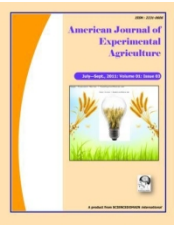

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Sensory and Nutritional Characteristics of Kununzaki Enriched with Moringa (*Moringa oleifera*) Seed Flour

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Authors' contributions

This work was carried out in collaboration between all authors. Author OAA designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors OOO and AAA managed the analyses of the study. Author ABA managed the literature searches. All authors read and approved the final manuscript.

Original Research Article

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ABSTRACT

Aims: The aim of this work was to determine the nutritional quality of kununzaki enriched with moringa seed flour.
Study Design: Analyses of variance (ANOVA).
Place and Duration of Study: Department of Food Science and Technology, Osun State Polytechnic, Iree, Nigeria, between July 2013 to January 2014.
Methodology: Sorghum grains were soaked, washed and then mixed with the spices and wet milled. Moringa seed flour (5,10,15%) was added to the kunun slurry. The slurry was divided into two; one portion was cooked and allowed to cool to 45°C and then the uncooked portion was added and mixed thoroughly. The mixture was allowed to ferment for 12h and sieved. Proximate, mineral, physicochemical, anti-nutritional and sensory evaluation was determined on the enriched kununzaki.
Results: There were reductions in the moisture and carbohydrate contents of kununzaki with increase in moringa seed flour incorporation while the protein, fat, ash and crude fibre contents increased. Kununzaki with 15% moringa seed flour had higher values in all the mineral contents determined. pH and total soluble solid increased as the percentage of moringa seed flour increased. Kununzaki with 15% moringa seed flour had higher anti-

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nutritional contents than other samples. Sensory analysis conducted on the kununzaki revealed no significant difference ($p>0.05$) in the taste, appearance and overall acceptability of control and 5 to 10% level of moringa seed substitution.
Conclusion: The proximate and mineral contents of the substituted kunuzaki were increased with the incorporation of moringa seed flour. The anti-nutrients in the beverage were low and within the range permissible for food. Addition of up to 10% moringa seed flour to kununzaki is desirable as higher concentrations (15%) of moringa seed flour impact undesirable effect on the taste of the product.

Keywords: Kununzaki; Moringa oleifera; proximate composition; anti-nutrient; sorghum; substitution.

1. INTRODUCTION

Kununzaki is a traditionally fermented non-alcoholic beverages mostly consumed in Northern Nigeria [1-2]. Among the several types of kunun, kununzaki is the most preffered according to Gaffa et al. [3]. Preparation of kununzaki varies amongst people and can generally be produced from either the following substrates; millet (*Pennisetum typhoideum*), maize (*Zea mays*) or sorghum (*Sorghum bicolor*), but millet is the most common substrates [4]. Spices such as ginger, black pepper, red pepper, cloves and sugar are commonly added as flavor and taste improver [5]. The method of production of kununzaki is crude involving only household utensils and varies from locality to locality [6]. Kununzaki is consumed as a beverage with or without addition of sugar and sweetener [7]. Its consumption is high among all age groups and is fast spreading in Nigeria as it is cheaper than the carbonated drinks [8]. Kununzaki was reported to have low nutritional status providing substantial carbohydrate value [9,10]. The beverage is deficient in protein since it is majorly from cereal crops [3]. Therefore, protein-energy malnutrition is prevalent in the areas where kunun serves as their major food. There is need to improve the protein contents of kununzaki to solve the problem of malnutrition in our society. Due to this, Gaffa et al. [11] enriched kununzaki with soybean and the kununzaki was acceptable at 4% level. Substitution with *Moringa oleifera* seed flour could also improve the protein contents of kununzaki as it has been found to contain essential nutrients needed by the body.

