

## Pawpaw enriched soymilk beverage

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### Abstract

Effects of enriching soymilk with pawpaw puree at different ratios (10 – 40%) were evaluated for physicochemical properties, vitamin A and C, mineral contents, and sensory attributes. The results showed increase in total soluble solids (5.5 – 8.5 °Brix), total titratable acidity (0.53 – 0.87 g/kg) and viscosity (19.9 – 26.7 cp), but decreased in pH (7.4 – 6.8). Vitamin A and C contents of the soy-pawpaw beverage increased from 12.4– 20.4 µg/100 ml and 10.9 – 25.8 mg/100 ml, respectively. All the macromineral contents of the enriched soymilk beverages increased significantly except for sodium. Enrichment of soymilk with pawpaw puree improved the sensory attributes of the drink in terms of flavour, taste, mouthfeel and overall acceptance, especially at high supplementation level (40%). Enrichment of soymilk with pawpaw puree resulted in products with better vitamin A and C and macro-mineral contents than plain soymilk drink, thus, the soy-pawpaw beverage will complement consumers micro and macro-nutrient intake.

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### Introduction

Beverages are foods consumed in liquid form, which can either be alcoholic or non-alcoholic. Non-alcoholic beverages play a key role in the dietary pattern of people in developing countries such as Nigeria. Non-alcoholic beverages are regarded as after meal drinks or refreshing drinks, however, most of these beverages are made up of about 90% water, sugar, flavouring agents and sometimes preservatives. Although most commercially available non-alcoholic beverages in developing countries are less nutritious, some of them such as soymilk, fruit juices etc., are nutritious and of medicinal value (Aka *et al.*, 2008; Nwachukwu *et al.*, 2010).

Soybean (*Glycine max*) is an excellent source of protein (35-40%), containing all the essential amino acids, and rich source of calcium, iron, phosphorus and vitamins (Jiang *et*

*al.*, 2000). It is rich in vitamins (riboflavin, thiamine, folic acid), minerals such as magnesium, lecithin, and also contains all essential fatty acids (Mc Watters *et al.*, 1995). Soybeans contain about 3% lecithins which are helpful for infant brain development.

Soymilk is a watery extract of whole soybeans, rich in water soluble protein, carbohydrate and oil (Adebayo-Tayo *et al.*, 2008). The milk is a white or creamy emulsion which resembles conventional milk in both appearance and consistency (Iwe, 2003; Kolapo and Oladimeji, 2008). In developing countries, soymilk is one of the most common protein rich healthy alternatives to cow milk. Soymilk is affordable and economical when compared to industrially processed cow milk. Soymilk contains 4.6% protein, 2.3% fat, 4.3% carbohydrate, no cholesterol, no lactose, 15%

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saturated fatty acid, 64% polyunsaturated fatty acid and 21% monounsaturated fatty acid (Adeleke and Odelola, 1997). The increasing popularity of soymilk as a beverage worldwide is credited to its health benefits which includes low cholesterol and lactose, its ability to reduce bone loss and menopausal symptoms, prevention and reduction of heart diseases and certain cancers (Iwe, 2003; Kolapo and Oladimeji, 2008; Adebayo -Tayo *et al.*, 2008).

Pawpaw (*Carica papaya* L.), which belongs to the family *Caricaceae* is a tropical plant with potential medicinal value, and a rich source of vitamin A and C (Bolarinwa *et al.*, 2020a, 2020b). The fruit high nutritional quality makes it an excellent contributor to a balanced diet. Pawpaw is a potential source of natural fruit flavor and contains high levels of potassium, calcium and iron (Bolarinwa *et al.*, 2020a). It is also a very good source of free-radical scavenging vitamin A, due to its several form of beta-carotene (Dimitrovski *et al.*, 2010).

