserving its traditional identity. Standardising fermentation duration can contribute to improved quality consistency, enhanced nutrition, and increased market potential, thereby positioning Aliha as a culturally relevant beverage option that may support healthier dietary choices and local value addition within Ghana's maize-based food systems.

Keywords: Aliha, fermented maize beverage, fermentation duration, sensory acceptability, proximate composition, physicochemical properties, traditional Ghanaian beverage, product standardisation, acidic fermentation, vitamin C

INTRODUCTION

Maize (*Zea mays* L.) is the cornerstone of food security in sub-Saharan Africa, accounting for approximately 40 % of total cereal production and supplying a substantial proportion of dietary calories for more than 4.5 billion people in developing regions (Forsido et al., 2020). In Ghana, maize constitutes over 50 % of cereal consumption and serves as raw material for numerous traditional foods and beverages. However, the country records annual post-harvest losses estimated at 18% of total production, equivalent to approximately 318,514 tonnes (Ridolfi et al., 2018). Such losses exacerbate food insecurity and economic hardship for smallholder farmers.

Traditional processing techniques, particularly fermentation and malting, have long been employed by Ghanaian households to extend shelf life, enhance flavour, and improve the nutritional profile of maize-based products. Fermentation, mediated primarily by lactic acid bacteria and yeasts, degrades anti-nutritional factors, increases mineral bioavailability, and elevates levels of limiting amino acids such as lysine and tryptophan (Mpho et al., 2021; Nkhata et al., 2018). These biochemical changes are especially valuable in populations reliant on maize-heavy diets, where protein-energy malnutrition and micronutrient deficiencies remain prevalent.

Aliha is a low-viscosity, sweet-sour, non-alcoholic beverage produced by malting maize, cooking the flour, and allowing spontaneous fermentation. It occupies a cherished place in Ewe culture and is consumed daily by children and adults alike. Despite its popularity, production parameters vary widely between households, leading to inconsistent quality and limited commercial potential. Only one previous study has characterised the basic process and proximate composition of Aliha (Madilo et al., 2022), but none has systematically examined how fermentation duration affects nutritional and sensory outcomes.

Meanwhile, Ghana, like many African countries, faces a rapid rise in consumption of sugar-sweetened carbonated beverages, particularly among children and adolescents. Excessive intake has been conclusively linked to obesity, type 2 diabetes, dental caries, and metabolic syndrome (Luger et al., 2017; Malik & Hu, 2022). Promoting nutrient-dense, low-sugar traditional beverages represents a culturally acceptable strategy for reversing this trend while simultaneously adding value to maize and reducing post-harvest losses.

The present study therefore investigated the effect of five fermentation durations (3, 4, 5, 6, and 7 days) on proximate composition, selected physicochemical properties, and consumer acceptability of Aliha. The specific objectives were to determine the fermentation period that simultaneously maximises nutritional enhancement and sensory appeal, thereby providing a scientific foundation for standardisation and potential scale-up.

MATERIALS AND METHODS

Raw Material and Aliha Preparation

Honampa maize, a widely cultivated local variety, was procured from Kumasi Central Market. Grains were sorted, washed, and soaked overnight (12 h) in potable water (1:3 w/v). After draining, grains were spread on clean jute sacks and germinated for 72 h at ambient temperature (28–32 °C) with daily rinsing. Germinated grains were oven-dried at 60 °C for 24 h, de-rooted manually, and pounded into malt flour using a motor and pestel.

For Aliha production, 2 kg of unmalted maize flour was mixed with water (1:4 w/v), cooked to full gelatinisation with constant stirring, and cooled to 45 °C. Ten percent (w/w) malt flour was added as inoculum, and the slurry was divided into five equal portions. Each portion was transferred to sterilised plastic fermentation vessels and allowed to ferment spontaneously at ambient temperature for 3, 4, 5, 6, or 7 days respectively. At the end of each fermentation period, the mash was strained through double-layered muslin

cloth, sweetened with caramelised sugar (browned sugar solution), adjusted to uniform sweetness, and refrigerated at 4 °C pending analysis. All preparations were performed in triplicate.

Proximate and Physicochemical Analyses

Moisture, crude protein (Kjeldahl, N × 6.25), crude fat (Soxhlet), ash, and crude fibre were determined according to AOAC (2019) official methods. Carbohydrate was calculated by difference. pH was measured using a calibrated digital pH meter, titratable acidity (expressed as % lactic acid) by titration with 0.1 M NaOH, total soluble solids by refractometer (°Brix), vitamin C by 2,6-dichlorophenolindophenol visual titration, and reducing and non-reducing sugars by Lane-Eynon method.

