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Nutritional and sensory evaluation of African breadfruit-corn yoghurt

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Single extracts of African breadfruit (*Treculia africana var africana*) and sweet corn (*Golden cob F1*) were blended on 60:40 proportions to produce breadfruit-corn milk. The breadfruit-corn milk was fermented to obtain a yoghurt-like product (breadfruit-corn yoghurt), using inoculums drawn from activation batch of dried starter and previously made breadfruit-corn milk. The breadfruit-corn yoghurt was subjected to nutritional and sensorial evaluation using commercial cow milk yoghurt as a control. The breadfruit-corn yoghurt was significantly (p<0.05) higher in moisture, carbohydrate, calcium, potassium, magnesium, iron, zinc, vitamin B_2 and vitamin C. The commercial cow milk yoghurt was significantly (p<0.05) higher in protein, fat, ash, crude fibre, sodium, manganese, vitamins A, B_1 and B_3. Sensory scores show that the commercial milk yoghurt was significantly (p<0.05) higher in all the sensory attributes considered. In all, the breadfruit-corn yoghurt has acceptable nutritional and sensorial qualities which show it is a potential alternative to cow milk yoghurt from economic and health perspectives.

Key words: Yoghurt, lactic acid bacteria, nutritional, fermentation, breadfruit-corn yoghurt.

INTRODUCTION

Yoghurt is a Turkish name for fermented milk product. It originated from early nomadic herdsmen, especially from Asia, Southern and Eastern Europe (Olakunle, 2012). Milk, for thousands of years has been transformed through microbial fermentation into various food products with high nutritional value (Tamine and Robinson, 1999).

Yoghurt is made by adding a culture of acid forming bacteria to milk that is usually homogenized, pasteurized and fermented. Species of lactic acid bacteria (LAB) represent as potential microorganisms and have been widely applied in food fermentation worldwide. The presence of LAB in milk fermentation can be either spontaneous or inoculated starter culture, since milk is known as one of the natural habitats (Wouters et al.,

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2002; Delavenne et al., 2012). Although, under spontaneous fermentation, the growth of LAB cannot be predicted or controlled, but the procedure has been practiced and carried out traditionally for years (Mennane et al., 2007; Sharma et al., 2012).

Yoghurt is generally produced by lactic acid fermentation through the action of *Streptococus thermophilus* and *Lactobacillus bulgaricus*, and the viability and activity of yoghurt bacteria are of important commercial consideration so that they survive throughout shelf life, transit through acidic conditions in the stomach as well as enzymes and bile salts in the small intestine (Walia et al., 2013). The *S. thermophilus* and *L. bulgaricus* are inoculated simultaneously at 1:1 composition, for instance and remain present throughout the production of yoghurt, as well as in the final product. When both bacteria grow in association, the times for milk coagulation are faster than if either of them is grown separately. The *S. thermophilus* grow and, while they grow, they produce formic acid that in turn stimulates the growth of the *L. bulgaricus*. The activity of the latter on casein induces the presence of free amino acids, which in turn stimulates the growth of the former (Ginovert et al., 2002).

Industrial production of yoghurt has increasingly developed worldwide due to the nutritional benefit of milk constituents and live lactic acid bacteria (Birollo et al., 2000; Park et al., 2005). Due to the prohibitive cost of dairy milk and its products in developing countries, and avoidance of cow milk by vegetarians and people who are allergic to cow milk, enormous efforts are diverted towards making yoghurt from a variety of food resources (Kumar and Mishra, 2004; Lal et al., 2006). Yoghurt-like products have been developed from soymilk (Trindade et al., 2001; Olubimiwa et al., 2006), peanut milk (Isanga and Zhang, 2009), corn milk (Supavititpatana et al., 2010), tiger nut-coconut milk (Belewu et al., 2010), soy-corn milk (Olakunle, 2012; Kpodo et al., 2014a) and skim milk fortified non-dairy milk extracts (Elsamani et al., 2014; Kpodo et al., 2014b).

Yoghurt production from breadfruit-corn milk is envisaged on nutritional and health grounds, since a beverage blend from legume and cereal is considered a nutritional balance product (Olakunle, 2012). In addition, non-dairy yoghurt, such as soymilk based yoghurt, has been reported to offer several distinct health advantages over cow milk yoghurt to the consumer, such as reduced level of cholesterol, saturated fats and lactose (Lee et al., 1990).

