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PHYSICAL AND NUTRITIONAL COMPOSITION OF INSTANT KUNUN-ZAKI POWDER OBTAINED BY THREE DRYING METHODS

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ABSTRACT

Effect of drying methods on some physical and nutritional composition of instant kunun-zaki powder were studied. The fresh kunun-zaki was dried in a tray dryer at 45°C for 24 hours, freeze dried for 72 hours and oven dried at 60°C for 24 hours. The powders obtained were reconstituted and analyzed for some of their physical and nutritional composition. The three drying methods drastically reduced the moisture content of the fresh slurry of kunun zaki to produce an instant 'kunun-zaki' powders. This was evident in the marked reduction of its weight which was reduced from a moisture content of 85.60% to arrange of 8.87 – 8.95%. The protein, ash, fat, crude fibre and carbohydrate contents increased from 1.75%, ash 0.40%, 1.02%, crude fibre 0.26% and carbohydrate 10.97% respectively to range of 17.22 to 17.93% for protein, 2.98 to 3.15% for ash, 1.14 to 1.18% for fat, 2.18 to2.22% for crude fibre and 67.23 to 67.86% for carbohydrate. There were no significant differences ($P < 0.05$) between the values of bulk density, titratable acidity, pH and viscosity of the fresh and the reconstituted samples. The total soluble solid value for fresh and instant kunun-zaki powder ranged from 3.00 to 15.00°Brix, ascorbic acid ranged from 22.66 to 32.00mg/100ml. Calcium ranging from 2700 - 2873mg/l was the most abundant mineral element followed by potassium, magnesium, iron, phosphorus and sodium, while copper was considerably low. Chemical analysis showed that major nutrients were retained in the instant kunun-zaki powder. Wettability of the instant kunun-zaki powder showed that freeze dried sample dissolved faster within 12 seconds, 28 seconds for the tray dried and 41 seconds for the oven dried samples. The most abundant amino acid was glutamic acid (8.56, 6.97 and 7.88g/100g) followed by leucine (6.23, 4.86 and 5.30g/100g) and aspartic acid (6.14, 5.64 and 5.83g/100g) while methionine (0.62, 0.52, 0.57g/100g) was the least amino acid found in the samples. The most concentrated essential amino acid (EAA) was leucine (4.86-6.23 g/100g protein) followed by phenylalanine (2.95g/100g). The Total Essential Amino Acid (%) ranged from 34.84 - 36.69 %. The values were well above 26% considered to be adequate for ideal protein for children and 11% for adult. Instant kunun-zaki powder can be produced using tray drying at (45°C) and freeze drying methods without adversely affecting its physical and nutritional composition hence they will be appropriate methods of extending the shelf life of kunun zaki, a non alcoholic beverage.

Keywords: Instant kunun-zaki, nutritional, amino acid, chemical, physical properties.

INTRODUCTION

'Kunun-zaki' is a traditional fermented non-alcoholic beverage widely consumed in Northern Nigeria but becoming more widely accepted in several other parts of Nigeria, owing to its refreshing qualities (Adeyemi and Umar, 1994, Gaffa and Ayo, 2002). It can be produced either from millet (*Pennisetum glaucum* (L.) R.Br.), sorghum (*Sorghum bicolor* (L.) Moench) or maize (*Zea mays* L.). Kunun-zaki is produced with some other ingredients such as spices (ginger, cloves, pepper) and sweet potato tubers. The final product is a thin free-flowing gruel (Akpapunam *et al.,* 1997). It is widely consumed among all social classes and age groups because it costs little and the raw materials are cheap and readily available. It is almost replacing the conventional carbonated drinks. Kunun-zaki is consumed as a beverage with or without addition of sugar as a sweetener. The whole process lasts about 24 h. The nutrient content and microbiological quality of this product had been reported (Gaffa *et al*., 2002b; Onuorah *et al*., 1987b). The consumption rate of the beverage has also been studied (Gaffa *et al*., 2002a). The gross chemical composition of Kunun-zaki is 87.85-89% moisture content, 9.84-12% carbohydrate, 1.56-3% protein, 0.10-0.30% fat and 0.61-0.75% ash (Adeyemi and Umar, 1994; Badifu *et al.*, 1998) indicating that the drink is low in protein. Studies by some workers show that kunun-zaki is rich in carbohydrate, vitamin and minerals but low in protein (Ayo and Okaka, 1998).

