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Production and sensory evaluation of *Kunun-zaki* sweetened with orange fleshed sweet potato (*Ipomoea batatas*) syrup

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ABSTRACT

Vitamin A deficiency is a public health problem in Nigeria, hitting the people in the savannah zones the hardest. This has accounted for child mortality and blindness. Therefore, there is a need to develop vitamin A rich food that is affordable and appealing to consumers. Orange-Fleshed Sweet Potato (OFSP) (*Ipomoea batatas*) is a variety of sweet potato now emerging as an important root crop with the possibility of tackling the problem of vitamin A deficiency. In this study, the physicochemical properties and sensory quality of *Kunun-zaki*, a non-alcoholic beverage sweetened with OFSP syrup, was compared to the same beverage sweetened with sugar and sugar syrup (100 mL/10 g of sweetener). The result of the physicochemical properties showed that the *kunun-zaki* samples were not significantly different in their pH and total titratable acidity; with values ranging from 3.93 to 4.0 and from 0.18 to 0.20 g/100 mL, respectively. The *kunun-zaki* samples were however significantly different in their ^{o}brix content. The OFSP sweetened sample recorded the highest ^{o}brix value of 15.20^{o}, followed by the sugar sweetened *kunun-zaki* sample (13.30^{o}) and the sugar syrup sweetened *kunun-zaki* (11.63^{o}). The result of the sensory analysis showed that the sample sweetened with OFSP syrup had the best sensory attributes. The OFSP sweetened sample also had the best evaluated sensory attributes (colour, flavour, texture, and overall acceptability). The result of this study showed that *Kunun-zaki* sweetened with OFSP syrup was highly acceptable and could therefore serve as a dietary means of alleviating vitamin A deficiency, especially in the northern part of Nigeria where the local beverage is mostly consumed.

Introduction

Kunun-zaki is a Hausa word meaning sweet beverage (Sengev et al., 2010). It is a traditional cereal based non-alcoholic fermented beverage, mostly consumed 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 (Amusa and Ashaye, 2009) and the high cost of other non-alcoholic drinks, which makes them unaffordable to the commoners. It is usually produced from millet (*Pennisetum glaucum*), sorghum (*Sorghum bicolor*), and maize (*Zea mays*). It is of low viscosity, has a sweet-sour taste and a milky cream appearance (Adeyemi and Umar, 1994). *Kunun-zaki* plays a vital role in the dietary pattern of the people in developing countries like Nigeria (Adeyemi and Umar, 1994). It is acceptable to 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 (Essien et al., 2009). *Kunun-zaki*, being a cereal based beverage, it has a low nutritional content but high-water content (Fapohunda and Adeware, 2012). This calls for fortification in order to improve the dietary status of consumers. Vitamin A deficiency, which is the

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leading cause of preventable blindness (Maziya-Dixon et al., 2006), is a serious public health issue in most developing countries. It is known to contribute towards over 0.6 million deaths per annum (Odongo et al., 2015). Young children and pregnant women are affected the most (Akhtar et al., 2013). Globally, 190 million preschool children and 19 million pregnant women are at risk of vitamin A deficiency (WHO, 2009). The dietary approach employed by the Government and the nutritional agencies in Nigeria includes mandatory fortification of some household foods such as sugar, salt, flour, and vegetable oil with Vitamin A. The intake of this vitamin through other sources is quite low due to socioeconomic reasons. According to Bovell-Benjamin (2007) and Irakiza et al. (2014), Orange-Fleshed Sweet Potato (OFSP) contains a high concentration of trans-β-carotene and exhibits high pro-vitamin A activity. OFSP is an underutilized bio-fortified crop that has great potential to be used in food-based intervention programs for addressing vitamin A deficiency (Kurabachew, 2015). It could serve as a good vitamin A supplement for cereal based beverages such as *Kunun-zaki*. On average, OFSP contains 3000-16000 μg/100 g of β-carotene and could contribute 250 to 1300 Retinol Activity Equivalent (RAE) (Gurmu et al., 2014). It is also an excellent source of energy.

Nutritional quality of food is a key element in maintaining good health, as nutritional well-being is a sustainable force for health and development. Enhancing the nutritional value of *Kunun-zaki* (a beverage largely consumed by low income Nigerians) could help in solving the challenge of vitamin-calorie malnutrition in developing countries. Hence, this study is aimed at evaluating some of the quality attributes of *Kunun-zaki* sweetened with sugar, sugar syrup, and OFSP syrup, and also at assessing the consumer acceptability of the *Kunun-zaki* samples.