Enrichment of milk-based or cereal-based foods with fruits such as pawpaw, carrot etc., has been reported to improve the nutritional composition and sensory attributes of the enriched foods. According to Njoya *et al.* (2017) incorporation of pawpaw puree at different levels in yoghurt preparation improved the flavour of plain yoghurt. In another study, enrichment of natural yoghurt with pawpaw was reported to produce acceptable pawpaw flavoured yoghurt with higher nutritional characteristics (Othman *et al.*, 2019). Enrichment of white bread with pawpaw puree was also reported to improve the micronutrient contents and sensory attributes of the bread (Bolarinwa *et al.*, 2020a). Furthermore, fortification of soymilk with carrot powder has been reported to improve the nutritive quality of soymilk (Madukwe and Eme, 2012). It is therefore expected that incorporation of pawpaw puree into soymilk will enhance the quality attributes of the beverage. Hence, the objectives of this study are to determine the physicochemical properties, vitamin A and C, mineral contents, and sensory attributes of pawpaw enriched soymilk beverage.

## Materials and methods

### Materials

Soybeans and pawpaw fruits were procured from a local market in Ogbomoso, South West, Nigeria. Soy-pawpaw beverage preparation and experimental analyses were done at Ibrahim Owodunmi Food Processing laboratory, and Food Chemistry laboratory, Ladoke Akintola University of Technology, Ogbomoso, Oyo state, Nigeria. All reagents were of analytical grade.

### Methods

#### Production of pawpaw puree

Fresh mature ripe pawpaw fruits (Solo sunrise variety) were selected, washed with 5% hypochlorite solution and rinsed with distilled water. The fruits were peeled with sterile stainless knife, cut into small pieces of between 3-4 mm thick and seeds were removed. Puree was prepared by blending the pawpaw pulp in a blender for 3 min. The puree was filled in airtight screw cap sterilized glass bottles and refrigerated at 5°C for few hours prior to further use.

#### Production of soymilk

Soybean (*Glycine max* L.) (1 kg) was sorted and soaked for 12 h in clean water (1:3 w/v) and decanted. The soybean was dehulled and wet milled (1:3 w/v) using hammer mill. The slurry was cooked for 10-15 min. The cooked slurry was cooled for 10 min and sieved, following addition of 200g sugar.

#### Preparation of pawpaw enriched soymilk beverage

The soymilk was mixed with pawpaw puree at varying proportions: 100:0 (control sample), 90:0, 80:20, 70:30 and 60:40(soy: pawpaw) (Table I). The blends were homogenized, bottled and pasteurized at 75 °C for 5 min in a

**Table I. Formulation of pawpaw enriched soymilk beverages**

Sample	Soymilk (%)	Pawpaw puree (%)
Plain soymilk	100	0
10%Soy-pawpaw	90	10
20%Soy-pawpaw	80	20
30%Soy-pawpaw	70	30
40%Soy-pawpaw	60	40

thermostatically controlled water bath with agitator, cooled to room temperature ( $27 \pm 2$  °C) and stored in a refrigerator (5 °C) until analysed.

#### *Physicochemical analyses*

##### *pH*

The pH of the beverage was determined using a digital pH meter (pHs-2F, Harris, England) according to AOAC (2012) method. 50 ml juice was transferred to a beaker and the pH was determined after the meter was calibrated using standard buffer solutions of pH 4.0 and 7.0. Sufficient time was allowed for equilibration before readings were taken.

##### *Total titratable acidity (TTA)*

10 ml beverage was pipetted into a conical flask and 25 ml of distilled water was added, following AOAC (2012). 0.1M NaOH (200 ml) was poured into a burette and was titrated against the sample in the flask using three drops of phenolphthalein as indicator. The solution was titrated until a pink colouration was observed and the corresponding burette reading taken.

##### *Viscosity determination*

The viscosity of the beverage was determined as described by Awolu *et al.* (2013), using a Rion-visco-tester (model VA-04F). The soy-pawpaw beverage was poured into the viscometer cup, the rotor was suspended into the sample to rotate and the values was determined in decipascal-second unit (cp) at varying temperatures (30, 40 and 50 °C).

##### *Total soluble solids (°Brix)*

A hand-held sugar refractometer was used for the total soluble solids (TSS) determination. The prism of the refractometer was cleaned and a drop of the beverage was placed on the prism and closed. The TSS (°Brix) value was read off the scale of the refractometer when held close to the eye (AOAC, 2012).