Moringa oleifera (Syn. *M. ptrygosperma* Gaertn.) is of the family *Moringaceae.* It is a small graceful tree with sparse foliage, often planted in compounds or used as hedge in northern Nigeria [12]. *Moringa oleifera*is a fast growing, aesthetically pleasing small tree. The specie is characterized by its long, drumstick shaped pods that contain its seeds within the first year of growth [13]. It is well known for its nutritional and medicinal values by many communities in northern Nigeria [12]. *Moringa oleifera*was reported to be a good source of vitamins and amino acids [14]. In developing countries, moringa has potential to improve nutrition, boost food security, foster rural development and support sustainable land care [15]. Therefore, this paper presents the quality of kununzaki substituted with moringa seed flour.

2. MATERIALS AND METHODS

2.1 Materials

Sorghum and spices were obtained at Igbona market, Osogbo, Osun State, Nigeria, while Moringa seeds were obtained at IAR & T research Institute, Ibadan, Oyo State, Nigeria.

2.2 Methods

2.2.1 Production of kununzaki

The grains (sorghum) were cleaned and steeped in tap water for 24h. The grains were washed and then mixed with the spices (ginger, cloves, black pepper and cinnamon) and wet milled. The paste was divided into two portions; one portion was cooked and allowed to cool to 45°C and then the uncooked portion was added and mixed as described by Efiuvwev were and Akoma [16] and Evans et al. [17]. The mixture was allowed to ferment for 12h after which it was sieved.

2.2.2 Production of moringa seed flour and substitution

Moringa seeds were removed from the pods, dried in the oven and milled. Moringa seed flour (5,10,15%) was added to the kunun slurry. The slurry was divided into two; one portion was cooked and allowed to cool to 45°C and then the uncooked portion was added and mixed thoroughly. The mixture was allowed to ferment for 12h and sieved.

2.2.3 Proximate composition of kununzaki substituted with moringa seed flour

Moisture content, crude protein, crude fibre, crude fat and ash were determined as described by AOAC [18]. Carbohydrate was calculated by difference while the metabolizable energy was calculated using the method of Adubiaro et al. [19].

2.2.4 Mineral compositionofkununzaki substituted with moringa seed flour

Kununzaki (0.5g) was weighed into a clean ceramic crucible. A blank was prepared with empty crucible. The crucible was placed in a muffle furnace at 500°C for 4hr. The sample was allowed to cool down in the oven after which it was removed carefully. The ashed sample was poured into already labeled 50ml centrifuge tube. The crucible was rinsed with 5ml of distilled water into the centrifuge tube. The crucible was rinsed again with 5ml of aqua regia. This was repeated to make a total volume of 20ml. The sample was mixed properly and centrifuged (IEC Centra GP8) for 10min at 301.86g. The supernatant was decanted into clean vials for mineral determination. The absorbance was read on atomic absorption spectrophotometer (Buck Scientific Model 200A) at different wavelength for each mineral element (Ca-422.7nm, Fe-248.3nm, Mg-285.2nm, Mn-279.5nm) [20]

2.2.5 Physico-chemical analysis of kununzaki substituted with moringa seed flour

pH of the kununzaki was measured using digital pH meter (ELICO L1 614 pH analyser) and expressed as pH units. Total soluble solids (TSS) as°Brix was determined using digital ATAGO refractometer (ATAGO, PAL-Maple Pocket type). Total titratable acidity as % lactic acid was determined by titration using 0.1N sodium hydroxide and phenolphthalein indicator solution [21-22]. The relative amount of lactic acid was calculated as follows;

$$\%Lacticacid = \frac{Volumeof\ 0.1NaoHXNormalityofAlkaliX\ 0.09}{Volumeofsample}$$

2.2.6 Antinutritional analysis of kununzaki substituted with moringa seed flour

Method of Dairo [23] was used for phytate determination while oxalate content was determined using the method of Nwinuka et al. [24]. Total phenol and alkaloid determination were done using method of Obadoni and Ochuko [25] and Sahoré et al. [26] respectively.

2.2.7 Sensory evaluation of kununzaki substituted with moringa seed flour

Sensory evaluation was done on each of thekunu-zaki samples produced by a panel of 20 judgesthat are familiar with kununzaki comprising of lecturersat Osun State Polytechnic, Iree, Nigeria, as described by Evans et al. [17]. The quality characteristics including appearance, aroma, taste and overall acceptability of the samples were evaluated based on a seven point hedonic scale (where 1=like extremely, 2=like very much, 3=like slightly, 4=neither like nor dislike, 5=dislike slightly, 6=dislike very much, 7=dislike extremely).