Materials and methods

Materials

Fresh samples of OFSP were obtained from the Adeoye farm in Agbamu in Irepodun Local Government of Kwara state. Other raw materials and ingredients, such as millet, sweet potato (white fleshed), clove, ginger, and sugar, used in the production of *Kunun-zaki* were purchased from a local market in Ilorin, Kwara state. A known sugar syrup product (Huletts golden syrup) was also purchased from Shoprite, Fate area, Ilorin, Kwara state.

Preparation of the OFSP syrup

The method of sweet potato syrup production described by Irakiza et al. (2014) was used with little modification. OFSP roots (500 g) were washed, peeled, and sliced into smaller pieces (2 mm). The slices of OFSP were crushed using a domestic kitchen blender (China Kenwood BL330) to extract the juice. Previously boiled water (1 litre) was added to the extracted juice and filtered using a muslin cloth. The obtained extract (750 ml of OFSP juice) was mixed with 400 g of sugar and heated at 60-62 ^{o}C for 60 minutes. The produced OFSP syrup was packaged in sterilized jars and hot water sterilization was used afterwards for the packaged syrup before storing for later use.

Production of Kunun-zaki

The methods described by Akoma et al. (2014) and Obadina et al. (2008) were modified for *Kunun-zaki* production. The millet grains (500g) were screened manually by winnowing to remove foreign matter. The grains were steeped in 1000 ml of warm water (1:2 w/v) for 8 hours, after which 50 g of spices (ginger 40 g, clove 10 g) and 100 g of sweet potato were added. These were properly rinsed and wet milled using locally a fabricated hammer mill. The resulting slurry was then sieved with muslin cloth and divided into two equal portions. A portion was cooked by adding boiling water and allowed to cool to about 50 ^{o}C, while the other portion was added to the cooled gelatinized starch and then mixed thoroughly. The mixture was allowed to ferment (anaerobic) for 8 hours and then sieved. The *Kunun-zaki* was measured (100 mL) into three different containers. 10 g of each of the sweeteners (sugar, OFSP syrup, and sugar syrup - Huletts golden syrup) was added into each container and the code numbers A, A1, A2, respectively were assigned to each one. The sample containing sugar served as the control.

Physicochemical Analysis

The pH was determined at 25 ^{o}C using a pH meter (model HI 9812-5, Hanna Instructions, Europe). The pH meter was calibrated with pH 4, 7, and 10 buffers prior to usage. The pH of the *Kunun-zaki* sample was determined by placing the probe in 10 ml of the *Kunun-zaki* drink. Total soluble solids content of the solution was determined by the index of refraction. This is measured using a refractometer, and is referred to as the degree of ^{o}brix. The total soluble solids of the *Kunun-zaki*

samples was determined using a digital refractometer (Model 13751LO, Reichert technologies, (USA). Titratable acidity was determined by titrating 10 ml of each sample against standard alkali (0.1 NaOH) to a phenolphthalein end point, and the titre value was recorded. The following formula was used to calculate the total titratable acidity expressed as "lactic acid".

$$Titratable\ acidity = \frac{value\ x\ 100}{vol\ of\ sample} \quad (1)$$

Sensory evaluation

The sensory profile of *Kunun-zaki* was evaluated by 20 semi-trained panellists, using simplified quantitative descriptive analysis (Meilgaard et al., 2007; Tomlins et al., 2012). The panel consisted of students of the University of Ilorin who were screened for familiarity with the product. Sessions were conducted at the University of Ilorin and language used for the sensory testing was English.
Panel training sessions were performed in order to familiarize the assessors with the vocabulary of sensory attributes (descriptors) and the products under investigation. The sensory attributes generated and their definitions are shown in Appendix 1. The attributes were quantified with an intensity scale from 1 to 5; where 1 = not at all and 5= very strong. Evaluations were then conducted on coded *Kunun-zaki* samples in a randomized order.

Statistical analysis

The results are given as (mean + standard deviation) of at least three independent determinations. One-way Analysis of Variance (ANOVA) was used to compare the means, while the means were separated using the Duncan's multiple range test on Statistical Package for Social Sciences (SPSS) version 16.0.