Sensory Evaluation

One hundred regular Aliha consumers (54 females, 46 males; aged 18–65 years) from Global Evangelical Church, Ayeduase-Kumasi, participated in the sensory evaluation. Most panellists were of Ewe descent and familiar with the beverage. Testing was conducted in individual booths under daylight illumination. Coded samples (50 mL each, served at 10 °C) were presented monadically in balanced random order. Panellists rated colour, taste, aroma, mouthfeel, aftertaste, and overall acceptability on a 9-point hedonic scale (1 = dislike extremely, 9 = like extremely). Water was provided for palate cleansing.

Statistical Analysis

Experiments were conducted in triplicate, and data were expressed as mean ± standard deviation. One-way analysis of variance (ANOVA) followed by Duncan's multiple range test was performed using IBM SPSS Statistics version 25. Differences were considered significant at $p < 0.05$.

RESULTS AND DISCUSSION

Sensory Evaluation of Aliha Samples

The sensory evaluation scores of Aliha samples fermented for different durations are presented in Table 1. Generally, all samples recorded mean scores above 5.0, indicating acceptable consumer perception of colour, taste, aftertaste, aroma, mouthfeel, and overall acceptability.

Table 1: Sensory Evaluation Scores of Aliha Samples (Mean ± SD)

Sample	Colour	Taste	Aftertaste	Aroma	Mouthfeel	Overall Acceptability
TDFMD	6.59 ± 1.43	6.26 ± 1.56	6.08 ± 1.61	5.55 ± 1.65	6.22 ± 1.52	6.69 ± 1.57
FDFMD	6.89 ± 1.27	6.51 ± 1.70	6.32 ± 1.68	5.81 ± 1.78	6.16 ± 1.78	6.66 ± 1.62
FIDFMD	6.65 ± 1.62	6.22 ± 1.69	5.98 ± 1.79	5.39 ± 1.90	5.91 ± 1.90	6.39 ± 1.87
SDFMD	6.70 ± 1.59	6.31 ± 1.65	6.16 ± 1.83	5.70 ± 1.69	6.24 ± 1.94	6.58 ± 1.87
SEDFMD	6.70 ± 2.06	6.27 ± 4.65	5.55 ± 2.08	5.39 ± 2.11	6.01 ± 1.92	6.07 ± 2.28

The colour scores ranged from 6.59 ± 1.43 to 6.89 ± 1.27, indicating that consumers generally liked the colour of the samples. Taste scores ranged from 6.22 ± 1.69 to 6.51 ± 1.70, with the four-day fermented sample (FDFMD) recording the highest mean taste rating. Aftertaste scores ranged from 5.55 ± 2.08 to 6.32 ± 1.68, while aroma ranged from 5.39 ± 1.90 to 5.81 ± 1.78, suggesting that fermentation duration influenced flavour-related attributes. Mouthfeel scores ranged from 5.91 ± 1.90 to 6.24 ± 1.94, showing that the drink texture and body were generally acceptable across samples. Overall acceptability ranged from 6.07 ± 2.28 to 6.69 ± 1.57, with the three-day fermented sample (TDFMD) recording the highest acceptability score (6.69 ± 1.57), closely followed by the four-day fermented sample (FDFMD) (6.66 ± 1.62) and the six-day fermented sample (SDFMD) (6.58 ± 1.87). The seven-day fermented sample (SEDFMD) had the lowest overall acceptability score (6.07 ± 2.28), suggesting that longer fermentation may slightly reduce consumer preference.

Proximate Composition of Aliha Samples

The proximate composition of Aliha samples fermented for different durations is presented in Table 2. The results indicate that fermentation duration influenced the nutrient composition of the samples, particularly moisture, ash, crude protein, crude fibre and carbohydrate contents**.**

Table 2. Proximate Analysis of Aliha Samples from Different Fermentation Periods

Sample	Moisture (%)	Ash (%)	Crude Fat (%)	Crude Protein (%)	Crude Fibre (%)	Carbohydrate (%)
TDFMD	86.50 ± 0.06	0.58 ± 0.18	0.18 ± 0.01	0.16 ± 0.00	0.43 ± 0.02	12.58 ± 0.10
FDFMD	84.83 ± 0.07	0.68 ± 0.05	0.14 ± 0.00	0.48 ± 0.00	0.36 ± 0.01	13.88 ± 0.11
FIDFMD	86.52 ± 0.09	0.60 ± 0.22	0.16 ± 0.00	0.38 ± 0.00	0.67 ± 0.04	12.34 ± 0.10
SDFMD	86.16 ± 0.05	0.56 ± 0.06	0.14 ± 0.01	0.39 ± 0.00	0.22 ± 0.01	12.75 ± 0.11
SEDFMD	85.49 ± 0.14	0.56 ± 0.22	0.14 ± 0.01	0.16 ± 0.00	1.12 ± 0.09	12.66 ± 0.18

