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Quality evaluation, consumer acceptability, and cost-benefit analysis of mango-plus beverage

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ABSTRACT

This study aims to produce a mango-plus beverage from a blend of mango and pineapple fruits and its market prospects determined. Mango and pineapple were processed into beverages at different ratios (1:0, 1:1, 1:2, and 1:3) and coded as FKJ, WTC, PMG, and QTC, respectively. Parameters that include proximate, TSS, pH, vitamin C, total phenol, sensory characteristics, microbial load, and cost-benefit analysis were determined. Findings show significant differences existed among the sample's parameters at $p<0.05$. Sample QTC, which was a mango-pineapple blend (1:3), gave the highest ash content (1.64%), which was higher than FKJ (1.00%), WTC (1.43%), and PMG (1.46%). Similarly, QTC has the highest energy (54.27 kcal/100 mL), significantly higher than sample FKJ (30.95 kcal/100 mL), WTC (44.03 kcal/100 mL), and PMG (50.53 kcal/100 mL) at $p<0.05$. Vitamin C for samples was between 12.15 mg/100 mL and 13.33 mg/100 mL; total phenol was between 204.44 mg/100 mL and 249.50 mg/100 mL; and antioxidant activity ranged between 50.11 mg/100 mL and 60.68 mg/100 mL, respectively. QTC has the highest vitamin C concentration (13.33 mg/mL), significantly higher ($p<0.05$) than other samples. Additionally, QTC (1:3) has the highest phenol (249.50 mg/100 mL), significantly higher than FKJ (204.44 mg/100 mL), WTC (224.22 mg/100 mL), and PMG (244.22mg/100mL). The microbial loads (cfu/100 mL) were within an acceptable range, indicating their suitability for human consumption during the evaluation period. Cost-benefit analysis suggested prospects for favourable returns. The practical implication of the study is that mango-pineapple at a ratio of 1:2 and 1:3 has good market prospects.

Contribution/Originality: The Mango-plus beverage is a unique, nutrient-rich, and aesthetically pleasing product that is not available on our local supermarket shelves. Venturing into production, especially product mixed at a ratio of 1:2 (PMG) and ratio1:3 (QTC), can add to functional varieties of beverages in market and thus contribute to economy and health.

1. INTRODUCTION

In developing countries, post-harvest losses of fruits range from 30 to 50 percent. The substantial losses could pose a significant risk to both nutrition insecurity and economic waste, given the significant resources required for their production. Fruit processing into value-added products such as fruit beverages presents a viable option for minimizing excessive losses and maximizing returns.

A series of steps, including sorting, peeling, pulping, homogenization, sterilization, and packaging, can transform fruits into juice. The process of converting mangoes into juice provides a convenient and refreshing way to enjoy the flavors of this delicious fruit. Addressing the challenges associated with post-harvest losses through processing can obviously ensure the availability of high-quality fruit juices for consumers to enjoy beyond the region of the fruit production.

Recently, interest in consumption of fruit juice beverages as part of a daily diet is becoming popular due to awareness of their health benefits. Fruit juices are consumed for their nutritional values and refreshing nature (Minich & Bland, 2007). Fruit juice did not only provide hydration and basic nutrition but also contained an array of bioactive compounds (antioxidants) that supported overall well-being and prevented the risk of diseases. Cardiovascular diseases and some cancers have been reported to be caused by low fruit consumption (Proteggente, Saija, De Pasquale, & Rice-Evans, 2003; Ruxton, Derbyshire, & Sievenpiper, 2021).

Mango (Mangifera indica) is an important fruit globally; it is the second most traded tropical fruit and ranks seventh in terms of production, according to FAO (2018). They are greatly appreciated for their succulence, flavor, and delicious taste. Mangoes are a rich source of minerals, vitamins, and phytochemicals. They possess carotenoids that could improve eyesight and protect skin against ultraviolet (UV) damage (Hamidah, Maghfira, & Tjitraresmi, 2023; Song et al., 2013). However, (Owino & Ambuko, 2021) estimated their post-harvest loss in developing countries and Asia to be between 30-50%.

