**ABSTRACT**

Beverage consumption is increasing but rarely used to promote micronutrient intakes in Nigeria. Diversifying the crops in local beverage production could improve dietary diversification and increase nutrients intake. This study determined the nutritional composition, microbial load and consumer acceptability of tiger nut, date and ginger blended beverage. Fresh tiger nuts, date and ginger were processed to formulate four beverage blends in these ratios 100:0:0; 85:10:5; 70:20:10; and 55:30:15. Samples were analysed for proximate, vitamins, minerals, anti-nutrients content and microbiological attributes using standard procedures. Consumer acceptability was determined using a 9-point hedonic scale by 30 untrained panelists. Data were analysed using descriptive statistics, independent t-test and ANOVA at p ≤ 0.05. Moisture, protein, fat, fibre, ash, carbohydrate (mg 100 g⁻¹) and metabolizable energy composition (kCal 100 ml⁻¹) ranged from 80.33-84.78, 0.71-0.8, 2.96-4.94, 0.20-1.63, 0.34-0.44, 9.10-13.63 and 78.2-101.5, respectively. Thiamin, niacin, ascorbic acid and tocopherol composition (mg 100 g⁻¹) ranged from 0.30-0.68, 0.08-0.17, 4.73-8.40, and 7.20-15.31, respectively. Calcium, potassium, phosphorus, and iron contents (mg 100 g⁻¹) ranged from 0.17-0.30, 0.08-0.17, 2.96-4.94, 0.20-1.63, 0.34-0.44, 9.10-13.63 and 78.2-101.5, respectively. Saponin ranged from 0.01-0.05 mg 100 g⁻¹. Number of colonies were negligible after refrigeration for 10 days. Sensory properties ranged from 6.40-6.63, 4.93-6.40, 4.70-7.20, 5.93-6.90, and 5.27-7.17 for appearance, aroma, taste, consistency and general acceptability, respectively. Date and ginger substitution enhance fibre, ash, carbohydrate, and calcium composition, the shelf life and sensory properties of tiger nut beverage, the blends are generally acceptable to consumers and considered safe up to day 10 when refrigerated.

**Key words:** *Kunnu* sensory properties, antinutrients, nutrient content, microbiological attributes

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**INTRODUCTION**

Micronutrient malnutrition remains a major public health problem in Nigeria despite availability of large diversity of traditional crops with potentials to contribute to micronutrients intake. Indigenous beverages are prepared from traditional crops like cereals, nuts, fruits and vegetables and are widely consumed by various population age groups as refreshments or part of main meals (Belewu and Abodunrin, 2006) and for nutritional (Corbo et al., 2014) and functional health values (Yilmaz-Akyuz et al., 2019). Many of these beverages are cheap and energy dense but nutrient-poor and therefore limited in contributing to the efforts at promoting good nutrition especially improved micronutrient intake. These shortcomings have prompted efforts at harnessing the potentials of the lesser known and underutilized crops in the development of new products with good sensory acceptance and high nutritional value (Potter and Hotchkins, 1996). Blended non-alcoholic beverage development has been identified as an approach to improve the nutritional quality of traditional products (Jain and Khurdiya 2004). When blends are selected across two to three food groups, dietary diversity is ensured and this expands the coverage of nutritive, sensory and flavor properties of the beverage.

Tiger nut (*Cyperus esculentus* L.) is a monocotyledonous plant which belongs to the family *Cyperaceae* and is made up of over 4000 species (Ekeanyanwu and Ononogbu, 2010). The tubers are about the size of peanuts and are abundantly produced in Nigeria. Tiger nuts are valued as a rich source of starch, dietary fibre, fat, protein and selected minerals like sodium, calcium, potassium and zinc (Oladele and Aina, 2007). In addition, certain functional health properties have been attributed to consumption of tiger nut including treatment and prevention of colon cancer, coronary heart disease, obesity, diabetes, and gastrointestinal disorders, dysentery, diarrhea following high content of soluble glucose (Adjeuyitan et al., 2009). The high fiber content makes tiger nut suitable in the management of weight, diabetes and diverticulosis (Beniwal, 2004; Borges et al., 2008). Despite these known benefits,
utilization of tiger nuts in Nigeria is presently limited to consumption as snacks (Ukwuru et al., 2011), drinks (Musa and Hamza, 2013), production of flour to make cakes and biscuits (Chinma et al., 2010; 2011), and extraction of oil for cooking (Ezeh et al., 2014). Tiger nut drink commonly called ‘Kamnu aya’ in Nigeria is relished as a milk substitute and widely consumed throughout the year especially in hot weather of the dry season (Bamishaiye and Bamishaiye, 2011).

