Original Research Article

Physicochemical and Sensory Characteristics of Mixed Fruit Juices prepared from Blend of Pineapple, Pawpaw, and Watermelon Fruits juices

Abstract
This study investigated the production of mixed fruit juices from pawpaw, watermelon and pineapple fruits. , pawpaw and watermelonfruits.Fresh ripe fruits (pineapple, watermelon and pawpaw and watermelon) were washed, manually peeled, deseeded, sliced, squeezed and sieved to obtain pineapple, watermelon and pawpaw juicepawpawand watermelonjuice. The prepared juices were pasteurized at 85 °C for 15 s,sec., packaged in air-tight plastic cans. The pineapple, watermelon and pawpaw juiceand watermelonjuice were blended in ratios of 100:0:0;0:100:0; 0:100:0; 20:20:60:20; 33.33:33.33:33.33; 60:20:20 and 40:30:30 %.The juice samples were evaluated for physicochemical and sensory characteristics using standard procedures. The sensory results showed colour rating of (6.33 - 7.22), flavour (6.11 – 7.78), taste (6.44 – 7.78), and general acceptability of(6.89 – 8.00). Sample 100% PIN was rated the best(8.00)in general acceptability. However, all the juice samples were generally accepted. The physicochemical results showed the following range of values for titrabletitratable acidity (0.60 - 1.21%), total soluble solids (8.10 - 15.55 %), total sugar (7.22 - 9.51 %), pH (4.05 - 5.30) and vitamin C (4.80-17.00 mg/100g). Generally, the juice samples were within the regulatory specifications, and acceptable. The study showed that fruit juice with good physicochemical and sensory qualities could be formulated using pineapple, watermelon andusingpineapple, pawpaw andwatermelon blend. The formulatedfruit juicescould find domestic and industrial applications.
Keywords:,Fruit Juice, pineapplePineapple, Pawpaw Physicochemical, Sensory and Watermelon,Sensoryproperties

Introduction

“Fruits are essential component of human diet because of their nutritional and health benefits. They are packed with vitamins, minerals, anti-oxidants and many phytonutrients” (Agbaje*et*Agbaje *et al*., 2020; Bhardwaj *et al*.,2014). Fruits can be consumed fresh or squeezed into juice either for immediate consumption or for future use. They add variety to our menu and a delight to our sight because of their colour or flavor.Nigeria is blessed with variety of fruits such as pineapples, bananas, mangoes, oranges, watermelon, pawpaw, soursop among others. These fruits are highly perishable leading to post harvest loss. Hence, fruits are traditionally and commercially processed into products such as wine, fruit juice, jam, jelly and alcoholic drinks to extend the shelf-life.

“Fruit juices are liquid, non-alcoholic drink produced with a different degree of clarity and viscosity, obtained through squeezing of the fruits with or without addition of sugar or carbondioxide” (Opeifa*et al*., 2015). “Fruit juices are low in calories and fat;they are excellent source of simple sugars, dietary fibre, essential vitamins, minerals, amino acids and bioactive phytonutrients” (Agbaje*et al*., 2020; Bhardwaj *et al*.,2014). Mixed fruit juices are liquid, non-alcoholic drink produced from the blends of fresh fruit juicejuices such as orange, tangerine, banana, watermelon, pineapple and others. Low consumption of fruits could be due to lack of awareness of the nutritional and health benefits as well as lack of postharvest management to extend the shelf-life. Fruits are high in antioxidants. Daily intake of fruits is reported to protect the body and reduce the risk of cardiovascular disease, neurodegenerative disease, aging, cancer, skin related diseases, oxidative stress, and inflammation (Awsi Jan and Dorcus 2012; Chong *et al.*,2010).

"Pineapple (Ananascomosus) is an economically important plant in the Bromelanceae family that includesaboutincludes about 50 genera and 2000 species" (Agbaje*et*Agbaje *et al.*,2020). "Pineapple and its juice is non-alcoholic drink and the demand continues to rise mainly due to increasing awareness of its health benefits" (Nwachukwu and Ezejiaku, 2014). "Pineapple juice has a proximate composition of 81.2 – 86.2% moisture, 13 – 19% total solid of which sucrose, glucose and fructose are the main compositions, 0.4% fibrefiber and a rich source of vitamin C" (Agbaje*et*Agbaje *et al.*, 2020). "Its pulp is juicy and fleshy with the stem serving as a supporting fibrous core.Pineapple contains polyphenolic compounds and possesses antioxidant activity. It is an excellent source of vitamin C which is vital for the collagen synthesis in the body" (Agbaje*et*Agbaje *et al.*, 2020). "Pineapple juice is popularly consumed worldwide, as canning industry by-products and in the blend composition to obtain new flavours in beverage and other products" (De-Garvalho*et al.*, 2007).

