***Original Research Article***

**COMPREHENSIVE EVALUATION OF NUTRITIONAL, PHYTOCHEMICAL, AND FUNCTIONAL PROPERTIES OF WATERMELON-TIGER NUT JUICE BLENDS**

**ABSTRACT**

The present study was aimed at assessing the physicochemical properties, phytochemical composition, antioxidants activity, and sensory quality of ready-to-serve beverage produced from blends of watermelon and tiger nut juices. Watermelon and tiger nut were separately processed into juices blended at the ratios of 50:50, 60:40,70:30, 80:20,90:10, 100:0 and 0:100 (tiger nut: watermelon juice). The blended juices were separately pasteurized at 72°C for 15 min, cooled, filled into sterile glass bottles, labeled and stored at 4°C then subjected to the various analyses. The results revealed that all the blends in ratio had high amount of moisture from (65.82-69.11); protein (9.46-18.36); fat (3.7-7.08); ash (0.15-0.50) and carbohydrate (7.76-16.6). The mineral results reveal blends were significantly high in in magnesium, calcium and potassium but have lower value of phosphorus and zinc. The pH of the blends reveals that the blends has a shelf life with a range from 5.30 to 5.87, it’s also has a high value of total soluble solids and total titratable acid with a range of 10.35- 15.80 and 0.46 to.87 respectively. The phytochemical results reveal that all blends are rich in phenol and carotenoids which are abundant in water melon and increases in the blend because of the increasing ratio of water melon in each blend and are lower in flavonoids. The sensory evaluation results reveal that the entire blend is acceptable in taste, color, consistency, flavors and can be consumed but the blends that is generally acceptable by all and has the highest value is the 50:50% blends. From the result obtained the water melon has a very high value of vitamin C which is incorporated to each blend in different ratio that increases the vitamin C in each of the blends. Tiger nut has the highest values of DPPH and FRAP. At the end of the research it’s recommended that further work should be carried out on the antioxidant properties, medicinal properties and storage stability of the beverage to determine shelf life.

**Keywords:** Proximate composition, physicochemical properties, antioxidant activity, Watermelon, kunu aya milk, Phytochemicals

1. **INTRODUCTION**

“Tiger-nut milk, popularly known in the Northern part of Nigeria as ‘Kunu aya’ is one of the indigenous, locally fermented, non-alcoholic beverage drinks that are widely consumed for its thirst quenching and nutritive properties” [1]. “Even though, it is being consumed throughout the year, its extensive consumption is known to be during the dry season” [2]. “It is locally prepared by washing the tiger-nut thoroughly in order to remove soil and dirt. Once they are washed, the nuts are then soaked for about 4 - 8 hours, after which they can be ground along with coconut, date fruit or pineapple into a mash. During the process, some cold water is added in a ratio of 3 liters of water for unit kilogram of tiger nut and the mixture is left to macerate. When the appropriate time is spent, it is pressed and sieved and then known quantity of sugar or honey can be added depending on the volume obtained.

The mixture is then filtered again to get the pure filtrate. Once this is done, it is often served cold” [3]. “Significant variations exist in the procedures depending on the desired taste and cultural habits that leads to differences in quality and stability. While some cultures prefer ‘Kunu aya’ with different fruit flavours, others prefer it with no sugar” [4]. “It is usually packaged and sold in a 1litre and 500ml plastic bottles. Tiger-nut milk or ‘Kunu aya’ must be consumed within 2 - 24 hours at 40oC – 65oC due to its poor shelf life” [1]. “This drink is very cheap because the tiger nuts and additives used in its production are easily and locally sourced. The packaging materials are also cheap and available.

Furthermore, the methods of production are simple and cheap as no elaborate equipment and expertise are required” [3]. “The preparation of this beverage has become a technology in many homes particularly in rural communities and more recently in the urban areas where more women have developed the skill and commercial production which has helped to alleviate poverty amongst the people. However, the high-water content coupled with crude methods of production and packaging under improper sanitary conditions predisposes ‘Kunu aya’ to microbial contamination. A large number of lactic acid bacteria, coliforms, molds and yeast have been reportedly implicated in food spoilage as they use the carbohydrate content for undesirable fermentation processes” [5]. “Tiger-nuts have long been recognized for their health benefit as they have a high content of soluble glucose and oleic acid along with high energy content (starch, fats, sugar and proteins). This nut produces high quality oil of up to about 25.5% content and about 8% of protein. The nut is high in oil content and is valued for the nutritious starch content, dietary fiber and carbohydrates” [6]. “Tiger-nut is also an excellent source of some useful minerals such as iron and calcium which are essential for body growth and development” [7]. “They also contain other mineral elements such as phosphorus, potassium sodium, magnesium, zinc and traces of copper and vitamins E and C” [7]. “It is believed that they help to prevent heart attacks, thrombosis and cancers, especially of the colon” [6]. “They are thought to be beneficial to diabetic patients (if sugar-free) and those seeking to reduce cholesterol or lose weight” [7].

