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Processing and evaluation of instant *kunun zaki* from millet-cowpea malt and millet-soybean malt

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This study evaluated some properties of steam-heated *kunun zaki* flour and beverage produced from millet and malts of cowpea or soybean. Malting increased the diastatic activities and protein content of cowpea and soybean. The diastatic activity of the millet-cowpea malt (MC_m) or soybean malt (MS_m) increased as the solid-water ratio increased from 1:0 to 1:3. The instant blends produced from a 1:1 (w/v) slurry had crude protein contents of 203.4 (MC_m) and 317.1 g kg⁻¹ (MS_m), sugar contents of 0.6444 (MC_m) and 0.6378 g kg⁻¹ (MS_m), which were higher than millet's (M). The apparent viscosity of *kunun zaki* from MS_m was 125 cP, MC_m (121.3 cP) and millet (1605 cP). Sensory evaluation by an 80-member panel showed that *kunun zaki* from millet-soybean malt (MS_m) was most preferred. The dry instant flour products can be stored and reconstituted on demand for consumption; the reduced viscosity of the blends would encourage increased nutrient densities.

Key words: Instant *kunun*, millet, cowpea and soybean malts.

INTRODUCTION

Kunun-zaki is a non-alcoholic, non-carbonated and refreshing cereal beverage popular in Northern Nigeria and is becoming widely consumed in the South (Sowonola and Tunde-Akintunde, 2005). It serves as breakfast drink, appetizer, weaning food and is also medicinal (Akoma et al., 2006). It is made from cereals including millet (*Pennisetum typhoideum*), sorghum (*Sorghum bicolor*), maize (*Zea mays*), rice (*Oryza sativa*) and "acha" (*Digitalls exilis*). Optional ingredients include spices (ginger, red pepper, black pepper, clove and garlic), sweet potatoes and tiger nut (*Cyperus esculentus*) which may be added to enhance flavour, groundnut (*Arachis hypogea*) is added for protein enrichment while *Cadaba farinosa* crude extract is used as a thinning agent (Gaffa et al., 2002).

The traditional process for the manufacture of

kunun-zaki lasts some 24 h (Adeyemi and Umar, 1994) but has been shortened to a maximum of 12 h (Gaffa and Ayo, 2002). Traditional *kunun-zaki* is rich in carbohydrates, B-vitamins and minerals but is low in protein content which may have a negative effect on the nutritional status of infants to whom it is fed as a weaning drink. *Kunun-zaki* has a shelf life of about 24 h (Adeyemi and Umar, 1994) at ambient temperature (28±2°C). Attempts to improve the shelf life have met with some success: pasteurization in bottles followed by refrigeration storage (Osuntogun and Aboada, 2004) prolonged the shelf life to 8 days while sodium benzoate treatment followed by refrigeration improved the shelf life to 21 days (Olasupo et al., 2000). A dry, instant *kunun* powder from millet has been commercialized by Dala Foods Limited, Kano, Nigeria. These products are limited in protein content and quality to that residual from millet. Against this background, this project was designed to produce and evaluate instant *kunun zaki* from millet-cowpea malt and millet-soybean malt for enhanced