MATERALS AND METHODS

Source of materials

The seeds of African breadfruit (*Treculia africana var africana*) were purchased from Oye Agu Market, Abagana, Njikoka L. G. A., Anambra State, Nigeria. Green field sweet corn (*Golden cob F1*) was purchased from Songhai Farm Initiative, Heneke, Ezeagu L.G.A., Enugu State, Nigeria.

Preparation of samples

The breadfruit seeds were washed in excess volume of water to remove extraneous materials and immature seeds, drained and parboiled in water at 95°C for 15 min with constant stirring. The parboiled seeds were drained, air dried and dehulled in a hand mill (Corona, Landers YCIA, South Africa) with teeth gap adjusted to approximately 15 mm to crack the hull without crushing the seeds, subsequently winnowed and washed to obtain clean seeds. The green field sweet corn was firstly husked, the silks removed and washed with water. The grains were separated from the cob using knife, cleaned to remove hairs and other extraneous materials.

The milk blending method of Udeozor (2012) was used. Approximately 2 kg of the clean breadfruit seeds were soaked in potable water for 6 h, with soak water changed every 2 h to avoid fermentation and to eliminate foul odour and greasy substances. At the end of the soaking, the seeds were repeatedly washed in potable water before wet-milling in a variable speed blender (SB-736, Sonic, Japan), with intermittent addition of distilled water. The slurry was filtered through double layer linen cloth, wet-milled and filtered repeatedly to final seeds to water ratio of 1:3 (w/v). The filtrate was boiled for 20 min with continuous stirring, re-filtered to obtain plain breadfruit milk. Approximately 2 kg of corn grains was soaked for 6 h and the soak water changed as before. The grains were repeatedly washed, wet-milled and filtered as before to a final grain to water ratio of 1:3 (w/v). The filtrate was boiled for 15 min, re-filtered to give plain corn milk. The breadfruit milk and corn milk were blended on 60:40 proportions (v/v) to obtain breadfruit-corn milk as shown in Figure 1.

The breadfruit-corn yoghurt was then produced using the method reported by Jimoh and Kolapo (2007) with slight modification. Vegan yoghurt starter culture could not be sourced locally as at the time of this study. A starter culture (Yogourmet, Canada) containing *S. thermophilus*, *L. bulgaricus* and *L. acidophilus* was used according to manufacturer specifications. However, using the free dried pack of this starter did not give expected result after the prescribed incubation period. Extending the fermentation duration and varying incubation temperature did not yield the desired coagulum. The product was however put in tight lid container and preserved in the refrigerator to serve as activation batch for subsequent productions. Exactly 2 L of plain breadfruit-corn milk was pasteurized at 88°C for 15 min and left to cool to 45°C. Approximately, 200 ml of inoculums from the activation batch was transferred aseptically into the 2 L milk. This was stirred with sterile spoon for even distribution, incubated at 45±2°C for about 8 h to obtain a product with acceptable gel strength. The set yoghurt was placed in the refrigerator for 3 h to stop fermentation. About 5% of sucrose, 0.02% of carboxyl methyl cellulose (CMC), preservatives (0.01% sodium benzoate and 0.01% potassium sorbate) and milk flavoring (to taste) were added to the coagulum, stirred to mix, filled into screw capped plastic bottles as in Figure 2. The products were stored in the refrigerator prior to analysis.

Commercial cow milk yoghurt

The commercial cow milk used in this study was obtained from a manufacturer in Nigeria to serve as a control for the breadfruit-corn yoghurt as in the characteristic shelf life study of corn milk yoghurt (Supavititpatana et al., 2010).

