International Journal of Food Science and Nutrition
ISSN: 2455-4898
Impact Factor: RJIF 5.14
www.foodsciencejournal.com
Volume 3; Issue 2; March 2018; Page No. 05-11

Physicochemical and organoleptic properties of flavored vegetable milk drinks made from tiger nuts (*Cyperus esculentus*) and Coconuts (*Cocos nucifera*) milk blends

Akusu OM, Emelike NJT
Department of Food Science and Technology, Rivers State University, Nkpolu Oroworukwo, Port Harcourt, Rivers State, Nigeria

Abstract
Physicochemical and organoleptic properties of vegetable milk drinks made from tiger nut and coconut milks were investigated. The two milk drinks were further blended with watermelon (T:C:W:G) and pineapple (T:C:P:G) in various proportions and both were flavored ginger extract. They were labeled A – E and F – J, respectively while whole tiger-nut and coconut milk drinks were used as control and labeled TNMD and CNMD, respectively. The proximate properties of the flavored milk drinks analyzed are moisture, ash, fat, protein and carbohydrate while pH, total sugar, titratable acidity and energy were the physical properties analyzed. The result showed that all the samples had high moisture contents ranging from 88.37 – 91.552% for samples I and CNMD, respectively. Ash ranged from 0.31 – 0.57%, fat 2.02 – 3.30% (A and TNMD samples, respectively), protein 0.59 – 3.28% (CNMD and F samples) and carbohydrate 4.69 – 5.80 (H and C samples). The pH and titratable acidity showed no significant difference ($P<0.05$) in all the blended milk drink samples as the pH values ranged from 4.09 – 4.59% (samples J and B) and titratable acidity 0.02 – 0.05% for samples B and H, I, respectively. Total sugar recorded significant difference in all the vegetable milk drinks with a range of 3.10 – 7.70% for samples CNMD and G, respectively. Organoleptic evaluation showed that vegetable milk drinks with blends of T:C:P:G were the most acceptable samples. This is in correspondence to the total sugar contents of the products as T:C:P:G had more sugar compare to T:C:W:G. The study revealed that whole CNMD was more acceptable to panelists compare to TNMD while the later contained more protein than the previous. Protein contents of the milk drink samples also revealed that samples blended in the ratios of T:C:P:G had significantly high values.

Keywords: physicochemical, organoleptic, tiger-nut, coconut, milk drinks, milk blends, vegetable milk

1. Introduction
Health, good taste and smooth texture are some of the biggest motivating factors in consumers' decision making process in the consumption of milk drinks. The health consciousness of today's consumers about product from cows' milk is on the increase and there is a growing trend in moving away from cows' milk drinks to vegetables' milk drinks. However, milk drink may have, somewhat, been redefined technically. Milk consumption gives more consideration to its constituent substances especially of carbohydrate, mainly in the form of lactose (milk sugar) which is of great concern to some consumers whom have the difficulty of digesting milk.

The prevalence of health related problems associated with the consumption of cows' milk drink has generated a lot of concern about our dietary intake considering the present dietary trend which is geared towards low cholesterol and low saturated fatty diets as well as its effect on our health (Sanful, 2009) [27]. Lactose intolerance, milk allergy, increased cholesterol, constipation, flatulence as well as exorbitant cost are most of the major reasons for the diversion from cows' milk drinks to vegetables' milk drinks. Adults and children who consume milk in Nigeria, do so by adding small amounts of evaporated milk (milk powder) to breakfast cereals, porridge, cocoa beverage, tea or coffee probably because of its exorbitant cost (Onweluzo and Nwakalor, 2009) [23]. In view of this high cost in various countries and the ever increasing gap between the requirement and population, efforts have been made over the years to develop alternative cow milk from vegetable sources which should either be incorporated into tea, coffee, cocoa beverage or consumed naturally as vegetable milk drink. Vegetable milk drinks also known as plant milk and imitation milk (Mohammed *et al.*, 2011) [17] has shown to contain low amount of cholesterol, high vitamins and minerals. Vegetable milk sources included; tiger nuts milk, coconuts milk, rice milk, oat milk and soy milk. Recently, researchers have shown strong interest in these milk sources due to their high nutritional values and economic potentials (Singh and Bains, 1988, Belewu and Belewu, 2007) [29, 8]. In the effort of this, peanuts milk-based yoghurt has been reported by Mohamed and Isam (2014) [16] as well as soybean milk used as substitute to cow milk in the formulation of carrot drinks flavored with beetroot (Banigo *et al.*, 2015) [10].

