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RESEARCH ARTICLE

Evaluation of Physiochemical, Nutritional, Sensorial, and Microbiological Properties of Juice Blends Produced from *Parkia biglobosa* Pulp and *Ixora coccinea* Fruits

Onukogu Stella Chiamaka[1] and Ogunniyi Damilola Ebenezer[2]

[1]Biotechnology Advanced Research Centre, Sheda Science and Technology Complex, Abuja Nigeria
[2]Department of Microbiology, Faculty of Life Sciences, University of Ilorin, Ilorin Kwara State Nigeria
*Corresponding author: stella.onukogu@gmail.com

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ABSTRACT

This study was carried out to determine the physicochemical, proximate, microbial, and sensory properties of juice blends made from *Parkia biglobosa* pulp and *Ixora coccinea* fruit. The *P. biglobosa* pulps and *I. coccinea* fruits were blended in different ratios of sample A (100% *P. bigblosa* pulp), sample B (100% *I. coccinea* fruit), sample C (50% *P. bigblosa* pulp; 50% *I. coccinea* fruit), sample D (30% *P. bigblosa* pulp; 70% *I. coccinea* fruit), E (70% *P. bigblosa* pulp; 30% *I. coccinea* fruit). The physicochemical parameters assessed include pH, titratable acidity, and vitamin C content. The proximate, sensory, and microbiological properties of the juice blends were also evaluated. The proximate analysis of the juice blend samples revealed that samples C, D, and E had higher moisture, carbohydrate, protein, and fat content compared to samples A and B. The phytochemical analysis showed the presence of saponins, tannins, phenols, flavonoids, coumarins, steroids, glycosides, terpenoids, and alkaloids in the juice blends. The flavonoid and phenol content was found to be highest in sample E. The samples containing mixed juice blends (C, D, and E) had the highest vitamin C content. The microbial analysis of the juice blends showed no viable microbial counts in the samples. The sensory evaluation of the juice blends revealed that sample E, which contains the mixed blends, had the highest acceptability in terms of color, taste, texture, and aroma. This study revealed that the mixed blends of *P. biglobosa* pulp and *I. coccinea* fruit have improved nutritional and sensory acceptability, which could serve as potentially useful materials in the production of beverages.

Keywords: juice blends, *Parkia biglobosa*, *Ixora coccinea*, nutritional and sensory

1. INTRODUCTION

Fruits refer to the mature ovary of a plant or the edible fleshy structures of certain plants (Manitah, 2012). Fruits contain an array of micronutrients and non-nutrient bioactive compounds such as vitamins, phytochemicals, dietary fibers, and minerals that are needed by the body. A deficiency in certain nutrients could be a result of low intake of fruits (Dhandevi and Rajesh, 2015). In recent times, it has been discovered that an increase in the consumption of fruit is directly proportional to the increase in the knowledge of its beneficial properties

(Kaparapu and Geddada, 2020). The beneficial effect of the intake of fruit has been attributed to the additive interactions between the phytochemicals that could affect various pathways such as the reduction in cholesterol level, reduction of blood pressure, stimulation of antiviral, antibacterial, and antioxidant properties, enhancement in cardiovascular activity and enhancement of immune response to foreign bodies (Yu and Ahmedna, 2013).

P. biglobosa (African locust bean) is a very popular tree across west Africa belonging to the Leguminosae family, it is deciduous with a very broad crown tree that may reach a height of 20-30m and it's a species known for the ability to grow under a wide range of conditions such as annual rainfall of 600-1500mm and a dry season of 5-7months. Moreover, it occurs in natural and seminatural habitats such as savannahs and woodlands, occasionally on stony ridges, sand, stone hills, and rocky slopes (Builder, 2014). Its leaves, roots, bark, stem, and seed usage for medicinal and nutritional purposes have been documented (Burlando et al., 2019). Although, as popular as the tree is across its documented region which extends across the Sudan and Guinea savannah ecological zones and in nineteen African countries (Hall et al., 1997), the commercial usage and reports on the exploitation of its yellowish fruit pulp are not fully known. It is used in preparing local dishes and producing of a local drink called dozim (Abbi, 1990; Shao, 2002). Apart from the traditionally recognized food purpose of *P. biglobosa*, it has also been implicated in medicinal, cultural, economic, and therapeutic purposes (Koura et al., 2011). Its seed is well known for its fermented products across major ethnic groups, such as iru/Dawadawa/ogiri okpe, a protein-rich food among the major ethnicities in Nigeria (Hassan and Umar, 2005). Although its medicinal uses are indigenous to African countries (Udobi and Onaolapo, 2012), it has been well reported as a major ingredient in the treatment of leprosy and hypertension (Odetola et al., 2007), also, it has been identified as one of the prospects with a promising therapeutic potential in the prevention, treatment, and management of a number of metabolic diseases such as diabetes mellitus (Odetola et al., 2006), and leprosy (Erakhrumen et al., 2010), and the leaves are also used in lotions for sore eyes, burns, heamorrhoids, and toothache (Banwo et al., 2004; Udobi and Onaolapo, 2012).

