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Nutritive Value of Fermented Soy Drink from Tamarind and Nono

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Abstract

Nutritive value of fermented soy drink was evaluated. Soymilk was extracted from whole soybean seeds and pasteurized 76°C for 30 minutes and apportioned into two: one portion inoculated with tamarind pulp juice and the other with *nono* containing. They were incubated at 42°C for 12 hours, second generation fermented soy drink (A2) was produced using back slopping method from the first generation fermented soy drink (A)The proximate composition, titrable acidity and the pH of the fermented soy drink samples were examined using the method of Association of Official Analytical Chemist (AOAC). Sensory evaluation was carried out using 9point hedonic scale. Tamarind pulp contained saponins, glycosides, tannins and alkaloids but flavonoids were absent. There was significant ($p<0.05$) difference in the crude protein, oil extract, energy, ash and NFE contents for the three samples. Sample A2 had significantly ($p<0.05$) higher nutrient content with energy (43.37±0.15%), crude protein (4.41±.023%), NFE (2.38±0.03%) and ash (0.43±0.06%) but lower in moisture content (85.39±0.29%) when compared to A (88.43±1.20 %).Sample C contained significantly ($p<0.05$) higher lactic (1.62%), tartaric (1.35%), citric (1.20%), malic (1.20%) and acetic (1.08%) than A and B however, there was no significant ($p>0.05$) difference between sample A and B. The pH of tamarind (D) samples A, A2, B and C were (2.46), (5.28), (5.23), (4.77) and (4.78) respectively. The organoleptic scores obtained showed that sample A had significantly ($p<0.05$) higher overall acceptability (7.50±1.4902) than sample B (5.51±2.3356). The results obtained in the present study validate the use of tamarind as starter culture for making fermented soy drink.

Keywords: Soy Drink, Tamarind, Fermented, Nutritive, Nono.

Introduction

Soybean *Glycine max* (L.) (also soya- or soja bean), is an annual herbaceous plant (Huang, 2008). It is also called waken soya in Bwagi and Hausa. Soybean are grown from seeds planted in rows in the field and can grow well on a wide variety of soils and climates (Shurtleff and Aoyagi, 2013). Soybean milk is richer in protein than most animal milk. Due to the current worldwide shortage of food, attempts have been made to find alternative sources of protein, particularly for the developing countries, where malnutrition exists (Raja *et al*., 2014). As a result, shifts from animal to vegetable sources of protein have increased significantly with soya beans as a potential candidate (Abd El-Gawad *et al*., 2015). Intake of fermented soymilk improves the surrounding of the intestinal tract by increasing the amount of probiotics (Chang *et al*., 2005). Soybean and its products are excellent sources of high-quality protein, high dietary fiber and bioactive components such as isoflavones. Soy milk is inexpensive and rich in iron contents that could be used for iron fortification (Abd El-Gawad *et al*., 2015). Soy yoghurt contain sucrose as the basic disaccharide, which breaks down into glucose and fructose. Like lactose-free cow milk, soymilk contains no lactose, which makes it an alternative for those who are lactose-intolerant. It has been suggested that soy consumption is associated with a reduction in low-density lipoprotein (bad cholesterol) and triglycerides (Anderson and Johnstone, 1995).

Fermented soy drink is a product obtained from the inoculation of yoghurt starter to soymilk (Rezvan *et al.*, 2012). Ihekoronye and Ngoddy (1985), defined yoghurt as a fermented milk product that developed empirically some centuries ago by letting naturally contaminated milk to sour at a warm temperature, in the range of 40-50°C. Fermented soy drink (yoghurt) improved flavour, texture and increases nutritional properties of soymilk. Soy yoghurt offers a significant demand for a rising segment of consumers with firm health and dietary concern due to several nutritional advantages over cow milk yoghurt such as low levels of cholesterol and saturated fat, and it is lactose-free (Abiodun and Adelodun 2008). However, soy yoghurt increases bone health, lessens menopausal symptoms and risk of heart disease and certain cancers (Amanze and Amanze 2011). The microorganisms which are used conventionally in this process are referred to as "starter culture". They include *Lactobacillus bulgaricus* and *Streptococcus thermophilus*. Soymilk has been reported to support the growth of bifidobacteria, but at slower rates than those in reconstituted skim milk. *Bifidobacteria* have α-galactosidase activity, which enables them to utilize sugars such as raffinose and stachyose, and sufficient proteolytic activity to support growth in soymilk (Farnworth *et al*., 2007). *Bifidobacteria* were only able to acidify the media by half the value compared to the yoghurt culture (Horáčková *et al*., 2015). Soy yoghurt prepared with different strains of bacteria may have distinct compositions and functions (Xiao, 2011), such as *Lactobacillus delbrueckii* sp*. bulgaricus* and *Streptococcus thermophilus* evidently increased the protein quality of soymilk during the fermentation and a reduction in trypsin inhibitor levels of about 30% (Silva JÃºnior*et al*., 2012).Aside starter culture and *nono*, there are some plant extracts used traditionally to curd milk such as tamarind plant.

Tamarind (*Tamarindus indica*) is a leguminous tree in the family Fabaceae and is indigenous to Tropical Africa. It is a multipurpose tree of which almost every part finds at least some use (Kumar and Bhattacharya, 2008), either nutritional or medicinal. The pulp is composed of tartaric acid, citric and malic acids, potassium bitartarate, pectin, gum, water and parenchymatous fiber (Nyadoi and Abdullahi, 2004). In Nigeria, particularly in the Northwestern part, *Tamarindus indica* pulp is popularly employed on a daily basis as a flavour in the production of local drinks, preservation of food and in the general trado-medical practice as a drug conveyor, in combination with other herb for treatment of various diseases such as indigestion, constipation, fever and inflammation (Nyadoi and Abdullah, 2004). Malabar tamarind has been used to make a curd starter culture successfully for buffalo milk fermentation as an alternative to expensive commercial starter cultures. This study aims to evaluate the nutritional value of fermented soy drink from tamarind and nono.

Materials and Methods

Collection of Raw Materials

Soybean seeds, commercially available starter cultures (*nono*) and tamarind fruits were purchased from Bosso market in Minna, Niger State Nigeria. Soybean seed and Tamarind were transported in sterile sampling bags and *nono* was collected in a sterile sampling bottles and immediately transported in ice packed box within temperature of 10ºC to the laboratory of Microbiology Department of Federal University of Technology, Minna, Nigeria for analysis.