“It was reported that tiger-nut is high in dietary fiber content, which could be effective in the treatment and prevention of many diseases including colon cancer, coronary heart diseases, obesity, diabetics and gastro intestinal disorders. Its tubers are also use as an aphrodisiac, carminative, diuretic and a stimulant” [8]. “Tiger-nuts have been reported to be used in the treatment of flatulence, indigestion, diarrhea and dysentery” [27]. “In addition, tigernut has been demonstrated to contain higher essential amino acids than those proposed in the protein standard by the FAO/WHO in 1985 for satisfying adult needs” [9]. However, kunu aya is low in essential vitamins, minerals and phytochemicals, which could be obtained by fortifying it with good sources of these constituents. Fruit juices have been used to achieve this purpose in many beverages. However, watermelon juice has not been evaluated for these reasons in kunu aya.

“Watermelon (*Citrullus lanatus*) belongs to the *Cucurbitaceae* family and is cultivated in almost all warm regions of the world. It can exist in different colors such as red, orange and yellow depending on the lycopene and β-carotene contents. To date, watermelon has been viewed as a non-nutritional crop, but in recent years, several bioactive compounds have been determined and the beneficial effects have been demonstrated by *in vivo* and *in vitro* studies” [10]. “Watermelon contains phenolics, which are mainly hydroxycinnamic acid derivatives and a large amount of lycopene giving its characteristic red color and powerful antioxidant activity. Watermelon juice is gaining popularity in recent years due to its sensorial, physical, and nutritional characteristics. Due to its pleasant flavor, watermelon juice is also used in alcoholic cocktail beverages.” [11] indicated that 85.3% of watermelon is consumed in the home in the United State. “It is used as a dessert fruit and a thirst quencher and in the very dry parts of Africa, it is relished by both man and his animals as a source of water” [28].

Therefore the objective of this study was to determine the quality of kunu-aya incorporated in Water melon juice

1. **MATERIAL AND METHODS**

### Material procurement

Big yellow tiger nut (the most commonly used for preparation of tiger nut milk), ginger, cloves, coconut, sugar and dates were obtained from Old Market in Wukari, Taraba State, Nigeria. The nuts were taken to the laboratory in a clean polythene bag for processing and analysis. The raw materials were stored in prior to analysis .

**Table 1: Experimental Design**

**Table 1: Formulation (%) of kunun aya and watermelon juice blends**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Kunun aya (KA)** |  | **Watermelon Juice (WM)** |
|  | 100 |  | 0 |
|  | 090 |  | 10010 |
|  | 80 |  | 20 |
|  | 70 |  | 30 |
|  | 60 |  | 40 |
|  | 50 |  | 50 |

###

### Preparation of kunu aya

Tiger nuts were sorted to remove broken, rotten, stones, pebbles, and other dirt materials before rinsing in water to remove adhering soils. Other ingredients used in the milk preparation (coconut, date, cinnamon and ginger) were also processed before used. The shell of the coconut was removed using knife and the water was discarded. The coconut flesh was cut into smaller pieces. The seed of the date was removed and discarded. These entire ingredients were thoroughly washed using warm water.

One kilogram (1 kg) of tiger nuts was soaked in 3 liters of boiled water at 60oC for 6 hours according to modified method of [12]. After washing, the nut was mixed with 300 g of coconut, 150 g of date, 15 g of ginger and 3 g cinnamon, and the mixture was blended with 6 L of cooled boiled water several times into slurry with engine moteur (GX 160). The slurry was pressed using muslin cloth to extract the milk. To the extracted milk, 60 g of refined sugar was added. The extracted milk was transferred into sterile containers and stored in a refrigerator prior to use.

**Preparation of watermelon juice**

The watermelon fruits were washed with saline (30%), and allowed to dry. The fruits were then cut with a sharp sterile kitchen knife and the seeds removed. The edible pink portion was cut into small bits for extraction. Juice was extracted from the cut bits using Master chef food processor, JBL, 2102. The extracted juice was then filtered through three fold muslin cloth [13].

### Blending of kunu- aya and water melon juice

The water melon juice was used to substitute 10%,20%,30%,40%, and 50% of kunu- aya in a food blender that was operated of full speed at 10min. The 100% kunu-aya served as control. The samples were packaged in plastic bottles and stored in a refrigerator (10 oC) prior to use.

