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Effects of Chemical Treatment and Pasteurization on the Shelf Life of Kunun Zaki (Sorghum and Maize Gruel)

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Research Article

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ABSTRACT

This study was aimed to investigate the effects of chemical treatment as well as pasteurization on the shelf life of "kunun zaki" (a non-alcoholic beverage commonly consumed by the people of northern Nigeria), to increase the shelf life and preserve the quality of the beverage. Kunun zaki was produced by dry -cleaning, washing, steeping (sorghum for 24 hours and maize for 48 hours), malting for 72 hours at room temperature, wet milling, mixing, cooking and filtering to obtain the liquor. The product was treated with 0.1% sodiumbenzoate or sodium metabisulphite or their combinations. These were packed and pasteurized in bottles at 60^{o}C for one hour. Another batch of samples were chemically treated but not pasteurized. Pasteurized samples which were not chemically treated served as control. Samples were stored at ambient temperature and monitored for changes in pH, titratable acidity, total solid, total sugars, acceptability and colour for four weeks. The pH and sugar decreased and the decrease was more pronounced in non pasteurized samples irrespective of chemical treatment. Titratable acidity increased in all samples with storage time. Pasteurized kunun zaki which received no chemical treatment deteriorated after one week of storage. Samples treated with 0.1% sodium benzoate or sodium metabisulphite or their combination without pasteurization deteriorated after two weeks of storage. Samples which were similarly treated and pasteurized were stable for more than three weeks. Pasteurization enhanced effectiveness of chemical preservation and acceptability of kunun zaki.

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1. INTRODUCTION

Kunun zaki is a product obtained from cereal grains such as sorghum (*Sorghum vulgare*), maize (*Zea mays*), and millet (*Pennisetum typhoideum*). These grains can be used singly or in combination (Gaffer et al., 2002a). Sorghum and millet are the most common combinations used in the ratio of 1:2 (w/w) kunun zaki, a non-alcoholic cereal beverage commonly consumed by the people of the Northern Nigeria though; it is becoming popular in other parts of the country (Gaffer et al., 2002a). Kunun is produced all year round with the peak production during the dry season. Production of kunun is done by all classes of people in the country. Its consumption follows the same pattern regardless of social status.

It has a short shelf life of about 24 hours under tropical ambient conditions, though a little longer under refrigeration (Gaffer et al., 2002b). Different types of kunun exist based on the materials that are used in the production. Common example found in literature is kunun zaki from millet (Onuorah et al., 1982).

The nutritional composition of kunun zaki and its microbiological quality have been reported (Gaffer et al., 2002a). The beverage is high in energy; the malted grain is also rich in protein, essential mineral elements and vitamins (Onuorah et al., 1982). At household level, kunun is used as a thirst quenching drink. Kunun is popular in both cities and villages, most especially in the Northern parts of the Nigeria, where it is also frequently served at ceremonies such as wedding, naming and even at Christmas celebrations. It serves as a source of income for processors.

The problem associated with the drink is short shelf life due to autolysis (enzymatic factor as well as microbial action) such as that of yeast and mould (Gaffer et al., 2002b). This short shelf life has been the limitation or problem which necessitated the current investigation into the use of chemical in the preservation of kunun zaki.

The objectives of this study therefore was to explore the feasibility of extending the shelf life of kunun zaki drink using low level of chemical preservatives in combination with pasteurization method. The study also evaluates the sensory properties of the chemically preserved kunun zaki stored at ambient temperature.

2. MATERIALS AND METHODS

2.1 MATERIALS USED FOR PREPARATION OF KUNUN ZAKI

Sorghum grains (Sorghum vulgare), maize (Zea mays), malted grain of millet, sweet potatoes and spices were obtained from Anyigba market in Kogi State, Nigeria. The spices like ginger (Zingiber officinate), Cloves (Eugenia coryphée), red pepper (Capsicum onnum) were used. The chemical preservatives used were Sodium benzoate, and Sodium metabisulphite (BDH).