Preparation of Tamarind Pulp

The tamarind fruits were spread on a foil paper and sundried in a one square metre (1sqm) wood frame and a 70µm pore size net covered tent dryer to prevent the tamarind from insects and dust. The fruits were placed in a desiccator towards evening on daily basis for the period of five days. *Tamarindus indica* fruit pulp powder was obtained by aseptic manual removal of the seeds from the pulp and pulverished to fine powder using an electric blender (Binatone model). One hundred grams of the pulp powder was soaked in 500mL of sterile distilled water (cool extraction). This was shaken for 10 minutes and then filtered with sieve (El-Siddig *et al.*, 1999). The filtrate (solution) was immediately used for the production of fermented soy drink.

Phytochemical Screening

The phytochemical components of tamarind pulp was screened for the presence of flavonoids, glycoside, saponin, tannins and alkaloid using the methods described by Trease and Evans (1986), Sofowora (1993) and Oloyede (2005).

Test for Saponins

Two grams (2g) of tamarind pulp powder was heated in 20 ml of distilled water in a test tube in boiling water bath and filtered. Ten millilitres of the filtrate was mixed with 5 ml of distilled water and shaken vigorously to form a stable persistent froth. The frothing was mixed with three drops of olive oil and shaken vigorously for the formation of emulsion (foam appearance) characteristic of saponins (Trease and Evans, 1986).

Test for Glycosides

Two millilitres of tamarind solution was taken in a test tube. A piece of sodium picrate paper was suspended above the solution by trapping the top edge between the cork and the tube wall. This was allowed to stand for thirty minutes in a warm water bath of about 45°C. Yellow coloration of Sodium picrate turns to brick red indicates the presence of glycosides due to free hydrogen cyanide (HCN).

Test for Tannins

Point five millilitres of tamarind solution was stirred with 10ml portions of distilled water, ferric chloride reagent was then added. Blue green coloration indicates the presence of tannins.

Test for Alkaloids

Three millilitres of tamarind extract was stirred with 3 ml of 1% hydrogen chloride HCl on steam bath. One millilitre of mixture was taken separately in two test tubes. Few drops of Dragendorff's reagent were added in one tube. Occurrence of orange red precipitated was taken as positive test for alkaloids. To the second tube Mayer's reagent was added and appearance of buff colored precipitate was taken as positive test for presence of alkaloids.

Production of Soy Milk

Soymilk was produced by the traditional method of Abd- El Gawad *et al.*(2015). Cleaned soybean seeds was soaked in water for 12 hours and rinsed. The soaked soybeans was then ground in a warring blender Hamilton Beach (model 909-220). The slurry was boiled at 76°C for 30 minutes, filtered at ratio 7:1 of water to slurry with cheese cloth Filtrate was simmered for 20 minutes to obtain soy milk.

Fermented Soy Drink Production

Two fermented soy drink premixes were formulated to contain: (i) soy milk plus tamarind (ii) soy milk plus (*nono*) starter culture. Each of the two soymilk premixes were homogenized and pasteurized at 76°C for 30 minutes as described by Collins *et al*. (1991) and Abd- El Gawad *et al.* (2015). The milk was subsequently placed in a water bath to reduce the temperature to 45°C prior to inoculation with *nono* and tamarind pulp juice respectively. All the milk premixes were poured into plastic cups before inoculation and incubated at 42°C and allowed to ferment for 12 hours. After incubation, the premixes were stirred and cooled in a refrigerator at temperature of 5°C until evaluation within 12 hours.

Determination of proximate composition of samples

Proximate composition of tamarind, fermented soy drink from tamarind, *nono* and commercial yoghurt samples were determined. Five commercial samples were used. This was to ensure choice of best commercial sample to use as control. The seeds were removed from the pulp, the tamarind pulp was ground to powdered form by using a blender. The powdered samples were sieved to obtain uniform size that were analyzed for moisture, protein, fat, ash, fiber and nitrogen free extract by the methods of Association of Analytical Chemist (AOAC, 2003).

Determination of mineral content of the samples

One gram (1g) of the samples was measured and added into a digesting glass tube. Twelve millilitres (12mL) of HNO_3 was added to the tamarind pulp powder and the fermented soy drink samples respectively and the mixtures were kept for overnight at room temperature. Four millilitres (4.0mL) per chloric acid ($HClO_4$) was added to the mixture and was kept in the fume block for digestion. The temperature was increased gradually, starting from 50ºC to 250ºC. The digestion was completed after 70 minutes as indicated by the appearance of white fumes. The mixture was left to cool and the contents of each tubes were transferred to 100 mL volumetric flasks and the volumes of the contents were made to 100 mL with distilled water. The wet digested solution was transferred to labelled plastic bottles (AOAC, 2003).

Determination of calcium

One millilitre (1mL) of lithium oxide solution was added to samples to unmask calcium (Ca) from magnesium (Mg). The concentrations of minerals recorded in terms of "ppm" were converted to milligrams (mg) of the minerals by multiplying the ppm with dilution factor and dividing by 1000, as follows:

$$\text{Mass} = \frac{\text{absorbency (ppm) x dry weight x D}}{\text{Weight of sample x 1000}}$$

Where D = dilution factor

Note: Dilution factor for phosphorus is 2500, for magnesium is 10000, while for other minerals including calcium, iron, potassium (K), sodium (Na), manganese and chromium is 100.

Determination of sodium and potassium content of samples

Flame photometry was used in determining the Na and K content of the samples. The same wet digested tamarind pulp powder and the fermented soy drink solutions as used in atomic absorption spectroscopy (AAS) were used for the determination of Na and K contents. Standard solutions of 20, 40, 60, 80 and 100 milli equivalent/L were used both for Na and K. The calculations for the total mineral intake involved the same procedure as given in AAS.