"Pawpaw (*Carica papaya*) is grown mostly for fresh consumption or for production of latex. Pawpaw plants produce natural compounds (annonaceous, acetogenins) in leaf bark and twig tissues that possess both highly anti-tumour and pesticidal properties" (Nwachukwu and Ezejiaku, 2014). "The papaya fruit, as well as all other parts of the plant, contain a milky juice in which an active principle known as papain is present that has value as a remedy in dyspepsia and has been utilized for the clarification of beer. The juice has been in use on meat to make it tender" (De-Garvalho*et*Garvalho *et al.*, 2007). The unripe fruit is used as a remedy for ulcer and impotence. It cleans bacteria from the intestines and hence encourages the absorption of vitamins and minerals, especially vitamin B12.

"Watermelon (*Citrulluslanatus*) is a fruit which belongs to the family of Cucurbitaceae and contain about 95% water. The fruit is round with reddish mesocarp having a lot of seeds. There are various species with different colored endocarp, for example, red flesh, yellow flesh, and orange flesh" (Onyekwelu, 2017). Watermelon contains vitamins B1 and B6, potassium, calcium, iron, zinc and magnesium Teraka and Khaled (2001) in addition to vitamin A and C which are generally common to all fruits and vegetables (Abdelwahab*et al.*, 2011). "Watermelon (*Cochlioboluslunatus*) is rich in carotenoids some of which include lycopene, phytofluene, phytoene, beta-carotene, lutein and neurospnene"(Onyekwelu, 2017).

Pawpaw and watermelonhave attractive colour while pineapple has a distinctive appealing flavor, taste and in addition to their health benefits. Due to an increase in the demand for fruit juice and vegetable beverage with the original characteristics of the fresh fruit beverage free from chemical additives in the potential food market. Blending of the three fruits couldyield products with improvedquality with a simple technology. So the aim of This paper investigated theis to investigatethe physicochemical properties and consumer acceptability of mixed fruit juices fromfrompineapple, pawpaw, and watermelon and pineapple.

Materials and Method

Sample collection:

Sound and freshlyFreshly harvested ripe fruits of pineapple, watermelon and pawpaw wereand watermelonwere obtained from an accredited farmer in UnwanaEbonyi state.

Processing of Raw Materials:

The fruits (pawpaw and watermelon and pawpaw) werethoroughly washed with potablewater to remove foreign extraneous materials. They were manually peeled using stainless kitchen knife and the seeds were separated from the pulp. The pulp was sliced and then mashed with a mechanical blender (Blixer 4 V.V., Robot Couple, France) to obtain a smooth paste. The blended pulp was transferred into a clean muslin cloth then pressed with a fruit pulp presser (50 PI, VoranMaschinen GmbH, Austria) to separate the juice from the pulp to obtain watermelon and pawpaw juiceand watermelonjuice.On the other hand, the pineapple was thoroughly washed with potable water, peeled with stainless knife and thereafter sliced. The sliced pulp was blended and sieved to obtain pineapple juice. The individual fruit juices were mixedblended at different ratio to obtain mixed fruit juices.

The blended juice ratio is as shown in chart 1 below.

Chart 1. Blended Ratio

Treatment	Pineapple (%)	Watermelon(%)	Pawpaw (%)
A	100	0	0
B	0	100	0
C	0	0	100
D	20	60	20
E	33.33	33.33	33.33
F	60	20	20
G	40	30	30
Control (Commercial fruit Juice)			

The mixed fruit juices were pasteurized at 9585°C for 15 minutes and subsequently filled into plastic cans. They were stored in the refrigerator for further analysis.