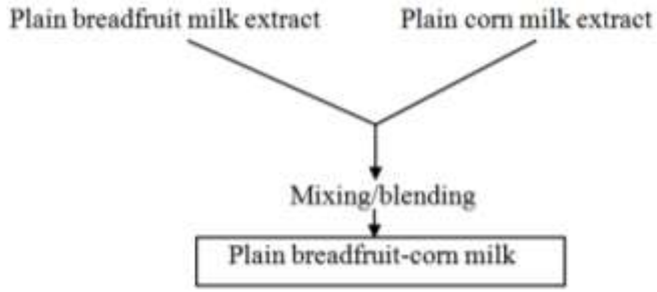

Figure 1. Flow chart for the production of plain breadfruit-corn milk

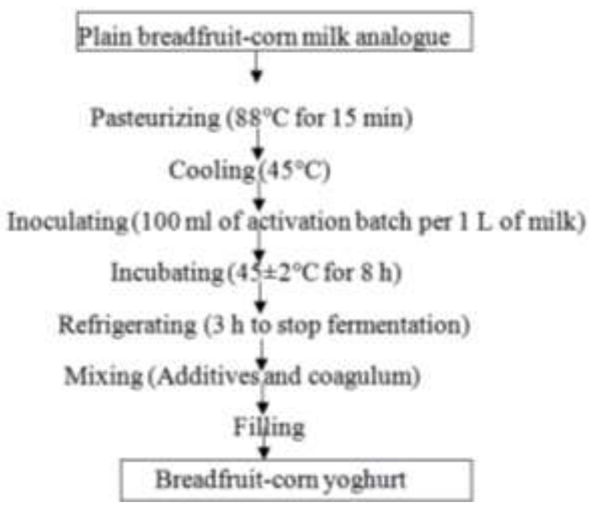

Figure 2. Flow chart for production of breadfruit-corn yoghurt.

Proximate analysis

The proximate composition of protein, fat, ash, fibre, moisture content and carbohydrate were determined according to the method of analysis described by the Association of Official and Analytical Chemists (AOAC, 2000).

Mineral content analysis

Mineral analysis was conducted using Varian AA240 Atomic Absorption Spectrophotometer (AAS) according to the method of APHA 1995 (American Public Health Association). Approximately 2 g of the sample was weighed into a digestion flask and 20 ml of the acid mixture (650 ml conc. HNO_3; 80 ml perchloric acid; 20 ml conc. H_2SO_4) was added.

The flask was heat until a clear digest was obtained. The digest was diluted with distilled water to the 100 ml mark. Appropriate dilutions were then made for each element.

Preparation of reference solution

A series of standard metal solution in the optimum concentration range were prepared. The reference solutions were prepared daily by diluting the single stock element solutions with water containing 1.5 ml concentrated nitric acid/liter. A calibration blank was prepared using all the reagents except for the metal stock solutions. Calibration curve for each metal was prepared by plotting the absorbance of standard versus their concentrations.

Vitamin content analysis

Determination of vitamin A

Vitamin A was determined by the calorimetric method of Kirk and Sawyer (1991). About 1 g of the sample and standard were mixed with 30 ml of absolute alcohol and 3 ml of 50% KOH solution was added to it and boiled gently for 30 min under reflux. After washing with distilled water, vitamin A was extracted with 150 ml of diethyl ether. The extract was evaporated to dryness at low temperature and then dissolved in 10 ml of isopropyl alcohol. 1 ml of standard vitamin A solution was prepared and that of the dissolved extract were transferred to separate cuvettes and their respective absorbance were read in a spectrophotometer at 325 nm with a reagent blank at zero.

Concentration of vitamin A in sample $= \frac{\text{Abs of samples}}{\text{Abs of std}}$ x conc. of standard

Determination of vitamins B_1 and B_2

Approximately 1 g of sample was weighed into a conical flask and dissolved with 100 ml of deionized water. This was shaken thoroughly and heated for 5 min and allowed to cool and then filtered. The filtrate was poured into cuvette and their respective wavelength for the vitamins set to read the absorbance using spectrophotometer.

Vitamin B_1 = 261 nm
Vitamin B_2 = 242 nm

Concentration (mg/%) = $\frac{\text{A X D.F volume of cuvetter (5)}}{\text{E}}$

Where A = absorbance; DF = dilution factor; E = extinction coefficient = 25 for B_1 and B_2.

Determination of vitamin B_3

Approximately 5 g of sample was dissolved in 20 ml of anhydrous glacial acetic acid and was warmed slightly. About 5 ml of acetic anhydride was added and mixed. Two to three drops of crystal violet solution was added as indicator. 0.1 M perchloric acid was added to titrate to a greenish blue colour.

$$\text{Vitamin } B_3 = \frac{\text{titre value X 0.012}}{0.1}$$

Determination of vitamin C

This was determined by the titrimetric method (Kirk and Sawyer, 1991). Approximately 2 g sample was homogenized in 6% EDTA/TCA solution. The homogenate was filtered and used for analysis. 20 ml of 30% KI solution was added to it and titrated against 0.1 M $CuSO_4$ solution. The end point was marked by a black coloration. A reagent blank was also titrated. Vitamin C content was calculated based on the relationship below:

