Nigerian Food Journal
Official Journal of Nigerian Institute of Food Science and Techonology www.nifst.org

NIFOJ Vol. 30 No. 2, pages 8 – 16, 2012

Physicochemical and Sensory Properties of Instant *Kunun-Zaki* Flour Blends from Sorghum and Mango Mesocarp Flours

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ABSTRACT

Instant *Kunun-zaki,* a fermented non-alcoholic sorghum beverage, was prepared by mixing different per cent blend ratios of unmalted sorghum flour: mango mesocarp flour (90:0, 75:15, 70:20, 65:25, and 60:30) with 10% malted sorghum. Proximate compositions, chemical and functional properties of the blends were analyzed. Addition of mango mesocarp flour significantly ($p \leq 0.05$) increased the ash (1.31 to 1.75%), crude fibre (2.57 to 3.39%) and decreased significantly ($p < 0.05$) the energy content (368.21 to 354.67kcal/100 g) of the blends. The β-carotene content also increased from 95.65 to 139.13 μg/100 g with increased mango mesocarp flour. Hygroscopicity increased significantly ($p < 0.05$) from 6.10 to 10.28% while viscosity of the blends decreased significantly ($p < 0.05$) from 1715 to 1195.46 cP. Mango mesocarp flour addition increased the ash, crude fibre and introduced β-carotene into the product.

Keywords: *Kunun-zaki*, physicochemical, beta-carotene, sensory properties, mango.

Introduction

Kunun-zaki is a traditionally fermented non-alcoholic beverage mostly consumed in Northern Nigeria. It can be produced either from millet *(Pennisetum typhoideum)*, sorghum *(Sorghum bicolor)*, or maize (*Zea mays*). *Kunun-zaki* is a Hausa word meaning sweet beverage. Although several types of *kunu* exist, few have been reported in literature: *kunun-zaki*, *kunun-tsamiya* (Inatimi *et al*., 1988), *kunun-gyada* (Nkama *et al*., 1995) and *kunun-akamu* (Oyeyiola, 1991).Others include *Kunun baule*, *Kunun jiko*, *Amshau* and *Kunun gayamba* (Amusha and Ashaye, 2009). *Kunun-zaki* is the most preferred among the *kunu* types reported in the literature (Gaffa *et al*., 2002a). Although production of *kunun-zaki* is on small scale level, the beverage is widely sold in the local markets and at resorts. Gaffa *et al.* (2002a) reported that 73% of the population in Nigeria consumes *kunun-zaki* daily and 26% occasionally. The product costs less compared to conventional carbonated beverages but the products are not usually properly packaged. The product is offered in cups, transparent polyethylene sachets, plastic and glass containers for retail sale. Consumption is all year round with peak production in the hot season (February – July) when the beverage is served preferably chilled. The production process of *kunun-zaki* is done with local household utensils with processes varying between individuals, household and localities (Adeyemi and Umar, 1994; Sopade and Kassum, 1992). Akpapunam *et al.* (1999) investigated the production practices and product quality of *kunu*. The nutrient content and microbiological properties of *kunun-zaki* have been reported (Gaffa *et al*., 2002b). Sengev *et al.* (2010) reported that supplementation of instant *kunun-zaki* with mango mesocarp flour improved its sensory attributes.

Kunun-zaki with its wide acceptance could be deficient in provitamin A due to the deficiency of

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this vitamin in the grains which form the major raw material for its production. This problem is most prevalent in developing countries particularly in the rural areas. World Health Organization (WHO) estimated that VAD existed in 61 countries and was likely to become a problem in at least 13 additional countries (WHO, 1995). Furthermore, according to the same report, at least 245 million children at preschool age were at risk in terms of their health and survival. In Nigeria, VAD affected 9.2 to 17% of children and 7.2 to 15% of mothers (UNICEF/FGN, 1994). Vitamin A deficiency (VAD) is more prevalent in the northern part than the southern part of Nigeria. Sorghum supplemented with vitamin (provitamin A) would reduce vitamin A deficiency. Therefore, the objective of this study was to produce instant *Kunun-zaki* flour blends as a carrier of provitamin A with improved nutrient content and consumer acceptability.

