06.30.2025

JOURNAL OF

African Sustainable Development (JASD) Vol. 8 No. 2

UTILIZATION OF ORANGE FLESH SWEET POTATO AND GERMINATED RICE GRAINS TO MODIFY THE PHYSICAL AND SENSORY ATTRIBUTES OF KUNU-ZAKI FROM GUINEA CORN

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DOI Link: https://doi.org/10.70382/bejasd.v8i2.023

ABSTRACT

Kunun-Zaki plays a vital role in the dietary pattern of the people in developing countries like Nigeria. Orange Flesh Sweet Potato (OFSP) is an excellent source of beta-carotene, which the body converts into vitamin A. This study produced Kunu-Zaki by the application of orange flesh, sweet potato and whole grain germinated rice to modify the physical and sensory characteristics of Kunu Zaki from Guinea Corn. The Guinea corn and orange flesh sweet potato (OFSP) were purchased from Bida new market, Niger state while germinated rice were gotten from Onyx rice mill located along Bida-Baddegi road. The study shows that pH, titratable acidity, specific gravity of the beverage are significantly different (P<0.05). Among the samples Kunu-Zaki made from all the proportion of admixtures had good physical

Introduction

Kunun-Zaki is a Hausa word meaning sweet beverage (Sengev *et al*., 2014). It is a traditional cereal based non-alcoholic fermented beverage, widely consumed in West Africa, particularly in the northern part of Nigeria. This non-alcoholic beverage is however becoming more widely accepted in other parts of Nigeria, owing to its unique refreshing qualities (Fapohunda and Adeware, 2012; Amusa and Ashaye, 2019) and the high cost of other non-alcoholic drinks, which makes them

and sensory properties. The result for sensory evaluation: taste, appearance, consistency and overall acceptability of the samples were also significantly different (P<0.05). Kunu-Zaki produced from sample B (40% Guinea Corn, 35% Orange Flesh Sweet Potato, 25% Germinated Whole Grain Rice) has a better appearance compared to variants while Kunu- Zaki produced from sample C (35% Guinea Corn, 35% Orange Flesh Sweet Potato, 30% Germinated Whole Grain Rice) had a better taste than others. Hence, it is recommended for consumption because it had better physical and sensory properties suitable for quality and shelf stability.

Key word: Kunu-zaki, orange flesh sweet potatoes, sensory attributes, guinea corn, germinated rice

Unaffordable to the commoners.

Kunun-Zaki, a cereal based beverage, has a low nutritional content but high-water content (Fapohunda and Adeware, 2012). It plays a vital role in the staple consumption menu of most people in developing countries like Nigeria (Adeyemi and Umar, 2024). Kunu-zaki is a well acceptable beverage among people from all walks of life (both adults and children). This drink is usually hawked in motor parks, military barracks, school premises, and market places (Fapohunda and Adeware, 2012; Essien *et al*. 2019). In recent times, kunu zaki is well packaged in hygienic zealed bottles for commercial purposes among elites and high profile citizen who are hygiene conscious.

This traditional fermented beverage is typically made from grains such as millet, sorghum, or maize. Its popularity stems from its refreshing taste and nutritional value (Sengev *et al*. 2014; Adeyemi and Umar, 2024). However, there is growing interest in enhancing the nutritional profile and sensory attributes of Kunuzaki through the incorporation of other nutrient-dense ingredients to solve the problem of malnutrition and hidden hunger especially Vitamin A deficiency (Bede *et al.* 2015). Vitamin A is crucial for maintaining healthy vision, supporting immune function, and promoting skin health. However, Vitamin A deficiency is one of the leading causes of preventable blindness especially in Africa (Maziya-Dixon *et al*. 2016). It is a serious public health issue in most developing countries. Vitamin A is known to contribute towards over 0.6 million deaths annually affecting children and pregnant women the most (Akhtar *et al*. 2013; Odongo, 2015). Globally, 190 million preschool children and 19 million pregnant women are at risk of vitamin A deficiency (WHO 2019).