The problem associated with the drink is its short shelf life due to autolysis (enzymatic factor as well as microbial action) such as that of yeast and mould (Gaffa *et al*., 2002b). This short shelf life has been the limitation or problem which necessitated the various investigations into how its shelf life could be increased. Adejuyitan *et al.* (2007) evaluated the quality characteristics of kunun produced from dry-milled sorghum. Gaffa (2000) studied the improvement on traditional kunun production and its storage stability. Aderinola and Oluwamukomi (2014) studied the use of sodium benzoate, and pasteurization in increasing the shelf life of *kunun-zaki* supplemented with groundnut. The use of bacteriocin-producing Lactobacillus has also been employed to extend the shelf-life of Kunun by about 10 days. Inyang and Dabor (1997) tried to extend the shelf life of kunun zaki by two week using pasteurization. Dehydrating the kunun was viewed as a way of extending the shelf life for a longer period. Chavez *et al*. (1989) tried to study the effect of drum drying, they reported that drum drying led to the destruction of heat-sensitive nutrients in kunun. Obanewo and Zidon (2003) produced and evaluated powdered kunun-zaki using the fluidized bed dryer at 50^{o}C for 10 hrs. Hence, the objective of this work was to study the comparative effects of three drying methods: tray drying (at 45°C), freeze drying (at 0^{o}) and hot air oven drying (at 60°C) on the physical and nutritional qualities of the instant kunun-zaki powder.

MATERIALS AND METHODS

The millet (*Pennisetum glaucum* (L.) R. Br.), sorghum (*Sorghum bicolor* (L.) Moench*)*, red pepper (*Capsicum anuum* L), black pepper (*Piper nigrum*), sweet potatoes (*Ipomoea batatas* (L.) Lam.), ginger (*Zingiber officinale* Roscoe), cloves (*Syzygium aromaticum* (L.) Merr.), and granulated sugar were purchased from a local market in Ado Ekiti, Ekiti State, Nigeria.

Production of Instant kunun-zaki

Kunun-zaki slurry was produced as described by Akoma *et al*. (2002b) using millet and sorghum. The process involved cleaning and steeping in 1000 ml tap water (1:2, w/v) for 24 h at 30-32°C. The water was then decanted off and the grains (500 g) washed with more tap water before wet milling with addition of spices (mixture of cloves, ginger and black pepper) plus 1000ml tap water and wet milled to form a wet paste.. The paste was divided into two unequal portions (1:3, v/v). The larger part (3/4) was gelatinized (by addition of hot water), cooled to 40°C and added to the ungelatinized portion to form kunnu zaki slurry. This slurry was stirred vigorously for about 2 min and then allowed to stand and ferment for 8-12 hours. The fermented kunun-zaki was sieved through 350 µm diameter mesh and sweetened (addition of granulated sugar).The Kunun zaki slurry was divided into three protions and dried using three method of drying: vis; tray drying (at 45°C), freeze drying (0^{o}) and hot air oven drying (at 60°C). The dried samples were milled into fine particles using Malex blender. The milled powder was packaged in high density polythene nylon and stored in refrigerator until further analysis. Fresh Kunun-zaki slurry produced with the same method was used as a control.

Chemical Analysis

The proximate composition of the kunun-zaki was determined according to the standard method of AOAC (2005). The protein content was determined by micro Kjeldahl method described by Kirk and Sawyer (1991). Carbohydrate was estimated as difference of the percentage of moisture, protein, fat, crude fibre and ash from 100. The bulk density of the Kunun was determined by the method of Ige *et al*. (1984), the Wettability by the method of Armstrong *et al*. (1979) and the specific gravity by the use of the picnometer-specific gravity bottle. The pH was measured with pH meter (Model 7020 Electronic Ltd, England) after standardization with pH 4 and 9 buffers (BDH, England), titratable acidity was determined according to the procedure of Pearson (1976) and total soluble solid was measured using refractometer and the result expressed as degree (^{0}Brix). The reconstitution Index was determined by the method of Banigo and Akpapunam (1987) and the viscosity was determined using rotational viscometer (NDJ-1A Rotational viscometer, Shangai, China). The sodium and potassium were determined using a flame photometer as described by AOAC (2005). Phosphorus was determined using phosphovanandate. Calcium, iron, copper, magnesium and zinc of the instant kunun-zaki powdered samples were determined using an automated atomic absorption spectrophotometer (Perkin-Elmer, Model 2380). The samples and standard solutions were prepared according to the procedures of the AOAC (2005).