Moisture content was high in all samples, ranging from 84.83 ± 0.07% to 86.52 ± 0.09%, reflecting the beverage nature of Aliha and processing steps such as soaking prior to fermentation. Ash content ranged between 0.56 ± 0.06% and 0.68 ± 0.05%, with the four-day fermented sample (FDFMD) recording the highest ash value, suggesting a higher mineral residue at this fermentation duration. Crude fat content was low across all samples (0.14–0.18%), with the three-day fermented sample (TDFMD) recording the highest value (0.18 ± 0.01%). Crude protein ranged from 0.16 ± 0.00% to 0.48 ± 0.00%, with the four-day fermented sample (FDFMD) recording the highest crude protein content (0.48 ± 0.00%). Crude fibre content ranged from 0.22 ± 0.01% to 1.12 ± 0.09%, with the seven-day fermented sample (SEDFMD) recording the highest fibre value (1.12 ± 0.09%). Carbohydrate content ranged from 12.34 ± 0.10% to 13.88 ± 0.11%, and the four-day fermented sample (FDFMD) recorded the highest carbohydrate value, indicating that this fermentation duration produced a relatively improved proximate profile under the study conditions.

Physicochemical Properties of Aliha Samples

The physicochemical properties of Aliha samples fermented for different durations are presented in Table 3. The results show that fermentation duration influenced vitamin C, titratable acidity, soluble solids, sugar profile, and contamination-related indicators.

Vitamin C content ranged from 52.13 ± 0.00 mg/100ml to 63.95 ± 1.02 mg/100ml, with the six-day fermented sample (SDFMD) recording the highest vitamin C content (63.95 ± 1.02 mg/100ml). This suggests that Aliha samples contain appreciable levels of vitamin C and may contribute to dietary intake. Titratable acidity ranged from 0.32 ± 0.00% to 0.34 ± 0.09%, indicating organic acid production during fermentation. The pH values ranged from 3.71 ± 0.00 to 3.77 ± 0.00, confirming that all samples remained acidic across fermentation periods, which is beneficial for product stability and microbial safety. Acid-insoluble ash ranged from 0.14 ± 0.06% to 1.10 ± 0.03%, and the higher value observed in the three-day fermented sample may indicate higher contamination risk compared to samples fermented longer. Soluble solids (°Brix) ranged from 11.80 ± 0.00 to 13.30 ± 0.00, with the four-day fermented sample (FDFMD) recording the highest °Brix value. Sucrose and fructose levels varied with fermentation duration, suggesting biochemical transformations of sugars during fermentation. Overall, the physicochemical results demonstrate that fermentation produced Aliha samples with acidic pH and measurable nutrient and sugar changes across fermentation durations

Table 3. Physicochemical Parameters of Aliha Samples

Sample	Vitamin C (mg/100ml)	Titratable Acidity (%)	pH	Acid Insoluble Ash (%)	°Brix	Sucrose (%)	Fructose (%)
TDFMD	56.61 ± 0.68	0.32 ± 0.00	3.71 ± 0.00	1.10 ± 0.03	12.00 ± 0.00	30.69 ± 0.00	8.08 ± 0.05
FDFMD	57.38 ± 0.00	0.34 ± 0.09	3.77 ± 0.00	0.19 ± 0.12	13.30 ± 0.00	36.43 ± 0.06	10.03 ± 0.02
FIDFMD	52.13 ± 0.00	0.34 ± 0.05	3.71 ± 0.01	0.17 ± 0.00	11.80 ± 0.00	16.21 ± 0.04	4.89 ± 0.84
SDFMD	63.95 ± 1.02	0.33 ± 0.00	3.73 ± 0.01	0.17 ± 0.01	12.20 ± 0.00	17.12 ± 0.01	5.16 ± 0.04
SEDFMD	58.25 ± 0.80	0.33 ± 0.04	3.72 ± 0.01	0.14 ± 0.06	13.05 ± 0.07	30.01 ± 0.06	8.21 ± 0.25

CONCLUSION

The findings from this study demonstrate that fermentation duration plays an important role in shaping the sensory acceptability, proximate composition, and physicochemical properties of Aliha. Across the fermentation periods investigated (three to seven days), the samples were generally acceptable to consumers, with mean sensory scores above the neutral point for all attributes assessed. The overall acceptability results showed that the three-day fermented sample (TDFMD) recorded the highest consumer preference, closely followed by the four-day (FDFMD) and six-day (SDFMD) fermented samples, indicating that Aliha achieves optimal acceptability within a moderate fermentation window. In addition, the proximate composition results showed that the four-day fermented sample (FDFMD) had the highest crude protein and ash contents, suggesting that this fermentation duration supports improved nutritional composition.