The dietary approach employed by the Nigerian government and the nutrition agencies includes mandatory fortification of some household foods such as sugar, salt, flour, and vegetable oil with Vitamin A (Hagenimana *et al*., 2019; GAIN 2022). The intake of this vitamin through other sources is quite low due to socioeconomic reasons. Hence, the fortification of locally made beverages from staple grains like Kunu-zaki with nutrient-dense underutilized crops like orange flesh sweet potatoes will help to enhance Vitamin intake especially among the vulnerable groups (Bede *et al.* 2015; Hagenimana *et al*. 2019).
According to Maziya-Dixon *et al*. (2016), Orange Fleshed Sweet Potato (OFSP) contains a high concentration of trans-ù-carotene that exhibits high pro-vitamin A activity. Orange Fleshed Sweet Potato (OFSP) is an underutilized bio-fortified crop that has great potential to be used in food-based intervention programs for addressing vitamin A deficiency and thus, serve as a good vitamin A supplement for cereal based beverages such as Kunun-zaki. (Odongo, 2015). OFSP contains about 3000- 16000μg/100g β-carotene and could contribute 250 to 1300 Retinol Activity Equivalent (RAE). It is also an excellent source of energy (Gurmu *et al*. 2014).
Germinated rice, particularly when consumed whole grain, has enhanced nutritional properties due to the germination process, which increases the bioavailability of vitamins, minerals, and essential amino acids. This process also reduces anti-nutritional factors, making the nutrients more accessible for absorption (Hagenimana, 2019). Mohan & Janardhanan (2015). Bechoff *et al*. (2014) and Talsma, *et al.* (2013) highlighted that germinated rice has increased levels of gamma-aminobutyric acid (GABA), an amino acid that benefits brain function and can also help lower blood pressure. Additionally, germinated rice is rich in antioxidants, which protect the body from oxidative stress and reduce the risk of chronic diseases (Bello *et al*., 2018).
Due to increase in the consciousness of consumption of nutrient-dense healthy foods, there is a growing interest in enhancing the nutritional profile and sensory attributes of traditional beverages like Kunu-zaki through the incorporation of other nutrient-dense ingredients. Hence, this study explores the application of orange flesh sweet potato (OFSP) and whole grain germinated rice as additives to Kunuzaki made from guinea corn.

