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MICROBIOLOGICAL, PHYSICOCHEMICAL, NUTRITIONAL AND ANTI-NUTRITIONAL EVALUATION OF LOCALLY MADE NON-ALCOHOLIC KUNUN ZAKI BEVERAGE SOLD IN LAGOS STATE, NIGERIA

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Abstract: *Kunun zaki is a traditionally fermented cereal-based beverage produced locally and generally consumed throughout Nigeria. This study aimed to evaluate the microbiological, physicochemical, nutritional and anti-nutritional content of kunun zaki samples sold in various markets in Lagos, Nigeria using standard methods. The total bacteria and coliform count in kunun zaki ranged from 12 x 10^6 - 39 x 10^6 cfu/ml for bacteria and 3 x 10^5 - 17 x 10^5 cfu/ml for coliform respectively, while mould and yeast had total counts of 5 x 10^4 - 19 x10^4 cfu/ml and 1.0 x 10^4 - 9 x 10^4 cfu/ml respectively. The predominant bacterial species isolated were Staphylococcus aureus, E.coli, Klebisella sp., Bacillus sp. Streptococcus sp., Citrobacter feundii and Pseudomonas aeruginosa. The predominant fungal species isolated from the samples were Fusarium sp., Aspergillus parasiticus, Aspergillus niger, Candida albicans, Penicillium sp. and Saccharomyces cerevisiae. The pH, titratable acidity and specific gravity of the samples ranged from 3.87-4.28, 0.18-0.43 g/L and 0.736-0.75 respectively. The proximate analysis revealed that kunu samples contained 0.3-0.6% protein, 0.4-1.1% fat, 1.3-1.62 ash, 12.8-20.4% carbohydrate and moisture content ranging from 76.75-84.45%. The results for the mineral content analysis showed the presence of Phosphorus, Calcium, Potassium, Copper, Manganese and Magnesium. This study revealed that kunun zaki obtained from different markets in Lagos, Nigeria contained pathogenic microorganisms that pose threats to public health. Awareness campaign, training of local producers, and monitoring of compliance with safety standards are required to reduce risk of contamination.*

Keywords: *Kunun; Coliform; proximate; bacteria; fungi; mineral.*

1. Introduction

Fermented cereal-based non-alcoholic beverages like kunun zaki have formed an essential part of the dietary lifestyle of many adult and children in developing countries [1]. Kunun zaki, is a highly nutritious, refreshing and filling cereal-based beverage which is widely consumed in Nigeria due to its sweet, creamy,

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refreshing taste and consistency [2]. Kunun zaki has been reported to contain a variety of nutrients including carbohydrates, proteins, vitamins and several amino acids [3].

The traditional production of kunun zaki majorly requires the use of various grains, which include sorghum (*Sorghum bicolor*), pearl millet (*Pennisetum glaucum*), rice (*Oryza sativa*), fonio (*Digitaria exilis*) and maize (*Zea mays*) [4]. Spicy ingredients such as chili pepper, ginger and cloves are also used in addition to sweet potatoes, malted cereals as well as saccharifying agents to improve aroma, taste, nutritional quality and medicinal values of kunun zaki [5,6]. According to Adeleke and Abiodun [7], the appearance of kunun zaki is milky cream and is usually consumed few hours after its production. The method of processing kunun zaki generally varies based on the producer's household, personal interests, taste and cultural preferences. This results in a difference in the presentation, appearance, taste, flavor, consistency and overall quality of kunun zaki [8]. Due to the traditional method of preparation of kunun zaki, the ingredients used are neither quantified nor standardized, therefore the risk of contamination is very high [9].

Kunun zaki and other cereal-based products have been reported to contain probiotic bacterial communities including *Bifidobacterium* spp., *Lactobacillus brevis*, *Weissella confusa*, *Streptococcus lutetiensis*, *Streptococcus gallolyticus* [10,11]. Several scientific studies have evaluated the microbial and nutritional composition of kunun zaki in various parts of Nigeria with different results. According to Osuntogun and Aboabo [12], "kunun zaki contains lactic acid bacteria (LAB) such as *Lactobacillus* spp., *Streptococcus* spp. and *Leuconostoc* spp. which can cause food borne illnesses". Findings have shown that non-alcoholic beverages consumed in different parts of Nigeria contained anti-nutritional factors such as phytate and trypsin inhibitors, which may negatively affect their nutritional values [13,14]. Presently, there is a high intake of non-alcoholic beverages in different parts of Lagos, Nigeria, and some of these beverages are produced under unhygienic conditions [15]. This suggests that safety and nutritional values associated with the consumption of kunun zaki may be compromised. Hence, the present study aimed to evaluate the microbiological, physico-chemical, nutritional and anti-nutritional qualities of kunun zaki sold in Lagos, Nigeria.

