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NUTRITIONAL AND ANTINUTRITIONAL PROPERTIES OF NOVEL MILK BEVERAGES PRODUCED FROM AFRICAN BREADFRUIT, TIGERNUT, COCONUT AND DATE FRUIT

Ogbuele Chinedu O.[1+]
Nwabueze Titus U.[2]
Enyi Chukwunwike U.[3]
Okorie Chinasa[4]
Emecheta Wisdom N.[5]
Iwuamadi Adaobi C.[6]

[1,2,3,4,5]*Department of Food Science and Technology, College of Applied Food Sciences and Tourism, Michael Okpara University of Agriculture, Umudike, Abia State Nigeria.*
[1]*Email: ogbuelefranklin48@gmail.com Tel: +2348033181000*
[2]*Email: teeubueze@yahoo.co.uk Tel: +2348035422843*
[3]*Email: nnasedo@gmail.com Tel: +2347039650852*
[4]*Email: nasaokorie985@gmail.com Tel: +2348065145481*
[5]*Email: wisenewgem@gmail.com Tel: 08034864883*
[6]*Department of Food Technology, Federal Polytechnic Nekede, Owerri Imo State, Nigeria.*
[6]*Email: aiwuamadi@fpno.edu.com Tel: +2347034264316*

(+ Corresponding author)

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ABSTRACT

Nutritional and antinutritional properties of novel milk beverages produced from African breadfruit, tigernut, coconut and date fruit were studied in this research. The plant milk beverages were formulated from these plants and compared with the quality characteristics of conventional plant milk beverage "Vita milk" which served as the control sample. Mineral and phytochemical properties were determined for the raw plant samples and beverage products. The mineral composition analysis showed that the values for the contents of calcium, magnesium, sodium, and iron (8.25, 1.42, 9.50 and 0.33) percent from the control sample were higher than the average values recorded for the same mineral content from the formulated beverage samples (3.70, 0.63, 4.94 and 0.06)percent, while the average values for the contents of potassium and phosphorous (2.72 and 5.77) from the formulated beverage samples were higher than the values from the control sample (0.33 and 0.46)percent. Out of ten phytochemicals screened in the beverage samples viz; flavonoids, alkaloids, saponins, tannins, phenols, oxalate, glycosides, carotenoids, terpenoids and steroids, seven were present in the formulated beverage samples (flavonoids, alkaloids, saponins, tannins, phenols, oxalate and glycosides), while four were present in the control sample (flavonoids, alkaloids, saponins and tannins). The study revealed that plant milk formulated from breadfruit milk, tiger nut milk, coconut milk and date fruit juice gave products that are comparable to the conventional soy bean based vita milk in terms of their nutritional composition.

Contribution/Originality: There is need to develop new products from nutritional but underutilized indigenous crops. Hence producing a food product that will serve the need of a beverage and also make for healthier and more nutritious alternative will reduce the numerous side effects associated with consuming beverages from other sources

1. INTRODUCTION

People being intolerant to cow's milk, including lactose intolerance came as a result of consumer need for cow's milk alternatives. Presently, consumers avoid dairy products based on health concerns, like cholesterol and antibiotic residues in cow's milk. There is market growth for non-dairy milks by 9 % in 2015 to reach $1.9 billion with 138 variants of plant-based milk substitutes (PBMS's). Generally, PBMS's are extracted from plant material, which resemble cow's milk in appearance (Mintel Group Ltd, 2016). Due to health problems associated with milk nutrients, there is a rise in global demand and consumption of beverages from alternative animal milk sources (Granato, Ribeiro, Castro, & Masson, 2010). These products are regarded as healthy foods with positive cardiovascular function and they can be derived from plant/vegetable sources.

Plant milk is a food product gotten from plant source, which is similar in appearance to milk but does not contains milk fat, sugar (lactose) or other components (Jenkins et al., 2006). Excellent nutritional characteristics are required for raw materials that can be used as substitutes for milk. Soy is the best known and most popular vegetable milk although the demand for almond, rice, tiger nut, breadfruit, and coconut milks which are good substitute as they contain good nutritional and antioxidant properties are on the rise (Bernat, Cháfer, Chiralt, & González-Martínez, 2014). To improve the taste, consistency and nutritional profile of these nuts, they should be combined in various proportions. Consumers do not take beverages to satisfy their thirst only, they also look out for specific functionalities like energy booster, fatigue, stress and ageing fighter (Sethi, Tyagi, & Anurag, 2016). Their quest for quality products has seen a rise to newer and better products which satisfy consumers need, improve physical and mental wellbeing and prevent nutrition-related chronic diseases. Beverages from vegetable sources act as protectors against cardiovascular diseases and contain beneficial bioactive compounds, flavonoids and other phytosterols as a result are regarded as healthy foods (Jenkins et al., 2006).