Tiger nut (*Cyperus esculentus*) as a form of vegetable milk source is undergoing underutilization phase in its use for the production of alternative milk drinks. It has been reported that grainy sandy soil and mild temperatures are special for the growth and cultivation of tiger nut (Abaejoh *et al.*, 2006) [1]. The cultivation time of tiger nut is between April to November where they must be irrigated every week until they are harvested and the maturing period is 90 – 110 days (Osagie *et al.*, 1986) [24]. It is known with different names in Nigeria such as "*aya*" in Hausa, "*ofio*" in Yoruba and "*aki hausa"* in Igbo (Umerie *et al.*, 1997) [31]. Three major varieties of tiger nuts are cultivated in Nigeria (yellow, brown and

black) but only two varieties (yellow and brown) are readily available in the Nigerian market (Oladele and Aina, 2007) [22]. The yellow variety is preferred to any other varieties because of its intrinsic properties such as bigger size, attractive color and freshness (Belewu and Belewu, 2007; Belewu and Abodunrin, 2006) [8, 7]. The yellow variety yields more milk upon extraction and contains lower fat, more protein and possess less anti-nutritional factor especially polyphenol (Okafor *et al*., 2003). Tiger nuts milk is a by-product of tiger nut plant. Its health benefits were enumerated by Adejuyitan *et al.,* (2009) and they are valued for their highly nutritious starch content, dietary fiber and protein. Consumption of tiger nut and its milk could be effective in the prevention of many diseases including colon cancer, coronary heart diseases, obesity, diabetes and gastrointestinal diseases. The protein content of tiger nut has biological implications considering the amount of amino acids it contains (Ojobe and Tempo, 1983). They are also rich in minerals such as phosphorous and potassium and in vitamins C and E (Belewu and Belewu, 2007; Belewu and Abodunrin, 2008) [8, 7]. It is a very nutritive energy drink both for the young and old, ideal for hypertensive people, sports men and women and does not produce allergy (Sanful, 2009) [27].

Coconuts are scientifically called "*Cocos nucifera*". It is a member of the *Aracacea* family and the only member of the genus *Cocois*. Early Spanish explorers called it coco meaning "monkey face" because of the three indentations (eyes) on the hairy nut resembling the head and face of a monkey and "*nucifera*" meaning nut bearing (Coconut Research Institute, 2002) [11]. The color and taste of the coconut are attributed to its high oil content, most of which is saturated fat (Nieuwentus and Nieuwelink, 2002) [18]. Coconut milk is being used in confectionaries, bakeries, biscuits production and ice cream industries worldwide to enhance flavor and taste of various products (Persley, 1992). They are highly nutritious and rich in fibre, vitamins and minerals and are classified as a 'functional food' because it provides many health benefits beyond its nutritional content (Coconut Research Institute, 2002) [11]. Coconut milk contains several anti-oxidant compounds which can provide protection against harmful, free radicals and their damaging effects on the body cells and tissues. Coconut milk can improve digestive system, promote digestion and gives about 22% of the Recommended Daily Allowance (RDA) of iron which helps in the treatment of anemia caused by iron deficiency (Seed Guides, 2013).

To benefit from all these nutritional values of tiger-nut and coconut milk, they can be blended with watermelon and pineapple in the production of vegetables' milk drinks. Therefore, the aim of the research is to produce tiger-nut and coconut milk blends using watermelon and pineapple flavored with ginger. Hence, analyze the organoleptic, physical and chemical properties of the vegetable milk blends to ascertain the most preferable.

2. Materials and Method

2.1 Materials

Fresh yellow tiger nut (*Cyperus esculentus*), matured coconuts (*Cocos nucifera*), watermelon (*Citrullus lanatus*), pineapple (*Ananas comosus*) and ginger (*Zingiber officinale*) were all purchased from Sangana Market (fruit market) in Port Harcourt, River State. The chemicals and equipment used were of analytical grade and were obtained from the Food Chemistry/Analytical Laboratory in the Department of Food Science and Technology, Rivers State University, Port Harcourt, Nigeria.

2.2 Methods

2.2.1 Preparation of Tiger Nut Milk

One kilogram (1kg) of fresh yellow tiger nuts was blended after thorough washing with 2 liters of distilled water in a Qlink blender (QBL-15L40). The slurry was pressed using a muslin cloth folded in 2, 4 and 8 layers to extract the milk. The milk was pasteurized at 72ºC for 5min, homogenized, bottled and cooled at room temperature (30±2ºC).

2.2.2 Preparation of Coconut Milk

Coconut milk was prepared by shelling the nuts and the meat was separated using a dull knife. The brown skin was removed and the meat thoroughly washed and milled into paste with Qlink blender (QBL-15L40). The milled meat was placed in a bowl and 250ml of sterile warm water was added to extract the aromatic compounds. The extract was later filtered with the folded washed and sterilized muslin cloth to obtain a milky emulsion with a sweet coconut flavor.

2.2.3. Preparation of Watermelon Juice

The washed watermelons were peeled with a sharp knife (Meco Kitchen Knife), the rind and the seeds were removed to get the pulp. The pulp was cubed and blended using Qlink blender (QBL-15L40) to obtain a homogenous mass and was pressed to release the juice into a lean container using a muslin cloth.