Dates (Phoenix dactylifera L.) is known as Dabino in Nigeria. It is a drupe widely used in pudding, bread, cakes, cookies, ice cream, candy bars and cereals and as paste, spread, sweetener, jam, jelly, juice, syrup, vinegar, alcohol and animal feeds especially among Arabs (El Hadrami and Al-Khayri, 2012). In addition, dates contain 44-80% carbohydrates, 0.2-0.5% fat, 2.3-5.6% protein and 6-12% dietary fiber (El-Hadrami and Al-Khayri, 2012) and this makes it an important dietary source of nutrients among its consumers. Dates is also high in phenolic compounds and therefore exhibits antioxidant and antimutagenic properties thereby protecting nucleic acids, proteins and lipids from oxidative damage and carcinogens (Vayalil, 2002). The high phenolic composition also confers antimicrobial properties (El-Hadrami and Al-Khayri, 2012). In addition, date palm fruits are used in Arab countries in the management of aphrodisiacs and treatment of ulcers (Al-Qarawi et al., 2005; Mansouri et al., 2005).

Spices and herbs such as garlic, black cumin ginger (nigella) cloves, cinnamon, thyme, anise and ginger have been used for generations by humans to treat ailments, prevent diseases and as food additives. Ginger (Zingiber officinale) is a plant that has been used as a spice in food preparation and more recently for its antimicrobial and antioxidant properties (Awe et al., 2013). There is an increasing need to diversify sources of dietary nutrients and bioactive compounds, and tweak the food system to promote improved nutrition and health. It has, therefore, become necessary to explore optimization of the potential of existing locally available plant materials to support intakes of micronutrients and other bioactive substances. This is expected to positively impacts on the health and well-being of the local beverage consumers and contribute to making the food system more pro-nutrition. Thus, this study was conducted to formulate and determine the nutritional composition, microbial load and consumer acceptability of tiger nut, date and ginger blended beverage.

MATERIALS AND METHODS

Materials
Fresh tiger nuts, yellow variety (Cyperus esculentus), date palm fruit (Phoenix dactylifera L.), and ginger (Zingiber officinale Roscoe) used for this study were randomly purchased from Bodija market, Ibadan, Nigeria. The samples were prepared at the Dietetics Kitchen, Department of Human Nutrition and the analysis of the samples was conducted in the Research Laboratory of the Department of Human Nutrition, University of Ibadan and the Central Laboratory of the Institute of Agriculture, Research and Training, Ibadan, Oyo State, Nigeria.

Sample Preparation
Fresh tubers of tiger nuts, date palm fruit and ginger (peeled) were sorted to remove extraneous materials, bad/ cracked nuts and seeds which may affect the taste and keeping quality of the drink. The samples were washed, rinsed with water and used to produce beverage.

Production of Tiger Nut Milk
Extraction of tiger nut milk was carried out using the method described by Udeozor (2012) with little modification (Figure 1). One kilogram (1 kg) of the fresh tiger nuts was manually sorted and cleaned to remove extraneous materials. The nuts were soaked in potable water at ratio nut: water (1:3) for 12 h. The soaked nut was milled into a slurry (Philips-Kenwood, UK) with addition of 3 L of water. The slurry was pressed using muslin cloth (300 µm pore size) to extract the milk. The extracted liquor was homogenized using Q-Link Blender (Model 365XG) and the filtrate obtained was transferred into sterilized plastic bottles, corked and stored in the freezer at −18°C (for not more than three days) prior to analysis.

