Comparative sensory and proximate evaluation of spontaneously fermenting kunu-zaki made from germinated and ungerminated composite cereal grains

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Abstract
This study evaluated the sensory properties, proximate composition, and overall consumer acceptability of kunu-zaki using germinated and ungerminated *Sorghum bicolor* (sorghum), *Pennisetum americanum* (millet), and *Digitaria exilis* (acha) cereal grains. The three cereal grains were used in nongerminated and germinated composite and noncomposite proportions coded A (Acha), S (Sorghum), M (Millet), AS (Acha–Sorghum), AM (Acha–Millet), SM (Sorghum–Millet), ASG (Acha–Sorghum Germinated), AMG (Acha–Millet Germinated), and SMG (Sorghum–Millet Germinated). Proximate analysis determined the moisture content, ash, crude fiber, fat, and crude protein content of the fermented grains. The 9-point hedonic scale was used to judge the sensory parameters of taste, color, and aroma. The paired comparison test was used to judge consumer preference between kunu-zaki made from germinated grains and the ungerminated counterpart. Scores were statistically analyzed using the Kruskal–Wallis test in the SPSS analytical software package. Panelists ranked the ASG-coded drink highest in terms of taste and aroma, the AMG-coded drink highest in terms of color. SM ranked least in terms of taste; SMG ranked least in terms of aroma; and AM ranked the least in terms of color. Preference for each parameter was significantly different ($P < 0.001$). Panelists ranked overall preference for the drinks from the most liked to the least liked in the order ASG > AMG > A > S > M > SMG > AM > SM. The overall preference for the drinks was also significantly different ($P < 0.001$). Panelists pairing both ungerminated drinks with the germinated drinks ranked the ungerminated drink AS as most preferred in terms of taste, color, and aroma above its germinated counterpart ASG with preference not significantly dependent on the parameters ($P = 0.065 > 0.05$). Ungerminated AM was also preferred above the germinated counterpart AMG in terms of taste, color, and aroma with preference not significantly dependent on parameters ($P = 0.055 > 0.05$). However, panelists showed preference for the taste and aroma of the germinated drink SMG but more preference for the color of the ungerminated drink SM with preference significantly dependent on the parameters ($P = 0.028 < 0.05$). Crude fiber values were higher – 11.3%, 13.1%, and 17.37% for SMG, AMG and ASG, respectively. Germination increased %Fat values slightly but the %Ash was relatively stable in both germinated and ungerminated drinks. Addition of germinated acha cereal grains to either sorghum or millet prior to fermentation offers desirable sensory and nutritional quality attributes in kunu-zaki.
Introduction