Materials and Methods

Sample procurement

Sorghum grains (*Sorghum bicolor*, [L] Moench) and semi-ripe mango fruits (*Mangifera indica*) were purchased as offered for sale in Makurdi metropolis of Benue State, Nigeria.

Preparation of mango mesocarp flour

About 25 kg of moderately-ripe mango fruits, *Mangifera indica* (Local variety) were sorted, washed, peeled and the mesocarp manually sliced (1.50 – 2.50 mm thick). The slices of mango mesocarp were spread on a tray covered with low density polyethylene to avoid non-enzymic browning as a result of direct contact of the slides with the metal tray and oven-dried at 601^{o}C for 24 h to a moisture content of 8.95%. It was then milled after cooling, using a disc attrition mill and sieved through a 212 μm sieve to obtain mango mesocarp flour.

Preparation of malted sorghum flour

Two kilograms of sorghum grains were sorted, washed and steeped in tap water (1:3, w/v) for 16 h at 311^{o}C. The water was changed after every 6 h interval to avoid fermentation. The grains were drained and spread about 1cm thick on a tray and covered with sterilized jute bag. It was moistened and allowed to sprout for 72 h. The sprouted grains were washed and oven-dried at 601^{o}C for 12 h and cleaned to remove the vegetative parts (rootlets and shoots). The grains were milled using a disc attrition mill (Model: Asiko AII). The flour was sieved through a 212 μm sieve to obtain malted sorghum flour.

Preparation of unmalted sorghum flour

Two kilograms of sorghum grains were washed in tap water and dehulled, using mortar and pestle, and washed again to remove the bran. The dehulled grains were oven-dried at 601^{o}C for 12 h and thereafter milled and sieved through a 212μm sieve to obtain unmalted sorghum flour.

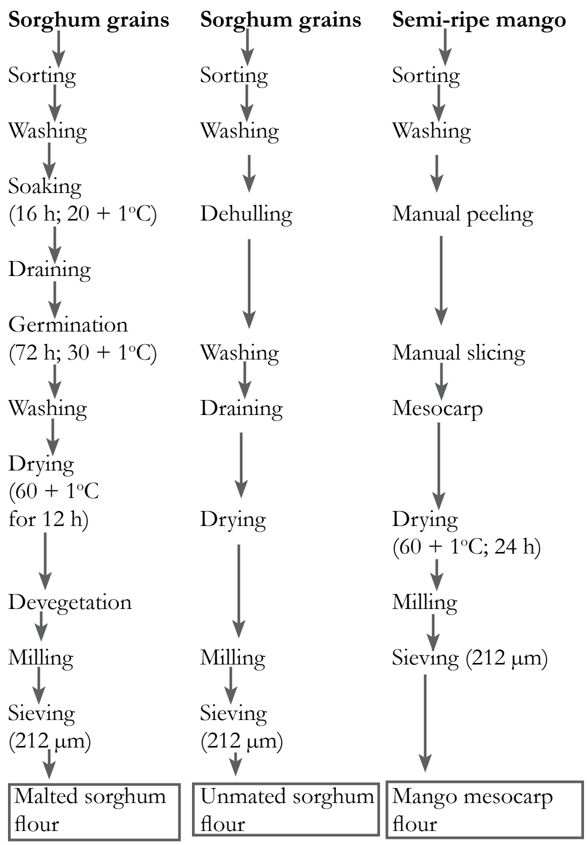

Fig. 1: Flow chart for production of malted sorghum flour, unmalted sorghum flour and mango mesocarp flour