2.3 Statistical Analysis

The analyses were carried out in triplicate. The mean scores were computed and significant differences among the mean were determined using SPSS version 17.0.

3. RESULTS AND DISCUSSION

The proximate composition of kununzaki substituted with moringa seed flours are shown in Table 1. Moisture contents ranged from 81.37 to 85.33%. Moisture contents obtained were slightly lower than the values reported by Gaffa and Ayo [7], Ogbonna et al. [27] and Gaffa et al. [11] for kununzaki enriched with soybean. Difference in the moisture contents may be due to the methods used in preparing the kununzaki. Kununzaki consists of majorly water to quench our thirst. It had low shelf stability due to high moisture content observed and they readily undergo microbial induced spoilage within 2 to 3 days of production [10]. Moisture content of the kununzaki decreased with increase in moringa seed flour substitution.

Kununzaki substituted with 15% moringa seed flour was significantly different ($p<0.05$) from other kununzaki in ash content. There was no significant difference ($p>0.05$) in the control and kununzaki substituted with 5% moringa seed flour in ash contents. Gaffa and Ayo [7] reported 1.22% ash content for traditionally processed kununzaki. The highest ash content (1.96%) was observed in kununzaki substituted with 15% moringa seed flour. Ash contents increased with increase in moringa seed flour substitution.

Fat content ranged from 1.67 to 3.33%. There were significant differences ($p<0.05$) in the fat contents of the kununzaki with higher value in kunun with 15% moringa seed flour. Lower fat contents were observed in the control but there was increase in the fat contents of the substituted kununzaki which could be due to incorporation of moringa seed flour. Fat content of moringa seed flour was reported to be high (45.84%) [28]. The storage life of the substituted kununzaki may however be reduced owing to increase in fat content and high fat content in kununzaki may lead to susceptibility of the kunun to oxidative rancidity.

Crude fibre contents of the kununzaki increased with moringa seed flour substitution. The highest value (1.52%) was in kunun with 15% moringa seed flour. There were significant differences ($p<0.05$) in crude fibre contents of all the kununzaki produced. This was due to addition of moringa seed flour. Moringa seed flour had 7.73% crude fibre as reported by

Abiodun et al. [28] showing that the crude fibre of moringa seed flour was high. The seed contain appreciable amount of crude fibre which aid in digestion process.

Table 1. Proximate composition of kununzaki substituted with moringa seed flour

Parameter	Level of moringa seed flour substitution (%)			
	0	5	10	15
Moisture content (%)	85.33±0.61a	83.03±0.70b	82.38±0.40c	81.37±0.10d
Ash content (%)	1.03±0.11 c	1.08±0.10c	1.73±0.10b	1.96±0.18a
Fat (%)	1.67±0.10d	2.20±0.05c	2.51±0.05b	3.33±0.13a
Crude fibre (%)	0.88±0.41d	1.01±0.11c	1.20±0.40b	1.52±0.40a
Crude protein (%)	2.96±0.20d	4.63±0.26c	5.57±0.32b	6.73±0.30a
Carbohydrate (%)	9.63±0.09a	8.05±0.07b	6.61±0.10c	5.09±0.13d
Energy (kj/100g)	275.82±0.62c	296.96±0.77b	299.93±0.90b	324.15±0.50a

Values with the same subscript along the row are not significantly different (p>0.05)

Protein contents increased from 2.96 to 6.73% with moringa seed flour substitution. The least protein content (2.96%) was in the control sample. Increase in protein content in the kununzaki was recorded with higher value at 15% moringa seed flour substitution. The high protein content of moringa seed flour (28.04%) gives an indication of their usefulness in human diet and as animal feed [28-29]. Therefore, moringa seed flour had tendency to improve the protein contents of kununzaki.