For many years, the Nigerian soft drink industry has been heavily dependent on imported raw materials. In order to conserve foreign exchange, emphasis is now on the development of indigenous beverages and the country’s attention has begun to shift toward the local sourcing of raw materials for economic development (Obadina et al. 2008). Kunu-zaki is an indigenous fermented beverage made from unsprouted cereal grains (Adeyemi and Umar 1994). The drink has its origin in the northern parts of Nigeria but is now popular in almost all the states in Nigeria (Gaffa and Ayo 2002). Cereal grains form a major source of dietary nutrients for all people, particularly those in the developing countries (Slavin 2010). However, the nutritional quality of cereal grains and sensory properties of their products are inferior due to lower protein content, deficiency of certain essential amino acids, lower protein and starch availabilities, presence of certain antinutrients, and the coarse nature of the grains (Kahlon 2009). Germination of cereal seeds has been reported as an effective processing treatment to improve the nutritional quality of cereals (Amadou et al. 2011). Sprouting of grains for a limited period causes increased activities of hydrolytic enzymes, improvement in the contents of certain essential amino acids, total sugars, and B-group vitamins, and a decrease in dry matter, starch, and antinutrients (Akínhinnmi et al. 2008). The digestibility of storage proteins and starch is improved due to their partial hydrolysis during sprouting (Inyang and Zakari 2008). The magnitude of the nutritional improvement is, however, influenced by the type of cereal, seed quality, and sprouting conditions (Kahlon 2009). The consumption of sprouted cereals is gradually becoming popular in various parts of the world (Slavin 2010). Kunu-zaki (sweet kunu) is a cheap traditional non-alcoholic fermented beverage widely consumed especially during the dry season (Adeyemi and Umar 1994). Kunu-zaki processing is mostly done by women using simple household equipment and utensils. Depending on cereal availability, the unsprouted cereal grains used for kunu-zaki processing are sorghum, maize, millet, guinea corn, or rice in mostly noncomposite proportions. Even though kunu-zaki is popular and fast becoming a household technology in the country, the cereal grains used are selected randomly and diversely. For instance, some women use millet only or sorghum only, while others use only maize. Some also use sorghum with rice, while others use millet with sorghum. The most popular cereals used are sorghum and millet. When kunu-zaki is made from sorghum, the final product is a light-brown liquid. When made from millet, the resulting liquid product is milky white. Investigative studies on comparative sensory properties or consumer preferences of the drink when produced from these different grains are nonexistent. Furthermore, few scientists (Nzelibe et al. 2000; Daramola et al. 2008; Inyang and Zakari 2008) have investigated the effect of some selected malted cereals on properties of kunu-zaki but the sensory properties of each resulting drink were examined only in isolation. Studies have not yet been conducted to compare either the sensory properties and determine the overall acceptability of kunu-zaki when made from sprouted composite cereals, unsprouted composite cereals, composite cereal mixes, or noncomposite cereal proportions. Kunu-zaki is not conventionally produced using sprouted cereals and acha is not a cereal commonly used in kunu-zaki production in spite of its established nutritional advantage. This study therefore sought to compare the sensory properties, the resulting proximate composition, and overall consumer acceptability of kunu-zaki when produced from sprouted and unsprouted cereals in either composite or noncomposite proportions. The conventional grains used in the production of kunu-zaki (sorghum and millet) were used with acha being introduced into the kunu-zaki processing as a composite complement.

Figure 1. Flow diagram for the traditional processing of kunu-zaki from composite grains.
Materials and Methods

Laboratory production of kunun-zaki

Sorghum, *Sorghum bicolor*, millet, *Pennisetum americanum*, and Hungry rice (locally known as fonio or acha), *Digitaria exilis* grains were obtained from the Nigeria Cereal Research Institute in Ibadan. The grains were cleaned, weighed, and washed before steeping in distilled water. Two hundred grams of cereal grains was used for the kunun-zaki production. A control experiment was set up with distilled water without the grains. For the kunun-zaki made from composite grains (Fig. 1), an equal weight of grains was used for each part. The laboratory production method followed the traditional process of kunun-zaki fermentation.

Composite cereals

The composite grains were used in the ratio of 50:50 and coded as follows: AS, Acha/Sorghum ungerminated composite grains; AM, Acha/Millet ungerminated composite grains; SM, Sorghum/Millet ungerminated composite grains; ASG, Acha/Sorghum Germinated composite grains; AMG, Acha/Millet Germinated composite grains; SMG, Sorghum/Millet Germinated composite grains.

Germination of cereal grains

Two hundred grams of cereal grains was rinsed in distilled water and drained. Steeping was carried out at a temperature of 48°C to a moisture content of about 42–45%. Water was drained and germination carried out by spreading the steeped grains on a tray, in a room at temperature of 28 ± 2°C. Seeds were sprayed intermittently with water. The germinated grains were recovered when the radical was about 1.5 mm in length.

Proximate composition

Estimations were made of nitrogen (as an index of crude protein), water, fat, ash, and crude fiber. When the total was subtracted from 100%, the difference was termed carbohydrate by difference. Determination of the moisture content, ash, and crude fat followed the method of AOAC (1990). Crude fiber determination followed the method of Pearson (1981). Estimation of nitrogen content was by the Kjeldahl method multiplied by 6.25, the nitrogen-protein factor to convert to crude protein.

Moisture content

The moisture content was determined using procedure described by AOAC (1990). The moisture content of each sample was determined by weighing 5 g of the sample into a aluminum moisture can. The sample was then dried to constant weight at 105 ± 2°C.

\[
\text{Moisture content} = \left(\frac{\text{Weight of can} - \text{weight of empty can}}{\text{Weight of sample}}\right) \times 100
\]

Crude protein and fat content

The protein and fat content of the samples were determined (AOAC 1990).

