International Scholars Journals

Advances in Agriculture and Agricultural Sciences ISSN 2381-3911 Vol. 2 (4), pp. 117-123, June, 2016.
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Full Length Research Paper

Pasteurization and chemical preservatives effects on the physiochemical, sensory properties and microbial qualities of kunun-zaki

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Accepted 31 May, 2016

"Kunun-zaki" was prepared using millet, with varied levels (0.01-0.05%) of chemical preservatives (sodium benzoate and metabisulphite). The effects of the chemical preservatives on the physico-chemical (total soluble solids, total solids, moisture, ash, and protein), sensory (colour, mouth feel, flavour and general acceptability), and microbial qualities were evaluated. Total soluble solid decreased from 11.0 to 4.2, 11 to 5.3, 11.0 to 10, 11.0 to 9, 11.0 to 9.0, 11.0 to 7.5, 11.0 to 10, and 11.0 to 9.0%; total solids decreased from 21.20 to 20.8, 21.0 to 20.9, 21.2 to 21.0, 21.8 to 21.1, 21.8 to 21.7, 21.0 to 20.9, 21.5 to 20.9, and 21.9 to 21.7 g/100g, while protein increased from 3.27 to 4.31, 3.57 to 3.59, 3.4 to 3.44, 3.48 to 3.49, 3.22 to 3.29, 3.29 to 3.32, 3.19 to 3.23, and 3.22 to 3.29%, total titratable acidity increased from 0.28 to 2.1, 0.12 to 0.91, 0.13 to 0.42, 0.2 to 0.61, 0.18 to 0.83, 0.19 to 0.34, 0.18 to 0.32, and 0.17 to 0.3 g/100ml, total microbial count increased from 1.8×10^4 to TNTC, 4.0×10^3 to 8.7×10^4, 2.5×10^3 to 7.4×10^4, 0 to 5.4×104, 0 to 3.85×10^4, 2.0×10^3 to 6.9×10^4, 1.0×10^3 to 6.45×10^4 and 0 to 4.9×10^4 cfu/ml for UPK, PK, P (0.01) NaBZ, P (0.03) NaBZ, P (0.05) NaBZ, P (0.01) MBS, P (0.03) MBS, and P (0.05) MBS respectively with increase in the storage duration (0-7 days). The samples preserved with metabisulphite had the lowest mean scores for colour. The pasteurized samples chemically preserved with 0.03% sodium benzoate product had the least microbial count, and was most accepted in terms of assessed sensory attributes.

Key words: Effects, chemical preservatives, pasteurization, shelf-life, *kunun-zaki*.

INTRODUCTION

Kunun zaki most probably originates from the Northern part of Nigeria, and is becoming one of the most popular drinks in this part of the country. The beverage can be used for entertainment during social gatherings like weddings and naming ceremonies, festive periods like 'Christmas' and 'Sallah' celebration. It is taken as a substitute for soft drinks and is relatively cheap (Ayo, 1998). However, it is a good source of energy.

The method of Kunun-zaki varies slightly from one locality to another. However, they all employ the same principle as described by Adeyemi and Umar (1996):

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cleaning and washing of grains, steeping with spices, wet milling, dividing the paste into three parts, gelatinising two of the parts (adding boiled water), cooling, mixing with the last part, leaving overnight (to ferment), then sieving and sweetening to taste.

As *kunun zaki* can be produced from different types of grains, particularly common in the area of production, they invariably carry the common name of the grain it is made of, for example, *Kunun-gero* (from millet), *Kunun-dawa* (from sorghum), *Kunun-masara* (from maize), *Kunun-acha* (from hungry rice or acha), *Kunun-shinkafa* (from rice), *Kunun-gyada* (from groundnut), *Kunun-tsamiya* (from tamarind), *Kunun-kanwa* (potassium hydroxide) (Maduegwe, 1995).

The major problem of k*unun zaki* is principally its short shelf life which could be attributed to its high moisture content, non-pasteurisation, poor hygienic handling and

no addition of preservatives. The product is therefore highly perishable (Kordylas, 1991). To minimize this, an attempt was made in this work to preserve the drink using some preservatives techniques.

The aim of this work is to assess the effects of pasteurisation and chemical preservatives on the physiochemical, sensory properties and microbial qualities of k*unun-zaki*.