Source: Sengev *et al.,* 2010

Formulation of composite flour for instant kunun-zaki production

The formulation was carried out using the method of Sengev *et al.* (2010). Malted sorghum flour (10%), unmalted sorghum flour and mango mesocarp flour of varying proportions were blended to obtain composite flour (Table 1). Sorghum flours were blended, mixed with tap water (2: 1, w/v) and allowed to ferment for 48 h at 301°C in a covered plastic bucket (3000 ml and 1.0 mm thick). Mango mesocarp flour was added in different proportions and mixed in a blender (Philips HR 1702) to produce different blends maintaining 2:1, w/v ratio of flour to water. Spices such as ginger (0.6%), cloves, (0.4%) and pepper (0.1%) were added to the blends. The blended flours were packed into cellophane bags (20 cm x 15 cm x 0.5 cm), steamed for 35 min at 100°C and oven-dried at 601°C for 12 h, milled and sieved through a 212 μm sieve to obtain composite flour (Fig. 2).

Table 1: Proportions (%) of malted, unmalted and mango mesocarp flour blend formulations for instant *Kunun-Zaki*

Blend	Proportion (%)		
	Malted sorghum flour (MSF)	**Unmalted sorghum flour (USF)**	**Mango mesocarp flour (MMF)**
A	10	90	0
B	10	75	15
C	10	70	20
D	10	65	25
E	10	60	30

Source: Sengev *et al.*, 2010

Determination of chemical composition

Moisture, fat, protein (%N x 6.25), ash and crude fibre were carried out according to standard methods described by AOAC (2000); carbohydrate was determined by difference (Ihekoronye and Ngoddy, 1985). Energy values were estimated from Atwater factors (protein x 4 + carbohydrate x 4 + fat x 9) as reported by Chinma and Gernah (2007).

Determination of functional properties

Loose and packed bulk densities were determined according to the method of Akpapunam and Makarkis (1981). Ten grams of the prepared samples were weighed into a measuring cylinder (100 ml) and the loose volume was noted for loose bulk density and then tapped for packed bulk density. Bulk density was expressed as mass per volume of the sample.

The method of Armstrong *et al.* (1979) was adapted for wettability. Wettability was estimated by measuring the wetting time (sec.) of 1g of flour sample dropped from a height of 15 cm on the surface of 200 cm^3 distilled water contained in 250 cm^3 beaker at ambient temperature (30 ± 1°C). The wetting time was regarded as the time required for all the flour to become wetted and penetrate the surface of still water.

Hygroscopicity was determined using the method described by Bhatty (1988). Five grams of the prepared samples were exposed to ambient conditions (30 ± 1°C) at average relative humidity of 75%. Hygroscopicity was expressed as the percentage weight gained by the sample after 48 h of exposure.

The viscosity of the prepared samples of the flour (20%w/v) was determined using a Brookfield viscometer (Type LV-8 viscometers UK LTD) according to the method of Regenstein and Regenstein (1984). The viscosity was determined at room temperature (30 ± 1°C) using spindle No. 2 at a speed of 12 rpm. Readings were taken after 120 sec of rotation.

Dispersibility was determined according to the method of Kulkarni *et al.* (1991). Ten grams of the flour samples were weighed into a 100 ml measuring cylinder. Distilled water was added up to 100 ml volume. The samples were vigorously stirred and allowed to settle for 3 h. The volume of settled particles was recorded and subtracted