2.2.4 Preparation of Pineapple Juice

The washed pineapples were peeled with a sharp knife (Meco Kitchen Knife) to remove the rind and obtain the pulp. The pulp were thin sliced and blended. The filtrate was filtered into a clean container using a muslin cloth to obtain the juice.

2.2.5 Preparation of Ginger Extract

Ginger was washed and scrapped to remove superficial skin, cut into small pieces of about 1 – 2mm thickness and blended using Philips HR2000 blender for 10min. Distilled water was added to prepare ginger extract in the ratio of 2:2 of ginger to water. The blend was then filtered through muslin with 2, 4 and 8 folds according to the method outlined by Emelike *et al.*, (2016) [12].

2.2.6 Formulation of Flavored Vegetable Milk Blends

Tiger nut and coconut milks were mixed at various blend proportions using either watermelon or pineapple juice flavored with ginger extract as shown in Table 1.

Table 1: Tiger nut and Coconut Milk Blend Ratios (Per 100ml)

Samples	Tiger Nut Milk	Coconut Milk	Watermelon Juice	Pineapple Juice	Ginger Extract
Control 1	100	0	0	0	0
Control 2	0	100	0	0	0
A	65	20	10	0	5
B	60	25	10	0	5
C	55	30	10	0	5
D	50	35	10	0	5
E	45	40	10	0	5
F	65	20	0	10	5
G	60	25	0	10	5
H	55	30	0	10	5
I	50	35	0	10	5
J	45	40	0	10	5

Keys: Tiger nut/Coconut/Watermelon/Ginger Extract (T:C:W:G) A = 65:20:10:5, B = 60:25:10:5, C = 55:30:10:5, D = 50:35:10:5, E = 45:40:10:5

Tiger nut/Coconut/Pineapple/Ginger Extract (T:C:P:G) F = 65:20:10:5, G = 60:25:10:5, H = 55:30:10:5, I = 50:35:10:5, J = 45:40:10:5

Control 1 = 100% Tiger Nut Milk and Control 2 = 100% Coconut Milk

2.3 Organoleptic Evaluation

Organoleptic evaluation was carried out using twenty trained panelists consisting of staff and students of Food Science and Technology Department, Rivers State University, Port Harcourt, Nigeria. Criteria for selection were that panelists were above 15 years of age and regular consumers of tiger nuts, coconuts and fruit drinks. They were neither sick nor allergic to nuts, fruits and ginger extract. 9 – point Hedonic Scale reported by Ihekoronye and Ngoddy (1985) and described by Iwe (2010) was used to evaluate the milk blend products with scores descending from 9 to 1 representing 'Like and Dislike Extremely', respectively. The panelists were guided to rinse their mouth with water after evaluating each sample to prevent transferring flavor and taste from one sample to the other. Five organoleptic parameters evaluated included taste, aroma, appearance, flavor and overall acceptability.

2.4 Chemical Analysis

Chemical analysis of the tiger nut and coconut flavored vegetable drinks were carried out to determine the moisture, ash, fat and protein contents of the milk blend drinks using the official method of analysis described by the Association of Official Analytical Chemists (AOAC, 2012). Carbohydrate content of the flavored vegetable milk blends were analyzed using Anthrone Reagent method reported by Osborne and Voogt (1978).

2.5 Physical Analyses

2.5.1 pH

The pH of the tiger nut and coconut flavored vegetable drinks were determined using Thomas Scientific pH meter (TS 625, USA). Ten (10ml) of the samples were measured into a 50ml beaker and the pH was determined after the meter was calibrated using standard buffer of pH 4.0 and 7.0. Sufficient time was allowed for stabilization before readings were taken.

2.5.2 Total Sugar Content (^{o}brix)

The hand held sugar refractometer ATAGO (0-32^{o}Brix) was used to determine the sugar content of the milk blends. The hand held prism of the refractometer was cleaned and a drop of the milk blend drinks was placed on the prism and closed. The total sugar content (^{o}brix) was read off the scale of the refractometer hold firmly close to the eye according to the method of AOAC (2012).

2.5.3 Titratable Acidity

Ten metres (10ml) of the milk blend samples were weighed into a beaker. Two drops of phenolphthalein indicator were added to each sample and were titrated against 0.1N of sodium hydroxide (NaOH). The appearance of a change in color (pink) indicated the end point of titration. The titratable acidity expressed as percentage (%) of lactic acid was determined (AOAC, 2012).

2.5.4 Total Energy

Total energy of the flavored vegetable milk blends was estimated using the modified Atwater factor (4 X protein + 4 X carbohydrate + 9 X fat) according the Hunt *et al.,* (1987) method.

