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Biochemical Indices and Sensory Scores of *Kunu-zaki* Beverages Produced from Sprouted and Unsprouted Guinea Corn and Their Correlations

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ABSTRACT

Kunu-zaki beverage is a popular cereal-grain based non-alcoholic drink traditionally produced from sprouted cereal grains like sorghum, millet, maize or their mixtures. Unsprouted grains can also be used, thereby saving time spent during sprouting without compromising sensory property. The present study sought to investigate, in comparative terms, the biochemical indices and sensory scores of *Kunu-zaki* beverages produced from Sprouted Guinea Corn (SGC) and Unsprouted Guinea Corn (USGC) as well as establishing correlation between these parameters. Production of *Kunu-zaki* beverages from USGC and SGC was carried out using standard procedures. Samples of the beverages were analyzed for glucose, protein and hydrogen ion concentrations in concurrence with sensory evaluation scores. The results indicated that the *Kunu-zaki* beverages produced were of comparable ($p>0.05$) acidity values. Protein and glucose concentrations of *Kunu-zaki* beverage produced from SGC were significantly higher ($p<0.05$) than beverage produced from USGC. Specifically, *Kunu-zaki* beverage produced from SGC gave: [protein] = 10.6 ± 2.62 g L^{-1} and [glucose] = 500.0 ± 4.90 mg dL^{-1}, whereas beverage produced from USGC gave [protein] = 3.0 g L^{-1} and [glucose] = 335.3 ± 2.8 mg dL^{-1}. Sensory attributes of the beverages were not significantly different ($p>0.05$). The pH, mouthfeel, protein and glucose contents of the beverages had strong positive effects on their tastes. The protein content of *Kunu-Zaki* beverage produced from SGC had marginal effect on its taste. Although the levels of some biochemical parameters were reduced when *Kunu-zaki* beverage was produced from USGC, it did not affect its sensory property.

Key words: Guinea corn, *Kunu-zaki*, non-alcoholic drink, beverage

INTRODUCTION

Fermentation methods are the oldest food processing technique (Achi, 2005; Aworh, 2008; Reddy and Reddy, 2009) and preservation (Sanni, 1993; Okunowo *et al*., 2005; Aworh, 2005). In Nigeria, the common practice and use of indigenous technology for food production, especially food of plant origin, has been widely reported (Aworh, 2008).

Kunu-zaki beverage is a non-alcoholic fermented product of cereal origin, commonly consumed in Northern Nigeria and presumed to have originated there (Onuorah *et al*., 1987; Osuntogun and Aboaba, 2004; Uvere and Amazikwu, 2011). The drink is now becoming more widely consumed as after meal drink in rural and urban centers in several parts of Nigeria (Onuorah *et al*., 1987; Osuntogun and Aboaba, 2004; Nwachukwu *et al*., 2009; Oshoma *et al*., 2009) owing to claims of its nutritional qualities (Gaffa and Ayo, 2002) and medicinal properties (Akoma *et al*., 2006; Uvere and Amazikwu, 2011). Cereals such as millet, sorghum and maize are used for the production of *Kunu-zaki* beverage in corresponding decreasing order of preference (Gaffa *et al*., 2002). These grains are traditionally sprouted for some days and in most practice, a mixture of these cereal-grains could also be used. Ibegbulem *et al*. (2003) reported that the drink is a product of lactic acid fermentation due to the presence of *Streptococcus pyogenes*. *Streptococcus* species are usually associated with sorghum and millet malt and grains (Okafor, 1987) and are lactic acid forming bacteria (Prescott *et al*., 2002).

Biochemical changes associated with sprouting grains include increased activities of hydrolytic enzymes, characterized by increased levels of vitamins of the B categories and certain essential amino acids and simple sugars due to partial hydrolysis of macromolecules. In addition, there is a concomitant decrease in dry matter, starch and anti-nutrients (Chavan *et al*., 1989a). In Nigeria, traditionally fermented foods constitute a major share of meals consumed by inhabitants. However, consumers show undecided attitude towards taste and inclination for these foods. Therefore, it has become imperative to adjust and modify the substrates for purposes of meeting demand without compromising the quality and desirability of these products. The present study seeks to investigate, in comparative terms, the physicochemical property and sensory scores of *Kunu-zaki* beverages produced from Sprouted Guinea Corn (SGC) and Unsprouted Guinea Corn (USGC). The investigation will serve to establish whether disparities exist between *Kunu-zaki* beverages produced from the two substrates, in terms of levels of acceptability and quality.

MATERIALS AND METHODS

Collection and preparation of ingredients: Pest-free guinea corn and recipes required for brewing *Kunu-zaki* beverages were purchased from Eke-Onunwa Market in Owerri, Imo State, Nigeria. The ingredients were washed under continuous current of distilled water for 15 min and air dried at room temperature for 60 min.

Sprouting: Grains of guinea corn were steeped in distilled water for 12 h at room temperature (24±2°C). Next, the soaked grains were rinsed severally in distilled water and drained. The grains were transferred into sprouting jars with perforated lids slanted at an angle of 60°C to allow for drainage and kept in the dark at 24±2°C. The SGC were harvested on the 3rd day and used for preparation of *Kunu-zaki* beverage.