Tiger-nut (*Cyperus esculentus L)* is among the under-utilized crops in Nigeria which has been reported to be high in mineral and dietary fiber content, which could be effective in the treatment and prevention of many diseases including colon cancer, coronary heart diseases, obesity, diabetes and gastrointestinal diseases (Anderson, Smith, & Gustafson, 1994). Its yellowish brown colour is due to the presence of some phytochemical compounds which among many other benefits helps the defense mechanism of our body. Milk from tiger nut is an authentic natural vegetable drink or dessert and it is prepared with water, sugar and tiger nuts. Tiger nut milk is very rich nutritionally. It is a very nutritive, energy drink for both the young and old (Udeozor, 2012).

Coconuts are from the tree (*Cocos nucifera*) and they are known for their versatility, which is why they have many uses ranging from food to cosmetics. People in the tropics and subtropics use them as major part of their diets. The oil and milk derived from it are commonly used in cooking, frying, as beverages and also in soaps and cosmetics (Brown, 2014). Date fruit which refers to the fruits of the date palm tree *(Phoenix dectylifera)* is also among the under-utilized crops in Nigeria. Dates are eaten in both fresh and dried state. Dates have sweet taste, rich flavor and a chewy texture. Aside their taste, they are powerhouses of nutrients which can serve as energy booster (Manickavasagan, Essa, & Sukumar, 2012). African breadfruit (*Treculiaafricana*) is a legume which is a known and valued food in the diet of many Nigerians. It is being prepared using different method of traditional preparations and the consumption may vary depending on food habits, ethnic background, culture and traditions. But the processing method in most areas involve cooking in water to make porridge and adding ingredients like salt, pepper, crayfish and dried fish. One can choose to add oil and, in some cases, run off some of the cooking water into a dish to serve as beverage (Nwabueze, 2012). Several researchers have evaluated on the nutritional and antinutritional properties of plant extracts. However, novel beverage from blends of African breadfruit, tigernut, coconut and date fruit have not be developed, likewise no existing reports on the nutritional and antinutritional potential of beverage formulated from a blend of these plant extracts. The study therefore seeks to formulate a novel beverage from blends of the milk extracted from these plants and compare it with conventional soy bean based vita milk and also evaluate the nutritional and antinutritional properties of the plant milk blend beverages.

2. MATERIALS AND METHODS

2.1. Source of Raw Materials

African breadfruit seeds, tiger nuts, coconut and date fruits were purchased at Oyibo market, old Aba Road Port Harcourt, River state, Nigeria. The chemical additives that were used in this research were purchased from Pokobros Food and Chemical Industries Limited, No.1 Harbour Industrial Layout, Port Harcourt, Rivers state Nigeria and they were of analytical standards.

2.2. Preparation of Raw Materials

The raw materials were prepared and processed in the Food Processing Laboratory of Food Science and Technology Department, Michael Okpara University of Agriculture, Umudike, Abia State Nigeria.

The breadfruit seeds were sorted to remove bad seeds and other solid contaminates. Two (2) kg of the sorted seeds was divided into two parts of 1kg each. One part was thoroughly washed, par-boiled/blanched in hot water for 10-15 min and drained after. The par-boiled seeds were de-hulled manually to get the per-boiled dehulled seeds. The second part of the sorted breadfruit seeds were washed drained and roasted at 72ºC for 30 min, then de-hulled and winnowed to separate the seeds from husks to get the roasted breadfruit seeds. The tiger nuts were sorted to remove bad nuts and contaminants and 2 kg sorted nuts were soaked in worm water for 2 h. The coconut seeds were cracked manually and their endocarp or meat detached from the pericarp using a knife. Two (2) kg of the endocarp were measured, cut into smaller pieces and washed, while the dried date fruits were sorted to remove bad fruits and contaminants, then two (2) kg of the sorted date fruits were chopped into smaller sizes and the enclosed seeds removed and washed.

2.3. Processing of Raw Materials

African bread fruit milk was processed according to the method described by Okafor and Ugwu (2014).

Tiger nuts milk was processed according to the method described by Udeozor (2012).