2.6 Statistical Analysis

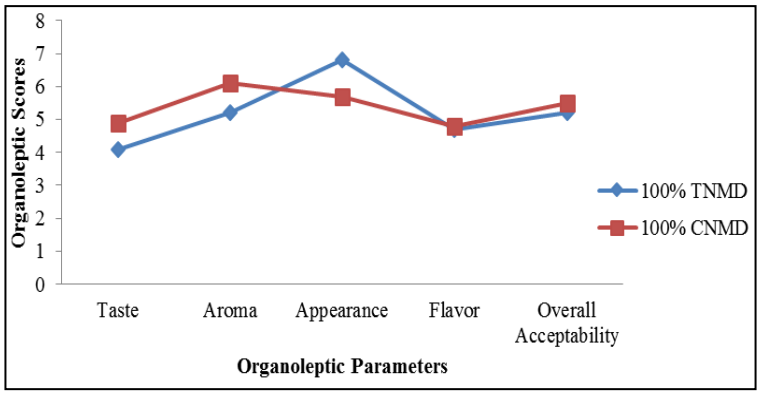
The results obtained were expressed as mean values and standard deviation of duplicate determinations. Data obtained were subjected to One-Way Analysis of Variance (ANOVA) and a randomized complete block design to test the level of significance at 5% level of probability ($p<0.05$) using Statistical Package for Social Science (SPSS, Inc. Chicago) Version 20.0, year 2011. Duncan New Multiple Range Test was used to separate the means where significant differences existed according to Wahua (1999) method.

3. Results and Discussion

3.1 Organoleptic Properties of the Flavored Vegetable Milk Drinks

The organoleptic evaluation portrayed varied significant differences of the samples used in this work. Taste of any product is an important feature for the consumers. Hence, it determines their purchasing power. Vegetable milk blends in this research were produced in two varying forms such as tiger-nut/coconut/watermelon (TCW) shown in Table 2 and tiger-nut/coconut/pineapple (TCP) shown in Table 3 and both were flavored with ginger extract. Notwithstanding, whole tiger nut (TNMD) and coconut (CNMD) milk drinks were equally produced and used as a base (control). The result showed that samples F – J (TCP samples) had higher scores compare to samples A – E (TCW samples). This implies that pineapple juice improved the taste of the milk blends than watermelon juice. The taste scores of both whole tiger nut and coconut milk drinks (4.1 and 4.9, respectively as presented in Figure 1) is an indication that the blends were more preferred by the panelists. While CNMD were more preferred to TNMD. This agreed with the literature stating that taste of the coconut is attributed to its high oil content, most of which is saturated fat (Nieuwentus and Nieuwelink, 2002) [18]. Mohamed and Isam (2014) [16] equally reported higher organoleptic acceptability of fresh yoghurt with different

concentrations. Sample J received the highest acceptable score (7.1) in terms of aroma. Sample G (7.9) was the most preferred in the aspect of appearance followed by sample F (7.8). Consumers tend to accept products for consumption based on their appearance and if the aroma appeases their sense of smell. The flavor of these milk drinks indicates the varieties of each sample. Sample F (7.0) received the highest acceptable score which was significantly higher ($P<0.05$) than other samples when compared including the control samples. The overall acceptability is one of the most important factors for consumers' most acceptable preference of any food product. The panelists found sample F (8.1) as the overall acceptable vegetable milk drinks. The least overall acceptability score recorded in sample E (5.2) and whole tiger nut milk drink (5.2) on a 9 – point hedonic scale is an indication that the vegetable milk drinks were acceptable by the panelists.



Key: TNMD = Tiger Nut Milk Drink and CNMD = Coconut Milk Drink

Fig 1: Organoleptic Properties of 100% Tiger nut and Coconut Milk Drinks

Table 2: Organoleptic Properties of Tiger-Nut/Coconut/Watermelon Milk Blends Flavored with Ginger Extract

Samples	Taste	Aroma	Appearance	Flavor	Overall Acceptability
A	5.2^{a}	6.0^{a}	6.6^{b}	4.9^{b}	5.4^{a}
B	5.0^{a}	5.0^{bc}	7.0^{a}	5.5^{a}	5.9^{a}
C	4.7^{b}	4.9^{c}	6.6^{b}	4.9^{b}	5.6^{a}
D	5.3^{a}	6.1^{a}	7.0^{a}	5.6^{a}	5.8^{a}
E	4.8^{b}	5.5^{b}	6.9^{a}	5.1^{ab}	5.2^{a}

*mean values not followed by the same superscript in the same column are significantly different ($p<0.05$).