Similarly, pineapple is another important tropical fruit appreciated for its sweet taste and several nutritional benefits: Pineapple is rich in vitamin C, which is essential for a healthy immune system, wound healing, and collagen synthesis. It also contains manganese, which plays a role in bone health and metabolism (Assumi, Jha, & Kaur, 2018; Chaudhary, Kumar, Singh, Kumar, & Kumar, 2019). Pineapple contains bromelain that possesses anti-clotting, anti-cancer, and anti-inflammatory properties (Habotta, Dawood, Kari, Tapingkae, & Van Doan, 2022). The international market highly demands them (Mahmud, Abdullah, & Yaacob, 2018). However, they cannot be kept for long due to their highly perishable nature. The blending of mango and pineapple to produce mixed fruit beverages offers an opportunity to reduce post-harvest losses, promotes varieties, and is convenient for consumers to enjoy the arrays of combined nutrients in both fruits. Blending is a common practice in fruit beverage industries, as many fruit juices are either too acidic or too strongly flavored to be pleasant for consumption; thus, blending is done to achieve balance. The idea of fruits blending has been suggested to provide greater nutritional qualities and create unique flavor profiles that may not be accomplished by consuming fruit juice individually as a single strength (De Carvalho, Maia, De Figueiredo, De Brito, & Rodrigues, 2007). The juice market has stimulated the continuous development of new products that present good sensory acceptance and are of high nutritional value (Ameh, Gernah, Obioha, & Ekuli, 2015). There are prospects for commercialization of mixed fruit juice as a natural health beverage. This study is aimed at determining the quality characteristics of mango juice, its blend with pineapple at varying mixing ratios, and the possible cost benefit of each sample. This study aims at providing insights into possible market prospects for individuals or small groups of entrepreneurs who might want to venture into production of mango-plus beverages from blend of mango and pineapple fruits.

2. MATERIAL AND METHODS

2.1. Collection of Materials

The mango collection (Juli variety) was obtained from the NIHORT mango orchard, and the pineapples (smooth cayenne) were collected from one of the outsourced farmers.

2.2. Fruit Preparation and Formulation

The mango fruits were thoroughly washed under running tap water, peeled, and cut into smaller pieces of pulp. The pulp was blended with water at a ratio of 1:1 w/v, which was then filtered using a muslin cloth. The pineapple fruits were washed, peeled, blanched, and extracted using a juice extractor at the NIHORT pilot processing plant. The mango and pineapple juices were mixed according to the blending ratios shown in Table 1.

Table 1. Ratio of mixing mango juice with pineapple.

Samples represented with code	Mixing ratio of ingredients (Mango: Pineapple)
FKJ	1: 0
WTC	1:1
PMG	1:2
QTC	1:3

Note: FKJ = (Whole mango juice without pineapple), WTC = (Mango juice mixed with pineapple @ ratio one to one, PMG = (Mango juice mixed with pineapple@ ration one to two) and QTC= (Mango juice mixed with pineapple @ ration one to three).

Figure 1 illustrate the flow chart of mango-pineapple mixed juice production.