Production of Date Juice
The whole of the fruit flesh was obtained by splitting the fruit open to remove the seed. A two-stage extraction described by Agriculture and Consumer Protection was employed with some modifications. The date flesh/water (ratio 4:1) was blended to a fine paste and later centrifuged at 300 rpm (to separate the desirable from undesirable components). At the lower part of the tube, debris was collected and above this layer is a lighter coloured layer and the final layer above the clear colour liquid is the thin film of materials which may contain fat (Figure 2).

Materials and Methods: Tiger Nut Milk Production

Source: Udeozor (2012)

Figure 1: Flow chart for tiger nut milk production

Figure 2: Flow chart for date juice production
Production of Ginger Juice
Ginger was peeled and sliced with stainless steel knives and blended/water (1:1) with Q-Link Blender (Model 365XG) for the extraction of juice. The juice was kept for 24 h in refrigerator (4±2°C) for sedimentation. Then the clear juice was siphoned off. The juice was filtered through muslin cloth (300 µm pore size) and the filtrate obtained was transferred into sterilized plastic bottles, corked and stored in the freezer.

Production of Tiger Nut-Date-Ginger Beverage Blend
Tiger nut milk, date juice and ginger juices were standardized to obtain formulations of varying ratio of 100:0:0 = A, 85:10:5 = B, 70:20:10 = C and 55:30:15 = D. Each blend was homogenized at maximum speed in a Q-Link Blender (Model 356 XG) for 10 min. The products were pasteurized at 65°C for 30 min. and bottled, then cooled under ambient condition as showed in Figure 3.

Chemical Analysis
Proximate analysis
Protein, moisture, fat, ash, and crude fibre content of the samples were analysed as described by the Association of Official Analytical Chemist (AOAC, 2005). All analyses were done in triplicates while carbohydrate content was obtained by difference.

Micronutrient content
Beta-carotene, vitamins B1, B3, C and E were determined using the standard methods of AOAC (2005). Potassium (K), calcium (Ca) and sodium (Na) were analyzed using flame photometry; magnesium (Mg), iron (Fe), manganese (Mn) and copper (Cu) by Atomic Absorption Spectrophotometry, and phosphorus (P) content was determined using spectrophotometric method.

Anti-nutritional factors analysis
Antinutrients, oxalates, phytates, saponins and tannins were determined as described by AOAC (2005).

Microbiological Analysis
One milliliter (1 ml) of each sample was serially transferred into nine milliliters (9 ml) of the sterile diluent (peptone water) with a sterile pipette and shaken vigorously. Serial dilution was continued until 10⁶ dilution was obtained (Cheesbrough, 2006). Aliquot portion (0.1 ml) of the 10⁶ and 10⁵ dilutions were inoculated onto freshly prepared, surface-dried nutrient agar (NA) and MacConkey agar (MCA) respectively. The same quantity (0.1 ml) of the 10⁴ dilution was inoculated onto Potato Dextrose Agar (PDA). The inoculi were spread with a sterile (hockey stick-like) glass spreader to obtain even distribution of isolates after incubation. Nutrient agar and MacConkey agar plates were incubated for 24-48 h at 37°C, while PDA plate was incubated at ambient temperature (28±0.2°C) for 3-5 days (Cheesbrough, 2006). Total plate counts for the nutrient and MacConkey Agar were done by counting colonies at the reverse side of the culture plates. Total colony count was expressed in colony forming units per millilitre (cfu ml⁻¹) (Harrigan and McCance, 1990). Plate counts for PDA plates was done using colony counter for the yeasts and hand lens for moulds (Harrigan and McCance, 1990).

Sensory Evaluation
The sensory analysis was conducted at the Dietetics laboratory of the Department of Human Nutrition, University of Ibadan, Ibadan, Nigeria between 12:00 noon and 3:00 pm. Thirty (30) untrained panelists who were students, and non-smokers evaluated the samples for appearance, aroma, taste, consistency and overall acceptability on a 9-point hedonic scale (like extremely-9, like very much-8, like moderately-7, like slightly-6, neither like nor dislike-5, dislike slightly-4, dislike moderately-3, dislike very much-2, dislike extremely-1) (Iwe, 2010). The order of presentation of samples to the panel was randomized. Bottle water was given to the panelists to rinse their mouths between evaluations.

