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Full Length Research Paper

Influence of malting on the nutritional characteristics of kunun-zaki

O Akoma[1*], E. A. Jiya, D. D. Akumka[2] and E Mshelia[3]

[1]Dept of Science Lab Technology, Federal Polytechnic, PMB 55, Bida 912001, Nigeria
[2]Dept of Microbiology & Biotech, National Inst. for Pharmaceutical Res. & Dev., Abuja,
[3]Dept of Pharmacology & Toxicology, National Institute for Pharmaceutical Research & Development, Abuja, Nigeria.

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Kunun-zaki, a traditional fermented cereal beverage was produced in this study using various combinations of malted cereals (millet, sorghum singularly or in combination with rice) and, were evaluated for its nutritional composition using chemical, organoleptic and growth studies and as well as the analysis of blood samples of the sacrificed animals. The results obtained show that the weaning albino rats fed with laboratory diet and kunun-zaki produced by the addition of ground malted rice to millet for 14 days gained more weight (27.7 g) and was significantly different ($p< 0.05$) from the other products. A similar trend was observed in the lymphocyte count. The crude protein, crude fat and calcium contents of kunun-zaki produced with the addition of malted rice to millet were higher (0.74%, 0.53% and 88 ppm) than the other products. A similar trend was observed in the titratable acidity and pH (0.76% lactic acid, 4.78), respectively, at the end of fermentation period. Furthermore, kunun-zaki produced by the addition of ground-malted rice to millet was generally preferred organoleptically (aroma and taste) and was significantly different ($p< 0.05$) from the other products. This study has shown that use of malted cereals improved the nutritional quality of the kunun-zaki. Also, the elevated lymphocyte counts obtained in the blood samples of animals fed with kunun-zaki produced using combinations of malted cereals is indicative of its medicinal attributes, a concept widely believed by its numerous consumers.

Key words: kunun zaki, ground malted cereal, growth studies, nutritional quality.

INTRODUCTION

'Kunun-zaki' is a traditional fermented non-alcoholic beverage widely consumed in Northern Nigeria. It can be produced either from millet (*Pennisetum typhoideum*), sorghum (*Sorghum bicolor*) or maize (*Zea mays*). It is believed to be of immense social, economic, nutritional and medicinal importance to its numerous consumers (Efiuvwevwere and Akoma, 1995). Studies by some workers show that kunun-zaki is rich in carbohydrate, β-vitamin and minerals but low in protein (Ayo and Okaka, 1998). The increase in acidity (lactic acid) of kunun-zaki during production has been attributed to the dominance of *Lactobacillus leichmannii* and *L. fermentum* during the fermentation process (Efiuvwevwere and Akoma, 1995).

*Correspondence Author. E-mail: oakoma2002@yahoo.com, Tel: 234-804-313-9680, 234-803-632-5203.

In the production of kunun-zaki, two methods are employed. In one of the method, the cereal is steeped in water for 24 h, wet milled and sieved. The sediment obtained is divided into two unequal portions; one portion is cooked and then mixed with the uncooked portion (being the source of inoculum) and allowed to ferment for 8-10 h (Efiuvwevwere and Akoma, 1995). In the second method, a portion of the cereal is malted, dried, ground and then mixed with the uncooked portion. The mixture is then added to the cooked portion and stirred vigorously and allowed to ferment (Akoma et al., 2002b). The hydrolytic enzyme (amylase) in the malted cereal aids in digesting the thick slurry thereby converting the complex carbohydrate to simple sugars. The final product is usually sweet (Akoma et al., 2002b).

Foods fermented with lactic acid bacteria have long been held in special favour as safe and nutritious food that may elicit positive effect on health and well being

(Kaplan and Hutkins, 2000). Over the last 30 years, intensified efforts to identify and characterize lactic bacteria have revealed their many important roles in food, including acid production, texture development, flavour generation, preservation and synthesis of β-vitamin. Selected members of the lactic acid bacteria have now been implicated through clinical studies to provide resistance to enteric pathogens, stimulate the immune system and help maintain a balanced gastrointestinal microflora (Kullen and Klaenhammer, 1990; Chin et al., 2001).

Information on the evaluation of the nutritional value of kunun-zaki by feeding trial experiment on rats is rare. However, in the literature are found several studies on kunun-zaki. Awogbenga et al. (1999) studied the glycemic effect of kunun-zaki in blood glucose and observed that kunun-zaki has lower glycemic index (44%) as compared to the high-energy drink (glucose as standard, 100%) and this may be beneficial to diabetics. Akoma et al. (2002b) reported that kunun-zaki produced with the addition of ground malted rice to either millet, sorghum or maize resulted in 33, 44, 63% increases in crude protein. The objectives of this work are to evaluate both by chemical analysis and feeding trial experiments on rats: the nutritional and sensory characteristics of kunun-zaki, produced from malted cereals.