Amino Acid Determination

The amino acid profile of the instant kunun-zaki powder, their protein fractions and protein isolates was determined using the Ion Exchange Chromatography (IEC). The sample was defatted, hydrolysed and evaporated in a rotatory evaporator and then injected into the Technicon sequential multisample Amino Acid Analyzer (TSM) Model DNA 0209.

Statistical Analysis

Means and standard errors of the mean (SEM) of replicate scores were determined and subjected to analysis of variance (ANOVA) using the Statistical Package for Social Statistics (SPSS version 17). Means were separated using the Duncan's New Multiple Range (DNMR) Test (Steel *et al.*, 1997).

RESULTS

Table 1 shows the proximate composition of fresh and instant kunun-zaki powders (oven dried, freeze dried and tray dried samples). The value for the moisture content were 85.60%, 8.95%, 8.92%, and 8.87% for freshly prepared kunun-zaki, tray dried , oven dried and freeze dried samples respectively. The moisture content of the freshly prepared kunun-zaki was high compared to instant kunun-zaki powders (oven dried, freeze dried and tray dried samples). The protein content ranged from 1.75% to 17.22%, ash content ranged from 0.40% to 3.15%, crude fibre ranged from 0.26% to 2.22% and fat content ranged from 1.02% to 1.18%, the values for the fresh kunun-zaki were significant low than the values obtained for the instant kunun-zaki powders and there were significant difference at $p < 0.05$ in the values obtained for the protein, ash, fat and the crude fibre of the instant kunun-zaki powders. The percentage carbohydrate for instant kunun-zaki powders (tray dried, oven dried and freeze dried) ranged from 67.23% to 67.86%, these values were significant high compared to fresh kunun-zaki which was 10.97%. The values for the carbohydrate of the instant kunun-zaki powders were significant difference at $p < 0.05$ from each other. The ascorbic acid of the fresh kunun–zaki sample (32.00 mg/100ml) was higher than the instant kunun–zaki powders; this could be due to loss of vitamin C during drying. There were significant differences at $p < 0.05$ between the ascorbic acid of the samples except oven dried and freeze dried samples where there were no differences. There were no significant difference ($P > 0.05$) between the values of titratable acidity and pH of the dried samples. There was also no variation ($P > 0.05$) in the titratable acidity and pH of the dried samples. The pH of the samples ranged from 3.30 to 3.90, the pH of the fresh kunun–zaki sample was slightly lower than that of the instant kunun–zaki.

Table 2 shows the physical properties of fresh and instant Kunun-zaki powders (tray dried, oven dried and freeze dried). There were no significant differences ($p > 0.05$) between the values of bulk density, specific gravity, viscosity and total soluble solids for products obtained by the three drying methods. There were no significant differences ($P > 0.05$) in the values of bulk density among the dried samples which ranged from 0.60 - 0.72g/cm^3. There was also no significant differences ($P > 0.05$) between the values of viscosity of the reconstituted kunun zaki and the freshly prepared kunun zaki ranging between 0.30 - 0.50 cp. The total soluble solid of the fresh Kunun–zaki (5.00 ^{o}Brix) was significantly difference from the instant kunun–zaki powders (3– 4 ^{o}Brix) but the differences among the values for the dried samples were not significant. Using any of the drying methods did not significantly affect the total soluble solids, bulk densities and the viscosities of the dried product. However, there were significant differences ($P < 0.05$) in the values obtained for wettability and reconstitution indices of the three instant kunun–zaki samples. The oven dried sample

(41 seconds) took longer time before it could dissolve followed by the tray dried sample (28 seconds), while the freeze dried sample (12seconds) took a shorter time. The reconstitution indices of the dried products in warm and cold water differ significantly by the method of drying used. The time taken for the reconstitution in warm water (5, 7 and 4 seconds for tray dried, oven dried and freeze dried samples) respectively was shorter than in cold water (12, 14 and 11 seconds) respectively. The type of drying used will have significant different effects on the reconstitution index of the dried sample.