2. Materials and Methods

Sample collection

Collection of kunun zaki samples were collected randomly at thirteen (13) major markets in Lagos State, Nigeria. A total of one hundred (100) samples of kunun zaki were collected, stored in sterile bottles and transferred to the laboratory for further evaluation. However, the samples were stored at 4º C and analyzed within 6 h after collection on sampling days twice per week for 1 month. Figure 1 shows the satellite image of sampling points in Lagos State, Nigeria.

Microbiological Analysis

One milliliter (1.0 ml) of kunun zaki sample aseptically taken and introduced into 9 ml sterile water previously autoclaved at 121ºC and 15psi for 15 min to make 1:10 dilution. This was followed by 6 serial 10-fold dilutions (10^{-1} – 10^{-7}) with 1 ml of each dilution mixed with molten agar (45ºC) to determine microbial count. Nutrient agar, MacConkey agar,

potato dextrose agar were used for total bacterial count, total coliform count and total fungal count respectively. Malt extract agar supplemented with streptomycin was used for total yeast count. Plates for total and coliform count determination were incubated at 37°C for 48 h, while those for total and yeast count determination were incubated at 28 ºC for 72 h [16]. All experiments were performed in triplicates with mean count calculated and measured as mean colony forming unit (cfu/ml) of kunun zaki [17].
Colonial, morphological and biochemical characterization of bacteria isolates were carried out using standard microbiological techniques according to Bergey's manual of Determinative Bacteriology [18]. Fungal identification and enumeration was based on their colony elevation, colour, texture, shape and arrangement of conidia (spherical or elliptical, unicellular or multicellular), branched or unbranched mycelia, presence or absence of cross walls (whether septate or non-septate) and others. They were enumerated according to 'illustrated manual on identification of some seed borne fungi' [19] and 'illustrated genera of imperfect fungi' [20].

Determination of pH, Titratable Acidity and Specific gravity
The pH, titratable acidity and specific gravity of the kunun zaki samples were determined according to the method of Association of Official Analytical Chemists (AOAC) [21]. The titratable acidity was expressed as % lactic acid present in the sample. Determinations were done in triplicates and mean values were calculated.

Proximate and Mineral Analysis
Moisture content, crude fat, protein and carbohydrate content were determined according to AOAC methods [21]. 'Atomic Absorption Spectrophotometer' (AAS) was used to determine three mineral contents (Calcium, Copper, Iron, and Magnesium) of the samples, while other minerals (Potassium, Phosphorus) were determined using'flame photometry'according to AOAC [21]. Determinations were performed in triplicates and mean values were calculated.

Anti-nutritional factors determination
The levels of phytate and trypsin inhibitor in the samples were determined using the colorimetric method [22,23]. Determinations were done in triplicates and mean values were calculated and expressed as mg per 100g (mg/100g) sample.

Statistical Analysis
Data obtained in this study were subjected to one-way analysis of variance (ANOVA) Graph pad prism® software package, version 5.0 (Graph- Pad Software Inc., San Diego, CA, USA).

