



Effect of Preservatives on the Nutritional and Microbiological Quality of Wheat Flour Cake

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Authors' contributions

This work was carried out in collaboration between both authors. Author KSO designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript and supervised the work. Author HTN managed the analyses of the study and literature searches. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/BJAST/2014/12472

Editor(s):

(1) Ming-Chih Shih, Department of Health and Nutrition Science, Chinese Culture University, Taiwan.

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Peer review History: <http://www.sciencedomain.org/review-history.php?iid=659&id=5&aid=6107>

Original Research Article

Received 1st July 2014
Accepted 18th August 2014
Published 16th September 2014

ABSTRACT

Aims: This study was undertaken to know the effect of different preservatives on the nutritional and microbial quality of wheat flour cake

Study Design: To assess the effect of sodium propionate, food grade alcohol (Brandy) and sodium bicarbonate on the nutritional and microbial load of preserved cake using unpreserved cake as a control.

Place and Duration of Study: Samples were purchased from Bida Modern Market Niger State, Nigeria. Analyze at Central Services Laboratory of National Cereal Research Institute, Badeggi, Niger State. Experiment was conducted between September 2013 and April 2014.

Methodology: Wheat flour cake was produced using wheat flour, fat sugar, salt, milk, eggs and three different preservatives: sodium bicarbonate, sodium propionate and food

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grade alcohol while the cake without preservative was used as control. The nutritional analysis (proximate analysis and micronutrients) were carried out on preserved and unpreserved cakes. The shelf life of the cake was studied for 15 days. The microbial load was observed at different days (0, 5, 10, and 15).

Results: Generally, the preserved cake differ significantly ($p < .05$) in terms of moisture, crude fibre, carbohydrate and energy content from the unpreserved cake. The unpreserved cake had higher vitamin contents. There was reduced spoilage rate on the treated samples than untreated sample at ambient temperature. The total viable count of the cake without preservative increased from 2.8×10^2 - 2.0×10^6 cfu/g while cakes with preservatives increased from 2.4×10^2 - 5.0×10^4 , 2.0×10^2 - 4.1×10^2 and 2.0×10^2 - 1.5×10^4 cfu/g for sodium bicarbonate, alcohol and sodium propionate after 15 days at ambient temperature.

Conclusion: It is obvious that preservatives though very effective in lowering cake spoilage and maintaining its quality have nutritional effect on the cake.

Keywords: Wheat flour cake; preservatives; nutritional analysis; microbial assessment.

1. INTRODUCTION

Cake is often the desert of choice for meals at ceremonial occasions particularly weddings, anniversaries, birthdays and also sold as snacks in shops [1]. Cake is a perishable food and a rich medium for moulds and yeast as such different preservatives are added in order to maintain its wholesomeness and freshness. Today consumers demand and enjoy food supply that is flavourful, nutritious, safe, colourful and affordable [2]. One of today's challenges for the food industry is to guarantee safe food throughout the supply chain whilst retaining the same properties that were present when the foods were freshly made. The increasing demand for ready-to-eat fresh food products has led to challenges for food distributors regarding the safety and quality of their food. Artificial or chemical preservatives meet some of these challenges by preserving freshness for longer periods of time, but these preservatives can cause side effect as well [3]. However some preservatives such as sodium bisulphite prevent discolouration of food and also destroy vitamin B₁ [4]. Other chemical preservatives change the texture of food having no nutritional value left in [5].

Mould and bacteria are serious and cause problems for bakeries and the use of preservative is therefore an attractive means to diminish spoilage and insure food safety [6]. However consumers are not in favour of preservatives and urge to reduce the quantities been used [7]. Sodium propionate, Calcium propionate and sodium bicarbonates are preservatives mostly used in baked food stuff. Sodium propionate inhibits moulds and *Bacillus* spores but not yeast [6]. In view of the present interest in the preservatives whether it does more good than harm, this paper was undertaken to determine the effect of different preservatives on the nutritional and microbiological quality of wheat flour cake.

2. MATERIALS AND METHODS

2.1 Source of Materials

All the materials used for the production of the various cakes were purchased from Modern market in Bida, Niger State.