Table 1: Chemical composition of fresh and dried Kunun zaki samples

	Samples			
	Freshly produced	**Tray dried**	**Oven dried**	**Freeze dried**
Protein (%)	1.75±0.00^{d}	17.22±0.02^{a}	17.09±0.01^{b}	17.93±0.01^{c}
Ash content (%)	0.40±0.00^{d}	3.15±0.01^{b}	3.21±0.01^{a}	2.98±0.01^{c}
Fat content (%)	1.02±0.03^{a}	1.16±0.01b^{c}	1.14±0.01^{c}	1.18±0.01^{b}
Crude fibre (%)	0.26±0.00^{d}	2.22±0.03^{a}	2.17±0.01^{b}	2.18±0.01^{b}
Carbohydrate (%)	10.97±0.00^{d}	67.23±0.02^{c}	67.47±0.04^{b}	67.86±0.01^{a}
Moisture content (%)	85.60±0.02^{a}	8.95±0.01^{b}	8.92±0.01^{c}	8.87±0.02^{d}
pH	3.30±0.00^{a}	3.80±0.00^{a}	3.90±0.00^{a}	3.80±0.00^{a}
Titratable acidity (% Lactic acid)	0.85±0.02^{a}	0.76±0.01^{a}	0.73±0.01^{a}	0.74±0.02^{a}
Ascorbic Acid (mg/100ml)	32.00±0.10^{a}	26.00±0.20^{b}	22.66±0.31^{c}	22.66±0.15^{c}

^{a,b} :Means along the same row with different superscript are significantly different (P < 0.05).

Table 2: Physical properties of Kunun zaki

	Samples			
	Freshly produced	**Tray dried**	**Oven dried**	**Freeze dried**
Bulk Density (g/cm^{3})	-	0.72±0.00^{a}	0.65±0.00^{a}	0.60±0.00^{a}
Specific gravity	1.06±0.01^{a}	1.02±0.00^{b}	1.03±0.01^{b}	1.02±0.00^{b}
Wettability (seconds)	-	28±0.08^{b}	41±0.05^{a}	12±0.08^{c}
Viscosity (cp)	0.50±0.00^{a}	0.40±0.00^{a}	0.40±0.00^{a}	0.30±0.00^{a}
Total soluble solid (^{o}Brix)	5.00±0.00^{a}	4.00±0.00^{b}	3.00±0.00^{b}	4.00±0.00^{b}
Reconstitution Index:				
Cold water (seconds)	-	12.00±0.03^{b}	14.00±0.01^{a}	11.00±0.02^{c}
Warm water (seconds)	-	5.00±0.01^{b}	7.00±0.01^{a}	4.00±0.01^{c}

^{a,b} Means along the same row with different superscript are significantly different (P < 0.05).

Table 3: Mineral composition of Kunun-zaki

	Samples (mg/100ml)		
Mineral content	**Tray dried**	**Oven dried**	**Freeze dried**
Sodium	17.30±0.57^{a}	17.67±0.58^{b}	21.33±0.58^{a}
Potassium	144.92±1.13^{b}	212.70±1.00^{a}	115.92±0.76^{c}
Phosphorus	21.60±0.60^{a}	15.20±0.20^{b}	14.80±0.20^{b}
Iron	89.00±0.49^{a}	92.30±0.42^{a}	72.33±0.42^{b}
Copper	1.65±0.02^{a}	0.87±0.02^{b}	0.58±0.02^{c}
Magnesium	126.67±0.58^{b}	139.67±0.58^{a}	108.00±0.01^{c}
Calcium	273.00±0.50^{b}	270.00±0.17^{c}	287.30±0.22^{a}
Na/K ratio	0.12	0.08	0.32
Ca/P ratio	12.64	17.76	19.41

^{a,b} :Means along the same row with different superscript are significantly different (P< 0.05).

Table 4: Amino Acid Composition of Instant Kunun Produced (g/100g protein).