##### *Vitamin A determination*

Vitamin A was extracted from the soy-pawpaw beverage with a mixture of acetone and hexane (4:6 v/v) by the method of Singh *et al.* (2015) and Bolarinwa *et al.* (2020a). Ten grammes (10g) of each drink was extracted with a mixture of 20 ml of acetone and 30 ml of hexane (4/6 v/v). The mixture was poured into a separatory

funnel and shaken until the content became homogenous. The mixture was allowed to separate in a dark place (inside a cupboard) and the top layer was taken with a pipette. Optical density was measured at 452 nm for  $\beta$ -carotene and converted to vitamin A, as follows;

$$\beta - \text{carotene } (\mu\text{g}/100) = \frac{\text{OD} \times 13.9 \times 10000 \times 100}{\text{Weight of sample} \times 560 \times 1000}$$

$$\text{Vitamin A} = \beta - \text{carotene } (\mu\text{g}/100) / 0.6$$

where OD = optical density of the solution at 452 nm

##### *Vitamin C determination*

Vitamin C content was determined by the spectrophotometric method using ascorbic acid as a reference compound. About 10 ml of the beverage sample was weighed into 10ml of water and mixed together. The extract (200  $\mu$ l) was pipetted and mixed with 300  $\mu$ l of 13.3% of trichloro-acetic acid (TCA) and 75  $\mu$ l (0.075 ml) of dinitrophenylhydrazyl (DNPH). The mixture was incubated in water bath at 37°C for 3 h, and 500  $\mu$ L of 65% sulphuric acid was added and the absorbance was read at 520 nm on a spectrophotometer (Okwu and Josiah, 2006).

##### *Mineral content determination*

The macro-mineral content of the pawpaw enriched soymilk beverage was determined following the method described by Nwozo *et al.* (2017) with slight modification. The moisture in the beverage was evaporated to concentrate the sample and one gram of the sample was digested with nitric acid/perchloric acid mixtures (1:2). The digest was boiled (5 min), cooled and transferred to 50 ml volumetric flask and made up to mark with diluted water. The resulting digest was filtered using Whatman No.1 filter paper, and the filtrate from each sample was used for the specific mineral analysis using Flame Atomic Absorption Spectrophotometer (Buck Scientific Atomic Absorption Emission Spectrophotometer model 205, Nowalk, Connecticut, USA). All determinations were performed in triplicates.

##### *Sensory evaluation*

Sensory evaluation of the five soy-pawpaw beverage samples were carried out using the preference tests. The samples were served to 50 semi-trained panelists comprising of a population of staff and students of Ladoké Akintola University of Technology (LAUTECH) who are regular consumers of soymilk. Sensory test was conducted in compliance with all regulations and according to established

ethical guidelines at LAUTECH. The purpose of the study was explained to the panelists verbally and through written information in the sensory form. The panelists signed an informed consent form if they were in agreement with the purpose of the study and submitted it to the researcher. Participants were informed that the soymilk beverages are enriched with pawpaw puree. The beverage samples were randomly labelled numerically and served to the panelists. The panelists were requested to evaluate the colour, flavour, taste, mouthfeel, and overall acceptance of the beverages. A 9-point hedonic scale (with 1 and 9 representing dislike extremely and like extremely, respectively) was used to measure the degree of preference for the beverage samples.

#### Statistical analysis

All data obtained in the study were subjected to analysis of variance (ANOVA) using Statistical Package for the Social Science (SPSS) version 17.0., and means were separated with the use of Duncan's multiple range test to detect significant differences ( $p \leq 0.05$ ) among the beverage samples.

### Results and discussion

#### Physicochemical properties of the pawpaw enriched soymilk beverage

The physicochemical properties of the soy-pawpaw beverages are presented in Fig. 1. Fortification of soymilk with pawpaw puree resulted in decrease in the pH of the soy-pawpaw beverages. The pH of the plain soymilk was higher (7.4) than the pH of the pawpaw enriched soymilk drink (7.1 – 6.8), with the highly supplemented soy-pawpaw beverage having the lowest pH value (6.8). These results are