Carbohydrate contents decreased with increase in moringa seed flour substitution. It ranged from 5.09 to 9.63%. The control was significantly different ($p<0.05$) from the substituted kununzaki in carbohydrate content. Addition of moringa seed flour caused reduction in the carbohydrate contents and increase in protein content of the kununzaki. The beverage serves as a good source of energy.

The mineral compositions of kununzaki are shown in Table 2. The major mineral contents in the control and substituted kununzaki were calcium and magnesium. There were no significant differences ($p>0.05$) in the calcium content of 10 and 15% moringa seed flour substituted kununzaki. Likewise, no significant differences in the manganese and nickel compositions of kununzaki substituted with 5 and 10% moringa seed flour. All the mineral contents increased with increase in moringa seed flour substitution. There were significant differences ($p<0.05$) in magnesium and iron contents of the kunuzaki. Magnesium and iron contents increased rapidly with increase in moringa seed flour. This showed that moringa seed flour serves as a source of essential minerals needed by the body.

Physico-chemical properties of kununzaki substituted with moringa seed flour are shown in Fig. 1. pH, total soluble solid and titratable acidity ranged from 3.20 to 3.90, 3.20 to 5.20 °Brix and 0.34 to 1.25% respectively. pH and total soluble solid increased with increase in moringa seed flour addition while the titratable acidity decreased with moringa addition. pH obtained were lower than the observed value (4.10-4.49) for instant kununzaki substituted with mango mesocarp flour [1] and 3.80-4.08 for kununzaki reported byOgbonna et al. [27].

Increase in level of moringa seed flour incorporation reduced the acidity of the products therefore could affect the storability of the kununzaki.

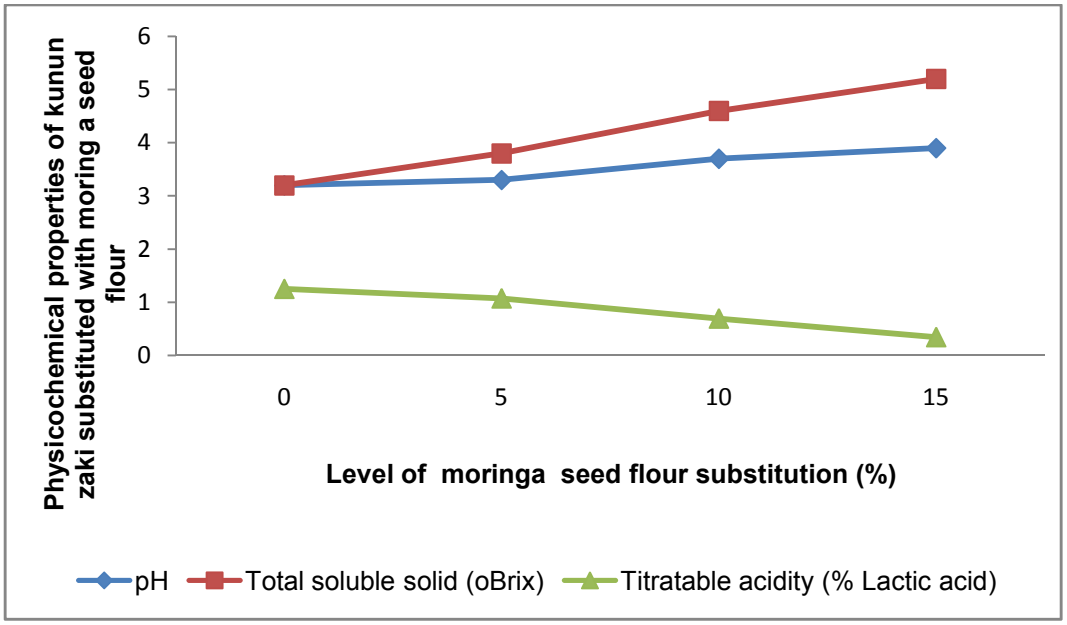

Fig. 1. Physico-chemical properties of kununzaki substituted with moringa seed flour

Table 2. Mineral composition (ppm) of kununzaki substituted with moringa seed flour