Ash content

Two grams of samples was weighed in well incinerated crucibles and then ashed in a muffle furnace at 600°C for 3 h. The ash content was calculated as

\[
\text{Ash content} = \left(\frac{\text{Weight of crucible} + \text{Ash} - \text{Weight of empty crucible}}{\text{Weight of sample}}\right) \times 100
\]

Crude fiber

Two grams of the sample was transferred into a 1 L conical flask. One hundred milliliters of sulfuric acid (0.255 mol/L) was heated to boiling and then introduced into the conical flask containing the sample. The contents were then boiled for 30 min, ensuring that the level of the acid was maintained by the addition of distilled water. After 30 min, the contents were then filtered through a muslin cloth held in a funnel. The residue was rinsed thoroughly until its washing was no longer acidic to litmus. The residue was then transferred into a conical flask. One hundred milliliters of sodium hydroxide (0.313 mol/L) was then brought to boil and then introduced into the conical flask containing the sample. The contents were then boiled for 30 min, ensuring that the level of the acid was maintained by the addition of distilled water. After 30 min, the contents were then filtered through a muslin cloth held in a funnel. The residue was rinsed thoroughly until its washing was no longer alkali. The residue was then introduced into an already dried crucible and ashed at 600°C ± 200°C.

\[
\text{Crude fiber} = \left(\frac{\text{Final weight of crucible} - \text{Initial weight of crucible}}{\text{Weight of sample}}\right) \times 100
\]

Sensory evaluation

The 9-point hedonic scale assessment and the paired comparison tests were used as described by Larmond.
A total of 87 untrained panelists from a cross-section of students and staff of the Department of Food Science from the Federal University of Technology, Akure, Ondo State and the Bells University of Technology, Ota, Ogun State communities were selected based on their familiarity with kunu-zaki beverage. The panelists scored coded drinks in terms of degree of liking to taste, color, and aroma. The 9-point hedonic scale used by the panelists for the evaluation ranged from 1 to 9 representing “extremely dislike” to “extremely like”. The coded samples were served in clean, transparent cups at room temperature 25°C. The panelists used booths that were illuminated with fluorescent light and the coded drinks were tasted one at a time. Panelists also scored preference between the coded drinks made from germinated or ungerminated grains. Water was given to each panelist for oral rinsing in between tasting of the samples. One sensory attribute was tested for at each sitting (Tables 1–8).

The scores were statistically analyzed using the Kruskal–Wallis test in the SPSS analytical software package (IBM SPSS Inc., Chicago, IL).

### Results and Discussion

Figure 2 shows that ASG (Acha–Sorghum Germinated) was ranked highest by panelists, hence the most liked of all in terms of taste. SM (Sorghum–Millet) had the least liked taste. The preference for the taste of the drinks was significantly different \((P < 0.001)\). Figure 3 similarly shows that ASG (Acha–Sorghum Germinated) was again ranked highest by panelists in terms of aroma while the aroma of SMG (Sorghum–Millet Germinated) was the least liked. The preference for the drinks was significantly different too \((P < 0.001)\). Figure 4 shows that AMG (Acha–Millet Germinated) was, however, ranked highest by panelists in terms of color while AM (Acha–Millet) was the least liked. The preference for the color of the drinks was significantly different \((P < 0.001)\). The results from Figure 5 show that ASG (Acha–Sorghum Germinated) was given the overall highest rating by panelists, hence the most liked of all while SM (Sorghum–Millet) was the least liked. The preference for the drinks on the overall was also significantly different \((P < 0.001)\). Ranking from the most liked ASG > AMG > A > AS > S > M > SM-
From the overall ranking, it is easy to see that kunu-zaki drinks made from germinated grains of sorghum and acha or millet and acha grains were rated high by panelists. This is an indication of the acceptability of acha cereal grains for production of the fermented beverage in composite mixes. It is interesting to note that kunu-zaki made from acha cereal alone was rated quite poorly by panelists. These results agree with earlier preliminary studies by Gaffa and Jideani (2001) and Gaffa et al. (2001, 2002a,b, 2004). Jideani (1999) had
highlighted the possible technological uses of *D. exilis*. Acha has become an attractive focus in recent times and its research has covered many areas (Jideani and Akingbala 1993; Jideani et al. 1994a,b; Ayo et al. 2008). In reviews by Jideani (1999), Jideani and Jideani (2011), and some other workers (Balde et al. 2008), it was reported that acha helps diabetic patients. These previous discoveries are now complemented by the results of sensory studies from this research work. Jideani (1993) had earlier demonstrated the production of kunu-zaki from acha grains alone with the resulting drink labeled “kunu-acha.” From the paired comparisons, Figure 6 shows that when kunu-zaki drinks made from germinated and nongerminated grains were compared simultaneously, panelists showed a higher preference to the taste and aroma of SMG (Sorghum–Millet Germinated) than the nongerminated counterparts.