Various studies have established that the African locust bean plant parts are rich in different phytochemicals (Alinde et al., 2014). Multiple secondary metabolites have been described as present in the bark, leaves, and roots of plants, including saponins, tannins, flavonoids, resins, carbohydrates, terpenoids, phenols, sterols, isoquinolines, alkaloids, indole alkaloids, reducing sugars and cardiac glycosides (Femi-Ola et al., 2008; Alinde et al., 2014; and Bawa-Allah and Akinnuoye, 2019). The *I. coccinea* plant, also called jungle geranium, jungle flame, or flame wood, is a flowering plant that is grown mainly for ornamental purposes. It belongs to the Rubiaceae family native to southern India, Sri Lanka, and Bangladesh (Anisha, 2020). It is grown in soils that are slightly acidic and dry. The *I. coccinea* plants are shrubs, usually 3 ft in height. However, they differ in height, flower, leaf size, and color (Sunitha, 2015). The leaves are oblong and are about 2 cm in height. The flowers are produced at the end of the branches, in clusters. The other varieties of *I. coccinea*, which are seen as wild varieties, produce flowers that are reddish-orange in color (Elumalai, 2020).

The fruits of *I. coccinea* like spherical berries, purplish black or dark red, and contain 1-2 seeds. According to Sunitha et al. (2015), the flower, leaves, and roots of the *I. coccinea* plant have numerous benefits and are used traditionally in treating ailments such as skin ulcers, diarrhea, dysentery, Eczema, organ infection, and irregular menstruation. The phytochemical studies of *I. coccinea* show that the leaves contain terpenoids, flavonoids, alkaloids, and proanthocyanidins, the roots contain fatty acids, and essential oils while the flowers contain triterpenoids, sterols, and flavonoids (Sunitha, 2015). A recent study on the fruit of *Ixora coccinea* has shown that the fruits contain phenols, flavonoids, and anthocyanin content and exhibit antioxidant and anticancer activity (Saligrama, 2021).

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Blending of two fruits can be seen as a way of complementing and enhancing the physicochemical properties of the fruit blends. Research has shown that mixed fruit blends potentially promote the health of individuals (Ray et al., 2019). A new product could be developed from blending to produce a healthy drink, serving as an appetizer and supplying the body with the required nutrients. The aim of this work is to develop juice blends from locally sourced raw materials of *P. biglobosa* pulp and *I. coccinea* fruits. Juice blends made from *P. biglobosa* pulp and *I. coccinea* fruit have not been reported. Hence, this study determined the nutritional content, phytochemical constituents, pH, titratable acidity, microbial analysis, vitamin C content, and sensory evaluation of the juice blends. Moreover, this study was used to compare the properties of different percentages of juice blends made from *P. bigblosa* pulp and *I. coccinea* fruits.

2. MATERIALS AND METHODS

2.1. Sample Collection and Preparation

Fruits of *I. coccinea* and *P. biglobosa* pulps were collected from the locals in Omu-aran area of Kwara state, Nigeria. The fruits were washed with distilled water to remove any attached dirt deseeded. The deseeded fruit of 500 g was added to 250 mL of distilled water and blended using an electric blended to obtain a ground paste. Then distilled water was added to the ground paste to make up to 2500 mL. The juice was then sieved using a clean muslin cloth. Class II preservative (sodium benzoate) of 0.40 mg/mL was added to the blends. Sugar of 10% v/v was added as a sweetener and then stored in the refrigerator for further analysis. *P. biglobosa* fruit pods were screened, cleaned of foreign materials, and then split open. The yellow pulp and its attached seeds were removed and weighed. The juice was extracted by adding 570 g of the pulp into 2000 mL of distilled water in a beaker and placed on a hot plate magnetic stirrer set at a temperature of 60°C until the black seeds became visible. Then the volume was made up to 2500 mL. The juice was then sieved using a clean muslin cloth. Class II preservative (sodium benzoate) of 0.4 mg/mL was added to the blends. Sugar of 5% v/v was added as a sweetener and then stored in the refrigerator for further analysis.