MATERIALS AND METHODS

Malting

Five hundred grams of cereal grains (paddy rice, millet or sorghum) was washed separately with tap water and soaked in 1000 ml of tap water (1:2, w/v) for 12 h and then drained. The drained grains were couched by covering them with moist cloth for 3 to 4 days at ambient temperature (25-30°C) to germinate. The dried malted cereal grains (paddy rice, millet or sorghum) were ground and packed separately in cellophane bags.

Production of kunun-zaki

Kunun-zaki was produced as described by Akoma et al. (2002b) using either millet or sorghum. The process involves cleaning and steeping of the grains before addition of spices (mixture of cloves, ginger and black pepper) and wet milling. 500 g of cleaned grains were steeped in 1000 ml tap water (1:2, w/v) for 24 h at ambient temperature (30-32°C). The water was then decanted off and the grains washed with more tap water before wet milling with 10 g of spices in 2 volume tap water. The paste, about 800 g, was divided into two portions (1:3, v/v). One of these was cooked using 2 volume of boiling water and allowed to cool to 45°C. Ground malted rice, millet or sorghum was mixed separately with the remaining uncooked paste (1:4, w/w) before being added to the cooked paste (i.e. gelatinized starch at 45°C). This mixture was stirred vigorously for about 5 min and then allowed to ferment for 8-10 h to produce two types of kunun-zaki made with either millet or sorghum. The fermented kunun-zaki was sieved (mesh size approx. 350 µm) and served without the addition of sweetening agent (Akoma et al., 2002b).

Chemical analysis

The pH of the various samples was measured with pH meter (Model 7020 Electronic Ltd, England) after standardization with pH 4 and 7 buffers (BDH, England). Titratable acidity (TA%, lactic acid) was determined by titration of 10 ml *kunun-zaki* against 0.1 N NaOH to phenolphthalein end point. Crude protein and crude fat of samples (10 ml) were determined with standard macro-Kjeldahl and soxhlet procedures, respectively (AOAC, 1990; Pearson, 1976). Total ash was obtained by igniting 10 ml sample at 600°C using muffle furnace (Pearson, 1976). Mineral content of the samples were determined with an automated atomic absorption spectrophotometer (Perkin-Elmer, Model 2380). The samples and standard solutions were prepared according to the procedures of the AOAC (1990).

Sensory evaluation

The sensory attributes (appearance, taste, texture, aroma and overall acceptability) of kunun-zaki produced from various cereals were evaluated by a 10-member panel, comprising of students and lecturers in the Department of Science Laboratory Technology Federal Polytechnic, Bida using a 7 point hedonic scale; where 1 = like extremely, 4 = neither like nor dislike and 7 = dislike extremely (Larmond, 1977) to assess the level of acceptability of the products.

Growth studies

30 weaned albino rats (weighing between 70 and 100 g) were purchased from Animal Facility Centre (AFC) NIPRD, Idu, Abuja, Nigeria. The weight of the 30 rats were taken at the beginning and divided into 5 groups of 6 rats each, housed in stainless rat cages and acclimatized for 2 days with access to free water and laboratory diet (NIPRD FEED). Each group was fed with laboratory feed plus kunun-zaki produced using various cereals (malted rice + millet, malted rice + sorghum, malted millet + millet, malted sorghum + sorghum) and water (as control). The weight of all the animals were taken and recorded daily for 14 days and the gain in weight computed.

Blood analysis

At the end of the experimental period, all the rats were sacrificed. Rats were anaesthetized and blood collected by cardiac puncture using anticoagulant (EDTA). Blood samples were analyzed for packed cell volume (PCV), red blood count (RBC), white blood count (WBC) and differential WBC (Baker et al., 1998).

Statistical analysis

Mean differences in sensory quality were computed using analysis of variance (ANOVA). The weight gain for rat feed with the four brands of kunun-zaki as well as the PCV, RBC, WBC collected from the animals at the end of experimental period were computed and significant difference among the mean was determined using Duncan's Multiple Range test (Duncan, 1955).

RESULTS

Chemical changes during fermentation of kunun-zaki

The changes in the pH and titratable acidity are shown in Table 1. There was marked decrease in pH of all the kunun-zaki produced. Particularly noticeably is the

Table 1. Changes in pH and titratable acidity during kunun-zaki production at ambient temperature.

