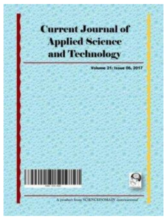

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Formulation and Evaluation of Ready–to–Serve Beverage from Blends of Watermelon, Pineapple and Tiger Nut Juices

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Authors' contributions

This study was carried out in collaboration between authors UEI and USA. Author UEI designed the study. The two authors carried out the experimentation and gathered the initial data. Author USA managed the literature searches. Author UEI performed the statistical analysis, wrote the protocol and the first draft. Both authors read and approved the final manuscript.

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ABSTRACT

Aim: The present study was aimed at assessing the physical properties, nutritional composition, microbial and sensory quality of ready-to-serve beverage produced from blends of watermelon, pineapple and tiger nut juices.
Study Design: Complete randomized design was used.
Place and Duration: Department of Food Science and Technology, University of Uyo, Akwa Ibom State, Nigeria, from October 2017 to April 2018.
Methodology: Watermelon, pineapple and tiger nut were separately processed into juice. The three juices were blended at the ratios of 50:50:00(T_0), 33.33:33.33:33.33(T_1), 50:25:25(T_2), 25:50:25(T_3) and 25:25:50(T_4) (watermelon: pineapple: tiger nut juice). The blended juices were separately pasteurized at 80°C for 15 min, cooled, filled into sterile glass bottles, labeled and stored at 4°C prior to analysis.

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Results: The result revealed that all the parameters except total coliform count varied with the proportion of individual juice in the blends. The pH, total soluble solids and titratable acidity ranged from 5.60 – 5.32, 10.60 – 12.39 ^{o}Brix and 0.32 – 0.58% respectively. The moisture, crude protein, fat, and ash contents of the blends ranged from 87.51 – 89.84%, 0.85 – 1.90%, 0.34 – 1.20% and 0.40 – 0.52% respectively. Incorporation of tiger nut juice significantly (p=.05) increased the protein and fat contents in the beverage. The vitamin C and beta-carotene contents ranged from 21.58 – 36.62 mg/100 mL and 121.05 – 144.00 μg/100 mL respectively. Potassium, calcium, magnesium and zinc contents ranged from 70.39 – 122.38 mg/100 mL, 9.92 – 13.50 mg/100 mL, 8.27 – 18.39 mg/100 mL and 0.47 – 0.55 mg/100 mL respectively. The total viable counts and fungal counts ranged from 0.7 x 10^2 – 1.4 x 10^2 cfu/mL and 0.9 x 10^2 – 1.5 x 10^2cfu/mL respectively. No coliform growth was detected in all the beverages. Mean scores for sensory evaluation showed that samples T_1 and T_3 were the most acceptable samples.

Conclusion: The results showed that acceptable beverage of higher protein content could be produced by supplementing watermelon and pineapple juice blend with 25 to 33.33% of tiger nut juice.

Keywords: Watermelon juice; pineapple juice; tiger nut juice; physical properties; nutritional composition; microbial quality; preference test.

1. INTRODUCTION

Fruits and their juices constitute one of the most important foods for human being. Fruit juices are popular and healthful drinks due to their nutritional value and health promoting properties. Processing of fruits into juice adds economic value to raw fruits and transforms perishable into storable and marketable products [1]. The consumption of natural fresh juices has increased in recent years driven mostly by higher consumer awareness about the importance of choosing healthy foods to reduce the risk of developing diseases such as diabetes and some cancer [2]. According to Hussein et al. [3], fruit juices contain minerals, vitamins and bioactive compounds that are essential to promote healthy life in human beings and they also play an important role in the prevention of many diseases.

In recent years, blends of fruit juices have been extensively marketed due to their unique palatable flavour [4]. Different fruits contain different levels of nutrients and health promoting bioactive compounds. Development of new product where two or more kinds of fruits are blended to obtain a product that combines the nutritional value of the blended fruits with the benefit of a pleasant taste has been well accepted by consumers [5,6]. As some varieties of fruits used for juice production may not have favourable characteristics such as colour, flavour and mouth feel, the blending of fruit juices could be an economic requisite to utilize such fruits profitably.

