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Research Article

Production and Nutritional Evaluation of Tamarind Squash Blended with Banana (*Musa acuminate*) and Pawpaw (*Carica papaya*)

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Abstract

The study was carried to produce and evaluate nutritional contents of Tamarind based squash blended with Musa acuminate (L) (Banana), Carica papaya (L) (Pawpaw). Banana, and Pawpaw were used for the production of Tamarind based squash in ratio of 40:30:30, which were compared with commercial Tamarind. The following parameters were: Proximate composition, Vitamins, Minerals, Rheological, Microbial analysis and Sensory evaluation were assayed using standard laboratory methods. The statistical package for social science (SPSS), version 20.0 expressed as means ± SEM. One way analysis of variance (ANOVA) and Duncan's multiple range test were used to compare the means obtained after each experiment. Differences were considered significant at P <0.05. There were significant increases in the Ash, Fiber, Fat, Protein, Carbohydrate, Energy, Vitamin A, Vitamin C, Manganese, sucrose value of Tamarind based squash compared to commercial Tamarind (T_2) in the following values: blend T_7 (Tamarind, Banana, Pawpaw, 40:30:30) recorded high of Ash (13.83 ± 0.02^d), Fat ($3.41 \pm 0.01_d$), protein ($13.74 \pm 0.01_d$), Fiber ($5.83 \pm 0.02_d$), Carbohydrate ($205.48 \pm 0.01_d$), total energy ($907.52 \pm 0.02_d$), Vitamin A ($10.17 \pm 002_d$), Vitamin C ($242.90 \pm 0.01_d$), Manganese ($0.59 \pm 0.01_d$), Sucrose ($43.46 \pm 0.02_d$). The list liked treatment are commercial control Tamarind (T_2), normal control Tamarind (T1a), while the highest like treatment are normal control Pawpaw (T1d), blend Tamarind, Banana, Pawpaw (T_7) are more satisfactory and overall acceptable in terms of sensory evaluation and microbial quality. Tamarind with the blend have meet up with the recommended daily allowance of vitamin C and Carbohydrate.

Keywords: Banana; Tamarind; Pawpaw

Introduction

Fruits are a major source of both "macro" nutrients such as fiber and carbohydrates, and "micro" nutrients such as Vitamin C, B complex (thiamin, riboflavin, B6, niacin, folate), A, E, minerals, and the lesser-studied polyphenolics, carotenoids, and glucosinolates. Nutrients may be classified as either water or lipid soluble—meaning they dissolve in water or a lipid medium. Water soluble nutrients include Vitamin C, B complex, polyphenolics, and glucosinolates. Fat soluble nutrients include Vitamin A, E, and other carotenoids such as lycopene and β-carotene [1]. Fruit have been shown to contain high amount of minerals, moisture, low ash and crude fibre and are sources of sugar, vitamin A, C, and B groups, low protein and lipid [2] and enriched in antioxidant [3]. Tamarind (*Tamarindus indica* L.) is a leguminous tree in the family *Fabaceae* indigenous to tropical Africa. The tamarind is a long-lived, medium-growth shrub, which attains a maximum crown height of 12 to 18 meters (39 to 59 ft) [4]. The fruit is an indehiscent legume, sometimes called a pod, 12 to 15 cm (4.7 to 5.9 in) in length, with a hard, brown shell [5]. The fruit has a fleshy, juicy, acidulous pulp. It is mature when the flesh is coloured brown or reddish brown. The tamarinds of Asia have longer pods (containing six to 12 seeds), whereas African and West Indian varieties have shorter pods (containing one to six seeds). The seeds are somewhat flattened, and a glossy brown. The fruit is best described as sweet and sour in taste, and is high in tartaric acid, sugar, B vitamins, and, unusually for a fruit, calcium, but inadequate in Vitamin A, and Manganese and 3.5mg of Vitamin C as compare to recommended daily allowance male adult of 90 mg [6,7]. Tamarind pulp is a key ingredient in flavoring curries and rice in south Indian cuisine, as well as in the Chigali lollipop. Across the Middle East, from the Levant to Iran, tamarind is used in savory dishes, notably meat-based stews, and often combined with dried fruits to achieve a sweet-sour tang [8]. Bananas are known for their high nutritional values too. Potassium, fiber, magnesium, and vitamin C and B6 are among the nutritious contents in it. It is also believed as bananas help to fight depression, kidney cancer and diabetes [9]. Bananas are a staple starch for many tropical populations. Depending upon cultivar and ripeness, the flesh can vary in taste from starchy to sweet, and texture from firm to mushy. Both the skin and inner part can be eaten raw or cooked. The primary component of the aroma of fresh bananas is isoamyl acetate (also known as banana oil), which, along with several other compounds such as butyl acetate and isobutyl acetate, is a significant contributor to banana flavor [10]. *Carica papaya* is sometimes known as paw paw which is a fast growing herbaceous plant, it belongs to the Caricaceae family. This plant is a dicotyledonous, polygamous and diploid spieces. It originated from Southern mexico, Central America and the Northen part of South America [11]. *Carica papaya* comes into fruiting within 5 months and live for 4-5 years. Usually male and female flowers are on different trees, but some flowers are bisexual. Pollinating agents include various insects such as larger bees (*Xylocarpa, Trigona*) [12]. Pawpaw are good source of Vitamin C, Manganese, Vitamin A, Potassium, and sugars [11]. Pawpaw can be used to make fruits salads, refreshing drinks, jam, jelly, marmalade, candies and crystallized fruit. Green fruit is pickled or cooked as vegetable or as a substitute for applesauce [12]. Tamarind (*Tamarindus indica*), Banana (*Musa acuminate*), Pawpaw (*Carica papaya*) are popular fruit used for commercial fruit juice and mixed fruit nectar production in Nigeria. Blending of fruits like Banana and Pawpaw will be helpful to enhance the Nutritive content, sensory quality characteristics such as colour, flavor, taste, and overall acceptability of the prepared Tamarind based squash product.