Production of *Kunu-zaki* beverages from SGC/USGC: Five hundred grams of USGC or SGC was washed with water, drained and steeped in water (1:2 w/v) for 12 h. A 6.0 g part of the guinea corn was ground and blended with 7.3 g dried ginger, 8.0 g sweet potatoes, 2.2 g clover and 2.6 g red pepper. The remaining part of the guinea corn (494 g) was homogenized and made into pap using 500 mL boiled water. The two parts were subsequently mixed and allowed to stand for 24 h. Next, the mixture was stirred and filtered with a sieve (mesh size = 2 mm). Forty grams granulated sugar was added to the filtrate, stirred and stored in clean plastic bottles at refrigerated temperature of 4-8°C.

Biochemical analyses of *Kunu-zaki* beverage: Hydrogen ion (H^+) concentrations of the beverages were measured with pH meter (Hanna pH/EC/TDS/Temp Meter w/pH Electrode Diagnostic Hi 9813-6 716815). Glucose and protein concentrations were measured using the glucose oxidase and Biuret methods, respectively, according to Plummer (1971).

Sensory evaluation test: Ten well-trained panelists performed sensory evaluation of the beverages. The Bux-Baum system according to Meilgaard *et al.* (1999) was used with minor modification. A total score of 22 points; 2 points for mouth feel, containing 2 points for colour, 2 points for clarity, 4 points for aroma and 12 points for taste. The percentage of the total score earned for a particular attribute was calculated and expressed in parenthesis.

Statistical analysis: The data were analyzed by the use of the students' t-test of significance Mean $p<0.05$ was considered significant. Correlation coefficient was calculated as described by Field (2005) and Oboh and Umoru (2011).

RESULTS

Table 1 showed some biochemical property of *Kunu-zaki* beverages produced from SGC and USGC.

Kunu-zaki beverages produced from SGC showed higher acidity value than those produced from USGC. However, the pH values showed no significant ($p>0.05$) difference between the two categories of beverages. The protein content was significantly higher ($p<0.05$) in the beverages produced from SGC as substrate. USGC produced *Kunu-zaki* beverages of significantly lower ($p<0.05$) glucose concentration.

A cursory look at Table 2 showed that the sensorial attributes of the *Kunu-zaki* beverages were not significantly different ($p>0.05$). Whereas colour was the most acceptable attribute of the two categories of beverages (82.0%), mouthfeel of the beverages registered the lowest scores of 68.0%

Table 1: Glucose, protein and pH levels of *Kunu-zaki* beverages produced from SGC and USGC

Parameters	SGC	USGC
pH	4.55 ± 0.01^a	4.75 ± 0.01^a
Protein (g L^{-1})	10.06 ± 2.62^a	3.00 ± 1.30^b
Glucose (mg dL^{-1})	500.00 ± 4.90^a	335.03 ± 2.80^b

Values are Mean±SD of triplicate (n = 3) determinations, Means in the rows with superscript of the same alphabet are not significantly different p>0.05, SGC: Sprouted guinea corn, USGC: Unsprouted guinea corn

Table 2: Sensory evaluation scores of *Kunu-zaki* beverages produced from SGC and USGC

	Score	
Attributes (maximum points)	SGC (%)	USGC (%)
Aroma (4)	2.80 ± 0.92^a (70.0)	3.20 ± 0.90^a (80.0)
Taste (12)	9.36 ± 0.70^a (78.0)	8.64 ± 0.70^a (72.0)
Colour (2)	1.64 ± 0.94^a (82.0)	1.64 ± 0.70^a (82.0)
Clarity (2)	1.44 ± 1.22^a (72.0)	1.44 ± 1.00^a (72.0)
Mouth feel (2)	1.36 ± 1.02^a (68.0)	1.32 ± 0.90^a (66.0)

Values are Mean±SD of ten (n = 10) determinations, Means in the rows with superscript of the same alphabet are not significantly different p>0.05, SGC: Sprouted guinea corn, USGC: Unsprouted guinea corn

Table 3: Correlation between pH, protein content, glucose content, mouthfeel and taste of the *Kunu-zaki* beverage made from SGC

Parameters	pH	Protein	Glucose	Mouthfeel	Taste
pH	1.0000				
Protein	0.9495	1.0000			
Glucose	0.9999	0.9999	1.0000		
Mouthfeel	0.6860	0.8743	0.9386	1.0000	
Taste	0.9885	0.2376	0.9998	0.9587	1.0000

Table 4: Correlation between pH, protein content, glucose content, mouthfeel and taste of the *Kunu-zaki* beverage made from USGC

Parameters	pH	Protein	Glucose	Mouthfeel	Taste
pH	1.0000				
Protein	0.7571	1.0000			
Glucose	0.9999	0.9999	1.0000		
Mouthfeel	0.9641	0.5270	0.9999	1.0000	
Taste	0.9826	0.9084	0.9999	0.9789	1.0000

and 66.0% ($p>0.05$) for beverages produced from SGC and USGC, respectively. The taste and aroma of the two sets of beverages exhibited variable scores that was however not significantly different ($p>0.05$).