Watermelon (*Citrusllus lanatus*) is botanically considered as a fruit and belongs to the family Cucubitaceae [7]. Watermelon is a tropical fruit which grows in almost all parts of Africa and South East Asia [8]. In Nigeria, it is abundantly grown in the Northern part of the country. It is a highly nutritious fruit and greatly appreciated by many consumers because of its palatable taste and delightful colour. The fruits are very juicy with a moisture content of over 90% [9]. Watermelons contain a large amount of beta-carotene and are rich source of lycopene which are strong antioxidants [10,11]. They are also a rich source of vitamin C, which is an essential ingredient for collagen synthesis and also protecting the body against oxidative damage [12]. In Nigeria, watermelon juice, as a beverage, is mostly found as an over-the-counter drink made from the pink flesh of watermelon fruit.

Pineapple (*Ananas comosus*) belongs to the family Bromeliaceae and is one of the most popular tropical non-citrus fruits because of its attractive aroma and refreshing flavour. It is a wonderful fruit having exceptional juiciness, vibrant flavour and immense health benefits [13]. It is known as the queen of fruits due to its excellent flavour and taste [14]. The pineapple fruits are normally eaten fresh or as fresh pineapple juice. It can be processed into other products such as nectar, squash, and jelly [15]. The juice is widely consumed by both adult and children. Pineapple is a good source of vitamin C which is an effective antioxidant [13]. Pineapple contains considerable amount of calcium, potassium, magnesium and manganese among other minerals [16].

Tiger nut (*Cyperus esculentus*) is an edible perennial grass-like plant that is abundantly cultivated in the northern part of Nigeria. Tiger nut is cultivated for its small tuberous rhizomes which are eaten raw, roasted or processed into refreshing milk which is very nutritive and healthy for consumption. The tiger nut is rich in energy giving constituents (starch, fat, sugar and protein), minerals (especially potassium and phosphorus) and vitamins E and C [17]. According to Chinma et al. [18], the nut is rich in sucrose (17.4 – 20.0%), fat (25.5%) and protein (8.0%). Ojobo and Tempo [19] reported that the protein in tiger nut is of high biological value considering the many essential amino acids it contains. The nut is also high in dietary fibre [18]. Tiger nut has been reported to be a "health" food, since its consumption can help prevent heart disease and thrombosis and is said to activate blood circulation [20,21]. It was also found to assist in reducing the risk of colon cancer [22]. Despite its nutritional and health benefits, tiger nut is under-utilized in Nigeria [20].

Tiger nut contains higher crude protein content (8.0%) [18], relative to the values in watermelon (0.48-0.64%) [9] and pineapple (0.54%) [13]. Therefore, supplementation of watermelon and pineapple juice blend with tiger nut juice would help to boost the protein content in the mix beverage. Fruits contain high moisture, minerals including potassium, calcium, magnesium, iron and zinc and vitamins including vitamins A (as beta-carotene), B_1, B_2 and C [3]. Dietary potassium has been shown to exert a powerful, dose-dependent inhibitory effect on sodium sensitivity [23]. Calcium is essential macronutrient required for strong bones, teeth, muscle and for proper functioning of nerve system [24]. Magnesium is one of the essential minerals required by the body for maintenance of normal muscle and nerve function as well as for keeping a healthy immune system [25]. Zinc on the other hand is a crucial micronutrient needed for the activity of many enzymes, tissue growth and repair, proper immune function, storage and release of insulin, mobilization of vitamin A from the liver and stabilization of cell membranes [26]. Beta-carotene is considered the most important source of pro-vitamin A in carotenoid rich foods [27]. It can be converted to vitamin A in the intestinal mucosa and in the liver at the rate of 12µg of beta- carotene to 1µg of vitamin A [26]. Vitamin A is needed in the body for vision, growth and differentiation of cells [26]. Vitamin C exhibits antioxidant properties in the blood and other body fluid, thus protecting the body from reactive oxygen molecules, maintains the immune system, and aids in the absorption of iron [26].