Analyses	Fermentation time[1] (h)				
	0	2	4	6	8
pH					
Malted rice + millet	5.68 ± 0.08	5.58 ± 0.15	5.38 ± 0.43	4.93 ± 0.19	4.78 ± 0.16
Malted rice + sorghum	5.58 ± 0.31	5.43 ± 0.31	5.10 ± 0.25	5.05 ± 0.25	4.75 ± 0.11
Malted millet + millet	5.75 ± 0.33	5.60 ± 0.37	5.48 ± 0.19	4.98 ± 0.30	4.80 ± 0.20
Malted sorghum + sorghum	5.65 ± 0.18	5.48 ± 0.25	5.25 ± 0.27	5.00 ± 0.32	4.70 ± 0.21
Titratable acidity (% lactic acid)					
Malted rice + millet	0.55 ± 0.05	0.62 ± 0.08	0.67 ± 0.11	0.73 ± 0.14	0.76 ± 0.15
Malted rice + sorghum	0.50 ± 0.007	0.54 ± 0.06	0.63 ± 0.12	0.68 ± 0.16	0.69 ± 0.15
Malted millet + millet	0.45 ± 0.04	0.49 ± 0.04	0.51 ± 0.03	0.53 ± 0.03	0.55 ± 0.05
Malted sorghum + sorghum	0.44 ± 0.03	0.48 ± 0.04	0.51 ± 0.03	0.53 ± 0.04	0.56 ± 0.06

[1]Each value is the mean ± SD of four determinations.

Table 2. Sensory characteristics of kunun-zaki produced using malted cereals.

Sensory attributes	Products/ Sensory Score[1,2]			
	Malted rice + millet	Malted rice + sorghum	Malted millet + millet	Malted sorghum + sorghum
Appearance	2.35 ± 0.5^{ab}	2.25 ± 0.3^{ab}	2.60 ± 0.4^{a}	3.0 ± 0.3^{a}
Aroma	1.90 ± 0.4^{b}	2.4 ± 0.4^{a}	2.75 ± 0.8^{a}	2.65 ± 0.5^{a}
Taste	1.95 ± 0.6^{c}	2.45 ± 0.5^{b}	3.55 ± 1.0^{a}	2.75 ± 0.9^{a}
Overall acceptability	2.25 ± 0.7^{a}	2.4 ± 0.4^{ab}	2.85 ± 1.1^{a}	3.35 ± 1.0^{a}

[1]Each of data is the mean ± SD of 10 panellists where 1 = like extremely, 2 = like very much, 3 = like slightly, 4 = neither like nor dislike, 5 = dislike slightly, 6 = dislike very much, 7 = dislike extremely.
[2]Different letters within the score row are significantly different ($p < 0.05$).

Table 3. Proximate and mineral composition of kunun-zaki produced using malted cereals.

Analyses	Products[1]			
	Malted rice + millet	Malted rice + sorghum	Malted millet + millet	Malted sorghum + sorghum
Crude protein (%)	0.74	0.54	0.72	0.53
Ash (%)	0.12	0.18	0.05	0.13
Carbohydrate (%)	83.21	89.32	84.07	90.16
Crude fat (%)	0.50	0.40	0.45	0.40
Iron (ppm)	50.0	38.5	11.3	13.0
Calcium (ppm)	88.0	94.0	78.0	58.0
Sodium (ppm)	39.0	32.0	23.0	30.0
Potassium (ppm)	130.0	120.0	135.0	6.0

[1]Each is the mean of 2 determinations.

kunun-zaki produced using combination of malted sorghum and sorghum at the 8th hour (4.70). The titratable acidity (% lactic acid) increased throughout the period of fermentation especially in the kunun-zaki produced with the addition of ground malted rice to millet (0.76), which may have led to the decreased pH.

Organoleptic analysis of kunun-zaki

The sensory scores of kunun-zaki produced in this study are shown in Table 2. Kunun-zaki produced by the addition of ground malted rice to millet was generally preferred especially in aroma and taste and was significantly different ($p < 0.05$) from the other products.

Proximate and mineral compositions of kunun-zaki

In Table 3 is shown the proximate and mineral composition of four types of kunun-zaki produced in this study. The kunun-zaki produced by the addition of ground-malted rice to millet and ground malted millet to millet had higher crude protein values (0.74% and 0.72%)

Table 4. Growth response of rats fed with lab feed in combination with of kunun-zaki produced using malted cereals.