Determination of vitamin C content of the samples

Five grams (5g) of the sample was extracted in 4% oxalic acid and centrifuged. Five millilitre of the supernant was pipetted and added to 10ml of oxalic acid and it was titrated against the Dye (42mg sodium hydrogen trioxocarbonate IV, 52mg 2, 6-dichloro phenol indophenol dissolve and made up to 200ml with distilled water). End point is the appearance of pink colour which persisted for a few minutes. The amount of Dye consumed is equivalent to the amount of ascorbic acid present.

$$\text{Ascorbic acid mg/100g} = \frac{0.5\text{mg} \times V_2 \times 100\text{mL} \times 100}{V_2\ \text{mL} \quad 5\text{mL} \quad \text{wt}}$$

Given that:

Sample weight= 1g. Volume of extract =100mL; Volume of extract used =5mL; Dye titre value against standard V_2 = 5.0mL; Dye titre value V_2 = 1.5mL; Wt = weight of sample.

Determination of titratable acidity of the samples

The percentage lactic, acetic, citric, and malic and tartaric acids content of Tamarind and fermented soy drink samples were determined according to the technique AOAC (1990). Twenty grams of well homogenized sample were placed in a beaker and titrated against O.IN NaOH with phenolphthalein as indicator. Titratable acidity was expressed as percent lactic acid where 1mL of 0.1N NaOH is equal to 0.0090gms for lactic acid, acetic 0.0060gms, malic 0.0067gms, citric 0.0070gms and tartaric 0.0075gms.

$$\frac{\text{Titrable acidity (\%)} \times \text{Vol} \times 100}{\text{wt}}$$

Where:

Vol = volume of NaOH used

Wt = weight of sample

pH determination of the samples

The pH of the tamarind and fermented soy drink samples were measured directly using PYE UNICAM Model 292 MK2. The pH meter was standardized with pH 4.0, 7.0 and 9.0 buffer solutions. The electrode of the pH meter was standardized by dipping it into sterile water after which two different buffers (4.0 and 7.0) were used. The set electrode was then used for the various samples and readings were recorded (Jimoh and Kolapo 2007).

Sensory evaluation

A total of 150 trained assessors, 100 drawn from Federal University of Technology, Minna and 50 from National Biotechnology Development Agency Abuja were used to assess the sensory quality of the fermented soy drink. Samples were served at 10°C in plastic disposable cups and coded with alphabets A and B. Order of presentation of the samples was randomized. A test form comprising six sensory attributes namely; taste, colour, texture, aroma, consistency and overall acceptability was measured on a standard nine-point hedonic scale. The assessors rated the fermented soy drink samples on a scale varying from 1 = dislike extremely to 9 = like extremely.

Results

Phytochemical and proximate composition of tamarind pulp powder

Flavonoids were not detected in the tamarind pulp powder while saponins, glycosides, alkaloids and tannins were present as shown in Table1.

Table 1: Phytochemical component of tamarind pulp

Phyto constituents	Tamarind pulp
Alkaloids	+
Glycosides	+
Flavonoids	-
Saponins	+
Tannins	+

+ present and – Absent

Proximate composition of tamarind pulp and fermented soy drink with tamarind and *nono*

The proximate composition of the samples, are shown in Table 2. Tamarind sample D contained energy 361.94 k/Cal, Nitrogen free extracts (NFE) 76.31%, crude protein 9.54%, moisture 6.88% crude fiber 6.26% and ash 1.95% respectively.

The moisture contents of fermented soy drink with tamarind sample A was (88.43±0.37) and fermented soy drink with *nono* sample B (88.31±0.23) was not significantly ($p>0.05$) different from each other but higher than the commercial yoghurt sample C. However, sample A had significantly ($p<0.05$) higher amount of energy (36.46±0.23), oil extract (1.54±0.13) and crude protein (3.60±0.12) but significantly ($p<0.05$) lower in ash (0.38±0.03) than sample B and C while Sample B had significantly ($p<0.05$) higher amount of ash (0.41±0.06) and NFE (2.38±0.07) but significantly ($p<0.05$) lower amount of energy (35.87±0.15), oil extract (1.35±0.06) and crude protein (3.55±0.07) respectively.

Sample A was used to ferment (back slopping) the second batch of soymilk, second generation (A2). The second generation had significantly higher contents of energy (43.37±0.15), crude protein (4.41±.023), NFE (2.38±0.03) and ash (0.43±0.06) than A which recorded energy (36.46±0.23), crude protein (3.60±.0.13), NFE (2.05±0.12) and ash (0.38±0.03) respectively. However, A had significantly ($p<0.05$) higher moisture content (88.43±1.20) than A2 (85.39±0.29) while both (A and A2) had no crude fibre contents.

Table 2: Proximate composition of the tamarind, fermented soy drink and commercial yoghurt

Constituents	A	A2	B	C	D
Moisture (%)	88.43±0.37^{a}	85.39±0.29^{b}	88.31±0.23^{a}	79.13±0.12^{b}	6.88±0.14
Ash (%)	0.38±0.03^{b}	0.43±0.06^{a}	0.41±0.06^{a}	0.40±0.03^{a}	1.95±0.21

Crude protein (%)	3.60±0.12[c]	4.41±.023[a]	3.55±0.07[d]	3.74±0.03[b]	9.54±0.16
Crude fibre (%)	0.0	0.0	0.0	0.0	3.26±0.03
Crude oil extract (%)	1.54±0.13[b]	1.35±0.09[c]	1.35±0.06[c]	4.44±0.12[a]	2.06±0.02
NFE (%)	2.05±0.03[c]	2.38±0.05[b]	2.38±0.07[b]	12.29±0.12[a]	76.31±0.10
Energy in K/Cals	36.46±0.23[b]	43.37±0.15[b]	35.87±0.15[c]	104.08±0.12[a]	361.94±0.0

Values are means ± Standard error of mean in duplicate. Values with the same superscript in the same row are not significantly different from each other at P ≤ 0.05.

A- Fermented soy drink using tamarind, A2 second generation fermented soy drink, B- fermented soy drink using *Nono;* C- Commercial yoghurt, D: tamarind pulp powder, NFE: nitrogen free extract.