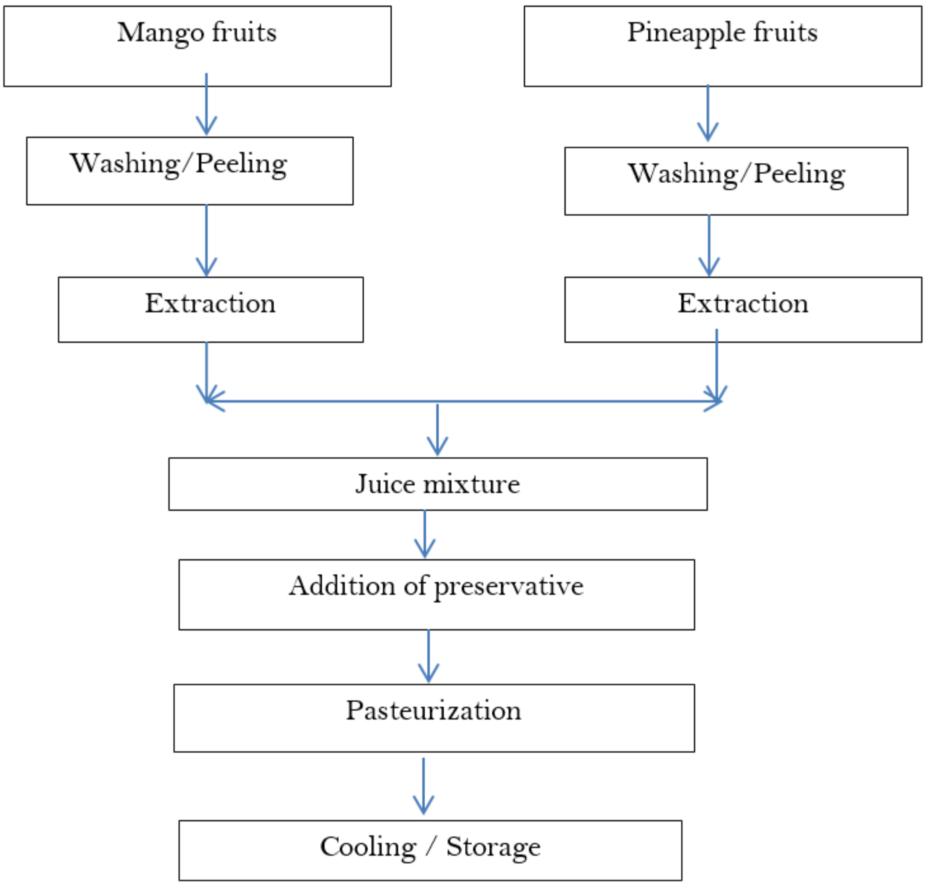

Figure 1. Flow chart of mango-pineapple blends.

2.3. Analysis

2.3.1. Proximate

The proximate analysis of the samples was carried out according to AOAC (2015) for moisture content, ash, fat, crude protein, crude fibre, and carbohydrates). Energy is calculated using the formula (Energy = {CHO*4+ Protein *4+ Fat*9}).

2.3.1.1. Total Soluble Solids (TSS)

Total soluble solid (TSS) was determined using a hand refractometer (Bellingham and Stanly, Model A85171) at 20°C according to the method of AOAC (2015), and the value obtained from the reference standard table was expressed as percentage sucrose by weight (°Brix).

2.3.1.2. Determination of pH Value

The pH of the samples was determined using digital pH meter (JENWAY 3510) according to the method reported in AOAC (2015). 10 ml of the juice sample blends were used for the calibration of the pH using standard buffer solutions of pH 4.0 and 7.0.

2.4. Determination of vitamin C

The vitamin C (ascorbic acid) was determined according to the procedures of AOAC (2015). 20 ml of the fruit juice sample was pipetted into a 250 ml conical flask; 150 ml of distilled water and 1 ml of starch solution indicator were added. The sample was titrated with 0.005 M iodine solution. The endpoint of the titration indicated a dark blue-black colour. The amount of vitamin C in the sample was calculated in mg/100 ml.

2.5. Determination of Total Phenol

Total phenolic content was determined by the Follin-Ciocalteu method: 10 mL aliquots of extract solution mixed with 1.16 mL of distilled water and 100 mL of Follin-Ciocalteu reagent, followed by the addition of Na2CO3 solution (20%). Subsequently, the mixture was incubated in a shaking incubator at 400 °C for 30 minutes, and its absorbance at 760 nm was measured.

2.6. Antioxidant Activity

Madhu (2013) reported the total antioxidant activity of the juice blends in the present work using the DPPH free radical scavenging assay method. Briefly, 12.5 µL to 100 µL/mL of samples in 0.002% methanol were prepared. Next, 2 mL of 2,2-diphenyl-1-picrylhydrazyl (DPPH) solution was mixed with 2 mL of samples. Then, the mixture was incubated at room temperature for 30 minutes. The optical density was then measured at 517 nm, and the scavenging activity was calculated using

Scavenging activity (%) = [(A-B)/A] × 100.

Where A = absorbance of DPPH and B = absorbance of the blended mix with DPPH.

2.7. Sensory Evaluation

The method described by Iwe (2010) was used. The organoleptic properties of the juice samples were evaluated by 20 semi-trained panelists randomly selected from the staff and I.T. students' of the National Horticultural Research Institute, Ibadan, Oyo State. They evaluated the sensory properties of color, taste, aroma, and overall acceptability using a seven-point hedonic scale.

2.8. Microbial Load

The compendium of methods for the microbiological examination of foods (APHA, 1992) provided the methods used to determine the total counts of bacteria, coliforms, and fungi in samples.

2.9. Statistical Analysis

The results of all determinations were expressed as means of duplicate values. Data were subjected to one-way analysis of variance (ANOVA), and significant differences were detected using the Duncan multiple range test at a 95% confidence level ($p<0.05$). An IBM SPSS Statistical Package (version 22.0) was used for all statistical analyses.