Sensory evaluation

Sensory evaluation of all the juice samples was carried out by 30 semi-trained panelists of both genders selected from the Department of Food Technology, Akanu Ibiam Federal Polytechnic Unwana according to Kalu *et al*., (2020). The panelists were briefed about the experiment before assessing the sensory characteristic of the mixed juice samples. The samples were evaluated for colour, flavour, taste, and overall acceptability. A 9-point hedonic scale where 9 = like extremely, 8 = like very much, 7 = like moderately, 6 = like slightly, 5 = neither like nor dislike, 4 = dislike slightly, 3 = dislike moderately, 2 = dislike very much, 1 = dislike extremely was used for the sensory attributes. The panelists were randomly served with about 30 mL of each juice mix in transparent plastic cups for evaluation. They were given water to rinse the mouth after each sampling.

Physicochemical properties

From the sensory evaluation resultresults, fruit juices withjuice sampleswith the best sensory attributes were selected and analyzed for their physicochemical properties.

Determination of titratable acidity:

Titratable acidity of the fruit juice samples was determined using the method described by AOAC (2010). Exactly 5 mL of the mixed fruit juice was titrated with standardized 0.1 N sodium hydroxide (NaOH) solution.Phenolphthalein (0.5 mL) indicator was used for the titration to a pink end point, which persisted for 30 seconds.

Determination of vitamin C:

The 2,6dichlorophenol titrimetric method as described by AOAC (2010) was used. The sample (2 mL) was extracted by homogenizing sample in acetic acid solution. The standard solution was prepared by dissolving 50 mg of ascorbic acid in 100 mL of water. The solution was filtered to get a clear solution. Then, 10 mL of the filtrate was added into a flask in which 2.5 mL acetone had been added. This was titrated with indophenols solution (dye 2,6, dichlorophenol indophenols) to a faint pink color which persisted for 115 seconds. The standard was treated identically.

Calculation mg ascorbic acid/ml = C × V × DF/WT

Where; C = mg ascorbic acid ml dye; V = volume of dye used for titrate of diluted sample;

DF = Dilution factor; WT = volume of sample in mL

Total soluble solids :

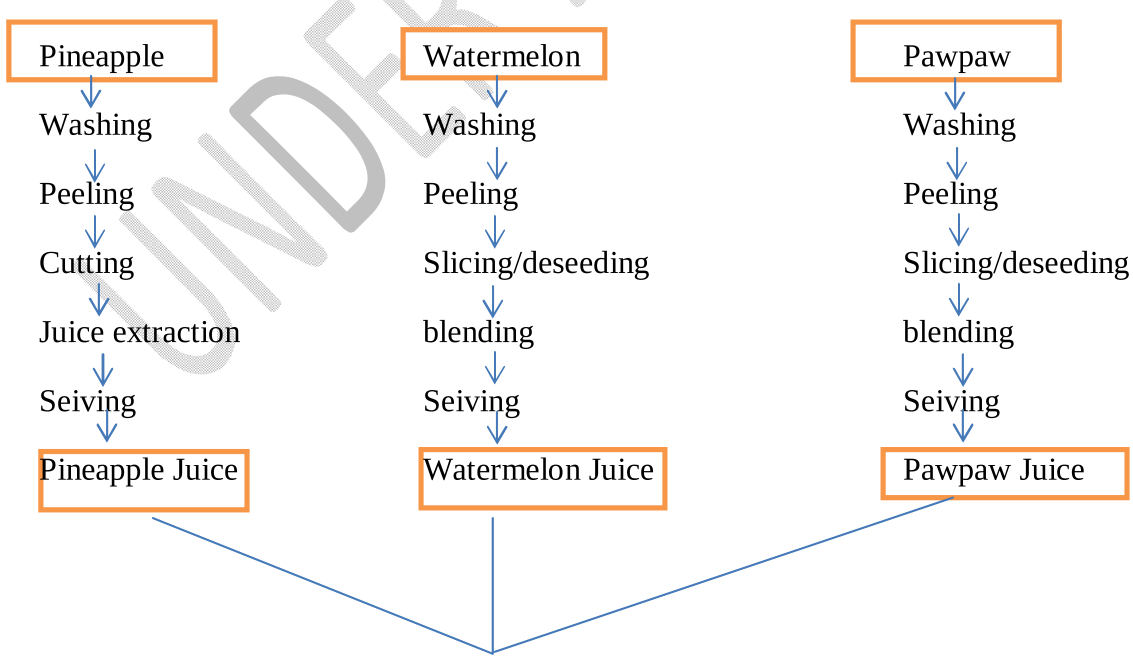
Total soluble solids (TSS) in the fruit juice samples was measured as°Brix using a digital refractometer (ATAGO, Japan) with TSS ranging between 0 and 88 °Brix and a precision of 0.1 °Brix. The refractometer was standardized before each TSS measurement.

pH determination

The pH of the fruit juice samples was determined using an electronic pH meter (Model PHN-850, Villeur-Banne, France)with 0.01 precision according to the method of Gulzar(2011). The pH meter was standardized with buffers of pH 10.0, 7.0 and 4.0 prior to the determination. Into a clean beaker, 5 mL of the fruit juice samples were measured; a glass pH electrode was dipped into the beaker and the readings were taken.

