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Physicochemical Properties of Pumpkin Fruit Pulp and Sensory Evaluation of Pumpkin-Pineapple Juice Blends

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Abstract Pumpkin pulp has rich source of vitamins and mineral salts for human consumption. However, there is limited utilization in terms of it commercial acceptability. The aim of this study was to determine some physicochemical properties of pumpkin pulp and the sensory properties of pumpkin-MD2 pineapple juice blends. The pulp of round and cylindrical pumpkin fruits containing white seeds were analyzed for some physicochemical properties such as protein, ash, titratable acidity (TA), pH and minerals (Ca, Na, Zn, K, Mg and Fe). The pulps of the fruit were peeled, cut, grated, fermented and the juices extracted were blended with MD2-pineapple juice in different formulation ratios. Sensory evaluation of the juice blend was carried out using the nine-point hedonic scale. Preference ranking test was also carried out on the formulated juices. The result showed moisture content of (95.03 and 95.66%), ash (0.66 and 0.83%), crude protein (2.58 and 2.42), pH (4.39 and 4.13), titratable acidity (0.38 and 0.34% as citric acid), for round and cylindrical pulp, respectively. Significant differences ($p<0.05$) existed in TA, ash, pH and moisture contents of the pulps from the round and cylindrical fruits. The predominant minerals in the pulps were potassium and calcium which were 266.30 and 13.18 mg/100g for the round and 363.05 and 9.63mg/ 100g for the cylindrical, respectively. The results showed that the most accepted blend was (55:45) pumpkin (round)-MD2 pineapple juice. In the case of the cylindrical fruit, the 100 % pineapple juice was the most accepted. The 100 % pumpkin juice had the lowest acceptability. Thus, the (55:45) pumpkin-MD2 pineapple juice blend with the pulp from both round and cylindrical fruits has the potential to compete with single strength pineapple juice on the market.

Keywords: *round and cylindrical pumpkin fruits, pumpkin pulp, pumpkin juice, MD2 pineapple juice, physicochemical properties, juice blends, sensory evaluation*

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1. Introduction

Pumpkin belongs to the family *Cucurbitaceae* of flowering plants and of the genus *Cucurbita*. Crops belonging to this family are known as cucurbits and includes melon, water melon, pumpkin, squash and cucumbers. Pumpkin fruits vary in size, colour, shape and weight. They have a moderately hard rind with a thick, edible flesh below a central seed cavity [1]. Cultivars of pumpkin include *Cucurbita pepo, Cucurbita mixta, Cucurbita maxima and Cucurbita moschata* and they are classified according to the texture and shape of their stems [2]. Pumpkin is a seasonal crop, and since fresh pumpkins are very sensitive to microbial spoilage, even at refrigerated conditions, they must be frozen or dried [3]. Pumpkin has a good shelf-life and it contains carotene, water-soluble vitamins and amino acids. Pumpkins are relatively low in total solids, usually ranging between 7 and 10% [4]. Its unique constituents, antioxidants and vitamins, allow pumpkins to have an important health-protecting effect. In fact, the higher values of lipophilic substances such as carotenoids, present in pumpkin varieties can significantly contribute to increasing the uptake of pro vitamin A and lutein, one of the carotenoids with special physiological functions [5]. Carotenoids present in pumpkins are among the phytochemical components believed to reduce the risk of developing some degenerative diseases and are responsible for the attractive colour of many fruits and vegetables. The yellow to orange colour of the pumpkin flesh arises from this group of substances.

Pumpkins are best cultivated in the warm season in good well drained soil. The fruit is very sensitive to heat and highly perishable in warm conditions [6]. In the fresh mass of the fruit, total content of carotenoids, a major contributory factor in the high nutritional value of pumpkins, ranges from 2 to 10 mg/100 g, the content of vitamins C and E accounting for 9–10 mg/ 100 g and 1.03–1.06 mg/100 g, respectively. Pumpkin fruit is also a valuable source of other vitamins, e.g., B6, K, thiamine, and riboflavin, as well as minerals, e.g., potassium, phosphorus, magnesium, iron, and selenium. The fruit flesh is a fully appreciated additive in diverse kinds of products for children and adults. The major carotenoid in pumpkin (>80%) is β-carotene, with lesser amounts of lutein, lycopene and cis α-carotene [7]. Pumpkin is poor in taste and carbohydrates but high in antioxidants and it is mixed with orange or carrot to improve its nutritional and sensory properties [8]. Pumpkin is a fruit which is healthy and functional, being rich in phenolic compounds, flavonoids and vitamins, and has a low energy. [9] showed that a pumpkin-rich diet could reduce blood glucose levels. Also, [10] showed that the active polysaccharides from the pumpkin fruit could obviously increase the levels of serum insulin, improve tolerance of glucose and hence could be developed as new antidiabetic agent. Pumpkin fruits mainly are being processed to obtain juice, pickles and dried products [11].The pulp is used in the preparation of soups, purees, jams and pies throughout the world and the leaves are also consumed as a vegetable [12,13].