MATERIALS AND METHODS

Materials

Millet (SOSAT C88) was collected from the Lake Chad Research Institute Maiduguri, Borno State, while the spices (ginger, cloves, and red pepper) and sweet potatoes were purchased from Yewa Tudu market, Bauchi. All the materials were vacuum packed in polythene (seran type) bag prior to their usage.

Production of kunun zaki

One kilogram of cleaned (sorted and washed using tap water) millet grains was steeped for 12 h (overnight) in water to soften the seed. The soaked grains were washed to remove stones, wet milled along with added spices (65 g of ginger, 25 g of cloves, 10 g of red pepper), and 15 g of sweet potatoes into a slurry. The slurry was divided into three parts: two parts were mixed together with 2500 ml of boiled water, stirred to form a gel, and allowed to cool for 3 h. The remaining slurry was added to the gel, mixed with cold boiled water, and left open overnight (12 h) for chance fermentation. It was then sieved with a muslin cloth and the filtrate (2000 ml) sweetened with sucrose (250 g) to produce *kunun-zaki* (Figure 1).

For the purpose of this work, preservatives (sodium benzoate and metabisulphite) were used in varied concentrations and the samples were packed in polythene bags.

The product (1400 ml) was pasteurised (65°C for 30 min), divided into portions (30 ml) and preserved with varied concentrations (0.01 to 0.05%) of the following chemical preservatives (sodium benzoate and sodium metabisulphite separately): pasteurized with 0.01% sodium benzoate [P (0.01) NaBZ], pasteurized with 0.03% sodium benzoate [P (0.03) NaBZ], pasteurized with 0.05% sodium benzoate [P (0.05) NaBZ], pasteurised with 0.01% metabisulphite [P (0.01) MBS], pasteurised with 0.03% metabisulphite [P (0.03) MBS], and pasteurized with 0.05% metabisulphite [P (0.05) MBS].

The product was then vacuum packaged in seran type polyethylene and kept for physicochemical, microbial and sensory evaluations with unpasteurised (UPK), pasteurized and without preservatives of *kunun zaki* (PK).

Proximate analysis

The moisture, ash, protein, total solid and total soluble solids, were determined by the method of Pearson (1976), and microbial analysis was carried out by the method of Odo and Ishiwu (1999). The acidity of the sample was determined by titrating 10 ml of the sample against 0.1 m NaOH using phenolphthalein as indicator and the result expressed as lactic acid. All analyses were in replicates.

Sensory evaluation

The coded samples were presented to 20 untrained panellists (from the Department of Food Science and Technology (who are familiar with the product) and evaluated using the five-point Hedonic scale (1 for extremely dislike and 5 for extremely like). The qualities evaluated for were: colour, taste, odour, after mouth feel and general acceptability. The sensory evaluation was done for the first day, second, fourth and seventh day. The data were analyzed using Analysis of Variance (ANOVA).

RESULTS AND DISCUSSION

Effect of preservatives on the physicochemical properties of kunun-*zaki*

The physicochemical properties of treated samples were monitored for a period of seven days. The effects of preservatives on the physicochemical properties of *kunun-zaki* are summarized in Table 1.

Total titrable acidity

The TTA of the samples UPK, PK, P (0.01) NaBZ, P (0.03) NaBZ, P (0.05) NaBZ, P (0.01) MBS, P (0.03) MBS, and P (0.05) MBS, increased from 0.28 to 2.1, 0.12 to 0.19, 0.13 to 0.42, 20 to 0.61, 0.18 to 0.83, 0.19 to 0.34, 0.18 to 0.32, and 0.17 to 0.30%, respectively, with increase in duration of storage (0 to 7 days) as shown in Table 1. This could be due to lactic acid produced from sugar or carbohydrate in the *kunun-zaki* by the lactic acid bacteria.

The increase in acidity is known to favour growth of yeasts. The unpasteurized *Kunun-zaki* had the highest % TTA of 2.1%, while the pasteurized sample with 0.05% MBS had the least % TTA. The decrease in the acidity of the pasteurised kunun could be due to the destruction of some of the fermenting organisms especially the *Lacobaccilus spp* (Table 2), by the applied heat treatment and the chemical preservatives hence reducing the quantity of acid produced. This agrees with the work of Adeyemi and Umar (1994) who observed a decrease in the titrable acidity of preserved kunun-zaki.