3. Results and Discussion

The microbial counts in kunun zaki are presented in Table 1. The total bacteria and coliform count in kunun zaki ranged from 12 x 10^6 - 39 x 10^6 cfu/ml for bacteria and 3.0 x 10^5 - 17 x 10^5 cfu/ml for coliform respectively. Total count of mould ranged from 5.0 x 10^4 - 19 x10^4 cfu/ml while total yeast count ranged from 1.0 x 10^4 - 9 x 10^4 cfu/ml.The results showed that Ojuelegba had the highest bacteria count (39 x 10^6 cfu/ml) followed by Oyingbo (35 x 10^6 cfu//ml) while Yabatech had the least count (12 x 10^6 cfu/ml). The samples from Oyingbo had the highest fungi count (19 x 10^4 cfu/ml) followed by Orile (17 x 10^4

cfu/ml) while Unilag had the least fungi count (5 x 10^4 cfu/ml). Bariga had highest yeast count (9 x 10^4 cfu/ml) while Surulere had the least yeast count (1.0 x 10^4 cfu/ml). The occurrences of bacteria and fungi species were presented in Figures 2 and 3. Bacillus sp. had the highest occurrence (27.14%) followed by *E.coli* (22.86%) while *Citrobacter feundii* had the least occurrence (5.71%). Whereas *Saccharomyces cerevisiae* had the highest occurrence (61.72%) followed by *Candida albicans* (25.31%). *Penicillium* sp. (1.23%) had the least occurrence. From this present study, the results indicate that kunun zaki presented high microbial counts.

Coliforms and *E. coli* are known as indicators of faecal contamination in food products. According to WHO guidelines for drinking water [25], indicator organisms must not be present (=0 cfu/100ml). The coliform counts obtained in this study are far higher than the 10^4 cfu/g taken as tolerable in foods in developed countries [26]. Studies have shown that *Escherichia coli*, *Clostridium*, *Staphylococcus*, *Campylobacter*, and *Vibrio* are some of the common bacteria that cause food-related illness with severe implications [27]. The presence of coliform and *E. coli* in the kunun zaki indicates fecal contamination that may be due to unhygienic practices during or after processing the beverage [28]. Poor water quality, an unsanitary environment, low quality of materials, unclean equipment, stock containers, and improper handling by vendors could be the cause of microbial contamination in all kunun zaki samples [29, 30].

Ekanem *et al*. [31] previously reported that "samples of kunnu had total colony counts ranging from 0.5×10^5 to 3.2×10^5, 0.5×10^5 to 3.2×10^5, 5.2×10^5 to 8.0×10^5 (cfu/ml) for coliform bacteria, heterotrophic bacteria and heterotrophic fungi respectively". Efiuwevwere and Akoma [32] also reported the occurrence of high microbial communities in kunu-zaki samples produced in Jos metropolis. Anumudu and Anumudu [33] found the following occurrence (%) for nine genera of bacteria in kunnu: "*Staphylococcus* sp. (16.66%), *E. coli* (13.33%), *Citrobacter* sp. (13.33%), *Proteus* sp. (10.00%), *Serratia* sp. (10.00%), *Lactobacillus* sp. (10.00%), *Salmonella* sp. (10.00%), *Streptococcus* sp. (10.00%) and *Enterobacter* sp. (6.66%)".

Table 1
Microbial counts in the kunun zaki samples.

Sampling site	Bacterial counts (x 10^6 cfu/ml)	Coliform counts (x 10^5 cfu/ml)	Fungi counts (yeast) (x 10^4 cfu/ml)	Fungi counts (mould) (x 10^4 cfu/ml)
Jibowu	18	3	2	7
Surulere	15	6	1	9
Tejuosho	20	8	2	11
Orile	34	11	3	17
Obalende	19	9	NYG	10
Iyana-Ipaja	42	12	4	15
Ojuelegba	39	16	6	13
Unilag	16	5	NYG	5
Yabatech	12	4	NYG	6
Sabo-Yaba	26	7	5	16
Oyingbo	35	17	7	19
Lagos Island	17	8	8	8
Bariga	31	16	9	15

NYG-No yeast growth

Seven (7) bacteria species were isolated and identified (*E. coli* (3 strains), *Klebisella* sp. (5 strains*), Staphylococcus aureus* (5 strains), *Bacillus* sp. (3 strains), *Streptococcus* sp. (3 strains), *Citrobacter feundii* (3 strains), and *Pseudomonas aeruginosa* (3 strains)). Six (6) fungal species were isolated and identified as *Aspergillus parasiticus*, *Aspergillus niger*,