Pineapple (*Ananas comosus* L.) belongs to the family *Bromeliacea*e and is one of the most important commercial fruits in the world [14]. The production of MD2 in Ghana has been estimated to be 2% of total pineapple production [15]. The pineapple fruits are normally eaten fresh or as fresh pineapple juice. The fruits are an excellent source of vitamins and minerals and supply arrays of colour, flavour and texture to food [16]. The popularity of the pineapple is due to its sweet sour taste containing 15% sugar, malic and citric acids. It is also high in vitamin C and the essential mineral, manganese [17]. The pineapple was originally consumed only as a fresh fruit. With the development of the processing industry, the fruit is now prepared and consumed in various forms such as chunks, slices, juices, syrups, jams and diced pineapple. Pineapple is the only source of bromelain, a complex proteolytic enzyme used in the pharmaceutical industry and as a meat-tenderizing agent [18,19].

Pineapples, unlike pumpkins are one of the most popular fruits worldwide. They are produced on a large scale in Ghana for export to Europe. The MD2 variety is mostly cultivated in Ghana because it is preferred by the European market over the smooth cayenne variety which used to be cultivated by farmers [20]. Pineapple juice is a common product on the Ghanaian market and some small and medium scale companies process the fruit into juices for local consumption [21].

Juices are liquids naturally contained in fruits and vegetables. They are normally obtained by mechanically squeezing the fruit or vegetable and commonly consumed as a beverage or used as an ingredient. Freshly squeezed juices are rich in vitamins, minerals and other nutrients [22, 23]. Two or more pure juices may be mixed together in the act of juice blending to produce a new juice product that is less than 100% fruit juice of one of the ingredient fruits used. Blending juices offers many benefits: overcoming single strength juice consistency, improving organoleptic quality, enhancing nutritional or phytochemical properties and correcting low soluble solids level. Blending of juices offers the opportunity to adjust and compensate for imbalances in juice from a single harvest or cultivar [24]. Furthermore, juice blending is also a way of utilizing underutilized and less popular fruits and vegetables [25]. In Ghana, one such less popular fruit is the pumpkin fruit [26].

Both pumpkin and pineapple juices have a lot of nutritional and health benefits. It is known to aid digestion, reduce high blood pressure, reduce heart disease, lower cholesterol and prevent gall stones [27]. Pineapples are good sources of vitamin C, potassium, beta-carotene and bromelain which is known to be effective in treating blood clots which may cause thrombosis. It also aids in digestion [28].

Despite the enormous health benefits of pumpkins, they are grown on a low scale in backyard gardens in the Upper West Region of Ghana because of lack of knowledge on its nutritional value and market potential. Poor storage of the pumpkins also accounts for quick deterioration and spoilage of the fruits. It is very important to have knowledge about its nutritive value in order to encourage the increase in its consumption and usage for nutritional and technological applications. The objective of the study was to determine the physicochemical properties of pumpkin fruit pulp and to evaluate the sensory properties of pumpkin-pineapple juice blends.

2. Materials and Methods

2.1. Source of Raw Materials

The pumpkin fruits were obtained from the Upper West Region of Ghana. MD2-pineapples, ginger and table sugar for the preparation of the juice blends were obtained from two satellite markets in Kumasi in the Ashanti Region of Ghana. The fruits were grouped into two types based on shape (round or cylindrical) and sub-grouped based on their different weights. Each fruit type was grouped into the range; 2.00 - 2.99 kg, 3.00 - 3.99 kg and 4.00 - 6.99 kg. Fruits selected from these weight ranges were cut, peeled and all blended together for analyses of the pulp and pumpkin juice extraction.

2.2. Preparation of Pumpkin Pulp for Analysis of Physicochemical Properties

Fruits were washed with clean water and cut into two portions. Fruits having white seeds embedded in the cavity after cutting were used for the sample preparation. Fruit matrix and seeds were scooped out. The two portions were peeled, cut into small pieces and grated. Grated samples were blended using Philips blender (HR 1840, China), poured into containers and labeled as RO (round shape) and CYL (cylindrical shape) samples.

