International Journal of Food Science and Nutrition Engineering 2016, 6(4): 73-80
DOI: 10.5923/j.food.20160604.01

Nutritional, Sensory and Storage Quality of Sekete from *Zea mays.*

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Abstract Many of our cultural values have been going into extinct including the nutritionally related habits. Rejuvenating these could enhance the application of dietary diversification towards achieving nutrition security. Sekete is one of the traditional beverages in Nigeria that is no longer commonly produced nor consumed, hence, a deep understanding of its nutritional, sensory and storage quality may promote its consumption and even commercialization. This study was therefore designed to determine the nutritional, sensory and storage quality of Sekete from Zea mays. Sekete was prepared from yellow maize using traditional method and was divided into pasteurized (at 65°C for 30 minutes), unpasteurized plain, sweetened and fortified (with soymilk in ratio 3:1 v/v). Samples were analyzed (1st day and at 4 weeks of cold storage (4°C) for proximate composition, antioxidant capacity, thiamine, riboflavin, niacin, ethanol, pH as well as microbial analyses (total viable, coliform, total fungal and total anaerobic count) with the isolation of the microbes using standard methods. Mean data were analyzed using Duncan's Multiple Range Test at $p \leq 0.05$. Processing of the maize into Sekete did not significantly improve the nutritional composition, pasteurization significantly lowered the antioxidant capacity in all the samples but storage significantly increased this parameter. Fortification and sweetening significantly increased the nutritional and sensory properties of the drink. Bacillus and Lactobacillus were isolated and the samples were free of coliforms even after storage. The pH ranged from 2.9 to 3.0 (unfortified) and 3.4 to 3.5 in fortified compared with 7.0 in the control. Fortification and sweetening improved the nutritional and sensory properties of Sekete and storage at refrigerating temperature for 4 weeks preserved the drink. Fortified and sweetened Sekete production for household consumption and commercial purpose is hereby recommended.

Keywords Sekete, Nutritional quality, Sensory evaluation, Storage quality

1. Introduction

Dietary diversification is a strategy for improving food and nutrition security by making variety of foods available at individual, household and national levels. Possible dietary diversification techniques or activities include: promotion of mixed cropping and integrated farming systems; introduction of new crops (for example soybeans); promotion of underexploited traditional foods and home gardens; small livestock raising; promotion of fishery and forestry products for household consumption; promotion of improved preservation and storage of fruits and vegetables to reduce wastage, post-harvest losses and effect of seasonality; strengthening of small scale agro-processing and food industries; income generation and nutrition education to encourage the consumption of healthy and nutritious diet year round (www.fao.org). Application of any of these is capable of enhancing food security at all levels.

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Published online at http://journal.sapub.org/food

Traditional food crops are the crops accepted by a community through habit and tradition as appropriate and desirable sources of food. People are accustomed to them; they know how to cultivate and prepare them and enjoy eating dishes made from them. However, these may be grouped into two major categories: those that are consumed as traditional dietary staples such as cassava, yam, plantain, sweet potato, millet, sorghum, maize, beans; and those that serve as ingredients in accompanying the staples in soups, sauces, stews, and drinks such as legumes, oilseeds, melon, fruits and vegetables. In Nigeria it is traditional to use cereals to prepare drinks. Sorghum is used in brewing beer for different cultural festivities such as meetings, weddings, birthdays, naming ceremonies, cultural festivals and so on. In some parts of the country over ripe plantain is used while some parts use maize, bark of fruit trees, tea leaves to prepare traditional drinks.

Dietary diversification increases the margin of food choices and presents a wide variety of foods from which individual choices can be made. The rejuvenation of our traditional foods and drinks which have been going into extinct could be a laudable and feasible intent towards achieving food security especially among the rural poor.

Burukutu, pito, kununzaki and zobo are indigenous to the northern part of the Nigeria, Sekete to the south western part while adoyo is indigenous to Ilorin also in south western part of the country. Burukutu, pito and kununzaki are prepared from sorghum, zobo drink from roselle, sekete from maize, adoyo from ripe pineapple and supernatant from ogi (fermented slurry from maize or sorghum). Pito can also be prepared from tea leaf (Camelia species), cashew tree bark (Anacardium occidentale) or bark of mango tree (Mangigera indica). Unfermented pito combined with adoyo may be served as a drink but more importantly for medicinal purposes. All these are traditional or indigenous beverages which may be taken for stimulating, nourishing, refreshing, or medicinal effect especially among the rural and urban poor people. There is therefore need to promote the consumption of these beverages.

