EFFECT OF DIFFERENT PRESERVATIVES ON THE SHELF LIFE OF Kunun-zaki: A TRADITIONAL FERMENTED CEREAL BASED NON-ALCOHOLIC BEVERAGE

Ojimulukwe¹, P., Elijah²*, A., Ekong³, U. and Nwokocha¹, K.

ABSTRACT

¹Department of Food Science and Technology, Michael Okpara University of Agriculture,, Umudike, Abia State, Nigeria. ²Department of Food Science and Technology, University of Uyo, Uyo, Akwa Ibom State, Nigeria; ³Department of Pharmaceutics and Pharmaceutical Technology, Faculty of Pharmacy, University of Uyo, Uyo, Akwa Ibom State, Nigeria. Corresponding author*

The effect of physicochemical (freezing, ohmic heat-treatment, pasteurization, acidification, sodium metabisulphite) and botanical (ginger extract) preservative treatments on the shelf-life of a traditional fermented cereal based non-alcoholic beverage Kunun-zaki (KZ), singly and in combination, was evaluated within an eight-day storage period for changes in pH, total titratable acidity (TTA), peroxide value (PV), microbial load (ML) and sensory characteristics (SC). Other preservative treatments except freezing showed gradual increase in quality parameters such as TTA, PV and ML with decreased pH within the study period indicating some level of deterioration of the beverage. However, a relatively better preservation was achieved by freezing which enhanced the quality parameters evaluated throughout the study period. Untreated sample recorded higher ML as well as deterioration in other quality parameters assessed. Sensory evaluation of the treated KZ samples demonstrated that a combined preservative treatment with ginger/sodium metabisulphite and pasteurization/sodium metabisulphite enhanced the quality of the beverage thus making it still acceptable to panelist on the fifth day of storage.

Keywords: Kunun-zaki, non-alcoholic, cereal-based beverage, shelf-life, quality, deterioration, preservation, fermentation.

INTRODUCTION

Kunun-zaki (KZ) is a traditional watery gruel fermented cereal based non-alcoholic beverage widely consumed by adults and children in Northern Nigeria. Presently, the beverage is gaining popularity in Southern Nigeria, where it is taken as a food compliment, appetizer and a refreshing drink for visitors and commonly served at social gatherings. The non-alcoholic nature of the beverage makes it readily consumed by Christians and Muslims alike, as a substitute for alcoholic ones (Onuorah et al., 1987).

KZ is commonly produced from millet (Pennisetum typhoideum), sorghum (Sorghum bicolor), maize (Zea mays); or using various combinations of malted cereals, which resulted in improved nutritional quality of the beverage (Akoma et al., 2006). The social, economic, nutritional and medicinal importance of the beverage has been widely reported. Lichtenwalner et al., (1979) reported that KZ made from sorghum contained 76.3% starch, 11.6% protein, 3.5% fat, 1.9% fibre and 1.3% ash, including a range of amino acids. In addition, Awogbenga et al., (1999) reported that KZ had hypoglycemic effect on blood glucose of rats fed with the beverage while Akoma et al., (2002) reported that KZ produced with the addition of ground malted rice to millet, sorghum and maize resulted in 33, 44 and 63% increases in crude protein respectively. Recently, it has been reported that animals fed with KZ produced using a combination of ground malted rice and millet had elevated lymphocyte counts in their blood samples (Akoma et al., 2006). Beside the poor hygienic conditions in which the beverage is traditionally prepared, KZ due to its nutritional composition, is a veritable source of microbial growth and metabolism. Thus a complex heterogeneous microflora comprising lactic acid bacteria, coliforms, free-living moulds and yeasts are the frequently associated spoilage organisms, producing undesirable organoleptic properties from such mixed fermentation (Osuntagun and Abaola, 2004).

Although there are many published works on the preservation of KZ, there is still a dearth of information on a standard preservation method for the beverage. Current attempts involve exploiting all the available techniques to determine the most suitable and affordable method. This study as one of such attempts was undertaken to evaluate the effect of different preservative treatments on the shelf life of KZ.