**Analytical methods**

**Determination of pH, total titritable acidity andtotal soluble solids of the blends**

The pH, total titratable acidity and total soluble solids of the samples were determined using the methods described by [14]. For the determination of pH, the pH meter was standardized using buffer solutions of pH 4.0 and 9.0. The pH electrode was dipped into the samples (5 ml) and after a few minutes of equilibration, the pH of the samples was measured. The titratable acidity of the samples was measured by direct titration where the sample (10 ml) was pipetted into each of the two beakers labeled C and S. To the color control beaker, 1ml of rosanilline solution was added and stirred. To sample beaker S, 1ml of phenolphthalein indicator was added and titrated with 0.1m NaOH, with continuous stirring until the color matched the pink color of beaker C. The total titratable acidity was then calculated using the formula:

Total soluble solids of the samples was determined in 3 replicates using a hand Refractometer and the results was expressed in oBrix

**Proximate Analysis of Blends**

The proximate compositions of the samples (moisture, ash, fiber, protein, and carbohydrate and energy value) were determined using the methods of [14].

**Determination of mineral composition of blends**

Calcium, Magnesium, Zinc, Phosphorus, Sodium and Potassuim contents were determined using Atomic Absorption Spectrophotometer (AAS) while Potassium was determined using flame photometry [14].

**Determination of vitamin C contents of blends**

The method of AOAC [14] was used to determine the vitamin C contentlculated

**Determination of phytochemical composition of blends**

The proximate compositions of the soup samples the total phenol, flavonoids, and carotenoids contents were determined using the method of [14].

**Determination of antioxidants**

The antioxidant activity of blends was determined using the DPPH scavenging system and the FRAP assay. For DPPH, a stock solution was prepared and mixed with methanol to achieve an absorbance of 0.70±0.01 at 516 nm. Samples were left overnight for the scavenging reaction. The FRAP assay involved mixing acetate buffer, TPTZ, and FeCl3.6H2O, and measuring the absorbance change at 593 nm after incubation. Results were expressed as mg of Trolox equivalent per gram of sample. [14].

**Sensory Evaluation of the yogurt and watermelon juice Blends**

A 9 -point Hedonic scale, where 9 is “like extremely” and 1 is “dislike extremely”, as described by [15] was used to evaluate the sensory properties of the yoghurt supplemented samples. A 15 - trained panel consisting of students and staff from the Department of Food Science and Technology, Federal University Wukari, Taraba State was used for the evaluation. The panelists were asked to evaluate the samples for flavor, color, taste, texture and overall acceptability on 9-point Hedonic scale. The samples were presented in 3-digit coded white glass cups. The order of presentation of the samples to the panelists was randomized. The sensory evaluation was carried out in sensory evaluation laboratory under adequate ventilation and lighting. Portable water was presented to the panelists to rinse their mouths in between evaluations.

**Statistical Analysis**

The study was carried out in completely randomized design All Analyses were carried out in 3 replicates. The data obtained were subjected to analysis of variance (ANOVA) using the Statistical Package for Social Sciences (SPSS) version 17.0. Means separation was done by Duncam Multiple range test (DMRT). Significance was acceptable at p<0.05.

## RESULT AND DISCUSSION

The physicochemical properties of the samples are presented in Table 2. The total titratable acidity (TTA) of the samples ranged from 0.46 – 0.87 %. The 100% watermelon juice had the lowest TTA. This is associated to the amount of Kunu aya that was supplemented with watermelon. The 50:50 blend has the highest amount of Kunu aya proportion. Studies made by [16] showed that the pH values of kunu aya samples ranged between 4.62 and 6.62. The TTA values of kunu aya samples ranged between 1.3 and 2.4%. The pH and TTA values obtained from this study differed from the findings reported by [1] who obtained pH 3.9 to 4.1 and TTA 0.5 to 0.75. The pH value of kunu aya decreased with increased acidity (TTA). The pH ranged of 5.5 – 5.8 There were significant differences (p>0.05) between the entire blends in the PH. The Blend 50:50 had the lowest pH, which indicated its high level of acidity as compared to other samples. “The pH and titratable acidity are inversely proportional to each other. The blends with the lowest pH value had the highest titratable acidity and vice versa. The pH of the beverage decreased while the titratable acidity increased with increase in the proportion of watermelon juice in the blends. This is attributed partly to the inherent acid naturally present in watermelon fruit” According to [17], “watermelon juice is acidic of which 87% is tartaric and 13% is malic acid. Similar decrease in pH of mixed juices with increasing concentration of watermelon juice had been reported by other authors” [18]. “Increase in juice acidity with higher level of watermelon juice incorporation could protect the beverage from the development of food spoilage organisms which would lead to increase shelf-life of the product. The acid influences the flavor, brightness of color, stability, consistency and keeping quality of the product” [19]. [20] also documented that pH plays a dual role of flavor promotion and preservative in fruit juices and fruit products The low PH, high acidity and sugar content (Table 2) of the jam would ensure good storage stability by inhibition of fungal growth The low pH of the kunu aya is also necessary to prevent alkaline degradation and discoloration during storage. The high level of acidity could be associated to the production. Water melon blend showed the highest pH of 5.8which was water melon juice that was supplemented to other blends increasing their pH level. The TSS of water melon juice and kunu aya were 14.6 and 15.8oBrix, respectively and the values for the blends varied from 10.3 to 13.7oBrix. The soluble solids content is one of the most important quality parameters in food processing. About 55% of soluble solids are sugars, glucose, fructose, and their amount and proportions influence the organoleptic qualities of fruits. High TSS is desirable as it yields high recovery of processed products. TSS as against water melon blend that has the lowest amount. The total soluble solid (TSS) of fruit juice is significantly influenced by the combined effect of stages of maturity and ripening conditions. The content depends mostly on the percentages materials dissolved in water in the juice. Juice blends or beverage with less than 7 are categorized as weak and watery, meaning that the total soluble solids are low. The total soluble solids recorded for the different blends ranged. Physicochemical properties of food are mainly responsible for the final quality of the product and these properties are functions of the product shelf-life.