Figure 6. Paired comparison between nongerminated composite grains SM (Sorghum–Millet) and the germinated counterpart SMG (Sorghum–Millet Germinated).

Figure 7. Paired comparison between nongerminated composite grains AM (Acha–Millet) and the germinated counterpart AMG (Acha–Millet Germinated).
Table 9. Panelists’ hedonic scale assessment (parameter = taste).

| Types of drink | Response cross-tabulation | Like extremely | Like very much | Like moderately | Like slightly | Neither like nor dislike | Dislike slightly | Dislike moderately | Dislike very much | Dislike extremely | Total |
|----------------|---------------------------|---------------|---------------|----------------|--------------|------------------------|------------------|-------------------|------------------|------------------|-------|
| SM Count       | 9                         | 81            | 99            | 9              | 18           | 0                      | 0                | 9                 | 0                | 9                | 225   |
| % within response | 5.1%                     | 20.5%         | 21.6%         | 2.3%           | 15.4%        | 0.0%                   | 0.0%             | 5.6%              | 0.0%             | 11.1%           |       |
| A Count        | 24                        | 9             | 63            | 54             | 18           | 27                     | 9                | 9                 | 9                | 9                | 222   |
| % within response | 13.6%                    | 2.3%          | 13.7%         | 14.0%          | 15.4%        | 13.6%                  | 12.5%            | 5.6%              | 16.7%            | 11.0%           |       |
| AS Count       | 0                         | 63            | 63            | 18             | 36           | 9                      | 9                | 18                | 9                | 9                | 225   |
| % within response | 0.0%                     | 15.9%         | 13.7%         | 4.7%           | 30.8%        | 4.5%                   | 12.5%            | 11.1%             | 16.7%            | 11.1%           |       |
| SMG Count      | 36                        | 54            | 18            | 72             | 9            | 36                     | 0                | 18                | 0                | 225   |
| % within response | 5.1%                     | 11.4%         | 9.8%          | 20.9%          | 7.7%         | 9.1%                   | 0.0%             | 11.1%             | 0.0%             | 11.1%           |       |
| ASG Count      | 18                        | 0             | 18            | 27             | 9            | 45                     | 27               | 63                | 18               | 225   |
| % within response | 10.2%                    | 0.0%          | 3.9%          | 7.0%           | 7.7%         | 22.7%                  | 37.5%            | 38.9%             | 33.3%            | 11.1%           |       |
| AM Count       | 54                        | 36            | 45            | 54             | 0            | 18                     | 0                | 18                | 0                | 225   |
| % within response | 30.5%                    | 9.1%          | 9.8%          | 14.0%          | 0.0%         | 9.1%                   | 0.0%             | 11.1%             | 0.0%             | 11.1%           |       |
| AMG Count      | 0                         | 63            | 27            | 36             | 18           | 36                     | 18               | 18                | 9                | 9                | 225   |
| % within response | 0.0%                     | 15.9%         | 5.9%          | 9.3%           | 15.4%        | 18.2%                  | 25.0%            | 11.1%             | 16.7%            | 11.1%           |       |
| S Count        | 27                        | 45            | 81            | 36             | 0            | 9                      | 9                | 9                 | 9                | 9                | 225   |
| % within response | 15.3%                    | 11.4%         | 17.6%         | 9.3%           | 0.0%         | 4.5%                   | 12.5%            | 5.6%              | 16.7%            | 11.1%           |       |
| Total Count    | 177                       | 396           | 459           | 387            | 117          | 198                    | 72               | 162               | 54               | 2022             |       |
| % within response | 100.0%                   | 100.0%        | 100.0%        | 100.0%         | 100.0%       | 100.0%                 | 100.0%           | 100.0%            | 100.0%           | 100.0%           | 100.0%|
nated counterpart SM (Sorghum–Millet). Various studies (Mbith-Mwikya et al. 2000; Makokha et al. 2002; Wadikar 2006; Inyang and Zakari 2008) have shown that germination followed by fermentation of millets and sorghum significantly reduce the amount of antinutrients (tannin and phytate) leading to effective starch and protein hydrolysis and increased mineral bioavailability. Even though these works did not compare sensory properties,