In the advent of civilization, the preparation and consumption of some of these traditional drinks has gradually gone into extinct as in the case of Sekete. Sekete is a traditional drink commonly prepared from sprouted maize. In Nigeria other traditional beverages consumed are pito, kununzaki, burukutu, zobo drink and so on. While burukutu is basically an alcoholic beverage, pito and zobo are refreshing and kununzaki is a nourishing drink. Sekete has also been identified as a local fermented drink and very few scientific studies have been reported on it. Decrease in phosphorous, magnesium, potassium and sodium was observed in the beverage after fermentation, riboflavin and niacin contents increased and thiamine decreased slightly at the end of fermentation, an increase was observed in nitrogen and protein content but the ash and crude fibre decreased (Sanni, 1989). Sekete was reported to be a rich source of important amino acids such as alanine, leucine, tyrosine and lysine but lacked proline and arginine (Fapohunda, 1988). The isolated microfungi from Sekete include *Aspergillus flavus*, *Cladosporium cladosporioides* and *Alternaria tenuissima* (Fapohunda, 1988). Pasteurization of Sekete at different temperatures was observed to reduce the microbial load and increase the keeping quality of the beverage. Samples pasteurized at 65°C for 30 minutes had a bacterial load increasing from 4.0×10^{1} (first week) to 2.0×10^{2} cfu/ml (fourth week), samples pasteurized at 70°C for 30 minutes had a bacterial load ranging from 1.0 × 10 cfu/ml (first week) to 2.0 ×10 cfu/ml (fourth week) while there was no bacterial growth in the samples pasteurized at 75°C for 30 minutes (Onaolapo and Busari, 2014). The samples were free of yeast growth throughout the storage periods and the samples were not significantly different in sensory properties except in taste (Onaolapo and Busari, 2014). Microorganisms isolated from Sekete, pito and burukutu were *Saccaromyces cerevisiae, Acetobacter aceti, A. hanseni, A. pasteurianus, Alcaligenes, Flavobacterium*, *Lactobacillus plantarum* and *L. brevis* (Sanni et al., 1999). There was also observed a decrease in ethanol from 3% in fresh products to 1% at the end of 72 hour retailing period and this was proportional to the acetic acid content of the drinks, however, the acid constituents of the drinks (lactic, malic, succinic and formic acids) witnessed a slight decrease. Even though no enterobacteriacieae was isolated some of the identified isolates are potentially pathogenic and may predispose consumers to food infection (Sanni et al., 1999).

Current in depth understanding of the nutritional, sensory and storage quality of sekete is a needed step in promoting the consumption and commercialization of the traditional beverage, hence, this study aimed at determining the nutritional, sensory and storage quality of sekete from Zea mays.

2. Materials and Method

Collection of maize

Yellow maize grains (DMR-LSR-Y) was obtained from the seed store of the Institute of Agricultural Research and Training, Apata, Ibadan. These were cleaned to remove broken grains and foreign materials.

Preparation of Sekete

The traditional method of preparing sekete as described by Adegoke et al, 1995 was used with slight modification. Maize was soaked in clean water for 24 hours after which the water was drained and the grains spread on wet muslin cloth. This was wet with water every day to sprout for 3 days. The sprouted grains were washed and wet-milled after which the slurry was diluted with clean water in the ratio 2:5 (v/v). This was covered in a plastic jar and allowed to ferment for 2 days after which it was sieved. This was then boiled for 30 minutes to obtain the plain alcoholic sekete sample. Half of this was boiled for extra 1 hour and designated as the non-alcoholic sekete sample.

Pasteurized and unpasteurized samples

Samples to be pasteurized were bottled in heat resistant plastic bottles while the unpasteurized samples were bottled in plain transparent PET bottles. Pasteurization was achieved by heating the sample at 65°C for 30 minutes after which cooling was done rapidly. To sweetened samples table sugar (sucrose) was added at 50g/L while to the fortified samples soymilk was added in ration 1:3 (v/v). Control sample was obtained by wet-milling the maize, diluting the slurry in ratio 2:5 and boiling for 30 minutes. Samples were designated as follows:

RCS--raw control sample
PCS–pasteurized control sample
UCS–unpasteurized control sample
PSNA–Pasteurized sweetened Non-alcoholic (NA) sample
USNA–Unpasteurized sweetened NA sample
PFNA–Pasteurized fortified NA
UFNA–Unpasteurized fortified NA
PPNA–Pasteurized plain NA
UPNA–Unpasteurized plain NA
PFA–Pasteurized fortified Alcoholic
UFA–Unpasteurized fortified Alcoholic
PPA–Pasteurized plain alcoholic

UPA– Unpasteurized plain alcoholic.

Proximate composition

Samples were analyzed for proximate composition, thiamine, riboflavin, niacin, ethanol, antioxidant capacity and pH at the day of production and at the 4th week of storage at 4°C. Microbial analysis (total anaerobic count, total aerobic count, coliform count and fungal count) was done weekly.

The method of A.O.A.C, 2005 was used to determine the protein, fat, crude fiber, ash content and carbohydrate was determined by difference.

Plate Count or microbial count using The Pour Plate Method (Harrigan Macanee, 1976)

One (l) ml of the sample was aseptically dispensed into a sterile petri dish using a sterile pipette. A measured quantity (15 - 20ml) of sterile nutrient agar was added and the two mixed thoroughly by swirling gently. The dish was then incubated at 37°C for 18-24hours. The number of colonies growing in the agar plate was then counted.