Statistical analysis

A completely randomized experimentation technique was utilized to avoid systematic errors. Evaluation of significant difference among means at a 5% significant level by the Duncan's Multiple Range Test was performed using the SPSS version 17(SPSS Inc., Chicago,III, USA).



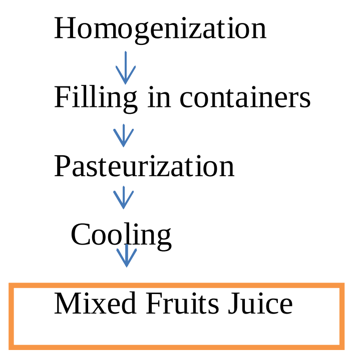


Fig 1: flow chart for the production mixed fruits juice.

Results and Discussion:

Sensory properties of mixed fruit juice

The sensory attributes of the mixed fruit juice are presented in Table (1). The results showed that There were no significant differences ($p<0.05$) among the samples. The choice was based on how the colours appealed to the panelists. The colour ranged between 6.33 and 7.22. Sample 40%PIN+30%PAW+30%WAMhad the highest mean score in colour (7.22) while 60%PIN+20%PAW+20%WAM had the least mean score (6.33). Blending the fruits juice may have improved the colour.

The sensory scores for flavor ranged from 6.11 to 7.78 with 40%PIN+30%PAW+30%WAM being the more preferred where 100%PAW was the least preferred. Few significant differences ($p<0.05$) existed among the juice samples. The taste scores ranged between 6.44 and7.78. The control(Commercial fruit juice) was most preferred by the panelists (7.78) while 40%PIN+30%PAW+30%WAM and 20%PIN+20%PAW+60%WAM were least preferred. Few significant differences ($p<0.05$) existed among the samples. General acceptability rating was between 6.89 and 8.00. Sample 100%PIN had the highest mean score (8.00) while 60%PIN+20%WAM+20%PAW had the least mean score (6.89). There were no significant ($p>0.05$) differences among the samples in terms general acceptability. It was found that, the 100%PIN, 100%PAW, 100% WAM and 33.3%PIN+33.3%PAW+33.3%WAM samples were the best fruit juice samples that had a good sensory attributes and were generally accepted by the panelists.

Table 1: Sensory Evaluation of JuiceFruitJuice Samples

PIN%	WAM %	PAW %	colour	flavour	Taste	General acceptability
PIN%	PAW%	WAM %	Colour	flavour	Taste	General acceptability
100	0	0	6.56 ± 0.52^{a}	7.44 ± 0.52^{ab}	7.33 ± 0.86^{ab}	8.00 ± 0.00^{a}
0	100	0	6.67 ± 1.32^{a}	7.00 ± 0.00^{bc}	7.00 ± 0.00^{ab}	7.00 ± 0.70^{b}
0	0	100	7.00 ± 0.00^{a}	6.11 ± 0.78^{e}	6.89 ± 1.16^{ab}	7.00 ± 0.00^{b}
20	60	20	7.00 ± 0.70^{a}	6.33 ± 0.86^{de}	6.44 ± 1.42^{b}	7.00 ± 0.70^{b}
0	0	100	6.67 ± 1.32^{a}	7.00 ± 0.00^{bc}	7.00 ± 0.00^{ab}	7.00 ± 0.70^{b}
0	100	0	7.00 ± 0.00^{a}	6.11 ± 0.78^{e}	6.89 ± 1.16^{ab}	7.00 ± 0.00^{b}
20	20	60	7.00 ± 0.70^{a}	6.33 ± 0.86^{de}	6.44 ± 1.42^{b}	7.00 ± 0.70^{b}
33.33	33.33	33.33	7.11 ± 1.26^{a}	6.78 ± 0.83^{cd}	6.67 ± 1.22^{b}	7.00 ± 0.00^{b}
60	20	20	6.33 ± 0.86^{a}	6.22 ± 0.44^{de}	6.56 ± 0.52^{b}	6.89 ± 1.16^{b}
40	30	30	7.22 ± 0.44^{a}	7.78 ± 0.44^{a}	6.44 ± 0.52^{b}	7.00 ± 0.00^{b}
CONTROL			6.56 ± 0.52^{a}	7.22 ± 0.44^{ab}	7.78 ± 0.44^{a}	7.44 ± 0.52^{b}