The mineral and vitamin C content of tamarind pulp and fermented soy drink with tamarind and *nono*

The mineral and vitamin C content of tamarind pulp and fermented soy drink with tamarind and *nono* are shown in Table 3. The tamarind pulp contains 564.3mg/L of potassium, calcium 140.7mg/L and sodium 38.2mg/L respectively but had a higher content of vitamin C 361.94 mg/100g. The vitamin C contents of sample A was significantly ($p<0.05$) low (4.13±0.09 mg/100g) than sample B (4.86±0.13 mg/100g). However, sample B had significantly ($p<0.05$) high amount of potassium (K) (788.0±2.35 mg/mL), calcium (Ca)(65.28±0.94 mg/mL) and low sodium (Na) content (168.8±2.10mg/mL) than sample A. The vitamin C content (4.13±0.06 mg/100g) of A was significantly ($p<0.05$) lower than A2 (4.20±0.12 mg/100g). However, sodium (171.20±1.23 mg/mL) and calcium (48.48±1.46 mg/mL) contents of A were significantly ($p<0.05$) higher than the amount of sodium (166.40±2.10 mg/mL) and calcium (4.20±0.13 mg/mL) in A2. But A2 had significantly ($p<0.05$) higher content of potassium (721.10±2.50 mg/mL) than A (693.30±2.46 mg/mL)

Table 3: Mineral and vitamin C contents of tamarind pulp, fermented soy drink and commercial yoghurt

Mineral / Vitamin C composition	A	A2	B	C	D
Calcium (mg/L)	48.60±0.14[c]	4.20±0.13[d]	65.28±0.94[b]	168.0±2.15[a]	140.7
Potassium (mg/L)	693.3±1.90[d]	721.10±2.50[c]	788.0±2.35[b]	823.6±2.12[a]	564.3
Sodium (mg/L)	171.2±1.58[b]	166.40±2.10[c]	168.8±2.10[c]	504.4±2.34[a]	38.2

Vitamin C (mg/100g)	4.13±0.09^{c}	4.20±0.12^{b}	4.86±0.13^{a}	3.75±0.06^{d}	361.94

Values are means±Standard error of mean for n= 2. Values with the same superscript in the same column are not significantly different from each other at P ≥ 0.05.

A- fermented soy drink using tamarind, A2 second generation fermented soy drink, B- fermented soy drink using *Nono;* C- Commercial yoghurt, D: Tamarind.

Titrable acidity of tamarind pulp, fermented soy drink and *nono*

The acids content of tamarind pulp were lactic (1.27%), tartaric (1.05%), citric (0.98%), malic (0.94%) and acetic (0.84%). Sample C contained significantly ($p<0.05$) higher lactic (1.62%), tartaric (1.35%), citric (1.20%), malic (1.20%) and acetic (1.08%) than A and B Table 4. There was no significant ($p>0.05$) difference between sample A acetic acid (0.19 %,) malic acid (0.21 %), citric acid (0.22 %), tartaric acid (0.24 %) and lactic acid (0.29 %) and sample B acetic acid (0.20%), malic acid (0.22%), citric acid (0.23%), tartaric acid (0.25%) and lactic acid (0.30%) respectively.

Table 4: Titrable acidity of tamarind pulp, fermented soy drink with tamarind and *nono*

Acid	A	B	C	D
Lactic (%)	0.29±0.03^{c}	0.30±0.03^{c}	1.62±0.12^{a}	1.27±0.10^{b}
Tartaric (%)	0.24±0.03^{c}	0.25±0.06^{c}	1.35±0.23^{a}	1.05±0.0^{b}
Malic (%)	0.21±0.09^{c}	0.22±0.13^{c}	1.20±0.12^{a}	0.94±0.08^{b}
Acetic (%)	0.19±0.03^{c}	0.20±0.06^{c}	1.08±0.0^{a}	0.84±0.12^{b}
Citric (%)	0.22±0.13^{c}	0.23±0.03^{c}	1.26±0.13^{a}	0.98±0.07^{b}

Values are means±Standard error of mean for n=2. Values with the same superscript in the same column are not significantly different from each other at P ≥ 0.05

A: fermented soy drink with tamarind, **B**: fermented soy drink with *nono*, **C:** commercial yoghurt, D: Tamarind pulp.

The pH of tamarind pulp, fermented soy drink and *nono*

The pH values of the tamarind, tamarind and *nono* fermented soy drink are shown in Figure 1. The pH of tamarind (D) samples A, A2, B and C were (2.46), (5.28), (5.23), (4.77) and (4.78) respectively.

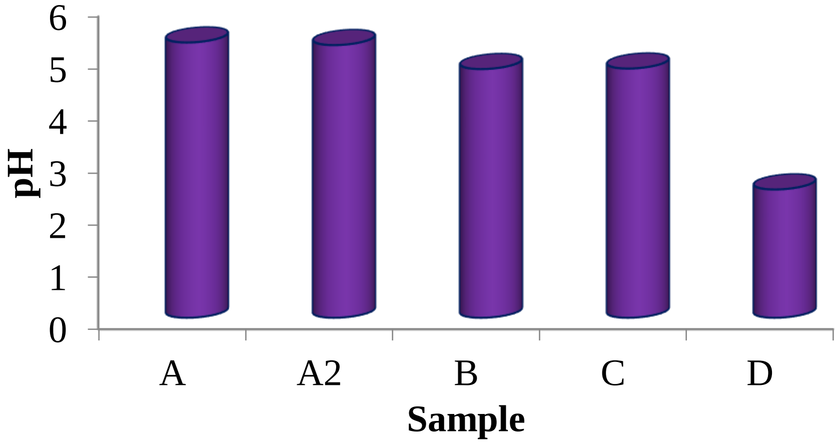

***Figure 1:** The pH of tamarind pulp, fermented soy drink with tamarind and nono*

A: fermented soy drink with tamarind, A2: second generation fermented soy drink, B: fermented soy drink with *nono*, C: commercial yoghurt, D: tamarind

Organoleptic qualities of fermented soy drink samples

The organoleptic qualities of fermented soy drink samples are shown in Table 5. Sample C was significantly ($p<0.05$) high in all attributes of aroma, colour, consistency, taste, texture and overall acceptability (9.31±0.5441) than sample A (7.50±1.4902) and sample B (5.51±2.3356). Sample A was significantly ($p<0.05$) more acceptable than sample B.

Table 5: Organoleptic qualities of fermented soy drink with tamarind and *nono*.