Determination of antioxidant capacity (Free Radical Scavenging Activity)

The method of A.O.A.C. 2005 was used. Method is based on measurement of loss of color of DPPH solution by the change of absorbance at 517nm caused by the reaction of DPPH with the test sample. To 0.2ml of the sample 2.8ml of freshly prepared 20mg/dm^3 DPPH in Methanol was added. This was incubated for 20min at room temperature. Inhibition in % RSC (Radical Scavenging Capacity) was calculated as follows:

$$RSC\ \% = (1 - A_{sample}/A_{blank}) \times 100\%$$

A_{blank} is Abs for Control while A_{sample} is Abs for test sample.

Determination of B vitamins

Riboflavin, Thiamine and Niacin

The Spectrophotometric method of the Association of Official Analytical Chemists (2005) was used.

Riboflavin

To 0.5g of the sample 30ml Dichloroethane and 30ml of 30% HCl (ratio1:1) were added after which 50ml Ammonium Hydroxide solution was added. This was filtered and the absorbance was read using a spectrophotometer (Thermo Scientific Spectronic 20 model, United States) at 415nm.

Preparation of standard curve

From the stock solution of standard Riboflavin, 0.1- 0.5 ppm solutions were prepared and the absorbance was read using the spectrophotometer. These were then used to plot the standard curve which was used to extrapolate the results of the readings for the samples.

Thiamine

A small quantity of the sample (1g) was weighed and 50ml of 50% methanol and 50ml of 17% sodium carbonate were added (ratio 1:1) in order to extract the vitamin. This was then filtered and Follins-Denis reagent was added to the filterate. This was allowed to cool until it gives a blue colour. The absorbance was then read at 415nm with a spectrophotometer. A standard curve was constructed using the absorbance values of calibrators with known thiamine content which was used to extrapolate the thiamine content of the samples.

Niacin

Niacin was extracted from the food by autoclaving the sample with aqueous calcium hydroxide. A small portion (1g) of food sample was mixed with 0.75g of calcium hydroxide in centrifuge tubes and 20ml of deionized water was added. The mixture was thoroughly mixed and heated in an autoclave for 30 minutes at 121°C with the centrifuge tube cap loosened. This was followed by dilution to 50ml with distilled water then mixing and was allowed to cool. The mixture was then centrifuged at 0°C, 2500rpm for 15 minutes. The pH of the supernatant (15ml) was adjusted to 7 with aqueous oxalic acid and made to 25ml with distilled water in a vial. The resultant suspension was centrifuged at 2500 rpm for 10 minutes to precipitate the calcium oxalate. The absorbance was read at 650nm.

Preparation of Standard Curve

The blank which contained all the reagents used in the extraction was prepared. The standard solutions of reference niacin at 1 to 10 ppm were also prepared and 1ml of cyanogen bromide per ml was added to each. The absorbance of these standard solutions was read at 650nm and these were used to plot a standard curve. The niacin contents of the samples were then extrapolated from the standard curve.

Determination of Ethanol

The method of A.O.A.C, 2005 was used. Into a volumetric flask 25ml of sample was measured at 20°C. This was washed into a separator with 100ml distilled water. The mixture was saturated with NaCl and shaking with 100ml light petroleum ether for 3 minutes was done. This was allowed to stand for at least 15 minutes after which the lower layer was run into a distillation flask. The light petroleum extract in the separator was shaken with 25ml saturated NaCl solution after allowing the mixture to separate. The solution was made just alkaline with 1N NaOH after adding solid phenolphthalein. Pumine was added and then 100ml distilled water after which distillation of 90ml of the mixture was done into a 100ml volumetric flask. This was then made up to the mark with water at 25°C and the specific gravity and refractive index were determined.

Sensory evaluation

Samples were given to a 20-member trained taste panel of judges. A 9-point hedonic scale was used with 1 designated as ‘dislike extremely’ and 9 designated as ‘like extremely’. The panelists were asked to evaluate the samples for appearance, flavor, color, mouthfeel, taste, aftertaste and overall acceptability (Ihekoronye and Ngoddy, 1985). The scores were subjected to Analysis of Variance using

Duncan's Multiple Range Test to signify significant difference ($p \leq 0.05$).

Statistical Analyses

Analyses were carried out in triplicates and mean data were analyzed using Duncan Multiple Range Test with SPSS version 17.

3. Result and Discussion

The proximate composition of the different sekete samples are expressed in Table 1.

Even though there existed significant reduction in the protein and fat content after germination and fermentation, these parameters were significantly increased in fortified Sekete samples on the day of production. Pasteurization did not alter the protein and fat content of the samples. The ash content which denotes the mineral composition of the samples was significantly reduced in pasteurized sweetened sample while in PFA, PPNA, USNA, UFNA and UFA it was significantly increased but this parameter was not altered in PPA and UPA. The pH reduced from neutral in the control to 5.2 in the slurry of the germinated grain. This further reduced significantly to 2.9 to 3.0 (Table 2) in the unfortified sekete samples and in the fortified samples the value ranged from 3.4 to 3.5. This suggests that the addition of soymilk in the course of fortification increased the pH of the beverage while sweetening with sucrose did not. The reduction in pH after germination suggests the production of acid during germination as is the case in the germination of soybean during which ɣ-aminobutyric acid was produced (Yuanxin et al., 2011). The further reduction in the pH after germination shows that more acid was produced during the fermentation procedure.