Fusarium sp., *Penicillium* sp., *Candida albicans* and *Saccharomyces cervisae* (Table 2 and 3). The result from this study is consistent with previous findings [34], which reported the isolation of *Staphylococcus aureus*, *Shigella* sp., *Streptococcus* sp., *Salmonella* sp., *E. coli*, *Lactobacillus* sp., *Klebsiella* sp., *Citrobacter* sp. in samples of kunu zaki produced in Kwara State, Nigeria. Adeyemi and Umar [1] had earlier reported the presence of *Lactobacillus plantarum*, *Leuconostoc mesenteriodes*, *Mucor* spp., *Rhizopus* spp. and *Saccharomyces cerevisiae* in kunun zaki prepared with a combination of sorghum and millet; while Osuntogun and Aboaba [12] isolated *Lactobacillus*, *Streptococcus*, *Aspergillus* and *Penicillium*. However, findings from Olasupo *et al.* [35], have confirmed the presence of lactic acid bacteria as the only test organism (including *Lactobacillus salivarius*, *Lactobacillus casei*, *Lactobacillus acidophilus*, *Lactobacillus jensenii*, *Lactobacillus cellobiosus* and *Lactobacillus plantarum*) found in kunun zaki. Adebayo *et al.* [3] isolated '*Aspergillus niger*, *Rhizopus stolonifer*, *Aspergillus nidulans* and *Aspergillus flavus* from kunun zaki. The results from this study indicates the presence of contaminants, which may be due to unhygienic practices or low production quality [3, 33, 36]. The consumption of such contaminated beverage may pose serious health risks to the consumers.

Proximate Analysis

As presented in Table 4, the result of the proximate analysis in this study showed that kunun zaki from different locations of Lagos metropolis contained 0.3-0.6% protein, 0.4-1.65% fat, 1.3-1.62% ash and 12.8-20.4% carbohydrate with moisture content ranging from 76.75-84.45%. The result of the proximate analysis in this present study are similar to a previous study by Onyeleke and Shittu [37] who reported that kunun zaki sold in Minna contain 0.33% protein, 1.0% fat, 1.52 ash and 12.2% carbohydrate. Previous report by Essien *et al.* [38] described that the loss of protein during processing may be responsible for the low protein content observed in the drinks.

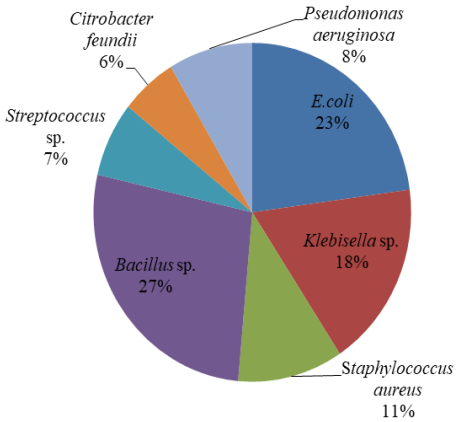

Fig.2: Occurrence of Bacteria species in the kunun zaki beverage obtained from different markets

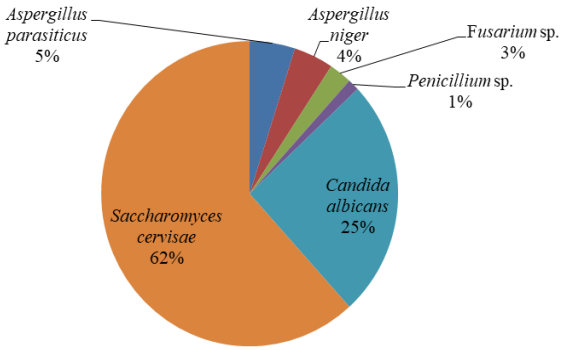

Fig.3: Occurrence of Fungi species in the kunun zaki beverage obtained from different markets