## Table 2: Physicochemical properties of kunu aya, water melon juice and their blends

|  |  |  |  |
| --- | --- | --- | --- |
|  Sample KA:WM  | Total titratable acidity (%)  | pH  | Total soluble solids(oBrix)  |
|  0:100  | 0.46a±0.06  | 5.89a±0.14  | 10.35a±0.07  |
|  100:0  | 0.64ab±0.17  | 5.57a±0.10  | 14.60c±0.28  |
|  90:10  | 0.61ab±0.14  | 5.46a±0.12  | 15.80f±0.24  |
|  80:20  | 0.87b±0.12  | 5.78a±0.13  | 12.44b±0.30  |
|  70:30  | 0.73ab±0.17  | 5.57a±0.16  | 12.64bc±0.12  |
|  60:40  | 0.74ab±0.17  | 5.30a±0.14  | 13.04c±0.04  |
|  50:50  | 0.77a±0.15  | 5.55a±0.15  | 13.73d±0.16  |

Values are means± standard deviation {SD} of two replicates Means within a column with the superscript were not significantly the same p>0.05

## Proximate composition and energy value of beverages.

The proximate composition and energy values of the samples are presented in Table 3. The result showed high protein, carbohydrates and moisture in all blends. However, the fat and ash contents were very low. This can be ascribed to the effect of heat in concentrating the blends by the reduction of the moisture content. The moisture contents of the all samples ranged from 65.8 – 69.1 with the sample containing 50% having the highest amount of moisture. According to [21], “the bulk of the fresh pulp and rind of *Citrullus lanatus* and *Cucumis sativus* contained high amount of moisture. However, the pulp of these fruits had higher moisture content compared to their rinds. The result was not misnomer since plants in the *Curbitaceae* family have been known to have high amount of water in their fruits. Therefore, consumption of these fruits by humans could serve as a better thirst quencher during hot weather conditions. However, , the high moisture content could account for rapid deterioration of these fruits if left unprocessed for long time. However, there were no significant differences (p<0.05) in moisture between blends of 100% kunu aya, 90:10,60:40 and 100% watermelon juice but there was significant difference between the blends containing20%, 30% and 50% watermelon juice. The protein contents ranged from 9.4 – 18.3. The increased in protein content of the sample containing 50% was as a result of the Kunu aya supplementation with the watermelon juice. There were significant differences (p<0.05) between the blends and the controls. The 100% watermelon juice had the highest ash content, although, there were significant differences (p<0.05) among all of the blends. The fat contents ranged from 3.7 – 7.08% with the 100% kunu aya having the highest fat content. The carbohydrate contents of the samples ranged from 7.76 – 16.6%.The watermelon juice had the highest content of carbohydrate. There were significant differences (p<0.05) between the samples. Carbohydrate is very essential for energy provision to animals and also for the nourishment of plants and animals” [22]. The high carbohydrates content imply that tiger nut are good sources of energy. Therefore, they can play vital roles in the sustenance and nourishment of animal body as carbohydrates are readily hydrolyzed to reducing sugar: a good source of ATP generation.