in congruent with the findings of Njoya *et al.* (2017) who reported slight decrease in pH values (5.01 – 4.99) of pawpaw enriched yoghurt. In contrary, Othman *et al.* (2019) reported increased in the pH values (5.66 – 5.82) of pawpaw enriched plain yoghurt. Reduction in the pH values of the soy-pawpaw beverage with increasing supplementation level could be due to the presence of organic acids in ripe pawpaw fruit (Hernandez *et al.*, 2009) and low pH (3.7 – 4.5) of pawpaw fruit (Frazier and Westhoff, 1995). However, the pH values (7.1 – 6.8) of the soy-pawpaw beverages are higher than the pH values reported for fruits and vegetable juices (3 – 5) (Harris *et al.*, 1991), cocktail juices (4.82 – 4.99) (Adubofuor *et al.*, 2010), orange juices (3.23 – 4.08) (Ndife *et al.*, 2013) and cashew juice (4.1) (Emelike and Ebere, 2015). This suggests that the soy-pawpaw beverage will be well tolerated by juice consumers.

TSS contents in fruit juice are directly related to the sugar contents of the juice. Supplementation of soymilk with pawpaw puree significantly  $p \leq 0.05$  increased the total soluble solids (TSS) of the beverages. Soy-pawpaw beverages with the highest supplementation level (40%) had the highest TSS value (8.5 °Brix) among the enriched soymilk beverages, while the plain soymilk beverage had the least TSS value (5.5 °Brix). Higher TSS values recorded for soy-pawpaw beverage compared to the plain soymilk could be due to high total sugar in pawpaw fruit. Total sugar contents of ripe pawpaw pulp are reported to be between 10.3% to 14.3%, depending on the pawpaw variety (bello and Enidiok, 2017). Thus, high TSS values recorded for samples with higher supplementation level (>20%) could be due to the enrichment of the soymilk with sweetness of ripe pawpaw.

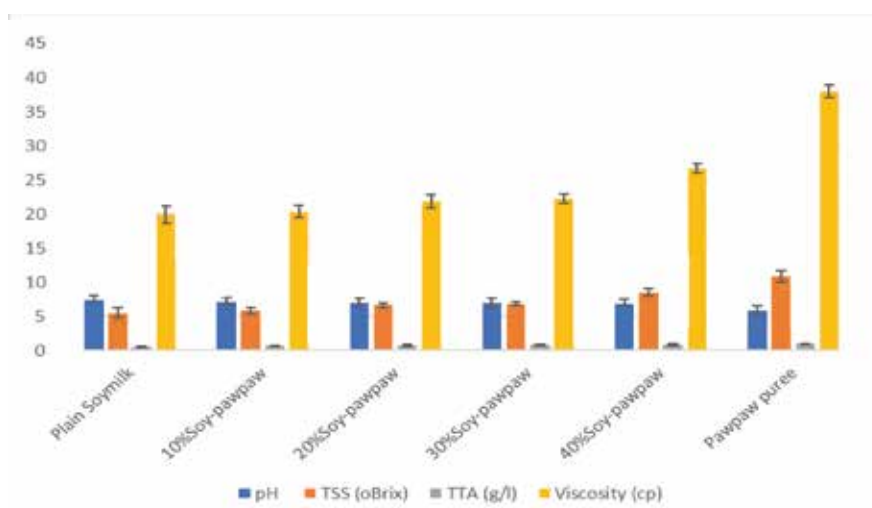


Fig. 1. Physicochemical properties of pawpaw enriched soymilk beverages

This is an indication that the soy-pawpaw beverages will be sweeter than soymilk. The total soluble solid values (5.8 – 8.5 °Brix) recorded for soy-pawpaw beverage in this study are similar to the TSS values (8.17 – 9.91 °Brix) for soy-carrot flavoured with beetroot (Banigo *et al.*, 2015) and within the range of TSS (0.50 – 11.80%) reported for commercial orange juice samples (Ndife *et al.*, 2013). The conformity of the TSS values of the soy-pawpaw beverages with commercially available juice samples indicates that the beverages will be generally acceptable in terms of taste.