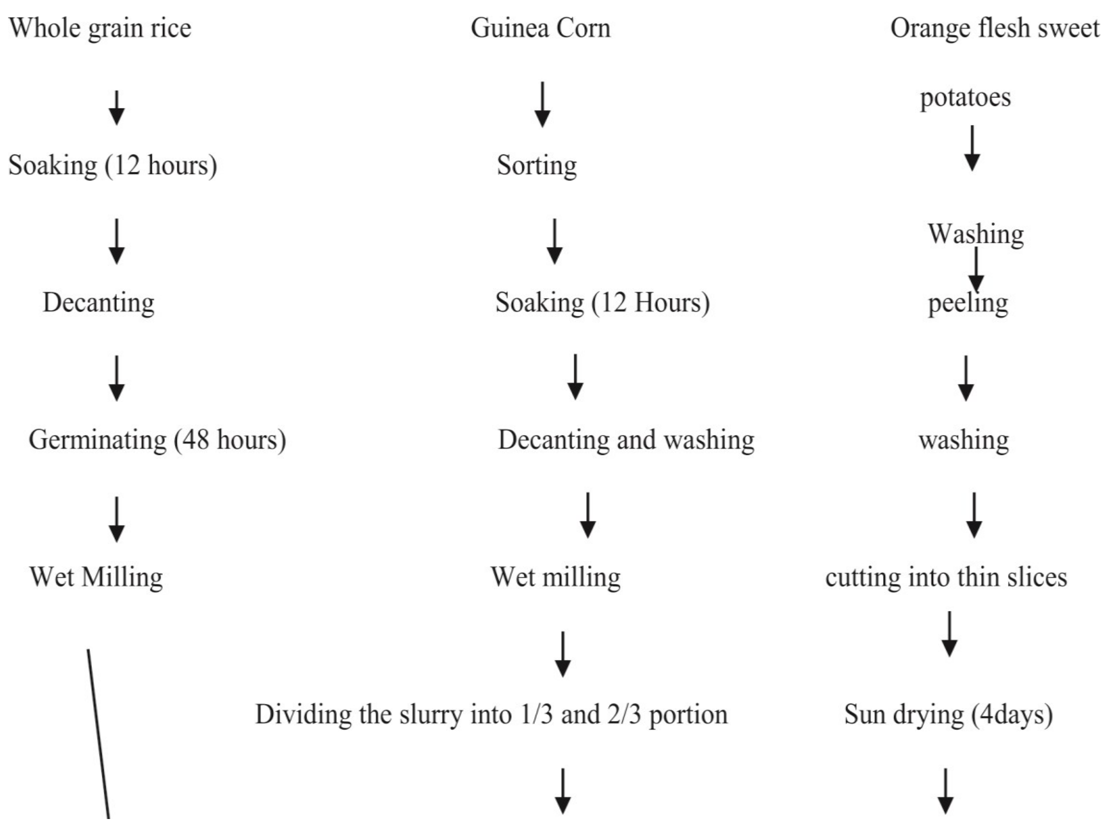
Methodology

Source of materials: Guinea corn, Orange flesh sweet potato (OFSP), and whole grain rice were locally purchase from the central market in Bida.

Preparation of Raw Materials (OFSP, and **whole grain germinated rice):** The OFSP were washed to remove any dirt, peeled, and cut into small slices and sun-dried. The whole grain rice was soaked for 12hrs after which it was decanted and put in an airtight container for it to germinate for 48hrs.It was then milled using wet milling method into a paste.

Preparation of Kunu Zaki

The sourced guinea corn was soaked for 12 hours, and then the water was drained and washed properly to remove sand and other debris. The dry potato was pounded and mixed together with germinated rice. The guinea corn, the mixed potato and the germinated rice were taken to the milling machine. The guinea corn was milled separately while the potato and the rice were milled together. The water was boiled to 100^{o}C then the guinea corn was made into a paste (not too thick) and lumps were avoided. The boiled water was poured into the paste and stirred. The milled potato and germinated rice were poured into the already prepared guinea corn and stirred. It was allowed to cool for 6 hours, then sieved and packaged for analysis.