Variable	**A**	**B**	C
Aroma	$6.68±1.6083^{b}$	$4.89±1.9761^{c}$	$8.67±1.0643^{a}$
Colour	$7.57±1.1716^{b}$	$6.47±1.8074^{c}$	$8.83±0.8076^{a}$
Consistency	$6.93±1.3041^{b}$	$5.35±1.8015^{c}$	$7.94±1.3023^{a}$
Overall acceptability	$7.50±1.4902^{b}$	$5.51±2.3356^{c}$	$9.31±0.5441^{a}$
Taste	$7.53±1.1729^{b}$	$5.57±2.0227^{c}$	$9.58±0.37255^{a}$
Texture	$7.47±1.4528^{b}$	$5.66±2.2413^{c}$	$8.33±1.0414^{a}$

Value are means ± standard deviation, value with the same superscripts in the same column are not significantly different from each other at $P \leq 0.05$.

A; fermented soy drink with tamarind B; fermented soy drink with *nono*, C; control.

Discussion

In the present study, phytochemical components were detected from tamarind pulp. Doughari (2006); Abubakar *et al.* (2008) and Paula *et al.* (2009) also detected these metabolites in tamarind pulp. According to Abubakar *et al.* (2008), these components have different mechanisms of action that may be beneficial to human health, inhibit microbial growth and interfere with some metabolic processes. The use of tamarind in this study containing these phytoconstituents explained their presences as metabolites that are used for defense against pathogens. Adeola *et al.* (2010) reported the presence of tannins in tamarind. Tannin has potential of repairing skin abrasions and also acts as the primary antioxidant compound in pain relief, preventing diarrhea (Ishaku *et al*., 2016).

The presence of alkaloid in this study was comparable to the report obtained by Abubakar *et al.* (2008) for the presence of alkaloid in tamarind. Alkaloids have many traditional uses including anti-inflammatory, anti-microbial, anti-parasitic and anti-cancer effects (Patel *et al*., 2012). Doughari (2006) detected the presence of saponins in tamarind similar to the finding in present study. Saponins are widely distributed in plants. They lower the surface tension of water, the solution are used as cleansing agents and also help lower cholesterol in humans and reduced the risk of heart disease (Paula *et al.*, 2009).

Glycoside were detected in tamarind in the present study. Similarly, Adeola *et al.* (2010) reported the presence of glycoside in tamarind pulp. The presence of glycoside in tamarind may have therapeutic benefit because glycoside possesss antiseptic properties that are useful for the health of the urinary tract (Bouayad *et al*., 2012).

Flavonoids was not detected in this study. Similar result was reported by Doughari (2006) who observed the absence of flavonoids in tamarind fruit. Flavonoids and polyphenols in association with alkaloids, were linked to the antimicrobial activity of tamarind fruits and leaves (Doughari, 2006).

The present study showed that tamarind and fermented soy drink are high in energy content, although, tamarind contained more energy content than fermented soy drink. Similar results were obtained by El-Siddig *et al*. (2006); Hamacek *et al*. (2013); Ishaku *et al*. (2016) and Sadiq *et al.* (2016). The high energy content in tamarind fruits may indicate that, the fruit can contribute significantly to the daily energy requirement of 239K/Cal for humans as recommended by USDA (Glew *et al.* 2005), the amount will vary according to age and level of activity. The energy content of the fermented soy drink obtained in the present study is within the recommended range of 59Kcal USDA compared to the commercial yoghurt that contained high energy content Hui and Foodnetbase (2004). Amanze and Amanze (2011) obtained energy content of (37Kcal) for soy yoghurt, similar to that obtained in the present study.

The nitrogen-free extract for the tamarind fruit was higher when compared to (50.22%) reported by Hamacek *et al*. (2013). In the present study, nitrogen free extract of the fermented soy drink was lower when compared with the commercial yoghurt that is within range (14%) of standard value. Nitrogen-free extract are important nutritive element in human body. They are energy source and help in detoxication (Hamacek *et al*., 2013). Tamarind pulp in the current study contained slightly high crude protein content when compared with the result obtained by Ishaku *et al*. (2016) for tamarind (9.15%). Hamacek *et al*. (2013) also obtained (7.86%) crude protein for tamarind. In the current study, second generation fermented soy drink contained high crude protein content than the other samples but all fermented soy drink samples were within crude protein range when compared with the standard (4.7%) USDA. The crude protein content can participate in the regulation of hormones which govern a range of body functions Moreso, the protein content of the fermented soy drink may be related to the high protein content of the soybean seed (Sadiq *et al.*, 2016).

The crude fibre content obtained for tamarind was lower compared with the result obtained by Hamacek *et al*. (2013) for tamarind (4.13%). Ishaku *et al*. (2016) also obtained (7.16%) of crude fibre in tamarind. Variation in the nutritional values found in tamarind are possibly due to difference in genetic strains, maturity phase at which the plant parts were harvested, growing conditions, harvesting and handling techniques and differences in method of analysis (Glew *et al.*, 2005). The crude fibre content obtained in fermented soy drink and the commercial yoghurt in this study was lower than the standard (0.2%) recommended for fermented soy drink. Crude fibre may help eliminate wastes from the gastrointestinal tract because of its ability to bind water and thus soften the stool. Fiber offers a variety of health benefits and is essential in reducing the risk of chronic disease such as diabetes, obesity, cardiovascular disease and diverticulitis (El-Siddig *et al.*, 2006; Ishaku *et al.*, 2016).

The oil extract in tamarind was lower when compared with the result obtained by Hamacek *et al.* (2013) for tamarind (5.04%). Ishaku *et al.*, (2016) also obtained (6.24%) for tamarind. In the present study the oil extract of fermented soy drink obtained was lower than the USDA standard of (2.7%). The commercial yoghurt contained higher oil extract than fermented soy drink in the current research. The low content of oil extract in samples obtained in this research indicated that fermented soy drink may be less susceptible to lipid oxidation which can lead to the formation of undesirable off-flavors and aroma, as well as potentially toxic compounds such as cholesterol oxides (Sadiq *et al.*, 2016).

Theash contents obtained for tamarind and fermented soy drink were lower in this study compared to the result obtained by Ishaku *et al.*, (2016) for tamarind (6.23%). Hamacek *et al.* (2012) also obtained ash content (2.37%) for tamarind. Similarly, Singh *et al*. (2007) obtained (2.9%) for tamarind. Low ash content of fermented soy drink obtained in current study was similar to the result obtained by Amanze and Amanze (2011) (0.51%) for fermented soy drink. Terna and Musa (1998) also obtained (5.08%) for soy yoghurt. The low ash content of fermented soy drink obtained in current study indicated that fermented soy drink may require fortification with minerals for body maintenance (Amanze and Amanze, 2011).