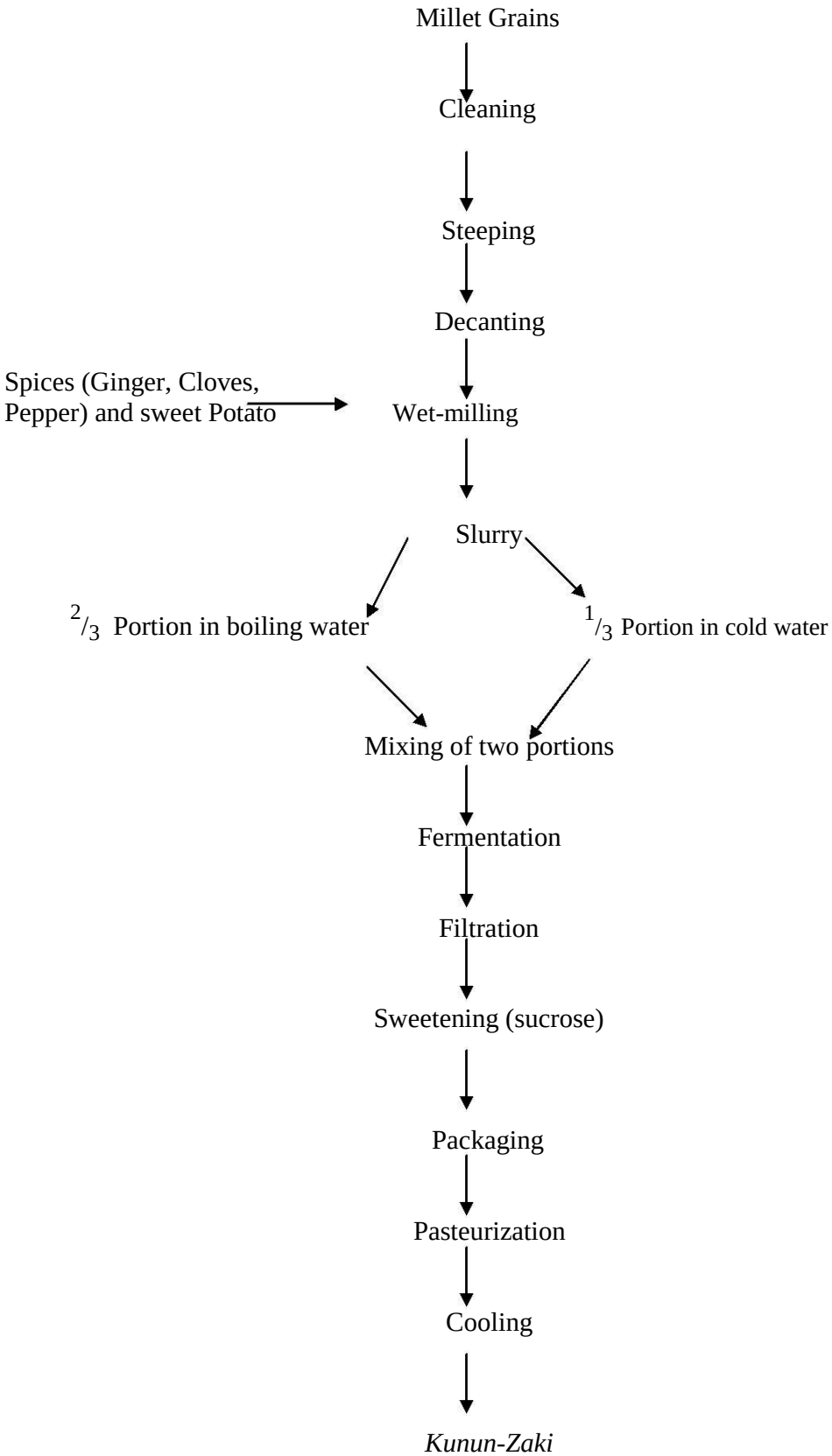

Fig. 1: Flow Chart for *Kunun – Zaki* Production (Adeyemi and Umar, 1994)

Figure 1. Flow chart for *Kunun –zaki* production (Adeyemi and Umar, 1994).