Coconut milk was processed according to the method described by Okafor and Ugwu (2014).

Date fruit juice was processed as described by JO-Ann (2016).

2.4. Formulation of Plant Milk Beverages

Two groups of the beverages were formulated using Roasted Breadfruit milk (rBFM), Tiger nut milk (TM), Coconut milk (CM) and Date fruit Juice (DFJ) in three different ratios of (3:5:1:1), (2:6:1:1) and (1:7:1:1) in one group and Cooked Breadfruit milk (cBFM), TM, CM and DFJ using the same ratio in another group. After which 0.3% CMC solution were added to the blends to serve as stabilizer and the formulation were thoroughly mixed, homogenized and pasteurized at 72ºC for 5 min in a water bath and allowed to cool. Exactly 0.2% Potassium sorbate solution and 0.05% Citric acid solution were added to the blends as preservatives. The beverages samples were homogenized, filled into screw capped plastic bottles and stored at room temperature.

Table 1 presents Proportions of extracts for plant milk formulation.

Table 1. Proportions of extracts for plant milk formulation.

Beverage brand	Samples	Proportion of the milk components in the beverage samples (%)			
		Breadfruit	Tiger nut	Coconut	Date fruit
Roasted	621	30	50	10	10
	742	20	60	10	10
	852	10	70	10	10
Cooked	536	30	50	10	10
	482	20	60	10	10
	941	10	70	10	10

2.5. Determination of Mineral Properties

Calcium, magnesium, potassium, sodium and iron contents were determined according to the method described by AOAC (2001). Phosphorus was determined by spectrophotometric method as described by Shyla and Nagendrappa (2011).

2.6. Determination of Phytochemical Properties

2.6.1. Qualitative Analysis

The beverage samples and the reference sample were screened for the presence of the following phytochemical flavonoids, alkaloids, saponins, tannins, phenols, glycosides, terpenoids, oxalate, carotenoids and steroids using the method described by Trease and Evans (1989) and Sofowara (1993).

2.6.2. Quantitative Analysis

Flavonoid, alkaloids, oxalate and saponin were determined using the method described by Harborne (1973).

Tannins and glycoside was determined according to the method of Amadi, Agomuo, and Ibegbulem (2004).

Phenol was done by the Folin-ciocaltean spectrophotometry method as described by AOAC (2001).

2.7. Data Analysis

Analysis of variance was used for the determination of significant differences ($p<0.05$) among treatment means and separation of means was carried out using the SPSS version 20.0. Separation of means was carried out by Duncan Multiple range test and values were reported as means and standard deviation.

3. RESULTS AND DISCUSSIONS

3.1. Mineral Properties of the Raw Materials

The mineral properties of the raw materials used in the production of the plant milk samples were shown in Table 2. The results show that breadfruit has the highest values for the following mineral contents; calcium (165.00 mg/100g), Mg (186.00 mg/100g), K (587.00 mg/100g) and P (176.01 mg/100g). The highest value of Na was recorded from tiger nut (235.06 mg/100g), while the highest value of Fe was recorded from date fruit (2.32 mg/100g), followed by the value recorded from coconut (1.94 mg/100g). The mineral content of these raw materials were high when compared to leguminous crops according to previous reports (Gambo & Da'u, 2014; Oni, Adeosun, Ladokun, Ighodaro, & Oyedele, 2015; Osabor, Ogar, Okafor, & Egbung, 2009; Sami, Owoade, Abdulhamid, Fakai, & Bello, 2014), thus making the combination of these crops good as sources of these important dietary minerals.

Table 2. Mineral composition of the raw materials used in the plant milk production.

Raw Materials	Calcium (mg/100g)	Magnesium (mg/100g)	Sodium (mg/100g)	Potassium (mg/100g)	Phosphorus (mg/100g)	Iron (mg/100g)
Breadfruit	$165.00^{a}\pm0.02$	$186.00^{a}\pm0.02$	$7.10^{b}\pm0.01$	$587.00^{a}\pm0.01$	$176.01^{a}\pm0.02$	$1.66^{b}\pm0.03$
Tiger nut	$140.01^{b}\pm0.01$	$56.30^{b}\pm0.02$	$235.06^{a}\pm0.01$	$255.03^{c}\pm0.01$	$121.01^{b}\pm0.01$	$0.80^{c}\pm0.01$
Coconut	$2.09^{d}\pm0.02$	$4.04^{c}\pm0.01$	$3.57^{c}\pm0.01$	$6.37^{d}\pm0.03$	$1.96^{d}\pm0.02$	$1.94^{b}\pm0.01$
Date fruit	$37.45^{c}\pm0.01$	$0.45^{d}\pm0.01$	$0.73^{d}\pm0.01$	$360.99^{b}\pm0.02$	$27.30^{c}\pm0.02$	$2.32^{a}\pm0.02$

Note: Values are means of triplicate of samples. Values with different superscript ^{a,b,c,d} in the same column are significantly different at ($P>0.05$).