Statistical Analysis
Data on three replicates of each parameter from the chemical analysis were analysed using independent T-test and sensory evaluation was analysed using one-way ANOVA. All statistical analyses were conducted using Statistical Package for Social Sciences (SPSS) version 20.0 (SPSS Inc., Chicago, IL USA) at 5% of significance.

RESULTS AND DISCUSSION
Proximate Composition of Tiger Nut, Date and Ginger Blended Beverage
The proximate composition of the blended beverage samples is presented in Table 1. The moisture content significantly increased with decreasing content of tiger nut from 80.33 g 100 g⁻¹ in 100% tiger nut beverage to 84.78g 100 g⁻¹ in 55:30:15 tiger nut/date/ginger blend. Quantitatively, the high...
moisture content reflects a characteristic quality of a typical beverage for thirst quenching and agrees with previously reported range of moisture content in tiger nut milk and chocolate beverage (Akande and Okunola, 2011; Okyere and Odamten, 2014). This suggests reduced storage quality (shelf life) and increased likelihood of microbial contamination and consequently the safety of the product. High moisture content has been shown to be indicative of poorer shelf life and stability of a product (Akande and Okunola, 2011).

The protein content of the beverage decreased with decreasing composition of tiger nut. Protein content was 0.80 g 100 g⁻¹ in 100% tiger nut beverage, 0.75 g 100 g⁻¹ in 85:10:5 (tiger nut/date/ginger) blend, 0.72 g 100 g⁻¹ in 70:20:10 blend and 0.71 g 100 g⁻¹ in 55:30:15 blend. The protein content of the blend in this study was low compared with protein range of 1.2-2.3 g 100 g⁻¹ in tiger nut beverage (Ukwuru and Ogbodo, 2011) compared with protein range of 1.2-2.3 g 100 g⁻¹ in 55:30:15 blend. The ash content of the blend suggests the potential of the blend in the prevention and management of weight, diabetes and diverticulosis (Beniwal, 2004; Borges et al., 2008). Fibers also possess the potential to function as prebiotic and thereby promote gut microflora (Singla and Chakkaravarthi, 2017) and enhance nutritional and texturizing properties of beverage (Yilmaz-Akuz et al., 2019). The ash content of the blend increased with increasing composition of dates and ginger from 0.34 g 100 g⁻¹ in 100% tiger nut blend to 0.44 g 100 g⁻¹ in 55:30:15 blend. The ash content in this study was within the standard limit of < 5% (SON) as reported by Adedokun et al. (2014), though lower than 1.5% reported by Ukwuru et al. (2011) and 0.85-0.97 g 100 g⁻¹ in tiger nut/Vigna-racemosa blend (Folashade et al., 2017).

The increasing ash content is a reflection of the improving rheological properties and the nutritional quality of the blends in terms of mineral composition (Schuck et al., 2012). The carbohydrate content and the metabolizable energy of the blends decreased with increasing dates and ginger composition from 13.63 g 100 g⁻¹ and 101.51 kCal in 100% tiger nut blend to 12.17 g 100 g⁻¹ and 78.20 kCal in 55:30:15 blend. Carbohydrate content in the present study is higher than reported by Musa and Hamza (2013), but lower compared to report of Ukwuru and Ogbodo (2011). The variations in the composition could be attributed to the difference in the cultivar of tiger nut and the soil properties which also affect the nutritional composition of the cultivated crops. The decline in the metabolizable energy content of the samples may be attributed to the decline in the carbohydrate and fat content of the blends.

Micronutrient Composition of Tiger Nut, Date and Ginger Blends

The minerals and vitamins composition of the blends is as shown in Table 2. The calcium (3.26-6.79 mg 100 g⁻¹) and manganese (0.45-0.46 mg 100 g⁻¹) composition increased in blended samples compared to 1.07 mg/100g and 0.43 mg 100 g⁻¹ in 100% tiger nut beverage, respectively. The sodium (1.95-2.66 mg 100 g⁻¹), iron (6.88-8.38 mg 100 g⁻¹), beta-carotene (21.90-27.67μg 100 g⁻¹), ascorbic acid (4.73-7.35 mg 100 g⁻¹) and tocopherol content (9.26-12.79 mg 100 g⁻¹) increased with increasing tiger nut composition as compared to 4.15 mg 100 g⁻¹, 9.26 mg 100 g⁻¹, 28.45 μg 100 g⁻¹, 8.40 mg 100 g⁻¹, and 15.31 mg 100 g⁻¹ in 100% tiger nut beverage, respectively. The increasing calcium level is of public health importance in Nigeria where dietary