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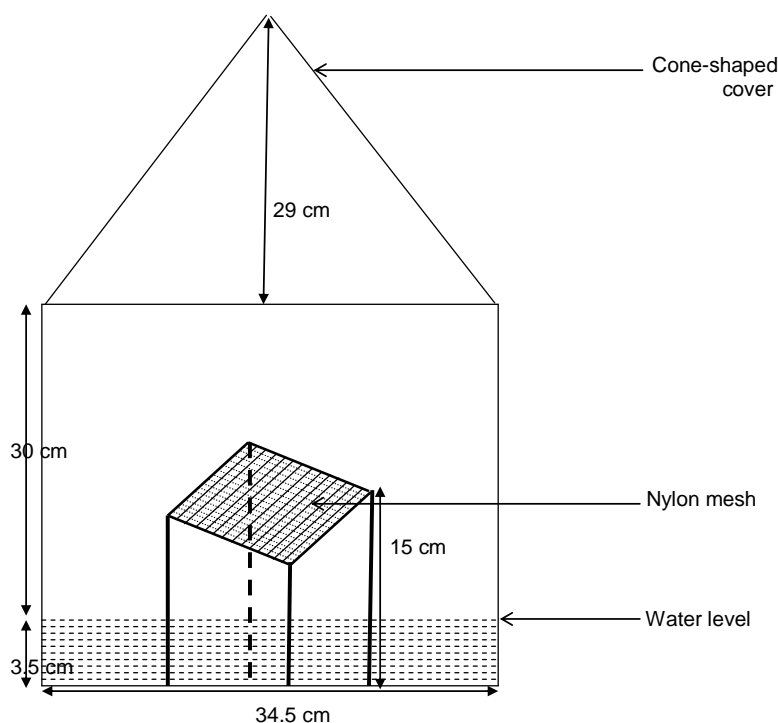


Figure 1. Steam pot for the generation of steam used to instantise the millet-cowpea malt and millet-soybean malt blends.

protein content and sensory qualities.

MATERIALS AND METHODS

Millet (*P. typhoideum*), cowpea (*Vigna unguiculata*), soybean (*Glycine max*) and ginger (*Zingiber officinale*) used for this work were purchased from Nsukka market, Enugu State, Nigeria.

Production of millet-cowpea malt and millet-soybean malt flours.

Healthy cowpea and soybean seeds (200 g each) were weighed into perforated nylon bags (25 × 45 cm) and malted by a modification of the two-step wet-steep method of EtokAkpan and Palmer (1990). The modification was based on the 6 h for maximum water absorption of cowpea and soybean seeds (Amaoge, 2007). The grains were steeped in 4 L of tap water for 4 h, air-rested for 2 h and re-steeped in clean tap water for 4 h. The out-of-steep grains were germinated for 72 h under dark conditions at $28\pm 2^\circ\text{C}$, during which the germinating grains were turned once every 24 h and moistened on alternate days by dipping each bag in 2 L of water for 30 s. The germinating grains were dried at 50°C for 24 h, cleaned by de-rooting, decortication by abrasion between the palms and air aspiration before milling into flour.

Millet grains (4 kg) were washed to remove dirt and stones and steeped in water for 12 h, drained and dried at 50°C for 4 days. The dried grains were milled using an attrition mill (Model 200 L090, E. H. Bentall, U. K) and then sieved through muslin cloth (approximate pore size = 0.25 mm). The ginger was dried in a VWR-1370 (VWR

Scientific) oven to a moisture content of 10.54% and milled in a disc attrition mill (Model 200 L090, E. H. Bentall, U. K). Flours from dried millet were blended with flours from malted cowpea or soybean (70:30). Each blend was then mixed with dried and powdered ginger in the ratio of 15:1 (w/w).

Optimum solid–water ratio for diastatic activity

Millet–malted cowpea and millet–malted soybean blends (10g each) were slurried in distilled water in the ratio of 1:0; 1:1, 1:2, 1:3 (w/v), stirred and incubated for 5 h at room temperature ($28\pm 2^\circ\text{C}$) during which the diastatic activities were determined.

Optimum incubation time for diastatic activity and heating times for instantisation

Three batches (15 g each) of millet–malted cowpea and millet–malted soybean were mixed with water (1:1, w/v) and incubated at $28\pm 2^\circ\text{C}$ for 0, 15 and 30 min. After each incubation period, the samples were steam-heated in a steam pot (Figure 1) for 0, 10 and 20 min respectively, dried in an air oven at 50°C for 24 h and then milled into flour.