2.2. Preparation of Juice Blends

The preparation of *P. biglobosa* pulp juice and *I. coccinea* fruit blends are shown in Figure 1 and 2, respectively. The *P. biglobosa* pulp juice blend was mixed with the juice blends of *I. coccinea* fruit using the formulated mixing ratio as presented in Table 1. The juice blends were bottled and pasteurized at 70°C for 15 min, cooled, and stored for further analysis.

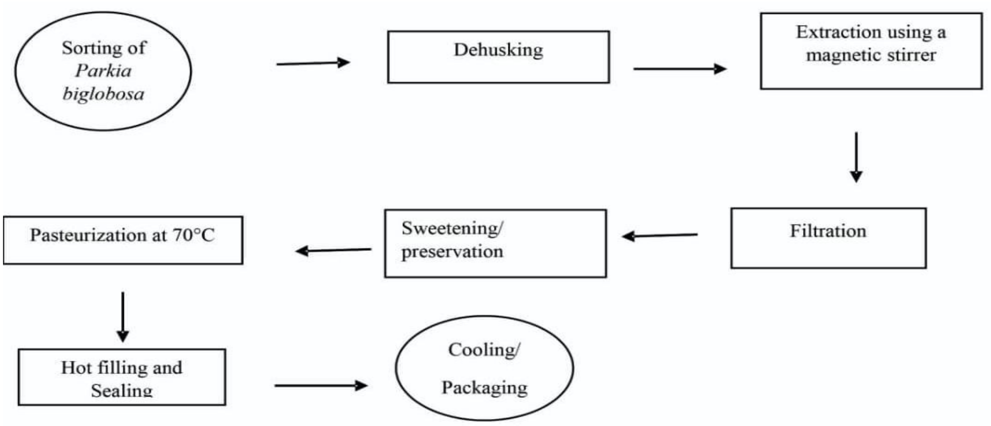

Figure 1. Schematic representation of the preparation of *Parkia bigblosa* pulp juice blends

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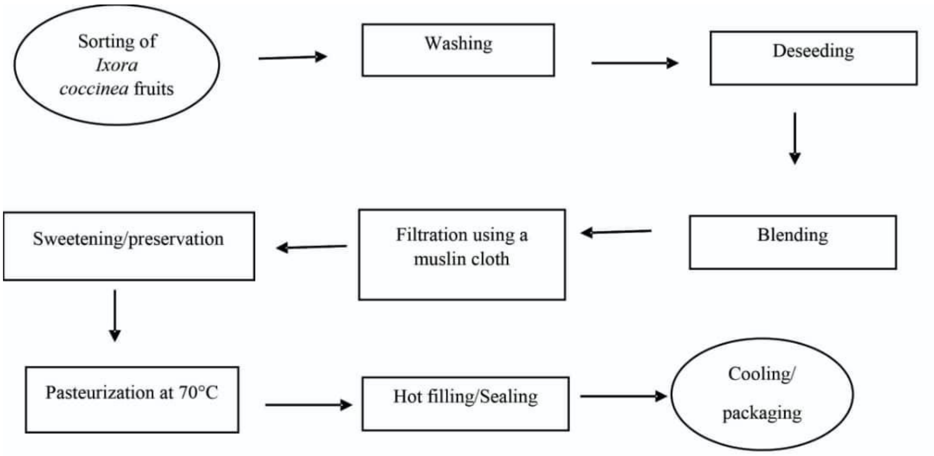

Figure 2: Schematic representation of the preparation of *Ixora coccinea* fruit blends

Table 1. Percentage composition of juice blends of various samples

Sample	*P. biglobosa* Pulp blends (%)	*I. coccinea* fruit blends (%)
A	100	0
B	0	100
C	50	50
D	30	70
E	70	30

2.3. Microbial Analysis

The microbial evaluation of the juice blends was carried out using standard microbiological analysis methods (Khan et al., 2015). The pour plate method was used to determine the total viable count and coliform count of the juice blends. A known quantity (1 mL) of the sample was diluted into 9 ml of distilled water to make serial dilutions of 10^{-1}, $10^{-2,}$ and 10^{-3}. A portion of (0.1 mL) of each of the dilutions was aseptically transferred into sterile plates and nutrient agar for the aerobic bacterial count and MacConkey agar for coliforms were poured. Plates for bacterial counts and coliform count were incubated at 37°C. Colonies were done in triplicate with triplicate dilution analysis and the average was considered.