3.2. Mineral Properties of the Plant Milk Samples

The mineral properties of the formulated plant milk samples are shown in Table 3. The calcium content of the toasted breadfruit-based samples ranged from 3.64 to 4.64 mg/l and were significant different ($P<0.05$) when compared to the values recorded from the cooked breadfruit-based samples which ranged from 2.98 to 3.97 mg/l.

The low calcium content recorded from the cooked breadfruit-based samples may be attributed to the leaching of some of the nutrients during boiling of the breadfruit seeds. Both the toasted and cooked breadfruit-based samples recorded low levels of calcium content when compared to the value recorded by the reference sample, which has calcium content of 8.25 mg/l. The high level of calcium in the control sample may be due to the controlled mineral fortification (that will not induce stability problems), which is usually carried out by commercial producers of vegetable milk (Ogundipe & Osho, 1990).

The magnesium content of the formulated plant milk samples followed the same sequence with the calcium content, with the toasted breadfruit-based samples having higher values which ranged from 0.71 to 0.79 mg/l, but the values were not significantly different (P>0.05) when compared to the values recorded by the cooked breadfruit-based samples which have values ranging from 0.44 to 0.71 mg/l.

The low magnesium content values recorded from the cooked breadfruit-based samples may also be due to the leaching of the nutrients during boiling of the breadfruit seeds. Also, the magnesium content of the reference sample (1.42 mg/l) was high in significant difference (P< 0.05) when compared to the values recorded for both brands of formulated beverage samples. And this may also be attributed to the controlled mineral fortification carried out by producers of vegetable milk (Ogundipe & Osho, 1990).

The sodium content of the toasted breadfruit-based samples ranged from 0.31 to 5.71 mg/l and these values were low in significant difference (P<0.05) when compared to the values recorded from the cooked breadfruit-based samples which have values ranging from 5.91 to 6.15 mg/l. The low values of sodium content recorded for the toasted breadfruit-based samples when compared to sodium content of the cooked breadfruit-based samples were contrary to Emenonye (2016), who reported that cooking reduces sodium content of breadfruit seeds more than toasting, but is in agreement with the report of Onweluzo and Nnamuchi (2009), who reported sodium content to be higher in cooked breadfruit seeds than in roasted breadfruit seeds. However, the sodium content of the reference sample (9.50 mg/l) was high in significant difference (P<0.05) when compared to both brands of the formulated beverages. This observation may be due to the presence of dairy milk as part of vita milk, which has high sodium content, Onweluzo and Odume (2008) and the mineral fortification of vegetable milk during commercial production.

The potassium content was significantly different (P<.05) in the toasted breadfruit-based samples (2.55 to 3.14 mg/l) when compared to the cooked breadfruit-based samples (2.36 to 2.92 mg/l). This observation corresponds to the report of Obiakor-Okeke and Nnadi (2014), who reported that toasted breadfruit seeds retain more nutrient than cooked breadfruit seeds. However, contrary to the preceding trend, the potassium content of the both brands of the formulated plant milk were significantly different (P<0.05) when compared to the value recorded from the reference sample (0.33). This observation may be due to the high potassium content of tiger nuts and breadfruit seeds as reported by Omode, Fatoki, and Olaogun (1995) and Nwabueze (2012) and possibly lack of potassium fortification during the commercial production of the reference sample.

The phosphorus content in the formulated plant milk samples were 7.33 mg/l, 6.31 mg/l and 5.31mg/l for the roasted breadfruit samples and 5.45 mg/l, 5.24 mg/l and 4.95 mg/l for the cooked breadfruit-based samples. Both set of values were also high in significant difference (P<0.05) when compared to the value recorded from the reference sample (0.46 mg/l).

The high phosphorous content of the formulated plant milk sample may be attributed to the high level of phosphorous content in tiger nut, breadfruit and date fruit (Nnam, 2003; Nwabueze, 2012; Omode et al., 1995) and also because of lack of phosphorous fortification by the producers of the reference sample.