Juice blending is one of the best methods commonly employed to improve the nutritional and sensory quality of the juice. Since different fruits have different nutritional value and rich antioxidant properties, the production of mixed juice in order to combine all the basic nutrients and vital antioxidants might be an excellent food product for human diet [6,28]. The present study was aimed at assessing the physical properties, nutritional composition, microbial and sensory quality of ready-to-serve beverage produced from blends of watermelon, pineapple and tiger nut juices.

2. MATERIALS AND METHODS

2.1 Source of Samples

Fully matured, ripe and fresh watermelon and pineapple of uniform size and dried tiger nuts with no signs of defect were purchased from Itam market in Uyo metropolis of Akwa Ibom State, Nigeria and transported to the Food Science and Technology Laboratory, University of Uyo, Nigeria for processing and analysis.

2.2 Sample Preparation

2.2.1 Preparation of watermelon juice

The watermelons were processed into juice following the method described by Ijah et al. [29] with slight modification. The watermelons were washed with distilled water to remove dirt and extraneous materials and then washed with 5% hypochlorite solution and rinsed immediately with distilled water. Each watermelon was cut into quarters and the edible fleshly portion (mesocarp) scooped out and cut into small pieces using a sterile stainless steel knife. The cut pieces were transferred into already sterilized blender and blended until sufficient juice was produced. The entire slurry was transferred into a sterile muslin cloth and the particles sieved off. The clear liquid obtained was transferred into clean sterile air tight glass bottles and kept at 4°C for subsequent use.

2.2.2 Preparation of pineapple juice

The pineapple fruits were processed into juice following the method described by Okwori et al. [30]. The ripe pineapple fruits were washed with potable water to remove dirt and adhering materials. They were then washed with 5% hypochlorite solution and rinsed thoroughly with sterile distilled water. They were peeled with sterile stainless steel knife, cut into small pieces (about 5mm thick) and the juice extracted using juice extractor (Philip juice extractor, model HR 2826, China). The extracted juice was filtered through a sterile muslin cloth, filled into clean sterile air tight glass bottles and kept at 4^oC for subsequent use.

2.2.3 Preparation of tiger nut juice

The tiger nuts were processed into juice following the method described by Sa'id et al. [31]. The tiger nuts were sorted to remove foreign materials and nuts with signs of defect and were thoroughly washed in sterile distilled water to remove adhering soil. They were soaked in sterile distilled water for 4h to hydrate at ambient temperature (27^oC), drained and ground to slurry using nut to water ratio of 1:3 (w/v). The homogenous slurry was filtered using a sterile muslin cloth by squeezing until virtually no extract was recovered, filled into air tight sterile glass bottles and kept in at 4^oC for subsequent use.

2.2.4 Formulation of mixed fruit juices

The prepared watermelon, pineapple and tiger nut juices were blended at different ratios as shown on Table 1 and designated as T_0, T_1, T_2, T_3, and T_4. The blend that did not contain tiger nut juice (T_0) served as the control. Each of the juices was pasteurized at 80°C for 15 minutes in a hot water bath, cooled, filled into air tight sterile bottles and stored at 4°C prior to analysis for various parameters.

2.3 Methods of Analysis

2.3.1 Physicochemical properties

The pH of the juice samples was measured using a digital pH meter (JENWAY, PHS – 25, Alibata). Total soluble solid (TSS) was determined using hand-held Refractometer (Atago 2351, Master 53a, USA) and result was reported in "^{o}Brix" [32]. Titratable acidity (TA) was determined by titration of each juice sample against O.IM NaOH to phenolphthalein end point [32]. Moisture, crude protein, fat, ash, beta-carotene and Vitamin C were determined following the methods described in AOAC [32]. The minerals (potassium, calcium, magnesium and zinc) were determined using atomic absorption spectrophotometer (UNICAM Model 939, UK) as described in AOAC [32].