2.2 Preparation of Wheat Flour Cake

The recipe used for the preparation of cakes includes: flour; 150g, baking powder; 2.5g, sugar ; 60g, margarine; 90g, milk; 18g, egg white; 14g, salt; 0.70g, water; 75ml , 0.03% sodium propionate; (0.08g), 0.1% sodium bicarbonate; (0.08g) and 20ml of 40% food grade alcohol. The fat and sugar were creamed together until fluffy (double its size) using a sterile wooden spoon in a bowl followed by addition of the liquids (beaten eggs, milk and preservatives). The sieved wheat flour with salt and baking powder was folded into the mixture gradually with a metal spoon and poured into greased cake baking tins. The cake mixture was baked in a preheated oven at 160°C for 20mins as described by [8,9]. The cakes were transported to Central Services Laboratory of the National Cereal Research Institute Badeggi, Bida Niger State for analysis.

2.3 Sensory Evaluation of Cake Samples

Sensory evaluation of cake samples was conducted using a 15-member sensory panellist including teachers and students. Degree of acceptance or likeness or preference was expressed (appearance, texture, taste, flavour and overall acceptability) on a 9 point Hedonic scale (where; 1=Dislike extremely, 2=Dislike very much, 3=Dislike moderately, 4=Dislike slightly, 5=neither like nor dislike, 6=Like slightly, 7=Like moderately, 8=Like very much, 9=Like extremely). Coded samples were served to panellist with glass of water to rinse their mouth in between the tasting period as described by [10].

2.4 Proximate Analysis of Cake Samples

Proximate analysis was carried out using standard procedures of the [11]. Moisture content was determined by drying the sample in a vacuum oven at 100°C and dried to a constant weight (5hrs). Ash content was determined by incinerations of 2g of the sample in a muffle furnace at 600°C for 8hrs. The percentage residue weight was expressed as ash content. Crude fat was determined by Soxhlet Extraction method using hexane as solvent. Crude protein was determined by microkjeldah techniques. Carbohydrate was determined by difference after analysis of all the other items methods in proximate analysis (CHO=100-% moisture+% crude protein+% crude fat+% crude fiber+% ash). Energy content of the cake samples was determined by multiplying % crude protein, % crude fat, % carbohydrate by 4, 9 and 4 respectively (Kcal/100g) [11].

2.5 Mineral and Vitamin Analysis of Cake Samples

One gram of the cake sample was digested using nitric acid and perchloric acid and made to a final volume of 25ml. The digest was made up to 100ml in a standard flask. The atomic absorption spectrophotometer was used to determine all the minerals (except phosphorus) using appropriate lamps. Phosphorus was determined with vandomolybdate using spectrophotometer at 425nm [12]. The vitamins were determined in triplicates titrimetrically and flourometrically as described by [13].

2.6 Microbiological Analysis Cake Samples

Twenty five grams of the cake samples was added to 225ml of sterile 0.1% peptone water and homogenize in sterile laboratory blender. 1ml of the homogenate was added to 9ml of 0.1% peptone water (1:10w/v). This was further diluted up to 10^5 for bacterial count and 10^4

for fungi count. The total viable count of each of these samples was determined using pour plate techniques on nutrient agar in triplicates. Plates were incubated aerobically at 37°C and colonies that developed were counted and recorded as colony forming unit (cfu/g) after 24h. The fungal count was however determined on potato dextrose agar plate using pour plate techniques. 4mg of chloramphenicol was added to 100ml of PDA prior to autoclaving. This was incubated at ambient temperature (37°C) for 6days [14].

2.7 Statistical Analysis

Analysis of variance (one way ANOVA) was carried out for nutritional and microbial analysis. The mean scores were computed and significant differences among the mean was determined (Duncan, $p=0.05$ using 2006 Statistical Packages for Social Sciences (SPSS) For Windows version 15.0 [15].

3. RESULTS AND DISCUSSION

3.1 Sensory Evaluation of Cake

As shown in Table 1, there was no significant difference ($p>0.05$) among cake samples in terms of appearance, texture, taste and flavour. However, the samples differ significantly ($p<0.05$) in overall acceptability. Cake preserved with alcohol was the most acceptable securing the highest score of 7.87 and “ranked like moderately” followed by cake preserved with sodium bicarbonate and sodium propionate securing 7.00 and 7.60 respectively and was equally acceptable. Samples were rated as being the same as control. This implies that the cake colour, taste, texture and flavour were not affected by the different preservatives. This is in agreement with the findings of [9] that preservatives slow or prevent changes in colour, flavour, or texture, delay rancidity (antioxidants) and maintain freshness.