2.3. Analyses of Physicochemical Properties of pumpkin Pulp

The physicochemical properties (moisture content, protein, ash and total soluble solids) of the pumpkin pulp were determined according to AOAC (2000) methods [29].The determination of the physicochemical properties were carried out in triplicate.

2.3.1. Titratable Acidity and pH

The juice was thoroughly mixed and filtered using muslin cloth. Ten (10) ml of the filtered juice was pipetted into a conical flask and diluted to about 80 ml with distilled water. About three drops of phenolphthalein indicator was added and titrated to a faint pink end point with 0.1M NaOH solution. The titre value was recorded. The results were expressed in % citric acid [30]. The pH of the fruit pulp was measured by using a digital pH meter (Mettler Toledo, HR4NHRJ).

2.4. Determination of Mineral Composition

Three grams of each sample was weighed into a porcelain crucible and ashed at 500^{o}C in muffle furnace overnight. The ash was dissolved in 10% 25ml HNO_3 and filtered through an acid –washed filter paper. The filtrate was made up to 100 ml with deionized water in a standard flask and shaken. Standards were prepared for the various determinations using a stock solution of 1000mg/L for all the various elements using a simple dilution formula M1V1=M2V2 where M and V are Concentration and Volume respectively. The diluent used was 10% HNO_3v/v. Ten millimeters (10ml) of stock solution was pipetted into a 100ml volumetric flask and diluted with 10% HNO_3 to obtain 100mg/L. The same step was repeated to prepare other standard solutions for the calibration of the spectrophotometer prior to the Ca, Mg, K, Na, Zn and Fe, content determination using Thermo Atomic Absorption Spectrometer (Serial no. GE711239, England) and standard curves were plotted out of which the various concentrations were calculated based on the absorbance readings [31].

2.5. Preparation of Pumpkin and MD2-Pineapple Juice

2.5.1. Preparation of Pumpkin Juice

The fruits were washed, cut into two and the white seeds within the inner layer (fibrous layer) were removed. The fruits were peeled, cut and grated. The grated slices were covered and kept in a room under ambient conditions for 48 hrs to allow mild fermentation to soften texture, develop aroma and release the juice from the tissues. To every 79g of fermented pulp from the round fruit, 21g of water was added, whereas to 78g of fermented pulp from the cylindrical fruits, 22g of water was added. The mixture was blended using an electric kitchen blender and the juice was extracted under gravity using a cheese cloth. Foams generated on top of the juice during the extraction process was manually skimmed off using a spoon. The juice was heated mildly for 30 min at 50 ^{0}C and was then stored in a refrigerator at 5°C.

2.5.2. Preparation of MD2 Pineapple Juice

The pineapples were washed, peeled and cut. The inner cores were removed and the fruits were further cut into pieces. The process was done in two batches. The ratio of the pieces of pineapple to the amount of water used in blending was 4:1 and the juice was extracted by gravity method using a cheese cloth. Foam formation occurring in the juice extraction process was skimmed off. The juice was then heated for 30 min at 50°C.

2.6. Preparation of ginger extract

The ginger was washed and peeled by scraping the outer parts with a kitchen knife. It was then cut into pieces. 0.44 kg of water was added to 0.60 kg of ginger and it was blended into a paste using an electric kitchen blender. The weight of ginger mixture obtained was 1.04 kg. The juice from the mixture was extracted using a cheese cloth.

2.7. Preparation of Juice Blends

The prepared pumpkin juices from both fruit types were blended with the pineapple juice in different ratios as shown in Table.1. Controls set aside were 100 % pumpkin juice and 100% pineapple juice. The amount of juice blend for each formulation was 4.00 kg. Ginger extract and sugar added to each formulation were 0.96 kg and 0.33 kg, respectively. The blends were thoroughly mixed and stored in a refrigerator at 5°C.

Table 1. Formulation ratios of juice blends

Pumpkin (%)	100	85	70	55	0
MD2-Pineapple (%)	0	15	30	45	100

2.8. Sensory Evaluation of Pumpkin-MD2 Pineapple Juice Blends

An acceptability test was used to assess the sensory qualities of the prepared juice blends using a nine point hedonic scale (9= dislike extremely and 1= like extremely). Forty three (43) untrained panellists (15 females and 28 males) who were regular consumers of pineapple juice were randomly selected to evaluate the coded samples for aroma, taste, aftertaste, mouth feel, colour and clarity. They were also asked to state reasons for which of the round pumpkin- MD2 pineapple juice blends was more acceptable as well as rank the products from the most preferred to the least preferred. Each panellist was served with five different samples. Water was used as the palate cleanser between samples. The same was done for the cylindrical pumpkin–MD2 pineapple juice blends; forty seven (47) untrained panellists (13 females and 34 males) who were regular consumers of pineapple juice were used.