Materials and Method

Fruit materials

Tamarind fruit, Pawpaw fruit, Banana fruit, were purchased at Monday Market Maiduguri, Borno State, Nigeria.

Methods

Modern method of preparation squash

Tamarind Fruit seeds was removed and cleaned properly. Then the tamarind was soaked in water in 1:1.5 ratios, heated up to 100ºC for 20 minute, then cooled and crushed. After crushing it was passed through an Xmm sieve size to obtain the freshly uniformed endosperms or the juice. The extract so obtained was used for the preparation of squash. Tamarind squash prepared by blending with Mango juice, Banana juice, and Pawpaw juice in ratio 1:1. Sugar syrup was obtained; juice was added to the cold syrup and mix thoroughly. Addition of sugar 10g/100ml of squash. Fill in sterilized bottles and cap [13].

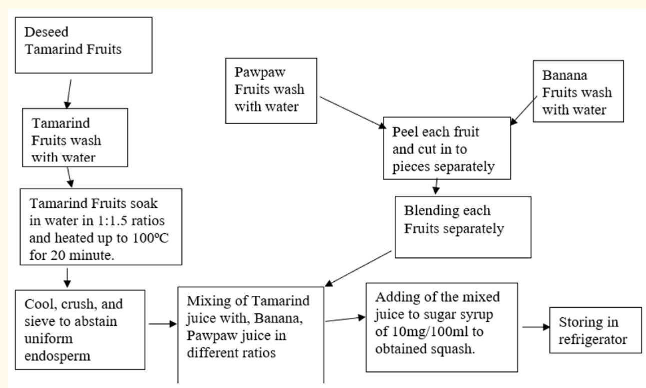

Figure 1: A Flow Chart for the Production of Tamarind Drink (Kiranmai *et al*., 2017).

Treatment Groups	Commercial Tamarind Juice (ml)	Tamarind Juice (ml)	Banana Juice (ml)	Pawpaw Juice (ml)
T1		a:100	c:100	25d:100
T2	100			
T3		40	30	30

Table a

Key: T1 = Normal control, T2 = Commercial control, T3 = Mixture of Tamarind, Banana and Banana.

pH

pH measures the amount of acidity or alkalinity in a food or solution using a numerical scale between 1 and 14. A pH value of 1 is most acidic, a pH value of 7 is neutral, and values above 7 are referred to as basic or alkaline. Acidified foods have a pH value less than or equal to 4.6 [15-17].

Procedure

- Standardize the pH meter using pH 4 and 7 buffer solutions at ambient Temperature.
- Switch off the pH knob and removed the glass electrode from the buffer solution. Rinse with distilled water and dry the tip of the electrode with soft tissue paper.
- Insert the cleaned and dried glass electrode into the water sample, switch on the pH knob and read the pH value directly from the scale [15-17].

Total Acidity

[15-17].

Determination manganese by atomic absorption spectrophotometer

[15-17].

Determination of ascorbic acid with N-Bromosuccinimide

[15-17].

HPLC assay of fat-soluble vitamins.

Determination of moisture [15-17].

Determination of ash insoluble in hydrochloric acid

[15-17].

Measuring the energy content of food

Procedure

Total energy (Kcal/ 100g) = [% available carbohydrate x 4] + % Protein x 4 + % Fat x 9 [15-17].

Tests for carbohydrates

Determination of total sugars [15-17].

Crude fiber content

Was then calculated using the expression: % Crude fiber = Loss in weight after ignition x 100

Weight of original sample

= i.e. % Crude fiber =

$$\frac{\text{weight after drying – weight after ignition x 100}}{\text{Weight of sample}}$$

Determination of total fats

[15-17].

Microbiological studies

After the incubation, the resulting colonies were counted using Colony Counter [15-18].

Evaluation and typical results

E. coli develops dark-blue to violet colonies, other coliforms red to pink colonies. Other gram-negative colonies are colorless, a few with ß-Glucuronidase activity was light blue to turquoise. Remarks: To confirm *E. coli* give one drop of Kovacs indole reagent on each dark blue colony. Cherry red color after a few seconds is a positive reaction. M Green Yeast and Mold medium for the detection of yeasts and molds according to Schaufus and Pottinger. Dehydrated culture medium for cultivating microorganisms in wine, soft drinks, concentrates, sugar, sugar products and other products [15-17,19].