Table 1. Effect of preservatives on the physicochemical properties of Kunun – zaki.

Kunun	TSS (%)				T.T.A (%)				T.S (%)				Protein (%)				Moisture (%)				Ash (%)	
	Days				Days				Days				Days				Days				Days	
	0	2	4	7	0	2	4	7	0	2	4	7	0	2	4	7	0	2	4	7	0	7
UPK	11	5	4.5	4.2	0.28	0.61	1.9	2.1	21	20.9	20.8	20.8	3.27	4.27	4.30	4.31	85	85.2	85.2		0.30	0.27
PK	11	6.5	6.3	5.3	0.12	0.58	0.87	0.91	21	20.9	20.9	20.91	3.57	3.57	3.59	3.59	85	85	85.1		0.27	0.26
P (0.01) NaBZ	11	10.5	10.5	10	0.13	0.17	0.39	0.42	21.2	21	21	21	3.40	3.42	3.42	3.44	84.5	84.4	84		0.25	248
P (0.03) NaBZ	11	9.0	9.0	9	0.20	0.55	0.59	0.61	21.3	21.3	21.1	21.1	3.48	3.48	3.49	3.49	85.2	85.3	85.3		0.26	0.252
P (0.05) NaBZ	11	9.5	9.3	9	0.18	0.42	0.77	0.83	22	21.8	21.8	21.7	3.22	3.24	3.27	3.29	85.4	85.4	85.5		0.28	0.27
P (0.01) MBS	11	10	9.0	7.5	0.19	0.24	0.29	0.34	21.0	21	21	20.9	3.28	3.29	3.30	3.32	85	85	85.1		0.24	0.23
P (0.3) MBS	11	10.5	9.5	8.0	0.18	0.19	0.24	0.32	21.8	21.5	21.5	21.49	3.19	3.21	3.23	3.23	85.2	85.2	85.2		0.24	0.237
P (0.05) MBS	11	10.5	10.0	9	0.17	0.17	0.22	0.30	21.9	21.9	21.7	21.7	3.22	3.24	3.26	3.29	85.6	85.8	85.8		0.27	0.266

Table 2. Effect of preservatives on the microbial qualities of kunun-zaki.

Samples	Microbial count (cfu/ml)				Colonial characteristics	Probable organisms
	Days					
	0	2	4	7		
UPK	1.8×10^4	6.75×10^4	TNTC	TNTC	Round whitish colonies	*Saccharomyces cerevisae*
PK	2×10^3	5.35×10^4	7.85×10^4	8.7×10^4	Round creamy colonies	*Lactobaccilus micrococcus*
P (0.01) NaBZ	2×10^3	3.8×10^4	6.25×10^4	7.4×10^4	Yellow spotish colonies	*Staphylococcus aureus*
P (0.03) NaBZ	2×10^3	2.95×10^4	4.25×10^4	5.4×10^4	Creamy flat colonies	*Streptococcus spp*
P (0.05) NaBZ	2×10^3	2.2×10^4	3.65×10^4	3.85×10^4	Creamy flat colonies	*Lactobaccilus spp*
P (0.01) MBS	2×10^3	4.1×10^4	6.65×10^4	6.9×10^4	Yellow raised round Colonies	*Lactobaccilus spp*
P (0.03) MBS	2×10^3	3.7×10^4	5.75×10^4	6.45×10^4	Round Creamy Colonies	*Sacchanomyces spp*
P (0.05) MBS	2×10^3	1.85×10^4	3.55×10^4	4.9×10^4	Round Creamy Colonies	*Sacchanomyces spp*

Total soluble solids (TSS)

The TSS for samples UPK, PK, P (0.01) NaBZ, P (0.03) NaBZ, P (0.05) NaBZ, P (0.01) MBS, P (0.03) MBS and P (0.05) MBS decreased from 11 to 4.2, 11 to 5.3, 11 to 10, 11 to 9, 11 to 9, 11 to 7.5, 11 to 8.0 and 11 to 9%, respectively with increase in duration of storage (0 to 7 days). The decrease could be attributed to the corresponding increase in titrable acidity resulting from break down of sugars by surviving micro organisms to produce alcohol and gas which could lead to decrease in TSS (Bender, 1990). The result shows that the unpasteurized k*unun-zaki* had the least total soluble solid of 4.2% and a corresponding high acidity, while sample P (0.01) NaBZ had the highest TSS of 10.0% at the end of storage compared to 11% at the beginning of storage. The result showed that high count of microorganisms could influence the TSS and TTA. The higher the microbial count, the higher the TTA and the lower the T.S.S.