2.9. Statistical Analyses

Statistical analyses were carried out using SPSS software version 16.0 and the statistical differences in means were established using the Tukey's test. Ranking of the various samples was established by finding the percentages of the frequency of ranking the samples from first to fifth.

3. Results and Discussion

3.1. Physicochemical Properties of Pumpkin Pulp

3.1.1. Moisture Content

As indicated in Table 2, there was a significant difference ($p<0.05$) between the moisture content of the two pumpkin pulps with the cylindrical having a percentage of (95.66%) and the round recording (95.03%). These values were slightly higher compared with the moisture content of fresh pumpkin pulp stated by [32] as 92.24%. The values were also higher than the reported moisture contents of 89.65, 89.50 and 88.20% of pumpkin pulps from *C. moschata,* and *C. maxima* by [33,34]. The high moisture contents of the pulps from the cylindrical and round fruits is an indication of the susceptibility of the fruits to microbial attack and spoilage [35]. In terms of consuming the raw fruit, it is an advantage because foods with high moisture content foods contain minimal calories and provides a feeling of fullness. Consuming such fruits after intense workout may hydrate the body more effectively than water or sports drink [36].

3.1.2. Ash Content

The ash content of the pulp from the cylindrical fruit was significantly higher (p <0.05) than that from the round pumpkin fruit. The ash content for the round and cylindrical pumpkin were 0.66 and 0.83%, respectively. This was lower than the ash content of 1.5 and 2.14 - 4.26% of pumpkin pulp reported by [33] and [37], respectively but compares well with (0.76%) reported by [32]. These differences in ash content may be attributed to varietal and geographical differences in cultivation of the pumpkin fruits [38]. Samples with high ash content are expected to have high concentration of various mineral elements, which are expected to speed up metabolic processes, improve growth and development [39].

3.1.3. Crude Protein Content

There was no significant difference (p>0.05) between the protein content of the pulps of the round (2.58 %) and cylindrical (2.42%) fruits as shown in Table 2. These values were higher than values reported by [32] which is 0.98%. The crude protein content in the round and cylindrical pulp were very low. The low values recorded for the pumpkin pulps in this study confirms the fact that fruits and vegetables are generally low sources of protein [40,41].

3.1.4. Titratable Acidity

Acidity is important for flavour balance and a low pH leads to more stable colour and inhibits microbial spoilage. Titratable acidity and juice pH are commonly measured as well as Total Soluble Solids (TSS) to give an overview of fruit maturity at harvest and are used as indicators of when to harvest fruits [42]. There was a significant difference (p<0.05) in the titratable acidity of the pulp of the round and cylindrical pumpkin fruits. The titratable acidity (as citric acid %) in the round fruit (0.38 %) was slightly higher than the cylindrical fruit (0.34 %). [43] reported that the titratable acidity of *C. maxima* as expressed in citric acid at ripened stage was 0.38%. This compares well with the citric acid values reported in this study for both the round cylindrical pumpkin fruit pulp.

3.1.5. pH

There was a significant difference (p<0.05) between the pH of the two samples, with the cylindrical (4.13) being more acidic than the round (4.39). The values were below the range of (4.90-5.50) stated by [44] for pumpkin fruits. Differences exist in the way fruits and vegetables are classified based on the pH. Pumpkin fruits are generally classified as medium acid foods with pH range of 4.99-5.50 [45]. Based on the values obtained in this study, the fruits are within the pH range of 3.7 to 4.6 stated for acid foods [46].

Table 2. Physicochemical properties of Round and Cylindrical Pumpkin fruits with white seeds

Parameter	Round shape (pulp)	Cylindrical shape (pulp)	p-Value
% Moisture	95.03±0.14^{a}	95.66±0.22^{b}	0.02
% Ash	0.66±0.07 ^{b}	0.83±0.05^{c}	0.03
% Protein	2.58±0.14 ^{d}	2.42±0.13^{d}	0.79
Titratable Acidity (as Citric acid %)	0.38±0.01^{b}	0.34±0.00^{c}	0.00
pH	4.39±0.02^{a}	4.13±0.02^{b}	0.00

Mean values with different superscript within a row are significantly different (p<0.05).