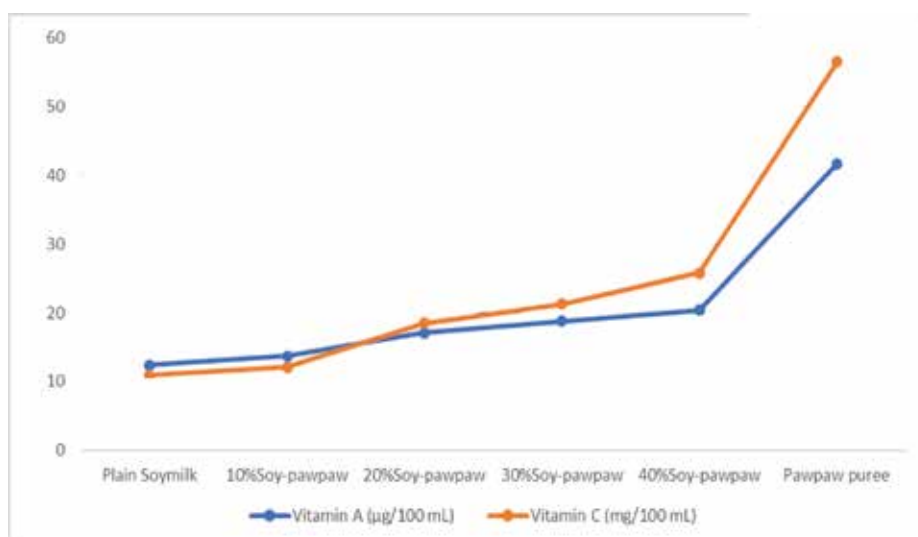
Total titratable acidity (TTA) of the beverages increased with increasing supplementation with pawpaw puree in the soy-pawpaw beverages (Fig. 1). The TTA values of the enriched soymilk beverages increased from 0.53 – 0.87 g/l, with the 10% Soy-pawpaw beverages having TTA value significantly lower ( $p \leq 0.05$ ) than that of 40% Soy-pawpaw beverage. The increments in the TTA of the soy-pawpaw beverages with increasing pawpaw puree supplementation with pawpaw puree could be due to the presence of numerous organic acids in pawpaw fruit. According to Hernandez *et al.* (2009), pawpaw fruit contains relatively high concentration of citric (335 mg/100 g FW) and malic acid (209 mg/100 g FW), in addition to low concentration of other fruit acids such as quinic acid, succinic acid, tartaric acid, oxalic acid, and fumaric acid. Although there was no significant difference ( $p \geq 0.05$ ) in the TTA values of the soy-pawpaw beverages at 10 - 20% supplementation level, the TTA value of the 100% soymilk (control) sample was significantly different from those of the soy-pawpaw beverages. The relatively high TTA values of the soy-pawpaw beverages indicates that the samples may have better keeping quality

than soymilk. This is because fruit acids dominant microflora in foods and determines the shelf stability of food products. Although acidic drinks are less susceptible to bacterial action, they may be prone to yeasts and moulds action.

The viscosity of the plain soymilk (19.9 cp) was significantly ( $p \leq 0.05$ ) lower than those of the soy-pawpaw beverage samples (20.3 – 26.7 cp). 10% Soy-pawpaw beverage had the lowest viscosity value (20.3 cp) while the 40% Soy-pawpaw drink had the highest viscosity (26.7 cp). Higher viscosity recorded for the soy-pawpaw beverages, especially at higher supplementation levels could be due to high solid contents of pawpaw puree. High viscosity value of the soy-pawpaw beverages could also be attributed to relatively high fibre content (6.2 – 11.2%) in pawpaw fruit (Chukwuka *et al.*, 2013). Past study reported higher consumer preference for viscous soy beverages (Terhaag *et al.*, 2013). This indicates that soy-pawpaw beverages produced from higher supplementation ratio (>20%) will be acceptable by soymilk consumers.