E-ISSN 3026-8575 P-ISSN 3027-1266

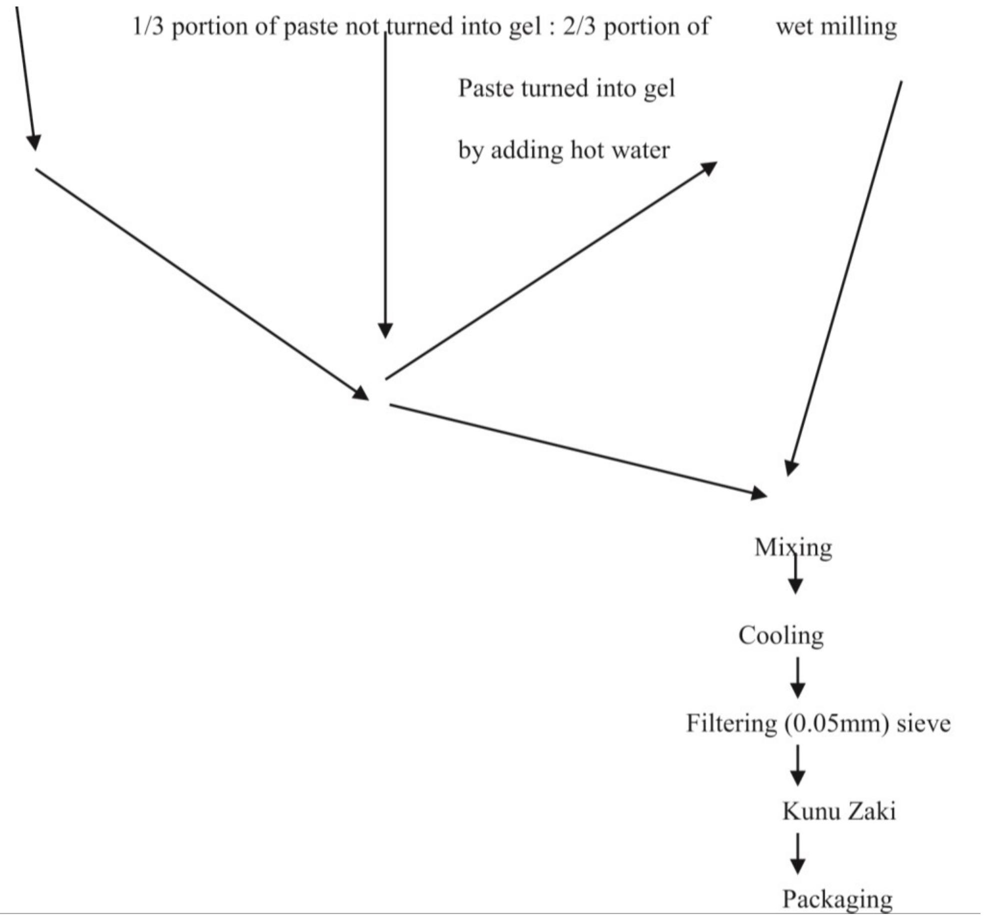


Fig 1: Flowcharts for preparation of kunu zaki

Sample Analysis

Physical properties of kunuzaki samples:

The physical attributes such as titratable acidity, pH, total solids, soluble solids, specific gravity, relative density and viscosity were carried out using the AOAC 2016. All laboratory analysis were carried out at the National Cereal Research Institute (NCRI), Bida-Baddegi road, Niger State.

Sensory evaluation analysis

Sensory analysis is a systematic process that evaluates the sensory attributes of food products, such as taste, texture, appearance, and aroma, which are critical in determining consumer acceptance using a 9 point hedonic scale where 1=dislike extremely, 2=dislike very much, 3=dislike moderately, 4=dislike slightly, 5=neither like nor dislike, 6=like slightly, 7=like moderately, 8=like very much and 9=like

E-ISSN 3026-8575 P-ISSN 3027-1266

extremely. This evaluation was done by 15 member panelists to identify and describe specific sensory attributes of the kunuzaki samples.

Statistical Analysis

Data from nutrient analysis and sensory evaluation are analyzed using appropriate statistical methods, including analysis of variance (ANOVA) and t-tests, to determine significant differences between the modified and traditional KunuZaki.

Table 1: Formulation of Blends

Samples	Guinea Corn	Orange Flesh Sweet Potato (OFSP)	Germinated Whole Grain Rice
A	100%	-	-
B	40%	35%	25%
C	35%	35%	30%

Keys:

Sample A: 100% Guinea Corn

Sample B: 40% Guinea Corn, 35% Orange Flesh Sweet Potato, 25% Germinated Whole Grain Rice

Sample C: 35% Guinea Corn, 35% Orange Flesh Sweet Potato, 30% Germinated Whole Grain Rice

Results and Discussion

The table 2 below shows the physical properties of the various kunu samples based on the formulation ratio. For sample A, pH was 5.42 $\pm$ 0.00, titratable acidity was 0.29 $\pm$ 0.00, total solid was 9.66 $\pm$ 0.48, soluble solid was 5.50 $\pm$ 0.71, specific gravity was 1.04 $\pm$ 0.01, relative density was 1.27 $\pm$ 0.33, and viscosity was 23.00 $\pm$ 0.00. For sample B, pH was 5.78 $\pm$ 0.00, titratable acidity was 0.20 $\pm$0.00, total solid was 11.43 $\pm$ 0.00, soluble solid was 8.50 $\pm$ 0.71, specific gravity was 1.05 $\pm$ 0.00, relative density was 1.06 $\pm$ 0.02, viscosity was 24.00 $\pm$ 0.00. For sample C the pH was 5.79 $\pm$ 0.00, titratable acidity was 0.21 $\pm$ 0.00, total solid was 13.54 $\pm$ 0.00, soluble solid was 10.50 $\pm$ 0.71, specific gravity was 1.06 $\pm$ 0.01, relative density was 1.48 $\pm$ 0.42 and viscosity was 25.00 $\pm$ 0.00. pH is a measure of the acidity or alkalinity of a food product and it affects the texture, flavor, and microbial growth of food products (Kumar et al.,2015).The pH of the samples increased with the addition of OFSP, this increase may be attributed to variations in ingredient composition or the processing conditions as opined by Kumar *et al.,* (2015). However, similar pH values were reported by Oyewole *et al.* (2017) for Kunu samples. For titratable acidity which is a measure of the total amount of acid present in a liquid food product (Weaver *et al.,*