2.2 METHOD OF PREPARATION

Sorghum and maize of ratio 2:1 were cleaned separately to remove adhering particles of stones and plant debris. The grains were washed with potable water to remove adhering particles that may serve as contaminants. The sorghum and maize were steeped for 24 and 48 hours respectively to soften the kernel. Some steeped grains were spread on clean table surface and allowed to germinate for seventy two (72) hours at room temperature. Germinated grains were subsequently dried at 45^0C for 24 hours.

The sorghum, maize and spices were milled together with small quantity of water to form a paste, while the sweet potatoes and the malted grains were milled separately.

Slurry I:
The slurry from the wet milling was dispersed in small quantity of cold water, followed by addition of 50% boiling water and was stirred to give partly cooked slurry.

Slurry II:
This was made up of sweet potatoes and malted grains grounded together and were diluted with small quantity of cold water. This was then added to slurry I and stirred. The mixed extracted kunun zaki was allowed to cool for 1-2 hours. The cooled extract was filtered through a muslin cloth.

Addition of chemical preservatives
The filtrate was divided into four batches and each was re-divided into two different batches. Chemicals of different proportion were added (sodium benzoate (0.144g) or sodium metabisulphite (0.189g) or a combination of the two). One set of the samples contained no preservatives and another set was pasteurized while the third batch received chemical treatment. The fourth batch was only pasteurized and served as control.

Packaging
Kunun zaki was filled aseptically into 33cl sterilized plastic bottle and corked automatically.

Pasteurization
The filled bottle were transferred into hot water bath and heated at 60^oC for 1 hour. The product was removed, cooled and stored at ambient temperature(30 to 31OC) for four weeks and the changes in color, taste, total acidity, total sugar and pH value were monitored.

2.3 pH DETERMINATION

The pH of kunun zaki was determined using a pH meter (Horiba, M-8). The pH meter was first standardized with a buffer solution of pH 4.0 and then introduced into a small beaker containing 100ml of kunun zaki.

2.4 TOTAL ACIDITY (AS LACTIC ACID)

A portion (10ml) of kunun zaki was measured into a 250ml conical flask and four drops of phenolphthaleine indicator was added. This was titrated with the standard 0.1N NaOH to distinct faint pink point. The total titratable acidity was expressed as lactic acid (g/100ml) as described by (Pearson, 1976).

2.5 TOTAL SUGARS

The total sugar content of the kunun zaki drink was determined following the method described by (Dubios et al., 1956).

2.6 TOTAL SOLID

Total solid was determined by evaporating 25ml of kunun zaki to dryness on boiling water bath which was followed by drying to constant weight in an oven at 130^{o}C for 2-3 hours.

$$\% \text{ Total solid} = \frac{\text{Dry weight}}{\text{Weight of sample}} \times 100$$

2.7 COLOUR

The colour of kunun zaki was determined following the procedure described in (AOAC, 1980). A portion (20 ml) of filtered kunun zaki was mixed and filtered through filter paper. Absorbance of clean total filtrate was determined at 340nm using spectrophotometer (Gensis, England).

Colour = 100 x A where A = absorbance**.**

2.8 SENSORY ANALYSIS

The chemically preserved kunun zaki samples were evaluated for taste, colour, flavour, general consistency and acceptability/preference on a 5-point scale (5,4,3,2,1), 5 as excellent and 1 as poor by a panel of 11 judges made up of lecturers, technologists, and non-academicians who were randomly selected from Kogi State University, Anyigba, Nigeria.

2.9 STATISTICAL ANALYSIS

The data collected was subjected to analysis of variance (ANOVA) and the means were separated using pre-packaged computer statistical software (MINITAB 15).

3. RESULTS AND DISCUSSION

Variation in properties of the pasteurized and non-pasteurized kunun zaki treated with 0.1% level of sodium benzoate or sodium metabisulphite or a combination of both during storage is presented in tables 1-7.