Protein content

The protein content of samples UPK, PK, P (0.01) NaBZ, P (0.03) NaBZ, P (0.05) NaBZ, P (0.01) MBS, P (0.03) MBS and P (0.05) MBS ranges from 4.25 to 4.31, 3.57 to 3.59, 3.40 to 44, 3.48 to 3.49, 3.22 to 3.29, 3.28 to 3.32, 3.19 to 3.23, 3.22 to 29%, respectively with increase in duration of storage (0 to 7 days). Slight increases were noticed with the unpasteurized samples having the highest % protein content of 4.25 to 4.31%. Pasteurization has been observed to denature about 10% of the protein content on products (Gaffa, 2000; Ogundana, 1989). The slight increase in protein content could be due to protein hydrolysis, which involves a consistently active proteinase activity resulting in rapid amino acid production during fermentation. A slight increase in the protein content (4.5%) was observed in the fermented locust bean (Odunfa, 1985).

Total solids

The T.S. of the samples UPK, PK, P (0.01) NaBZ, P (0.03) NaBZ, P (0.05) NaBZ, P (0.01) MBS, P (0.03) MBS, P (0.05) MBS were from 21 to 20.8, 21 to 20.91, 21.2 to 21, 21.3 to 21.1, 22 to 21.7, 21 to 20.9, 21.8 to 21.49 and 21.9 to 21.7%, respectively with increase in the duration of storage (0 to 7 days). Slight decreases were observed and this could probably be due to microbial decomposition of suspended and dissolved

solids.

The unpasteurized sample had the lowest value of 20.8% solids, which could be due to its high microbial count and consequent activities. Banwart (1989) observed that foods that receive heat treatment generally have lower microbial load than other foods.

Moisture content

The moisture content of samples UPK, PK, P (0.1) NaBZ, P (0.03) NaBZ, P (0.05) NaBZ, P (0.01) MBS, P (0.03) MBS and P (0.05) MBS ranges from 85 to 85.2, 85 to 85.19, 84.5 to 84.2, 85.2 to 85.4, 85.4 to 85.5, 85 to 85.2, 85.2 to 85.4 and 85.6 to 85.7%, respectively during the storage (0 to 7 days). The effect was very slight and could be said to be non significant. This could be due to the relatively high level of moisture in the product.

Ash content

Ash content of samples UPK, PK, P (0.01) NaBZ, P (0.03) NaBZ, P (0.05) NaBZ, P (0.01) MBS, P (0.03) MBS and P (0.05) MBS decreased from 0.3 to 0.27, 0.27 to 0.26, 0.25 to 0.248, 0.26 to 0.252, 0.28 to 0.27, 0.24 to 0.23, 0.24 to 0.237 and 0.27 to 0.266%, respectively with increase in storage duration (0 to 7 days).

The results showed a decrease in ash content for all the samples for the storage length of 7 days. The decrease in the ash content could be as a result of its usage as metabolic nutrients for the growth of microorganisms.

Effect of preservatives on the microbiological qualities of kunun – zaki

The effect of preservatives on the microbial qualities of k*unun-zaki* is summarized in Table 2. The microbial count of samples UPK, PK, P (0.01) NaBZ, P (0.03) NaBZ, P (0.05) NaBZ, P (0.01) MBS, P (0.03) MBS, and P (0.05) MBS increased rapidly from 1.8×10^4 – TNTC, 2×10^3 – 8.7×10^4, 2×10^3 – 7.4×10^4, 2×10^3 – 5.4×10^4, 2×10^3 – 3.8×10^4, 2×10^3 - 6.9×10^4, 2×10^3 - 6.45×10^4 and 2×10^3 – 4.9×10^4 cfu/ml, respectively with increase in storage duration (0 to 7 days). Sample P (0.05) NaBZ had the least counts of 3.85×10^4 cfu/ml.