Weight (g)	Diets[1,2]				
	Malted rice + millet	Malted rice + sorghum	Malted millet + millet	Malted sorghum + sorghum	Control (water)
Mean initial wt	91.6 ± 12.1	91.7 ± 12.9	86.7 ± 14.9	93.2 ± 9	91.7 ± 9
Final wt gain	173.1	107.2	98.4	124.7	93.2
Mean daily wt gain	27.7 ± 4.0[a]	12.1 ± 1.7[b]	16.7 ± 2.4[b]	19.2 ± 2.2[b]	6.0 ± 0.9[c]

[1] Each value is the Mean ± S.D of six weaning rats/cage.
[2] Different letters within the same row are significantly different (p< 0.05).

Table 5. Haematological parameters of rats fed on laboratory diet and kunun-zaki produced from malted cereals.

Analyses	Diets[1,2]				
	Malted rice + millet	Malted rice + sorghum	Malted millet + millet	Malted sorghum + sorghum	Control (water)
Total WBC 10^9/l	2.2±0.96	1.88±0.75	1.84±0.14	1.66±0.41	2.0±0.37
Total RBC 10^{12}/l	3.4±0.61	1.68±0.65	3.0±0.78	3.0±1.15	2.8±0.81
PCV (%)	44.7±3.30	34.5±1.51	40.0±5.72	41.0±7.56	41.3±4.03
Neutrophil	58.8±12.3	53.4±6.34	51.2±8.70	54.4±13.66	53.6±11.71
Lymphocyte	45±14.58[a]	37±7.8[b]	37.5±9.59[b]	36.8±8.89[b]	33±15.25[b]

[1]Each value is the Mean ± S.D of six weaning rats/cage.
[2]Different letters within the same row are significantly different (p< 0.05).

and crude fat (0.5% and 0.45%), respectively, than the kunun-zaki produced from the other combinations. A similar trend was observed in the potassium content.

Growth studies

The mean daily weight gain and blood analyses of albino rats fed with kunun-zaki produced using various combinations are shown in Tables 4 and 5. Rats fed with kunun-zaki produced by the addition of ground malted rice to millet was observed to have gained more weight (27.7 g) than the others (Table 4) and was significantly different (p< 0.05). A similar trend was observed in the lymphocyte count (Table 5).

DISCUSSION

Kunun-zaki is a fermented cereal beverage believed to be nutritious and medicinal by its numerous consumers. The result obtained in this study shows that kunun-zaki produced with the addition of ground-malted rice to millet was more nutritious (crude protein; 0.74%; crude fat: 0.50%; iron: 50 ppm; calcium: 88 ppm) than the rest products (Table 3).

Albino rats fed with different types of kunun-zaki gained weight when compared with those fed with water as control (6 g). Interestingly, those rats fed with kunun-zaki produced with the addition of ground malted rice to millet, gained 27.2 g and was significantly different (p< 0.05) from the other products (Table 4). The growth of an animal is related to the quality and quantity of the food fed by it, and results obtained from this study agrees with previous findings (Akoma et al., 2002a; Olohogbo, 1987). These workers related the measurement of growth response of animals fed with fermented feeds to their nutritional content and reported an appreciable increase in weight gain during the experimental period.

Although rats fed with the addition of ground malted rice to millet showed a high blood counts (RBC, WBC, PCV, neutrophil), this was not significantly different (Table 5). However, the lymphocyte count of the blood samples of animals fed with this product was higher than the rest and differed significantly (p<0.05). In a previous study, we reported the dominance of two species of lactic acid bacteria (*Lactobacillus leichmannii* and *L. fermentum*) in kunun-zaki during its production process (10 h), thereby establishing the fact that kunun-zaki is a lactic acid bacteria fermented food product (Efiuvwevwere and Akoma, 1995). Various other studies have reported that foods produced by fermentation using lactic acid bacteria have medicinal attributes (Kurmann and Rai, 1999). Lactic acid bacteria are reported to stimulate the immune system and various studies have described their ability to activate macrophages and lymphocytes, improve the levels of immunoglobulin A, (IgA) and produce gamma interferon (Crittenden, 1999;

Gibson and Reberfroid, 1995; Matar et al., 2001). These effects may contribute to hosts' resistance to pathogens.

The kunun-zaki produced by the addition of ground malted rice to millet was generally preferred in taste and aroma and differs significantly ($p< 0.05$) from the other products. It is likely that the higher acidity of these products possibly enhanced their sensory quality attributes, thereby making them more preferred. Lactic acid bacteria fermentation has been shown by several workers to improve the nutritional and sensory quality attributes of foods (Anderson, 1988; Cooke et al., 1987). Our observations support the findings of these workers.

This results obtained in this study has shown that use of malted cereals improved the nutritional quality of the kunun-zaki and further supports the claim by kunun-zaki consumers that the product is medicinal.

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