3. RESULT AND DISCUSSION

The proximate composition, which includes moisture, protein, mineral, fat, ash, fibre, carbohydrate, and energy value of the products, is as shown in Table 2. Significant differences were observed in the chemical compositions of the products at ($p<0.5$). Sample QTC, which was a mango and pineapple blend at a ratio of 1:3, had the highest ash content (1.64%). The value was higher than FKJ (1.00%), WTC (1.43%), and PMG (1.46%). The energy, which is one of the important quality indexes of fruit juice beverages, was between (30.95 kcal/100 mL - 54.27 kcal/100 mL). Sample QTC has the highest energy value (54.27 kcal/100 ml) and was significantly higher ($p< 0.5$) than PMG (50.5kcal/100mL) WTC (44.03 kcal/100mL), and FKJ (30.95 kcal/100mL). Ash value represents the total mineral content of the food product, which contributes to nutritional quality. Minerals are essential for various physiological functions in the human body, including bone health, nerve function, muscle contraction, and fluid balance. They fulfill a wide variety of functions in the optimal functioning of the immune system (Weyh, Krüger, Peeling, & Castell, 2022). Therefore, knowing the ash content of a product can provide an insight into the mineral strength of the food. The human body needs a certain amount of minerals everyday to build strong bones and muscles. These minerals also contribute to the maintenance of good health. Moreover, kilocalories, a measure of energy, significantly contribute to the nutritional composition of fruit juice. It plays a significant role in several aspects related to health, nutrition, and consumer satisfaction. Energy provides the body with the fuel needed to carry out various physiological functions, including metabolism, physical activity, and cellular processes (Jaiswal et al., 2019). Although each of the products has some measure of energy value that can contribute to the daily energy requirement, the product sample QTC (1:3) had the highest energy value, perhaps due to the greater inclusion of pineapple in the mix.

Table 2. The effect of blend on chemical composition of mango and pineapple beverage.

Parameter	Samples			
	FKJ	WTC	PMG	QTC
Moisture (%)	90.96±0.01^{d}	87.76± 0.01^{c}	86.39± 0.01^{b}	85.51± 0.01^{a}
Protein (%)	0.53± 0.01d	0.64± 0.01c	0.65± 0.01b	0.68± 0.01a
Fat (%)	0.19± 0.01^{d}	0.31± 0.01^{c}	0.49± 0.01^{b}	0.70± 0.01^{a}
Ash (%)	1.32±0.01^{a}	1.43± 0.01^{a}	1.46± 0.01^{a}	1.64± 0.01^{a}
Fibre (%)	0.22±0.01^{d}	0.19± 0.01^{c}	0.13± 0.01^{b}	0.16± 0.01^{a}
Carbohydrate (%)	6.78±0.01^{d}	9.67±0.01^{c}	10.88±0.11^{b}	11.31±0.01^{a}
Energy (kcal/100mL)	30.95± 0.01^{d}	44.03± 0.01^{c}	50.53± 0.01^{b}	54.27± 0.01^{a}
Vitamin C (mg/100mL)	12.15 ± 0.01^{d}	12.56 ± 0.01^{c}	12.65 ± 0.01^{b}	13.33 ± 0.01^{a}
Total phenol (mg/100mL)	204.44± 0.01^{d}	224.220± 0.01^{c}	244.22± 0.01^{b}	249.50± 0.01^{a}
Antioxidant activity (%)	50.11± 0.11^{d}	52.88± 0.01^{c}	54.42± 0.01^{b}	60.68± 0.02^{a}

Note: Values are means ± standard deviation of duplicate determinations. Values with common superscripts (a, b, c, & d) in the same column of the table do not differ significantly @ ($p > 0.05$).

Figure 2 summarizes the product's °Brix value which is also known as (TSS) and pH values. The °Brix value was between (7.00%–11.00%) and the pH was between (3.58-3.75). The brix level showed that samples QTC (1:3) had the highest brix value (11.0%) and were significantly higher than WTC (9.47%), PMG (9.30%), and FKJ (7.00%), respectively. The highest pH value (3.75) was observed in sample QTC, although it was not significantly different from WTC (3.65), PMG (3.74), and FKJ (3.75) at $p <0.05$. The Brix of a product is a measure of the sugar content in the product, usually expressed in degrees Brix (°Bx). The food and beverage industry, particularly in fruit juice production, uses the Brix level, which directly correlates with sweetness, to evaluate the quality and sweetness of the juice. Higher Brix levels indicate higher sugar content, resulting in a sweeter taste. Consumers' often associate sweetness with quality in fruit juices, so maintaining an optimal Brix level ensures that the juice has a desirable flavor profile. The group of judges participating in the sensory evaluation most preferred the QTC with the highest brix level (11.0%) in this sample.