The result of the variation in pH value of the treated kunun zaki with storage time is presented on table 1. The pH value decreased with storage time and the decrease was not significantly different ($P>0.05$) with chemical treatment and pasteurization. The treatments became more acidic with storage time. The decrease in pH with storage time as expected was more rapid in samples given pasteurized treatment only as well as in sample treated with either sodium metabisulphite or sodium benzoate or their combination without pasteurization. These samples were found not to be stable beyond two weeks of storage. On

the other hand chemically treated sample that received pasteurized treatment had a short range of pH decrease and remained stable without any observable deterioration for up to 3 weeks or more though the samples became too acidic.

Combination of sodium benzoate with metabisulphite in pasteurized samples did not produce any significant ($p>0.05$) improvement in the rate of pH decrease, thus, the two preservatives showed no significant ($p>0.05$) additive effect with respect to sample pH. A pH value of 6.50 was reported tigernut based kunun zaki by Belewu and Abodunri (2008). The deviation from the reported result may be attributed to different techniques involved in the preparation and preservation of samples.

Table 1. Effect of different preservation treatments on the pH Value of Kunun zaki from 0 to 3rd week of storage time

Treatment	Weeks			
	0	1	2	3
Pasteurized	5.12	2.05	-	-
Sodium benzoate + pasteurized	2.34	2.27*	2.20	2.23
Sodium benzoate + not pasteurized	2.81	2.24*	-	-
Sodium metabisulphite + pasteurized	5.00	2.65*	2.90	3.85
Sodium metabisulphite + not pasteurized	3.79	2.93	-	-
Sodium benzoate and sodium metabisulphite + pasteurized	5.06	3.06*	2.90	2.68
Sodium benzoate and sodium metabisulphite + not pasteurized	3.80	2.80*	-	-

**No significant difference ($p>0.05$).*

The titratable acidity showed an increasing trend with storage time in all the samples tested (Table 2). This increased in all the samples though the increase was not much from week 1 to 3 where sample did not go off flavor. The off flavor characteristic was observed only in samples that were not pasteurized even though they had chemical treatment. As was found in pH, sample which received no pasteurized treatments irrespective of the chemical treatment given deteriorated significantly ($p<0.05$) after 2 weeks of storage. Samples treated with sodium benzoate or sodium metabisulphite or their combinations and subsequently pasteurized remained stable (maintain color and flavor) until the third week though the acidity levels were high. Combination of the two preservatives tend to have no significant ($p>0.05$) additive effect in respect of the titratable acidity of kunun zaki.

Table 2. Effect of different preservation treatments on Titratable Acidity (g/100ml) of Kunun zaki from 0 to 3rd week of storage time

Treatment	Weeks			
	0	1	2	3
Pasteurized	0.018[a]	0.067[c]	Off flavor	Off flavor
Sodium benzoate + pasteurized	0.048[a]	0.075[c]	0.106	0.290
Sodium benzoate + not pasteurized	0.036[b]	0.066[c]	Off flavor	Off flavor
Sodium metabisulphite + pasteurized	0.017[c]	0.028[c]	0.040	0.101
Sodium metabisulphite + not pasteurized	0.014[d]	0.032[c]	Off flavor	Off flavor
Sodium benzoate and sodium metabisulphite + pasteurized	0.011[e]	0.011[d]	0.45	0.050
Sodium benzoate and sodium metabisulphite + not pasteurized	0.017[f]	0.056[d]	Off flavor	Off flavor

Value in the same column with the same letter are not significantly different (P>0.05)

The change in total sugar content of kunun zaki with storage time is shown in table 3. The sugar content generally decreased with storage time, chemical treatment and pasteurization did not prevent this decrease. The decrease in total sugar was more pronounced in week 2 of the storage time for the treatment (Pasteurized and Sodium benzoate + Sodium metabisulphite + not pasteurized).The sample which was pasteurized without chemical treatment initially had a total sugar content of 12.9%. At the end of the 2nd week of storage, the total sugar reduced to 10%. Similar trend of total sugar reduction with storage time was found in sample treated with sodium benzoate or sodium metabisulphite or their combinations without pasteurized treatment. These samples also deteriorated after two weeks beyond a level for chemical analysis to be carried out on them owing to severe off flavor and color change

On the other hand, samples treated with these chemicals and also were given pasteurized treatment remained virtually stable in their sugar content until after three (3) weeks of storage. The sugar content dropped very drastically on the 4th week of storage in these samples. As was found in titratable acidity and pH analysis, the stability of the samples as conferred by sodium benzoate and sodium metabisulphite is only relevant as long as the sample was pasteurized and the combination of these chemicals did not provide any significant additive effects.