Compared with the control samples fermentation significantly reduced the thiamine content in most of the samples except in UFA and UPA. Similarly riboflavin significantly reduced after fermentation when compared with the unpasteurized control sample but there existed no significant difference between the riboflavin content of the pasteurized sample and most of the beverage samples (Table 2). There was also a significant reduction in the niacin content in most of the samples except in UPNA and UPA when compared with the control samples. Fortification did not increase the thiamine, riboflavin and niacin content of the beverage samples. It was clearly a noticeable effect that pasteurization significantly reduced the antioxidant capacity of all the samples (Table 2). Boiling significantly increased this parameter in the control samples because the antioxidant capacity of the raw control sample was 12.30 while in the pasteurized and unpasteurized samples it was 14.57 and 15.20 respectively. This suggests that boiling increased the free radical scavenging capacity of maize slurry but application of heat after packaging reduced this parameter as can be observed in the significant reduction of this parameter in the pasteurized samples. The alcohol content of all the samples ranged from 0.23 to 0.87% while in the boiled pasteurized and unpasteurized samples it was 0.47 and 0.57% respectively. This level of alcohol is too low to categorize sekete as an alcoholic beverage and it suggests that the fermentation was an acid fermentation and not saccharification fermentation.

Table 1. Proximate composition of sekete samples at the day of production

Samples	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	CF (%)	CHO (%)
RCS	83.70±0.10b	3.10±0.10d	0.70±0.10bc	1.03±0.06ab	0.13±0.06b	11.33±0.15de
PCS	82.93±0.15d	3.40±0.10c	0.83±0.06b	1.10±0.10ab	0.43±0.49a	11.57±0.06de
UCS	81.63±0.15g	4.00±0.10a	1.00±0.10a	1.00±0.10ab	0.03±0.06e	12.30±0.17a
PSNA	83.23±0.15c	3.10±0.10d	0.77±0.06bc	0.93±0.06bc	0.07±0.06d	11.97±0.11bc
USNA	82.47±0.15ef	3.73±0.15b	0.80±0.10b	1.17±0.15a	0.10±0.00c	11.67±0.32cd
PFNA	84.23±0.15a	3.67±0.15b	0.63±0.06cd	0.80±0.10c	0.17±0.06ab	11.50±0.00de
UFNA	82.67±0.15de	3.53±0.15bc	0.80±0.10b	1.13±0.15ab	0.10±0.00c	11.77±0.35cd
PPNA	82.23±0.21f	3.53±0.15bc	0.73±0.06bc	1.13±0.17ab	0.17±0.06ab	12.20±0.43ab
UPNA	83.43±0.21bc	3.10±0.10d	0.57±0.06d	1.00±0.10ab	0.13±0.06b	11.77±0.38cd
PFA	83.43±0.21bc	3.37±0.15c	0.73±0.06bc	1.20±0.10a	0.07±0.06d	11.47±0.21de
UFA	82.63±0.15e	3.57±0.15bc	0.73±0.06bc	1.17±0.15a	0.17±0.06ab	11.73±0.35cd
PPA	84.17±0.15a	2.90±0.10d	0.57±0.06d	1.00±0.10ab	0.10±0.10c	11.27±0.25e
UPA	83.37±0.15c	3.10±0.10d	0.63±0.06cd	1.00±0.12ab	0.10±0.00c	11.80±0.17cd

CF: Crude Fibre
CHO: Carbohydrate
Data in column with the same alphabet are not significantly different ($p \leq 0.05$)

Table 2. Vitamin, ethanol content, antioxidant capacity and pH of sekete samples at the day of production