2.4. Proximate Analysis of Juice Blends

The proximate analysis of the juice blends was determined with the method of AOAC (2019). The ash, fat, crude protein, and carbohydrate content were determined. The pH and titratable acidity of the juice blends were done using standard procedures (AOAC, 2019). The quantitative determination of flavonoids and phenols was determined following the previous method (Ajuru et al., 2017) as well as the qualitative phytochemical screening (Ajuru et al., 2017). The vitamin C content of the juice blends was determined spectrophotometrically using 2,4-dinitrophenylhydrazine (Al-Ani et al., 2007). Sensory evaluation of the juice blends was performed using the previous method (Adeniyi et al, 2010). Twenty panelists comprising students and adults in Omu-aran area of Kwara State, Nigeria, were used for the evaluation. Sensory attributes such as color, aroma, taste, and texture were determined using a 9-point hedonic scale analysis (9 = liked extremely and 1= disliked extremely).

2.5. Statistical Analysis

The data got from the results of the study were analysed using Microsoft Word Excel and SPSS.

3. RESULTS AND DISCUSSION

3.1. Proximate Analysis of Juice Blends

The result of the proximate analysis of the juice blends is shown in Table 2. Juice blends are good sources of water, this accounts for the high moisture content in samples A, B, C, D, and E. The moisture content ranges from 86-88%. The moisture content of sample E was the highest (88%), high moisture content has been reported for fruit juice such as orange juice, apple juice (Aleem et al., 2017). The protein content and ash content of sample A showed to be the highest compared to samples B, C, D, and E. Sample A, which contains 100%, has a high protein content, which was also reported by Adeloye and Agboola (2020). The juice blend sample C, D, and E, which contains different proportions of *P. biglobosa* and *I. coccinea* fruits, had a considerable amount of protein content. Sample E had the highest fat content compared to other samples. All samples of the juice blends showed a high carbohydrate content, with the mix-blend samples C, D, and E showing a considerably higher amount of carbohydrate content.

Table 2. Proximate analysis of juice blends (%)

Parameters	Sample A	Sample B	Sample C	Sample D	Sample E
Moisture content	86.73±0.72	87.44±0.33	87.30±02.29	87.30±0.67	88.12±0.11
Protein content	3.47±0.00	2.51±0.00	2.73±0.00	2.74±0.00	2.87±0.00
Ash content	0.45±0.01	0.16±0.01	0.28±0.05	0.23±0.06	0.34±0.15
Fat content	0.1±0.06	0.08±0.00	0.09±0.01	0.09±0.03	0.44±0.44
Carbohydrate	9.24±0.56	9.80±0.34	10.59±0.25	10.62±0.57	10.22±0.70
Energy (Kcal)	216.54±11.78	208.82±5.59	209.25±3.76	218.09±0.00	201.85±5.04

3.2. Physicochemical Characteristics of the Juice Blends Samples

The pH, mean titration and titratable acidity of the samples are shown in Table 3. The pH of the juice blends indicates that they are all moderately acidic, ranging from 3.78 to 4.67. The lowest pH value is seen in samples A (3.78) and E (3.84) compared to other samples. The titratable acidity measures the total acid concentration in the juice blend samples. The acid present in the juice blends influences the flavor and confers a longer shelf life for the juice blends (Adedeji et al., 2006). Fruit juice with lower pH has been said to have a longer shelf life, which makes them suitable for consumption over a certain period of time. The low pH of the juice blends in this study is in agreeing with juice blends such as apple and Orange (Patir et al., 2019). *P. biglobosa* is a good vitamin C source as reported by Adeloye and Agboola (2020). This may have contributed to the decrease in pH of sample E containing a higher percentage of *P. biglobosa*. Samples A and E which had the lowest pH had a higher titratable acidity value, this trend was also reported by Adeloye and Agboola (2020). Akusu et al. (2016), also reported an inverse relationship between pH and titratable acidity value in orange and pineapple juice blends.

