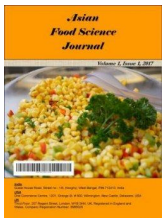

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Evaluation of the Nutritional Value and Acceptability of Powdered Reconstituted Kunu-zaki Drink; an Index of Increasing Shelf Life of the Drink

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Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

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ABSTRACT

Increasing the shelf life of kunu-zaki via conversion to powder form at the same time retaining its nutritional and sensory acceptability was evaluated on different cereal grains often used in the production of kunu (maize, sorghum, and millet). The grains were bought from Ibadan market, sorted carefully after which equal mass (250 g) of the sorted grains where soaked for seven two (72) hours, drained and were milled with the inclusion of other ingredients as spice. The mixture was sieved to remove the chaff and the liquid portion was allowed to Sediment after which it the

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upper layer containing water was decanted and the sediment layer was further processed to powdered form via drying. Sensory evaluation of the freshly prepared kunu and powdered reconstituted prepared kunu was done and compared. Similarly, the proximate, mineral composition and an assessment to verify any storage challenges such as insect infestation were investigated. The result obtained show that the shelf life of kunu-zaki was elongated from three days to more than six month as a result of the conversion to powdered form. The sensory evaluation of freshly prepared and powdered reconstituted kunu-zaki showed that there is no clear cut significant difference in the overall acceptability between freshly prepared kunu and powdered reconstituted kunu. Sorghum showed a better appearance, color and aroma both in the freshly prepared kunu and powdered reconstituted kunu above the other grains used. The proximate analysis carried out showed that the processed powdered form of kunu had a significant increase in protein, lipid and carbohydrate when compared with the freshly prepared kunu. The predominant minerals present in the sample include Iron, Copper, Zinc, Cobalt and Magnesium. It can be concluded that powdered reconstituted Kunu-zaki showed no significant difference in the major nutritional and sensory evaluated properties and was proven to have an elongated shelf life for more than six (6) months with no insect infestation during storage when compared to freshly prepared Kunu.

Keywords: Kunu-zaki; sensory properties; shelf life; nutritional evaluation; insect infestation; storage.

1. INTRODUCTION

One of the mostly consumed non alcoholic beverages especially in the Northern part of Nigeria is kunu-zaki [1,2], which tend to deteriorate with time owing to its short shelf life [3] and has thus, become a concern and difficult to produced in large quantity knowing fully that the non alcoholic beverage is on high demand due to its quenching properties [4], a source of energy and soothing taste [5]. The wastage incurred when produced in large quantity has dramatically reduced the income of the manufacturers. Different grains in the production of kunu-zaki and inclusion of several spices has only been advantageous to the nutritional enhancement not to its shelf life. Different type of grains in conjunction with spices such as ginger, black pepper, garlic, red pepper, and clover are commonly used as raw materials. Examples of grains being used include millet, sorghum, maize, groundnut amongst others [6]. However, the choice of any of these grains is dependent upon its relative abundance in any location. The resultant compound name of Kunu is determined by the grain it is made of. For instance, *Kunun-gero* is the name for Kunu made from millet, *Kunun-dawa* for the one made from sorghum, *Kunun-masara* for the one from maize, *Kunun-acha* from hungry rice or acha, *Kunun-shinkafa* from rice, *Kunun-gyada* from groundnut, *Kunun-tsamiya* from tamarind, and *Kunun-kanwa* from potassium hydroxide [7]. However, different culture in a way to increase the shelf life of Kunu involved the use of several processing procedure which only was successful in the sensory properties. The major area of concern is the short shelf life of this drink [3]. Reasons for this demerit include the unhygienic local technology being employed, the high moisture level of the product, microorganisms present in the drink that helps in the fermentation process, rodents and insect pests present in the vicinity during preparation amongst others [8,9]. This study is aimed at addressing this challenge. Hence, kunu made from three different sources (i.e. maize, millet, and wheat) were converted into a powdered form in order to reduce their moisture contents as to increase the shelf life. These powders were further investigated in term of shelf life, nutritional value and sensory evaluation. The goal is to ascertain a lasting solution to the spoilage and short shelf life of kunu and also to establish the best grain in terms of nutritional, shelf life, titratable acid, sensory evaluated properties when compared to the conventional mode of production.

2. METHODOLOGY

2.1 Production of Powdered Kunu

The grains were bought from Ibadan Market, sorted carefully after which two hundred and fifty gram (250 g) of the sorted grains where soaked for seven two (72) hours at room temperature, drained by decantation and were milled with the inclusion of other ingredients as spice. The mixture was sieved to remove the chaff and the liquid portion was allowed to sediment for 5 hours after which the upper layer containing water was decanted and the sediment layer was

further processed to powdered form via drying using NSPRI multipurpose dryer. The powdered sample were then stored in air tight container until the period for reconstitution to kunu-zaki drink following the procedure of Ogungbemi et al. [10].