The pH values as observed with the samples were within the expected range and were within the range observed by Kumar et al. (2022) in evaluating the pH of various commercially available beverages in Pakistan. The pH of a beverage plays a crucial role in the safety and preservation of fruit juice. It is an important parameter in juice preservation; variations in pH can influence flavor, consistency, and shelf life. Fruit juices usually have low pH values that range between 2.0 and 4.5 due to the presence of organic acids that vary within the different types of juices. Therefore, in order to maintain consistency in the quality of juice, the measurement of pH is important. Low pH levels inhibit the growth of pathogenic microorganisms, such as bacteria and molds, reducing the risk of foodborne illnesses and spoilage (Cendrowski, Przybył, & Studnicki, 2023). Therefore, maintaining an acidic pH is essential for ensuring the microbiological safety and shelf stability of fruit juice products (Omeiza, Egu, & Ologun, 2017).

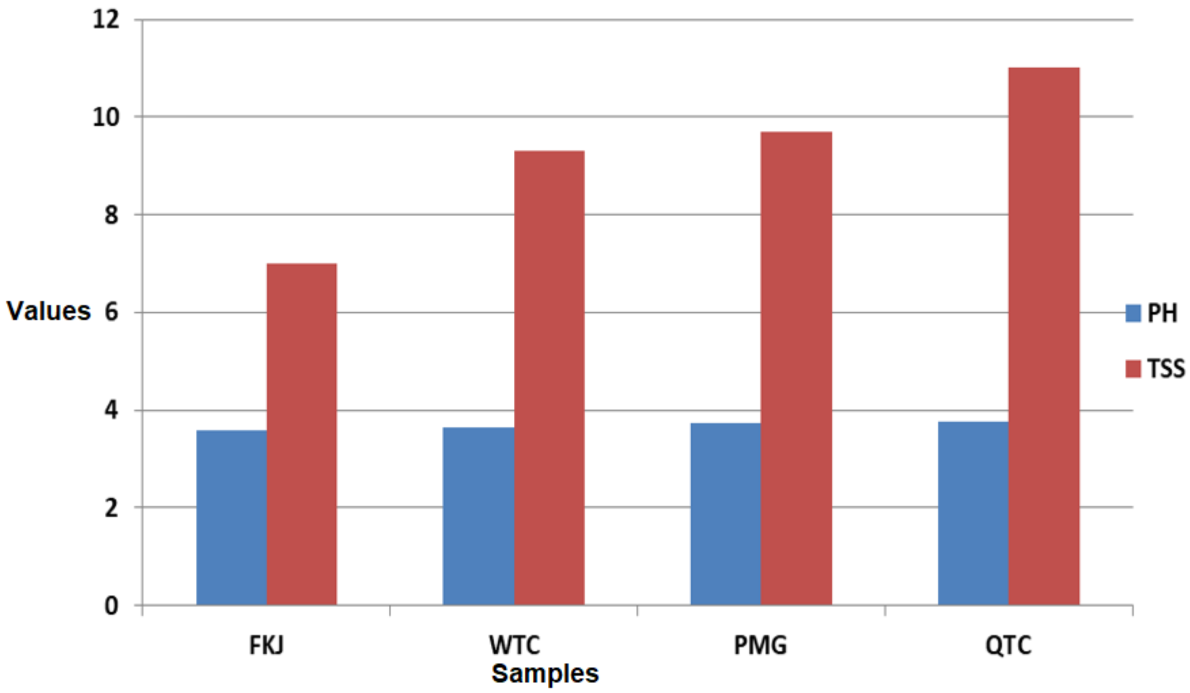

Figure 2. pH and TSS of mango and pineapple blends.

The vitamin C, total phenol, and antioxidant activity compositions as observed in the samples are as presented in Table 2. The vitamin C concentration ranged between (12.15 mg/100 mL- 13.33 mg/100 mL) while total phenol and antioxidant activity were between (204.44 mg/100 mL-249.50 mg/100 mL) and (50.11 mg/100 mL -60.68 mg/100 mL) respectively. Sample QTC has the highest vitamin C (13.33 mg/mL) which is higher than FKJ (12.15 mg/100 ml) which has the lowest value. Similarly, QTC (1:3) has the highest phenol (249.50 mg/100 ml) significantly higher than WTC (224.22 mg/100 mL), PMT (244.22 mg/100 mL) and FKJ (204.44 mg/100 mL).