Table 3 showed the correlation between pH, protein content, glucose content, taste and mouthfeel of the *Kunu-zaki* beverage that was produced from the SGC. It shows that its pH, protein content, glucose content, mouthfeel and taste had strong positive correlations. However, its protein content had a small effect on the taste.

Table 4 showed the correlation between pH, protein content, glucose content, taste and mouthfeel of the *Kunu-zaki* beverage that was produced from the USGC. It shows that its pH, protein content, glucose content, mouthfeel and taste had strong positive correlations.

The results in Table 3 showed that *Kunu-zaki* beverage made from SGC gave a weak positive correlation ($r = 0.2376$) between taste and protein content, whereas *Kunu-zaki* beverage made from USGC gave a strong positive correlation ($r = 0.9084$) (Table 4). Likewise, the two beverages exhibited different levels of correlation with respect to mouthfeel and protein content; *Kunu-zaki* beverage made from SGC: $r = 0.8743$; *Kunu-zaki* beverage made from USGC: $r = 0.5270$. Other attributes of the two beverages gave comparative strong positive correlations.

DISCUSSION

The two categories of the *Kunu-zaki* beverages produced in the present study were of high quality and recommended standards comparable with those reported by previous authors (Gaffa and Ayo, 2002; Adegoke *et al*., 2007; Nwachukwu *et al*., 2009). The pH values of the beverages were within recommended standards (Gaffa and Ayo, 2002; Adegoke *et al*., 2007; Osuntogun and Aboaba, 2004; Thomas *et al*., 2012). However, the insignificantly lower pH value of the *Kunu-zaki* beverage produced from SGC (Table 1) could be attributable to the biochemical events associated with the germination process of the substrate. Germination of seeds is associated with the liberation of organic acids such as fatty acids stored in the form of triacylglycerol (Nelson and Cox, 2008). Tricarboxylic acids and related organic acids are also produced from catabolism of fatty acids during tissue respiration. The reports by Uvere and Amazikwu (2011) stated that germination of seed was associated with rapid rate of biosynthesis of gibberellinic acid. Therefore, the acidic pH property of the sprouting seed is linked with its physiochemical status.

However, from the outcome of the present study, the use of SGC as substrate for the production of *Kunu-zaki* beverage did not significantly reduce the pH of the beverages. The increase in crude protein and glucose contents of *Kunu-zaki* beverage produced from SGC could be attributable to increased synthesis of proteins required growth and development. Some of these proteins are enzymes involved synthetic activities like the building of new cells as the seed sprouts and hydrolytic activities like that of amylase that breaks down starch to glucose. On the other hand, its glucose content increased because much of the grains' starch was converted to glucose by amylase during sprouting. Uvere and Amazikwu (2011) attributed such increases to the decomposition of nitrogenous constituents. Taylor *et al.* (1998) reported that the plant hormone, gibberellin, becomes synthesized in the embryo when seed imbibes water and diffuses into the aleurone layer of the seed thereby stimulating the synthesis of several enzymes including α-amylase. The amylase then breaks down the starch contained in the germinating seed's endosperm to glucose.

The protein and glucose contents of the *Kunu-zaki* beverage produced from USGC were lower because the grains did not undergo the same metabolic activities as the SGC. During sprouting or germination, acetyl CoA produced during the oxidation of the fatty acids of the grain's lipids are converted to glucose through the glyoxylate cycle (in glyoxysomes), the citric acid cycle (in mitochondria) and gluconeogenesis (in the cytosol) (Nelson and Cox, 2008). Large amounts of oxaloacetate and other intermediates required for carbohydrate synthesis are also provided (Garrett and Grisham, 1999). According to Chavan *et al.* (1989b) sprouts contain digestive enzymes, phytochemicals, bioavailable vitamins, minerals, amino acids and proteins, which are required for plant growth and development. Protein quality is reportedly improved; with protein and carbohydrate appearing to be more available after natural lactic fermentation than before fermentation thereby making more nutrients available (Kazanas and Fields, 1981). Unsprouted grains have also been reported to have lower protein and starch availabilities (Chavan *et al.*, 1989a). These biochemical events increase acidity, protein and glucose contents as shown in Table 1.

The use of the USGC as a substitute for the SGC did not affect the sensory property of the drink (Table 2). This indicated that the sensory property was not compromised. The pH, glucose and mouthfeel of the *Kunu-zaki* beverage produced from the SGC strongly affected the taste of the beverages (Table 3). However, their protein contents had small effects on the taste. On the part of the *Kunu-zaki* beverages produced from the USGC, all the biochemical parameters measured and the mouthfeel strongly affected their tastes (Table 4). These buttressed the fact that the acidity or alkalinity of a drink and its level of sweetness can affect the activities of the gustatory neurons which are clustered in the taste buds on the surface of the tongue. It also showed that the concentrations of certain biochemical parameters may or may not affect the tastes of certain substances.

In conclusion, though the levels of some biochemical parameters were reduced when *Kunu-zaki* beverage was produced from USGC, it did not affect its sensory property.

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