The iron content of the toasted breadfruit-based samples ranged from 0.06 to 0.08 mg/l but the values were not significantly different (P>0.05) when compared to the values recorded for the cooked breadfruit-based samples which ranged from 0.03 to 0.07 mg/l. The values for iron content was contrary to the report of Emenonye (2016), who reported that cooked breadfruit seeds retain more iron than toasted breadfruit seeds. The iron content of the reference sample (0.33 mg/l) was high in significant difference (P< 0.05) when compared to the values recorded from the formulated plant milk samples. This may be due to high iron content of the two major raw materials used in the production of the reference sample (soybean and dairy milk) as reported by Belewu, Belewu, and Bamidele (2010) and Udeozor (2012), and also possible iron fortification of the commercial producers of the reference sample.

In all, the mineral content recorded from the formulated plant milk samples were lower than the values for mineral composition recorded from the raw material used in the formulation of the beverage samples. This observation is expected because of many factors, which include the method of extraction of the milk components, the ratio of extract to seed or meal among other factors.

Table 3. Mineral composition of the plant milk samples.

Samples	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	K (mg/l)	P (mg/l)	Fe (mg/l)
621	$4.64^{b}\pm0.01$	$0.79^{b}\pm0.01$	$0.31^{f}\pm0.01$	$3.14^{a}\pm0.02$	$7.33^{a}\pm0.01$	$0.08^{b}\pm0.00$
742	$3.91^{d}\pm0.01$	$0.62^{de}\pm0.02$	$5.71^{d}\pm0.02$	$2.72^{c}\pm0.01$	$6.31^{b}\pm0.01$	$0.07^{b}\pm0.00$
852	$3.64^{e}\pm0.01$	$0.57^{e}\pm0.01$	$5.50^{e}\pm0.03$	$2.55^{e}\pm0.01$	$5.31^{d}\pm0.01$	$0.06^{b}\pm0.00$
536	$3.97^{c}\pm0.01$	$0.71^{c}\pm0.04$	$6.15^{b}\pm0.03$	$2.92^{b}\pm0.02$	$5.45^{c}\pm0.03$	$0.07^{b}\pm0.00$
482	$3.03^{f}\pm0.01$	$0.64^{d}\pm0.03$	$6.04^{bc}\pm0.02$	$2.62^{d}\pm0.02$	$5.24^{e}\pm0.01$	$0.06^{bc}\pm0.00$
941	$2.98^{f}\pm0.01$	$0.44^{f}\pm0.01$	$5.91^{c}\pm0.02$	$2.36^{f}\pm0.01$	$4.95^{f}\pm0.03$	$0.03^{c}\pm0.00$
804	$8.25^{a}\pm0.04$	$1.44^{a}\pm0.14$	$9.50^{a}\pm0.14$	$0.33^{g}\pm0.04$	$0.46^{g}\pm0.03$	$0.33^{a}\pm0.03$

Note: Values are means of triplicate of samples. Values with different superscript [a,b,c,d,e,f] in the same column are significantly different at (P>0.05). Samples 621,742 and 852 are toasted breadfruit milk-based samples blended with tiger nut milk, coconut milk and date fruit juice at the ratios of 3:5:1:1, 2:6:1:1 and 1:7:1:1 respectively and samples 536, 482 and 941 are cooked breadfruit milk-based samples blended with breadfruit milk, tiger nut milk, coconut milk and date fruit juice at the ratios of 3:5:1:1, 2:6:1:1 and 1:7:1:1 respectively. Sample 804 is vita milk which is the reference sample.

3.3. Phytochemical Compositions of the Raw Materials

The results of phytochemical screening and quantitative analysis of the raw materials used in the production of the plant milk samples are shown in Table 4 and 5. Out of ten different phytochemicals screened, namely; flavonoids, alkaloids, saponins, tannins, phenols, oxalate, glycosides, carotenoids, terpenoids and steroids, breadfruit and date fruit screened positive to more phytochemicals than the other two raw materials. Breadfruit screened positive to seven phytochemicals namely; flavonoids, alkaloids, saponins, tannins, phenols, oxalate and glycosides, while date fruit screened positive to eight different phytochemicals namely; flavonoids, alkaloids, saponins, tannins, phenols, oxalate, glycosides, carotenoids. The number of phytochemicals present in tiger nut and coconut were low compared to the number present in breadfruit and date fruit, with tiger nut screening positive to 5 different phytochemicals namely; alkaloids, saponins, tannins oxalate and glycosides, while coconut screened positive to three different phytochemicals namely; flavonoids, alkaloids and saponins.