Key:

Tiger-nut/Coconut/Watermelon/Ginger Extract (T:C:W:G) A = 65:20:10:5, B = 60:25:10:5, C = 55:30:10:5, D = 50:35:10:5, E = 45:40:10:5

Table 3: Organoleptic Properties of Tiger-Nut/Coconut/Pineapple Milk Blends Flavored with Ginger Extract

Samples	Taste	Aroma	Appearance	Flavor	Overall Acceptability
F	7.7^{a}	6.9^{a}	7.8^{a}	7.0^{a}	8.1^{a}
G	7.0^{a}	6.6^{ab}	7.9^{a}	6.9^{a}	7.6^{b}
H	7.0^{a}	6.1^{b}	6.9^{ab}	6.7^{a}	7.0^{bc}
I	6.4^{b}	5.9^{b}	6.4^{b}	5.8^{b}	6.8^{c}
J	7.3^{a}	7.1^{a}	7.3^{a}	6.7^{a}	7.6^{b}

*mean values not followed by the same superscript in the same column are significantly different ($p<0.05$).

Key:

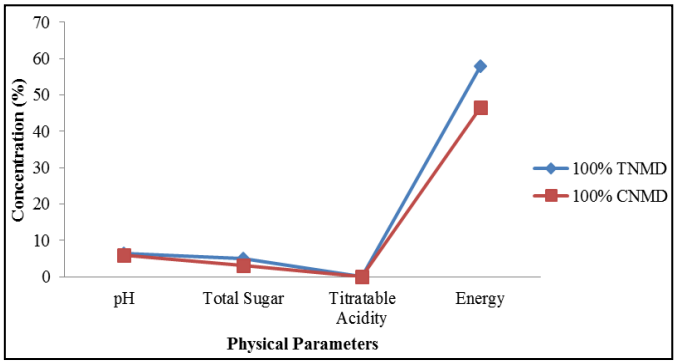
Tiger-nut/Coconut/Pineapple/Ginger Extract (T:C:P:G) F = 65:20:10:5, G = 60:25:10:5, H = 55:30:10:5, I = 50:35:10:5, J = 45:40:10:5

3.2 Physical Properties of the Flavored Vegetable Milk Drinks

Whole tiger nut and coconut milk drinks had pH value of 6.30 and 6.00, respectively as presented in Figure 2 with significant difference ($P<0.05$). This is an indication that these milk drinks will be better consumed immediately in fresh state as well as suitable for patients with ulcer and other health related problems especially milk allergy and lactose intolerance. The blends of the two vegetable milk sources with watermelon flavored with ginger reduced the pH towards acidity range of 4.33 – 4.59 for samples E and B, respectively as shown in Table 4. Similar trend was observed in the milk drinks blended with pineapple with pH range of 4.09 – 4.27 (samples J and F, respectively) as shown in Table 5. These values are in agreement with 4.36 – 4.41 for spiced cucumber and pineapple drinks reported by Babajide *et al.*, (2013) [5]. The reduction in the values of the vegetable milk blends flavored with ginger towards acidity is an indication that the milk blends have the tendency of withstanding the activities of microbes. Therefore, homemade vegetable milk drinks can be produce with fruit blends and ginger extract and consume later even without refrigerating by the populace who has no access to refrigerator. This report is in line with that of Nwachukwu and Ezejiaku (2014) [19] who observed a reduced pH of pineapple juice treated with garlic and ginger towards acidity. Mohamed and Isam, (2014) [16]; Emelike *et al.*, (2016) [12] also reported a decreased pH of peanut milks and beetroot juice treated with 6% ginger extract, respectively.

Even when external sugar was not incorporated into the vegetable milk blend drinks, the concentration of milk drinks with either watermelon or pineapple juice improved the total sugar content of the blends. The total sugar content of the tiger nut and coconut milk drinks was 5.10% and 3.10%, respectively with significant difference ($P<0.05$). Samples with watermelon and pineapple blends ranged from 4.50 – 5.00% and 6.90 – 7.70%, respectively. The result showed that watermelon can be used in the formulation of vegetable milk drinks for the elderly who requires fewer calories while pineapple can be used to formulate vegetable milk drinks for

the youth who requires high calories to perform their day-to-day activities. The amount of sugar present in the milk drink blends gave rise to the level of energy analyzed. The samples with reduced sugar content resulted to low energy while those with high sugar content resulted to high energy. This means that the produced vegetable milk drinks can serve as a good source of energy to the consumers.



Key: TNMD = Tiger Nut Milk Drink and CNMD = Coconut Milk Drink

Fig 2: Physical Properties of 100% Tiger nut and Coconut Milk Drinks

Table 4: Physical Properties of Tiger-Nut/Coconut/Watermelon Milk Blends Flavored with Ginger Extract

Samples	pH	Total Sugar (%)	Titratable Acidity (%)	Energy (Kcal 100^{-1}g)
A	4.57^{a}	5.00^{a}	0.04^{a}	45.85^{b}
B	4.59^{a}	4.50^{c}	0.02^{a}	50.30^{a}
C	4.52^{a}	4.80^{b}	0.03^{a}	46.85^{b}
D	4.37^{a}	4.50^{c}	0.03^{a}	49.24^{a}
E	4.33^{a}	4.80^{b}	0.03^{a}	50.51^{a}

*values are means ± standard deviation of duplicate samples. Mean values not followed by the same superscript in the same column are significantly different.