Vitamin C is an important natural antioxidant that helps to prevent oxidative stress in the body. The Vitamin C content of the juice blends is shown in Table 3. The vitamin C content of sample B which contains *I. coccinea* only was higher than sample A which contains P. *biglobosa* only. Sample A, which contains 100% *P. biglobosa* had the lowest level of vitamin C content (31.05 mg), Bot et al. (2013) also reported low vitamin C content, which does not agree with Adeloye and Agboola, (2020) who reported a higher value. This variation may result from differences in environmental factors, extraction, and processing methods. Bhavana et al. (2018), reported that *I. coccinea* fruit has a high vitamin C content making it desirable. The vitamin C level of samples C, D, and E which contains the blends of *I. coccinea* fruit blends in different proportions was higher than sample A (100% PB). Sample D had the highest vitamin

C content, and this could be as a result of a higher proportion of *I. coccinea* fruit in the juice blend. The mixture of the two juice blends resulted in a higher level of vitamin C content, making C, D, and E more desirable than samples A and B. Fruit are a good source of vitamin C content that is needed in the body. Therefore, consuming these juice blends that are made from the combination of *P. biglobosa* and *I. coccinea* provides a way of accessing vitamin C enhancing the body's metabolism.

Table 3. pH, titratable acidity, and vitamin C content of juice blends

Samples	pH	Mean Titre value	Titratable Acidity (%)	Vit. C content (mg/100ml)
Sample A	3.78	11.03±0.25	0.39	31.05
Sample B	4.67	5.73±0.83	0.20	37.25
Sample C	3.96	8.83±0.67	0.32	40.07
Sample D	4.14	8.50±2.36	0.31	41.79
Sample E	3.84	9.1±0.66	0.33	41.62

3.3. Phytochemical analysis of the Juice Blends Samples

Phytochemicals are an important constituent present in plants. Plant flowers, roots, stems, fruits, contain various phytochemicals (Manjeshwa and Poruthukaran, 2011). These phytochemicals are said to have medicinal and pharmacological properties. The qualitative screening of the phytochemicals found in the juice blends is shown in Table 4. The juice blends were screened for the use of saponins, tannins, phenols, flavonoids, coumarins, steroids, glycosides, terpenoids, and alkaloids. Sample A (100%, *P. bigblobosa*) shows the presence of saponins, flavonoids, coumarins, steroids, glycosides, terpenoids, alkaloids, flavonoids, and tannins. Arinola et al. (2019) also reported that the phytochemical analysis of *P. biglobosa* also known as African locust bean pulp contains tannin, flavonoids, steroids, terpenoids, alkaloids and cardiac glycosides. Moreover, sample B shows the presence of saponins, tannins, phenols, steroids, glycosides, terpenoids, alkaloids, and flavonoids. Furthermore, samples C, D, and E, which contain *P. biglobosa* and *I. coccinea* in different proportions, contain the nine phytochemicals screened for in this study. The quantitative analysis of flavonoids and total phenol content is shown in Figure 3. The flavonoid content of sample A (100% *P. bigblobosa*) was higher than sample B (100% *I. coccinea*). The mixed juice blends of samples C, D, and E had a high flavonoid content compared to samples A and B. Sample E had the highest flavonoid content of 113.67 mg/100 mL which is higher than the *Parkia*-orange juice blend reported by Adeloye and Agboola (2020), this could be as a result of the higher proportion of *P. biglobosa* pulp in the mixed blends. Toure et al. (2022), reported a high level of flavonoids in the root, stem, bark, and fruit of *P. biglobosa*, which may have been implicated in the fruit pulp blends of *Parkia* juice blends.

The result of the total phenol content of the juice blends revealed that sample B(100% *Ixora coccinea*) had a higher phenol content than sample A (100% *P. biglobosa*). Samples C, D, and E which contained the mixed juice blends also had a high phenol content while sample D, which had the highest proportion of *I. coccinea* fruit blends compared to other mixed juice blends, had the highest phenol content. This is a result of the high level of phenol content in *I. coccinea* fruit which according to Bhavana et al. (2018), in their comparative study of under-utilized fruits reported *I. coccinea* fruit to have a high phenol content of 465 µg/100 mg fresh weight compared to other utilized fruits. Adeloye and Agboola (2020), also reported a low phenol content in 75% *P. bigblosa* fruit pulp blends and 25% orange juice, and this could also be seen in the low phenol content in the sample A (100% *P. bigblobosa*). The combination of *P. bigblobosa* pulp blend and *I. coccinea* fruit blends yielded a combination that had an enhanced phenol and flavonoid content.