The total solid content as affected by storage time in test sample is presented in table 4. The result showed that the total solid content of the sample decreased rapidly in all cases after two weeks of storage. The decrease in total solids was observed from week 1 and disappeared completely in week 2 and 3. The chemical treatment and pasteurization therefore had some positive effect on the total solid.

Table 3. Effect of different preservation treatments on Total Sugar content (%) of Kunun zaki from 0 to 3rd week of storage time

Treatment	Weeks			
	0	1	2	3
Pasteurized	8.4[a]	10.0[c]	10.0	3.2
Sodium benzoate + pasteurized	8.1[a]	8.2[b]	8.1	-
Sodium benzoate + not pasteurized	8.3[a]	8.3[b]	8.3	2.3
Sodium metabisulphite + pasteurized	8.1[a]	8.5[b]	9.0	-
Sodium metabisulphite + not pasteurized	9.0[a]	8.0[b]	8.1	8.2
Sodium benzoate and sodium metabisulphite + pasteurized	9.9[a]	9.8[b]	-	-
Sodium benzoate and sodium metabisulphite + not pasteurized	8.4[a]	10.0[c]	10.0	3.2

Value in the same column with the same letter are not significantly different (P>0.05)

This observation might be due to the modified nature of the starch of the two cereals used and due to chemical treatment. Earlier work reported a total solid of 6.85g/100ml for Kunun zaki (Adeyemi and Umar, 1994) prepared from other cereals, suggesting that acceptable beverage could be prepared from maize and sorghum and preserved with these chemicals following pasteurization.

Table 4. Effect of different preservation treatments on total solid content (g/100ml) of Kunun zaki from 0 to 3rd week of storage time

Treatment	Weeks			
	0	1	2	3
Pasteurized	12.5[a]	8.7[b]	-	-
Sodium benzoate + pasteurized	10.1[a]	7.16[b]	-	-
Sodium benzoate + not pasteurized	11.7[a]	6.3[b]	-	-
Sodium metabisulphite + pasteurized	11.7[a]	4.8[c]	-	-
Sodium metabisulphite + not pasteurized	9.2[b]	3.5[c]	-	-
Sodium benzoate and sodium metabisulphite + pasteurized	9.6[b]	3.9[c]	-	-
Sodium benzoate and sodium metabisulphite + not pasteurized	12.3[a]	3.6[c]	-	-

Value in the same column with the same letter are not significantly different (P>0.05)

Variation in the color of kunun zaki given various treatments with storage time is presented in table 5. The result showed that samples given pasteurized treatment without chemical preservation lost color after one week of storage. Combination of the two chemicals hastened the disappearance of the normal color of Kunun zaki but sample given pasteurization treatment in addition to sodium benzoate or sodium metabisulphite retained their color for up to third week and there after deteriorated.

Pasteurized samples treated with the combination of the preservatives showed brighter color as the storage time progressed up to the first week but deteriorated rapidly thereafter. It may be inferred that the interaction of the two chemicals may have produced metabolite which inhibited color changes in kunun zaki for up to three weeks.