Evaluation and typical results

Molds develop velvety or fluffy whitish or greenish colonies which can get various colors after conidiophores production. Yeasts have a smooth surface. Acid forming sugar fermenters are whitish to yellow; non-acid formers are, by contrast, greenish to bluegreen. Remarks: The low pH suppresses the growth of most bacteria. This medium is available with various types of membrane filters: 3 different pore sizes and 2 different colors [15-17,20].

Viscometer

The viscosity of the sample flours can be determined by Sample dispersions with concentrations ranging from 0.4 to 2.0% (w/v) was prepared with distilled water at room temperature under continuous stirring (Monostir magnetic stirrer). The viscosity of the hydrated dispersion was measured at 25°C using the NV sensor of the Haake – Rotovisko viscometer (Haak – Rotovisko GMBH Germany) [21,22].

Sensory evaluation method

Fifty member panels of assessors with two squash sample was used. Panelists was asked to score sample based on the intensity of organoleptic quality attributes of appearance (colour), flavour (taste), aroma, texture and overall acceptability using the 9- point hedonic scale where 1 = like extremely and 9 = dislike extremely [23-25].

Statistical analysis

Data would be expressed as mean ± standard error mean (SEM) of three replications, and one-way ANOVA was used for the statistical analysis using SPSS program (version 20 SPSS Inc., USA) and Duncan multiple range test to compare the mean. The values of sensory evaluation was considered to be significantly different when $P< 0.05$ [26].

Results

Table 1 presents the proximate composition of Tamarind (T1a) and individual component that forms the blend, Banana (T1c), Pawpaw (T1d), commercial Tamarind (T2) and Tamarind, Banana and Pawpaw (T3) fruit squash. The moisture (%) content of normal and commercial control were analyzed and the highest mean for moisture percentage was recorded in normal control pawpaw (T1d) 25.65%, as compared to lower mean shown in normal control Tamarind (T1a) 16.65%, Banana (T1c) 15.42% and commercial Tamarind (T2) 16.58% and which are all lower when compared to blend Tamarind, Banana and Pawpaw (T3) 57.72% at significant difference of p (<0.05). The Ash (%) content of normal and commercial control were analyzed and the highest mean for Ash percentage were recorded in normal control Tamarind (T1a) 6.40% and commercial Tamarind (T2) 6.36%, as compared to lower mean shown in normal control Pawpaw (T1d) 3.45%, and Banana (T1c) 3.98% and which are all lower when compared to blend Tamarind, Banana and Pawpaw (T3)13.83% at significant different of p (<0.05).The fiber content of normal and commercial control were analyzed and the highest mean for fiber percentage were recorded in blend Tamarind, Banana and Pawpaw (T3) 5.83% and normal control Banana (T1c) 2.45, as compared to lower mean shown in normal control Pawpaw (T1d) 1.63%, Tamarind (T1a) 1.75% and commercial Tamarind (T2) 1.72% at significant difference of p (<0.05). The fat (%) content of normal commercial control were analyzed and the highest mean for fat percentage were recorded in normal control Tamarind (T1a) 2.47% and commercial Tamarind (T2) 2.45%, as compared lower mean shown in normal control Banana (T1c) 0.48%, Pawpaw (T1d) 0.50% and which are all lower when compared to blend Tamarind, Banana and Pawpaw (T3) 3.41% at significant difference p (<0.05). The protein (%) content of normal and commercial control were analyzed and the highest mean protein percentage were recorded in normal control Tamarind (T1a) 5.53%, and commercial Tamarind control (T2) 5.51 as compared to lower mean shown in normal control Pawpaw (T1d) 4.26%, Banana (T1c) 3.95% and which are all lower when compared to blend Tamarind, Banana and Pawpaw (T3) 13.74% at significant difference p (<0.05). The carbohydrate (%) content of normal and commercial control were analyzed and the highest mean carbohydrate percentage were recorded in normal Banana (T1c) 73.70%, as compared to lower mean shown in normal control Pawpaw (T1d) 64.56%, Tamarind (T1a) 66.93% and commercial Tamarind (T2) 67.10% and which are all lower when compared to blend Tamarind, Banana and Pawpaw (T3) 205.48% at significant difference of p (<0.05). The total energy (kcal/100g) content of normal and commercial control were analyzed recorded in normal control Banana (T1c) 314.99, as compared to lower mean shown in normal control Pawpaw (T1d) 279.39, Tamarind (T1a) 313.00 and commercial Tamarind control (T2) 313.09 and which are all lower when compared to blend Tamarind, Banana and Pawpaw (T3) 907.52% at significant difference of p (<0.05).