Table 4. Qualitative phytochemical analysis of juice blends

Samples	A	B	C	D	E
Saponin	+	+	+	+	+
Tannin	+	+	+	+	+
Phenols	+	+	+	+	+
Flavonoids	+	+	+	+	+
Coumarin	+	+	+	+	+
Steroids	+	+	+	+	+
Glycosides	+	+	+	+	+
Terpenoids	+	+	+	+	+
Alkaloids	+	+	+	+	+

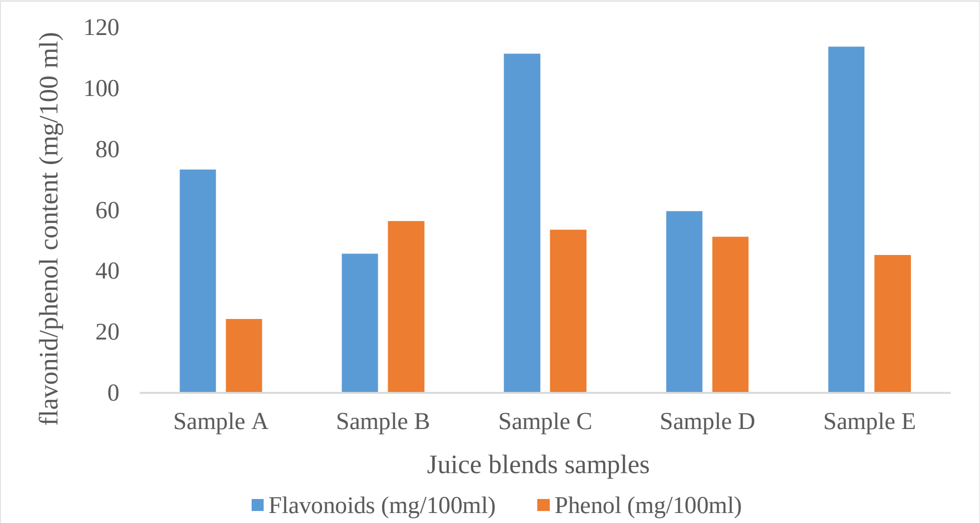

Figure 3. Quantitative evaluation of flavonoids and phenols in juice blend samples

3.4. Microbial Analysis of Juice Blends

The microbial analysis of the juice blends was done to establish its safety for human consumption. The results obtained (Table 5) showed no viable microbial counts in all samples which could be the effects of the acidic nature of the juice, the preservative used (sodium benzoate), the aseptic working conditions such as a clean environment, during processing as well as the pasteurization employed afterwards. The preservative used was in tandem with the study of Adeniyi et al. (2010), who reported the efficacy of 0.40 mg/mL of sodium benzoate in maintaining the shelf life of juice over a period of 45 days.

Table 5. Total microbial count of juice blends

Sample	Total bacterial count(cfu/ml)			Pathogenic bacteria
	10-1	10-2	10-3	Coliforms
A	0.00	0.00	0.00	Nil
B	0.00	0.00	0.00	Nil
C	0.00	0.00	0.00	Nil
D	0.00	0.00	0.00	Nil
E	0.00	0.00	0.00	Nil

3.5. Sensory Evaluation of the Juice Blends

The result of the sensory evaluation of each sample of the juice blends is shown in Figure 4. This was carried out to evaluate the color, taste, aroma, and texture in order to know the acceptability level of the juice blends. The results of the color show the sample A had the highest percentage (85%) of acceptance in terms of color which could be attributed to its attractive yellowish shade which is in line with the study of Adeloye and Agboola (2020), who also attributed the high score index of *Parkia* orange juice to the attractive impact of the bright yellow color of *Parkia,* while sample B had the lowest percentage acceptability with a reason not farfetched from its dark chocolate shade.

In terms of taste preference, E had the highest score of 70% which could be due to the combined taste of the mixed blends (*Parkia* 70% and *Ixora* 30%), followed by D (65%), A, and C (60%). In comparison, sample B had a very low acceptance (25%) for its taste, which could be attributed to its aftertaste. Sample E had the highest percentage (80%) and was the most preferred by the panelist in relation to its aroma/smell parameters, while B with 45% had the lowest acceptability. The results of the texture assessment show that sample E had the highest percentage of 85%, followed by D (65%), B (60%), and a (55%), while sample C had the lowest of 50%. The high acceptability of sample E's texture could be attributed to its honey-like consistency and could be a result of its composition which is majorly *P. biglobosa* fruit pulp.