Sample	pH	Thiamine (mg/100g)	Riboflavin (mg/100g)	Niacin (mg/100g)	AC (mg/100g)	Ethanol (%)
RCS	7.07±0.06a	0.06±0.01cd	0.13±0.06b	0.27±0.06	12.30±0.10fg	0.33±0.06ef
PCS	7.03±0.06a	0.07±0.01ab	0.10±0.00ab	0.40±0.10a	14.57±0.32c	0.47±0.06cd
UCS	7.00±0.00a	0.08±0.01a	0.20±0.10a	0.37±0.06ab	15.20±0.20b	0.57±0.06c
PSNA	2.90±0.00e	0.06±0.01cd	0.08±0.01bc	0.23±0.06dc	11.57±0.32h	0.23±0.06f
USNA	2.90±0.01e	0.06±0.01cd	0.08±0.01bc	0.33±0.06bc	12.67±0.15ef	0.57±0.06c
PFNA	3.50±0.00b	0.05±0.01d	0.08±0.01bc	0.27±0.06cd	11.73±0.15h	0.23±0.06f
UFNA	3.40±0.00c	0.05±0.00d	0.07±0.01c	0.23±0.06cd	12.23±0.21g	0.50±0.10c
PPNA	3.00±0.00d	0.04±0.01e	0.07±0.01c	0.20±0.00d	13.23±0.25d	0..87±0.06a
UPNA	2.90±0.00e	0.06±0.01cd	0.08±0.01bc	0.40±0.10a	15.23±0.25b	0.73±0.06b
PFA	3.47±0.15c	0.05±0.01d	0.07±0.01c	0.37±0.06ab	11.67±0.25h	0.37±0.06de
UFA	3.50±0.00b	0.07±0.01ab	0.10±0.01ab	0.27±0.06cd	15.63±0.21a	0.57±0.06c
PPA	3.00±0.00d	0.05±0.01d	0.09±0.01ab	0.20±0.00d	11.50±0.20h	0.37±0.06de
UPA	3.00±0.00d	0.07±0.01ab	0.11±0.01ab	0.37±0.06ab	12.70±0.10e	0.57±0.06c

AC: Antioxidant Capacity
Data in column with the same alphabet are not significantly different ($p \leq 0.05$)

Microbial analyses

On the day of production, Bacillus and Lactobacillus species dominated the aerobic and anaerobic count, *Aspergillus sp, Saccharomyces sp* and *Rhizopus sp* dominated the Total fungal count while the samples were free of coliform showing that the processing and packaging procedures were properly carried out though the hygiene still needs to be improved upon due to the presence of *Bacillus spp*. The dominating presence of *Lactobacillus* species denotes that the fermentation could be lactic acid fermentation. Total Aerobic Count (TAC) was from 1.0×10^4 to 1.3×10^5 CFU/ml, Total Anaerobic Count (TAnC) was from 1.2×10^2CFU/ml and Total Fungal Count (TFC) was from 1.1×10^4 to 8.7×10^4 CFU/ml.

At one week of cold storage (4°C), Bacillus and Lactobacillus still dominated the Total aerobic and anaerobic count, *Geotrichum sp* and *Saccharomyces sp* dominated the Total fungal count and the samples were free of coliforms. The Total aerobic count ranged from 2.6×10^3 to 6.9×10^4 CFU/ml, Total anaerobic count ranged from 8.5×10^2 to 6.6×10^4 CFU/ml and the Total fungal count was from 2.2×10^2 to 4.3×10^4 CFU/ml.

Total aerobic count and Total anaerobic count were still dominated by *Bacillus sp* (3.7×10^4 to 4.2×10^5 CFU/ml) and *Lactobacillus sp* (3.0×10^3 to 7.4×10^4 CFU/ml) respectively at the end of 2 weeks of cold storage while *Saccharomyces* (8.2×10^3 to 7.7×10^4 CFU.ml) still dominated the Total fungal count. The increase in the microbial count shows that the low pH medium favoured the thriving and multiplication of these microbes. The samples were free of coliform throughout the experimentation period.

The third week of storage witnessed a similar increasing trend in the total microbial count. *Bacillus sp* (3.7×10^4 to 9.0×10^4 CFU/ml) dominated the TAC, *Lactobacillus sp* (3.0×10^3 to 7.4×10^4 CFU/ml) was the only anaerobic count identified while *Saccharomyces sp* (8.2×10^3 to 7.7×10^4 CFU/ml) still dominated the Total fungal count.

While the TAC and TAnC reduced significantly at the end of 4 weeks of storage, TFC were still increasing. The TAC (*Bacillus sp*) ranged from 1.0×10^4 to 1.3×10^5 CFU/ml; TAnC (*Lactobacillus*) ranged from 1.2×10^2 to 1.1×10^4 CFU/ml while the Total fungal count which was dominated by *Saccahromyces sp* and *Aspergillus sp* ranged from 2.0×10^4 to 8.7×10^4 CFU/ml. The richness of sekete thus produced in *Lactobacillus* and *Saccharomyces* species coupled with the low pH may be the potential therapeutic constituents that exerts the medicinal, relaxative and stimulating effect of sekete as reported by the old people who used to drink it. Most *Lactobacillus* species are harmless to human beings but are beneficial. *Lactobacillus* are normal flora to the urinary, digestive and genital tracts of humans and has been reported to be effective in the prevention of diarrhea and bacterial vaginal infection (Reid and Burton, 2002). Some strains of *Lactobacillus* species and other lactic acid bacteria also possess anti-inflammatory (Della Riccia *et al.,* 2007; Carroll *et al.,* 2007; Tien *et al.,* 2006) and anti cancer properties (Khazaie *et al.,* 2012; Choi *et al.,* 2006). This therapeutic, antibacterial and anti fungal activity of *Lactobacillus* may be traceable to the production of bacteriocins and low molecular weight compounds that are inhibitory to these microorganisms (Inglin, 2015). *Saccharomyces spp* have also been reported to exert anti tumoral and anti cancer effect in mice (Chen *et al.,* 2009). However, even though *Streptococci* family bacteria (e.g. *Streptococcus mutans*) are the main cause of tooth decay, some *Lactobacillus* species have been found to be associated with dental caries, hence, *Lactobacillus* count in saliva has been used as a 'caries test' for many years (Twetman and Stecksen-Blicks, 2008; Meurman and Stamatova, 2007).