2.2 Mineral Analysis

9ml of concentrated hydrochloric acid (HCL) was added into 1.5 g of the sample, followed by 3ml of concentrated nitric acid (HNO_3) and heated on a hot plate slowly at first, until frothing ceases. Heating was continued until nitric acid evaporated and white fumes observed. It was allowed to cool and filtered. This was diluted and made up to 100 ml with distilled water. The following elements were identified using atomic absorption spectrophotometry (Buck 210VGP). The elements include calcium, chromium, manganese copper, zinc, iron, magnesium and nickel, potassium, cobalt, molybdenum, selenium and vanadium.

2.3 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 [11]. Crude fiber determination followed the method of Pearson [12]. Estimation of nitrogen content was by the Kjeldahl method multiplied by 6.25, the nitrogen-protein factor to convert to crude protein.

2.4 Crude Fibre

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 ash at 600°C ± 200°C. Pearson [12].

2.5 Sensory Evaluation

The 9-point hedonic scale assessment and the paired comparison tests were used as described by Larmond 1977 [13]. A total number of 30 staff of the Nigerian stored products research institute and industrial training student of the university of Ibadan were selected based on their familiarity with Kunu zaki, 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. Water was given to each panelist for oral rinsing in between tasting of the samples.

2.6 Statistical Analysis

The statistical significance between the control and other groups of experimental animals were determined by one-way analysis of variance (ANOVA) followed by Bonferroni t-test for multiple comparisons. The results are presented as mean ± SD at confidence level of 95% ($p \leq 0.05$).

3. RESULTS

The proximate analysis carried out on the powdered reconstituted kunu showed a similar nutritional status with the freshly prepared non-powdered reconstituted kunu. Although the observable difference was seen in the crude fiber and carbohydrate content while there was no significant difference in protein, lipid, ash and moisture. Powdered sorghum also showed the highest amount (%) of protein, lipid and ash when compared with other grains which is also closely related to the freshly prepared non powdered kunu.

The water activity of the powdered kunu was below 2% before reconstituted for proximate analysis and sensory evaluation with other non powdered freshly prepared kunu.

Table 1. Proximate analysis of powdered reconstituted kunu zaki (P-kunu) and freshly prepared non powdered kunu (F-kunu) produced from three different grains (sorghum, maize and millet)

Proximate	P. Maize	F. Maize	P. Sorghum	F. Sorghum	P. Millet	F. millet
Moisture	9.2±0.09[a]	9.3±0.09[a]	9.3±0.08[a]	9.4±0.08[a]	8.9±0.09[a]	8.9±0.09[a]
Protein	12.3±0.09[a]	15.3±0.09[b]	14.5±0.09[a]	17.5±0.09[b]	11.2±0.09[a]	14.2±0.09[b]
Lipid	1.3±0.08[a]	1.2±0.08[a]	1.9±0.09[a]	1.9±0.09[a]	1.7±0.08[a]	1.7±0.08[a]
Ash	2.8±0.08[a]	2.8±0.08[a]	3.8±0.08[a]	3.8±0.08[a]	1.9±0.08[a]	1.9±0.08[a]
Crude fibre	3.1±0.08[a]	8.1±0.08[b]	2.7±0.08[a]	7.7±0.08[b]	3.4±0.08[b]	8.4±0.08[a]
Carbohydrate	71.4±0.08[a]	63.1±0.08[b]	68.4±0.08[b]	59.7±0.08[a]	72.9±0.12[a]	64.9±0.12[b]

Means with same superscript (between P and F) indicate no significant different at 5% for the attribute
P. maize, P. sorghum, P. millet= **Powdered reconstituted kunu from maize, Sorghum and millet*
F. maize, F. sorghum, F. millet= **freshly prepared kunu not converted to powdered form (conventional mode of traditional preparation of kunu) produced from maize, sorghum and millet*

The findings on the sensory properties of powdered reconstituted kunu and conventional mode of freshly prepared kunu produced from different grains showed a similar overall acceptability with sorghum having an appealing aroma and a pleasing appearance for both powdered reconstituted kunu and conventional mode of freshly prepared. Similarly, aroma, taste and color of millet were found to have no significant different in kunu from the powdered reconstituted form and the conventional preparation. The overall acceptability for both powdered reconstituted and conventional mode of preparation was in favor of sorghum when compared with the other grains.