1 ml of 0.1 mole $CuSO_4$ = 0.88 mg vitamin C

$$\text{Vitamin C} = \frac{100 \times 0.8\ (\text{titre - blank})}{\text{Weight of sample}}$$

Sensory test

Two yoghurt samples coded BCY and CMY were presented in similar form to a 30 member sensory panel consisting of staff and students from a College of Agriculture community. They were requested to rate the yoghurts in terms of colour, texture, taste, aroma, mouth feel and overall acceptability on a 9-point hedonic scale where 1 = dislike extremely and 9 = like extremely (Onwuka, 2005; Iwe, 2014). Each panelist was provided with enough privacy to avoid biased assessment.

Statistical analysis

Results were obtained in triplicates and the data collected were subjected to T-Test using SPSS Version 17 and differences between mean values were evaluated at $p<0.05$ using paired samples test.

RESULTS AND DISCUSSION

Proximate composition

The moisture content of breadfruit-corn yoghurt (BCY) was significantly ($p<0.05$) higher than the values of the commercial cow milk yoghurt (CMY) as shown in Table 1. The 85.7% moisture content of the BCY correlated with the 87.55% of corn milk yoghurt by Supavititpatana et al. (2010) and 89.08% of soy-corn yoghurt by Olakunle (2012). The lower moisture content of the CMY may be due to skimmed milk powder which thickens slurry and reduces moisture content. Elsamani et al. (2014) reported that increased addition of skimmed milk powder reduced the moisture content of peanut milk based yoghurt due to thickening effect. The lower moisture content of the commercial cow milk yoghurt is an advantage when shelf life is considered (Adeiye et al., 2013).

The protein content of the BCY of 4.58% was significantly ($p<0.05$) lower than the 4.89% of CMY, but higher than the 4.17% of corn milk yoghurt and 3.89% of the commercial cow milk yoghurt (Supavititpatana et al., 2010). The 4.58% of BCY was also higher than 4.30% of soy-corn yoghurt by Olakunle (2012). The higher protein content of the CMY might be due to the use of skimmed milk powder which has generally high protein value. Elsamani et al. (2014) reported that the protein content of peanut based yoghurt increased from 11.55 to 20.65% when fortified with skimmed milk powder. The fat content of BCY was significantly ($p<0.05$) lower than that of CMY. This might be attributed to the higher fat content of skimmed milk. Rehman et al. (2007) reported increased fat content of *Lathyrus sativus* milk fortified with 5% skimmed milk powder. Drying of milk during skimmed milk production is well known to concentrate the biochemical constituents of the powdered milk leading to significant increase in fat, protein and total solids of incorporated compound. The breadfruit-corn yoghurt may be classified as low fat yoghurt since it is slightly above 0.5% fat (Kosikowski, 1997). The low fat content of the BCY could reduce chances of rancidity while the higher fat content of CMY may easily contribute to the production of off flavor during storage.

Table 1. Proximate composition of yoghurt samples.

Parameter	BCY	CMY
Moisture (%)	$85.70^a \pm 0.49$	$77.84^b \pm 0.31$
Protein	$4.58^b \pm 0.03$	$4.89^a \pm 0.02$
Fat	$0.58^b \pm 0.04$	$1.17^a \pm 0.02$
Ash	$2.14^b \pm 0.16$	$9.33^a \pm 0.30$
Crude fibre	$3.69^b \pm 0.04$	$3.80^a \pm 0.02$
Carbohydrate	$3.53^a \pm 0.50$	$2.81^b \pm 0.31$

Means within a row followed by different superscripts are significantly ($p<0.05$) different. BCY = breadfruit-corn yoghurt, CMY = commercial milk yoghurt.