2.3.2 Determination of microbial load

The microbial loads (bacteria (total viable count), coliform and total fungal counts) of the samples were determined using pour plate technique as described by Harrigan [33]. Each sample was serially diluted in sterile distilled water and I mL aliquot was separately subjected to spread – plate count test. Nutrient agar was used for enumeration of bacteria, MacConkey agar was used for the detection of coliform while sabouraud dextrose agar (SDA) was used for the enumeration of fungi (mold and yeast). Plates for total viable count and coliform count were incubated at 37°C for 24 – 48h while plates for total fungal count were incubated at 27°C for 48 – 96h. Colonies developed after incubation time were counted and recorded as colony forming units per milliliter (cfu/mL) of the sample. Each determination was done in triplicates.

2.3.3 Sensory evaluation of the samples

Organoleptic evaluation of the juice samples was done by a panel of twenty semi-trained judges using 9 point hedonic scale ranging from 1 (disliked extremely) to 9 (liked extremely) as described by Ihekoronye and Ngoddy [34]. The samples were coded with three digit random numbers and presented in identical containers. Questionnaire for entering scores and potable water for mouth rinsing between tasting were made available to the panelists. Each sample was rated for colour, taste, aroma and overall acceptability.

Table 1. Formulation of mixed fruit beverages

Samples codes	Blending ratios (%)		
	Watermelon juice	Pineapple juice	Tiger nut juice
T_0	50	50	00
T_1	33.33	33.33	33.33
T_2	50	25	25
T_3	25	50	25
T_4	25	25	50

2.4 Statistical Analysis

Data collected were subjected to Analysis of Variance (ANOVA) using SPSS version 18 statistical package (SPSS, Inc., USA) software. Means were separated using Duncan's Multiple Range Test (DMRT) at *p* = .05.

3. RESULTS

3.1 Physical Properties and Nutritional Composition of Formulated Ready-to-Serve Beverage

The physical properties and nutritional composition of the formulated beverages are presented on Table 2.

The result showed that all the parameters determined varied with the blending ratios of the three juices used in preparing the beverages. The pH of the samples ranged from 4.56 for T_0 (blend of 50% watermelon, 50% pineapple and 0% tiger nut juices) to 5.32 for T_4 (blend of 25% watermelon, 25% pineapple and 50% tiger nut juices). The titratable acidity ranged from 0.32 to 0.58%. There was inverse relationship between the pH of the samples and the titratable acidity.

The total soluble solids varied from 10.60 ^{o}Brix for T_4 to 12.39 ^{o}Brix for T_0. The moisture, crude protein, fat and ash contents in the samples varied from 87.51, 0.85, 0.34 and 0.40% to 89.84, 1.90, 1.20 and 0.52%, respectively. Increase in the percentage of tiger nut juice incorporation in the blends resulted in correspondence increases in crude protein and fat contents in the beverage.

The vitamin C content in the beverage varied from 21.53 mg/100 mL to 36.62 mg/100 mL while beta-carotene content varied from 121.05 μg/100 mL to 144.00 μg/100 mL of the juice. Sample T_0 recorded the highest values for both vitamin C and beta- carotene while sample T_4 recorded the least values. The potassium, calcium, magnesium and zinc contents in the samples varied from 70.39, 9.92, 8.27 and 0.47 mg/100 mL to 122, 13 50, 18.39 and 0.55 mg/ 100 mL respectively. Sample T_0 had the highest contents of potassium, calcium and magnesium but the least content of zinc while the sample (T_4), had the least contents of potassium, calcium and magnesium but the highest content of zinc.