Parameters Groups	T1a	T1d	T1c	T3	T_2
Moisture (%)	16.65 ± 0.07^a	25.65 ± 0.01^b	15.42 ± 0.01^c	57.72 ± 0.01^d	16.58 ± 0.03^a
Ash (%)	6.40 ± 0.03^a	3.45 ± 0.01^b	3.98 ± 0.00^c	13.83 ± 0.02^d	6.36 ± 0.02^a
Fiber (%)	1.75 ± 0.03^a	1.63 ± 0.01^b	2.45 ± 0.03^c	5.83 ± 0.02^d	1.72 ± 0.05^a
Fat (%)	2.47 ± 0.06^a	0.50 ± 0.01^b	0.48 ± 0.01^c	3.41 ± 0.01^d	2.45 ± 0.01^a
Protein (%)	5.53 ± 0.01^a	4.26 ± 0.01^b	3.95 ± 0.01^c	13.74 ± 0.01^d	5.51 ± 0.01^a
Carbohydrate (%)	66.93 ± 0.39^a	64.56 ± 0.01^b	73.70 ± 0.03^{cb}	205.48 ± 0.01^d	67.10 ± 0.06^a
Total Energy Kcal/100g	313.00 ± 0.22^a	279.39 ± 0.04^b	314.99 ± 0.13^c	907.52 ± 0.02^d	313.09 ± 0.05^a

Table 1: Proximate Composition of Mono Tamarind, Pawpaw, Banana, Commercial Tamarind and tri blend.

Key:

- n= 3
- Values are presented as mean ± SEM,
- Values with different superscript along the row horizontally are significantly different (P<0.05)
- T1a =Tamarind, T1d = Pawpaw, T1c =Banana, T3 = Tamarind, Banana and Pawpaw, T_2 =Commercial Tamarind

Table 2 presents the vitamin, mineral element and sucrose levels of Tamarind (T1a) and individual component that form the blend, Banana (T1c), Pawpaw (T3), commercial Tamarind (T2) and tri blend fruit squash. The vitamin A (µglg) content of normal and commercial control were analyzed and the highest mean for vitamin A µglg was recorded in normal control Pawpaw (T1d) 4.60µg/g, as compared to lower mean shown in commercial Tamarind control (T2) 2.36µg/g, normal control Tamarind (T1a) 2.40µg/g, and normal control Banana (T1c) 3.17µg/g, and which are all lower when compared to blend Tamarind, Banana and Pawpaw (T3) 10.17% at significant difference of p (<0.05).The highest mean for vitamin C mglg was recorded in blend Tamarind, Banana and Pawpaw (T3) 242.90mg/g, as compared to lower mean shown in normal control Pawpaw (T1d) 113.28mg/g, Tamarind (T1a) 49.86mg/g, Banana (T1c) 49.97mg/g, and commercial control Tamarind (T2) 49.85mg/g at significant difference of p (<0.05). The highest mean for manganese mglg was recorded in blend Tamarind, Banana and Pawpaw (T3) 0.59mg/g, as compared to lower mean shown in normal control Pawpaw (T1d) 0.20mg/g, Banana (T1c) 0.06mg/g, Tamarind (T1a) 0.06mg/g and commercial control Tamarind (T2) 0.06mg/g at significant difference of p (<0.05). The highest mean for sucrose was recorded in blend Tamarind, Banana and Pawpaw (T3) 43.46, as compared to lower mean shown in normal control Banana (T1c) 13.48, Tamarind (T1a) 14.26, Pawpaw (T1d) 15.70 and commercial control Tamarind (T2) 14.25 at significant difference of p (<0.05).

Table 3 Presents the physical and Rheological parameters of mono Tamarind, Pawpaw, Banana, commercial Tamarind and tri blend fruit squash. The highest mean for pH were recorded in treatment Banana (T1c) 7.29 and Pawpaw (T1d) 7.22, as compared to lower mean shown in blend Tamarind, Banana and Pawpaw (T3) 6.66, normal control Tamarind (T1a) 5.48, and commercial control Tamarind (T2) 5.48, at significant difference of p (<0.05). The citric

Parameters Groups	T1a	T1d	T1c	T3	T_2
Vitamin A (μglg)	2.40 ± 0.06[a]	4.60 ± 0.08[b]	3.17 ± 0.09[c]	10.17 ± 0.02 [d]	2.36 ± 0.04[a]
Vitamin C (mglg)	49.86 ± 0.01[a]	113.28 ± 0.02[b]	49.97 ± 0.01[a]	242.90 ± 0.01[c]	49.85 ± 0.01[a]
Manganese (mglg)	0.06 ± 0.01[a]	0.20 ± 0.00[b]	0.06 ± 0.01[a]	0.59 ± 0.01[c]	0.06 ± 0.01[a]
Sucrose	14.26 ± 0.01[a]	15.70 ± 0.01[b]	13.48 ± 0.01[c]	43.46 ± 002[d]	14.25 ± 0.01[a]

Table 2: Vitamin, Mineral Element and Sucrose levels of Mono Tamarind, Banana, Pawpaw, Commercial Tamarind and tri blend Squash.

Key:

- n= 3,
- Values are presented as mean ± SEM,
- Values with different superscript along the row horizontally are significantly different (P<0.05)
- T1a=Tamarind, T1d= Pawpaw, T1c= Banana, T3= Tamarind, Banana and Pawpaw, T_2= commercial Tamarind

Parameters Groups	T1a	T1d	T1c	T3	T_2
pH	5.48 ± 0.02[a]	7.22 ± 0.00[d]	7.29 ± 0.00[c]	6.66 ± 0.00 [d]	5.48 ± 0.02[a]
Citric Acid	0.72 ± 0.01[a]	0.14 ± 0.01[d]	0.06 ± 0.01[c]	0.50 ± 0.00[d]	0.72 ± 0.00[a]
Viscosity (cp)	6.77 ± 0.09[a]	8.27 ± 0.09[d]	7.03 ± 0.09[c]	7.37 ± 0.03[d]	6.80 ± 0.06[a]

Table 3: Physical and Rheological Parameters of Mono Tamarind, Pawpaw, Banana, Commercial Tamarind and tri blend.