## Table 3: Proximate composition and energy values of kunu aya, watermelon juice and the blends

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Sample KA:WM | Moisture (%)  | Protein (%) | Ash (%)  | Fat (%) | Carbohydrate(%)  | Energy value(kcal/100g) |
| 0:100  | 67.57ab±1.12  | 9.45a± 0.28  | 0.50b± 0.13  | 4.69b± 0.05  | 16.65c± 0.28  | 146.63b±2.69  |
| 100:0  | 65.82a± 0.22  | 14.58b±0.28  | 0.17a± 0.08  | 7.08c± 0.57  | 12.63b± 0.31  | 179.04b±7.79  |
| 90:10  | 66.06a± 0.31  | 14.06b± 0.03  | 0.20a± 0.08  | 6.84a± 0.53  | 16.25c± 0.28  | 185.76a±6.01  |
| 80:20  | 66.17b± 0.39  | 12.95a± 0.68  | 0.15b± 0.09  | 6.60c± 0.47  | 13.44a± 0.31  | 164.96c±7.87  |
| 70:30  | 66.34b± 0.48  | 13.04c± 0.53  | 0.29a± 0.09  | 6.37c± 0.42  | 13.85b± 0.30  | 164.89c±7.14  |
| 60:40  | 66.52a± 0.57  | 12.53b± 0.29  | 0.30a± 0.10  | 6.56b± 0.37  | 14.24a± 0.30  | 165.96c±5.69  |
| 50:50  | 69.11b± 0.92  | 18.36c± 0.15  | 0.21a± 0.07  | 3.70a± 0.13  | 7.76a± 0.28  | 207.08c±5.05  |

Values are means± standard deviation {SD} of two replicates Means within a column with the superscript were not significantly the same p>0.05

## Mineral composition of beverages

“The mineral compositions of the beverages are presented in Table 4. The beverages contained high amounts of phosphorus, potassium and calcium.” [23] reported that tiger nut tubers and water melon have high calcium, sodium and phosphorus and low magnesium, manganese, iron, zinc and copper mineral contents. “The high values of calcium in the kunu aya, are adequate for bone and teeth development in infants. The presence of other minerals such as iron is highly important because of its requirement for blood formation. Therefore, tiger nut and watermelon juice could be used as supplements for food products to improve its content of Ca” [7]. The phosphorus contents of the all samples ranged from 0.20 – 0.25mg/ml with the watermelon juice sample having the highest amount of phosphorus. However, there were no significant differences (p>0.05) between all blends in phosphorus content. The potassium contents ranged from 9.58 to 10.5mg/ml with the sample contain 10% watermelon juice with highest value. The calcium contents ranged from 3.92 to 4.75mg/ml with the sample containing 10% watermelon juice having the highest. There were significant differences among all the samples. The zinc contents ranged from 0.10 to 0.12mg/ml and there were significant differences (p<0.05) among the samples. The magnesium contents ranged from 7.77 to 8.52mg/ml with kunu aya having the highest value and sample with 50% watermelon juice with the lowest value.

## Table 4: Mineral composition (mg/mL) of kunu aya, watermelon juice and their blends

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Sample KA:WM  | P  | K  | Ca  | Zn  | Mg  |
| 0:100  | 0.25b±0.002  | 10.05b± 0.070  | 4.75c± 0.003  | 0.10b± 0.001  | 8.52c± 0.038  |
| 100;0  | 0.25b± 0.001  | 9.67b± 0.006  | 3.92a± 0.000  | 0.12c± 0.000  | 8.45b± 0.003  |
| 90:10  | 0.25b± 0.002  | 9.70a± 0.012  | 4.54a± 0.000  | 0.12a± 0.000  | 8.46a± 0.007  |
| 80:20  | 0.25a± 0.001  | 9.74a± 0.019  | 4.09b± 0.000  | 0.12c± 0.000  | 8.46a± 0.010  |
| 70:30  | 0.25b± 0.002  | 9.98b± 0.025  | 4.17c± 0.001  | 0.11b± 0.000  | 8.47b± 0.014  |
| 60;40  | 0.25b± 0.002  | 9.82a± 0.032  | 4.25c± 0.001  | 0.11a± 0.000  | 8.48c± 0.017  |
| 50:50  | 0.25b± 0.001 | 9.58a± 0.010 ± | 4.10b± 0.003  | 0.10a± 0.000  | 7.77a 0.003  |

Values are means± standard deviation {SD} of two replicates Means within a column with the superscript were not significantly the same p>0.05