3.2 Microbial Load of the Samples

The result of microbial assessment of the formulated beverages is presented on Table 3. The total viable counts in the ready-to-serve beverages ranged from 0.7×10^2cfu/mL to 1.4×10^2cfu/mL. No coliform was detected in the samples as there was no growth. Total fungal counts in the samples ranged from 0.9×10^2cfu/mL to 1.5×10^2cfu/mL.

Table 2. Physical properties and nutritional composition of formulated ready-to-serve beverage

Parameters	Samples				
	T_0	T_1	T_2	T_3	T_4
pH	$4.56^c \pm 0.01$	$5.07^b \pm 0.00$	$5.10^b \pm 0.06$	$4.75^c \pm 0.01$	$5.32^a \pm 0.00$
TSS (^{o}Brix)	$12.39^a \pm 0.00$	$11.06^c \pm 0.00$	$11.87^b \pm 0.06$	$12.04^b \pm 0.00$	$10.60^d \pm 0.00$
TA (%)	$0.58^a \pm 0.01$	$0.34^c \pm 0.02$	$0.47^b \pm 0.06$	$0.55^b \pm 0.01$	$0.32^c \pm 0.00$
Moisture (%)	$89.84^a \pm 0.06$	$88.65^b \pm 0.04$	$89.46^a \pm 0.06$	$89.37^a \pm 0.08$	$87.51^c \pm 0.01$
Crude protein (%)	$0.85^d \pm 0.15$	$1.73^b \pm 0.00$	$1.64^c \pm 0.06$	$1.58^c \pm 0.20$	$1.90^a \pm 0.14$
Fat (%)	$0.34^c \pm 0.00$	$1.09^a \pm 0.02$	$0.63^b \pm 0.06$	$0.60^b \pm 0.02$	$1.20^a \pm 0.01$
Ash (%)	$0.52^a \pm 0.03$	$0.44^b \pm 0.07$	$0.49^b \pm 0.06$	$0.46^b \pm 0.05$	$0.40^c \pm 0.03$
Vitamin C (mg/100 mL)	$36.62^a \pm 0.14$	$25.06^d \pm 0.12$	$28.73^c \pm 0.06$	$32.10^b \pm 0.13$	$21.58^e \pm 0.13$
Beta-carotene (μg/100 mL)	$144.00^a \pm 0.20$	$124.21^c \pm 0.14$	$138.05^b \pm 0.06$	$126.40^c \pm 0.09$	$121.05^d \pm 0.15$
Potassium (mg/100 mL)	$122.38^a \pm 0.27$	$91.86^c \pm 0.19$	$95.73^c \pm 0.06$	$112.14^b \pm 0.15$	$70.39^d \pm 0.40$
Calcium (mg/100 mL)	$13.50^a \pm 0.32$	$10.34^c \pm 0.55$	$11.48^b \pm 0.06$	$12.61^b \pm 0.10$	$9.92^c \pm 0.09$
Magnesium (mg/100 mL)	$18.39^a \pm 0.06$	$10.59^d \pm 0.13$	$13.04^b \pm 0.06$	$11.89^c \pm 0.24$	$8.27^e \pm 0.62$
Zinc (mg/100 mL)	$0.47^c \pm 0.11$	$0.53^a \pm 0.20$	$0.51^b \pm 0.06$	$0.49^b \pm 0.08$	$0.55^a \pm 0.21$

Values are means ± SD (standard deviation) of triplicate determinations. Means on the same row with different superscripts are significantly different at p = 0.05. T_0 = 50% watermelon juice, 50% pineapple juice and 0% tiger nut juice; T_1 = 33.33% watermelon juice, 33.33% pineapple juice and 33.33% tiger nut juice; T_2 = 50% watermelon juice, 25% pineapple juice and 25% tiger nut juice; T_3 = 25% watermelon juice, 50% pineapple juice and 25% tiger nut juice; T_4 = 25% watermelon juice, 25% pineapple juice and 50% tiger nut juice; TSS= total soluble solids; TA= titratable acidity