Key:

- n= 3,
- Values are presented as mean ± SEM,
- Values with different superscript along the row horizontally are significantly different (P<0.05)
- T1a=Tamarind, T1d= Pawpaw, T1c= Banana, T3= Tamarind, Banana and Pawpaw, T_2= commercial Tamarind

acid content of normal and commercial control were analyzed and the highest mean for citric acid were recorded in normal control Tamarind (T1a) 0.72 and commercial control Tamarind (T2) 0.72, as compared to lower mean shown in normal control Banana (T1c) 0.06, Pawpaw (T1d) 0.14, and blend Tamarind, Mango and Banana (T3) 0.54, at significant difference of p (<0.05).The viscosity (cp) content of normal and commercial control were analyzed and the highest mean for viscosity (cp) was recorded in normal control Pawpaw (T1d) 8.27, as compared to lower mean shown in commercial control Tamarind (T2) 6.80, and normal control Tamarind (T1a) 6.77, Banana (T1c) 7.03, and blend Tamarind, Banana and Pawpaw (T3) 7.37, at significant difference P(<0.05).

Table 4 present the Microbial composition of Tamarind (T1a) and individual component that form the blend Pawpaw (T1d), Banana (T1c), commercial Tamarind (T2) and Tamarind, Mango and Banana (T6) fruit squash. The highest mean for Aerobic mesophilic bacteria was recorded in normal control Pawpaw (T1d) 46.00, as compared to lower mean shown in normal control, Tamarind (T1d) 44.00, Banana (T1c) 37.00, Tamarind, Banana and Pawpaw (T3) 42.33 and commercial control Tamarind (T2) not detected, at significant difference of p (<0.05). The mould (cfu/g) content of different treatments were analyzed and the highest mean for mould was recorded in normal control Banana (T1c) 12.00, as compared to lower mean shown in blend Tamarind, Banana and Pawpaw (T3)

Parameters Groups	T1a	T1d	T1c	T3	T_2
Aerobic mesophilic bacteria (cfu/g)	44.00 ± 5.03[a]	46.00 ± 3.51[b]	37.00 ± 1.53[a]	42.33 ± 0.67[a]	ND
Mould (cfulg)	10.33 ± 0.88[a]	11.67 ± 0.88[a]	12.00 ± 0.58[a]	11.33 ± 0.33[a]	ND
Coliform(cfu/g)	ND	ND	ND	3.00 ± 0.58[a]	ND
E.coli (Cfu/g)	ND	ND	ND	ND	ND

Table 4: Microbial Composition of Mono Tamarind, Banana, Pawpaw, Commercial Tamarind and tri blend.

Key:

- n= 3,
- Values are presented as mean ± SEM,
- Values with different superscript along the row horizontally are significantly different (P<0.05)
- T1a = Tamarind, T1d= Pawpaw, T1c = Banana, T7 = Tamarind, Banana Pawpaw, T2 = commercial Tamarind, ND = Not detected.

11.33, normal control Pawpaw (T1d) 11.67, Tamarind (T1a) 10.33, and commercial control Tamarind (T2) not detected, at significant difference of p (<0.05). The coliform cfu/g count result for fruit squash normal and commercial control is negative, as detected in blend Tamarind, Banana and Pawpaw (T7) 3.00. The *E. coli* (cfu/g) count result for fruit squash normal, commercial control and blend Tamarind, Banana and Pawpaw (T7) is negative, at significant difference of P (<0.05).

Table 5 Present the Sensory evaluation of Tamarind (T1a), Banana (T1c), Pawpaw (T1d), commercial Tamarind (T2) and blend Tamarind, Banana and Pawpaw (T3) fruit squash. The colour content of normal and commercial control were analyzed and the highest mean for colour was recorded in commercial control Tamarind (T2) 2.80, as compared to lower mean shown in blend Tamarind, Banana and Pawpaw (T3) 2.62, normal control Tamarind(T1a) 2.24, Banana (T1c) 2.70, Pawpaw (T1d) 1.98, at significant different of p(<0.05). The highest mean for Aroma was recorded in normal control Tamarind (T1a) 2.92 and commercial control Tamarind (T2) 2.92, as compared to lower mean shown in normal control Banana (T1c) 2.32, Pawpaw (T1d) 2.80, blend Tamarind, Banana and Pawpaw (T3) 2.68, at significant difference p (<0.05). The highest mean for Flavour was recorded in commercial control Tamarind (T2) 3.12, as compared to lower mean shown in normal control Banana (T1c) 2.24, Pawpaw (T1d) 2.84, Tamarind (T1a) 2.96, blend Tamarind, Banana and Pawpaw (T3) 2.92 at significant different of p (<0.05). The highest mean for Texture was recorded in blend Tamarind, Mango Banana and Pawpaw (T3) 2.86, as compared to lower mean shown in normal control Pawpaw (T1d) 2.76, Banana (T1c) 2.40, Tamarind (T1a) 2.44, commercial control Tamarind (T2) 2.58, at significant different of p (<0.05). The acceptability score of Tamarind, Banana, Pawpaw, commercial Tamarind and tri blend. The highest score is commercial Tamarind control (T2) 2.00, which indicate people are slightly satisfied with the treatment. But the rest of the scores are within the range of people are very satisfied with the treatment.