The quantitative analysis as shown in Table 5 shows the levels of all the phytochemicals analyzed in each of the raw material. Date fruit recorded the highest levels for all the phytochemical analyzed. Alkaloids and tannins were also high in tiger nut with values of 0.55% and 9.62%, while glycoside was also high in breadfruit (4.23%). Coconut has the least levels of phytochemicals when compared to other raw materials. Carotenoids were only dictated in date fruit at the level of 0.01%.

Table 4. Qualitative screening of the raw materials.

Phytochemical	Breadfruit	Tiger nut	Coconut	Date fruit
Flavonoids	+	-	+	+
Alkaloids	+	+	+	+
Phenols	+	-	-	+
Carotenoids	-	-	-	+
Tannins	+	+	-	+
Oxalate	+	+	-	+
Terpenoids	-	-	-	-
Glycoside	+	+	-	+
Saponin	+	+	+	+
Steroids	-	-	-	-

Note: + = Sample tested positive to the phytochemical screening, **-** = Sample tested negative to the phytochemical screening.

Table 5. Quantitative screening of the raw materials.

Raw Materials	Flavonoids (mg/100g)	Alkaloids (mg/100g)	Saponin (mg/100g)	Tannins (mg/100g)	Phenols (mg/100g)	Oxalate (mg/100g)	Glycoside (mg/100g)
Breadfruit	0.25 ^{b}±0.01	0.09 ^{c}±0.01	0.18 ^{b}±0.03	0.15 ^{c}±0.01	0.28 ^{b}±0.01	0.22 ^{c}±0.00	4.23 ^{b}±0.01
Tiger Nut	-	0.55 ^{b}±0.01	0.88 ^{a} ±0.01	9.62 ^{b}±0.01	-	0.60 ^{b}±0.01	1.08 ^{c}±0.01
Coconut	0.23 ^{b}±0.02	0.11 ^{c}±0.02	0.03 ^{c}±0.02	-	-	-	-
Date Fruit	3360^{a}±0.01	1591 ^{a} ±0.02	1.37 ^{a} ±0.01	685 ^{a} ±0.01	147 ^{a} ±0.01	2534 ^{a} ±0.01	57.16 ^{a} ±0.01

Note: Values are means of triplicate of samples. Values with different superscript ^{a,b,c} in the same column are significantly different at (P>0.05).

The high levels of phytochemicals in date fruit, breadfruit and to an extent tiger nut were expected as they were in line with the report of previous researchers (Adekunle, Fanimo, Abiola, & Akegbejo-Samsons, 2006; El Hadrami & Al-Khayri, 2012; Obidoa, Joshua, & Nkechi, 2009; Osabor et al., 2009).

3.4. Phytochemical Compositions of the Plant Milk

Table 6 and 7 show the results of the phytochemical qualitative and quantitative analyses of the beverage samples. The beverage samples were screened for a total of ten phytochemicals namely; flavonoids, alkaloids, saponins, tannins, phenols, oxalate, glycosides, carotenoids, terpenoids and steroids. Both the toasted breadfruit and cooked breadfruit-based samples tested positive to the presence of seven different phytochemical compounds namely; flavonoids, alkaloids, saponins, tannins, phenols, oxalate, glycosides, while the reference sample tested positive to only four different phytochemicals namely; flavonoids, alkaloids, saponins, tannins. The presence of more varieties of phytochemicals in the formulated plant milk samples may be attributed to the impact of different component of the formulated plant milk samples which has been reported to be good sources of bioactive compounds, especially breadfruit and date fruit which according to reports contains all the phytochemicals that tested positive in the formulated plant milk samples (El Hadrami & Al-Khayri, 2012; Osabor et al., 2009). Even tiger nuts and coconut are also known to be good sources of phytochemicals (Adekunle et al., 2006; Obidoa et al., 2009; Osabor et al., 2009).

The reduced level of phytochemicals recorded from the reference sample is in line with the reported level of phytochemical reported by previous researcher about soybean which is the major component of plant milk source in the control sample (Obadoni & Ochuko, 2002; Okwu & Emenike, 2006).

Table 6. Phytochemical screening of the plant milk samples.