Table 10. Hedonic assessment for taste chi-square tests (parameter = taste).

| Value  | Asymp. significance (2-sided) |
|--------|------------------------------|
| Pearson chi-square | 928.822 | 64 | 0.000 |
| Likelihood ratio | 1042.638 | 64 | 0.000 |
| Linear-by-linear association | 1080.00 | 1 | 0.001 |
| Number of valid cases | 2022 |

10 cells (0.0%) have expected count less than 5. The minimum expected count is 5.93.

Table 11. Panelists hedonic assessment (parameter = aroma).

| Types of drink | Response | Like extremely | Like very much | Like moderately | Like slightly | Neither like nor dislike | Dislike slightly | Dislike moderately | Dislike very much | Dislike extremely | Total |
|----------------|----------|----------------|----------------|----------------|---------------|-------------------------|-----------------|-------------------|-----------------|-----------------|-------|
| SM Count | 9 | 16.7% | 54 | 20.0% | 54 | 12.5% | 36 | 10.8% | 36 | 12.9% | 36 | 15.4% | 0 | 0 | 0 | 0 | 0 | 11.5% |
| A | 18 | 16.7% | 18 | 6.7% | 18 | 4.2% | 81 | 24.3% | 45 | 16.1% | 27 | 11.5% | 9 | 0 | 0 | 0 | 0 | 216 |
| AS Count | 0 | 0.0% | 45 | 16.7% | 54 | 12.5% | 9 | 2.7% | 9 | 12.9% | 0 | 3.8% | 0 | 0 | 0 | 0 | 171 |
| M | 0 | 0.0% | 27 | 10.0% | 81 | 18.8% | 36 | 10.8% | 27 | 9.7% | 18 | 7.7% | 9 | 0 | 0 | 0 | 225 |
| SMG Count | 18 | 33.3% | 45 | 16.7% | 36 | 8.3% | 81 | 24.3% | 18 | 6.5% | 27 | 11.5% | 0 | 0 | 0 | 0 | 0 | 11.5% |
| ASG Count | 0 | 0.0% | 0 | 0.0% | 18 | 4.2% | 9 | 2.7% | 27 | 9.7% | 36 | 15.4% | 27 | 15.4% | 0 | 0 | 0 | 0 | 0 | 225 |
| AM Count | 9 | 16.7% | 63 | 23.3% | 45 | 10.4% | 36 | 10.8% | 18 | 12.9% | 9 | 7.7% | 9 | 0 | 0 | 0 | 0 | 11.5% |
| AMG Count | 0 | 0.0% | 18 | 6.7% | 27 | 6.3% | 45 | 13.5% | 36 | 12.9% | 18 | 7.7% | 54 | 0 | 0 | 0 | 0 | 0 | 225 |
| S Count | 9 | 16.7% | 0 | 0.0% | 99 | 22.9% | 0 | 0.0% | 18 | 6.5% | 45 | 19.2% | 18 | 4.2% | 9 | 0 | 0 | 0 | 0 | 225 |
| Total Count | 54 | 100.0% | 270 | 100.0% | 432 | 100.0% | 333 | 100.0% | 279 | 100.0% | 234 | 100.0% | 126 | 100.0% | 153 | 100.0% | 81 | 100.0% | 1962 |

11 cell (1.2%) has expected count less than 5. The minimum expected count is 4.71.