Composition at the end of 4 weeks cold storage

At the end of 4 weeks of cold storage the protein content of some of the samples significantly increased while it reduced in other samples (Table 3). The fat, ash and crude fiber also witnessed similar trend as the protein. The pH of most of the pasteurized samples was lower than that of the unpasteurized samples (Table 4). While thiamine reduced in some of the sekete samples after 4 weeks of cold storage riboflavin significantly increased but in the pasteurized control samples it remained constant and in unpasteurized control sample it markedly reduced. Similarly the 4 weeks of cold storage resulted in significant increase in niacin content in all the sekete samples. This increase in vitamin content may be as a result of the activity of the microorganisms present in the beverage. Antioxidant capacity and alcohol content significantly increased at the end of the 4 weeks cold storage in all the samples. This also may be the resultant effect of the activities of the microbes in the samples. The sekete samples were still safe for consumption at the end of the 4 weeks cold storage because coliforms were not present but more hygienic practice is recommended in the production and packaging procedures in order to reduce the Total aerobic count. More still, identification and quantification of the acid composition of sekete is recommended because these acids may be partly responsible for the relaxative, stimulating and medicinal effect of this beverage.

Table 3. Proximate composition of sekete samples at the 4th week of cold storage

Samples	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	CF (%)	CHO (%)
RCS	84.33±0.15a	3.37±0.15bc	1.03±0.06a	1.13±0.15ab	0.10±0.00c	10.33±0.40f
PCS	81.87±0.15e	3.40±0.10bc	0.90±0.10ab	1.20±0.10a	0.13±0.06b	12.50±0.35d
UCS	82.33±0.06cd	3.77±0.15a	1.03±0.06a	1.07±0.12ab	0.03±0.00e	11.77±0.06e
PSNA	81.67±0.12e	3.30±0.10bc	0.87±0.06b	0.93±0.06bc	0.10±0.00c	13.13±0.06c
USNA	82.17±0.06d	3.53±0.15ab	0.98±0.05ab	1.10±0.10ab	0.20±0.10a	13.90±0.10d
PFNA	80.77±0.15g	3.10±0.10d	1.03±0.06a	1.07±0.06ab	0.13±0.06b	13.90±0.10b
UFNA	81.27±0.15f	2.87±0.15e	0.53±0.06de	0.87±0.15cd	0.07±0.06bc	14.40±0.00a
PPNA	81.43±0.15f	3.73±0.15a	0.60±0.10cd	1.10±0.10ab	0.07±0.05bc	13.67±0.31c
UPNA	80.57±0.15g	3.70±0.10cd	0.40±0.10c	0.97±0.15bc	0.03±0.00e	14.67±0.32a
PFA	82.53±0.15c	3.23±0.06cd	0.60±0.06cd	1.00±0.10ab	0.13±0.06b	12.53±0.12d
UFA	82.57±0.15c	3.70±0.10a	0.40±0.10e	0.97±0.15bc	0.07±0.06bc	12.30±0.10d
PPA	83.30±0.10b	3.17±0.15cd	0.50±0.10de	0.80±0.10de	0.06±0.00d	12.23±0.23d
UPA	80.67±0.15g	3.40±0.10bc	0.60±0.10cd	0.80±0.10de	0.07±0.06bc	14.47±0.15a

CF: Crude Fibre
CHO: Carbohydrate
Data in column with the same alphabet are not significantly different ($p \leq 0.05$)

Table 4. Vitamin, ethanol content, antioxidant capacity and pH of sekete samples at the 4th week of cold storage