3.2. Mineral Composition

It could be seen from Table 3 that the calcium, zinc and magnesium contents of the pulp of the round fruit were significantly higher (p<0.05) than that of the cylindrical fruits. On the other hand, the sodium and potassium levels in the pulp of the cylindrical fruit were also significantly higher (p<0.05) than the amount in the round fruit. The predominant minerals found in pumpkin pulp as reported by [33] and [39] are potassium (355.22 and 340 mg/100g), calcium (46.35 and 21 mg/100g), phosphorus (44.05 mg/100g) and magnesium (12mg/100g), respectively. The potassium, calcium and magnesium levels reported in this study for round and cylindrical pumpkin fruits were (266.30 and 363 mg/100g), (13.18 and 9.63 mg/100g) and (7.54 and 3.56 mg/100g), respectively. The potassium content of the cylindrical and round fruits compares well with the previous stated values. Even though, the magnesium and calcium contents of these fruits were lower than the above reported values, they were still within the range of values for calcium (6-50/ 10-170mg/100g) reported for fruits and vegetables and magnesium (6-16 mg/100g) for some Australian cultivars of pumpkin [47,48]. [49] also reported the magnesium content of pumpkin pulp as 19 mg/100g. Differences in the mineral content can be attributed to the variations in the genetic makeup, maturity at harvest, crop growth and cultural practices, postharvest handling and storage conditions [39]. Potassium, along with sodium, helps to regulate blood volume and pressure, and a diet rich in this mineral might help protect against hypertension as reported by the Linus Pauling Institute. Potassium also plays a central role in nerve cell functioning and contributes to muscle function. According to the Linus Pauling Institute, the daily recommended intake of potassium is 4,700 milligrams, [50]. All the minerals present in the pulp can be vital for the overall mental and physical well-being of the human body. They play a functional role in the formation of bones, teeth, tissues, muscles, blood and nerve cells, thereby helping in the maintenance of acid-base balance, response to nerves leading to physiological stimulation and blood clotting [51].

Table 3. Mineral composition (mg/100g) of round and cylindrical pumpkin fruits with white seeds

Mineral	Round shape (pulp)	Cylindrical shape (Pulp)	p-Value
Calcium	13.18±0.045^{a}	9.63±0.015^{b}	0.01
Sodium	2.70±0.009^{b}	4.00±0.002^{c}	0.01
Zinc	0.16±0.009^{e}	0.12±0.007^{f}	0.01
Potassium	266.30±2.755^{g}	363.05±4.947^{h}	0.04
Magnesium	7.54±0.007^{i}	3.56±0.008^{j}	0.00
Iron	0.17±0.019^{b}	0.11±0.069^{b}	0.26

Mean values with different superscript within a row are significantly different (p < 0.05).

3.3. Yield of Pumpkin and Pineapple Juices

The mild fermentation of the pumpkin pulp resulted in the release of pectolytic, lipolytic and proteolytic enzymes during the fermentation process. These enzymes break down carbohydrates, fats and proteins leading to the production of alcohol, organic acids, aldehydes and ketones [35]. The pectolytic enzymes act on the cell walls of the pumpkin pulp softening the tissues of the pumpkin and releasing the juices. This agrees with the findings of [52], who reported that pectolytic enzyme treatment of banana pulp enabled food processors to obtain high yields of clear juices under practical conditions. The yield of pumpkin juice for the round variety was 88.62 % whereas the cylindrical variety yielded 87.33%. The yield of pineapple juice was 83.17 %.

3.4. Sensory Evaluation of pumpkin- MD2 Pineapple Juice Blends

The mean values of the sensory attributes and preference ranking scores of the pumpkin juice from the round fruit blended with MD2 pineapple juice are shown in Table 4 and Table 5 while the values of pumpkin juice from the cylindrical blended with MD2 pineapple juice are shown in Table 6 and Table 7.

3.4.1. Sensory Evaluation of Juice from Round Pumpkin Variety Blended with MD2 Pineapple Juice

3.4.1.1. Aroma and Taste

The mean score for aroma was from 3.98 to 6.60 interpreted by the nine-point hedonic scale used as liked moderately to disliked moderately. The most accepted product with regards to aroma was (55:45) whereas the least accepted was product 100% pumpkin juice. Significant differences existed in the aroma of all the five products ($p<0.05$). Although there was no significant difference ($p>0.05$) between product (55:45) and the 100% pineapple juice, product (55:45) was scored 3.98 (indicating moderately liked) whereas the 100% pineapple juice was scored 5.0 (indicating neither liked nor disliked). This could be attributed to the mild fermentation of the pumpkin pulp which resulted in the release of organic acids and other compounds that enhance the nutritional value and organoleptic properties of the juice blend through the production of different flavour compounds [53,54,55,56]. Significant differences ($p<0.05$) also existed between the mean values of the taste of all five products. The mean values for taste were from 4.14 to 7.09 and can be interpreted as liked slightly to disliked slightly. In terms of taste, the most accepted product was (55:45) and the least accepted was 100% pumpkin juice. This can be attributed to the high proportion of pineapple used in the blending process which is consistent with the findings of [57] who reported in their study on pumpkin-orange juice blend that the preference for taste increased with proportion of orange juice used. There was no significant difference ($p>0.05$) between the most liked product (55:45) and the 100% pineapple juice as control.