Table 12. Hedonic assessment for aroma chi-square tests (parameter = aroma).

| Value  | Asymp. significance (2-sided) |
|--------|------------------------------|
| Pearson chi-square | 1154.496 | 64 | .000 |
| Likelihood ratio | 1203.408 | 64 | .000 |
| Linear-by-linear association | 87.965 | 1 | .000 |
| Number of valid cases | 1962 |

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### Table 13. Panelists hedonic assessment (parameter = color).

| Types of drink | Response cross-tabulation | Like extremely | Like very much | Like moderately | Like slightly | Neither like nor dislike | Dislike slightly | Dislike moderately | Dislike very much | Dislike extremely | Total |
|----------------|---------------------------|----------------|---------------|----------------|--------------|------------------------|-----------------|-------------------|------------------|-------------------|-------|
| SM             | Count                     | 0              | 99            | 117            | 9            | 0                      | 0               | 0                 | 0                | 0                 | 225   |
| % within response | 0.0%                      | 23.4%          | 24.1%         | 2.9%           | 0.0%         | 0.0%                   | 0.0%            | 0.0%              | 0.0%             | 0.0%             | 11.6% |
| A              | Count                     | 9              | 54            | 18             | 18           | 36                     | 18              | 9                 | 9                | 225               |
| % within response | 5.6%                      | 4.3%           | 11.1%         | 17.1%          | 9.5%         | 30.8%                  | 33.3%           | 11.1%             | 8.3%             | 11.6%             |
| AS             | Count                     | 0              | 27            | 45             | 9            | 27                     | 9               | 9                 | 0                | 9                 | 135   |
| % within response | 0.0%                      | 6.4%           | 9.3%          | 2.9%           | 14.3%        | 7.7%                   | 16.7%           | 0.0%              | 8.3%             | 7.0%              |
| M              | Count                     | 45             | 54            | 72             | 45           | 9                      | 0               | 0                 | 0                | 225               |
| % within response | 27.8%                     | 12.8%          | 14.8%         | 14.3%          | 4.8%         | 0.0%                   | 0.0%            | 0.0%              | 0.0%             | 11.6%             |
| SMG            | Count                     | 36             | 54            | 27             | 45           | 27                     | 27              | 9                 | 0                | 0                 | 225   |
| % within response | 22.2%                     | 12.8%          | 5.6%          | 14.3%          | 14.3%        | 23.1%                  | 16.7%           | 0.0%              | 0.0%             | 11.6%             |
| ASG            | Count                     | 0              | 36            | 45             | 63           | 36                     | 27              | 9                 | 9                | 0                 | 225   |
| % within response | 0.0%                      | 8.5%           | 9.3%          | 20.0%          | 19.0%        | 23.1%                  | 16.7%           | 11.1%             | 0.0%             | 11.6%             |
| AM             | Count                     | 45             | 90            | 45             | 18           | 18                     | 18              | 0                 | 0                | 9                 | 225   |
| % within response | 27.8%                     | 21.3%          | 9.3%          | 5.7%           | 9.5%         | 0.0%                   | 0.0%            | 0.0%              | 0.0%             | 11.1%             |
| AMG            | Count                     | 0              | 0             | 9              | 27           | 27                     | 27              | 18                | 9                | 45                | 90    |
| % within response | 0.0%                      | 0.0%           | 1.9%          | 8.6%           | 14.3%        | 15.4%                  | 16.7%           | 55.6%             | 82.3%            | 11.6%             |
| S              | Count                     | 27             | 45            | 72             | 45           | 27                     | 0               | 0                 | 0                | 9                 | 225   |
| % within response | 16.7%                     | 10.6%          | 14.8%         | 14.3%          | 14.3%        | 0.0%                   | 0.0%            | 0.0%              | 11.1%            | 0.0%              | 11.6% |
| Total          | Count                     | 162            | 423           | 486            | 315          | 189                    | 117             | 54                | 81               | 108               | 1935  |
| % within response | 100.0%                     | 100.0%         | 100.0%        | 100.0%         | 100.0%       | 100.0%                 | 100.0%          | 100.0%            | 100.0%           | 100.0%            | 100.0%|
the results of this study have now also established sensory preference in addition to the nutritional advantage. Figure 7 shows that for the three parameters of color, taste, and aroma, panelists rated the ungerminated cereal drink acha–millet higher than the germinated counterpart AMG. This agrees with the work of Ayo (2004). Even though the work of Ayo (2004) did not include germination, sensory properties of acha inclusion in the production of kunu-zaki were rated very high by panelists. These results are also comparable to that of Inyang and Zakari (2008) and Nzelibe et al. (2000). All the drinks made from fermented noncomposite cereal grains ranked lower than all the drinks made from fermented composite grains. Out of all the kunu-zaki drinks made from noncomposite cereals, the acha-based noncomposite cereal drink was still rated higher. In their overall judgments, panelists preferred drinks made from cereal grains which contained acha in the composite mix. Akoma et al. (2012) also found that the addition of malted rice to millet was preferred organoleptically. Badau (2007) also reported that malting improved the taste of kunu-zaki formulations using pearl millet alone. Tables 9–14 explain the significant test results of the kunu-zaki drinks when panelists assessed each of the drinks for taste, color, and aroma on a 9-point hedonic scale. The bar chart of the panelists assessments explains more clearly the pattern of scoring by the panelists (Figs. 8–11). The inclusion of