3.3 Sensory Evaluation Result

Mean scores of sensory attributes of the beverages evaluated are presented on Table 4. The result showed that the mean scores by the panelists for colour, taste, aroma and overall acceptability varied between the samples. The mean score values for colour and aroma of the blended juice composed of 50% watermelon and 50% pineapple with no tiger nut juice (T_0) were significantly (p = .05) higher than the scores for the other samples. The mean score values for colour, taste, aroma and overall acceptability ranged from 7.01, 7.50, 6.62 and 6.84 to 8.45, 8.15, 8.16 and 8.13 respectively.

4. DISCUSSION

4.1 Physical Properties and Nutritional Composition of the Beverage

The physical properties and nutritional composition of the formulated beverage varied with the proportion of individual juice in the blend (Table 2). The pH and titratable acidity were affected by the level of pineapple juice in the blends. The pH and titratable acidity are inversely proportional to each other. The blend with the lowest pH value (T_0) 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 pineapple juice in the blends. This can be attributed partly to the inherent acid naturally present in pineapple fruit. According to Saranyah and Mahendran [35], pineapple juice is acidic of which 87% is acetic acid and 13% is malic acid. Similar decrease in pH of mixed juices with increasing concentration of pineapple juice had been reported by other authors [35,36,37]. Increase in juice acidity with higher level of pineapple juice incorporation could protect the beverage from the development of food spoilage organisms which would lead to increase shelf-life of the product. The higher pH (5.32) of the sample with the highest proportion of tiger nut juice incorporation (T_4) could be attributed to lower acid content in tiger nut juice relative to the other two juices. The total soluble solid (TSS) of fruit juice is significantly influenced by the combined effect of stages of maturity and ripening conditions [38]. The content depends mostly on the percentage of solid materials dissolved in water in the juice. Juice blends or beverage with less than 7 ^{o}Brix are categorized as weak and watery, meaning that the total soluble solids are low [25]. The total soluble solids recorded for the different blends ranged

Table 3. Microbial load of the formulated ready-to-serve beverage (cfu/mL)

Type of organism	Samples				
	T_0	T_1	T_2	T_3	T_4
Total viable counts	$0.7x10^2±0.02$	$1.2x10^2±0.01$	$1.1x10^2±0.04$	$1.0x10^2±0.01$	$1.4x10^2±0.03$
Total coliform counts	NG	NG	NG	NG	NG
Total fungal counts	$0.9x10^2±0.03$	$1.3x10^2±0.02$	$1.2x10^2±0.01$	$1.2x10^2±0.02$	$1.5x10^2±0.04$

Values are means ± SD (standard deviation) of triplicate determinations. T_0 = 50% watermelon juice, 50% pineapple juice and 0% tiger nut juice; T_1 = 33.33% watermelon juice, 33.33% pineapple juice and 33.33% tiger nut juice; T_2 = 50% watermelon juice, 25% pineapple juice and 25% tiger nut juice; T_3 = 25% watermelon juice, 50% pineapple juice and 25% tiger nut juice; T_4 = 25% watermelon juice, 25% pineapple juice and 50% tiger nut juice. NG = no growth detected

Table 4. Mean sensory values for the formulated ready-to-serve beverage

Parameters	Samples				
	T_0	T_1	T_2	T_3	T_4
Colour	$8.45^a±0.14$	$7.68^b±0.08$	$7.95^b±0.20$	$7.71^b±0.13$	$7.01^a±0.04$
Taste	$7.90^b±0.09$	$8.15^a±0.10$	$7.62^b±0.04$	$8.04^a±0.20$	$7.50^b±0.11$
Aroma	$8.16^a±0.03$	$7.83^b±0.06$	$6.71^c±0.18$	$8.00^a±0.09$	$6.62^a±0.23$
Overall acceptability	$7.02^b±0.06$	$7.95^a±0.15$	$7.36^b±0.30$	$8.13^a±0.02$	$6.84^b±0.14$