3.2 Effect of Preservatives on Proximate Quality of Cake

The proximate composition of chemically preserved wheat flour cake is presented in Table 2. There was no significant difference ($p>0.05$) in the fat and crude protein content of the cakes. Generally, the preserved cake differ significantly ($p<0.05$) in terms of moisture, crude fibre, carbohydrate and energy content from the unpreserved cake. The unpreserved cake had higher moisture content than the preserved cake. The reduction in moisture content of preserved cake may be due to the reduction of water activity by the preservatives. This may also account for the low bacterial count observed in Table 4. According to [2], preservative lowers the water activity of food. However, [10,16,17] confirm this when chemical preservatives were added to cakes and bread moisture content reduction was observed. There were no significant differences ($p>0.05$) in the fat and crude protein content of preserved cake. The result of this study was not in conformity with the findings of [16] increase in protein content of bread when calcium propionate and calcium lactate were used as preservatives. It was observed that there was drastic reduction in the phosphorus content of preserved cake. The health benefits of phosphorous include healthy bone formation, improved digestion, regulated excretion, protein formation, hormonal balance, improved energy extraction, cellular repair, optimized chemical reactions, and proper nutrient utilization. The health benefits of phosphorous make it an important constituent of any diet as such its loss can not be undermined.

Table 1. Sensory quality of wheat flour cake

	Cake samples ^{1,2,3}			
	CT	SB	AL	SP
Appearance	6.60±0.39 ^a	6.73±0.59 ^a	7.33±0.42 ^a	7.33±0.32 ^a
Texture	7.33±0.50 ^a	7.20±0.30 ^a	7.40±0.16 ^a	7.07±0.48 ^a
Sweetness	6.73±0.30 ^a	6.67±0.44 ^a	7.27±0.32 ^a	7.53±0.31 ^a
Flavour	5.87±0.72 ^a	7.00±0.41 ^a	7.33±0.30 ^a	7.73±0.38 ^a
Over all acceptability	6.80±0.26 ^b	7.00±0.50 ^{ab}	7.87±0.26 ^a	7.60±0.27 ^{ab}

¹Each value is the mean±S.E of 15 determinations²Different letters within the same row are significantly different ($p < .05$)³CT=unpreserved cake, SB=Cake preserved with sodium bicarbonate, AL=Cake preserved with alcohol and SP=Cake preserved with sodium propionate**Table 2. Effect of preservatives on proximate content of wheat flour cake**

Analyses (%)	Products ^{1,2,3}			
	CT	SB	AL	SP
Moisture content	13.85±0.03 ^a	13.41±0.01 ^b	13.25 ±0.01 ^c	9.08±0.01 ^d
Fat content	0.35±0.00 ^a	0.38±0.01 ^a	0.49±0.22 ^a	0.33±0.02 ^a
Crude protein content	11.88±0.17 ^a	11.13±0.01 ^a	10.10±0.00 ^a	11.40±0.06 ^a
Crude fibre content	1.14±0.01 ^a	0.91±0.01 ^d	0.98±0.03 ^c	1.08±0.01 ^b
Ash content	0.98±0.30 ^a	0.33±0.01 ^b	0.291±0.01 ^b	0.95±0.03 ^a
Carbohydrate content	77.97±0.01 ^a	72.94±0.00 ^d	73.18±0.01 ^c	74.50±0.06 ^b
Energy value (Kcal/100g)	396±0.01 ^c	402.04±0.01 ^b	392.30±0.00 ^d	412.55±0.03 ^a

¹Each value is the mean±S.E of 3 determinations²Different letters within the same row are significantly different ($p < .05$)³CT=unpreserved cake, SB=Cake preserved with sodium bicarbonate, AL=Cake preserved with alcohol and SP=Cake preserved with sodium propionate

3.3 Effect of Preservatives on Mineral and Vitamin Content of Cake

According to Table 3 Chemical preservative had effect on the mineral content of cake. There were significant differences in all the mineral quality of cake. Unpreserved cake had higher level of phosphorus and vitamin content. This may be attributed to denaturation of vitamins by preservatives [18]. Similar results were observed in the findings of [19], their findings revealed decrease in vitamin content of apple juice preserved with sodium benzoate.