### Table 1: Proximate composition of tiger nut, date and ginger blended beverage (g 100 g⁻¹)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>100:0:0</th>
<th>85:10:5</th>
<th>70:20:10</th>
<th>55:30:15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>80.3±0.01</td>
<td>83.7±0.02</td>
<td>84.4±0.04</td>
<td>84.7±0.04</td>
</tr>
<tr>
<td>Crude protein</td>
<td>0.8±0.02</td>
<td>0.75±0.02</td>
<td>0.72±0.02</td>
<td>0.71±0.02</td>
</tr>
<tr>
<td>Crude fat</td>
<td>4.9±0.02</td>
<td>4.9±0.13</td>
<td>3.8±0.02</td>
<td>2.9±0.01</td>
</tr>
<tr>
<td>Crude fibre</td>
<td>0.2±0.01</td>
<td>1.4±0.00</td>
<td>0.78±0.01</td>
<td>1.6±0.01</td>
</tr>
<tr>
<td>Ash</td>
<td>0.3±0.01</td>
<td>0.39±0.01</td>
<td>0.39±0.01</td>
<td>0.4±0.01</td>
</tr>
<tr>
<td>Carbohydrate</td>
<td>13.6±0.01</td>
<td>9.1±0.04</td>
<td>10.6±0.05</td>
<td>12.1±0.01</td>
</tr>
<tr>
<td>ME (kCal 100 ml⁻¹)</td>
<td>101.5±1.1</td>
<td>84.0±0.12</td>
<td>78.2±0.11</td>
<td>78.2±0.11</td>
</tr>
</tbody>
</table>

Values with the same superscript on the same row are not significantly different (p > 0.05). Values are means of three determinations ± standard deviation (n = 3). *Carbohydrate was obtained by difference ME - metabolizable energy.
intake of calcium is largely inadequate and dairy intake is limited due to high cost. The calcium content in the blends is similar to 2.8-6.3 mg 100 g⁻¹ found in Vigna-racemosa fortified tiger nut beverage (Folashade et al., 2017) and 5.44-7.35 mg 100 g⁻¹ in calcium-fortified tiger nut beverage (Abulude et al., 2006). Adequate intake of calcium is good for bone health (Sale and Elliott-Sale, 2019) and regulation of blood cholesterol level and blood pressure (Sale and Elliott-Sale, 2019) and regulation of intake of calcium thereby limiting their absorption. Phytates for example decrease the bioavailability of calcium, magnesium, iron and phosphorus (Anuonye et al., 2012). Tannins are water soluble polyphenols found in the seed coats of many foods (Onwuka, 2005) and could leach out during soaking and hinder nutrients bioavailability, however, tannin is not detectable in tiger nut beverage blends. High levels of phytates in human nutrition are toxic and limits the bioavailability of calcium, magnesium, iron and phosphorus by the formation of insoluble compounds with the minerals (Aletor and Odomara, 1994). The microbial load of tiger nut, date and ginger blended beverage (cfu ml⁻¹) in ambient and refrigerated storage condition is shown (Table 4). The numbers of microorganisms present both in ambient and refrigerated conditions increased with duration of storage. All ambient-stored samples had high numbers of micro-flora in them. Highest bacteria load (26.0 × 10⁵ cfu ml⁻¹) occurred in 100% tiger nut blend and lowest microbial load (4.0 × 10³ cfu ml⁻¹) in 55:30:15 blend. This suggests that the tiger nut, dates and ginger blends possibly benefitted from the high phenolic composition of dates and consequently enhanced antimicrobial properties (El-Hadrami and Al-Khayri, 2012) and the inhibitory effect of spices (ginger juice) towards micro-organisms.