Amino Acid	Tray dried	Oven dried	Freeze dried	FAO/WHO
Histidine	2.77±0.02[a]	2.21±0.01[c]	2.33±0.02[b]	-
Arginine	4.14±0.03[a]	3.88±0.27[b]	3.88±0.38[b]	-
Aspartic Acid	6.14±0.04[a]	5.64±0.03[c]	5.83±0.03[b]	-
Serine	2.11±0.01[a]	2.22±0.02[a]	2.01±0.01[b]	-
Glutamic Acid	8.56±0.11[a]	6.97±0.02[c]	7.88±0.15[b]	-
Proline	1.32±0.02[c]	1.63±0.03[b]	2.21±0.01[a]	-
Glycine	1.82±0.1[b]	1.68±0.01[c]	2.21±0.03[a]	-
Alanine	2.66±0.05[a]	2.05±0.03[c]	2.43±0.02[b]	-
Cystine	0.86±0.02[a]	0.53±0.02[c]	0.73±0.02[b]	2.00
Lysine*	2.27±0.03[b]	2.32±0.01[a]	2.11±0.01[c]	4.20
Threonine*	2.82±0.01[a]	1.82±0.01[c]	2.54±0.01[b]	2.80
Valine*	2.20±0.10[b]	1.97±0.02[c]	2.37±0.06[a]	4.20
Methionine*	0.62±0.02[a]	0.52±0.01[c]	0.57±0.02[b]	2.20
Isoleucine*	1.71±0.01[a]	1.46±0.04[c]	1.52±0.02[b]	4.20
Leucine*	6.23±0.03[a]	4.86±0.03[c]	5.30±0.11[b]	4.80
Tyrosine	2.06±0.04[b]	1.82±0.01[c]	2.22±0.01[a]	
Phenylalanine*	2.95±0.02[a]	2.36±0.03[c]	2.61±0.12[b]	2.80
TEAA (%)	36.69	34.84	35.04	
TSAA	1.48	1.05	1.37	

[a,b] :Means along the same row with different superscript are significantly different ($P < 0.05$).

[*] Essential Amino Acids

TEAA – Total Essential Amino Acid

TSAA – Total Sulphur Amino Acid

Table 3 shows the result of mineral composition of the instant kunun–zaki powders (tray dried, oven dried and freeze dried). There were significant differences ($p < 0.05$) in the mineral contents between the tray, oven and freeze dried samples. Freeze dried sample has the highest values for sodium (21.33 mg/100g) and calcium (287.30 mg/100g), while oven dried sample was high in potassium (212.70 mg/100g), iron (92.30 mg/100g) and magnesium (139.67 mg/100g) and tray dried sample was highest in phosphorus (21.60 mg/100g) and copper (1.65 mg/100g). The most abundant element in the three samples was calcium (270.00 - 287.30 mg/100g), followed by potassium (115.92 – 212.70 mg/100g) and the least element was copper (0.58 – 1.65 mg/100g). Table 4 presents the amino acid composition of instant kunun - zaki produced by oven, tray and freeze drying methods. The daily intake of essential amino acids suggested by the Food and Agriculture Organization (FAO) and World Health Organization (WHO) was also tabulated alongside for comparison. The most abundant amino acid was glutamic acid (8.56, 6.97 and 7.88 g/100g) for oven, tray and freeze dried samples respectively followed by leucine (6.23, 4.86 and 5.30 g/100g) and aspartic acid (6.14, 5.64 and 5.83 g/100g) while methionine (0.62, 0.52, 0.57 g/100g) was the least amino acid found in the samples. The most concentrated essential amino acid (EAA) in the instant kunun-zaki powders was leucine (6.23g/100 g/100g) followed by phenylalanine (2.95g/100 g/100g). Among the essential amino acids, lysine, valine, cystine and methionine were extremely low when compared with the FAO/WHO reference proteins values. The % Essential Amino Acid in the sample were 36.69%, 34.84% and 35.04% for oven dried, tray dried and freeze dried samples respectively. The amino acid contents of the tray dried sample were consistently higher than the oven dried and the freeze dried samples.