In current investigation, tamarind contained lower (6.88%) moisture content when compared to the result obtained by Hamacek *et al.* (2013) for tamarind (35.29%). Singh *et al.*, (2007) obtained moisture content of (28.2%) for tamarind. Similarly, Ishaku *et al.*, (2016) obtained moisture content (11.19%) for tamarind. Moisture content for fermented soy drink obtained in this study was within standard range for fermented soy drink (89.0%). Opara *et al.*, (2013) obtained moisture content (85.7%) for fermented soy drink. Low moisture content may be important in view of the sample shelf life (Sadiq *et al.*, 2016). The low moisture content of tamarind in the present study is an indication that the sample will have good storage stability when properly packaged. It may also contribute to the reduction in microbial growth of the sample. The disadvantage of sample having higher moisture content is thatpreservation period is reduced due to the risk of microbial deterioration and spoilage when store for long period of time (Amanze and Amanze, 2011).

The mineral content of tamarind and fermented soy drink was obtained in the present study. The Calcium content of tamarind obtained was higher when compared to the result obtained by Ishaku *et al.* (2016) for tamarind (21.6 mg). Singh *et al.* (2007) obtained high calcium content (170mg) for tamarind. Calcium content obtained for soy yoghurt in this study was low when compared with the standard (126mg) for yoghurt. Horáčková *et al*. (2015) obtained calcium content for fermented soy drink (72.10mg). The calcium content obtained for commercial yoghurt in the present study was higher for plain yoghurt when compared with the standard (126mg). The result for calcium content indicates that fermented soy drink offers low calcium content for the human diet. Yoghurt, is regarded as the best food source of absorbable calcium. Calcium keeps bones and teeth strong, thereby supporting skeletal structure and function. The rest of the calcium in the body play key roles in cell signaling, blood clotting, muscle contraction and nerve function (Sacks *et al.*, 2006).

The potassium content obtained for tamarind in this research was higher when compared with the result obtained by Singh *et al*. (2007) for potassium content (375mg) of tamarind. El-Siddig *et al*. (2006) also obtained potassium content (180mg) for tamarind. Similarly, Ishaku *et al*. (2016) obtained (187mg) potassium content for tamarind. The potassium content of fermented soy drink obtained in the present study was higher when compared with the standard (141mg) for plain yoghurt. The result of this study indicates that high potassium content of the fermented soy drink may increase potassium intake in humans. Potassium plays a key role in skeletal and smooth muscle contraction, making it important for normal digestive and muscular function (McCance and Widdowson, 2002).

The sodium content obtained for tamarind in this study was lower than the value (123.8mg) obtained by Sadiq *et al*. (2016) for the same fruit. But it was higher when compared with the value (24mg) obtained by Singh *et al.* (2007). Similarly, Ishaku *et al.* (2016) obtained (112.8mg) sodium content in tamarind. Sodium content of fermented soy drink in this study was higher than the standard value (0.0mg) for soy yoghurt. The result of this study indicates high sodium content in fermented soy drink, although sodium is often maligned as a cause of high blood pressure, it also plays several essential roles in the body. Sodium helps control blood pressure and regulates the function of muscles and nerves, which is why sodium concentrations are carefully controlled by the body (Rodriguez *et al.*, 2010).

The Vitamin C content of tamarind obtained in this study was higher when compared with the result obtained by Singh *et al*. (2007) 3.0mg for tamarind. Similarly, Yahia and Salih (2011) obtained Vitamin C content of 3.0mg for tamarind. Hamacek *et al*. (2013) also obtained 2.47mg for tamarind. Ishola *et al.*, (2010) obtained 20mg Vitamin C content for tamarind. The Vitamin C content of fermented soy drink obtained in the present study was within the range of standard value (4.0mg) for vitamin C for fermented soy drink. Osundahunsi *et al*. (2007) obtained Vitamin C content of 3.9mg for fermented soy drink. The result of the present study showed that the Vitamin C content obtained was equivalent to the standard (McCance and Widdowson, 2002). High Vitamin C content in the samples indicate improvement in their nutritive quality and consequently and increased acceptability. However, tamarind and fermented soy drink are good sources of Vitamin C for children, adult men and pregnant women (Ishola *et al.*, 2010).

The titrable acidity of the sample were detected in the current study, lactic, tartaric, malic, acetic and citric acids were detected. El-Siddig *et al.* (2006) detected the presence of these acids in tamarind. Similar result was obtained by Syed *et al.* (2014) who detected tartaric, citric and malic acids from tamarind leaves.

Low amount of these organic acids were detected in fermented soy drink in this study.

Tartaric acid is naturally found in many plants, especially in fruits such as grapes, banana, and tamarind. It is a food additive that gives a sour taste, and is also used as an antioxidant (El- Siddig *et al.*, 1999).

Malic acid plays a vital role in improving overall muscle performance, reversing muscle fatigue following exercise, reducing tiredness and poor energy levels, as well as improving mental clarity. It is used as a food additive (Syed *et al.,* 2014). Citric acid is naturally concentrated in citrus fruits frequently used as a food additive to provide acidity and sour taste to foods and beverages (Muangthai and Nookaew, 2015). The result of this study indicated that these acids in tamarind often influence flavour, stability, and storage quality of food when added. The organic acid content in plant pulp depend on heating time. Boiling temperature of the pulp destroyed some parts of organic acids and other important nutrients such as vitamins (Muangthai and Nookaew, 2015).