3.4.1.2. Clarity and Colour

Clarity is an attribute of appearance in which suspended materials are removed with the prevention of turbidity after juice bottling [58]. Based on the hedonic scale, the mean values of 3.14 to 4.14 indicated that, the clarity of the juices was liked moderately to liked slightly. Samples with pumpkin proportions of 70% and below were significantly different ($p<0.05$) from samples with 80 and 100% pumpkin fruit juice. Possibly, the higher amount of solids and suspended material in the samples with 80 and 100% pumpkin juice affected the clarity and acceptability by the panellists. The colour of the five products was scored from 2.72 to 5.05, which represented like very much to neither liked nor disliked. The most accepted product was 100% pineapple juice and the least accepted was the 100% pumpkin juice. The acceptability of the colour of the 100% pineapple juice could be due to the fact that the single strength juice had a consistent and an appealing appearance than the blends where some form of non-uniformity existed. There was a significant difference ($p<0.05$) between the most accepted and the rest of the products.

3.4.1.3. Aftertaste and Mouthfeel

Aftertaste as a sensory attribute is defined as one or two flavour impressions that are left on the palate after swallowing [59]. Significant differences existed in the aftertaste of all five products ($p<0.05$). The mean scores ranged from 4.19 to 6 .00 indicating liked slightly to disliked moderately. The product (55:45) was the most accepted and the least liked were products (100:0) and (85:15) which had high proportions of pumpkin juice. In terms of mouthfeel, there was a significant difference ($p<0.05$) between product (55:45) and the rest of the samples. This could be attributed to the high proportion of pineapple juice present in the product which to a greater extent masked the flat taste of the pumpkin juice. None of the attributes of the products was either liked extremely or disliked extremely. This could be due to the fact that, the panellists were not familiar with the pumpkin juice blends since it was their first time of assessing the taste and other attributes of the products.

3.4.1.4. Overall acceptability of Juices

To determine the most accepted product in terms of all the sensory attributes, an overall mean score which is a better indicator of product quality and acceptability for each product was determined [60]. As shown in Table 4, the most accepted blend for the round pumpkin variety was product (55:45) with an overall mean score of 3.91. The least liked product was 100% pumpkin juice with an overall mean score 5.72. Blending therefore adjusts the pH of both juices which in turn results in a product with a different taste from single strength pumpkin or pineapple juice. Product (55:45) being the most accepted suggests that the formulation ratio achieved an adjusted pH, reduced the acidity and consequently improved the taste and flavour. According to [61] fermentation leads to the development of aroma and flavour compounds in foods. Consequently the mild fermentation of the pumpkin pulp imparted a pleasant and distinct aroma and flavour to the blend and thus made product (55:45) much more appealing to panellists compared to 100% pineapple juice.

3.4.2. Preference Ranking Scores of the Juice from Round Pumpkin Variety Blended with MD2 Pineapple Juice

More than half of the panellists (53.49%) ranked product (55:45) as the most preferred juice blend (1^{st} position) whereas 2.38% ranked it as least preferred (5^{th} position). The 100% pumpkin juice also had the highest ranking as least preferred (45.24%) and the lowest ranking for most preferred (2.33%) This could be attributed to the flat taste of the fermented pumpkin juice. Reasons given by the panellists for choosing product (55:45) as the most preferred juice blend were that it had the best sensory qualities compared to all the other blends. Most of the panellists commented on liking all six attributes they evaluated. This confirms the way fermentation enhances the nutritional and sensory attributes of foods as reported by [62]. Some panellists liked only one of the attributes whilst others commented that the juices had a rich content and good balance of ingredients.