E-ISSN 3026-8575 P-ISSN 3027-1266

2016; Ashurst 2016) has been reported to affect the flavor, texture/consistency, and shelf life of food products. The titrable acidity decreased, the decreased titrable acidity may be attributed to the addition of alkaline ingredients (Weaver *et al.,* 2013). Similar, titrable acidity values were reported by Adeyeye *et al.* (2017) for Kunu Zaki samples. The total solids is the amount of solid matter present in a food product (Kumar *et al.,* 2015). It affects the texture, consistency, and shelf life of food products. The total solids content of the samples varied across the samples, the increase may be attributed to the addition of solid ingredients as reported by Kumar *et al.,* (2015). The findings observed was consistent with the report of Afolabi *et al.* (2018) on a similar study. Soluble solids which is the amount of dissolved solids present in a food product has been reported to affect the texture, flavor, and consistency of food products (Weaver *et al.,* 2016). The increase in the soluble solids content of the samples may be attributed to the addition of soluble ingredients like germinated grains and OFSP as opined by Iwe *et al.* (2013) and Weaver *et al.,* (2016). Specific gravity affects the texture, consistency, and stability of food products (Kumar *et al.,* 2015).The increase in the specific gravity observed in this study may be attributed to the addition of malted grains and OFSP (Kumar *et al.,* 2015). A similar trend was reported by Oyewole *et al.* (2017) for Kunu samples. Relative density affects the texture, consistency, and stability of food products. However, the decreased relative density significantly across the samples, this may be attributed to the processing technique which could have impacted on the complex carbohydrate content in the beverage, this is consistent with the findings of Adeyeye *et al.* (2016) in a similar study. The viscosity increased significantly across the samples, the increase may be due to the fermentation, processing method, enzymatic and microbial activity and combination of both GRGs and OFSP used in the current study, thus leading to production of extracellular polymers and polysaccharides (Sengev *et al.* 2012; Kumar *et al.* 2015; Okechukwu *et al.* 2021).

Table 2: Physical properties of Kunu zaki samples

Samples	pH	Titratable acidity	Total Solid	Soluble solid	Specific gravity	Relative density	Viscosity
A	5.42 ± 0.00^{a}	0.29 ± 0.00^{b}	9.66 ± 0.48^{a}	5.50 ± 0.71^{a}	1.04 ± 0.01^{a}	1.27 ± 0.33^{c}	23.00 ± 0.00^{a}
B	5.78 ± 0.00^{b}	0.20 ± 0.00^{a}	11.43 ± 0.00^{b}	8.50 ± 0.71^{b}	1.05 ± 0.00^{a}	1.06 ± 0.02^{a}	24.00 ± 0.00^{b}
C	5.79 ± 0.00^{b}	0.21 ± 0.00^{a}	13.54 ± 0.00^{c}	10.50 ± 0.71^{c}	1.06 ± 0.01^{b}	1.48 ± 0.42^{b}	25.00 ± 0.00^{c}

Values are mean ±SD (Standard Deviation). Mean values with the same letters along the column are not significantly different (P-value $\geq$ 0.05) using Duncan multiple comparison test.