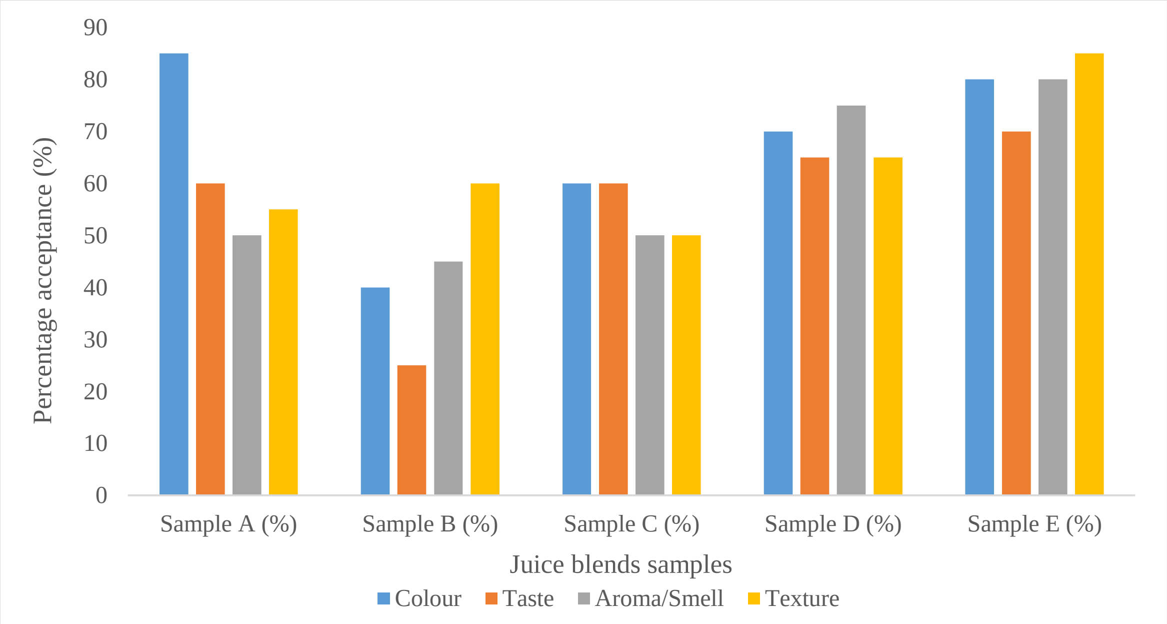

Figure 4. Sensory evaluation of the juice blends

Figure 4 showed that the mix blends (C, D, and E) had improved acceptability in terms of color, taste, aroma, and texture, which has been supported by Adeloye and Agboola (2020), who reported an increase in consumer acceptance of the *Parkia*-orange juice mix with the addition of *Parkia* juice to orange juice. Studies have shown that *P. bigblosa* pulp blend has already been used in the producing of juice blends (Adeloye and Agboola 2020). The combination of *I. coccinea* fruit and *P. biglobosa* produces an enhanced quality of juice blends in terms of nutritional requirements and sensory acceptability. *I. coccinea* plants grown mainly for ornamental purposes have been shown to contain various important bioactive components required by the body. The use of *I. coccinea* fruit in the production of juice blends proffers a beneficial use of the plant. However, apart from the use of these locally sourced materials in the food and beverage industries, more studies could be done on how to employ the bioactive compounds that are found in these sourced materials in the treatment and management of certain ailments.

4. CONCLUSION

This study revealed that juice blends made from locally sourced produce enhance the nutritional content and improve the vitamin C content, thus supplying the body with its nutritional requirements. The low pH of the mixed juice blends in samples C, D, and E ensures a longer shelf life, thereby preventing it from microbial spoilage. The acceptability of the mixed juice blends in terms of color, taste, aroma, and texture makes them suitable for the production of beverages. *P. bigblosa* pulp and *I. coccinea* fruits are cheap and readily available materials, which could serve as useful raw materials for the food industry.

Declaration of Interest

I declare that there is no conflict of interest.

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