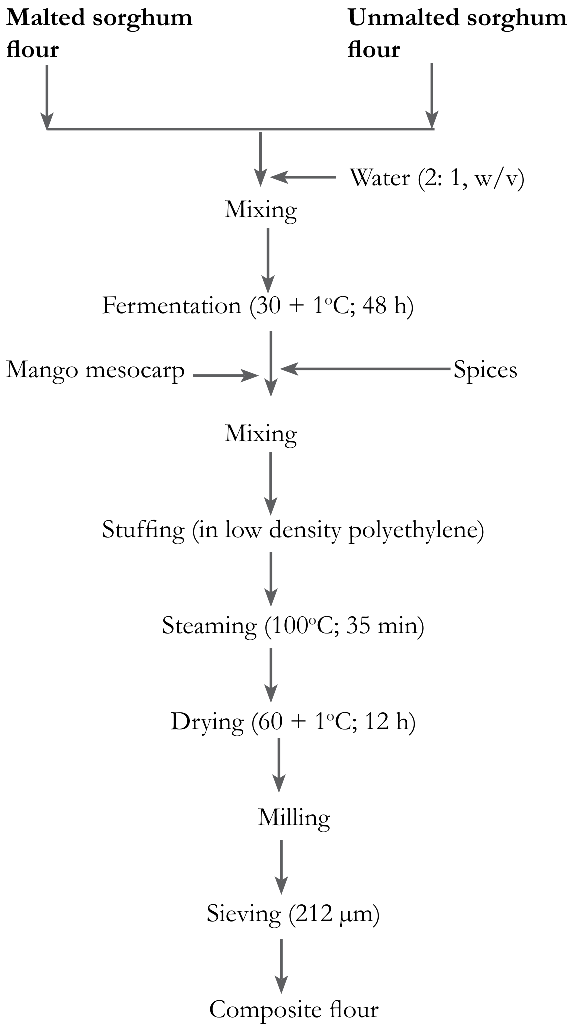

Fig. 2: Flow chart for production of composite flour from mango mesocarp and sorghum flour for instant *kunun-zaki*

Source: Sengev *et al.,* 2010

from 100 to give a difference that is taken as the percentage dispersibility.

Chemical analysis

The pH and titratable acidity of the samples were determined using the method described by Akpapunam and Sefa-Dedeh (1995). Beta-carotene (Provitamin A) was determined according to the method of AOAC (2000).

Sensory evaluation

Sensory evaluation was carried out using a 20-member semi-trained panelist including staff and students drawn from University of Agriculture Makurdi. A 9-point hedonic score system (Meilgaard *et al.*, 2007) was used with the following individual scores: 1 – Dislike extremely, 5 – neither like nor dislike and 9 – Like extremely. The sample was mixed with water in 1:10, w/v ratio, stirred, coded and presented for sensory analysis. The sensory attributes evaluated were appearance, taste, flavour and overall acceptability.

Statistical analysis

The GENSTAT statistical program (Rothamsted Experimental Station, 2007) was used for the analyses. Data were subjected to analysis of variance (ANOVA) and differences of mean were tested by the least significant difference (LSD) at $P \leq 0.05$.

Results and Discussion

Effect of mango mesocarp flour on the proximate composition and energy values of instant kunun-zaki flour blends

Results of proximate compositions (moisture, fat, protein, ash, crude fibre and carbohydrate) of blends are presented in Table 2. There was no significant ($p \geq 0.05$) difference in moisture and protein content of the blends. The low moisture content implies that the blends would have a better keeping quality. However, there was significant ($p \leq 0.05$) decrease in fat and no significant difference ($p \geq 0.05$) in carbohydrate of the blends. However, the slight variation in carbohydrate content may be due to alterations in other components (protein, fat, ash fibre and moisture) (Akpapunam *et al.*, 1996).

The ash and crude fibre content of the blends increased significantly ($p \leq 0.05$). This could be attributed to addition of mango mesocarp flour. The ash value of 4.10% for mango mesocarp flour was reported by Chinma and Gernah (2007) while Noha *et al.* (2011) reported 1.75% as the ash value for sorghum flour. Therefore, the increase in mango mesocarp flour is expected to increase the ash content of the blends. It was also reported that fruits and vegetables are good sources of vitamins, minerals and crude fibre (Ihekoronye and Ngoddy, 1985). Therefore, addition of mango mesocarp flour would increase the ash and crude fibre and reduce the fat content. The energy values of the blends decreased significantly ($p \leq 0.05$) with increase in the percentage of mango mesocarp flour; however, the product remained a good source of energy when consumed. This may be due to the reduction in the percentage of sorghum flour which is a good source of energy.