Parameters Groups	T1a	T1d	T1c	T3	T_2
Colour	2.24 ± 0.17^a	1.98 ± 0.28^a	2.70 ± 0.28^a	2.62 ± 0.21^b	2.80 ± 0.26^b
Aroma	2.96 ± 0.24^a	2.80 ± 0.2^9a	2.32 ± 0.23^a	2.68 ± 0.20^a	2.92 ± 0.24^a
Flavour	2.96 ± 0.25^a	2.84 ± 0.32^a	2.24 ± 0.24^a	2.92 ± 0.25^a	3.12 ± 0.26^a
Texture	2.44 ± 0.20^a	2.76 ± 0.32^a	2.40 ± 0.23^a	2.86 ± 0.27^a	2.58 ± 0.25^a
Overall Acceptability	1.33 ± 0.33^a	1.67 ± 0.33^a	1.67 ± 0.33^a	1.33 ± 0.33^a	1.33 ± 0.33^a

Table 5: Sensory Evaluation of Mono Tamarind, Banana, Pawpaw Commercial Tamarind and tri blend.

Key:

- n= 50,
- Values are presented as mean ± SEM,
- Values with different superscript along the row horizontally are significantly different (P<0.05)
- T1a=Tamarind, T1d= Pawpaw, T1c= Banana, T3= Tamarind, Banana and Pawpaw, T_2= commercial Tamarind

Discussion

The present study was aimed at production of Tamarind base squash and enhance its nutritive content, overall acceptability of a Tamarind squash. The fruit blends used were Banana Pawpaw in different ratios of mono, and tri fruit blends.

The proximate composition of mono Tamarind (T1a), Pawpaw (T1d), Banana (T1c), commercial Tamarind (T2), Tamarind, Banana and Pawpaw (T3) fruit squash; the decreased moisture recorded in normal control Banana (T1c) 15.42%, commercial Tamarind control (T2) 16.58%, normal control Tamarind (T1a) 16.65%, normal control Pawpaw (T1d) 25.65%, and in blend Tamarind, Banana and Pawpaw (T3) 57.72% moisture, when compared with earlier reported work, value 219%, 990%, 990% for Banana, Jack fruit and Mango [27] reported increase in moisture. Lower moisture prevents bacteria, yeast and mould from growing and spoiling food [28]. Fruit moisture diffusivities differ due to variation of composition and microstructure of foodstuff and drying variable [29] in the mono and tri fruit squash produced, the increased recorded in normal control Banana (T1c) 3.98%, commercial Tamarind control (T2) 6.36%, normal control Tamarind (T1a) 6.40%, normal control Pawpaw (T1d) 3.45%, and in blend Tamarind, Banana and Pawpaw (T3) 13.83%, when compared with earlier reported work, the value 0.85 for velvet Tamarind jam [30] reported decrease in Ash. Ash refers to any inorganic material, present in food, natural food have less than 5% ash in content [31] and it is an indicator for food quality evaluation (AOAC, 1990). In the mono and tri fruit squash produced the, increased recorded in normal control Pawpaw (T1d) 1.63% and Banana (T1c) 2.45%, Tamarind (T1a) 1.75%, commercial Tamarind control (T2) 1.72%, and in blend Tamarind, Banana and Pawpaw (T3) 5.83% is consistent with the report of [27,32] who reported a similar increased in fiber 1.6%, for mango and 2.6