METHODS

Production of Kunun-zaki

KZ was produced by traditional method from sorghum by steeping 100 g of cleaned grains in 200 ml tap water (1:2 w/v) for 48 h at an ambient temperature (30±2 °C) with the steeping liquor changed at 3 h interval. The water was then decanted and the steeped grains were milled with 3 l of tap water producing slurry to which boiled water
was subsequently added and was constantly stirred to form a paste. The paste was allowed to cool, and thereafter allowed to ferment for 8 – 10 h to produce KZ. The resulting KZ was wet-sieved using a clean muslin cloth and sugar (500 g) was added to taste.

**Preservation studies**

Freshly prepared KZ was subjected to 8 different preservative treatments. KZ (500 ml) was dispensed into 8 clean sterile plastic bottles (1000 ml capacity) which were labeled 1 to 8. Sample 1 contained no preservative and served as control. Sample 2 was subjected to ohmic heat-treatment (12 V at 65 °C for 45 min). Sample 3 was pasteurized at 65 °C for 30 min; while sample 4 was treated with 2 g/l of ginger powder. Sample 5 was subjected to a combination of chemical treatments involving acidification (40 ml of 0.1 M HCl) and 0.2 g/l sodium metabisulphite. Sample 6 was treated with a combination of ginger powder (2 g/l) and 0.2 g/l sodium metabisulphite. Sample 7 was treated with 0.2 g/l sodium metabisulphite followed by pasteurization at 65 °C for 30 min while sample 8 was stored at freezing temperature (-4 to -10 °C) and allowed to thaw and assumed room temperature before analysis. Except for sample 8, all other samples were stored at ambient temperature (30 ± 2 °C). Changes in physicochemical (TTA, pH, PV) parameters, total microbial count as well as organoleptic properties of all the samples was monitored over a 8-day period. The experiment was carried out in triplicate.

**Analytical methods**

(i) Physicochemical analysis

The pH values of the various samples were measured with pH meter. TTA was determined by titrating 100 ml of KZ against 0.1 N NaOH to phenolphthalein end point. TTA was calculated as

\[ \% \text{ TTA} = \left( \frac{T \times N \times 100}{V} \right) \]

where \( T \) = titre value, \( N \) = normality of NaOH, \( V \) = volume of sample. PV was determined as described by Pearson (1976). The sample (5 g) was mixed with 30 ml of chloroform, 0.5 g of potassium iodide and 30 ml of distilled water. The resulting solution was titrated against 0.1 N sodium thiosulphate using a 1 % starch solution as the end point indicator. Peroxide value was calculated as

\[ \text{PV} = \left( \frac{T \times N \times 100}{W} \right) \]

where \( T \) = titre value, \( N \) = normality of sodium thiosulphate, \( W \) = weight of sample.

(ii) Total microbial count

An aliquot (1 ml) of the serially diluted sample from each preservative treatment was spread-plated (in triplicate) on plate count agar (PCA). The plates were incubated aerobically at 37°C for 24 h and 28°C for 48 h for bacterial and fungal count respectively. Only plates with 20 – 200 colonies were counted.

**Sensory evaluation**

Sensory analysis was carried out daily throughout the eight-day storage period. Untreated sample was used as control. Appearance, taste, aroma, and general acceptability of samples were evaluated by a 10-man panel using a 9-point Hedonic scale where 1 = dislike extremely and 9 = like extremely. Samples were presented randomly in tinted glass at ambient temperature (29 – 32 °C) in a well ventilated and illuminated room. The frozen sample (sample 8) was allowed to thaw and assumed room temperature before tasting. Distilled water was presented to panelist to rinse their mouth in between samples. Analysis of Variance was used to determine the variation among treatments while Duncan’s Multiple Range Test was used to separate the means at 5 % level.