Table 5. Effect of different preservation treatments on color variation of Kunun zaki from 0 to 3rd week of storage time

Treatment	Weeks			
	0	1	2	3
Pasteurized	6.38[a]	-	-	-
Sodium benzoate + pasteurized	7.76[a]	9.70[b]	5.50	1.96
Sodium benzoate + not pasteurized	6.30[a]	6.30[a]	-	-
Sodium metabisulphite + pasteurized	6.81[a]	6.95[c]	4.34	2.56
Sodium metabisulphite + not pasteurized	6.68[a]	6.78[c]	-	-
Sodium benzoate and sodium metabisulphite + pasteurized	5.72[a]	7.79[c]	-	-
Sodium benzoate and sodium metabisulphite + not pasteurized	5.07[a]	5.80[c]	-	-

Value in the same column with the same letter are not significantly different (P>0.05)

The sensory scores of the chemically preserved kunun zaki samples stored under ambient storage condition (30 - 31°C) for one month are preserved in table 6. All initial samples gave very similar means ranging between 4.5-5 (excellent), 3.5-4.4 (very good) and 2.5-3.4 (good). The taste was rated as good (2.5-3.4). Treated samples did not differ significantly ($p>0.05$). This is similar to earlier report of Ade-Omowaye et al. (2009) on sensory scores for beverage samples prepared from tiger nut seeds. The beverages were not significantly different ($P>0.05$) in terms of appearance, flavor, mouth feel, after taste and over all acceptability from one another.

During storage the pasteurized sample which had no chemical treatment dropped significantly ($p<0.05$) in quality after one week whereas the chemically preserved samples

without pasteurization deteriorated significantly ($p<0.05$) in quality on the second week as shown in the overall acceptability scores presented in table 7.

Chemically preserved and pasteurized samples were found to stay up to three weeks with fair quality irrespective of the chemical preservative used. All samples at fourth week fell below acceptable range.

Table 6. Sensory Scores of Chemically Preserved Kunun Zaki Samples Stored Under Ambient Storage Conditions (30-31°C) for Four Weeks

Treatments	Taste	Color	Consistency	Flavor	Preference
Pasteurized	2.18[e]	2.36[d]	2.00[f]	2.00[e]	2.36[f]
Sodium benzoate + pasteurized	3.09[c]	3.27[a]	2.82[d]	2.73[c]	3.18[b]
Sodium benzoate + not pasteurized	3.0[d]	3.27[a]	3.00[b]	2.84[b]	3.27[a]
Sodium metabisulphite + pasteurized	3.18[b]	3.18[c]	2.91[c]	3.00[d]	2.64[d]
Sodium metabisulphite + not pasteurized	3.09[c]	3.4[b]	3.09[a]	2.73[c]	3.18[b]
Sodium benzoate and sodium metabisulphite + pasteurized	2.81[e]	3,27[a]	2,91[c]	2.55[d]	2.45[e]
Sodium benzoate and sodium metabisulphite + not pasteurized	3.27[a]	3.18[c]	2.73[e]	2.73[c]	2.73[c]

Value in the same column with the same letter are not significantly different (P>0.05)

Table 7. Overall Acceptability Score of Chemically Treated Kunun Zaki Samples Stored Under Ambient Condition for Four Weeks

Treatment	Weeks		
	2	3	4
Pasteurized	1.6[d]	Off flavor	Off flavor
Sodium benzoate + pasteurized	2.7[b]	2.50	Off flavor
Sodium benzoate + not pasteurized	1.40[e]	Off flavor	Off flavor
Sodium metabisulphite + pasteurized	2.90[a]	2.50	Off flavor
Sodium metabisulphite + not pasteurized	1.40[e]	Off flavor	Off flavor
Sodium benzoate and sodium metabisulphite + pasteurized	2.60[c]	2.40	Off flavor
Sodium benzoate and sodium metabisulphite + not pasteurized	1.40[e]	Off flavor	Off flavor

Value in the same column with the same letter are not significantly different (P>0.05)

4. CONCLUSION

Kunun zaki, a non-alcoholic drink, is an easily perishable product that cannot stay more than 24 hours after production without significantly deteriorating. The result of this study showed that a combination of pasteurization with chemical treatment can extend the shelf life of kunun zaki by two weeks, but pasteurization alone cannot extend it beyond 24 hours. This is an indication that acceptable beverage with longer shelf life could be produced or preserved with combination of chemical treatment and pasteurization.

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