Results and discussion

The results of the pH values, brix^o, and titratable acidity (TTA) of the *Kunun-zaki* samples are shown in Table 1. The pH mean values for the *Kunun-zaki* samples ranged from 3.93 to 4.00. The pH values of the *Kunun-zaki* samples were not significantly different ($p<0.05$). This result is comparable with the report of Akoma *et al*., (2014) for *Kunun-zaki* sold within Bida metropolis (3.25 to 4.20). The acidity of the *Kunun-zaki* beverage has been noted to be as a result of lactic acid production by some bacteria on the carbohydrate and other food nutrients during fermentation (Ashiru et al., 2003) and thus, the taste of the drink becomes sour and it becomes organoleptically unacceptable with time. Brix values of the *Kunun-zaki* samples (A, A1, and A2) were 13.3^o, 15.20^o, and 11.63^o respectively, differing significantly ($p<0.05$) from one another. The sample sweetened with OFSP syrup (A1) had the highest brix value of 15.20, followed by the sample sweetened with sugar (A) with the value of 13.3, and the sample sweetened with sugar syrup (A2) having the lowest value of 11.63^o. The high degree brix values obtained for sample A and A1 as compared to sample A2 is an indication of a higher level of soluble solids.
The mean values of Titratable Acidity (TTA) of the *Kunun-zaki* samples were not significantly different ($p>0.05$) and ranged from 0.18 to 0.20g/100ml. This is comparable to that obtained by previous researchers, with the value range of 0.05 - 0.46 g/100 ml (Obadina et al., 2008; Adelekan et al., 2013; Bede et al., 2015). A low TTA value might arise as a result of mild fermentation, which could have caused poor production of lactic acid. This invariably led to higher pH values (Bede et al., 2015).
Table 1 gives the result for the descriptive sensory evaluation and it is presented in Figure 1. The samples were evaluated in terms of colour (brown, light brown, and cream), taste (bitter, sweet, sour, and peppery), texture (gritty, lumpy, and smooth), consistency (thick and watery) and overall acceptability.
The average score recorded by the panellists indicated a low to moderate "light brown" colour in all the samples. The samples were not significantly different ($p<0.05$) in their colour attribute. This result agrees with that reported by Ikpoh et al. (2013) for the colour of *Kunun-zaki*, which ranges from a milky-light brown colour when made from sorghum and millet to a whitish colour when made from maize. The colour of *kunun-zaki* is generally determined by the colour of the main grain used for its production. Food colour is considered to be the most important sensory parameter that governs consumer choice concerning the foods and drinks that they search for, purchase, and subsequently consume (Spence, 2015).

Sensory Evaluation

All samples were described to be moderately sweet and also found to be slightly peppery with no significant difference among the samples ($P<0.05$). The peppery taste and flavour could be the result of the added spices. This taste is quite desirable by *Kunun-zaki* consumers.
Food texture could include those properties of a food that are sensed by touch in the mouth and/or with the hands. The texture of the *Kunun-zaki* samples was generally described as smooth by the sensory panellists.

Table 1. Physiochemical properties of *Kunun-zaki*

Samples	pH	Soluble solids (^{o}brix)	TTA (g/ml)
A	4.0a±0.10	13.3b±0.20	0.2a± 0.02
A1	3.93a±0.06	15.20a±0.17	0.18a±0.02
A2	3.96a±0.06	11.63c±0.12	0.20a±0.01

Values are mean±SD of triplicates. Mean values with different superscripts along a column are statistically different (p< 0.05). Key: A: Control (sweetened with sugar); A1: Kununzaki sweetened with OFSP syrup; A2: Kununzaki sweetened with Sugar syrup. TTA: Total titratable acidity

Table 2. Sensory Attributes of Kunun-zaki samples

	Colour			**Flavour**				**Texture**			**Consis tency**		**OA**
	Brown	**Light brown**	**Cream**	**Bitter**	**Sweet**	**Sour**	**Peppery**	**Gritty**	**Lumpy**	**Smooth**	**Thick**	**Watery**	
A	1.08^{a}±0.29	2.62^{a}±1.25	1.38^{a}±0.88	1.17^{a}±0.39	3.13^{a}±1.28	1.08^{a}±0.29	2.22^{a}±1.25	1.67^{a}±1.07	1.0^{a}±0.00	3.20^{a}±0.94	3.29^{a}±0.75	1.08^{b}±0.29	3.90^{a}±0.74
A1	1.50^{a}±0.29	2.38^{a}±1.36	1.33^{a}±0.78	1.08^{a}±0.29	3.60^{a}±1.21	1.04^{a}±0.14	2.14^{a}±1.15	1.00^{b}±0.00	1.0^{a}±0.00	2.75^{a}±1.12	2.98^{a}±1.26	1.17^{b}±0.39	3.91^{a}±0.76
A2	1.38^{a}±1.00	1.96^{a}±1.19	1.70^{a}±1.25	1.08^{a}±0.29	2.67^{a}±0.88	1.08^{a}±0.29	2.08^{a}±1.44	1.00^{b}±0.00	1.0^{a}±0.00	2.42^{a}±0.76	1.50^{b}±0.70	1.71^{a}±0.73	2.88^{b}±0.76