Samples	pH	Thiamine (mg/100g)	Riboflavin (mg/100g)	Niacin (mg/100g)	AC (mg/100g)	Ethanol (%)
RCS	3.00±0.00e	1.03±1.73a	0.11±0.01c	0.37±0.06de	16.10±0.10a	0.50±0.10h
PCS	2.80±0.00g	0.04±0.01e	0.10±0.01d	0.37±0.06de	15.70±0.10b	0.60±0.10gh
UCS	3.20±0.00d	0.04±0.01e	0.08±0.01e	0.40±0.10cd	15.53±0.15b	0.80±0.10fg
PSNA	3.00±0.00e	0.04±0.02e	0.10±0.01d	0.53±0.06ab	14.20±0.10d	0.53±0.06h
USNA	3.20±0.00d	0.08±0.01b	0.14±0.02a	0.50±0.10ab	14.40±0.10d	2.23±0.15b
PFNA	3.20±0.00d	0.87±0.06b	0.14±0.02a	0.57±0.15ab	15.17±0.15c	2.67±0.15a
UFNA	3.50±0.00a	0.07±0.01b	0.14±0.02a	0.43±0.06cd	14.40±0.10d	2.23±0.15b
PPNA	3.00±0.00e	0.05±0.01d	0.08±0.01e	0.33±0.06e	13.20±0.10g	1.27±0.15e
UPNA	2.90±0.00f	0.04±0.01e	0.10±0.01d	0.56±0.10ab	13.43±0.15f	0.87±0.06f
PFA	3.30±0.00c	0.06±0.01c	0.08±0.01e	0.63±0.06a	15.53±0.05b	1.63±0.21c
UFA	3.20±0.00d	0.09±0.01b	0.12±0.01c	0.53±0.06ab	15.16±0.10c	1.57±0.15cd
PPA	2.80±0.00g	0.08±0.01b	0.08±0.01e	0.40±0.10cd	13.60±0.10f	1.37±0.15de
UPA	3.40±0.00b	0.08±0.01b	0.13±0.01b	0.53±0.06ab	13.97±0.15e	0.90±0.10f

AC: Antioxidant Capacity
Data in column with the same alphabet are not significantly different ($p \leq 0.05$)

Table 5. Sensory evaluation of sekete samples

Sample	Color	Flavor	Mouth feel	Taste	Aftertaste	OA
PCS	7.25±0.23a	5.92±0.26a	5.66±0.01a	5.31±0.01a	5.65±0.01a	6.31±0.03a
UCS	6.54±0.02b	5.14±0.16b	5.24±0.01b	5.25±0.04a	5.74±0.03b	5.82±0.01b
PSNA	4.14±0.02c	4.81±0.01c	4.14±0.02c	4.01±0.14b	4.34±0.02c	4.72±0.01c
USNA	4.21±0.02d	4.85±0.03d	4.24±0.01d	4.95±0.22c	5.21±0.01d	4.28±0.02d
PFNA	5.85±0.01e	5.35±0.03e	5.31±0.01e	5.81±0.01d	5.61±0.02a	5.45±0.02e
UFNA	5.65±0.14f	5.91±0.02a	6.32±0.02f	5.92±0.02e	5.86±0.02e	6.01±0.01f
PPNA	3.71±0.14g	3.11±0.03f	3.15±0.02g	3.12±0.02f	3.72±0.02f	3.16±0.01g
UPNA	3.80±0.01h	3.54±0.01g	3.31±0.01h	3.08±0.01f	3.45±0.01g	3.41±0.01h
PFA	5.41±0.01i	4.89±0.03d	4.75±0.02i	4.34±0.02g	4.54±0.02h	4.93±0.03i
UFA	5.14±0.01j	4.54±0.02h	4.31±0.01j	4.40±0.01g	4.30±0.02i	4.54±0.01j
PPA	3.44±0.01k	3.84±0.04i	3.22±0.02k	3.41±0.01h	3.80±0.01j	3.36±0.02k
UPA	4.28±0.23l	4.70±0.02j	3.26±0.02l	3.23±0.04i	3.90±0.02k	3.72±0.02l

OA - Overall Acceptability
Data in column with the same alphabet are not significantly different ($p \leq 0.05$)

Sensory Evaluation

The colour of the control samples was most preferred of all the samples while fortification with soymilk increased the sensory scores in both alcoholic and non-alcoholic samples thus suggesting that the addition of soymilk improved the appearance or colour of the sekete samples (Table 5). Plain Pasteurized Alcoholic sample (PPA) had the least score. The panelists neither liked nor disliked the flavor of the control samples and fortified sweetened samples had the highest scores compared to other samples. Plain pasteurized and unpasteurized samples had the least scores for these were disliked moderately.

The score on the mouth feel of UFNA was highest for it was liked slightly while PPNA had the least score for it was disliked moderately. There existed no significant difference between the sensory score on taste of the control samples while the score of the other samples were significantly different (Table 5). Fortification improved the taste of the sweetened samples because these had the highest sensory score for taste and were liked slightly. PPNA and UPNA had the least sensory score for taste. The sensory score on aftertaste followed a trend similar to that of taste with the highest scores allotted to PPNA and UPNA followed by the control samples and the least score was allotted to UPNA (Table 5). For the overall acceptability, PCS had the highest score followed by UFNA for these were liked slightly. UCS and PFNA were neither liked nor disliked while other samples were disliked at varying degrees. This shows that fortification and sweetening improved the acceptability of sekete beverage. There is dire scarcity of past reports on not only the sensory evaluation but also on the nutritional composition of sekete, hence, appreciable comparison could not be made.