The ash content of CMY was significantly ($p<0.05$) higher than that of BCY, which might be attributed to use of skimmed milk powder. Increase in ash content with skimmed milk powder addition has been variously reported (Rehman et al., 2007; Trisnawati et al., 2013). Addition of corn has also been reported to increase ash content of yoghurt due to high mineral content of corn (Omueti and Ajomale, 2005; Olankunle, 2012). This conforms to the report of Odu et al. (2012) that high mineral content in products result in high ash content. Unlike CMY, the ash content of BCY was within the limit of <5% for milk beverages by Standard Organization of Nigeria (Adedokun et al., 2014). The crude fibre content of breadfruit-corn yoghurt was significantly ($p<0.05$) lower than that of the commercial cow milk yoghurt. Fortification of the CMY with corn starch, minerals and vitamins, as indicated on the label, may have contributed to the higher level of crude fibre. However, the 3.6% crude fibre of BCY and 3.8% 0f CMY were higher than the 3% minimum of the Codex Alimentarius Standards for dairies (Passmore and Eastwood, 1986). High crude fibre content of food could play a role in normal peristaltic movement of the intestine (Akinyele, 1983). The carbohydrate content of BCY was significantly ($p<0.05$) higher than that of CMY. The higher value of BCY may be due to substantial use of sweet corn in the milk blend.

Table 2. Mineral content of yoghurt samples.

Parameter	BCY	CMY
Sodium (ppm)	5.21^{b}±0.00	6.28^{a}±0.01
Calcium	15.47^{a}±0.03	13.76^{b}±0.06
Potassium	6.48^{a}±0.02	3.38^{b}±0.06
Magnesium	5.26^{a}±0.00	4.28^{b}±0.00
Manganese	0.01^{b}±0.00	0.02^{a}±0.01
Iron	0.03^{a}±0.00	0.02^{b}±0.00
Copper	0.00^{ns}±0.00	0.00^{ns}±0.00
Zinc	0.03^{a}±0.00	0.02^{b}±0.00

Means within a row followed by different superscripts are significantly (p<0.05) different. BCY = breadfruit-corn yoghurt, CMY=commercial milk yogh, ns = no significant value.

Table 3. Vitamin content of yoghurt samples.

Parameter	BCY	CMY
Vitamin A (mg/g)	39.05^{a}±0.00	56.51^{b}±0.44
Vitamin B_1 (mg%)	1.39^{b}±0.00	1.54^{a}±0.00
Vitamin B_2	2.01^{a}±0.00	1.06^{b}±0.00
Vitamin B_3	1.57^{b}±0.00	1.68^{a}±0.00
Vitamin C (mg/l)	36.28^{a}±0.03	30.80^{b}±0.01

Means within a row followed by different superscripts are significantly (p<0.05) different. BCY = breadfruit-corn yoghurt, CMY = commercial milk yoghurt.

Table 4. Sensory scores of yoghurt samples.

Attributes	BCY	CMY
Colour	7.66^{b}±0.41	8.13^{a}±0.40
Texture	6.90^{b}±0.74	7.83^{a}±0.56
Taste	6.90^{b}±0.73	7.66^{a}±0.69
Aroma	6.96^{b}±0.72	7.56^{a}±0.70
Overall acceptability	6.53^{b}±0.81	7.20^{a}±0.56

Means within a row followed by different superscripts are significantly (p<0.05) different. BCY = Breadfruit-corn yoghurt, CMY = commercial milk yoghurt.

Addition of corn in the production of soy-corn yoghurt was similarly reported to have increased the carbohydrate content of soy yoghurt (Olakunle, 2012). Cereals are generally known to be good source of carbohydrate.

Mineral content

The BCY was significantly (p<0.05) higher than CMY in calcium, potassium, magnesium, iron and zinc, but significantly (p<0.05) lower in sodium and manganese as shown in Table 2. It is expected that nutrient value of yoghurt will depend largely on the milk from which it was fermented. The higher values of breadfruit-corn yoghurt in most of the minerals may be due to their fair distribution in legumes and cereals (Onweluzo and Odume, 2007). Yoghurt is a rich source of calcium and good provider of magnesium, potassium and phosphorus, and other minerals such as iron, zinc, iodine, chloride and selenium are also found in yoghurt (Miller, 2000). The absence of copper in BCY and CMY might be due to the low value in the milk which was probably utilized during fermentation. It has been reported that copper could be used as a potential additive to inhibit the post acidification of yoghurt (Han et al., 2011), hence its inadequacy in the first instance might have led to the sudden depletion. The higher iron content of the breadfruit-corn yoghurt is understandable since dairy milk is known to be deficient in iron (Passmore and Eastwood, 1986).