The physicochemical results further revealed that Aliha maintained a consistently acidic pH (≈3.7) across all fermentation periods, a property that supports product stability and potential microbiological safety. Vitamin C levels were appreciable in all samples, with the six-day fermented sample (SDFMD) recording the highest value, highlighting the beverage's potential contribution to dietary vitamin intake. Collectively, these results establish an evidence-based foundation for optimising and standardising Aliha production, while preserving its traditional identity and enhancing consistency in quality. Compared with sugar-sweetened beverages

commonly consumed in Ghana, Aliha presents a culturally relevant and potentially healthier alternative with opportunities for local value addition and livelihood improvement.

On the basis of these findings, several recommendations emerge. First, producers of Aliha at household and small-scale commercial levels are encouraged to adopt fermentation durations within the three to six-day range, as this period produced the most favourable balance of consumer acceptability and product quality, with the four-day fermentation particularly supporting improved proximate composition. Second, local food processing groups, women's cooperatives, and small-scale enterprises should be trained in standardised Aliha production practices to improve consistency, hygiene, and marketability. Third, nutrition educators and public health practitioners may consider promoting Aliha as part of community nutrition initiatives and school feeding interventions to help reduce reliance on high-sugar beverages. Fourth, policymakers within the food and agricultural sectors should support small-scale processing technologies and value addition strategies for maize to encourage improved utilisation, reduce post-harvest losses, and create income-generating opportunities.

Overall, the study confirms that applying controlled fermentation practices can strengthen the nutritional and sensory quality of Aliha and enhance its potential as a safe, acceptable, and nutritious traditional beverage. The adoption of standardised methods will improve consumer confidence and expand market potential, while contributing to wider national goals related to public health nutrition, food security, and rural livelihood development.

REFERENCES

1. AOAC International. (2019). Official methods of analysis (21st ed.). AOAC International.
2. Forsido, S. F., Welelaw, E., & Rupasinghe, H. P. V. (2020). Influence of fermentation and malting on the nutritional and antinutritional properties of maize-based complementary foods. Journal of Food Science and Technology, 57(11), 4125–4136. https://doi.org/10.1007/s13197-020-04472-9
3. Luger, M., Lafontan, M., Bes-Rastrollo, M., Winzer, E., Yumuk, V., & Farpour-Lambert, N. (2017). Sugar-sweetened beverages and weight gain in children and adults: A systematic review from 2013 to 2015 and a comparison with previous studies. Obesity Facts, 10(6), 674–693. https://doi.org/10.1159/000484566
4. Madilo, F. K., Kunadu, A. P., Tano-Debrah, K., Mensah, G. I., Saalia, K. F., & Kolanisi, U. (2022). Process and product characterization of Aliha, a maize-based Ghanaian indigenous fermented beverage. Journal of Food Quality, 2022, Article 5604342. https://doi.org/10.1155/2022/5604342
5. Malik, V. S., & Hu, F. B. (2022). The role of sugar-sweetened beverages in the global epidemics of obesity and chronic diseases. Nature Reviews Endocrinology, 18(4), 205–218. https://doi.org/10.1038/s41574-021-00627-6
6. Mpho, M., Sivakumar, D., & Moyo, P. (2021). Fermentation as a strategy to improve nutritional and functional properties of cereal-based foods. Critical Reviews in Food Science and Nutrition, 61(22), 3789–3805. https://doi.org/10.1080/10408398.2020.1835818
7. Nkhata, S. G., Ayua, E., Kamau, E. H., & Shingiro, J.-B. (2018). Fermentation and germination improve nutritional value of cereals and legumes through activation of endogenous enzymes. Food Science & Nutrition, 6(8), 2446–2458. https://doi.org/10.1002/fsn3.846
8. Ridolfi, C., Hoffman, V. and Baral, S., 2018. Post-harvest losses: Global scale, solutions, and relevance to Ghana. Intl Food Policy Res Inst.