Vitamin C, also known as ascorbic acid, is an essential dietary nutrient for a variety of biological functions; it is vital in the biosynthesis of collagen in bones, cartilage, muscle, and blood vessels. Vitamin C is a potent free radical scavenger, protecting cells against oxidative damage (Grosso et al., 2013). The daily recommended allowance for vitamin C is 90 mg/day for adults and 75 mg/day for women (Zieve, 2009). Sufficient intake of both mango and mango-pineapple mix beverages can contribute to the daily vitamin C requirement. Likewise, phenols are the major dietary constituents in fruits and vegetables that exhibit antioxidant properties (Arogba & Omede, 2012). In addition to their antioxidant activity, phenols have many other health benefits. Some studies strongly suggest that diets rich in polyphenols may offer protection against the development of certain cancers, cardiovascular diseases, diabetes, and neurodegenerative diseases. Phenols are strong antioxidant compounds and vitamins that defend the body against the damaging effects of free radicals. Consuming a diet rich in phenol-containing foods has been associated with a reduced risk of heart disease (Arogba & Omede, 2012; Chandrasekara & Shahidi, 2011). The higher concentration of phenol in the blend of mango and pineapple may be due to the synergetic contribution of the two fruits. The sample with the highest concentration of phenol also exhibited greater antioxidant activity (Table 2). The high content of phenols and vitamin C might have contributed to the high antioxidant potential of the sample QTC.

Table 3 summarizes the sensory profiles of the samples, which include color, taste, aroma, and overall acceptability. For fruit beverages, colour, aroma, and taste are the basic attributes determining the sensory quality. Twenty participants in a consumer preference test received samples. The test was a pilot test to detect unacceptable attributes that could indicate defects in the technological process. The participants were recruited from staff and I.T. students of the National Horticultural Research Institute (NIHORT) in Ibadan based on their availability and interest in participation in this study. All assessors were familiar with the test format (questionnaire) and were trained in the attributes assessed. They were asked to follow the instructions on the questionnaire. A seven-point (7) hedonic scale was used for ranking. After the evaluations, the score ranges were as follows: color (5.1–5.5), taste (4.0–6.1), aroma (4.4–6.0), and overall acceptability (4.3-6.2), respectively. Sample QTC had the highest taste (6.1), aroma (6.0), and overall acceptability (6.2) out of a scoring scale of 7.0 (Table 3).

Table 3. The effect of blend on Sensory profile of mango and pineapple beverage.

Samples	Colour	Taste	Aroma	Over acceptability
FKJ	5.5 ± 0.98^{a}	4.0 ± 1.13^{d}	4.4 ± 0.97^{cd}	4.3 ± 1.23^{d}
WTC	5.5 ± 1.24^{a}	4.5 ± 1.13^{c}	4.55 ± 1.23^{c}	5.1 ± 1.24^{c}
PMG	5.1 ± 1.24^{b}	5.3 ± 1.17^{b}	$5.5+1.12^{b}$	$5.4+1.13^{b}$
QTC	$5.2+1.37^{a}$	$6.1+1.32^{b}$	$6.0+1.39^{c}$	$6.2+0.87^{a}$

Note: Values are means ± standard deviation of duplicate determinations. Values with common superscripts (a, b, c, & d) in the same column of the table do not differ significantly @ ($p > 0.05$).

Table 4 lists the microbial load counts found in the glass bottle package. The microbial test was done to ascertain the suitability or otherwise of the samples for human consumption for the period under evaluation. Colony-forming units (cfu/ml) represent the acceptable limits of microbial contamination in high-quality fruit juice.

The total bacteria count (TBC) was between 0.5×103 cfu/mL and 1.6×103 cfu/mL, the total fungi count (TFC) was between 0.1×103 cfu/mL and 0.2×103 cfu/mL, and there was no coliform detected. The total viable count in fruit juice refers to the total number of viable microorganisms present in the juice. This count includes bacteria, yeast, and molds that are capable of growing and reproducing under suitable conditions. The TVC is an important indicator of the microbiological quality of fruit juice and is used to assess its safety and shelf life. The acceptable limits of microbial contamination in high-quality fruit juice are measured in colony-forming units per milliliter (CFU/ml) of juice. The microbiological limit in fruit juices and nectars, according to (APHA (American Public Health Association), is a maximum of 103 cfu/mL. The microbial loads in the entire sample are within the acceptable limit. The samples were safe for consumption during the study period because all recorded counts fell within the specified acceptable limits.

Table 4. Microbial load of mango and pineapple blends in a glass bottle package stored @ room temperature.