Vitamin content

The breadfruit-corn yoghurt was significantly (p<0.05) higher in vitamin B_2 and C than the commercial cow milk yoghurt, but significantly (p<0.05) lower in vitamins A, B_1 and B_3, as shown in Table 3. The appreciable value of vitamin A (a fat soluble vitamin) in the BCY might be due to the yellow sweet corn which was partly used in milk production, since the yellow pigments (carotenoids) of yellow corn is a precursor of vitamin A. The higher vitamin C content of BCY is expected since vitamin C is synthesized primarily in plants. The presence of vitamin C in the CMY can be attributed to the fortification of the product with corn starch and minerals. The difference in values of B vitamins may be due to their levels in the milks that were fermented. The vitamins content of yoghurt is variable depending on the type of yoghurt and method of production, but remains fairly similar to the milk for the majority of vitamins (Kosikowski, 1997). Cow milk yoghurts are good providers of the B vitamins as reported by Miller et al. (2000).

Sensory scores

It is shown in Table 4 that the commercial cow milk yoghurt was significantly (p<0.05) higher than the breadfruit-corn yoghurt in all the attributes considered. The lower colour score of BCY might be due to the yellow pigments (carotenoids) of the yellow sweet corn. Olakunle (2012) reported low colour score of soy-corn milk which was attributed to the yellow colour of xanthophylls pigments (carotenoids) of yellow corn. This however contradicts the report of Lestiyani et al. (2014) where the pigments conferred better colour. The higher taste score of CMY may be due to the difference in composition of milk that was fermented, and the added ingredients. In addition, the higher fat content of CMY might have contributed to the higher taste score. Fat has been reported to promote mouth feel (FAO/WHO, 1993), which might have impacted positively on the taste of the commercial milk yoghurt. The panelists may have preferred the texture of the commercial cow milk yoghurt to the breadfruit-corn yoghurt due to difference in gel consistency. The structural arrangement of the gel network determines the textural characteristics of coagulated dairy product and is affected by factors such as composition and manufacturing processes (Rawson and Marshall, 1997). Non-dairy yoghurts are known for lower water holding capacity which leads to high syneresis and poor texture (Akalin et al., 2012). It has also been reported that total solids and fat levels in the milk, heat treatment of the milk prior to inoculation, homogenization, presence of stabilizers and incubation conditions will affect the body of the final product (Kumar and Mishra, 2004), and these may have contributed to the better texture of the CMY.

Aroma of yoghurt is supported by various compounds, in which lactic acid represent the major contributor, and other aroma compounds. The most common lactic acid bacteria cultures used in yoghurts manufacture *S. thermophilus* and *L. bulgaricus* act in association and synergistically to provide volatile metabolites that determine the flavor of yoghurt, and acetaldehyde and diacetyl were reported to be essential aroma compounds of typical yoghurt (Tamine and Robinson, 1999; Walstra et al., 1999). The higher aroma score of CMY might be due to different amino acids as well as organic acids which produce more lactic and aromatic compounds (Routrary and Mishra, 2011). The CMY had higher overall acceptability than the BCY, which is expected considering that it had excelled in all other attributes evaluated. However, the mean sensory scores of BCY were similar to the values reported by Zhanhi and Jideani (2012) for non-dairy yoghurts. Elsamani et al. (2014) also reported better sensory results for peanut yoghurt samples fortified with skimmed milk during maturation. Furthermore, the CMY was fortified with flavor, minerals and vitamins supplement in addition to being derived from reconstituted skimmed milk. It is also possible that familiarity of the panelists with cow milk yoghurt may have influenced the higher sensory scores of CMY, hence its higher overall acceptability. However, the sensory scores of BCY were within the commercially acceptable range (4-9 scores) recommended for yoghurts by the Karl Ruther nine point scheme (Tamine and Robinson, 1999).

Conclusion

The study has shown that breadfruit-corn milk can be fermented into a yoghurt-like product of good nutritional and sensorial quality. The non-dairy yoghurt was comparable to the cow milk yoghurt in virtually all the parameters evaluated. Given the nutritional balance of legume-cereal beverage, the breadfruit-corn yoghurt has the potentials as dairy yoghurt substitute from economic and health point of view.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

REFERENCES

Adedokun II, Okorie SU, Batu B (2014). Evaluation of proximate, fibre qualities and consumer acceptability of bambaranut-tigernut-coconut milk beverage blends. Inter. J. Nutr. Food Sci. 3(5):430-437.

Adeiye O.A, Gbadamosi S.O, Taiwo A.K (2013). Effects of some processing factors on the characteristics of stored groundnut milk extract. Afr. J. Food Sci. 7(6):134-142.