#### *Vitamin A and C contents of the pawpaw enriched soymilk beverage*

The vitamin contents of the soy-pawpaw beverages are presented in Fig. 2. Vitamin A plays vital roles in the wellbeing and healthy livelihoods of people in general, and children, and pregnant women in particular. It is involved in immune function, vision, reproduction and cellular communication. Vitamin C on the other hand, is a powerful water-soluble antioxidant that helps to protect other naturally occurring antioxidants (IOM, 2000). Vitamin A and vitamin C contents of the soy-pawpaw beverages significantly



**Fig. 2. Vitamin A and C contents of pawpaw enriched soymilk beverage**

increased at >10% pawpaw puree supplementation (Fig. 2). Vitamin A contents (13.4 – 20.4 µg/100ml) of the soy-pawpaw beverages were significantly ( $p \leq 0.05$ ) higher than that of the plain soymilk (12.4 µg/100ml). Similarly, Vitamin C contents of the soy-pawpaw beverages increased with increasing supplementation level. 40% soy-pawpaw beverage had the highest vitamin C content (25.8 mg/100 ml) while 10% soy-pawpaw beverage had the lowest Vitamin C content (12.09 mg/100ml). In general, vitamin A and C contents of the soy-pawpaw beverages were higher than that of the plain soymilk (Fig. 2).

High values of vitamin A and C reported for the soy-pawpaw beverages could be due to high values of these vitamins in pawpaw fruit. According to USDA (2019a), vitamin A and C contents of pawpaw fruit is 45 µg/100 g and 60.9 mg/100 g, respectively. Chukwuka *et al.* (2013), also reported fruits vitamin A and C values for ripe pawpaw fruit. However, vitamin C contents (12.09 – 25.8 mg/100 ml) of the soy-pawpaw beverages reported in this study is lower than the vitamin C content (43 mg/100 g) of fermented soymilk drink (Zhao and Shah, 2014), but higher than the vitamin C contents (9.53 – 9.82 mg/100 g) of carrot fortified soymilk (Madukwe and Eme, 2012). The differences could be due to different pawpaw cultivars used in the studies, and differences in the processing methods employed in the studies. In addition, vitamin C contents (12.09 – 25.8 mg/100 ml) of the pawpaw enriched soymilk is within the vitamin C contents (9.18 -32.06 mg/ 100 ml) of imported and local juices in Nigeria (Nwozo *et al.*, 2017).

Vitamin A contents (13.7 – 20.4 µg/100 ml) of the soy-pawpaw beverages are higher than vitamin A content (6 µg/100 g) of plain soymilk powder (Mazumder and Hongsprabhas, 2016). Similarly, the vitamin A contents of the soy-pawpaw beverages are higher than Vitamin A contents (0.45 – 8.80 µg/ 100 ml) of commercial juices in Nigeria (Nwozo *et al.*, 2017).

Although the vitamin C contents of the soy-pawpaw beverages (12.09 – 25.8 mg/100 ml) were lower than the recommended dietary allowance (RDA) of vitamin C for men and women (60 mg), and the amount of vitamin C (90 – 100 mg) required for optimum reduction of chronic disease risk in non-smoking men and women (Carr and Frei, 1999), the enriched beverages can contribute to vitamin C intake of consumers.

#### *Mineral composition of the pawpaw enriched soymilk*

Minerals are nutritionally important components in food, which are essential for healthy living. They are vital for normal growth, maintenance, effective immune system and prevention of cell damage (Kassa and Hailay, 2014). In addition, minerals are involved in growth and production of bones, teeth, hair, blood, nerves, skin, enzymes and hormones, blood circulation, cellular integrity, energy production and muscle contraction (Kassa and Hailay, 2014). The macro-mineral composition of the pawpaw enriched soymilk beverages is presented in Table II.