DISCUSSION

'Kunun-zaki' is a lactic acid bacterial fermented non-alcoholic cereal beverage with limited shelf-life. The high moisture content (88 - 92%) of the product (Akoma *et al*., 2002) and the poor sanitary practices associated with its production (Elmahmood and Doughari, 2007) could account for its short shelf-life (24 – 48 h) which has been a source of concern to its manufacturers and consumers (Efiuvwevwere and Akoma, 1997). Drying by the three methods had drastically reduced the moisture contents of the instant 'kunun-zaki' powders produced in this study and this was evident in the marked reduction of its weight. This is similar to the observation of Nkama *et al*. (2010) for freeze dried kunun zaki. The proximate composition of fresh and instant kunun-zaki powder revealed that protein content of the dried samples, were high compared to the fresh sample, the protein was more concentrated in the dried sample. The ash, fat and crude fibre content also followed the same trend with the protein. The carbohydrate content was low in fresh sample which may be as a result of the high moisture content in the fresh sample. The results obtained followed the same trend with the result obtained by Nkama *et al*., (2010). The protein content in the fresh and instant kunun-zaki samples were comparable with the result obtained by Nkama *et al*.(2010) but higher than those reported by Obadina *et al*. (2008), Adejuyitan *et al*. (2007) and Gaffa *et al*. (2002b). The values were also similar to those of Oluwajoba *et al*. (2013) that ranged between 13.97 and 18.54 % for kunun zaki made from germinated and un-germinated composite cereal grains. There was an increase in ash content of the instant kunun-zaki. There was a significant difference in the value obtained for the ash content of instant kunun-zaki and fresh sample. The oven dried kunun-zaki had the highest value followed by tray dried, freeze dried sample and fresh sample has the least value. This agreed with the observation of Obadina *et al*. (2008) and Gaffa *et al*. (2002b) but low compared to the result obtained by Nkama *et al*. (2010). The fat content of the fresh sample and those of the instant kunun-zaki powder were significantly different ($p < 0.05$) but the values were low compared to the result obtained by Nkama *et al*. (2010). Drying increased the percentage crude fibre of the sample with tray dried samples having the highest value of 2.22% followed by freeze dried and oven dried samples. Dehulling and milling of grains had been shown to reduce the crude fibre content of the food product (Adeyemi, 1983). The significant increase in the carbohydrate content of the instant kunun-zaki by drying must have been due to the drying of the products. The freeze dried kunun-zaki powder had the highest value followed by oven dried sample and then tray dried sample, while the least was the fresh sample. Drying makes the nutrient in the instant kunun-zaki powders to be more concentrated. There were no significant difference ($p > 0.05$) between the values obtained for titratable acidity and the pH. The pH of the fresh sample was lower than that of the instant kunun-zaki powders while there was no significant difference in the values for tray dried, oven dried and freeze dried sample which were 3.80, 3.90 and 3.80 respectively. The acidity of the fresh and instant kunun-zaki beverage was as a result of lactic acid production during fermentation (Ashiru *et al*., 2003). They suggested that the lower pH in fresh sample could be due to the decomposition of fermentable substrates and sugars by microorganisms especially *Lactobacillus* species which fermented the carbohydrates to produce energy and principally lactic acid and high moisture content which was responsible for the activity of microorganisms. The higher pH values in the instant kunun-zaki powder could have been due to the concentration of hydrogen ions in the dried kunun–zaki as a result of loss of volatile acids during drying. These observations were similar to those of Nkama *et al*. (2010).

There were no significant differences in the values bulk density among the dried samples. There was also no significant difference between the values of viscosity of the reconstituted kunun zaki and the freshly prepared kunun zaki. Specific gravity in the fresh sample was higher and differ significantly from the instant kunun-zaki powders. Oven dried sample was significantly different from tray dried and freeze dried sample. Wettability of the instant kunun-zaki powder shows that freeze dried sample got wet faster, within 12 seconds followed by tray dried (28 seconds) and oven dried samples (41 seconds). This shows that freeze dried sample will dissolve faster than the other two samples. The viscosity of the fresh and the reconstituted kunun-zaki powder were not significantly different from each other ($p > 0.05$). The ascorbic acid of the fresh sample (32.00mg/ 100ml) was significantly different ($P < 0.05$) from the instant kunun-zaki powder, this could be due to the loss of vitamin C during drying. Tray dried sample differ significantly ($p < 0.05$) from oven and freeze dried samples while there was no significant difference between oven dried and freeze dried samples ($P > 0.05$). This could be as a result of more vitamin C being lost during the drying in the hot air oven. The total soluble solids in the fresh sample was higher than the instant kunun-zaki powder while there were no significant differences ($p > 0.05$) in the values obtained for the tray dried, oven dried and freeze dried samples. The total soluble solid of the fresh Kunun–zaki (5.00 ^{o}Brix) was significantly different from the instant kunun–zaki powders (3– 4 ^{o}Brix) which may be due to the water added for the reconstitution, however individual preferences usually determines the amount of water desirable. The time taken for the reconstitution in warm water was shorter than in cold water. This is in agreement with the earlier findings of Adeyemi and Umar (1994). This might be because solubility increases with increase in temperature. Freeze dried sample reconstituted faster, followed by tray dried and the least was the oven dried sample. This might be because solubility increased with increase in temperature. Freeze dried sample dissolved faster both in warm water and cold water followed by tray dried samples while the oven dried sample took the longer time to dissolve. This was consistent with the result of wettability where freeze dried Kunun-zaki had the lowest time to dissolve In water, freeze-dried products can be rehydrated (reconstituted) much more quickly and easily because the process leaves microscopic pores. The pores are created by the ice crystals that sublimed, leaving gaps or pores in their place. This agreed with the observations of Obanewo and Zidon (2003) for powdered kunun-zaki using fluidized bed dryer.