Effect of mango mesocarp flour on some functional properties of instant Kunun-zaki flour blends

The results of functional properties are presented in Table 3. The addition of mango mesocarp flour did not significantly ($p \geq 0.05$) affect the bulk density of the flour blends. However, Jha *et al.* (2002) reported similar values of both loose and packed bulk densities for instant kheer mix (a mixture of agglomerated rice and spray-dried buffalo milk). The researcher reported 0.69g/cm^3 and 0.81g/cm^3 for loose bulk density and packed bulk density respectively. Bulk density gives an indication of the relative volume of packaging material required. Generally, higher bulk density is desirable for the greater ease of dispensability and reduction of paste thickness which is an important factor in convalescent child feeding (Padmashree *et al.*, 1987).

Table 2: Effect of mango mesocarp flour on the proximate composition and energy values of instant *Kunun-zaki* flour blends

Blend	Moisture	Fat	Protein	Ash	Crude fibre	Carbohydrate	Energy value kcal/100 g)
A	8.63 ± 0.02^a	3.45 ± 0.07^a	10.77 ± 1.54^a	1.31 ± 0.14^b	2.57 ± 0.00^c	73.27 ± 0.03^a	368.21 ± 0.03^a
B	8.68 ± 0.04^a	2.42 ± 0.04^b	10.77 ± 1.54^a	1.31 ± 0.14^b	2.57 ± 0.00^c	74.45 ± 0.01^a	364.86 ± 0.02^c
C	8.73 ± 0.04^a	2.21 ± 0.00^c	9.68 ± 0.00^a	1.41 ± 0.14^b	2.57 ± 0.00^c	75.40 ± 0.04^a	361.61 ± 0.01^b
D	8.63 ± 0.04^a	2.19 ± 0.00^c	9.77 ± 1.54^a	1.53 ± 0.14ab	2.96 ± 0.00b	74.97 ± 0.00^a	358.67 ± 0.05d
E	8.83 ± 0.18^a	2.11 ± 0.03^c	9.58 ± 0.00^a	1.75 ± 0.00^a	3.39 ± 0.00^a	74.34 ± 0.03^a	354.67 ± 0.03e

Values are mean standard deviation of triplicate determinations.
Means in the same column not followed by the same superscript are significantly different ($p \geq 0.05$)
A = 10% MSF: 90% USF: 0% MMF E = 10% MSF: 60% USF: 30% MMF MSF = Malted Sorghum Flour
B = 10% MSF: 75% USF: 15% MMF D = 10% MSF: 65% USF: 25% MMF USF = Unmalted Sorghum Flour
C = 10% MSF: 70% USF: 20% MMF MMF = Mango Mesocarp Flour

Addition of mango mesocarp did not significantly ($p \geq 0.05$) affect wettability of the flour blends. Jha *et al.* (2002) reported higher values of wettability for instant kheer mix. The low values which ranged from 45 to 33 sec may be due to fermentation of sorghum flour. Fermentation was reported to decrease the wetting time of the mucuna flour (Udensi and Okoronkwo, 2006). This may also be due to difference in product composition. Generally, wettability will provide a useful indication of the degree to which the dry flour is likely to possess instant characteristics. Hygroscopicity of the flour increased with mango mesocarp flour. This may be ascribed to the presence of more hydrophilic carbohydrates or reducing sugars in the mango mesocarp flour.

The addition of mango mesocarp flour could not significantly ($p \geq 0.05$) affect the dispersibility of the blends, however, the dispersibility values of the flour blends were high, ranging from 72.14 to 73.33%. Jha *et al.* (2002) also reported high values (69.73 – 86.51%) of dispersibility for instant kheer mix.