**Table II. Mineral composition of pawpaw enriched soymilk beverage**

Sample	Ca (mg/100mL)	K (mg/100mL)	Mg(mg/100mL)	Na(mg/100mL)	P(mg/100mL)
Pawpaw puree	21.10 ± 0.01 <sup>b</sup>	183.45 ± 0.05 <sup>a</sup>	94.63 ± 0.14 <sup>a</sup>	7.65 ± 0.04 <sup>c</sup>	25.01 ± 0.61 <sup>c</sup>
Plain soymilk	102.38 ± 0.02 <sup>a</sup>	120.13 ± 0.03 <sup>b</sup>	54.74 ± 0.07 <sup>b</sup>	34.00 ± 0.02 <sup>a</sup>	50.65 ± 1.18 <sup>d</sup>
10%Soy-pawpaw	102.59 ± 0.03 <sup>a</sup>	120.52 ± 0.02 <sup>b</sup>	54.83 ± 0.03 <sup>b</sup>	29.34 ± 0.02 <sup>b</sup>	52.10 ± 0.03 <sup>d</sup>
20%Soy-pawpaw	103.06 ± 0.24 <sup>a</sup>	121.73 ± 0.29 <sup>a</sup>	56.01 ± 0.04 <sup>a</sup>	25.72 ± 0.25 <sup>c</sup>	60.74 ± 0.05 <sup>c</sup>
30%Soy-pawpaw	103.25 ± 0.03 <sup>a</sup>	122.10 ± 0.57 <sup>a</sup>	56.82 ± 0.05 <sup>a</sup>	25.01 ± 0.02 <sup>c</sup>	63.19 ± 0.02 <sup>b</sup>
40%Soy-pawpaw	103.88 ± 0.04 <sup>a</sup>	122.50 ± 0.03 <sup>a</sup>	57.11 ± 1.19 <sup>a</sup>	20.97 ± 0.14 <sup>d</sup>	65.60 ± 0.03 <sup>a</sup>

Values are mean ± standard deviation (n = 3). Values with different superscripts are significantly different ( $P \leq 0.05$ )

The calcium content of the beverage did not increase significantly ( $p \geq 0.05$ ) as the proportion of pawpaw puree increased in the beverage samples. This could be due to low concentration of calcium in pawpaw fruit. According to USDA (2019a), the calcium content of pawpaw fruit is 20 mg/100 g. In contrary, Saxholt *et al.* (2008) reported higher values (57.93 – 255.9 mg/100g) for calcium in ripe pawpaw fruit. This could be due to variety differences. However, the calcium contents (102.59 – 103.88 mg/100 ml) of the pawpaw enriched beverages were higher than the calcium contents (21.00 - 24.20 mg/100g) of pawpaw juice-milk blend (Adebayo-Oyetero *et al.*, 2016). This could be due to high calcium contents (125 mg/100 mL) in soymilk (USDA, 2019b).

The potassium content of the beverages ranged from 120.13 to 122.50 mg/100 ml with the plain soymilk having the lowest potassium value while the soymilk beverage enriched with 40% pawpaw puree had the highest value. High potassium contents in the beverages could be due to high potassium contents in pawpaw fruit (185 mg/100 g) and soymilk (123 mg/100 ml) (USDA, 2019b). Similarly, Puwastien *et al.* (2000), reported high potassium contents (1,234 mg/100g) for pawpaw fruit. The potassium contents of the pawpaw enriched soymilk are within the range of potassium contents (152.5 and 305 mg/100 ml) of fruit juices (Nwozo *et al.*, 2017).

The magnesium contents (54.74 – 57.11 mg/100 ml) of the beverage significantly ( $p \leq 0.05$ ) increased at higher enrichment levels (Table II). This could be due to high magnesium content (95.24 mg/100 g) in pawpaw fruit (Sanchez-Castillo *et al.*, 1998). However, enrichment of soymilk with 10% pawpaw puree did not significantly ( $p \geq 0.05$ ) increase the magnesium content of the beverage. The magnesium contents of the enriched soymilk beverages are within the magnesium contents (53.76 – 54.82 mg/100 g) of soymilk produced from different improved soybeans varieties (Ugochi and Chukwuma, 2015).

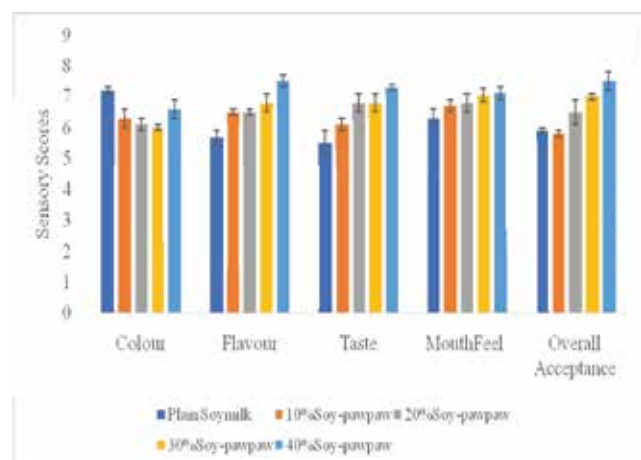
The sodium contents of the beverages decreased (34.0 – 20.97 mg/100 ml) with increasing enrichment ratio. Thus, enrichment of soymilk with pawpaw puree reduced significantly ( $p \leq 0.05$ ) the sodium contents of the beverages. This could be due to low sodium content (8 mg/100 g) in pawpaw fruit (USDA, 2019a). Highest sodium concentration (34 mg/100 ml) was recorded for the plain soymilk beverage. This could be due to high sodium content (50 mg/100 g) in soymilk (USDA, 2019b). Lower sodium values (20.97 – 29.34 mg/100 ml) recorded for the pawpaw enriched soymilk beverages indicate that the beverages will not contribute to high sodium intake.