Instantisation of the millet-malted cowpea and millet-malted soybean blends by steam-heating

Ninety-five grams of each of the millet–malted cowpea and millet–malted soybean flours were mixed with water (1:1, w/v) and

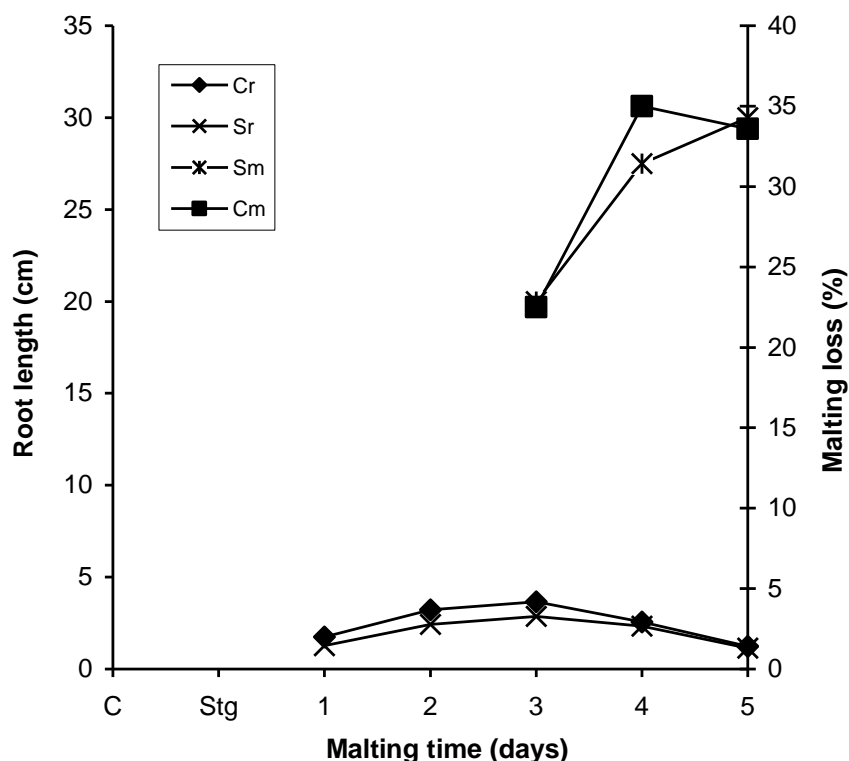


Figure 2. Root length and malting loss of cowpea and soybean seed. Cr, Sr-root length of cowpea and soybean seedlings; Cm, Sm- Malting loss of cowpea and soybean seed.

incubated for 15 min at $28 \pm 2^\circ\text{C}$. The slurry was then transferred into the steam pot and heated for 10 min before drying in an air oven at 50°C for 24 h and milling into flour.

Production of kunun-zaki

Kunun-zaki was produced from millet by the traditional method (Adeyemi and Umar, 1994) and by reconstitution of the preheated and dried millet-legume flour blends in water. Ginger was added to either product in a 1:15, w/w ratio. The instant *kunun-zaki* from millet-malted cowpea and millet-malted soybean (with added ginger) were reconstituted by adding boiling water (1:3, w/v) and then cooled to 25°C in 2 h before consumption.

Analyses

The diastatic activities of the malts and millet-legume malt blends were determined by the method of Hulse et al. (1980). The millet flour and millet-legume malt flour blends were analysed for crude protein using the micro-Kjeldahl procedure, moisture and fat contents by methods described in AOAC (1995); sugar content was determined by the method of Radley (1976). Fat deterioration was determined as peroxide value while the flow property of the *kunun* beverage was measured as apparent viscosity (Sathe and Salunhke, 1981). Each analysis was repeated 3 times.

Sensory evaluation of the *kunun-zaki* samples was based on acceptance testing of attributes (colour, consistency, odour, taste,

texture and general acceptability) on a 9-point hedonic scale (1 = not-acceptable). An 80-member panel (40 males and 40 females) aged 25 to 30 years who traditionally consume *kunun-zaki* as part of their cultural food habit was used for the test following a guideline. Evaluation for each attribute was repeated 3 times.