Where PIN – pineapple; PAW – pawpaw juice; WAM – watermelon juice; PIN – pineapple; CONTROL-commercial fruit juice

. Values are means ± standard deviation (n=5). Values with the same superscript on the same row are not significantly different ($p>0.05$).

Table 2: Physicochemical characteristics of Juice Samples

PIN%	WAM%	PAW%	pH	TSS°Brix	TTA %	Total sugar %	VitaminC mg/100 g
0	0	100	5.30 ± 0.14^{a}	15.55 ± 0.35^{a}	0.90 ± 0.00^{c}	7.22 ± 0.02^{a}	7.20 ± 0.00^{b}
0	100	0	4.65 ± 0.07^{c}	11.50 ± 0.71^{b}	1.12 ± 0.01^{b}	9.16 ± 0.63^{b}	5.30 ± 0.00^{c}
100	0	0	4.05 ± 0.07^{d}	10.85 ± 0.21^{b}	1.21 ± 0.01^{a}	9.28 ± 0.03^{c}	4.80 ± 0.00^{c}
33.3	33.3	33.3	4.95 ± 0.07^{b}	8.10 ± 0.14^{c}	0.60 ± 0.00^{d}	9.51 ± 0.00^{b}	17.00 ± 0.00^{a}

PAW – pawpaw juice; WAM – watermelon juice; PIN – pineapple;

2. The results showed that the colour ranged between 6.33 and 7.22.Sample 40%PIN+30%WAM+30%PAW had the highest(7.22) mean score in colour while 60%PIN+20%WAM+20%PAW had the least (6.33) score.There were no significant differences ($p<0.05$) among the samples. Blending the fruits may have improved the colour. The choice was based on how the colours appealed to the panelists.

The sensory scores for flavor ranged from 6.11 to 7.78 with 40%PIN+30%WAM+30%PAW being more preferred and 100%PAW as the least preferred. Few significant differences ($p<0.05$) existed among the juice samples.The taste scores ranged between 6.44 and7.78. The control was most (7.78) preferred by the panelists while 40%PIN+30%WAM+30%PAW and 20%PIN+60%WAM+20%PAW were least preferred. Few significant differences ($p<0.05$) existed among the samples.General acceptability rating was between 6.89 and8.00. Sample 100%PIN had the highest (8.00) mean score while 60%PIN+20%WAM+20%PAWhad the least (6.89) score. There were no significant ($p>0.05$) differences among the samples in terms general acceptability. All the juice samples had good sensory attributes and were generally accepted by the panelists.

Physicochemical properties of fruit juice samples.

The physicochemical parameters of the formulated fruit juices are presented in Table 2. The pH of the juice samples ranged between 4.05 and5.30.The physicochemical parameters of the best fruit juice samples are presented in Table 2.Sample PAWrecorded the highest pH value of 5.30 while PIN had the lowest value of 4.05. The values were comparable to values(3.23-4.50) reported by Agbaje *et al.* (2020) on different fruit juices and the range of 3.71– 4.15 reported by Onyekwelu (2017) for mixed fruit juices. pH measures the degree of acidity or Alkalinity of a product. pH value of 3 to 4 could inhibit the growth of spoilage microorganisms thereby extend the shelflife of the product. From data in table (2) the pH of the fruit juice samples ranged between 4.05 and5.30. There were significant differences ($p<0.05$) among the samples. Sample 100%PAWrecorded the highest pH value of 5.30 while100%PINsample had the lowest pH value (4.05). The pHvalues of fruit juice sampleswere comparable to both pH values (3.23-4.50) reported by Agbaje *et al*. (2020) andpH valuesof 3.71– 4.15 reported by Onyekwelu (2017) for mixed fruit juices.