The microbial count is not surprising following the high moisture content of the blend and also suggests that inclusion of dates and ginger improves its safety for consumption. Badau (2007) reported that addition of black pepper (Piper guineense) and hot pepper (Capsicum frutescens) did not affect the microbial count of tiger nut milk. In this study, total bacteria count reduced with increasing dates and ginger composition for storage conditions.

### Table 2: Micro-nutrient content of tiger nut, date and ginger blended beverage

<table>
<thead>
<tr>
<th>Parameter</th>
<th>100:0:0</th>
<th>85:10:5</th>
<th>70:20:10</th>
<th>55:30:15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium (mg 100 g⁻¹)</td>
<td>1.07±0.04a</td>
<td>3.26±0.0b</td>
<td>3.72±0.03c</td>
<td>6.79±0.01d</td>
</tr>
<tr>
<td>Potassium (mg 100 g⁻¹)</td>
<td>211.03±0.78a</td>
<td>184.98±0.59b</td>
<td>164.84±0.30c</td>
<td>259.27±0.13d</td>
</tr>
<tr>
<td>Magnesium (mg 100 g⁻¹)</td>
<td>6.46±0.04a</td>
<td>8.53±0.04b</td>
<td>4.25±0.01c</td>
<td>8.32±0.04d</td>
</tr>
<tr>
<td>Sodium (mg 100 g⁻¹)</td>
<td>4.15±0.04a</td>
<td>2.66±0.06b</td>
<td>1.97±0.06b</td>
<td>1.95±0.13c</td>
</tr>
<tr>
<td>Manganese (mg 100 g⁻¹)</td>
<td>0.43±0.04a</td>
<td>0.45±0.03b</td>
<td>0.49±0.02c</td>
<td>0.46±0.02c</td>
</tr>
<tr>
<td>Phosphorus (mg 100 g⁻¹)</td>
<td>46.54±0.07a</td>
<td>45.23±0.25b</td>
<td>43.86±0.09b</td>
<td>47.10±0.23a</td>
</tr>
<tr>
<td>Iron (mg 100 g⁻¹)</td>
<td>9.26±0.07a</td>
<td>8.38±0.04b</td>
<td>7.26±0.03b</td>
<td>6.88±0.03a</td>
</tr>
<tr>
<td>Copper (mg 100 g⁻¹)</td>
<td>0.03±0.01a</td>
<td>0.02±0.00b</td>
<td>0.03±0.00b</td>
<td>0.03±0.01a</td>
</tr>
<tr>
<td>Beta-Carotene (mg 100 g⁻¹)</td>
<td>28.45±0.02a</td>
<td>27.67±0.02b</td>
<td>21.90±0.02a</td>
<td>23.74±0.03a</td>
</tr>
<tr>
<td>Thiamin (mg 100 g⁻¹)</td>
<td>0.68±0.01a</td>
<td>0.58±0.03b</td>
<td>0.30±0.02c</td>
<td>0.35±0.02d</td>
</tr>
<tr>
<td>Niacin (mg 100 g⁻¹)</td>
<td>0.17±0.01a</td>
<td>0.14±0.01b</td>
<td>0.08±0.01c</td>
<td>0.10±0.01d</td>
</tr>
<tr>
<td>Ascorbic Acid (mg 100 g⁻¹)</td>
<td>8.40±0.14a</td>
<td>7.35±0.14b</td>
<td>4.75±0.17c</td>
<td>4.73±0.21c</td>
</tr>
<tr>
<td>Tocopherol (mg 100 g⁻¹)</td>
<td>15.31±0.03a</td>
<td>1.72±0.03a</td>
<td>7.20±0.02a</td>
<td>9.26±0.02a</td>
</tr>
</tbody>
</table>

Values with the same superscript on the same row are not significantly different (p > 0.05). Values are means of three determinations ± standard deviation (n = 3)