Akalin AS, Unal G, Dinkci N Hayaloglu, AA (2012).Micro structural, textural and sensory characteristics of probiotic yoghurts fortified with sodium calcium caseinate or whey protein concentrate. J. Dairy Sci. 95(7): 3617-3628.

Akinyele IO (1983). Combination of cereals and legumes and meat in extrusion processing. In role of cereals and legumes in nutrition (Dupont and Osman eds) Iowa State University Press. pp. 219-236.

American Public Health Association (APHA) (1995). 3112 B, Cold – Vapour Atomic Absorption Spectrometric Method, Standard Methods for Examination of Water and Wastewater, 20th Edition, APHA, AWWA, WEF.

Association of Official Analytical Chemists (AOAC) (2000). Official Methods of Analysis 17th edn. Association of Official Analytical Chemists. AOAC International , Arling, VA.

Belewu MA, Belewu KY Bamidele RA (2010). Cyper-coconut yoghurt preparation, compositional and organoleptic qualilities. Afr. J. Food Sci. Technol. 1(1):010 -012.

Birollo G.A, Reinheinmer J.A, Vinderola C.G (2000). Viability of lactic acid microflora in different types of yoghurt. Food Res. Inter. 33:799-805.

Delavenne E, Mounier J, Deniel F, Barbier G, Le Blay G (2012). Biodiversity of antifungal lactic acid bacteria isolated from raw milk samples from cow, ewe and goat over one-year period. Inter. J. Food Microbiol. 155(3): 185-190.

Elsamani MO, Isam A, Ahmed M (2014). Physichochemical characteristics and organolepitic properties of peanuts milk-based yoghurt fortified with skimmed milk powder. J. Res. Appl. Sci. 4:78-82.

Food and Agriculture Organization/World Health Organization Geneva (FAO/WHO) (1993). Evaluation of certain food additives and contaminants. Technical report series 837. World Health Organization Geneva.

Ginovert M, Lopez D, Vallis J, Silbert M (2002). Simulation modelling of bacteria growth in yoghurt. Int. J. Food Microbiol. 73:415-425.

Han X, Zhang L, Du M, Vi H (2011). Effects of copper on the post acidification of fermented milk by *Streptococcus thermophilus*. J. Food Sci. 77(6):25-28.

Isanga J, Zhang G (2009). Production and evaluation of some physicochemical parameters of peanut milk yoghurt. Food Sci. Technol. 42(6):1132-1138.

Iwe M.O (2014). Current trends in sensory evaluation of foods. Rejoin Communication Services Ltd Uwani Enugu. pp. 142-145.

Jimoh KO, Kolapo AI (2007). Effect of different stabilizers on acceptability of soy yoghurt. Afr. J. Biotectnol. 6(8):1000-1003.

Kirk RS, Sawyer R (1991). Pearson's Food Composition and Analysis 4th edn. Macmilan Publication Co. UK.

Kosikowski FV (1997). Cheese and fermented milk foods, volume I, Origins and Principles. Edwards, Brothers, Michigan. 106p.

Kpodo FMK, Afoakwa EO, Amoa BB, Busdu AS, Saalia FK (2014a). Nutritional and sensory characterization of full fat and partially defatted peanut soymilk yoghurt. Int. J. Nutr. Food Sci. 3(3):187-193.

Kpodo FMK, Afoakwa EO, Amoa BB, Busdu AS, Saalia FK (2014b). Effect of ingredient variation on microbial acidification, susceptibility to syneresis, water holding capacity and viscosity of soy-peanut-cow milk yoghurt. J. Nutr. Health Food Eng. 1(2):1-6.

Kumar P, Mishra H.H (2004). Mango soy fortified set yoghurt: Effect of stabilizer addition on physicochemical, sensory and textural properties. Food Chem. 87:501-507.

Lal SND, O'Connor CJ, Eyres L (2006). Application of emulsifiers/stabilizers in dairy products of high rheology. Adv. Colloid Interface Sci. 123:433-437.

Lee SY, Morr CV, Seo A (1990). Comparison of milk based and soymilk based yoghurt. J. Food Sci. 55(2):532- 536.

Lestiyani A.D, Susano T.I, Srianta I (2014). Characteristics of soy-corn yoghurt. J. Food Nutr. Disorders 3(2):1-3.