Key:

Tiger-nut/Coconut/Watermelon/Ginger Extract (T:C:W:G) A = 65:20:10:5, B = 60:25:10:5, C = 55:30:10:5, D = 50:35:10:5, E = 45:40:10:5

Table 5: Physical Properties of Tiger-Nut/Coconut/Pineapple Milk Blends Flavored with Ginger Extract

Samples	pH	Total Sugar (%)	Titratable Acidity (%)	Energy (Kcal 100^{-1}g)
F	4.27^{a}	7.50^{b}	0.04^{a}	56.80^{a}
G	4.22^{a}	7.70^{a}	0.04^{a}	58.99^{a}
H	4.17^{a}	7.30^{c}	0.05^{a}	57.65^{a}
I	4.20^{a}	7.00^{d}	0.05^{a}	59.11^{a}
J	4.09^{a}	6.90^{d}	0.04^{a}	58.85^{a}

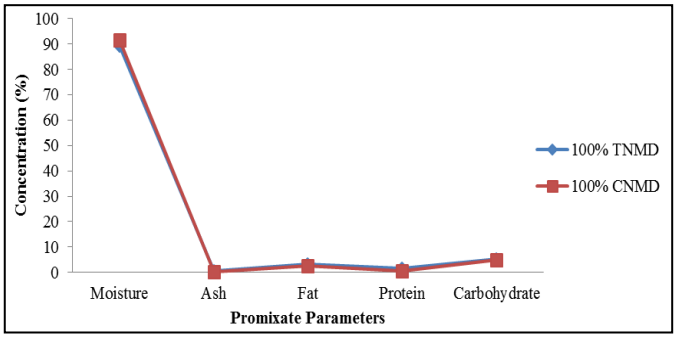
*values are means ± standard deviation of duplicate samples. Mean values not followed by the same superscript in the same column are significantly different.

Key:

Tiger-nut/Coconut/Pineapple/Ginger Extract (T:C:P:G) F = 65:20:10:5, G = 60:25:10:5, H = 55:30:10:5, I = 50:35:10:5, J = 45:40:10:5

3.3 Proximate Compositions of the Flavored Vegetable Milk Drinks

Results of the proximate compositions revealed that whole tiger nut and coconut milk drinks have moisture contents of 89.24 and 91.55%, respectively with significant difference ($P<0.05$) as depicted in Figure 3. Milk blend drinks shown moisture content ranging from 90.30 – 90.91% for samples D and A, C, respectively as shown in Table 6 while a reduced moisture was recorded for samples I to H with values ranging from 88.37 – 88.99% as presented in Table 7. This could be attributed to the natural amount of moisture contained in watermelon and pineapple used in the milk drink blend. These values are in relationship with 85.30% moisture content of peanut milks reported by Mohamed and Isam (2014) [16]. A range of 81.708 to 86.450% has equally been reported by Awonorin and Udeozor (2014) [4] for tiger nut-soy milk extract. The ash content of the tiger nut milk blend is 0.57% while 0.33% was recorded in the coconut milk drink. The blends affected the ash content of these two milk drinks especially tiger nut milk in respect to 0.57% reported for ash value of whole tiger nut milk drink. Therefore, the blends with watermelon ranged from 0.31% (samples A and E) to 0.38% (sample D) while those with pineapple ranged from 0.33 – 0.37% for samples F and H, respectively with no significant difference ($P<0.05$). These values are within the range of 0.288 to 0.495% for tiger nut-soy milk extract reported by Awonorin and Udeozor (2014) [4] while they are high compare to 1.5% reported by Ukwuru *et al.*, (2008) [30]. The fat content of the milk drinks blended with watermelon ranged from 2.02 – 2.92% (A and E) while those blended with pineapple ranged from 2.59 – 2.90% (F and H) samples, respectively. The protein values in this study are not in agreement with the reports of Belewu *et al.*, (2005) [6] and Belewu *et al.*, (2010) [9]. This might results from the protein content of the fruits and nuts used in this work as they may affect the protein content of the flavored vegetable milk drinks. The carbohydrate content also ranged from 4.69 – 5.80% for samples H and C, respectively which showed that the milk drinks are a good source of carbohydrates and energy.