The total soluble solids are used as indicators in the fruit juice; it characterizes the quality of juice and other beverage products (Egbekun and Akubor, 2007; Adubofuor*et al*., 2010).The total soluble solid content of the fruit juices ranged from 8.10-15.55 % (Table 2). The values were higher than values (4.20-8.20 %) reported by Agbaje *et al.* (2020) and the range 8.50 to10.50 % by Onyekwelu (2017) on different fruit juices but lower than values (14.50-23.60 %) reported by Matabura and Kibazohi (2021) on fruit juices. The difference could be attributed to varietal and enviromental differences. 2010). The relatively high sugar content of the formulated juiced is an indication of the maturity of the fruits used since reducing sugars are the main constituents of soluble solids.Ghana standard Board specifies that non-alcoholic beverage should have a refractive value of not less than 8°Brix. According to Adedeji and oluwalana(Oluwalana (2014), degree brix of common fruits rangeranges between 9 and 150. The total soluble solid content of the fruit juices studied were within this range.

Total acidity of the fruit juice samples ranged from 0.06-1.21 % (Table 2). The result compares with of Nwozo*et*Nwozo *et al.* (2017) and Onyekwelu (2017) who reported the range of (0.32-1.37 %) and (0.42-1.26 %) on different juice samples and mixed fruit juices respectively. Ghana standard Board (1995) documented that non-alcoholic beverage should have acidity between 0.50% and 1.90% which is calculated as anhydrous citric acid. The values reported in this work were within the acceptable limit.

The total sugar in this study was between the range of 7.22 to 9.51 % with sample 33.3%PIN +33.3%PAW+33.3%WAM+33.3%PIN having the highest value (9.51%) and where the 100%PAW sample had the lowestlowestvalue (7.22%). However, Agbaje *et al.* (2020) reported a range of 8.35 to 13.20 % on different juice samples. The total sugars in juices determine the sweetness of such juices and beverages. The total sugars could as well mask the astringent effect of organic acids (Adeola and Aworh, 2010).

The vitamin C content ranged from 5.30 to 17.00 mg/100 g. Significant difference ($p<0.05$) existed among the samples except between WAMPIN and PINWAM. Sample 33.3%PIN+ 33.3%PAW+33.3%WAM+33.3%PIN had the highest vitamin C content (17.00 mg/100 g) while PINthe 100%PINsample had the lowest values of 4.80 mg/100 g. The ascorbic acid content of the juices studied was higher than the range (1.22-1.79 mg/100 g) on mixed fruit juices (Onyekwelu 2017) but lower than the range (13.20-44.03 mg/100 g) reported on different fruit juices (Agbaje *et al.*, 2020). Fruit juices are essential in supplying body fluid and, important minerals and vitamins (Landon, 2007). "Moreover, vitamin C content of fruit juices is an essential quality index of fruit juices due to its health significance as a vitamin and cellular antioxidant" (Landon, 2007).

Table 3: Physicochemical characteristics of Juice Samples

PIN%	PAW%	WAM%	pH	TSS°Brix	TTA %	Total sugar %	VitaminC mg/100 g
0	100	0	5.30 ± 0.14^{a}	15.55 ± 0.35^{a}	0.90 ± 0.00^{c}	7.22 ± 0.02^{a}	7.20 ± 0.00^{b}
0	0	100	4.65 ± 0.07^{c}	11.50 ± 0.71^{b}	1.12 ± 0.01^{b}	9.16 ± 0.63^{b}	5.30 ± 0.00^{c}
100	0	0	4.05 ± 0.07^{d}	10.85 ± 0.21^{b}	1.21 ± 0.01^{a}	9.28 ± 0.03^{c}	4.80 ± 0.00^{c}
33.3	33.3	33.3	4.95 ± 0.07^{b}	8.10 ± 0.14^{c}	0.60 ± 0.00^{d}	9.51 ± 0.00^{b}	17.00 ± 0.00^{a}

PIN – pineapple; PAW – pawpaw juice; WAM – watermelon juice; CONTROL- commercial fruit juice. Values are means ± standard deviation (n=5). Values with the same superscript on the same row are not significantly different ($p>0.05$).

Conclusion

The study showed that juice with good physicochemical and sensory qualities could be formulated using pineapple,pawpawand watermelon and pawpaw; which can compare favourably with commercial juice products. The formulated fruit juices could find domestic and industrial applications.

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