The pH of tamarind obtained in the current research was similar when compared to the result obtained by Hamacek *et al*. (2013) 2.98 for tamarind. Chapman (2014) also obtained pH (3.64) for tamarind. The pH obtained for fermented soy drink in the present study was similar with the result obtained by Terna and Musa (1998) (5.1) for fermented soy drink. Opara *et al.*, (2013) also obtained pH value 5.7 for fermented soy drink. Rezvan *et al*. (2012) obtained pH value range 4.5- 4.7 for soy yoghurt. Similarly, Amanze and Amanze (2011) obtained pH of 5.11 for the same yoghurt. The low pH obtained in this study indicates that the amount and species of lactic acid bacteria introduced influenced the pH of the fermented soy drink produced. It was observed that the fermented soy drink produced was more acidic than the soymilk from which it was obtained because of fermentation by the lactic acid producing bacteria that converted the sugars in the soymilk into acids. The high acidity of the fermented soy drink makes it a poor breeding platform for pathogenic microorganisms (Opara *et al*., 2013).

The Organoleptic qualities of fermented soy drink was determined in the present study. Fermented soy drink with tamarind was highly accepted than soy drink fermented with *nono*. Although, tamarind fermented soy drink may have a preferred flavour than *nono*, there was slightly beany flavour retained. This may be masked with flavour. Yang and Li (2010); Opara *et al.* (2013) obtained similar reports in which fermented soy drink was rated high in terms of colour, taste, consistency but low in terms of flavour due to the beany flavour associated with soybeans when compared with the commercial yoghurt reported by Opara *et al.*, (2013). Differences were observed in terms of overall acceptability for fermented soy drink with tamarind when compared with *nono.*

It is evident from this study that fermented soy drink can be produced from tamarind (Yang and Li, 2010).

Conclusion

We conclude that production of soy beverages which are highly consumed by Nigerians and beyond because of the availability of soybeans in commercial quantity is another way of increasing the food value of the crop.

References

Abd El-Gawad, I. A., Hefny, A. A., El-Sayed, E. M., & Saleh, F. A. (2015). Preparation Technique of Soymilk-Based Yoghurt and it's Relation to Soybean Varieties and Anti-Nutritional Factors. *Journal of Nutrition and Food Science,* 5, 411- 416.

Abukakar, M. G., Ukwuani, A. N., & Shehu, R. A. (2008). Phytochemical screening and antibacterial activity of *Tamarindus indica* pulp extract. *Asian Journal of Biochemistry*, 3, 134-138.

Abiodun O. O. and Adelodun L. K. (2008). Evaluation of Nutritional Composition and Acceptability of Soy-Coconut Milk-Based Yoghurt Fermented with Different Starter Cultures. Original Research Paper. Food Global Science Books.

Adeola, A. A., Adeola, O.O., & Dosumu, O.O. (2010). Comparative analyses of phytochemicals and antimicrobial properties of extracts of wild *Tamarindus indica* pulps. *African Journal of Microbiology Research*, 4(24), 2769-2779.

Amanze, K.O., & Amanze, J. O. (2011). Quality evaluation of yoghurt from Cow milk, Soymilk and Cow/Soymilk. *Journal of Research in National Development*, 9, (2), 44- 47.

Anderson, J.,& Johnstone, B. (1995). "Meta-analysis of the effects of soy protein intake on serum lipids". *The New England Journal of Medicine*, 333 (5), 276–282.

AOAC, (1990). Official Methods of Analysis. Association of Official Analytical Chemists 15th Edition, Washington DC.

AOAC, (2003). Official methods of analysis of the association of official's analytical chemists, 17th ed. Association of official analytical chemists, Arlington, Virginia

Bouayad, N., Rharrabe, K., Lamhamdi, M., Nourouti, N. G., & Sayah, F. (2012). Dietary effects of harmine, a β-carboline alkaloid, on development, energy reserves and α-amylase activity of Plodia interpunctella Hübner (Lepidoptera: Pyralidae). *Saudi Journal of Biological Science,* 19(1), 73-80.

Chang, Y. J., Thompson, L. D., & Brittin, H. C. (2005). Soyurt-a yoghurt-like soybean product: Department and properties. *Journal of Food Science,* 54, 1178-1179.

Chapman, K. R. (2014). Tamarind. Tropical tree fruits for Australia. Queensland Department of Primary Industries. Information series Q 183018, Brisbane, 83- 86.

Collins, J. L., Ebah, C. B., Mount, J. R., Demott, B. J., & Draughon, F.A (1991). Production and evaluation of milk sweet potato mixtures fermented with yoghurt bacteria. *Journal of Food Science*, 56(3), 685-688.

Doughari, J. H. (2006). Antimicrobial Activity of *Tamarindus indica* Linn. Tropical *Journal of Pharmacology Resource*, 5,597–603.

El-Siddig, G., Prasad, P. R., & Vijayanand, W. (1999). Tamarind, *Tamarindus indica.* Southampton, UK: Southampton Centre for Underutilised Crops; Southampton, U.K, p 154

El-Siddig, K., Gunasena, H. P. M., Prasad, B. A., Pushpakumara, D. K. N. G., Ramana, K. V. R., Vijayanand, P., & Williams, J.T. (2006). Fruits for future: Tamarind (*Tamarindus indica* L.) First revised Edn, Southampton Centre for Underutlised Crops, Southampton, U.K, p 198.

Farnworth, E. R., Mainville, I., Desjardins, M. P., Gardner, N., Fliss, I., & Champagne, A. C. (2007). Growth of probiotic bacteria and bifidobacteria in a soy yoghurt formulation. *International Journal of Food Microbiology*, 116, 174–81.

Glew, R.S., VanderJagt, D.J., Chuang, L.T., Huang, Y.S., Millson, M., & Glew, R.H. (2005). Nutrient content of four edible wild plants from West Africa. *Plant Foods for Human Nutrition,* 60, 187-193.

Hamacek, F. R., Santos, P. R. G., Cardoso, L. M., & Pinheiro-sant'ana, H.M. (2013). Nutritional composition of tamarind (Tamarindus indica L.) from the Cerrado of Minas Gerais, Brazil. *Fruits Journal,* 68, 381–395.

Horáčková, Š., Mühlhansová, A., Sluková, M., Schulzová, V., & Plocková, M. (2015). Fermentation of soymilk by yoghurt and bifidobacteria strains. *Czech Journal of Food Science*, 33, 313–319.

Huang, H.T. (2008) "Early Uses of Soybean in Chinese History. Chapter 2 in The World of Soy, eds Christine M. Du Bois, Chee-Beng Tan, and Sidney Mintz. University of Illinois Press (August 4, 2008) ISBN 978-0252033414

Hui, Y. H., & FOODnetBASE. 2004. Handbook of food and beverage fermentation technology. Marcel Dekker, New York

Ihekoronye, A. I., & Ngoddy, P. O. (1985). Yoghurt. Integrated Food Science and Technology for the tropics, London, Macmillan Publishes, pp. 343.