Samples	Days						Interval											
	0			7th day			14th day			21th day			28thday				42thday	
	TBC	TCC	TFC	TBC	TCC	TFC	TBC	TCC	TFC	TBC	TCC	TFC	TBC	TCC	TFC	TBC	TCC	TFC
FKJ	$0.6*10^3$	NG	NG	$0.6*10^3$	NG	NG	$1.6*10^3$	NG	NG	$1.6*10^3$	NG	NG	$1.6*10^3$	NG	NG	$1.6*10^3$	NG	$0.2* 10^3$
WTC	$0.6*10^3$	NG	NG	$0.6*10^3$	NG	NG	$1.0*10^3$	NG	NG	$1.0*10^3$	NG	NG	$1.0*10^3$	NG	NG	$1.0*10^3$	NG	$0.1*10^3$
PMG	$0.6*10^3$	NG	NG	$0.6*10^3$	NG	NG	$0.8*10^3$	NG	NG	$0.8*10^3$	NG	NG	$0.8*10^3$	NG	NG	$0.8*10^3$	NG	$0.1*10^3$
QTC	$0.5*10^3$	NG	NG	$0.5*10^3$	NG	NG	$0.8*10^3$	NG	NG	$0.8*10^3$	NG	NG	$0.8*10^3$	NG	NG	$0.8*10^3$	NG	$0.1*10^3$

Note: TBC = Total bacteria count.
TCC = Total coliform counts.
TFC = Total fungus counts.
NG = No growth of bacteria.

The results of the cost-benefit analysis for mango and its blend with pineapple at different ratios are presented in Tables 5, 6, 7, and 8. Businesses, governments, and organizations use a cost-benefit analysis (CBA) as a systematic process to access the potential costs and benefits of a project, policy, or decision. It involves comparing the total costs associated with a particular course of action to the total benefits expected to be gained. For single-strength mango, the processing of 1000 kg of fresh mango is capable of generating 600 liters of mango juice. The estimated total cost and revenue from processing 1000 kg of fresh mango into juice were N 379, 500 and N 540, 000, respectively. The net profit was 160,500, while the rate of return on investment was 0.4 with a benefit-to-cost ratio of 1.4. The benefit-to-cost ratio of 1.4 implied that for every naira invested in the enterprise, 1.40 will be realized, while the rate of return on investment of 0.4 indicated that every naira invested in the processing of mango into juice returned 0.4k as profit. Table 5 demonstrates the profitability of processing mango into juice. The total cost and revenue incurred in the production of mangoes and pineapples in the ratio of 1:1 were 941,080 and 1,200,000. The anticipated net profit is N258, 920. The benefit-to-cost ratio and rate of return of 1.3 and 0.3 showed that the processing of mango and pineapple is profitable and worth investing in the business.

(Table 6). The total cost and revenue incurred in the production of mangoes and pineapples in the ratio of 1:2 were N1, 551,550 and N2, 250,000. It is anticipated that a net profit of N698, 450 will be attainable. The benefit-to-cost ratio and rate of return of 1.5 and 0.5 showed that the processing of mango and pineapple is profitable and worth investing in the business (Table 7). The total cost and revenue incurred in the production of mangoes and pineapples in the ratio of 1:3 were N2, 151,784 and N3, 300,000. It is anticipated that a net profit of N1, 148,216 will be attainable. The benefit-to-cost ratio and rate of return of 1.5 and 0.5 showed that the processing of mango and pineapple is profitable and worth investing in the business (Table 8).

Table 5. Cost and benefit of mango juice production (Mango only).

S/N	Items	Quantity and price ₦	Amount ₦
1	Mango	1000kg of mango at 100/kg	100,000
2	Sodium-benzoate	Sodium benzoate (0.3g/Litre) @10per litere (600 litre)	6,000
3	Citric acid	Citric acid (0.3gllitre) @ #10 for 600 liter production	6,000
4	Gas	Gas 40 kg @ 1000/kg	40,000
5	Label	1,800 @ N10/Label	18,000
6	Labour	10 Man-days @ 2,000/Day	20,000
7	Bottle	Bottle 700/Dozen for 150 dozens	105,000
8	Transportation	Expenses on procurement of materials	30,000
9	Depreciation on fixed assets (Knife, buckets, aluminium sieve, gas cylinder and stove)		20,000
	Sub-total	Cost of all the above items	345,000
10	Miscellaneous (10%)	Other expenses not probably provided for.	34,500
11	Cost of total item+10% miscellaneous		379,500
Revenue from sales			
12	600 litres will give 1,800 bottles	@ N300/Bottle	540,000
12	Profit (Total revenue – Total cost)	(Total revenue – Total cost)	160,500
13	Benefit to cost ratio (TR/TC)	$\frac{\text{Total Revenue}}{\text{Total cost}}$	1.4
	Return on investment TP/TC	$\frac{\text{Total profit}}{\text{Total cost}}$	0.4

Table 6. Cost and benefit of mango plus production (1 Mango: 1 Pineapple).