for Banana, since fruit have low crude fiber [2]. The value obtained is still lower when compared to the recommended daily allowance of adult male 38g and younger children 25g [33]. Fiber is a non-digestible form of carbohydrate, solute fiber help lower cholesterol and glucose level, while insoluble fiber helps soften and provide bulk stool [33]. In the mono and tri fruit squash produced, the increased in fat as recorded in normal control Tamarind (T1a) 2.47%, Pawpaw (T1d) 0.50%, Banana (T1c) 0.48%, Commercial control Tamarind (T2) 2.45% and in blend Tamarind, Banana and Pawpaw (T3) 3.41%, when compared with earlier reported work the value 0.6% for nutritive content of Tamarind indica is similar and higher [7]. Since fruit have low lipid content [2]. The value obtained is still lower when compared to the recommended daily allowance of adult over 19 consume 20-35% [33]. Fat and oil are examples of lipids [34,35], the melting profile of the fat crystals determine the texture, stability, spread ability, softness, mouth feel, structural integrity, air incorporation, heat transfer and shelf life increase [34]. In the mono and tri fruit squash produced, the increased in normal control Tamarind (T1a) 5.53%, Pawpaw (T1d) 4.26%, Banana (T1c) 3.95%, commercial Tamarind control (T2) 5.51% and in blend Tamarind, Banana and (T3) 13.74%, the protein value is in consistent with the report of [2,7] who reported a similar increased in 2.8% for Tamarinds indica and 2.3% for velvet Tamarind, since fruit content low crude protein [2]. The value obtained is still lower when compared to the recommended daily allowance of 1-3years 13g and adult male 56g.In the mono and tri fruit squash produced, the increased recorded in normal control Pawpaw (T1d) 64.56%, Banana (T1c) 73.70%, Tamarind (T1a) 66.93%, commercial Tamarind control (T2) 67.10%, and in blend Tamarind, Banana and Pawpaw (T7) 205.48%, when compared with earlier reported work of [27,32] showed decreased in value 14.98%, 13.3% for Mango and 19.2% for Banana, since fruit is a good source of sugar [2]. The value obtained in blend Tamarind, Banana and Pawpaw (T7) 205.48% is higher when compared to the recommended daily allowance younger children of 130g (IOM, 2005), as carbohydrate cover 45-65 percent of daily calories [33]. In the mono and tri fruit produced, the increased in normal control Pawpaw (T1d) 279.39kcal/100g and Banana (T1c) 314.99kcal/100g, Tamarind (T1a) 313.00Kcal/100g, commercial Tamarind control (T2) 313.09Kcal/100g and in blend Tamarind, Banana and Pawpaw (T7) 907.52 kcal/100g. The increased recorded in energy is consistent with report of [27,36-38] of 60 kcal for Mango and 9578 kcal for Banana. The value obtained is lower when compared to the recommended daily allowance of adult 2000 kcal/100g [33]. The energy that the body derived from food is lower than the amount of energy produced when food is burned or completely oxidized in a bomb calorimeter [39]. Vitamin, Mineral element and Sucrose levels mono and tri blend of fruits for squash production. In the mono and tri fruit squash produced. The decreased recorded in vitamin A of normal control Pawpaw (T1d) 4.60µg/g, Banana (T1c) 3.17µg/g, Tamarind (T1a) 2.40µg/g, commercial control Tamarind (T2) 2.36µg/g, and in blend Tamarind, Banana and Pawpaw (T7) 10.17 µg/g when compared with earlier 450mg nutritive content for Pawpaw [11]. Fruit are rich in vitamin A and antioxidant [2]. The value obtained is lower, when compared with recommended daily allowance of 1-3years 300mg and adult male 900ug, female 700ug (IOM, 2000). Vitamin A help in good vision, reproduction [40] mucus secretion [41], maintenance of differentiated epithelial, cell development [42] increase immunity, antioxidant role [43]. Deficiency impairs immunity, hematopoiesis and causes rashes and typical ocular effect [42,44]. In the mono and tri fruit squash produced. The increased recorded in vitamin C in blend Tamarind, Banana and Pawpaw (T7) 242.90mg/100g, normal control Banana (T1c) 49.97mg/100g, Pawpaw (T1d) 113.28mg/100g, Tamarind (T1a) 49.86mg/100g is consistent with report [11] who reported a similar increase in 74mg nutritive content for pawpaw [11]. Fruits are rich in vitamin C [2]. The value obtained normal control Pawpaw (T1d) and blend T7 are higher, when compared with recommended daily allowance for adult male 90mg and 75mg for adult female (IOM, 2000). Vitamin C take part in reducing reactions involved in the synthesis of steroid hormone, reducing Fe^{+++} to Fe^{++}, folic acid – Tetrahydrofolic acid needs the presence of ascorbic acid [42]. Deficiency of vitamin C result to scurvy [43]. In the mono and tri fruit squash produced. The decreased recorded in manganese of normal control Tamarind (T1a) 0.06mg/g, Banana (T1c) 0.06mg/g, Pawpaw (T1d) 0.20mg/g commercial control Tamarind (T2) 0.06mg/g, and in blend Tamarind, Banana and Pawpaw (T7) 0.59mg/g, when compared with earlier reported work 2.6mg for Pawpaw [11]. Fruit is rich in minerals content [2]. The value obtained is still lower, when compared with the recommended daily allowance of 1-3years 1.2mg, adult male 2.3mg and adult female 1.8mg [33]. Manganese is a cofactor of hydrolase, decarboxylase and transferase enzymes. It is involved in glycoprotein and proteoglycan synthesis and is a component of mitochondrial superoxide dismutase. Deficiency of manganese are severe birth defects, asthma, convulsions, retarded growth, skeletal defects, disruption of fat and carbohydrate metabolism, to join problems, infertility, still birth or spontaneous abortions [45]. In the mono and tri fruit squash produced. The decreased recorded in Sucrose of normal control Pawpaw (T1b) 15.70%, Tamarind (T1a) 14.26%, Banana (T1c) 13.48% commercial control Tamarind (T2) 14.25%, and in blend Tamarind, Banana and Pawpaw (T7) 43.46% which is slightly high, when compared with earlier reported work of glucose 29.8% and fructose 21.9% nutritive content for Pawpaw [11]. Fruit are rich source of sugar [2]. The value obtained is still lower, when compared with recommended daily allowance of 50g [33].