## Phytochemical composition of the beverages

The phytochemical composition of the formulated beverages is presented in Table 5. The samples had high flavonoid, phenolic and carotenoids contents. The flavonoid contents ranged from 0.16 – 0.96 mg/ml . There were no significant differences (p>0.05) between all the blends. The flavonoids contents increased as the level of watermelon juice increased. Watermelon juice is widely used for herbal medicine for anticancer, anti-inflammation, antimicrobials and antimutagenic [18]. The phenol contents also varied, though, not significantly(p>0.05) between watermelon juice and samples containing 10% and 30% watermelon juice. The phenol contents of kunu aya ranged from 0.89- 3.92 mg/ml. There was a high content of phenol in kunu aya, which has anticancer properties and exhibit antiaging and antioxidants activity. The 100% watermelon juice had the highest content of carotenoids which ranged from 3.8 -6.8mg/ml. The values increased with the level of watermelon juice. According to studies, carotenoid helps to produce color pigment in fruits. The high lycopene pigment in watermelon helps the fruits to give its characteristic color. [24] reported that intake of lycopene is associated with decreased risk of various cancers such as breast, colon, stomach, oral cavity, prostate, and lung cancer.

## Table 5: Phytochemical composition (mg/ml) of kunu aya, watermelon juice and the blends

|  |  |  |  |
| --- | --- | --- | --- |
|  Sample KA:WM | Flavonoids  | Phenols  | Carotenoids  |
|  100:0  | 0.16a±0.07  | 0.89a±0.06  | 5.44b±0.02  |
|  0:100  | 0.35a±0.3 | 3.92b±0.72  | 6.89c0.01  |
|  90:10  | 0.96a±0.04  | 3.62a±0.65  | 6.75ac±0.02  |
|  80:20  | 0.31a±0.05  | 3.31b±0.59  | 6.60c±0.01  |
|  70:30  | 0.29a±0.05  | 3.02a±0.52  | 6.42ab±0.01  |
|  60:40  | 0.27ab±0.25  | 2.71b±0.46  | 6.31b±0.02  |
|  50:50  | 0.25ab±0.01  | 3.56b±0.21  | 3.87b±0.02  |

 Values are means± standard deviation {SD} of two replicates Means within a column with the superscript were not significantly the same p>0.05

### Sensory properties of beverages

Mean scores of the sensory attributes of the beverage are presented on Table 6. Sensory evaluation of any food item contributes significantly to its consumer acceptance or rejection. According to [25], “sensory evaluation of food is routinely carried out by Food Scientists to help evaluate the acceptability or otherwise of any new food product. In the present study, the mean sensory scores for colour, taste, aroma and overall acceptability varied with the proportion of the watermelon juice in the blends. Color, taste and aroma are important sensory attributes that affect the acceptability of food products. The result showed that the mean scores by the panelists for color, taste, aroma and overall acceptability varied between the samples. The scores of tastes for the prepared samples ranged from 7.0- 8.26. The watermelon juice had the highest taste score of 8.26 as against the sample containing 10 % watermelon juice that had the least taste score 7.0. Although, there were no significant differences (p>0.05) in taste scores of the between the four blends of 80:20%,60:40%, 50:50% and 90:10%. The scores for color ranged from 7.1– 8.6. Kunu aya had the highest color as against 90:10%. There were significant differences the color scores there were significant difference in the scores for consistency. There were no significant differences (p>0.05) in flavor scores of the blends. However, there were significant differences (p<0.5) between kunu aya and the blends. This was because the kunu aya has a unique flavor associated with its production process. In the study of volatile flavor compound in kunu aya carried out by” [26], they opined that the underlying flavor of dairy products arises principally from the native volatile constituents in tiger nut, influenced by pasteurization, processing and storage. The blend containing 50% watermelon juice had higher score for general acceptability that the other blends. The score for this beverage was comparable to those of watermelon and kunu aya

**Table 6: Sensory properties of kunu aya, watermelon juice and their blends**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | SampleKA:WM | Taste | Color | Consistency | Flavors | General acceptability |
|  | 0:100%  | 8.26b±0.70 | 8.20bc±0.77 | 8.13b±0.63 | 8.20ab±0.67 | 8.40b±0.50 |
|  | 100:0 | 8.20b±0.67 | 8.60b±0.50 | 8.33b±0.81 | 8.20b±0.51 | 8.40b±0.50 |
|  | 90:10 | 7.06a±1.27 | 7.13a±1.35 | 6.53a±1.64 | 7.06a±2.12 | 7.20a±1.37 |
|  | 80:10 | 7.46ab±0.83 | 7.26ab±1.27 | 6.40a±1.29 | 7.06a±1.57 | 7.00a±1.463 |
|  | 70:30 | 7.13b±1.35 | 7.53ab±1.30 | 6.66a±1.39 | 7.20a±2.04 | 7.40a±1.35 |
|  | 60:40 | 7.53ab±1.72 | 7.66abc±1.04 | 6.66a±1.54 | 7.53ab±1.24 | 7.06a±1.75 |
|  | 50:50 | 7.46ab±1.72 | 7.66abc±1.95 | 7.33ab±1.79 | 7.26ab±1.90 | 7.80ab±1.97 |