Data obtained were characterized by means and standard deviation. One-way ANOVA and Duncan's New Multiple Range Test (Duncan, 1995) were used to determine significant differences between means. Differences between samples were accepted at $p < 0.05$.

RESULTS AND DISCUSSION

Malting of cowpea and soybean seeds

The root length and loss in weight (malting loss) of the malting cowpea and soybean seeds (Figure 2) shows that root lengths increased up to the 72nd h (3 days) of germination after which it decreased on the 4th and 5th days. The increased root length may be due to the synthesis of gibberellins which is produced within the first 48 h in barley (Palmer, 1979). The subsequent decrease may be due to decreased moisture availability for translocation of gibberellins and nutrients with consequent shrivelling of the roots.

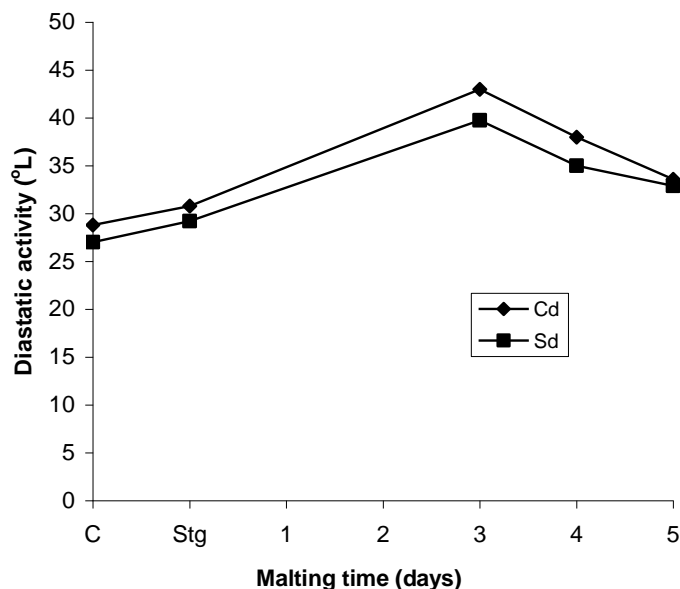


Figure 3. Diastatic activities of cowpea and soybean malts. Cd, Sd – diastatic activities of cowpea and soybean malts. C – unmalted grains. Stg – out - of - steep grains.

Malting loss peaked on day 4 for cowpea and on day 5 for soybean seeds. Cowpea had higher malting loss. Malting loss increased with germination time due to the degradation of cell wall contents, mobilization of endosperm matter and loss of dry matter as sprouts and volatiles (Briggs et al., 1981).

The diastatic activities of the cowpea and soybean malts (Figure 3) increased to a peak on germination day 3. Within the 3 days of malting, soybean's diastatic activity increased by 10.5°L while that of cowpea increased by 11.2°L suggesting that cowpea has a more active diastatic enzyme secretion and/or activation mechanism. The peak diastatic activities of the cowpea and soybean malts on germination day 3 could be due to synthesis and activation of the relevant enzymes. Malted cowpea had the higher diastatic activity of 38.8°L, which is in agreement with the fact that enzymes are synthesized in proportion to the amount of available substrate (Quass, 1995). Cowpea has a starch content of 55 to 68% while soybean has a starch content of 32 to 34% (Ogundipe, 1988).

Effect of solid-water ratio and incubation time on the pH and diastatic activity of the blends

The effect of solid-water ratio and incubation time on the pH of the blends is presented in Figure 4. The pH increased up to a solid-water ratio of 1:1 (w/v) and decreased as the solid-water ratio increased to 1:3 (w/v).