The physical and Rheological Parameters of mono Tamarind, Mango, Banana, commercial Tamarind and tri blend fruit squash. The highest pH obtained were in normal control Banana (T1c) 7.29, Pawpaw (T1d) 7.29, which is slightly alkaline as compared to lower pH in normal control Tamarind (T1a) 5.48, commercial control Tamarind (T2) 5.48 and in blend Tamarind, Mango and Banana (T6) 6.27, which is acidity. When compared with pH of fruit juice products around 8.2 or 7.0. The value of normal control Banana and Pawpaw are within the range [15-17]. pH is used to determine the degree of maturity of fruit, freshness of food, the higher the maturity, the lower the acid content [31]. The highest citric acid were recorded in normal control Tamarind (T1a) 0.72 and commercial control Tamarind (T2) 0.72, as compared with low citric acid in normal control Banana (T1c) 0.06, Pawpaw (T1d) 0.14 and in blend Tamarind, Banana and Pawpaw (T7) 0.50. This confirmed normal control Tamarind (T1a) and commercial control Tamarind (T2) to be highly acidity. Acidity is an indicator of quality of food, the amount of organic acid in food directly affects the food flavor, colour, stability and the level of quality [31]. The highest viscosity (cp) obtained was in normal control Pawpaw (T1d) 8.27cp, which indicate is more thicker as compared to lower viscosity in commercial control Tamarind (T2) 6.80cp, normal control Tamarind (T1a) 6.77cp, Banana (T1c) 7.03cp, and in blend Tamarind, Banana and Pawpaw (T7) 7.37cp, which were less thicker and less resistance to flow. Viscosity is the resistance to deformation and flow. It is the measure of the internal friction of a fluid [22,23].

Microbial composition of Tamarind, Pawpaw, Banana, commercial Tamarind, and tri blend. The highest Aerobic mesophilic bacteria (AMB) count was in blend Tamarind, Banana and Pawpaw (T7) 42.33 cfu/g, which is within the safe range of 25-250 colonies [31]. The highest mould obtained was in normal control Banana (T1c) 12.00 cfu/g, which is low within the safe range of 10-150 colonies. The coliform (cfu/g) count for normal and commercial control are negative, and 3.00 in blend Tamarind, Banana and Pawpaw (T7) and E. coli (cfu/g) count result for fruit squash are negative. Sensory evaluation of mono Tamarind, Pawpaw, Banana, commercial Tamarind, and tri blend squash. The highest scores for colour was commercial control Tamarind (T2) 2.80, which is still within the range of people like very much. The lower scores are normal control Pawpaw (T1d) 1.98, which are within the range people like extremely, while normal control Banana (T1c) 2.70, Tamarind (T1a) 2.24 and in blend Tamarind, Banana and Pawpaw (T7) 2.62 are still within the range of people like very much. The preference of Pawpaw colour over Tamarind and Banana may be due to its high B-carotenoids content which gives attractive yellow, orange, red colour [31,46,47] or anthocyanins which gives red, orange, blue colour, flavonoids which give yellow colour and betalains which give red colour [46,47]. The highest Aroma scores was normal control Tamarind (T1a) 2.96, commercial control Tamarind (T2) 2.92, which is still within the range of people like very much. The lower scores are normal control Pawpaw (T1d) 2.80, Banana (T1c) 2.32, and in blend Tamarind, Banana and Pawpaw (T7) 2.68, which are also within the range of people like very much, but with more preference to normal control Banana (T1c) 2.32. Aroma compounds are volatile—they are perceived primarily with the nose as spicy, flowery, fruity, resinous or balsamic, burnt, and foul [1,48]. The highest score for flavour obtained was in commercial control Tamarind (T2) 3.12, which indicate people like moderately and the rest of the treatment were within the range of people like very much, but with more preference to normal control Banana (T1c) 2.24. Taste receptors exist in the mouth and are impacted when the food is chewed in form of sweet, sour, salty, bitter, and umami [48]. The amount of organic acids in food directly affects the food flavour, colour, stability and the level of quality [31]. The scores for texture all are within the range of people like very much but with more preference to normal control Banana (T1c) 2.40. The texture of fruits is derived from their turgor pressure, and the composition of individual plant cell walls and the middle lamella "glue" that holds individual cells together [49]. The melting profile of fat crystals determine the texture, stability, spreadability and mouthfeel [34]. The acceptability score of Tamarind, Pawpaw, Banana, commercial Tamarind, and in blend Tamarind, Banana and Pawpaw (T7). The highest score is commercial Tamarind (T2) 2.00, which indicate people are slightly satisfied with the treatment. But the rest of the scores are within the range people are very satisfied with the treatment.

Conclusion

The present study showed increased in the nutritive content of blended mixed fruit squash as compared to normal and commercial Tamarind drink. T7 (Tamarind, Banana, Pawpaw 40:30:30) enhance Ash, Fiber, Fat, Protein, citric acid, Carbohydrate, Vitamin C, low moisture, Vitamin A, Manganese and Sucrose. The list liked treatment are commercial control Tamarind (T2), normal control Tamarind (T1a), while the highest liked treatment is blend T7 (Tamarind, Banana, Pawpaw) and normal control Banana (T1c), which is more satisfactory and overall acceptable in terms of sensory evaluation and microbial quality. Blended Tamarind have meet up with the recommended daily allowance of Vitamin C and Carbohydrate.

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Volume 3 Issue 6 June 2019