Values are means± standard deviation {SD} of two replicates Means within a column with the superscript were not significantly the same p>0.05

###

### Vitamin C content and antioxidant properties of beverages

The vitamin C contents and antioxidant activities of the samples are presented in Table 7. The vitamin C content of watermelon juice and kunu aya were 4.57and 1.63mg/ml, respectively. “The vitamin Contents increased with increase in the level of watermelon juice in the blends. Naturally, human being cannot produce vitamin C, so it must be obtained entirely through the diet. Without vitamin C, the bonds holding adjacent collagen molecules together cannot be formed and maintained, and this could lead to poor wound healing, reopening of previously healed wounds, bone and joint aches, bone fractures and improperly formed and loose teeth” [13]. The kunu aya (33.85 %) had higher DPPH value than the watermelon juice (27.15%).The DPPH values decreased with the level of watermelon juice due to additive effect. the FRAP values for the watermelon juice and kunu aya were 1.2 to 3.04 %, respectively with kunu aya having highest value and water melon juice the lowest value.. However, the DPPH and FRAP values of the blends were higher than those of the watermelon juice.

## Table 7: Vitamin C content and antioxidant properties of kunu aya, water melon and the blends

|  |  |  |  |
| --- | --- | --- | --- |
|  Sample KA:WM | Vitamin C (mg/g)  | DPPH %  | FRAP [mg/g]  |
|  0:100  | 4.57b±0.53  | 27.15a±0.23  | 1.22a±0.02  |
|  100:0  | 1.63a±0.00  | 33.85a±4.71  | 3.04b±0.12  |
|  90:10  | 1.87a±0.05  | 33.18ab±4.26  | 2.86b±1.10  |
|  80:20  | 2.22ab±0.10  | 32.51ac±3.81  | 2.68b±0.11  |
|  70:30  | 2.51b±0.16  | 31.84ab±3.36  | 2.50bc±0.09  |
|  60:40  | 3.39b±0.21  | 31.17a±2.92  | 2.31a±0.08  |
|  50:50  | 6.69c±0.39  | 33.59a±3.14  | 3.04b±0.12  |

 Values are means± standard deviation {SD} of two replicates Means within a column with the superscript were not significantly the same p>0.05

### CONCLUSION

The present study has shown that acceptable and safe ready-to-serve beverage of higher protein, fat, carbohydrates and zinc contents than the control sample could be produced by supplementing 50% watermelon juice blend with 50% tiger nut juice. Although the 50% water melon and 50% tiger nut juice incorporated beverages had lower calcium, potassium, magnesium, iron, vitamin C, and beta-carotene contents than the control (100% watermelon and 100% tiger nut blend), the products still contained appreciable level of these constituents that will be beneficial to consumers’ nutrition and health upon consumption. Successful supplementation of watermelon juice blend with tiger nut juice will enhance the utilization of tiger nut that is currently underutilized in Nigeria. The PH, TTA and TSS of the 50% water melon and 50% tiger nut which increases the shelf life of the product over other blends and control It is recommended that further work should be done on antioxidant properties and storage stability of the beverage to determine shelf-life.