Table 4. Sensory evaluation of the juice from round pumpkin variety blended with MD2 pineapple juice

Juice blends*	Aroma	Taste	Clarity	colour	After taste	Mouth feel	Overall acceptability
[100:0]	6.60±1.92^{d}	7.09±1.90^{c}	4.14±2.07^{b}	5.05±2.15^{b}	6.00±2.01^{c}	5.42±2.08^{b}	5.72±1.67^{c}
[85:15]	6.44±1.94^{c}	5.86±2.03^{c}	4.23±1.97^{b}	4.58±1.96^{b}	6.14±1.58^{bc}	5.53±1.91^{b}	5.46±1.90^{bc}
[70:30]	5.33±2.00^{bc}	5.33±2.06^{b}	3.77±1.70^{a}	4.21±1.54^{b}	5.42±2.05^{bc}	5.33±2.05^{b}	4.20±1.90^{abc}
[55:45]	3.98±1.82^{a}	4.14±1.72^{a}	3.14±1.63^{a}	4.12±4.64^{b}	4.19±1.89^{a}	3.91±1.89^{a}	3.91± 2.22^{a}
[0:100]	5.00±2.56^{ab}	4.60±2.09^{ab}	3.16±2.10^{a}	2.72±1.28^{a}	4.95±2.02^{ab}	4.93±2.02^{b}	4.23±2.02^{ab}

[Mean values with same superscript in the same column denote samples with no significant difference (p>0.05)].
*Blends (round pumpkin juice: pineapple juice).

Table 5. Ranking order in percentage (%) for the juice blend from the pulp of round pumpkin fruit and MD2-pineapple

Juice blends*	1st	2nd	3rd	4th	5th
[100:0]	2.33	7.32	24.39	18.61	45.24
[85:15]	2.33	9.76	26.83	39.53	21.43
[70:30]	13.95	24.39	29.27	27.90	7.14
[55:45]	53.49	39.02	4.88	2.33	2.38
[0:100]	27.91	19.51	14.63	11.63	23.81

*Blends (round pumpkin juice: pineapple juice).

3.4.3. Sensory Evaluation of the Juice from Cylindrical Pumpkin Variety Blended with MD2 Pineapple Juice

3.4.3.1. Aroma and Taste

The acceptance of aroma ranged from a mean score of 3.62 to 6.68, which represented liked moderately to disliked moderately. The most accepted product for aroma was 100 % pineapple juice which was followed by (55: 45) with the 100% pumpkin juice recording the least accepted. There were significant differences in all five products (p<0.05). The acceptance for taste ranged between 2.79 and 6.64, which also depicted liked very much to disliked moderately. Again product 100 % pineapple juice was the most accepted which was followed by product (55: 45) and the least accepted was product 100 % pumpkin juice which could be attributed to the flat or blunt taste of the juice. The MD2 pineapple fruit used in this study has been found to have an attractive sensory characteristics, pronounced flavour, sweetness to acidity balance and juiciness. The appealing flavour of the pineapple has been attributed to a number of inherent volatile and non-volatile compounds present in small amounts and in complex mixtures within the MD2 pineapple [63]. There were significant differences (p<0.05) in the taste of all the products.

3.4.3.2. Clarity and Colour

In terms of clarity, the mean score of acceptance as scored by the panelist ranged from 2.0 to 5.74 indicating liked very much to neither liked nor disliked. Significant differences (p<0.05) existed in all the five products. Product (0:100) recorded the most accepted followed by (55:45) whereas (100:0) was the least liked with regards to the clarity of the juice. The panellists scored colour from liked very much to neither liked nor disliked with corresponding mean scores of 2.09 to 5.11. The 100% pineapple juice and 100% pumpkin juice were respectively the most and least accepted products for colour. The reason for the acceptance of product 100% pineapple juice could be attributed to the deep yellow colour of the MD2 pineapple making it appealing to the panelists [64]. Significant differences (p<0.05) existed in the colour of all the five products.

3.4.3.3. Aftertaste and Mouthfeel

The evaluation of aftertaste as a sensory attribute ranged from 2.85 to 6.21 which indicate liked very much to disliked moderately. The most accepted product for this attribute was still the 100 % pineapple juice and the next after this was (55: 45). As already seen in previous attributes, the least accepted was product (100:0). There were significant differences (p<0.05) in the mean values of the aftertaste of all the five products. Mouthful has been defined as the textural attributes of a food or beverage responsible for producing characteristic tactile sensations on the surfaces of the oral cavity [65]. Mean scores for Mouthfeel was from 2.85 to 5.96 which represented liked very much to neither liked nor disliked. The most accepted product for mouthfeel was 100 % pineapple juice and followed by (55:45). The least acceptable product was 100 % pumpkin juice. Significant differences (p<0.05) existed in the mean values of mouthfeel of all the products.

3.4.3.4. Overall acceptability of Juices

Based on the overall mean values of the sensory attributes, the most accepted juice was 100% pineapple juice with a mean score of 2.70 representing liked very much. Product (55:45) was the second most accepted product by the panellist with an overall mean score of 3.95 which also represents liked moderately. The least accepted was the 100 % pumpkin juice with an overall mean score of 6.05 implying it was disliked slightly. There were significant differences (p<0.05) in the overall mean values of the products.