Key: TNMD = Tiger Nut Milk Drink and CNMD = Coconut Milk Drink

Fig 3: Proximate Properties of 100% Tiger nut and Coconut Milk Drinks

Table 6: Proximate Properties of Tiger-Nut/Coconut/Watermelon Milk Blends Flavored with Ginger Extract (Per 100ml)

Samples	Moisture	Ash	Fat	Protein	Carbohydrate
A	90.91±0.01[a]	0.31±0.01[a]	2.02±0.15[d]	1.53±0.13[a]	5.22±0.13[c]
B	90.42±0.02[a]	0.36±0.04[a]	2.22±0.07[c]	1.48±0.15[b]	5.20±0.05[c]
C	90.91±0.17[a]	0.33±0.02[a]	2.25±0.08[c]	0.74±0.02[e]	5.80±0.15[a]
D	90.30±1.09[a]	0.38±0.21[a]	2.55±0.17[b]	1.39±0.12[c]	5.68±0.17[b]
E	90.86±0.02[a]	0.31±0.03[a]	2.92±0.03[a]	1.10±0.14[d]	4.81±0.10[d]

*values are means ± standard deviation of duplicate samples. Mean values not followed by the same superscript in the same column are significantly different.

Key:

Tiger-nut/Coconut/Watermelon/Ginger Extract (T:C:W:G) A = 65:20:10:5, B = 60:25:10:5, C = 55:30:10:5, D = 50:35:10:5 and E = 45:40:10:5

Table 7: Proximate Properties of Tiger-Nut/Coconut/Pineapple Milk Blends Flavored with Ginger Extract (Per 100ml)

Samples	Moisture	Ash	Fat	Protein	Carbohydrate
F	88.86±0.07[a]	0.33±0.03[b]	2.59±0.11[d]	3.28±0.10[a]	4.94±0.10[c]
G	88.45±0.24[a]	0.34±0.06[d]	2.69±0.12[c]	3.23±0.12[b]	5.29±0.15[b]
H	88.99±0.30[a]	0.37±0.15[a]	2.90±0.05[a]	3.05±0.12[d]	4.69±0.11[a]
I	88.37±0.30[a]	0.34±0.02[c]	2.65±0.08[d]	3.09±0.16[c]	5.55±0.15[a]
J	88.68±0.04[a]	0.34±0.17[c]	2.86±0.06[b]	3.18±0.14[b]	4.95±0.14[d]

*values are means ± standard deviation of duplicate samples. Mean values not followed by the same superscript in the same column are significantly different.

Key:

Tiger-nut/Coconut/Pineapple/Ginger Extract (T:C:P:G) F = 65:20:10:5, G = 60:25:10:5, H = 55:30:10:5, I = 50:35:10:5 and J = 45:40:10:5

4. Conclusion

The analysis indicates that vegetable milk drinks with pineapple blend had the highest taste and overall acceptability in terms of organoleptic scores compare to those with watermelon blends as well as whole tiger nut and coconut milk drinks. Overall acceptability score of 8.1 on a 9 – point hedonic scale for milk drink blended with 20% pineapple is a good indication that the vegetable milk blends were highly acceptable by the panelists. The blends of either watermelon or pineapple equally decreased the pH range of the milk blend drinks towards acidity. This implies that vegetable milk drinks can be blended with these fruits flavored with ginger to prolong the storage capacity of the product. This is because acidic pH has the tendency of inhibiting the activities of microbes. It was also observed that the milk drink samples with fruit and ginger extract blends had significantly high protein values compare to whole tiger nut and coconut milk drinks. Therefore, vegetable milk blends can be produce and utilize by health conscious individuals and to stabilize the high cost associated with the consumption of animal milk products and their importation.