Means on the same row with different superscripts are significantly different at p= 0.05. T_0 = 50% watermelon juice, 50% pineapple juice and 0% tiger nut juice; T_1 = 33.33% watermelon juice, 33.33% pineapple juice and 33.33% tiger nut juice; T_2 = 50% watermelon juice, 25% pineapple juice and 25% tiger nut juice; T_3 = 25% watermelon juice, 50% pineapple juice and 25% tiger nut juice; T_4 = 25% watermelon juice, 25% pineapple juice and 50% tiger nut juice from 10.60 to 12.39 °Brix, indicating that they were not weak or watery. The blend that contained higher proportion of pineapple than watermelon (T_3) exhibited higher total soluble solids. Similar increase in total soluble solids in pineapple – watermelon juice blend with increasing proportion of pineapple juice incorporation was reported by Oyeleke et al. [39].

The formulated beverage had high moisture content which ranged from 87.51% to 89.84%. The high moisture content could affect the stability of the beverage with respect to microbial growth and proliferation. The moisture content of 89.84% recorded for the blend of 50% watermelon and 50% pineapple juice (T_0) was slightly higher than 88.82% reported by Oyeleke et al. [39] for the same ratio of watermelon – pineapple juice blend. The crude protein and fat contents in the 50% watermelon and 50% pineapple juice blend were 0.88% and 0.34% respectively. The crude protein and fat contents in the blends containing tiger nut juice significantly (p = .05) increased with increase in the proportion of tiger nut juice incorporation (Table 2). The increase could be attributed to higher crude protein (8.0%) and fat (25.5%) contents in tiger nut juice [18] relative to 0.48-0.64% protein and 0.25-0.35% fat in watermelon [9] and 0.54% protein and 0.10% fat in pineapple [13]. The result of the present study clearly showed that tiger nut juice or milk could be used to improve the nutritional value of ready-to-serve mixed fruit juice beverages.

The ash content of a food sample is an index of the mineral element of such food. In the present study, sample T_0 exhibited the highest potassium, calcium and magnesium contents while sample T_4 recorded the least values for the aforementioned minerals. Potassium was the most abundant mineral element in the prepared beverage and was followed by magnesium and calcium. This observation was in agreement with earlier report by Ekpete et al. [40] that potassium was the most abundant mineral found in some Nigerian fruits and was followed by magnesium, calcium, iron and zinc. Other authors [41,42] also recorded potassium as the most abundant mineral element in some Nigerian packed fruit juice concentrate/local beverages and in watermelon as well as in watermelon – orange juice mix. Potassium intake is required in relatively large amount in the body because it functions as an important electrolyte in the nervous system [23]. Magnesium is important for bone health; is needed as a cofactor for numerous reactions in the body [26]. High amount of magnesium, potassium and calcium have been reported to reduce blood pressure in humans [43]. The zinc content in the beverage ranged from 0.47 – 0.55 mg/100 mL. It is evident from the result of the study that consumption of the formulated beverage will be desirable as it will serve as a good source of these mineral elements.

The result of the study revealed that sample T_0 which composed of 50% watermelon and 50% pineapple juices had significantly (p = .05) higher vitamin C and beta-carotene values than all the blends with tiger nut incorporation. It is evident from the result that the formulated beverages are good sources of vitamin C and beta-carotene. 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 [26]. As a strong antioxidant, beta-carotene scavenges free radicals and quenches singlet oxygen. The intake of carotenoid – containing fruits and vegetables had been associated with reduced risk of certain cancer, cardiovascular disease and age related eye diseases such as cataracts and macular degeneration [44]. The consumption of the formulated beverage could provide substantial amount of vitamin C and beta-carotene needed by the body for its physiological functions.