Table 2

Morphology and biochemical tests of isolates from kunun zaki products

Isolates	1	2	3	4	5	6	7	8	9	10	Identification
BC1	rod	-	+	+	-	-	+	+	+	+	*E.coli*
BC2	rod	-	+	+	+	--	+	+	-	+	*Klebsiella* sp.
BC3	coccus	+	+	+	+	-	+	+	-	+	*Staphylococcus aureus*
BC4	rod	+	+	+	-	+	+	-	+	+	*Bacillus* sp.
BC5	coccus	+	+	+	+	-	+	+	-	+	*Staphylococcus aureus*
BC6	rod	-	+	+	+	--	+	+	-	+	*Klebsiella* sp.
BC7	rod	-	+	+	-	-	+	+	+	+	*Citrobacter freundii*
BC8	rod	-	+	+	-	+	+	-	-	-	*Pseudomonas aeruginosa*
BC9	coccus	+	+	-	-	-	+	+	+	+	*Streptococcus* sp.
BC10	rod	-	+	+	-	-	+	+	+	+	*Citrobacter freundii*
BC11	rod	+	+	+	-	+	+	-	+	+	*Bacillus* sp.
BC12	coccus	+	+	-	-	-	+	+	+	+	*Streptococcus* sp.
BC13	rod	-	+	+	-	-	+	+	+	+	*E.coli*
BC14	rod	-	+	+	-	+	+	-	-	-	*Pseudomonas aeruginosa*
BC15	coccus	+	+	+	+	-	+	+	-	+	*Staphylococcus aureus*
BC16	rod	-	+	+	+	--	+	+	-	+	*Klebsiella* sp.
BC17	rod	+	+	+	-	+	+	-	+	+	*Bacillus* sp.
BC18	coccus	+	+	+	+	-	+	+	-	+	*Staphylococcus aureus*
BC19	rod	-	+	+	+	--	+	+	-	+	*Klebsiella* sp.
BC20	rod	-	+	+	-	-	+	+	+	+	*Citrobacter freundii*
BC21	coccus	+	+	+	+	-	+	+	-	+	*Staphylococcus aureus*
BC22	rod	-	+	+	-	-	+	+	+	+	*E.coli*
BC23	rod	-	+	+	-	+	+	-	-	-	*Pseudomonas aeruginosa*
BC24	rod	-	+	+	+	--	+	+	-	+	*Klebsiella* sp.
BC25	coccus	+	+	-	-	-	+	+	+	+	*Streptococcus* sp.

1-Shape; 2-Gram status; 3-Growth in Air; 4-Catalase; 5-Urease; 6-Oxidase; 7-Glucose; 8-Maltose; 9-Arabinose; 10-Sorbitol, +=Positive, -=Negative

Table 3

Microscopic and macroscopic characteristics of fungi isolates

Colony colour	Colony Diameter (mm)	Conidia colour	Conidiophore colour	Conidiophore surface texture	Phialides	Identification
black	33±1.4	Brown to black	brown	very rough, globose	Biseriate	*Aspergillus niger*
dark green	28±2.2	brown	colourless	distinctly rough, globose	Uniseriate	*Aspergillus parasiticus*
pinkish white	32±0.9	light brownish	orange	rough-walled, with an apical swelling	biseriate	*Fusarium* sp.
black	25±1.3		green	blue fuzzy, smooth	uniseriate	*Penicillium* sp.
smooth creamy colonies	40±2.2	brush-like	white	white	biseriate	*Candida albicans*
cream	18±1.2	white	white	white	Biseriate	*Saccharomyces cerevisiae*

Table 4

Proximate analysis of kunun zaki products obtained from various Lagos markets

Proximate contents	Moisture content	Fat	Ash	Protein	CHO
Jibowu	76.75±1.3	1.63±0.02	1.5±0.05	0.25±0.05	12.8±0.10
Surulere	79.47±0.36	1.42±0.01	1.3±0.25	0.6±0.10	17.2±0.10
Tejuosho	81.72±0.32	1.59±0.01	1.38±0.03	0.37±0.01	20.2±0.05
Orile	79.31±0.39	1.48±0.03	1.62±0.03	0.45±0.01	18.3±0.10
Obalende	82.38±0.72	1.57±0.06	1.38±0.010	0.33±0.07	17.6±0.50
Iyana-Ipaja	78.63±1.30	1.65±0.03	1.6±0.10	0.5±0.10	19.4±0.10
Ojuelegba	78.52±0.49	1.63±0.06	1.48±0.09	0.45±0.05	18.4±0.10
Unilag	81.16±0.02	1.57±0.06	1.6±0.10	0.37±0.03	17.3±0.05
Yabatech	82.13±0.33	1.54±0.01	1.5±0.10	0.42±0.02	18.8±0.40
Sabo-Yaba	84.45±0.21	1.61±0.02	1.3±0.10	0.6±0.10	19.3±0.40
Oyingbo	83.29±0.81	1.54±0.02	1.55±0.11	0.3±0.01	20.4±0.70
Lagos Island	78.24±0.03	1.43±0.02	1.5±0.10	0.4±0.05	19.8±0.25
Bariga	83.77±0.06	1.61±0.20	1.4±0.10	0.5±0.05	20.3±0.10