The initial increase in pH may be due to enzymatic hydrolysis of starch and proteins on addition of water while the subsequent reduction would be attributed to the leaching out of acidic substances in the blends due to the higher moisture contents. The cowpea and soybean blends incubated for 5 h had lower pH at 1:2 and 1:3 w/v suggesting the presence of acid components in the grain and some degree of fermentation due to more available substrates. The cowpea blends had lower pH values.

The diastatic activity of the blends increased as solid-water ratio increased (Figure 5) and may have resulted from the increased mobility of the diastatic enzymes and starch molecules. The millet-cowpea malt (MC_m) and millet-soybean malt (MS_m) blends incubated for 5 h had higher diastatic activities than those incubated for 0 h due to the longer contact time. The millet-cowpea malt incubated for 5 h (MC_m) had higher diastatic activity than the millet-soybean malt (MS_m) because of the higher diastatic activity and starch content of cowpea malt.

On the basis of pH and diastatic activities of the blends, the optimum solid-water ratio was 1:3; however, further work was carried out at a solid-water ratio of 1:1 to eliminate the need for more intense or longer drying of the product.

Optimum incubation and heating times for instantisation of the rehydrated flour blends.

The optimum incubation and heating times for

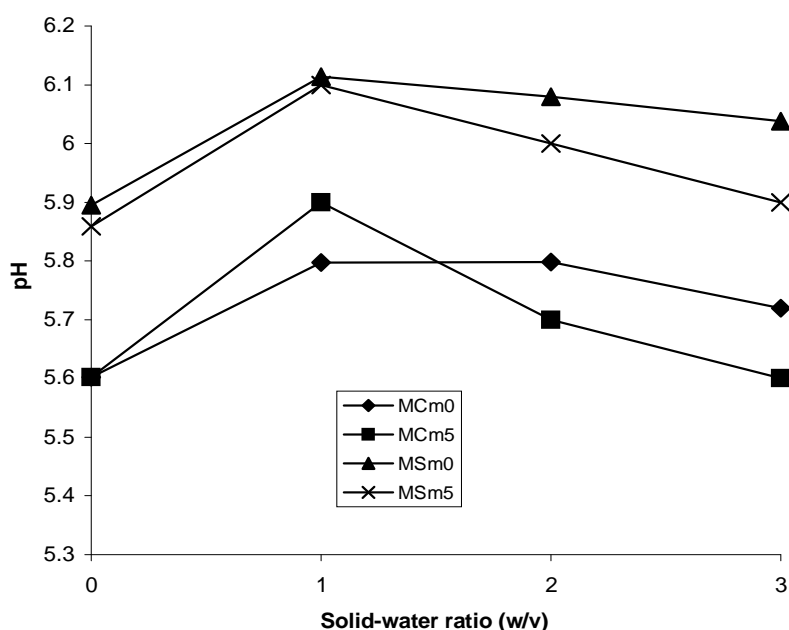


Figure 4. Effect of solid-water ratio and incubation time on the pH of the blends. MCm0, MSm0-millet-cowpea malt, millet-soybean malt blends after 0 h incubation; MCm5, MSm5- millet-cowpea malt, millet-soybean malt blends after 5 h incubation.