E-ISSN 3026-8575 P-ISSN 3027-1266

Keys:
Sample A: 100% Guinea Corn
Sample B: 40% Guinea Corn, 35% Orange Flesh Sweet Potato, 25% Germinated Whole Grain Rice
Sample C: 35% Guinea Corn, 35% Orange Flesh Sweet Potato, 30% Germinated Whole Grain Rice

The table 3 below shows the organoleptic parameters of the various samples. For samples A, taste mean score was $8.27^a \pm 1.33$, appearance was $8.40^a \pm 1.12$, consistency was $8.60^a \pm 1.24$, and the overall acceptability was $8.60^a \pm 1.24$. For sample B, taste was $8.60^a \pm 1.06$, appearance was $8.60^a \pm 1.06$, consistency was $8.47^a \pm 1.06$ and the overall acceptability was $8.20^a \pm 0.86$. Sample C, taste score was $9.40^a \pm 0.63$, appearance was $9.07^a \pm 1.28$, consistency was $9.07^a \pm 0.89$, the overall acceptability was $9.80^a \pm 0.78$. Taste plays a crucial role in consumer acceptance and preference for food products. The taste scores showed significant increase across the samples. The increased taste score may be attributed to the optimal balance of sweet and savory flavors impacted by the OFSP and other spieces used in the kunu preparation (Spence *et al.,* 2015). This agrees with the findings of Adeyeye *et al.* (2016) for Kunu Zaki samples in a similar study. Appearance plays a significant role in consumer acceptance and preference for food products. The appearance score increased across the samples. The increased appearance scores may be attributed to the appealing color impacted by the OFSP.
Consistency plays a crucial role in consumer acceptance and preference for food products, however, the consistency score decreased across the samples, this decrease may be as a result of the ingredients and processing techniques involved in the production of kunuzaki. The findings of this study are similar to the report of Oyewole *et al.* (2017) where consistency score decreased across the kunuzaki samples.
The overall acceptability plays a crucial role in consumer preference and purchasing decisions of the kunuzaki samples. However, the overall acceptability score decreased across the samples. The decrease may be attributed to the combination of lower scores in taste, appearance, and consistency scores. A similar value was reported by Afolabi *et al.* (2018). However, Sample B was the most accepted in terms of all sensory parameters because it had a higher score compared with Samples A and C.

Table 3: Organoleptic Parameters of Kunu Zaki

Samples	Taste	Physical Appearance	Consistency	Overall Acceptability
A	8.27[a]±1.33	8.40[a]±1.12	8.60[a]±1.24	8.60[a]±1.24
B	8.60[a]±1.06	8.60[a]±1.06	8.47[a]±1.06	2.20[a]±0.86
C	9.40[a]±0.63	8.07[a]±1.28	8.07[a]±0.89	9.80[a]±0.78

Values are mean ±SD (Standard Deviation). Mean values with the same letters along the column are not significantly different (P-value ≥ 0.05) using Duncan multiple comparison test.

KEYS:

Sample A: 100% Guinea Corn

Sample B: 40% Guinea Corn, 35% Orange Flesh Sweet Potato, 25% Germinated Whole Grain Rice

Sample C: 35% Guinea Corn, 35% Orange Flesh Sweet Potato, 30% Germinated Whole Grain Rice

Conclusion and recommendation

The result for the physical properties of the samples showed that sample C had the highest scores for all the assessed physical parameters, similarly, the sensory evaluation parameter: taste, appearance, consistency and overall acceptability of ($P<0.05$) increased across the samples. Kunu Zaki produced from 40% Guinea Corn, 35% Orange Flesh Sweet Potato, 25% Germinated Whole Grain Rice which is sample B had a better appearance (8.60) compared to others while sample C (Kunu Zaki produced from 35% Guinea Corn, 35% Orange Flesh Sweet Potato, 30% Germinated Whole Grain Rice) had a better taste (9.40) than others. Based on the findings of this study, the following recommendation were made:

- The sample C, Kunu Zaki (35% Guinea Corn, 35% Orange Flesh Sweet Potato, 30% Germinated Whole Grain Rice) is recommended for consumption and commercialization because it scored the highest value in both physical and sensory properties essential for quality and shelf stability**.** However,
- Futher studies should explore the shelf stability of the kunu samples
- The probiotic content of the samples
- The bio digestibility properties of the kunu samples.

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