CHO-Carbohydrate; S.I units for all parameters are in %

Physicochemical analysis

The physicochemical properties of kunun zaki are presented in Table 5. The pH value of the kunun zaki samples ranged from 3.87- 4.28 which shows that the samples are acidic. Studies have shown that the pH value of a food is considered a measure of microbial spoilage.

Table 5

Physicochemical characteristics of kunun zaki samples sold in Lagos, Nigeria

Sampling site	pH	titratable acidity	Specific gravity
Jibowu	3.87±0.05	0.24±0.05	0.745±0.01
Surulere	4.03±0.01	0.18±0.01	0.738±0.02
Tejuosho	4.1±0.05	0.36±0.03	0.75±0.01
Orile	4.16±0.02	0.32±0.02	0.742±0.02
Obalende	3.97±0.05	0.43±0.01	0.745±0.015
Iyana-Ipaja	4.23±0.18	0.28±0.01	0.741±0.00
Ojuelegba	4.27±0.05	0.31±0.06	0.739±0.00
Unilag	4.12±0.05	0.18±0.01	0.738±0.00
Yabatech	4.28±0.03	0.24±0.01	0.745±0.00
Sabo-Yaba	4.05±0.25	0.32±0.01	0.743±0.00
Oyingbo	4.2±0.06	0.37±0.01	0.748±0.00
Lagos Island	4.15±0.03	0.41±0.02	0.736±0.00
Bariga	4.27±0.01	0.28±0.05	0.739±0.00

Microorganisms have been reported to have optimum pH requirements and so the higher the pH of a food, the more prone it is to microbial spoilage. This indicates kunun zaki as a food with high acid content (<4.6) may therefore be more resistant to microbial spoilage [39]. The pH values recorded in this study were lower than the previously reported values of 4.70-5.75 [40], but comparable to 3.3-4.3 reported by Elmahmood and Doughari [41].

In this study, the titratable acidity (TTA) of kunun zaki ranged from 0.18 to 0.43 of

lactic acid. This result is consistent with previous studies by Adebayo *et al.* [3] and Essien *et al.* [38]. Since high acidity and low pH can be attributed to the absorption of amino acids and the release of organic acid, the acidity of kunun zaki may be as a result of lactic acid production during fermentation [42]. Microorganisms utilize carbohydrates and this contributes to the production of more hydrogen ions, which signify increased production of acid in the beverage [43]. In this study, the specific gravity of the kunun zaki samples ranged from 0.736-0.75. This is lower than the values (1.02-1.06) reported by Omowaye-Taiwo and Oluwamukomi [44].

Mineral Composition

The results obtained for the mineral content of kunun zaki are presented in Table 6. In this study, the kunun zaki samples contained P (176.4-278mg/100g), Ca (290.7-427.2mg/100g), K (155-203mg/100g), Cu (0.1-0.9mg/100g), Mn (0.4-1.5mg/100g) and Mg (90.2-112.8mg/100g). The mineral content of kunun zaki recorded in this study is similar to a previous study by Nkama *et al.* [45]. Minerals are nutritionally important components in food and they are essential for health and cellular functions in the body [12]. In this study, calcium had the highest value followed by phosphorus, potassium, magnesium and manganese while copper was the least abundant in kunun zaki samples. This is consistent with previous findings by Ofudje *et al.* [33] who observed that kunun zaki has high content of calcium and low content of copper and manganese. The results for potassium, magnesium and copper are similar to results from previous study by Omowaye-Taiwo and Oluwamukomi [44].