The results showed that the unpasteurized sample has a relatively high microbial count with increase in length of storage. Also it was observed that the microbial count decreased with reduction of level of chemical preservative which could be due to the inhibitory and destructive effect of the chemicals against micro organisms such as yeast, mould and bacteria (Brown and Booth, 1991; Abdulahi, 1993).

The PK sample had a fairly high count (4×10^3 cfu/ml) which could be due to non effectiveness of the pasteurization process, recontamination due to poor post process handling and leakage of the package. While the absence of microbe in P (0.03) NaBZ, P (0.05) NaBZ and P (0 - 0.05) MBS at the beginning of storage showed the effectiveness of the chemical preservatives at the higher concentration, subsequent presence of microbes on storage could be due to recontamination as a result of leakage of the package. Gaffa (2000) observed that at 0.05% concentrations (w/w), sodium benzoate and sodium metabisulphite kept *kunun zaki* product for three days. However, this work showed that the combine effect of pasteurisation and these chemical preservatives can extend their shelf life to more than six days.

Micro organisms isolated from spoilt beverage were mostly lactic acid bacteria (*Lactobicillus plantarum* and *Leuconostoc mesenteriodes*) and *Saccharomyces cerevisiae* indicating that not all the organisms involved in the processing were eliminated by the effect of the preservatives as earlier proved by Gaffa (2000). Kabara and Eklund (1991) showed that sodium metabisulphite and sodium benzoate exhibit a mycostatic and bacteriostatic action only on susceptible organisms.

Sulphites and benzoate interfere with chemical and enzymic changes inhibiting growth in microbes. Another explanation for the survival of some micro organisms could be that the low concentration of the chemicals added might have reacted with some components of the beverage leaving an extremely low quantity in the solution which could not be effective. Gould and Russel (1991) observed that sulphites chemically react with sugars lowering concentration and hence reducing their antimicrobial effect. Moreover, sodium sulphite is unstable in foods and therefore may lose its effectiveness substantially during storage as it oxidises to sulphide which is ineffective as antimicrobial. Secondly, sulphite undergoes many reactions with molecular components of the plants to form products which do not retain the functionality of the free sulphite. The probable organisms observed in the samples include *Saccharomyces cerevisae, Lactobaccus micrococcus, Staphylococcus aureus, Eschericia coli*, etc., which can be compared with those identified by Efiuvwevwere and Akona (1995) and Ityang and Dabet (1997) in their respective works on fermentation.

To some extent, the microbial count or load might be used to evaluate the potential safety of foods and the determination of microbial load which is needed to evaluate the effectiveness of methods of preservation (Banwart, 1989; Efiuvwevwere and Akona, 1995).This work has showed that increase in the concentration of the preservatives to some extent reduced the total counts of micro organisms which can as well be said to increase their potential safety.

Effect of preservatives on the sensory qualities of *Kunun zaki*

The effect of preservatives on the sensory qualities of

Table 3. Effect of preservatives on the sensory qualities of Kunu-zaki.

Sample	Colour			Flavour			After mouth feel			General acceptability		
	Days			Days			Days			Days		
	0	2	4	0	2	4	0	2	4	0	2	4
UPK	4.3	4.25	4.0	4.25	1.85	1.9	4.4	1.55	1.75	4.3	2.0	1.8
PK	3.05	4.15	4.0	3.25	3.65	3.4	3.25	3.45	2.9	3.25	3.4	2.75
P (0.01) NABZ	3.85	3.8	3.85	3.3	3.9	3.55	3.0	3.45	3.6	3	3.35	3.4
P (0.03) NABZ	3.85	3.25	3.9	3.2	3.4	3.75	3.1	3.15	3.4	3	3.15	3.75
P (0.05) NABZ	3.35	2.65	2.25	3.25	2.7	2.5	3.05	2.35	2.4	3.15	2.5	2.55
P (0.01) MBS	3.15	2.85	2.6	2.8	1.9	2.5	2.7	1.9	2.3	2.75	2.1	2.15
P (0.03) MBS	2.65	2.6	3.35	2.9	2.5	1.95	2.4	2.25	1.75	2.55	2.15	1.65
P (0.05) MBS	2.85	2.0	2.00	2.3	2.6	2.05	2.15	2.2	1.5	2.05	2.05	1.7
LSD at $p \leq 0.05$	1.15	.24	2.8	.68	.24	2.3	0.77	0.17	2.8	0.88	0.19	2.7

kunun zaki is summarized in Table 3.