Table 3: Effect of mango mesocarp flour on some functional properties of instant *Kunun-zaki* flour blends

Blend	Bulk density (g/cm^3)		Wettability (sec)	Hygroscopicity (%)	Dispersibility (%)	Viscosity (cP) 12rpm
	Loose	Packed				
A	0.58 ± 0.11^{a}	0.79 ± 0.02^{a}	45.00 ± 0.00^{a}	6.10 ± 0.04c	73.33 ± 0.01^{a}	1715.00 ± 0.02^{a}
B	0.59 ± 0.01^{a}	0.80 ± 0.01^{a}	42.50 ± 0.20^{b}	6.75 ± 0.01c	73.88 ± 0.20^{a}	1707.34 ± 0.10^{b}
C	0.59 ± 0.02^{a}	0.81 ± 0.02^{a}	39.50 ± 0.01c	9.11 ± 0.00^{b}	72.69 ± 0.11^{a}	1273.94 ± 0.01^{c}
D	0.57 ± 0.01^{a}	0.77 ± 0.01^{a}	35.50 ± 0.11^{d}	8.95 ± 0.05^{b}	73.37 ± 0.03^{a}	1201.71 ± 0.03^{d}
E	0.59 ± 0.00^{a}	0.82 ± 0.03^{a}	33.00 ± 0.41^{e}	10.28 ± 0.20^{a}	72.14 ± 0.01^{a}	1194.46 ± 0.02^{c}

Values are mean standard deviation of triplicate determinations.
Means in the same column not followed by the same superscript are significantly different ($p \geq 0.05$)
A = 10% MSF: 90% USF: 0% MMF E = 10% MSF: 60% USF: 30% MMF MSF = Malted Sorghum Flour
B = 10% MSF: 75% USF: 15% MMF D = 10% MSF: 65% USF: 25% MMF USF = Unmalted Sorghum Flour
C = 10% MSF: 70% USF: 20% MMF MMF = Mango Mesocarp Flour

Table 4: Effect of mango mesocarp flour on some chemical properties of instant *kunun-zaki* flour blends

Blend	pH	TTA (% lactic acid)	β-Carotene (μg/100 g)
A	4.49 ± 0.13^{a}	0.02 ± 0.00^{a}	ND
B	4.29 ± 0.01^{a}	0.02 ± 0.01^{a}	95.65 ± 0.05^{d}
C	4.40 ± 0.07^{a}	0.02 ± 0.06^{a}	110.61 ± 0.03^{c}
D	4.21 ± 0.06^{a}	0.02 ± 0.06^{a}	121.22 ± 0.02^{b}
E	4.10 ± 0.01^{a}	0.03 ± 0.06^{a}	139.13 ± 0.01^{a}

Values are mean ± standard deviation of triplicate determinations.
Means in the same column not followed by the same superscript are significantly different ($p \geq 0.05$)
A = 10% MSF: 90% USF: 0% MMF E = 10% MSF: 60% USF: 30% MMF MSF = Malted Sorghum Flour
B = 10% MSF: 75% USF: 15% MMF D = 10% MSF: 65% USF: 25% MMF USF = Unmalted Sorghum Flour
C = 10% MSF: 70% USF: 20% MMF MMF = Mango Mesocarp Flour ND = Not Detected

The viscosities of the flour blends decreased significantly ($p \leq 0.05$) as the mango mesocarp flour increased. The decrease in viscosity may be ascribed to the reduction of sorghum flour which consequently reduced the starch content of the blends. The lower viscosity indicated that the flour could be used as a weaning food and more flour concentration would be required to form a gel and improve on the nutrient density of the food (Mosha and Svanberg, 1983).

Effect of mango mesocarp flour on some chemical properties of Kunun-zaki flour blends

Results of some chemical properties of the blends are presented in Table 4. There was no significant difference ($p \geq 0.05$) among the blends in terms of TTA and pH. The low pH (acid) of the blends may be partly due to fermentation and the organic acid present in the mango mesocarp flour. The low pH is an indication that the blend would be less susceptible to microbial attack. It has been reported that fermented foods with low pH have some antimicrobial activities (Mensah *et al.*, 1991). There was no significant ($p \geq 0.05$) increase in titratable acidity (TTA) with increase in mango mesocarp flour.