Having being monitored for the emergence of insect pests in the powdered samples of kunu, the result is presented in the table below. The outcome of the investigation revealed no occurrence and development of flour beetles in the powdered kunu produced from maize, millet and sorghum.

Mineral composition of Kunu zaki converted to powder form produced from three different grains (sorghum, maize and millet) showed a commendable erythropoietin potentials with high amount of Fe, Cu, Co, which are minerals associated with erythropoiesis according to Ogungbemi et al. [14]. Also, the amount of calcium and potassium of the three grains are estimable for several regulation of body system such as the electrolyte regulation and the blood pressure.

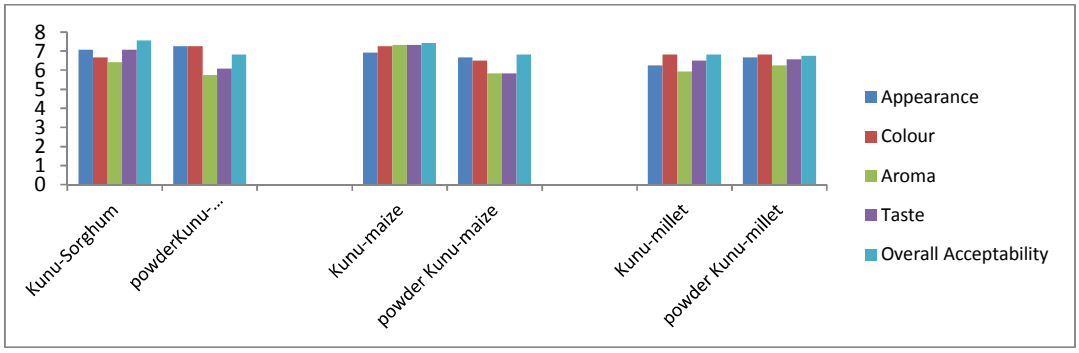

Fig. 1. Sensory properties of powdered reconstituted kunu and conventional mode of freshly prepared kunu produced from three different grains

Table 2. Emergence of flour beetles in different powdered grains stored for 6 months for reconstitution into kunu (Nigerian Non-alcoholic beverage)

Sample	T. castaneum	C. cephalonica	T. confusum
Powder Maize	—	—	—
Powder millet	—	—	—
Powder sorghum	—	—	—

*+= presence of flour beetles, ___ = Absence of flour beetles, **T. castaneum** = Tribolium castaneum (Herbst)*
***C. cephalonica** = Corcyra cephalonica (Stainton), **T. confusum** =Tribolium confusum (J. du Val)*

Table 3. Mineral composition of kunu zaki converted to powder form produced from three different grains (Sorghum, maize and millet)

Minerals	Maize	Sorghum	Millet
Cobalt (mg/100 g)	0.010±0.00[a]	0.02±0.03[b]	0.017±0.003[ab]
Iron (mg/100 g)	6.41±0.04[a]	14.71±0.05[b]	7.15±0.06[c]
Zinc (mg/100 g)	0.27±0.02[a]	0.53±0.03[b]	0.47±0.004[b]
Copper (mg/100 g)	0.17±0.03[a]	0.50±0.06[b]	0.37±0.03[b]
Calcium (mg/100 g)	92.0±2.89[a]	76.0±16[b]	101.67±2.23[c]
Magnesium (mg/100 g)	2.47±0.02[a]	4.37±0.08[a]	1.91±0.04[a]
Potassium (mg/100 g)	26.67±1.67[a]	35.00±0.00[b]	38.33±1.67[b]

Means with same superscript indicate no significant different at 5% for the attribute