Phytochemical	Beverage Samples Studied						
	621	742	852	536	482	941	804
Flavonoids	+	+	+	+	+	+	+
Alkaloids	+	+	+	+	+	+	+
Phenols	+	+	+	+	+	+	-
Carotenoids	-	-	-	-	-	-	-
Tannins	+	+	+	+	+	+	+
Oxalate	+	+	+	+	+	+	-
Terpenoids	-	-	-	-	-	-	-
Glycoside	+	+	+	+	+	+	-
Saponnin	+	+	+	+	+	+	+
Steroids	-	-	-	-	-	-	-

Note: + = Sample tested positive to the phytochemical screening, - = Sample tested negative to the phytochemical screening. Samples 621,742 and 852 are toasted breadfruit milk-based samples blended with tiger nut milk, coconut milk and date fruit juice at the ratios of 3:5:1:1, 2:6:1:1 and 1:7:1:1 respectively and samples 536, 482 and 941 are cooked breadfruit milk-based samples blended with breadfruit milk, tiger nut milk, coconut milk and date fruit juice at the ratios of 3:5:1:1, 2:6:1:1 and 1:7:1:1 respectively. Sample 804 is vita milk which is the reference sample.

The result recorded in Table 7 show that the level of flavonoids and alkaloids in the formulated beverage samples were higher in samples 621 (toasted breadfruit based) and sample 536 (cooked breadfruit based) compared to the other formulated plant milk samples with values 4.31 mg/l and 4.81 mg/l for flavonoids and alkaloids for sample 621 and 4.51 mg/l and 4.85 mg/l for sample 536. These samples contain the highest proportion of breadfruit milk during formulation. And the trend continues in the other set of results with the level of flavonoids and alkaloids decreasing in the formulated plant milk samples as the proportion of breadfruit milk decreases. This shows that breadfruit seeds which have been reported to contain high levels of flavonoids and alkaloids are responsible for the observations (Osabor et al., 2009). The reference sample recorded 1.05 mg/l and 2.16 mg/l for flavonoids and alkaloids, and these values in either case were low in significant difference ($P<0.05$) when compared to the values recorded from all the formulated beverage samples.

The presence of saponins and tannins in the formulated plant milk samples were low compared to the level of flavonoids and alkaloids and were within the range of 0.31 to 0.54 mg/l for saponin and 0.36 to 0.96 mg/l for tannins. This observation may be due to the low level of saponin and tannin in tiger nuts as reported by Umerie, Okafor, and Uka (1997), thus affecting its composition in the formulated plant milk since milk from tiger nut is a major component of the formulated beverage samples. Also, tannins according to reports are not contained in coconut (Obidoa, Joshua, & Eze, 2010). However, the values recorded for the formulated beverage samples for saponin and tannins were still high in significant difference ($P<0.05$) when compared to the values recorded for the reference sample; 0.01 mg/l for saponin and 0.56 mg/l for tannins. But the 0.56 mg/l value recorded for the reference sample was high in significant difference ($P<0.05$) when compared to values recorded from samples 482 and 941 both of the cooked based samples which recorded tannins values of 0.36 mg/l and 0.42 mg/l, but is equal to the value recorded from sample 852 of the toasted breadfruit-based sample. This high level of tannins in the reference sample may be attributed to the reported low levels of tannin in tiger nut (Umerie et al., 1997), which isa major component of the formulated plant milk samples and also the low proportion of breadfruit milk contained in these samples. While tannins have been reported to be high in soybean according to report of and thus justifies its high level in the reference sample which have soybean as the major component.

The phenolic compounds present in the formulated plant milk samples were 0.1 mg/l for all the cooked breadfruit-based samples, but were only present in sample 621 of the roasted breadfruit-based samples at the level of 0.01 mg/l. This observation could be due to the fact that cooked breadfruit seeds have been reported to contain more phenolic compounds than the toasted seeds according to reports (Ijeh, Ejike, Nkwonta, & Njoku, 2010), and the presence of phenolic compounds in sample 621 of the toasted breadfruit based sample could be due to the high proportion of breadfruit seed milk present in the sample as toasted breadfruit seeds has been reported to contain low phenolic compounds level as compared to the cooked breadfruit seeds (Ijeh et al., 2010). However, there was no record of phenolic compound in the reference sample and this could be due to low level of such compound in soybean which is a major component of the control sample (Ajayi, Ogungbuji, & Ganiyu, 2015; Iwe, 2003).