### Table 3: Anti-nutrient composition of tiger nut, date and ginger blended beverage (g 100 g⁻¹)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>100:0:0</th>
<th>85:10:5</th>
<th>70:20:10</th>
<th>55:30:15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saponin</td>
<td>0.05±0.00a</td>
<td>0.04±0.00b</td>
<td>0.01±0.00c</td>
<td>0.02±0.00d</td>
</tr>
<tr>
<td>Phytate</td>
<td>0.01±0.00a</td>
<td>0.01±0.00a</td>
<td>0.00±0.00a</td>
<td>0.00±0.00a</td>
</tr>
<tr>
<td>Oxalate</td>
<td>0.01±0.00a</td>
<td>0.00±0.00a</td>
<td>0.00±0.00a</td>
<td>0.00±0.00a</td>
</tr>
<tr>
<td>Tannin</td>
<td>0.00±0.00a</td>
<td>0.00±0.00a</td>
<td>0.00±0.00a</td>
<td>0.00±0.00a</td>
</tr>
</tbody>
</table>

Values with the same superscript on the same row are not significantly different (p > 0.05). Values are means of three determinations ± standard deviation (n = 3)
up to 10 days, this shows that dates and ginger combination may be useful in improving the shelf life of tiger nut milk. Ajayi and Oyetayo (2009) reported that moisture content encouraged growth of microorganisms and food spoilage. In this study, the rate of spoilage is faster at ambient temperature and the shelf life of products is limited. Refrigeration reduced the growth of bacteria and yeast and prevented the growth of coli forms up to day 15 of storage. The lower the temperature, the slower the chemical reactions, enzyme actions and microbial growth (Essuman, 1990). This suggests the need to ensure safe environment for the preparation, storage and vending of tiger nut, dates and ginger blends. The increasing practice of tiger nut beverage vending therefore needs to be regulated and minimum benchmark must be created for the vendors including availability of a cooling devices for safe keeping of the beverage.

**Sensory Properties of Tiger Nut, Date and Ginger Blends**

The sensory properties of the blends are as indicated in Table 5. There was no significant difference in the appearance of the blends with highest being 6.63 in 85:10:5 blend and lowest (6.40) in 55:30:15 blend. The aroma of the blend increased from 4.93 in 100% tiger nut blend to 6.40 in 55:30:15 blend. Taste also improves with increasing substitution from 4.70 in 100% tiger nut blend to 7.20 in 55:30:15 blend. Similar improvement was observed for consistency and general acceptability from 5.93 to 6.90 and 5.27 to 7.17, respectively.

The improving sensory properties with increasing tiger nut substitution level shows likelihood of acceptability of the blend by the tiger nut beverage consumers. The general acceptability of the blends is promising for commercialization of the blends and conforms with reports on orange-tiger nut beverage (Ukwuru et al., 2011). Increasing taste could be attributed to the sweetening properties of date palm fruits (El Hadrami and Al-Khayri, 2012) and higher aroma and general acceptability could be a result of satiety and flavor associated with ginger (Mansour et al., 2012).

**CONCLUSION**

Date and ginger substitution enhance fibre, ash, carbohydrate, calcium, and manganese composition, and sensory properties of tiger nut beverage; and inhibit bacteria and yeast growth. Tiger nut, date and ginger blends are generally acceptable to consumers and considered safe up to day 10 when refrigerated. The 55:30:15 blend of tiger nut, dates and ginger is hereby recommended for consumption following higher calcium, potassium, beta-carotene, and tocopherol content and higher sensory acceptability. The iron and protein content of the blends reduce with increasing substitution; hence the inclusion of iron- and protein rich crops is recommended for subsequent formulations. This approach has the potential to increase the micronutrient intakes and strengthen the food system to promote adequate nutrition.

**ACKNOWLEDGEMENT**

The authors are grateful to the panelists and the laboratory staff that did the analyses. We thank also the Department of Human Nutrition, University of Ibadan for continued support and protected time given for the use of the Dietetic Kitchen and the Laboratory during this study.

**Authors' Contributions**

All the authors participated in the conceptualization of the study, Ariyo and Adetutu developed the methodology. Keshinro and Ariyo validated the methodology. Adetutu conducted the sample selection, preparation and analysis under the supervision of Ariyo. Keshinro and Ariyo supervised the entire activities. Adetutu prepared the first draft, Ariyo reviewed and edited. Final manuscript was read and approved by Keshinro.
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