Beta-carotene was not detected in control (100% sorghum flour) but increased significantly ($p \leq 0.05$) from 95.65 to 139.13 μg/100 g as the percentage of mango mesocarp flour increased. This could be attributed to the rich content of beta-carotene in mango mesocarp flour. Rodriguez-Amaya (1997, 1999a, 1999b) also reported that mango fruits are rich sources of vitamin C and provitamin A (β-carotene).

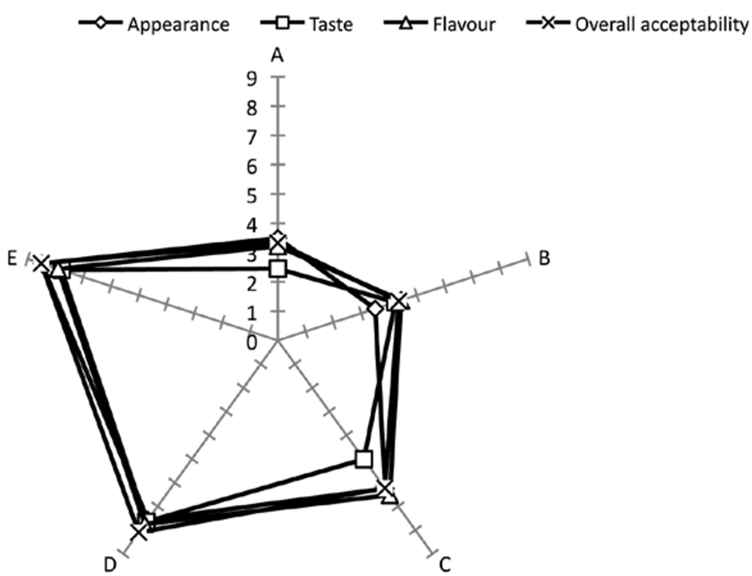

Fig. 3: Effect of mango mesocarp flour on the sensory attributes of reconstituted *kunun-zaki*

A = 10% MSF: 90% USF: 0% MMF
B = 10% MSF: 75% USF: 15% MMF
C = 10% MSF: 70% USF: 20% MMF
MSF = Malted Sorghum Flour
D = 10% MSF: 65% USF: 25% MMF
E = 10% MSF: 60% USF: 30% MM
MMF = Mango Mesocarp Flour
USF = Unmalted Sorghum Flour

Effect of mango mesocarp flour on the sensory attributes of reconstituted kunun-zaki

The mean sensory scores are presented in Figure 3. The control (Sample A) was rated low in all the attributes tested. The preference for the attributes increased significantly ($p \leq 0.05$) as the percentage of mango mesocarp flour increased. The blends with higher percentages of mango mesocarp flour were most preferred. The increase in preference for appearance may be ascribed to the impact of the yellow colour of beta-carotene present in mango mesocarp flour. This implies that incorporation of mango mesocarp flour could improve the sensory attributes of instant *kunun-zaki*. Badifu *et al.* (2005) reported that supplementing wheat bread with mango mesocarp flour improved its sensory attributes. Sengev *et al.* (2010) also reported that supplementing sorghum flour with mango mesocarp flour improved the sensory attributes of instant *kunun-zaki*. The preference for the taste and flavour of the blends increased significantly ($p \leq 0.05$) with increase in percentage of mango mesocarp flour. The increase in preference may be attributed to the sugar and flavour components of mango fruits respectively. The general acceptability followed a similar pattern with appearance, taste and flavour.

Conclusion

Mango mesocarp flour improved the beta-carotene (provitamin A) contents of instant *kunun-zaki* and also reduced the viscosity of the reconstituted flour blends. Introduction of mango mesocarp flour resulted in more acceptable instant *kunun-zaki* products. Blending mango mesocarp and sorghum flour to produce instant *kunun-zaki* is quite feasible.

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