**RESULTS AND DISCUSSION**

The effect of the different preservative treatments on the pH values of KZ within the storage period is presented in Fig.1. The result showed a marked decrease in the pH values of samples as the storage period progressed; except the sample preserved by freezing which recorded a slight decrease in the pH values. This decrease in pH values could be attributed to increased acidity resulting from organic acids produced during microbial fermentation especially by *Lactobacillus leichmannii* and *Lactobacillus fermentum* (Efuvweeweere and Akoma, 1995). However, KZ treated with a combined preservative (ginger and sodium metabisulphite) showed stable pH within the storage period.

Changes in TTA of the beverage following the different preservative treatments are presented in Fig. 2. There was a marked increase in TTA of all the samples which corresponded with the fall in pH as the storage period progressed. Particularly noticeable was the sample with a combined treatment involving acidification and sodium metabisulphite on the 8th day (0.143 %), most likely due to the acid (HCl) introduced into the beverage. However, the sample preserved by freezing, and the one preserved with a combined treatment involving pasteurization and sodium metabisulphite recorded a relatively stable TTA, as the storage period progressed. These two treatments retarded microbial fermentation that could have resulted in higher acidity by acidophiles. Changes in PV of the samples are presented in Fig. 3. All the samples, except the frozen sample, showed marked increase in PV, as storage period increased, indicating some level of rancidity; while only a slight increase in the PV was noticed in the frozen sample, hence freezing giving a better preservation in terms of its ability to inhibit rancidity. Amongst the combined treatments, only the combination of acidification and sodium metabisulphite fairly prevented
rancidity of the beverage, while ohmic heat-treatment was the least effective in checking rancidity. With a fat content of 3.3 % (Lichtenwalner et al., 1979), KZ could possibly undergo rancidity, but the preservative treatment of freezing and a combined treatment of acidification and sodium metabisulphite effectively inhibited the formation of hydroperoxides - a primary product resulting from the oxidation of fats and oil, which is a measure of PV. Although hydroperoxides have no off-flavour, its decomposition as oxidation progresses produce volatile compounds that have strong objectionable flavours and odours and thus serious consequences on the organoleptic quality of the beverage.

**Microbiological analysis**

The results of the changes in total microbial count of the samples are presented in Fig. 4. The frozen sample recorded relatively low microbial load within the storage period, while samples treated by other preservation methods recorded progressive increase in microbial load up to Day 3 of storage, and thereafter gradually decreased. This gradual decrease in microbial load could be attributed to low pH, resulting from increased acidity from acid-producing bacteria, which retarded non-acidophilic bacterial growth.

**Sensory evaluation**

The sensory scores of untreated KZ, and those subjected to different treatments are presented in Table 1. There was no significant difference (p>0.05) in colour, among the samples on Day 1. However, the sample treated with ginger and that treated with a combination of ginger and sodium metabisulphite had significantly higher scores (p<0.05) in aroma, taste and overall acceptability. The ginger added to these samples may have boosted these sensory attributes but could not be sustained beyond 48 h of storage (as shown by the response of the panelist). From Day 2, the frozen sample recorded significantly higher (p<0.05) sensory scores in taste, aroma and overall acceptability. This was followed by the sample treated with a combination of ginger and sodium metabisulphite, which were not significantly different (p>0.05) from each other. Until Day 5, there was no notable colour change in all samples.

Except freezing which enhanced all the quality parameters of the beverage evaluated, other preservative treatments showed gradual increase in quality parameters such as TTA, PV and ML, with decreased pH within the study period indicating some level of deterioration of the beverage. Thus as expected, this study shows that freezing is the most effective of all the preservation methods evaluated. Although freezing may not be affordable to rural dwellers who engage in the production of KZ, a combined preservation with ginger and sodium metabisulphite or pasteurization and sodium metabisulphite could be adopted as they result in reasonable preservation. This study also revealed that besides the sensory attribute for which it is added to KZ, ginger also confer a preservative property on the beverage.

**REFERENCES**


Fig. 1: Changes in pH values of samples during storage

Fig. 2: Changes in total titratable acidity of samples during storage

Fig. 3: Changes in Peroxide value of samples during storage

Fig. 4: Changes in microbial load of samples during storage