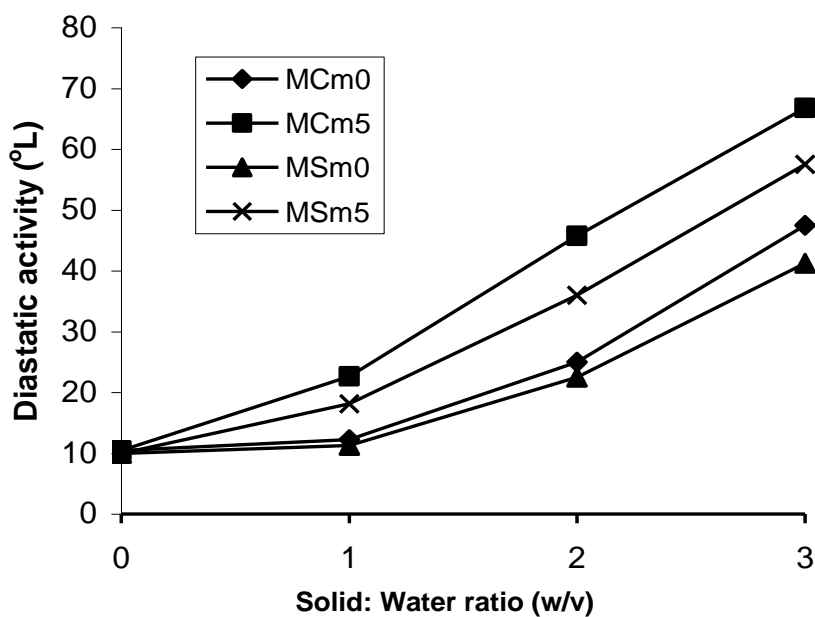


Figure 5. Effect of solid:ware ratio on the diastatic activity of millet-cowpea malt and millet-soybean malt incubated for 5 h at room temperature ($28 \pm 2^\circ\text{C}$).

instantiation of the blends (Figure 6a-c) shows that at each incubation time, crude protein content increased as steaming at 100°C progressed from 0 to 10 min, then

decreased slightly at 20 min. The increase in crude protein content could be due to increased decomposition of nitrogenous constituents while the subsequent slight

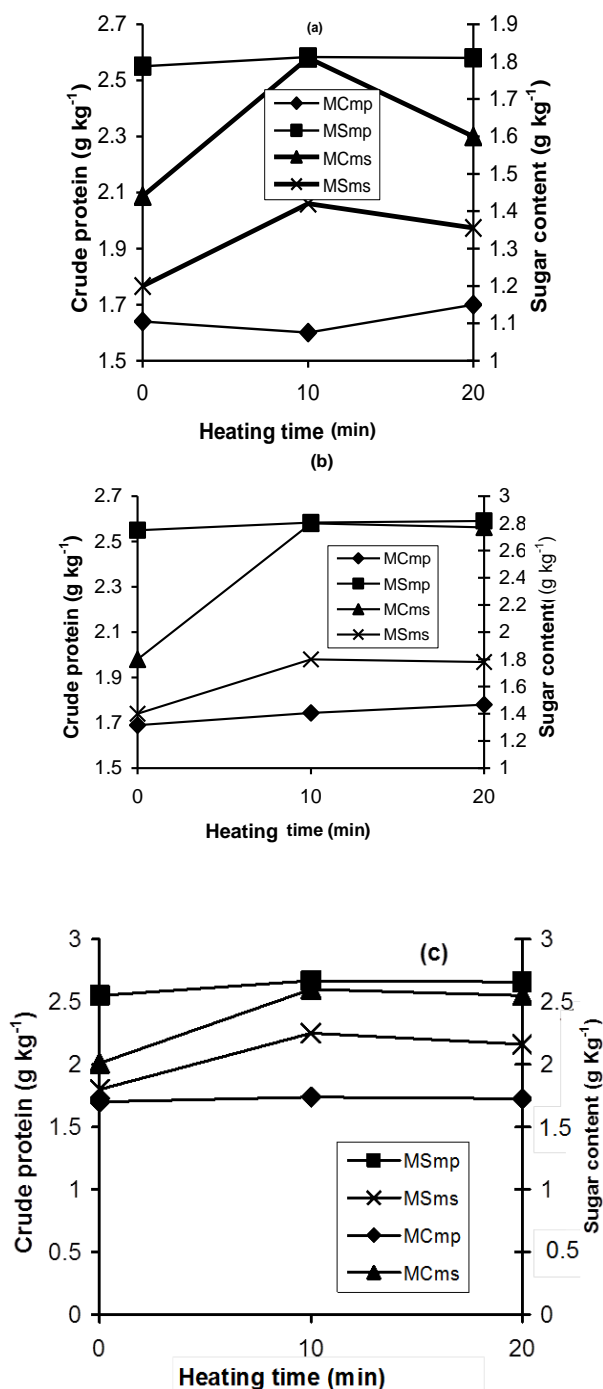


Figure 6. Effect of heating time on the crude protein and sugar contents of *kunun zaki* blends (1:1, w/v). a, b, c – after incubation for 0, 15 and 20 minutes. M – millet, C_m – cowpea malt, S_m – soybean malt, s – sugar content (g/kg), p – protein content (g/kg).