3.4 Microbiological Qualities of Preserved Cakes

The effect of chemical preservatives on microbial quality of wheat flour cake stored for 15-day period indicates significant difference ($p < .05$) among the samples. The total viable count of the unpreserved cake at ambient temperature after 15days increased from 2.38-6.36 and 2.32-4.71, 2.31-4.60, 2.29-4.08 Log₁₀cfu/g for cake preserved with sodium bicarbonate, alcohol and sodium propionate respectively. The result in Table 4 shows that there was reduced spoilage rate on the treated samples than untreated sample at ambient temperature. Similar findings have been documented in [20,21]. The microbial load of the unpreserved samples at day 0 (2.38 Log₁₀cfu/g) were in conformity with the recommended limit (10⁵ cfu/mg) for ready to consume food by guidelines for microbiological examination for ready-to-eat food [22]. This may be a reflection of hygienic practices of the producer during production of the cake. Drastic reductions in the total viable count of both bacteria and fungi

were observed with all sample with preservatives compared with the untreated ones indicating the effective inhibition of growth of micro-organisms by chemical preservatives. Also, the cake preserved with sodium propionate had higher inhibition rate compared to other preservatives.

Table 3. Effect of preservatives on mineral and vitamin content of wheat flour cake

	Products ^{1,2,3}			
	CT	SB	AL	SP
Mineral (100 mg/ml)	1.84±0.00 ^b	1.95±0.01 ^a	1.62±0.01 ^d	1.82±0.00 ^c
Nitrogen				
Phosphorus	1.54±0.01 ^a	0.36±0.00 ^d	0.55±0.00 ^c	1.09±0.01 ^b
Zinc	0.01±0.00 ^c	0.02±0.00 ^{bc}	0.01±0.00 ^c	0.03±0.01 ^a
Iron (Fe)	1.44±0.01 ^a	1.39±0.03 ^a	1.32±0.00 ^b	1.42±0.00 ^a
Vitamins (mg/ml)				
Vit A	0.82±0.00 ^a	0.73±0.00 ^b	0.07±0.00 ^c	0.76±0.20 ^b
Vit B ₁	1.77±0.01 ^a	1.70±0.00 ^b	1.68±0.00 ^c	1.69±0.00 ^b
Vit C	0.91±0.00 ^a	0.85±0.01 ^b	0.79±0.01 ^c	0.67±0.02 ^d
Vit E	1.40±0.17 ^a	1.56±0.00 ^a	1.58±0.01 ^a	1.64±0.08 ^a

¹Each value is the mean±S.E of 3 determinations

²Different letters within the same row are significantly different ($p < .05$)

³CT=unpreserved cake, SB=Cake preserved with sodium bicarbonate, AL=Cake preserved with alcohol and SP=Cake preserved with sodium propionate

Table 4. Effect of preservatives on microbiological quality of wheat flour cake

Storage period (day)	Microbial load (Log ₁₀ Cfu/g) ^{1,2,3}			
	CT	SB	AL	SP
Total viable count				
0	2.38±0.04 ^a	2.32±0.03 ^{ab}	2.31±0.00 ^{ab}	2.29±0.01 ^b
5	3.57±0.00 ^a	3.54±0.00 ^b	3.52±0.00 ^b	3.48±0.01 ^c
10	4.80±0.01 ^a	3.62±0.00 ^c	3.68±0.01 ^b	3.56±0.01 ^d
15	6.36±0.03 ^a	4.71±0.00 ^b	4.60±0.01 ^c	4.08±0.05 ^d
Fungi count				
0	1.33±0.00 ^a	1.29±0.01 ^a	1.23±0.012 ^a	1.26±0.04 ^a
5	3.94±0.34 ^a	2.46±0.01 ^b	2.39±0.05 ^b	2.38±0.00 ^b
10	4.73±0.15 ^a	4.60±0.00 ^b	4.60±0.01 ^b	2.60±0.00 ^c
15	6.60±0.01 ^a	4.77±0.01 ^b	4.69±0.01 ^c	4.57±0.03 ^d

¹Each value is the mean ±S.E of 3 determinations

²Different letters within the same row are significantly different ($p < .05$)

³CT=unpreserved cake, SB=Cake preserved with sodium bicarbonate, AL=Cake preserved with alcohol and SP=Cake preserved with sodium propionate

4. CONCLUSION

Preservatives though very effective in lowering cake spoilage and maintaining its quality have nutritional effects on the cake since N, P, Fe, vit B₁, and vit C were reduced in wheat flour cake preserved with different preservatives. Sodium bicarbonate, food grade alcohol and sodium propionate all have inhibitory effects on spoilage organisms of cake with sodium propionate being most inhibitory. However, the cake colour, taste, texture and flavour were not affected by the different preservatives.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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