Calcium was found to be the most abundant mineral element followed by potassium, magnesium, iron, sodium, and the least is copper. The high value obtained for potassium agreed with the observation of Olaofe *et al*. (1994) who observed that potassium was the most predominant mineral in Nigeria agricultural products. There was no significant difference ($p< 0.05$) in the results obtained for calcium for tray dried, oven dried and freeze dried samples. The mineral composition results obtained were comparable with the result obtained by Nkama *et al*. (2010). Phosphorus is always found with calcium in the body, both contributing to the bone formation and supportive structure of the body. Therefore, the presence of phosphorus and calcium in the instant kunun-zaki powder would make it suitable for bone formation for children since the deficiencies in these mineral (phosphorus and calcium) in the body can lead to rickets or abnormal development (Shills and Young, 1992). The amino acid composition of instant kunun-zaki powder produced by oven dried, tray dried and freeze dried revealed that the most abundant amino acid is glutamic acid followed by aspartic acid and leucine. Similar observation has been reported by Gaffa *et al.* (2002b) on four types of kunun-zaki containing different saccharifying agents. This was similar to the findings of Gaffa *et al*. (2002b) that Glutamic acid (4.49-11.66 g/100g) was the most abundant amino acid in the samples while cysteine a similar sulfur amino acid was the least abundant (0.34-1.45 g/100g) in all the samples. The result obtained for the oven dried sample, tray dried sample and freeze dried sample, were high compared to the result obtained for kunun-zaki with malted rice, cadaba farinosa and sweet potatoes while they were low compared to the kunun-zaki with soybean (Gaffa *et al*., 2002b). The oven dried instant kunun-zaki powder, had the higher levels of seven essential amino acids, namely histidine, arginine, threonine, valine, methionine, isoleucine, leucine and phenylalanine. Among the essential amino acids, valine, methionine and isoleucine were generally low compared with the FAO/WHO references protein values. This finding was also similar to that of Gaffa *et al*. (2002b) where cysteine, valine, isoleucine and methionine occurred in extremely low quantities compared with FAO/WHO reference protein values. The instant kunun-zaki powder produced using tray drier were consistently lower in essential amino acids than the FAO /WHO reference except for its notably higher leucine content (4.86g/100g). The tray dried kunun zaki was consistently having the highest values of amino acid followed by the freeze dried sample while oven dried sample was having the least values. This was a bit strange since one would have expected the freeze dried product to retain the highest amount of amino acid. The Total Essential Amino Acid (%) in the samples showed that the values were below the 39% considered to be adequate for ideal protein for infants, but were well above 26% considered to be adequate for ideal protein for children and 11% for adults (FAO/WHO/UNN, 1985).

CONCLUSION

This study has shown that instant kunun-zaki powder could be produced successfully using the oven drying method at controlled temperature of 60°C, tray drying method at 45°C and freeze drying method (0^oC) with similar physiochemical properties. When the instant kunun zaki powder was reconstituted with water, it produced kunun zaki of similar physicochemical properties with those of fresh kunun-zaki. However, tray drying method resulted in kunun zaki of better nutritional content. Instant kunun-zaki powder can therefore be produced using tray drying at (45°C) and freeze drying methods without adversely affecting its physical and nutritional composition hence they will be appropriate methods of extending the shelf life of kunun zaki, a non alcoholic beverage.

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