Colour

The colour of samples UPK, PK, P (0.01) NaBZ, P (0.03) NaBZ, P (0.05) NaBZ, P (0.01) MBS, P (0.03) MBS and P (0.05) MBS had a mean score range of 4.3 - 4.0, 3.05 - 4.0, 3.85 - 3.85, 3.85 - 3.9, 3.35 - 2.25, 3.15 - 2.6, 2.65 - 3.35 and 2.85 - 2.0, respectively, with increase in length of storage (0 to 4 days). There was significant difference between the samples ($p<0.05$). The unpasteurized sample had the highest mean scores of 4 while the k*unun-zaki* preserved with metabisulphite generally had low mean scores.

The low mean scores could be due to the dark colour produced probably as resultant products of the reaction of metabisulphite added and the iron content in the millet. Millet has iron content of 9 mg/100 g which is capable of reacting with metabisulphite to produce iron sulphite that is dark in colour (Okaka, 1997).

Flavour

The average mean flavour scores of samples UPK, PK, P (0.01) NaBZ, P (0.03) NaBZ, P (0.05) NaBZ, P (0.01) MBS, P (0.03) MBS and P (0.05) MBS ranges from 4.25 – 1.9, 3.25 – 3.4, 3.3 – 3.55, 3.2 – 3.75, 3.25 – 2.5, 2.8 – 2.5, 2.9 – 1.95 and 2.3 – 2.05 respectively, within the storage duration (0 to 4 days). The unpasteurized sample had the least mean score of 1.9 and sample P (0.03) NaBZ had the highest mean score. The low average mean scores observed for the pasteurized and chemically preserved samples could be due to the destructive effect of heat on the volatile flavouring compounds inherent in *kunun zaki*. The use of preservative properties has been found to improve the flavour of food (Rinzler, 1990).

Mouth feel

The average mean scores for mouth feel for samples UPK, PK, P (0.01) NaBZ, P (0.03) NaBZ, P (0.05) NaBZ, P (0.01) MBS, P (0.03) MBS and P (0.05) MBS ranges from 4.4 – 1.75, 3.25 – 2.9, 3.0 – 3.6, 3.1 – 3.4, 3.05 – 2.4, 2.7 - 2.3, 2.4 – 1.75 and 2.15 – 1.5, respectively, at $p<0.05$. The samples P (0.01) and P (0.03) NaBZ had the highest mean score of 3.4 and 3.6 respectively, while sample P (0.05) MBS had the lowest mean of 1.5. This could be due to the residual component of the preservatives in the product.

General acceptability

The mean scores of samples UPK, PK, P (0.01) NaBZ, P (0.03) NaBZ, P (0.05) NaBZ, P (0.01) MBS, P (0.03) MBS and P (0.05) MBS ranges from 4.3 – 1.8, 3.25 – 2.75, 3 – 3.4, 3 – 3.75, 3.15 – 2.55, 2.75 – 2.15, 2.55 – 1.66 and 2.05 – 1.7, respectively. Sample P (0.03) NaBZ had the highest mean score of 3.75. The low acceptability of the products preserved by sodium metabisulphite could be due to its choking and harsh flavour.

For all the quality attributes, the decrease in mean score was associated with a corresponding increase in microbial count. Banwart (1989) observed that as microbial count increases, the quality of the food is reduced.

Conclusion

This work showed that pasteurization and chemical preservation has effect on the shelf life, chemical and sensory quality of *kunun-zaki*. The shelf life of the product was generally improved. The samples P (0.05) NaBZ had the lowest microbial count of 3.85×10^4 cfu/ml after 7 days, while the unpasteurized sample had the highest

microbial count. The sensory qualities of sample P (0.03) NaBZ were most preferred. Generally, the combination of pasteurisation and chemical preservation (sodium benzoate at 0.03%) has proved to be the most effective preservative method for kunun *zaki.*

ACKNOWLEDGEMENT

Special appreciation to the Lake Chad Research Institute, Maiduguri, Nigeria for supplying the millet (SOSAT 88) that was used in this work.

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