formation of Maillard reaction products. At all incubation times, crude protein content was higher in MS_{mp} than MC_{mp}, due possibly to the higher protein content of soybean. For the cowpea blend (MC_m), the highest crude protein (178 g/kg) was obtained after 15 min incubation and 20 min heating while for MS_m,S the highest crude protein content (259.3 g/kg) was obtained after 15 min incubation and 10 min heating. The longer heating time for MC_m may suggest that it has a higher phytate and/or tannin content.

At all incubation times, sugar content increased as the steaming time increased up to 10 min and decreased slightly at 20 min. Sugar content increased with incubation time possibly due to the longer contact time between diastatic enzymes and starch. Sugar content was higher in MC_m than MS_m because of the higher diastatic activity and starch content of cowpea malts. The highest sugar content for MC_m (279.5 g/kg) was obtained after 15 min incubation and 10 min heating while for MS_m (225 g/kg), it was after 30 min incubation and 10 min heating confirming the lower diastatic activity in soybean malt and the blend (MS_m).

Selected physical and chemical characteristics of instant *kunun zaki* flour blends and beverage

The moisture, sugar, crude protein and fat contents of instant *kunun-zaki* flour samples are shown in Table 1. The moisture content of the samples varied from 63.413 to 87.633 g kg⁻¹ and were significantly different ($p < 0.05$) from each other. The low moisture contents could be attributed to the ease of moisture loss during drying resulting from hydrolytic enzyme activities during malting and incubation.

The sugar content of the legume malt blends were significantly ($p < 0.05$) higher compared to millet only; sample MC_m had the highest sugar content of 0.6444 g kg⁻¹ and may be due to the higher diastatic activity and starch content of cowpea malts.

The crude protein contents of the blends (MS_m, MC_m) were higher than millet's and may result from blending with cowpea and soybean malts which have higher protein contents. MS_m had higher crude protein content (317.1 g kg⁻¹) than MC_m (203.4 g kg⁻¹) and is due to the higher protein content of soybeans.

MS_m blends had the highest fat content which differed significantly ($p < 0.05$) from M and MC_m. The highest fat content of MS_m was due to the presence of soybean malt which is derived from soybean, an oil seed with a fat content of 199 mg/kg which is higher than the 7 to 35 mg/kg of cowpea (Ene-Obong and Carnovale, 1992).

The peroxide value of instant *kunun-zaki* flour samples and apparent viscosity of instant *kunun-zaki* beverage (Table 2) shows that MC_m had the highest peroxide value compared to MS_m and M flour samples. The peroxide

decrease after 20 min heating may be due to increased

Table 1. Selected proximate composition of flours for *kunun zaki* production.

Attributes/properties	Samples*		
	M	MC _m	MS _m
Moisture (g kg ⁻¹)	87.633 ^a ±0.0057	72.600 ^b ±0.006	63.413 ^c ±0.0006
Crude protein (g kg ⁻¹)	124.533 ^a ±0.0100	203.40 ^b ±0.0100	317.100 ^c ±0.0057
Sugar (g kg ⁻¹)	0.5887 ^a ±0.0755	0.6444 ^b ±0.010	0.6378 ^c ±0.0577
Fat (g kg ⁻¹)	30.500 ^a ±0.7778	39.000 ^a ±1.272	110.00 ^b ±5.6560

*Values are in means ± standard deviation. *Means with different superscripts along the same row are significantly different at $p < 0.05$. M = Millet, MC_m = Millet-Cowpea malt, MS_m = Millet-Soybean malt.