| Parameter | Value | df | Asymp. significance (2-sided) |
|-----------|-------|----|------------------------------|
| Pearson chi-square | 1491.132 | 64 | 0.000 |
| Likelihood ratio | 1429.881 | 64 | 0.000 |
| Linear-by-linear association | 73.059 | 1 | 0.000 |
| Number of valid cases | 1935 | | |

1 cell (1.2%) has expected count less than 5. The minimum expected count is 3.77.

Figure 8. Panelists’ hedonic assessment on TASTE.

Figure 9. Panelists’ hedonic assessment on AROMA.
acha in composite proportion to either sorghum or millet also had a considerable impact on composite proximate composition (Tables 15–20). Tables 21 and 23 show the proximate composition of both germinated and ungerminated acha–millet grains revealing higher protein and crude fiber contents relative to the other composite grains. These differences were, however, not significant (Tables 22 and 24). Germination did have an increased effect on the protein content as the germinated counterpart of the grains showed an increase. These results complement the findings of Litchenwainer et al. (1979). In the present study, percentage values of protein in kunu-zaki from composite mix ranged between 13.9% and 18.54%, fat values were between 0.43% and 4.1%, ash content ranged from 1.2% to 4%, crude fiber values were between 8.0% and 17.73%, and carbohydrates ranged between 70.4% and 80.6%. Litchenwainer et al. (1979)
had reported that kunu-zaki processed from sorghum alone contains 11.6% protein, 3.3% fat, 1.9% ash, and 76.8% carbohydrate. This study therefore demonstrates that composite cereal blends exhibit a better nutritional advantage over the noncomposite cereal blends in kunu-zaki production.

Conclusion

The sensory advantage resulting from the inclusion of acha in the processing of kunu-zaki with either sorghum or millet has been demonstrated by this study. An overall consumer preference for the germinated acha–sorghum composite cereal-based kunu-zaki was also exhibited. Preference for germinated acha–millet kunu-zaki followed closely. The study underscores the corresponding values.

Table 18. Chi-square tests.

| Value     | df | Asymp. significance (2-sided) |
|-----------|----|-------------------------------|
| Pearson chi-square | 5.792¹ | 2 | 0.055 |
| Likelihood ratio   | 6.482 | 2 | 0.039 |
| Linear-by-linear association | 0.000 | 1 | 1.000 |
| No. of valid cases | 87  | |

The chi-square table above shows that preference was not significantly dependent on parameters ($P = 0.055 > 0.05$).

¹0 cells (0.0%) have expected count less than 5. The minimum expected count is 7.67.

Table 19. Paired comparison and chi-square test scores between AS and ASG.

| Taste | Color | Aroma | Total |
|-------|-------|-------|-------|
| Pair3 AS Count | 26 | 19 | 24 | 69 |
| % within Parameter3 | 89.7% | 65.5% | 82.8% | 79.3% |
| ASG Count | 3 | 10 | 5 | 18 |
| % within Parameter3 | 10.3% | 34.5% | 17.2% | 20.7% |
| Total Count | 29 | 29 | 29 | 87 |
| % within Parameter3 | 100.0% | 100.0% | 100.0% | 100.0% |

The chi-square table above shows that preference was not significantly dependent on parameters ($P = 0.065 > 0.05$).

¹0 cells (0.0%) have expected count less than 5. The minimum expected count is 6.00.