Table 6

Mineral Composition ofkunun zaki products obtained from various Lagos markets

Sampling site	P (mg/100g)	Ca (mg/100g)	K (mg/100g)	Cu (mg/100g)	Mn (mg/100g)	Mg (mg/100g)
Jibowu	180.4±0.10	320.7±0.20	155±2.0	0.5±0.10	0.7±0.10	90.5±0.02
Surulere	176.4±0.20	290.7±0.10	160±2.0	0.3±0.20	1.2±0.15	107.2±0.10
Tejuosho	205.1±0.00	308.5±0.10	172±1.0	0.2±0.1	1±0.11	98.2±0.20
Orile	240±1.0	407.5±0.02	159±2.0	0.6±0.1	1.1±0.16	91.5±0.40
Obalende	195±2.0	370.3±0.3	163±3.0	0.1±0.01	0.9±0.01	93.7±0.10
Iyana-Ipaja	187.4±0.20	350.2±0.2	174±1.0	0.35±0.12	1.25±0.06	90.2±0.20
Ojuelegba	195±2.0	410.7±0.1	180±0.58	0.51±0.06	1.3±0.06	95.1±0.05
Unilag	230.5±0.10	345.1±0.03	203±1.0	0.27±0.07	0.8±0.10	108.4±0.10
Yabatech	240±2.0	290.7±0.2	165±1.0	0.4±0.03	0.7±0.11	112.8±0.10
Sabo-Yaba	278±2.0	350.2±0.1	190±1.0	0.22±0.01	1.2±0.20	102.9±0.79
Oyingbo	251.8±0.10	380±2.0	185±1.0	0.3±0.10	1.5±0.10	94.2±1.2
Lagos Island	270.4±0.10	345±1.0	175±2.0	0.4±0.09	0.7±0.20	90.8±1.6
Bariga	265±2.0	427.2±0.10	200±2.0	0.9±0.20	0.4±0.10	91.4±0.3

P-Phosphorus; Ca-Calcuim; K-Potassium; Cu-Copper; Mn-Manganese; Mg-Magnesium

Anti-nutritional contents of kunun zaki samples

The result of the anti-nutritional contents (phytate and trypsin) of kunun zaki samples are presented in Table 7. The phytate content of the samples ranged from 0.093mg/100g to 0.27mg/100g, while a range of 0.058mg/100g to 0.081mg/100g was obtained for trypsin inhibitor.

According to Food and Agriculture Organization (FAO) [46], anti-nutritional factors are generally defined as naturally occurring substances present in grains and other substances present in grain as a result of fungal or other environmental contamination. The reductions in the concentration of anti-nutritional factors in several grains have been attributed to the use of different processing techniques including germination, fermentation, soaking and cooking [47]. Adelekan *et al.* [12] reported a reduction in the concentration of trypsin inhibitor from 0.067 mg/100 g in unmalted kunun zaki to 0.057 mg/100 g in malted kunun zaki and similar occurrence was found in the result of the phytic acid. Studies have shown that some anti-nutritional factors affect the nutritional value of grains, while others have significantly serious consequences [46].

Table 7
Anti-nutritional contents of kunun zaki samples sold in Lagos metropolis.

Sampling site	Phytate (mg/100g)	Trypsin (mg/100g)
Jibowu	0.15±0.01	0.068±0.01
Surulere	0.17±0.01	0.072±0.01
Tejuosho	0.093±0.03	0.061±0.001
Orile	0.14±0.04	0.069±0.003
Obalende	0.27±0.05	0.08±0.01
Iyana-Ipaja	0.22±0.03	0.065±0.005
Ojuelegba	0.18±0.01	0.073±0.002
Unilag	0.14±0.02	0.072±0.002
Yabatech	0.12±0.01	0.074±0.002
Sabo-Yaba	0.2±0.01	0.062±0.001
Oyingbo	0.18±0.01	0.058±0.005
Lagos Island	0.17±0.01	0.073±0.001
Bariga	0.13±0.02	0.081±0007

4. Conclusion

The study showed that kunun zaki contains many essential nutrients, such as carbohydrates, protein, and fat. In addition, kunun zaki also contains essential mineral elements necessary for growth and development. The presence of contaminants in the kunun zaki samples, shows that the vended kunun zaki had been prepared under low hygienic condition and may pose serious health risk to consumers. Hence, improving the nutritional value and microbial quality of locally produced kunun zaki has become imperative.

5. References

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