Table 2. Peroxide value of flour blends and viscosity of *kunun zaki* beverage.

Attributes/properties	Samples*		
	M	MC _m	MS _m
Peroxide value (meq/kg)	55.5500 ^a ± 4.1500	83.3433 ^b ± 3.6500	66.6500 ^c ± 3.2550
Apparent viscosity (cP)	120 ^a ± 0.00	121.333 ^b ± 1.1547	1605.00 ^c ± 0.00

Table 3. Sensory quality of *kunun-zaki* from millet-cowpea malt and millet-soybean malt blends.

Attributes	Kunun zaki samples*		
	M	MC _m	MS _m
Appearance*	6.8875 ^b ± 1.98726	6.2125 ^a ± 2.0234	5.9750 ^a ± 1.71350
Consistency*	6.0250 ^a ± 2.25004	6.0374 ^a ± 2.00281	5.8625 ^a ± 1.68946
Taste*	5.3625 ^a ± 2.29056	5.9500 ^{ab} ± 1.87522	6.3125 ^a ± 1.78314
Odour*	4.5875 ^a ± 2.36372	6.3125 ^b ± 2.00375	6.8750 ^b ± 5.2490
Texture*	6.0750 ^a ± 2.18032	5.7250 ^a ± 1.75379	6.0125 ^a ± 1.75379
General acceptability*	5.5125 ^b ± 2.1819	6.2750 ^b ± 1.9794	6.4250 ^b ± 1.79856

*Values are means ± standard deviation. *Means with different superscripts along the same row are significantly different at $p < 0.05$. M = Millet; MC_m = Millet-Cowpea malt; MS_m = Millet-Soybean malt.

value of millet flour was the lowest and may be due to its low oil and unsaturated fatty acid content. The peroxide value of MC_m was higher than that of MS_m due possibly to higher unsaturated fatty acid content in cowpea (27.3%) compared to the 6.4% of soybean (Enwere, 1998).

The apparent viscosity of *kunun zaki* from millet was the highest (1605 cP) followed by MS_m, and then MC_m. The highest apparent viscosity of 1605 cP could be because of its high starch content (Akpapunam and Sefa-Dedeh, 1996). The higher viscosity of MS_m compared to MC_m may be due to its higher content of denatured protein.

Sensory evaluation

Kunun zaki from the blends were generally more preferred than the millet (Table 3). MS_m was rated the

overall best sample followed by MC_m and then sample M. MS_m was rated the overall best sample probably on the basis of its taste which may have resulted from the flavourful character of soybean malted for up to 72 h. MC_m was rated second best on the basis of its thinner consistency resulting from the higher diastatic activity of cowpea malt and hence MC_m.

The consistency and texture of the samples were similar, while MS_m and MC_m resembled each other in terms of odour and taste in which attributes, they were significantly better than millet *kunun*. The preference of the odour and taste of MC_m and MS_m over M may arise from the flavours developed during malting of the legumes. MS_m was preferred to MC_m because of the reduced or masked beany flavour and good aroma of soybean malt. These results suggest that consumer preference for *kunun zaki* may be primarily based on taste and less on consistency, appearance, odour and

texture in that order.

Conclusion

Acceptable instant *kunun-zaki* was produced from millet-cowpea malt and millet-soybean malt after 15 min incubation of 1:1 (w/v) slurry and 10 min steam-heating. The addition of cowpea/soybean malts increased the crude protein and sugar contents, decreased moisture content and apparent viscosity. The low moisture contents suggest a longer shelf life if adequate packaging and control of mould growth are effected. The lower apparent viscosity of the blends would allow for an increased nutrient and energy density. *Kunun-zaki* from millet-soybean malt (MS_m) was the most preferred by the 80 sensory panelists and it had the highest protein content which would recommend it for use in diverse situations.

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