4.2 Microbial Quality of the Beverage

The microorganisms present in fruit juice could have originated from the natural flora of the raw material used for its preparation and those that found their way into the product during processing. Fruit juices contain essential nutrients which support the growth of acid tolerant bacteria, mold and yeast. Microbial quality of food is a very important measure of the safety of the food for human consumption. The total viable counts obtained in the present study ($0.7 \times 10^2 – 1.4 \times 10^2$ cfu/mL sample) were lower than 1.3×10^3 cfu/mL reported by Ijah et al. [29] for watermelon and orange juice mix as well as 4.50×10^3 cfu/mL reported by Olagunju and Sandewa [44] for soursop juice supplemented with 30% milk. The low values of total viable counts and total fungal counts recorded in the present study could be due to good hygienic practices observed during preparation of the beverage. According to Babalola et al. [45], production of fruit juice performed under hygienic conditions with strict attention to sanitary practices will result in a product with low bacterial content of good keeping quality. The low microbial population may also be attributed to the positive effect of pasteurization in destroying microorganisms in liquid food products [46]. Sampedro et al. [47] reported that bacterial counts were reduced by 4.57 log cfu/mL and mold and yeast counts were reduced by 4.1log cfu/mL in orange juice – milk based beverage as a result of pasteurization treatment. Pasteurization is usually carried out to destroy pathogenic microorganisms and not to totally destroy microbes present in the product. Although a large number of organisms are eliminated during pasteurization, some still resist the pasteurization temperature [45]. This in part accounts for the total viable counts of bacteria as well as total fungal counts per milliliter of the beverage. A low pH is known to favour microbial stability. This probably explains the lower microbial population with reduction in the pH of the sample.

The non- detection of coliform growth in all the samples is in agreement with the report by Ijah et al. [29] for watermelon and orange juice mix. Coliforms are mostly of faecal origin and their presence in foods is an indication of contamination from faecal sources including contaminated water and poor hygiene practices. Their presence is highly undesirable because some coliforms like *Escherichia* coli can cause diseases such as diarrhea and gastroenteritis [48]. The results from the microbial assessment of the formulated beverages suggest that they are safe for human consumption and not likely to cause any health hazard.

4.3 Sensory Evaluation of the Beverage

Sensory evaluation of any food item contributes significantly to its consumer acceptance or rejection. According to Dzogbefia and Djokoto [49], 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 individual juice in the blends. Colour, taste and aroma are important sensory attributes that affect the acceptability of food products. The result showed that the colour of sample T_0 (50% watermelon and 50% pineapple juice) was the most preferred colour by the panelists and was significantly different (p = .05) from the colour of the other samples. The aroma of samples T_0 and T_3 with 50% of pineapple juice inclusion was the most preferred by the panelists and the mean score values were significantly higher (p = .05) than the rest of the samples. The taste and overall acceptability of samples T_1 (composed of 33.33% each of the three juices) and T_3 (composed of 25% watermelon, 50% pineapple and 25% tiger nut juices) were the most preferred beverage by the panelist and their mean score values were significantly higher (p = .05) than the rest of the samples. Blended sample with 50% tiger nut juice incorporation (T_4) was the least acceptable beverage by the panelists.

5. CONCLUSION

The present study has shown that acceptable and safe ready-to-serve beverage of higher protein, fat and zinc contents than the control sample could be produced by supplementing watermelon and pineapple juice blend with 25 – 33.33% tiger nut juice. Although the tiger nut juice incorporated beverages had lower calcium, potassium, magnesium, iron, vitamin C, and beta-carotene contents than the control (50% watermelon and 50% pineapple juice 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 and pineapple juice blend with tiger nut juice will enhance the utilization of tiger nut that is currently underutilized in Nigeria [20]. It is recommended that further work should be done on antioxidant properties and storage stability of the beverage to determine shelf-life.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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