Table 20. Chi-square tests.

| Value     | df | Asymp. significance (2-sided) |
|-----------|----|-------------------------------|
| Pearson chi-square | 5.464¹ | 2 | 0.065 |
| Likelihood ratio   | 5.392 | 2 | 0.067 |
| Linear-by-linear association | 0.415 | 1 | 0.519 |
| No. of valid cases | 87  | |

The chi-square table above shows that preference was not significantly dependent on parameters ($P = 0.065 > 0.05$).

¹0 cells (0.0%) have expected count less than 5. The minimum expected count is 6.00.

Table 21. Proximate composition of kunu-zaki from composite undergerminated cereal grains (dry matter basis).

| Drink type | Moisture content (% moisture) | Protein (%) | Fat (%) | Ash (%) | % Crude fiber | % CHO |
|------------|-------------------------------|-------------|---------|---------|--------------|------|
| SM         | 39.45                         | 16.3        | 1.4     | 1.8     | 9.8          | 70.5 |
| AM         | 49.90                         | 14.82       | 1.19    | 2.1     | 11.0         | 70.7 |
| AS         | 43.70                         | 17.7        | 1.9     | 1.8     | 8.0          | 70.4 |

The significant test shows that there is no significant difference in the proximate composition of undergerminated cereal blends in composite mix.

Table 22. Analysis of variance (ANOVA).

| Sum of squares | df | Mean square | F | Sig. |
|----------------|----|-------------|---|------|
| Proximate composition of kunu-zaki | | | |
| Between groups | 9.224 | 2 | 4.612 | 0.006 | 0.994 |
| Within groups | 11579.115 | 15 | 771.941 |
| Total | 11588.339 | 17 | |

As the probability value (0.994) is greater than the significant level (0.05), it shows that it is not significant. The significant test shows that there is no significant difference in the proximate composition of ungerminated cereal blends in composite mix.

Table 23. Proximate composition of kunu-zaki from composite germinated cereal grains (dry matter basis).

| Drink type | Moisture content (% moisture) | Protein (%) | Fat (%) | Ash (%) | % Crude fiber | % CHO |
|------------|-------------------------------|-------------|---------|---------|--------------|------|
| SMG        | 37.5                          | 17          | 4.1     | 1.74    | 11.3         | 77.1 |
| AMG        | 43.92                         | 18.54       | 0.43    | 1.2     | 13.1         | 79.8 |
| ASG        | 42.6                          | 13.97       | 1.33    | 4       | 17.73        | 80.6 |

The significant test shows that there is no significant difference in the proximate composition of germinated cereal blends in composite mix.

Table 24. Analysis of variance.

| Sum of squares | df | Mean square | F | Significance |
|----------------|----|-------------|---|--------------|
| Proximate composition of kunu-zaki | | | |
| Between groups | 11.699 | 2 | 5.849 | 0.007 | 0.993 |
| Within groups | 13365.713 | 15 | 891.048 |
| Total | 13377.412 | 17 | |

As the probability value (0.993) is greater than the significant level (0.05), it shows not significant. The significant test shows that there is no significant difference in the proximate composition of germinated cereal blends in composite mix.

had reported that kunu-zaki processed from sorghum alone contains 11.6% protein, 3.3% fat, 1.9% ash, and 76.8% carbohydrate. This study therefore demonstrates that composite cereal blends exhibit a better nutritional advantage over the noncomposite cereal blends in kunu-zaki production.

Conclusion

The sensory advantage resulting from the inclusion of acha in the processing of kunu-zaki with either sorghum or millet has been demonstrated by this study. An overall consumer preference for the germinated acha–sorghum composite cereal-based kunu-zaki was also exhibited. Preference for germinated acha–millet kunu-zaki followed closely. The study underscores the corresponding values.
which accompany the use of composite cereal mixes for the processing of kunu-zaki over the use of noncomposite cereals as is the common practice today. Though sprouting of the cereals did not seem to significantly affect proximate composition of kunu-zaki of the composite cereal blends, sprouting did improve the sensory qualities of the resulting drink. This study provides valuable information on the consumer acceptance of new kunu-zaki varieties made from different cereal blends and is helpful for manufacturers who wish to embark on the large-scale commercial production of kunu-zaki beverage.

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Conflict of Interest

None declared.

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