4. DISCUSSION

Low shelf life and spoilage of food commodities have been the bane of productivity in the tropics. This could be attributed to high temperature and humidity of the region which enhances the activities of microbes and pest organisms in storage environment [15]. This has constituted a clog in the wheel of exportation in agrarian countries like Nigeria. In a bid to addressing this challenge, effort was made in the present study to convert the freshly prepared kunu drinks (produced from three different grains) into powdered form. After 6 months on the shelf, these powders were reconstituted and their organoleptic properties and nutritional status were evaluated and compared with those of freshly prepared kunu (produced from three different grains). The result showed that the sensory attributes of the powdered reconstituted kunu was not significantly different from those of the freshly prepared drinks. This is in consonance with the result of the proximate analysis which shows no significant difference except in terms of crude fibre and carbohydrate content. From the forgoing, one may assert that the period of storage did not negatively affect the macro nutrients of the powdered sample. The low moisture content after conversion to powdered form which was below 2% before reconstitution may have discouraged the growth of microbes thereby enabling it to be in storage for six months [16]. On the other hand, the increase in carbohydrate could have resulted from the degradation of polysaccharides inherent in the powders into monosaccharides like glucose and sucrose. It could also be as a result of increase in amylose content [17]. Since the dietary fats function to increase food palatability [18], the lipid contents of the powdered coupled with its increased carbohydrate could have made the reconstituted drinks appealing to consumers. This is why the reconstituted kunu powder drink as related to the conventional mode of freshly prepared would be a good source of energy. Moreover, the powdered kunu was observed to be free from insect pest while being kept in tightly closed glass containers for over 6 months. The drying process employed in the conversion of freshly produced kunu into powdered form could have helped disinfested the commodities from any insect developmental stage. This is in agreement with the assertion of Ofuya and Lale 2001 [19] who stated that temperature has an important quantitative effect upon insect development. Appert (1987) also stated that temperature in excess of 35^0c is lethal for certain species [16]. The thickness of the glass container could have also prevented any pest from chewing its way into the commodities. However, in terms of mineral composition, the reconstituted kunu powder drinks were observed to be significantly different from one another. In fact, kunu-sorghum was observed to have the highest composition of all the minerals investigated except calcium (76.0±16) which was observed to be relatively more in millet (101.67±2.23) and maize (92.0±2.89). This finding is in line with the work done by Ogungbemi et al. 2017 on freshly made kunu drinks (prepared from maize, millet and sorghum) but with one striking difference [10]. This difference is found in the mineral composition of the reconstituted kunu-sorghum powder. Our study revealed this particular powder to be richer in micronutrients compared to when freshly prepared. This could be as a result of some intrinsic chemical reactions leading to the release of more cations of medicinal benefits. Hence, the reconstituted kunu-sorghum powder could be said to be more nutritious that other kunu drinks. These micro nutrients are constituent of bones, teeth, blood, muscles, hair and nerve cells and according to Rumeza et al. [20], they are very important and essential ingredients of diet required for normal metabolic activities of body tissues.

5. CONCLUSION

It can be concluded that powdered reconstituted kunu-zaki showed no significant difference in the major nutritional, sensory evaluated properties and the powdered product has been proven to have an elongated shelf life for more than (six) 6 months as its moisture level is lesser than 2% with no insect infestation during storage when compared to freshly prepared kunu drink.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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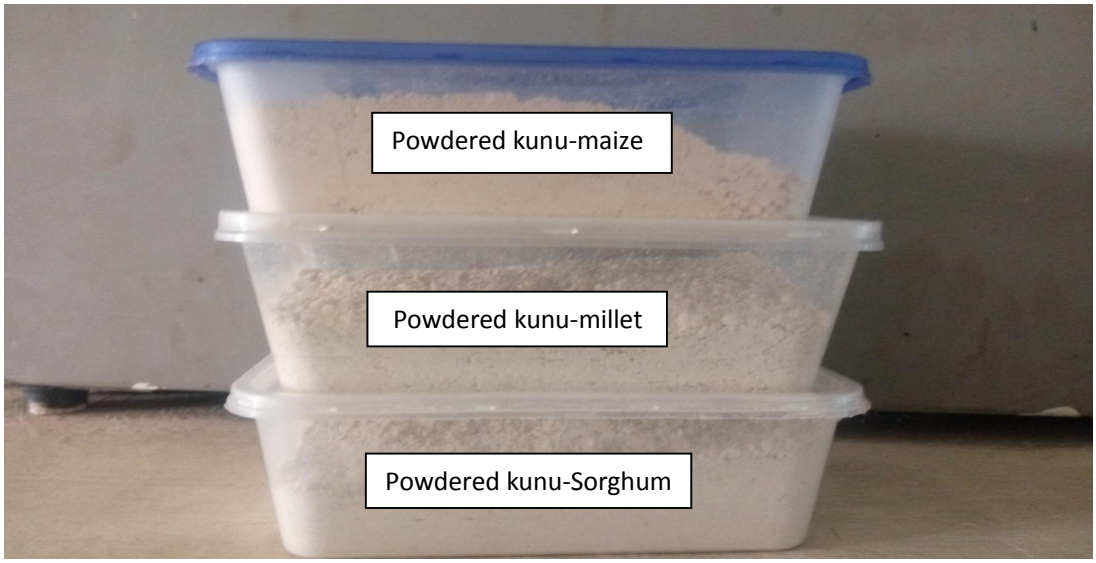
APPENDIX



Pictorial representation of kunu made from different grains converted to powdered form.

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