The oxalate and glycoside levels in the formulated plant milk samples were 0.24 mg/l, 0.17 mg/l and 0.12 mg/l for oxalate and 0.17 mg/l, 0.14 mg/l and 0.12 mg/l for glycoside in the toasted breadfruit-based samples. These values were slightly high in no significant difference ($P>0.05$) when compared to the value recorded from the cooked breadfruit-based samples which values were; 0.17 mg/l, 0.16 mg/l and 0.13 mg/l for oxalate and 0.17 mg/l, 0.16 mg/l and 0.12 mg/l for glycoside. The slight difference may be attributed to the toasting and cooking of breadfruit seeds pretreatment process which have varying effect on the nutritional composition of the breadfruit seeds. There was no record of both oxalate and glycoside in the reference sample. And this is expected as the level of both bioactive compounds in soybean according to literature have been reported to be very low (Obadoni & Ochuko, 2002) and as such might not have been extracted from the soymilk used in the production of the reference sample.

In all, the level of the bioactive compounds present in the formulated plant milk samples is way higher than the values recorded from the reference sample. This is in line with one of the objectives of this research which is formulating nutritional balanced beverage that will be rich in bioactive composition.

Table 7. Phytochemical composition of the plant milk samples.

Samples	Flavonoid (mg/l)	Alkaloid (mg/l)	Saponin (mg/l)	Tannin (mg/l)	Phenol (mg/l)	Oxalate (mg/l)	Glycosides (mg/l)
621	$4.31^b\pm0.01$	$4.81^a\pm0.01$	$0.54^a\pm0.01$	$0.95^a\pm0.02$	$0.01^a\pm0.00$	$0.24^a\pm0.01$	$0.17^a\pm0.01$
742	$3.96^d\pm0.02$	$4.62^b\pm0.02$	$0.42^b\pm0.02$	$0.72^c\pm0.01$	$0.00^b\pm0.00$	$0.17^b\pm0.01$	$0.14^{bc}\pm0.01$
852	$2.94^e\pm0.01$	$3.24^d\pm0.02$	$0.31^d\pm0.01$	$0.56^d\pm0.01$	$0.00^b\pm0.00$	$0.12^d\pm0.02$	$0.12^c\pm0.01$
536	$4.51^a\pm0.01$	$4.85^a\pm0.02$	$0.52^a\pm0.02$	$0.87^b\pm0.01$	$0.01^a\pm0.00$	$0.17^b\pm0.01$	$0.17^{ab}\pm0.01$
482	$4.06^c\pm0.02$	$4.51^c\pm0.01$	$0.41^b\pm0.01$	$0.42^e\pm0.02$	$0.01^a\pm0.00$	$0.16^{bc}\pm0.01$	$0.16^{ab}\pm0.01$
941	$2.92^e\pm0.02$	$3.21^d\pm0.01$	$0.35^c\pm0.01$	$0.36^f\pm0.01$	$0.01^a\pm0.00$	$0.13^{cd}\pm0.01$	$0.12^c\pm0.01$
804	$1.05^f\pm0.04$	$2.16^e\pm0.03$	$0.01^e\pm0.01$	$0.56^d\pm0.03$	$0.00^b\pm0.00$	$0.00^e\pm0.00$	$0.00^d\pm0.00$

Note: Values are means of triplicate of samples. Values with different superscript ^{a,b,c,d,f} in the same column are significantly different at (P>0.05). Samples 621,742 and 852 are toasted breadfruit milk-based samples blended with tiger nut milk, coconut milk and date fruit juice at the ratios of 3:5:1:1, 2:6:1:1 and 1:7:1:1 respectively and samples 536, 482 and 941 are cooked breadfruit milk-based samples blended with breadfruit milk, tiger nut milk, coconut milk and date fruit juice at the ratios of 3:5:1:1, 2:6:1:1 and 1:7:1:1 respectively. Sample 804 is vita milk which is the reference sample.

4. CONCLUSIONS

This study showed that the milk beverages differ in nutritional and antinutritional properties depending on the ratio of the raw materials used. The study revealed that plant milk formulated from breadfruit milk, tiger nut milk, coconut milk and date fruit juice gave products that are comparable to the conventional soy bean based vita milk in terms of their nutritional composition. The formulated plant milk contains more bioactive compounds like phenol, oxalate, favoniod and saponin than their corresponding values in the reference sample. Formulation of novel beverage from locally available plant materials would improve the industrial utilization of these crops and serve as an ideal alternative to imported ones.

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