S/N	Items	Quantity and price	Amount
1	Mango	1000kg of mango at #100/kg	100,000
2	Pineapple (1375)	1375 kg of pineapple at #300/kg	412,500
3	Sodium benzoate	Sodium benzoate (0.3g/Lire) @10per litter for 1000 litres	10,000
4	Citric acid	Citric acid (0.3gllitre) @ #10 for 1000litre production	10,000
5	Gas	Gas 34 kg @ 1000/kg	34,000
6	Label	3,000 @ N10/label	30,000
7	Labour	12 Manday @ 2,000/Day	24,000
8	Bottle	Bottle 700/Dozen for 250 dozen	175,000
9	Transportation	Expenses on running around to procure materials	30,000
10	Depreciation on fixed assets (Knife, buckets, aluminium sieve, gas cylinder and stove)		30,000
	Sub-total	Cost of all the above items	855,500
	Other exigencies (10%)	Other expenses not probably provided for	85,580
	Total cost	Cost of item plus other exigencies	941,080
11	1000 litres of juice will give 3,000 bottles	3,000 @ N400/Bottle	1,200,000
12	Profit	Total revenue – Total cost	258,920
13	Benefit to cost ratio	Total Revenue / Total cost	1.3
14	Return on investment	Total profit / Total cost	0.3

Table 7. Cost and benefit of mango plus production (1 Mango: 2 Pineapples).

S/N	Items	Quantity and price	Amount
1	Mango	1,000kg of mango at #100/kg	100,000
	Pineapple	2750kg of PINEAPPLE at #300/kg	825,000
2	Sodium benzoate	Sodium benzoate (0.3g/Lire) @10per litter for 1,500 litres	15,000
3	Citric acid	Citric acid (0.3gllitre) @ #10 for 1,500 litre production	15,000
4	Gas	Gas 50kg @ 1000/kg	50,000
5	Label	4,500 bottles @ N10/Label	45,000
6	Labour	14 manday @ 2,000/Day	28,000
7	Bottle	Bottle 700/Dozen for 375 dozen	262,500
8	Transportation	Expenses on running around to procure materials	40,000
9	Depreciation on fixed assets (Knife, buckets, aluminium sieve, gas cylinder and stove)		30,000
	Sub-total	Cost of all the above items	1,410,500
	Other exigencies (10%)	Other expenses not probably provided for	141,050
	Total cost	Cost of item plus other exigencies	1,551,550
10	Revenue from sales		
11	1,500 litres of mango plos produced into 4,500 bottles	@ N500/Bottle	2,250,000
12	Profit	Total revenue – Total cost	698,450
13	Benefit to cost ratio	Total Revenue / Total cost	1.5
14	Return on investment	Total profit / Total cost	0.5

Table 8. Cost and benefit of mango plus production (1 Mango: 3 Pineapple).

S/N	Items	Quantity and price	Amount
1	Mango	1000kg of mango at #100/kg	100,000
	Pineapple (4125 kg)	4,125kg of PINEAPPLE at #300/kg	1,237,500
2	Sodium benzoate	Sodium benzoate (0.3g/Lire) @10per litter for 2,000 litres	20,000
3	Citric acid	Citric acid (0.3gllitre) @ #10 for 2000 litre production	20,000
4	Gas	Gas 66.7kg @ 1000/kg	66,667
5	Label	6,000 @ N10/Label	60,000
6	Labour	16 manday @ 1,500/day	32,000
7	Bottle	Bottle 700/Dozen for 20 dozen (500 dozens)	350,000
8	Transportation	Expenses on running around to procure materials	40,000
9	Depreciation on fixed assets (Knife, buckets, aluminium sieve, gas cylinder and stove)		30,000
	Sub-total	Cost of all the above items	1,956,167
	Other exigencies (10%)	Other expenses not probably provided for	195,617
	Total cost	Cost of item plus other exigencies	2,151,784
10	Revenue from sales of 6,000 b0ttles produced	@ 550/Bottle	3,300,000
11	Profit	(Total revenue – Total cost)	1,148,216
12	Benefit to cost ratio	Total revenue / Total cost	1.5
13	Return on investment	Total profit / Total cost	0.5

4. CONCLUSION

The blend of mango and pineapple juice showed a high amount of energy and antioxidant capacity that establishes their potential as functional beverages vital in health promotion. The blending of the fruit juices improved the sensory attributes and subsequently consumers' acceptance. This study also provides information highlighting the quality attributes of blends of mango with pineapple juices. Additionally, it provides a guide to the beverage industry in the development of new functional beverages, improving the utilization of these fruits and becoming a source of income generation for the producers as well as retailers.

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