Parameter	Level of moringa seed flour substitution (%)			
	0	**5**	**10**	**15**
Ca	30.02±0.06c	35.42±0.35b	40.22±0.07a	40.65±0.10a
Mg	15.27±0.19d	25.10±0.37c	30.11±0.16b	55.78±0.08a
Fe	0.80±0.06d	1.38±0.05c	1.65±0.05b	2.58±0.02a
Mn	0.08±0.02c	0.14±0.11b	0.15±0.10b	0.23±0.02a
Ni	0.09±0.10c	0.15±0.02b	0.16±0.02b	0.21±0.04a

Values with the same subscript along the row are not significantly different (p>0.05)

Anti-nutritional compositions of kunun are presented in Table 3. Phytate, oxalate, tannin, phenol and alkaloid contents of kununzaki substituted with moringa seed flour ranged from 0.12 to 0.33, 0.09 to 0.36, 0.10 to 0.64, 0.08 to 0.13 and 0.10 to 1.02 mg/100g respectively. Kununzaki without moringa had the least values in all the anti-nutrients determined. There were no significant differences ($p>0.05$) in the kununzaki with 5 and 10% moringa seed flour in phytate and phenol contents. There were significant differences ($p<0.05$) in oxalate, tannin and alkaloid levels of the substituted kununzaki. All the anti-nutrients increased with increase in moringa seed flour substitution. The levels of anti-nutrients in the kununzaki were low and within the permissible level for food [30].

Table 4 showed the sensory properties of kununzaki. Kununzaki substituted with 15% moringa seed flour was significantly different ($p<0.05$) in appearance than other samples. There was no significant difference ($p>0.05$) in the appearance of control and kununzaki substituted with 5 and 10 % moringa seed flour. At 15% level, settling and coagulation of the components of kununzaki was noticed. This may be due to the natural coagulating properties exhibited by the seeds of moringa reported by Santos et al. [31] and Ogbe and Affiku [32]. Likewise the taste of kununzaki substituted with 15% moringa seed flour was

significantly different ($p<0.05$) from other samples. The taste of up to 10% moringa seed flour substitution was acceptable while above 10% objectionable taste was perceived. The aroma of the substituted kununzaki were not significantly different ($p>0.05$) from the control sample. Overall acceptability showed that kununzaki substituted with up to 10% moringa seed flour were acceptable.

Table 3. Antinutritional composition of kununzaki substituted with moringa seed flour

Parameter	Level of moringa seed flour substitution (%)			
	0	5	10	15
Phytate (mg/100g)	0.12±0.21c	0.19±0.15b	0.21±0.11b	0.33±0.19a
Oxalate (mg/100g)	0.09±0.16d	0.18±0.14c	0.23±0.09b	0.36±0.20a
Tannin (mg/100g)	0.10±0.11d	0.23±0.05c	0.41±0.13b	0.64±0.10a
Phenol (mg/100g)	0.08±0.10c	0.10±0.10b	0.11±0.11b	0.13±0.09a
Alkaloid(mg/100g)	0.10±0.10d	0.52±0.10c	0.76±0.10b	1.02±0.12a

Values with the same subscript along the row are not significantly different (p>0.05)

Table 4. Sensory properties of kununzaki substituted with moringa seed flour

Parameter	Level of moringa seed flour substitution (%)			
	0	5	10	15
Appearance	1.43b	1.40b	1.47b	1.58a
Taste	1.95b	1.99b	2.09b	4.23a
Aroma	2.17a	2.14a	2.12a	2.15a
Overall acceptability	1.58b	1.60b	1.62b	3.84a

[1]*Values with the same subscript along the row are not significantly different (p>0.05)*

[2] *7-point hedonic scale (where 1=like extremely, 2=like very much, 3=like slightly, 4=neither like nor dislike, 5=dislike slightly, 6=dislike very much, 7=dislike extremely).*

4. CONCLUSION

The proximate and mineral contents of the substituted kunuzaki were increased with the incorporation of moringa seed flour. The anti-nutrients in the beverage were low and within the range permissible for food. Addition of up to 10% moringa seed flour to kununzaki is desirable as higher concentrations (15%) of moringa seed flour impact undesirable effect on the taste and appearance of the product.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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