Key: A: Control (sweetened with sugar); A1: *Kununzaki* sweetened with OFSP syrup; A2: *Kununzaki* sweetened with Sugar syrup; OA: Overall Acceptability

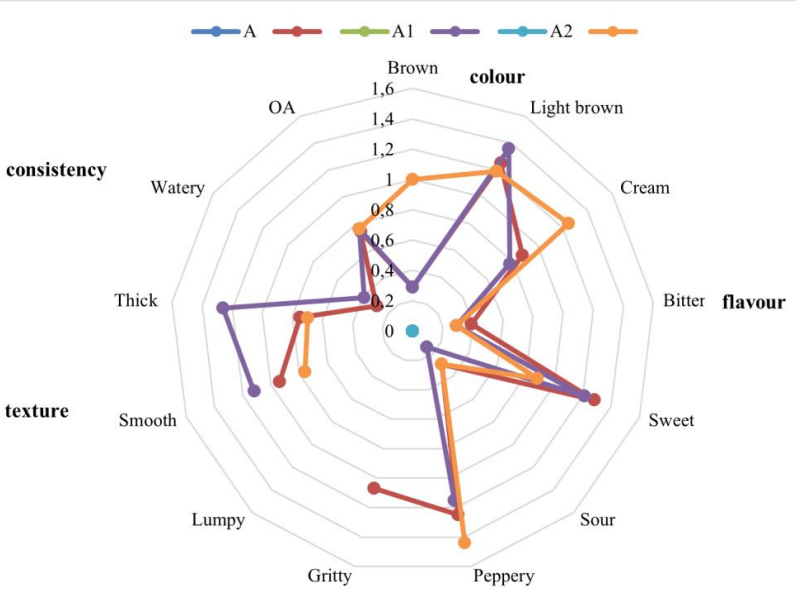

Fig. 1. Sensory Attributes of Kunun-zaki samples. Key: A: Control (sweetened with sugar); A1: *Kununzaki* sweetened with OFSP syrup; A2: *Kununzaki* sweetened with Sugar syrup; OA: Overall Acceptability

Average scores for the attributes "watery" are 1.08, 1.17, and 1.71 for sample A (sweetened with sugar), A1 (sweetened with OFSP syrup), and A2 (sweetened with sugar syrup), respectively. The values were significantly different (p<0.05). For the attribute "thick", the mean scores were 3.29, 2.98, 1.50 respectively for sample A (sweetened with sugar), A1 (sweetened with OFSP syrup), and A2 (sweetened with sugar syrup) respectively. The values were significantly different (p<0.05). This indicates that samples A and A1 were thicker than sample A2. The thicker *Kunun-zaki* samples were generally preferable by the consumers because they are more filling and therefore may delay hunger.

The samples sweetened with the OFSP syrup had the highest overall acceptability score. This result shows that *Kunun-zaki* sweetened with the OFSP syrup and the sample containing sugar recorded significant acceptance.

Conclusion and recommendation

This study has revealed that the OFSP syrup can be successfully used as a sweetener and/or sugar substitute in the production of *Kunun-zaki* with improved organoleptic properties and acceptability. The incorporation of the OFSP syrup in the development of confectioneries, beverages, bakery, and pastry products both at the domestic and industrial levels is therefore

encouraged. This would increase the consumption and utilization of OFSP and could simultaneously decrease vitamin A deficiency. Further research on its potential incorporation and chemical indications on other products is also recommended.

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Appendix 1. Sensory attributes generated for colour, taste, texture, consistency and overall acceptability of *Kunun-zaki* (Akissoé et al., 2015)

Sensory attribute	**Definition**
Brown colour	Brown colour of wood or coffee
Light brown colour	Slightly brown
Cream colour	Colour similar to cream
Bitter	Chemical-like, the taste for which coffee is a typical example
Sweet (sugary)	A taste sensation that is related to sugar
Sour	A taste sensation that is acidic and sharp, relating to lime
Peppery	Taste of pepper or spices, producing a burning hot sensation at the sides of the tongue
Smooth	A textural characteristic of a clean mouth feel
Gritty	Presence of small grainy or sandy particles
Lumpy	Uneven mouth feel with tiny chunks
Watery	A consistency similar to that of water
Thick	A viscous consistency
Overall acceptability	General acceptability of the product