**Disclaimer (Artificial intelligence)**

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

# REFERENCES

1. Akoma, O., Elekwa, U. O., Afodunrinbi, A. T., & Onyeukwu, G. C. (2000). Yogurt from coconut and tigernuts. *Journal of Food Technology in Africa*, *5*(4), 132-134.
2. Okafor, T.S., and Nwachukwu, E. (2003). Phytochemical screening of Tiger-nut (*Cyperus esculentus*) of three different varieties. *Journal of Biological sciences*. 81:115 120
3. Musa, A. A., & Hamza, A. (2013). Comparative Analysis Of Locally Prepared ‘Kunun Aya’(Tiger-Nut Milk) Consumed By Students Of Kaduna State University, Kaduna-Nigeria. *Science World Journal*, *8*(2), 13-18.
4. Ndukwe, J. K., Aduba, C. C., Ughamba, K. T., Chukwu, K. O., Eze, C. N., Nwaiwu, O., & Onyeaka, H. (2023). Diet diversification and priming with Kunu: An indigenous probiotic cereal-based non-alcoholic beverage in Nigeria. *Beverages*, *9*(1), 14.
5. Ibrahim, S. A., Ayivi, R. D., Zimmerman, T., Siddiqui, S. A., Altemimi, A. B., Fidan, H., ... & Bakhshayesh, R. V. (2021). Lactic acid bacteria as antimicrobial agents: *Food safety and microbial food spoilage prevention. Foods,* *10*(12), 3131.
6. Bibek, R. (2001). “Fundamental Food Microbiology” (2nd Ed.) The C.R.C Press Ltd Washington D. C. pp 56 – 90
7. Oladele, A. K., & Aina, J. O. (2007). Chemical composition and functional properties of flour produced from two varieties of tigernut (Cyperus esculentus). *African Journal of Biotechnology*, *6*(21).
8. Auta, R., Ahmad, I., Aliyu, J., & Mohammed, L. (2019). Evaluation Of Nutritional Content Of Tiger Nut (Cyperus esculentus). *Confluence Journal of Pure and Applied Science*, *2*(1), 160-167..
9. Belewu, M. A., & Abodunrin, O. A. (2006). Preparation of Kunnu from unexploited rich food source: Tiger nut (Cyperus esculentus). *World Journal of Dairy and Food Sciences*, *1*(1), 19-21.
10. Perkins-Veazie, P., Davis, A., & Collins, J. K. (2012). Watermelon: From dessert to functional food. *Israel Journal of Plant Sciences*, 60(4), 395–402.
11. Lucier, B. and Lin, B.H., (2014). Factors affecting watermelon consumption in the United States, U.S. *Int. J. Food Sci. Technol.* 49, 2083–2091.
12. Djomdi, R.A.E. and Ndjouenkeu, R. (2006). Characteristics of Tiger Nut Tubers and their Performance in the Production of a Milky Milk, *Journal of Food Preservative,* 30:145-163
13. Joseph, B. O., & Akubor, P. I. Production and Quality Evaluation of Yogurt and Watermelon Juice Blends. *European Journal of Nutrition & Food Safety*, *16*(10), 92-101
14. AOAC (2010). *Official Methods of Analysis*, Association of official Analytical Chemists, Washington, D.C., USA. pp 200 -210
15. Ihekoronye, A.I, Ngoddy, P.O, 1985. Integrated food science and technology for the tropics. First edition. *Macmillian Education Ltd,* London
16. Adgidzi, E.A. and Abu, J.O. (2014). Effects of processing methods on the quality of yogurt- likeproducts from tigernut (Cyperus Esculentus). *Production Agriculture and Technology Journal,* 10(2): 145-156.
17. Saranyah, K., & Mahendran, T. (2015). Standardization and characterization of value added watermelon juice (Citrullus lanatus) ready-to-serve beverage. *Sri Lanka Journal of Economic Research*, *3*(1).
18. Tucson & Arizona (2003). USGS Weeds in the West project: Status of introduced Plants in Southern Arizona Parks, Factsheets for *Cyperus esculentus* L.
19. Adedeji, A.A., Gachovska, T.K., Ngadi, M.O., & Raghavan, G.S.V. (2006). Effect of Pretreatment on the Drying Characteristics of Okra. *Dry. Tech journal*. 26, 1251–1256.
20. Akhtar, S., Ismail, T., Fraternale, D., & Sestili, P. (2015). Pomegranate peel and peel extracts: Chemistry and food features. *Food Chemistry*, 174, 417-425.
21. Ozioma, P., Davis, A., & Collins, J. K. 2012. Watermelon: From dessert to functional food. *Israel Journal of Plant Sciences*, 60(4), 395–402.
22. Edeoga, H. O., Okwu, D. E., & Mbaebie, B. O. (2005). Phytochemical constituents of some Nigerian medicinal plants. *African journal of biotechnology*, *4*(7), 685-688.
23. Arafat, S. M., Gaafar, A. M., Basuny, A. M., & Nassef, S. L. (2009). Chufa tubers (Cyperus esculentus L.): As a new source of food. *World Applied Sciences Journal*, *7*(2), 151-156.
24. Przybylska, S. (2020). Lycopene–a bioactive carotenoid offering multiple health benefits: a review. *International journal of food science and technology*, *55*(1), 11-32.
25. Dzogbefia, V. P., & Djokoto, D. K. (2006). Comparison of Physico–Chemical and Sensory Characteristics of Pawpaw Juice Extracted with Locally Produced and Commercial Pectin Enzymes. *Journal of Science and Technology (Ghana)*, *26*(3), 59-68.
26. Ankomah, J. (2022). *Effect of microbes and sensory properties on varieties of tiger nut milk* (Doctoral dissertation, University of Education, Winneba).
27. Richard, O. N., & Paul, O. B. (2016). Tiger nuts: A healthier pseudo-nut of all nuts in the tropics. *Int. J. Innov. Res. Multidiscip. Field*, *2*, 307-312.
28. Paris, H. S. (2023). Origin of the Dessert Watermelon. In *The Watermelon Genome* (pp. 1-16). Cham: Springer International Publishing.