5. References

1. Abaejoh R, Djomdi I, Ndojouenkeu R. Characteristics of tiger nuts (*Cyperus esculentus*) tubers and their performance in the production of a milky drink. Journal of Food Processing and Preservation. 2006; 30:145-163.
2. Adejuyitan JA, Otunola ET, Akande EA, Bolarinwa IF, Oladokun FM. Some Physicochemical properties of flour obtained from fermentation of tiger nut (*Cyperus esculentus*) sourced from a market in Ogbomoso, Nigeria. African Journal of Food Science. 2009; 3(2):051-055.
3. AOAC. Association of Official Analytical Chemists, Official Methods of Analysis, 17th ed., Washington, DC, U.S.A, 2012.
4. Awonorin SO, Udeozor LO. Chemical properties of tiger nut-soy milk extract. IOSR Journal of Environmental Science, Toxicology and Food Technology. 2014; 8(3v1):87-98. Doi: 10.9790/2402-08318798
5. Babajide JM, Olaluwuye AA, Taofikshittu TA, Adebisi MA. Physico-chemical properties and phytochemical components of spiced cucumber – pineapple fruit drink. NIFOJ. 2013; 31:40-52.
6. Belewu MA, Belewu KY, Olatunji SA. Soy-coconut yoghurt: preparation, compositional and organoleptic qualities. Bioscience Research Bulletin. 2005; 21(2):129-137.
7. Belewu MA, Abodunrin OA. Preparation of kunnu from unexploited rich food source: tiger nut (*Cyperus esculentus*). World Journal of Dairy Food Science. 2006; 1:19-21.
8. Belewu MA, Belewu KY. Comparative physico-chemical evaluation of tiger-nut, soybean and coconut milk sources. International Journal of Agriculture and Biology. 2007; 9(5):785-787.
9. Belewu MA, Belewu KY, Bamidele RA. Cyper-coconut yoghurt: preparation, compositional and organoleptic qualities. African Journal of Food Science and Technology. 2010; 1(1):010-012.
10. Banigo EB, Kiin-Kabari DB, Owuno F. Physicochemical and sensory evaluation of soy/carrot drinks flavoured with beetroot. African Journal of Food Science and Technology. 2015; 6(5):136-140.
11. Coconut Research Institute. Coconut Production in Africa, 2002.
12. Emelike NJT, Barber LI, Ebere CO. Quality characteristics of beetroot juice treated with indigenous spices (lemon, ginger and ehuru). International Journal of Food Science and Nutrition Engineering. 2016; 6(1):14-19.
13. Hunt C, Bum P, Adamezuk ZC. Proximate composition and fat type of three popular take away meal. International Journal of Food Science and Technology. 1987; 22:669-675.
14. Ihekoronye AI, Ngoddy PO. Integrated Food Science and Technology for the tropics. London Macmillian Publishers Ltd. 1985; 178-180,372-373.
15. Iwe MO. Handbook of Sensory of Analysis, Enugu, Nigeria. Rejoint Communication Science Ltd. 2010; pp. 75-78.
16. Mohamed OE, Isam AMA. Physicochemical characteristics and organoleptic properties of peanuts milk-based yoghurt fortified with skimmed milk powder. Journal of Research in Applied Sciences. 2014; 1(4):78-82.
17. Muhammed NO, Bamishaye EI, Bamishaye OM, Usman LA, Salawu MO, Nafiu MO, Oloyede OB. Physicochemical properties and fatty acid composition of

Cyperus esculentus (tiger nut) tuber oil. Bioresearch Bulletin. 2011; 35-36.
18. Nieuwentus R, Nieuwelink J. Soy and Other Leguminous Crops. Agrodok Series No. 10 CTA, Netherlands. 2002; pp. 28-30.
19. Nwachukwu E, Ezejiaku FC. Microbial and physicochemical characteristics of locally produced pineapple juice treated with garlic and ginger. International Journal of Current Microbiology and Applied Sciences. 2014; 3(6):895-901.
20. Ojobe TO, Tempo VJ. Amino acid composition of tiger nuts (*Cyperus esculentus*) tubers. Nigerian Journal of Science Biotechnology. 1983; 2:35-38.
21. Okafor JNC, Mordi JI, Ozumba AU, Solomon HM, Olatunji O. Preliminary Studies on the Characterization of Contaminants in Tiger nut (Yellow Variety). In: Proceedings of 27th Annual Nigerian Institute of Food Science and Technology (NIFST) Conference. 13-17 October, 2003; pp. 210-211.
22. Oladele AK, Aina JO. Chemical composition and functional properties of flour produced from two varieties of tiger nut. African Journal of Biotechnology. 2007; 6:2473-2476.
23. Onweluzo JC, Nwakalor C. Development and evaluation of vegetable milk from *Treculia africana* (Decne) seeds. Pakistan Journal of Nutrition. 2009; 89(3):233-238. **Doi:** 10.3923/pjn.2009.233.238
24. Osagie AU, Okoye WI, Oluwayose BO, Dawodu OA. Chemical quality parameters and fatty acid position of oils of under exploited tropical seeds. Nigeria Journal of Applied Science. 1986; 4:151-162.
25. Osborne DR, Voogt P. The Analysis of Nutrients in Foods. London Academic Press. 1978; pp. 130-134.
26. Persely JG. Replanting the Tree of Life. CAB International Wallingford Oxon. 1992; pp. 38-40.
27. Sanful RE. Promotion of coconut in the production of yoghurt. African Journal of Food Science. 2009; 3(5):147-149.
28. Seed Guides. Saskachewan Seed Growers Association. Broadway Street West, Yorkton, SK, S3N 0L6. 2013; pp. 10-14. http://saskseed.ca/2013-seed-guide/
29. Singh T, Bains GS. Grain-extract milk beverage, processing and physicochemical characteristics. Journal of Food Science. 1988; 53:1387-1390.
30. Ukwuru MU, Omachona LJ, Onokah N. Production and quality assessment of tigernuts (*Cyperus esculents*) imitation milk during storage. Journal of Food Science and Technology. 2008; 45:180-182.
31. Umerie SC, Okafor EP, Uka AS. Evaluation of the tubers and oil of *Cyperus esculentus*. Bioresource Technology. 1997; 61:171-173.
32. Wahua TAT. Applied Statistics for Scientific Studies African Link Press Aba, Nigeria, 1999.