4. Conclusions and Recommendations

Sekete is a high acid local beverage from maize which is rich in *Lactobacillus* species and *Saccharomyces* species and the fermentation was more of a lactic acid fermentation rather than saccharification. Fortification improved the nutritional composition of the beverage and it increased the pH of the samples while 4 weeks of cold storage increased the antioxidants and alcohol content. The cold storage did not adversely alter the nutritional composition of the beverage. The sekete samples were still free of coliforms at the end of 4 weeks of cold storage (4°C). While pasteurization reduced the antioxidant capacity in all the samples it did not alter other components. The relaxative, medicinal and stimulating effect commonly experienced after sekete consumption may be a result of the microbial profile, acid composition and the activities of the microbes. Also, fortification and sweetening increased the overall acceptability of the beverage, hence, fortified and sweetened sekete is recommended for commercial and household production and consumption. However, quantification and identification of the acid component of sekete is recommended as well as the storage quality beyond 4 weeks cold storage.

REFERENCES

[1] Adegoke G.O., Nwaigwe R.N. and Oguntimehin G.B. (1995). Microbial and biochemical changes during production of sekete, e fermented beverage from maize. Journal of Food Science and Technology; 32: 516-518.

[2] Carroll I.M., Andrus J.M., Bruno-Barcena J.M., Klaenhammer T.R., Hassan H.M. and Threadgill D.S. (2007). Anti-inflammatory properties of Lactobacillus gasseri expressing manganese superoxide dismutase using the interleukin 10-deficient mouse model of colitis. American Journal of Physiology-Gastrointestinal and Liver Physiology; 293(4): G729-G738.

[3] Chen X., Fruehauf J., Goldsmith J.D., Xu H., Katchar K.K., Koon H.W., Zhao D., Kokkotou E.G., Pothoulakis C. and Kelly C.N.P. (2009). Saccharomyces boulardii inhibits EGF receptor signaling and intestinal tumor growth in Apcmin mice. Gastroenterology; 137(3): 914-923.

[4] Choi S.S., Kim Y., Han K.S., You S., Oh S. and Kim S.H. (2006). Effect of Lactobacillus strains on cancer cell proliferation and oxidative stress in vitro. Letters of Applied Microbiology; 42(5): 452-458.

[5] Della Riccia D.N., Bizzini F., Perilli M.G., Polimeni A., Trinchieri V., Amicosante G. and Cifone M.G. (2007). Anti-inflammatory effects of Lactobacillus brevis (CD2) on periodontal disease. Oral Diseases; 13(4): 376-385.

[6] Fapohunda S.O. (1988). Amino acid composition and mycology of Sekete, a fermented product from Zea mays L. Food/ Nahrung; 32(6): 571-575.

[7] Harrigan W.F and McCanee M.E. (1976). Laboratory methods in food and dairy microbiology, Academic Press, London, pp 17-68.

[8] Ihekoronye A.L. and Ngoddy P.O. (1985). Integrated Food Science and Technology for the Tropics. Academic Press London: pp 155-193.

[9] Inglin R.C. (2015). High throughput screening assays for antibacterial and antifungal activities of Lactobacillus species. Journal of Microbiological Methods; 114: 26-29.

[10] Khazaie K., Zadeh M., Khan M.W., Bere P., Gounari F., Dennis K., Blatner N.R., Owen J.L., Klaenhammer T.R. and Mohamadzadeh M. (2012). Abating colon cancer polyposis by Lactobacillus acidophilus deficient in lipoteichoic acid. Proceedings of the National Academy of Science; 109(26): 10462-10467.

[11] Meurman J.H. and Stamatova I. (2007). Probiotics: Contributions to oral health. Oral Diseases; 13(5): 443-51.

[12] Onaolapo I.O. and Busari T. (2014). The effect of pasteurization on microbial growth and sensory qualities of Sekete, a fermented maize beverage. IOSR Journal of Environmental Science, Toxicology and Food Technology; 8(6): 51-54.

[13] Reid G. and Burton J. (2002). Use of Lactobacillus to prevent infection by pathogenic bacteria. Microbes and Infection; 4(3): 319-324.

[14] Sanni A.I. (1989). Chemical studies on sekete beer. Food Chemistry; 33(3): 187-191.

[15] Sanni A.I., Onilude A.A., Fadahunsi I.F. and Afolabi R.O. (1999). Microbial deterioration of traditional alcoholic beverages in Nigeria. Food Research International; 32(3): 163-167.

[16] Tien M-T., Girardin S.E., Regnault B., LeBourhis L., Dillies M-A., Coppee J-Y., Bourdet-Sicard R., Sansonetti P.J and Pedron T. (2006). Anti-inflammatory effect of Lactobacillus casei on Shigella-infected intestinal epithelial cells. The Journal of Immunology; 176(2): 1228-1237.

[17] Twetman S. and Stecksen-Blicks C. (2008). Probiotics and oral health effects in children. International Journal of Paediatric Dentistry; 18(1): 3-10.

[18] www.fao.org/docrep.

[19] Yuanxin., Hui C., Yu S. and Zhenxin G (2011). Effects of soaking and aeration treatment on γ-aminobutyric acid accumulation in germinated soybean (Glycine max L.). Euro. Food Res. Technol; 232: 787-795.