3.4.4. Preference Ranking Scores of the Juice from Cylindrical Pumpkin Variety Blended with MD2 Pineapple Juice

The preference ranking scores of the juices from the cylindrical fruit blended with the MD2 pineapple juice is shown in Table 7. About 71.11% of the panellists ranked the 100% pineapple juice as the most preferred whereas 6.67% ranked it as least preferred. In commenting on reasons for this choice, some of the panellists liked three or more of its attributes (colour, taste, aroma and/or mouth feel, aftertaste and clarity). Generally, panellists preferred all the attributes they evaluated on this product. The second most preferred blend was the (55:45). This formulation was the same as the most preferred for the round fruit. Sixty percent (60%) of the panellists ranked this blend second to 100% pineapple juice whereas 20% ranked it as first.

Table 6. Sensory evaluation of juices from cylindrical pumpkin variety blended with MD2 pineapple juice

Juice blends*	Aroma	Taste	Clarity	colour	After taste	Mouth feel	Overall mean score
[100:0]	6.68 ± 1.59^{d}	6.64 ± 1.86^{d}	5.74 ± 1.98^{d}	5.11 ± 2.15^{d}	6.21 ± 2.06^{d}	5.96 ± 2.00^{d}	6.05 ± 1.94^{d}
[85:15]	5.83 ± 1.79^{cd}	5.55 ± 1.90^{c}	4.94 ± 1.82^{cd}	4.57 ± 1.69^{cd}	5.28 ± 2.00^{cd}	5.09 ± 2.00^{cd}	5.21 ± 1.87^{c}
[70:30]	5.43 ± 1.96^{bc}	5.28 ± 2.18^{c}	4.49 ± 1.68^{c}	4.02 ± 1.59^{bc}	4.89 ± 2.07^{bc}	4.89 ± 2.07^{c}	4.83 ± 1.93^{c}
[55:45]	4.79 ± 1.97^{b}	3.85 ± 1.92^{b}	3.53 ± 1.54^{b}	3.64 ± 1.35^{b}	4.00 ± 1.84^{b}	3.89 ± 1.66^{b}	3.95 ± 1.71^{b}
[0:100]	3.62 ± 2.03^{a}	2.79 ± 1.68^{a}	2.00 ± 1.37^{a}	2.09 ± 1.18^{a}	2.85 ± 1.68^{a}	2.85 ± 1.68^{a}	2.70 ± 1.30^{a}

[Mean values with same superscript in the same column denote samples with no significant difference ($p>0.05$)]
*Blends (cylindrical pumpkin juice: pineapple juice).

Table 7. Ranking order in percentage (%) for the juice blend from the pulp of cylindrical pumpkin fruit and MD2-pineapple.

Juice blend*	1st	2nd	3rd	4th	5th
[100:0]	2.22	0.00	8.89	17.78	73.33
[85:15]	2.22	8.89	22.22	51.11	13.33
[70:30]	4.44	15.56	55.56	15.56	6.67
[55:45]	20.00	60.00	6.67	13.33	0.00
[0:100]	71.11	15.56	6.67	2.22	6.67

*Blends (cylindrical pumpkin juice: pineapple juice)

4. Conclusion

The results indicated that round and cylindrical pumpkin pulp have higher moisture content of 95.03% and 95.66%. The pH and titratable acidity of the pulp from the round fruit were significantly higher ($p< 0.05$) than the corresponding amount in the cylindrical pumpkin fruit pulp. The magnesium, zinc and calcium contents of the round pumpkin pulp were significantly higher ($p< 0.05$) than the amounts found in the cylindrical. However, the potassium and sodium contents in the cylindrical pumpkin pulp were also significantly higher than the quantities in the round pumpkin pulp. In ranking the products for the first position, approximately 54% of panellists ranked (55:45) as the leading product for the juice blend with pulp from the round followed by (0:100) which was ranked by 28% of panellists. Similarly, the most preferred amongst the product formulations with the cylindrical pumpkin fruits was 100% pineapple juice (control) which was ranked by approximately 71% of the panellists for the first position. This was directly followed by (55:45) pumpkin pineapple juice blend which was ranked by 20% of the panelists for the first position. However, 60% of the panellists ranked (55:45) pumpkin pineapple juice blend as the most preferred in the second position. The 100% pumpkin juice from the two types of fruits was poorly ranked amongst all the product in terms of its acceptance and preference. The most accepted juice blend [55:45] has a great potential to compete with the single strength pineapple juice on the market.

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