Ishaku, G. A., Ardo, B. P., Abubakar, H., & Peingurta, F. A., (2016). Nutritional Composition of *Tamarindus indica* fruit pulp. *Journal of Chemistry and Chemical Sciences,* 6 (8), 695-699.

Ishola, M.M., Agbaji, E. B., & Agbaji, A. S. (2010). A chemical study of *Tamarindus indica* (Tsamiya) fruits grown in Nigeria. *Journal of Science*, *Food and Agriculture*, 51, 141-143.

Jimoh, K.O., & Kolapo, A.L. (2007). Effect of different stabilizers on acceptability and shelf-stability of soy-yoghurt. *African Journal of Biotechnology*, 6(8), 1000-1003.

Kumar, C.S., & Bhattacharya, S. (2008). Tamarind Seed: Properties, Processing and Utilization. Critical Reviews in *Journal of Food Science and Nutrition*, 48, 1-20.

McCance, B., & Widdowson, J. (2002). The Composition of Foods, Food Standards Agency; Sixth summary edition. Institute of Food Research, Norwich.

Muangthai, P., & Nookaew, P. (2015). Monitoring on Some Organic Acids in Fresh and Processed Rural Plant Leaves in Thailand. *Asian Journal of Natural and Applied Sciences*, 4(1), 82.

Nyadoi, P., & K. Abdullah, (2004). Tamarind growth in Tharaka, Eastern Kenya. Prunus tribune. World Agroforestry Centre (ICRAF), 4-12.

Oloyede, O. I. (2005). Chemical profile of unripe pulp of *Carica papaya*. *Pakistan Journal of Nutrition*, 4 (6), 379-381.

Opara C. C., Ahiazunwo N. J., & Okorie. O. (2013). Production of soy-yoghurt by fermentation of soymilk with lactobacillus isolated from Nunu. *International Journal of Science and Engineering Investigations,* 2(12), 2251-8843.

Osundahunsi, O.F., Amosu D., & Ifesan, B.O.T. (2007). Quality Evaluation and Acceptability of Soy-yoghurt with Different Colours and Fruit Flavours. *American Journal of Food Technology,* 2, 273-280.

Patel, K., Gadewar, M., Tripathi, R., Prasad, S. K., & Dinesh K. P., (2012).A review on medicinal importance, pharmacological activity and bioanalytical aspects of beta-carboline alkaloid ''Harmine''. *Asian Pacific Journal of Tropical Biomedicine*, 2(8), 660–664.

Paula, F.S., Kabeya, L. M., Kanashiro, A., de Figueiredo, A. S. G., Azzolini, A. E. C. S., & Uyemura, S.A. (2009); Modulation of human neutrophil oxidative metabolism and degranulation by extract of *Tamarindus indica* L. fruit pulp. *Food Chemistry Toxicology*, 47 (1), 163–170.

Rezvan, P., Atefeh, G., Masoud, F., & Mahnaz, M. A. (2012). Production of probiotic soy yoghurt. *Annals of Biological Research,* 3 (6), 2750-2754.

Rodríguez Furlán, L. T., Pérez Padilla, A., & Campderrós, M. E. (2010). Inulin like lyoprotectant of bovine plasma proteins concentrated by ultrafiltration. *Food Research International,* 43, 788-796.

Sacks, F., Lichtenstein, A., Van Horn, L., Harris, W., Kris-Etherton, P., & Winston, M. American Heart Association Nutrition Committee (2006). "Soy protein, isoflavones, and cardiovascular health: an American Heart

Association Science Advisory for professionals from the Nutrition Committee". *Circulation,* 113 (7), 1034–1044.

Sadiq, I. S., Duruminiya, N. I., Balogun, J. B., kwada, D., & Izuagie, T. (2016). Nutritional and Anti-nutritional Value of Tamarind Fruit (*Tamarindus indica*). *International Journal of Applied Research and Technology*, 5(3), 50 – 56.

Shurtleff, W., & Aoyagi, A. (2013). History of Whole Dry Soybeans, Used as Beans, or Ground, Mashed or Flaked (240 BCE to 2013). Lafayette, California. 950 pp.

Singh, D., Wangchu, L., & Moond, S. K. (2007). Processed products of Tamarind. *Natural Product Radiance*. 6 (4), 315- 321.

Silva JÃºnior, S. I. A. Demonte, E. A. Rossi, O. L. &Tavano, A. (2012). Nutritional evaluation of soy yoghurt in comparison to soymilk and commercial milk yoghurt. Effect of fermentation on soy protein. Food and Agriculture Organization, National Agricultural Library Beltsville, United States.

Sofowora, A. (1993). *Medicinal Plants and Traditional Medicine in Africa*. 2nd ed. Spectrum Books Ltd., Ibadan, Nigeria, ISBN13: 9782462195, pp 289.

Syed, S. N., Rizvi, W., Kumar, A., Khan, A, Moin, S. A., & Ahsan, A., (2014). In vitro antioxidant and in vivo hepatoprotective activity of leave extract of *Raphanus sativus* in rats using ccl4 model. *African Journal of Traditional Complement and Alternative Medicine,* 11(3), 102-106.

Terna, G., & Musa A. (1998). Soybeans Yoghurt production using starter culture from 'nono'. *Nigerian Journal of Biotechnology,* 9, 17- 22.

Trease, G. E., & Evans, W.C. (1986). *Textbook of Pharmacognosy*. Trindal, London, 546-554.

Xiao, C.W. (2011). Functional Foods; Concept to Product 2nd Edition Woodhead Publishing Series in Food Science, Technology and Nutrition Book.

Yahia, E. M., & Salih, N. K.-E. (2011). Tamarind (*Tamarindus indica* L.) Postharvest biology and technology of tropical and subtropical fruits; New York, Woodhead Publishing Limited.

Yang, M., & Li, L. (2010). Physicochemical, Textural and Sensory Characteristics of Probiotic Soy Yogurt Prepared from Germinated Soybean. *Journal of Food Technology and Biotechnology,* 48 (4), 490–496.