The phosphorus contents (52.1 – 65.6 mg/100 ml) of the enriched soymilk beverages containing >10% pawpaw puree was significantly higher than that of the plain soymilk (50.65 mg/100 ml). The phosphorus contents of the enriched soymilk beverages are however, lower than phosphorus values (84.55 – 89.63 mg/100 g) of soymilk produced from different improved soybeans (Ugochi and Chukwuma, 2015). This could be due to variety differences in the soybean's cultivar used for the soymilk production.

In general, high macro-mineral contents (calcium, potassium, magnesium and phosphorus) of the beverage indicates that the beverage will enhance the macro-mineral intake of consumers.

#### *Sensory evaluation of the pawpaw enriched soymilk beverage*

The results of the sensory evaluation of the pawpaw enriched soymilk beverages are shown in Fig. 3. Sensory attributes are important parameter that determines consumer's acceptability of new products. As shown in Fig. 3, the plain soymilk (control) sample was highly rated in terms of colour (7.2) compared to the colour (6.0 – 6.6) of the soy-pawpaw beverages. Lower sensory rating recorded for the colour of the soy-pawpaw beverages compared to the plain soymilk drink could be due to familiarity of the panelists with the milky colour of plain soymilk beverage.



**Fig. 3. Sensory evaluation results of the pawpaw enriched soymilk beverage**

The flavour (6.5 – 7.5), taste (6.1 - 7.3), and mouthfeel (6.7 – 7.1) of the soy-pawpaw beverages were highly rated by the panelists compared to the flavour (5.7), taste (5.5), and mouthfeel (6.3) of plain soymilk. Higher sensory rating for flavour of the soy-pawpaw beverage samples could possibly

be because of the ability of the pawpaw puree (due to its fruity flavour) to mask the beany flavour of soybeans in the beverages. Higher sensory scores for taste of the soy-pawpaw drinks could be due to the sweet taste of the beverage as imparted by pawpaw puree sweetness. This result corroborates the TSS values of the pawpaw enriched soymilk beverage (Fig. 1). Higher sensory scores recorded for the beverage could be due to high viscosity of the pawpaw enriched beverage samples compared to plain soymilk (Fig. 1). According to Terhaag (2013), consumers have high preference for viscous soymilk beverages.

In terms of overall acceptance, soymilk sample enriched with 40% pawpaw puree had the highest sensory score (7.5) while plain soymilk had the least sensory score (5.9). Highest overall acceptance rating recorded for the 40% Soy- pawpaw drink could be due to the general high rating of the 40% pawpaw puree enriched soymilk beverage in terms of most of the sensory attributes. The acceptance rating of the soy-pawpaw beverages (5.8 – 7.5) reported in this study is within the range of the acceptance value (6.05 – 7.80) reported for fruits incorporated soy drink (Banigo *et al.* (2015).

### Conclusion

The findings of this study have established that enrichment of soymilk beverage with pawpaw puree produced beverages with enhanced physicochemical properties and high concentration of vitamin A and C, and minerals especially at 40% supplementation level. Soy-pawpaw beverage produced from 40% pawpaw puree had the highest sensory score rating for flavour, taste, mouthfeel and overall acceptance, but lower rating than plain soymilk in terms of colour. The soy-pawpaw beverage produced in this study will complement vitamin A and C, and macro-mineral intake of consumers, and add variety to soymilk beverage. There is need for further studies on antioxidant properties, storage stability and development of optimum packaging materials for the soy-pawpaw beverages.

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