Mennane Z, Khedid K, Zinedine A, Lazouli M, Ouhssiane M, Elychioni M (2007). Microbial characteristics of Klila and Iben traditional Moroccan cheese from raw cow's milk. World J. Dairy Food Sci. 2(1):23-27.

Miller R (2000). Food nutrient analysis of peanuts: the food chain. Food Agric. 14:78-83.

Odu NN, Egbo NN, Okonkwo IO (2012). Assessment of the effect of different preservatives on the shelf-life of soymilk stored at different temperatures. Researcher 4(6):62-69.

Olakunle MM (2012).Production and quality evaluation of soy-corn yoghurt. Adv. J. Food Sci. Technol. 4(3):130-134.

Olubimiwa AO, Kolapo AL, Odetoyinbo BB (2006). Effect of different starter cultures on the chemical composition and acceptability of soy-yoghurt. Being a paper delivered at the proceeding of 37th Annual Conference of Nutrition Society of Nigeria, Abeokuta, Nigeria: 8-11.

Omueti O, Ajomale K (2005). Chemical and sensory attributes of soy-corn milk types. Afr. J. Biotechnol. 4(6):847-851.

Onwuka G.I (2005). Food analysis and instrumentation. Theory and practice. Napthali Printers, Nigeria, 198p.

Park DJ, Oh S, Ku K.H, Mok C, Kim SH, Imm JY (2005). Characteristics of yoghurt-like products prepared from the combination of skim milk and soymilk containing Saccharified–rice solution. Inter. J. Food Sci. Nutr. 56(1):23-34.

Passmore R. Eastwood WA (1986). Human Nutrition and Dietetics. 8th Edition, New York, English Language Books Society, Churcill livingstone, pp. 235-240.

Onweluzo LJC, Odume CE (2007). Effect of method of seed extraction and demuciligination on the composition of *Treculia africana* (African breadfruit) kernel. Nigerian Food J. 26:90-99.

Rawson HL, Marshall VM (1997). Effect of ropy strains of *Lactobacillus delbruckii spp. bulgariccus* and *Streptococcus thermophillus* in rheology of stirred yoghurt. Inter. J. Food Sci. Technol. 32:213-220.

Rehman S, Hussain H, Nawaz H, Ahmad MM, Huma N, Virk WA (2007). Preparation and quality evaluation of *Lathyrus sativus L*-bovine milk blend. Pak. J. Nutr. 6:134-137.

Routrary W, Mishra HN (2011). Scientific and technical aspects of yoghurt aroma and taste: A review. Comprehensive Reviews Food Sci. Food Safety 10(4):208 -220.

Sharma R, Sanodiya BS, Bagrodia D, Pandey M, Sharma A, Bisen PS (2012). Efficacy and potential of lactic acid bacteria modulating human health. Inter. J. Pharm. Bio Sci. 3(4):935-938.

Supavititpatana P, Wirjantoro T, Raviyam P (2010). Characteristics and shelf-life of corn milk yoghurt. CMU J. Nat. Sci. 9(1):133-147.

Tamine AY, Robinson RK (1999). Background to manufacturing practices. Yoghurt Science and Technology. Woodhead Publishing Ltd and CRC Press LLC, Boca Raton, Florida pp. 11-61.

Trintade CS, Terzi SC, Trugo LC, Delta MRC, Court S (2001). Development and sensory evaluation of soy milk based yoghurt. Arch Latinoam Nutr. 51:100-104.

Trisnawati CY, Srianra I, Marsono Y (2013). Effect of varieties on the characteristics of soy-corn milk. Inter. Food Res. J. 20(3):1187-1190.

Udeozor LO (2012). Tiger nut-soy milk drink: Preparation, proximate composition and sensory qualities. Inter. J. Food Nutr. Sci. 1(4):18-26.

Walia A, Mishra HN, Kumar P (2013). Effect of fermentation on physicochemical, textural properties and yoghurt bacteria in mango soy fortified yoghurt. Afr. J. Food Sci. 7(6):120-127.

Wouters JTM, Ayad EHE, Hugenholtz J, Smit G (2002). Microbes from raw milk for fermented dairy products. Int. Dairy J. 12(2-3): 91-109.

Zanhi NK, Jideani IA (2012). Physicochemical and sensory qualities of soy and milk solids fortified low fat yoghurt. Afr. J. Agric. Res. 7(38):5336-5343.