Cogent Food & Agriculture

ISSN: (Print) 2331-1932 (Online) Journal homepage: https://www.tandfonline.com/loi/oafa20

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**To cite this article:** A.O. Adebayo-Oyetoro, O.O. Ogundipe, I.G. Adeyemo, F.O. Ogundipe, F.A. Bamidele & S.A.O. Adeyeye | (2016) Chemical, sensory and shelf life study of pawpaw juice–milk blend, Cogent Food & Agriculture, 2:1, 1271276, DOI: 10.1080/23311932.2016.1271276

**To link to this article:** https://doi.org/10.1080/23311932.2016.1271276

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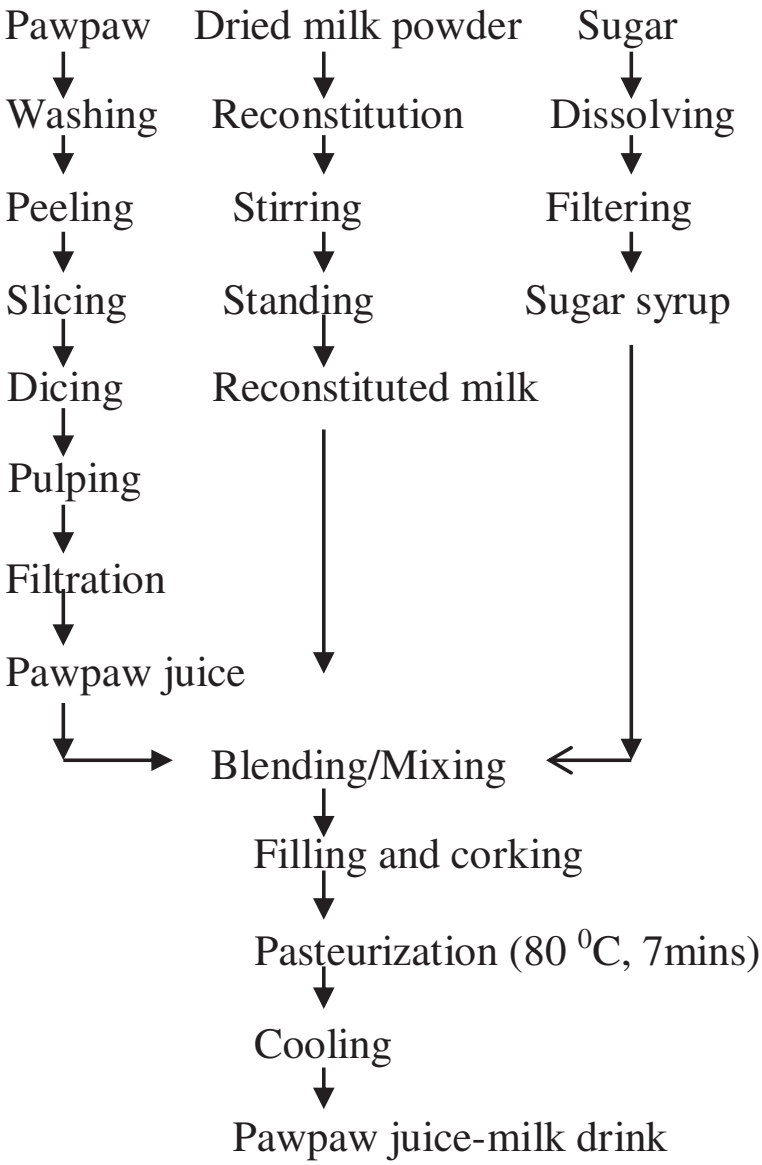


FOOD SCIENCE & TECHNOLOGY | RESEARCH ARTICLE

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*Cogent Food & Agriculture* (2016), 2: 1271276

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# Chemical, sensory and shelf life study of pawpaw juice–milk blend

A.O. Adebayo-Oyetoro[1]*, O.O. Ogundipe[1], I.G. Adeyemo[1], F.O. Ogundipe[2], F.A. Bamidele[2] and S.A.O. Adeyeye[3]

Received: 22 August 2016
Accepted: 08 December 2016
First Published: 20 December 2016

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Reviewing editor:
Fatih Yildiz, Middle East Technical University, Turkey

Additional information is available at the end of the article

**Abstract:** This study was carried out to assess the chemical properties, storage stability and consumer acceptability of a drink (functional food) from ripe pawpaw juice blended with milk and sugar. Pawpaw juice was produced from mature and ripe pawpaw (*Carica papaya*) fruits obtained from Ketu market in Lagos State, Nigeria. Powdered milk (200 g) was reconstituted in clean, boiled and cooled potable water (500 mL). Sugar syrup was made by dissolving 50 g into 250 mL water. All these were blended in appropriate ratios, filled into clean bottles and pasteurized at 80°C for 7 min, followed by cooling before further analysis. Some of the samples were kept on the shelf and analysed weekly for chemical (pH, vitamin C and protein), sensory and storage tests. The results showed significant differences ($p \leq 0.05$) between the samples in most of the parameters assessed. Chemical and sensory analysis showed that pH, vitamin C and protein ranged between 5.0–6.3, 15.0–18.7 mg/100 mL, and 26.2–29.0% respectively Sample LAH was most preferred in terms of sensory attributes. Microbial count was between $2.1 \times 10^1$ and $1.6 \times 10^2$ Cfu/mL while coliform was not detected. The findings revealed that good functional drink, products of blend of juice from pawpaw and milk could be produced from ripe pawpaw and powdered milk which may possess health benefits and also

A.O. Adebayo-Oyetoro

## ABOUT THE AUTHOR

The lead author A.O. Adebayo-Oyetoro (PhD) is a Senior Lecturer in the Department of Food Technology, at the Yaba College of Technology. She has authored several peer reviewed articles in several Journals and presented papers at many international conferences. She has attended several trainings in Nigeria and internationally on food quality, safety and nutrition. She has an interest in enhancing local underutilized foods to promote sustainable development and empowering vulnerable groups to ensure food security.

## PUBLIC INTEREST STATEMENT

Pawpaw a seasonal tropical fruit, abundant in tropical countries is relished for its taste and health promotional benefits due to its rich Vitamin A and Vitamin C content. It however has a short postharvest shelf life. Biotransformation of pawpaw into value added products, have potentials to address the challenge of hidden hunger and promote food and nutrition security at an economic cost and reduce post-harvest losses. FAO (2010) reported that, hidden hunger, also referred to as micronutrient deficiencies, affects more than 2 billion people, or one in three people, globally. Mild to moderate micronutrient deficiencies can significantly affect a person's well-being and development. Its effects are socio-economic, and include but are not limited to mental deficiency, poor health, low productivity, and even death if not properly addressed. Research and development into underutilized tropical fruits like paw-paw with good micronutrient profile, can solve malnutrition problems particularly in low- and middle-income countries.

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reduce long term sustainable intervention programmes of micronutrient deficiency in patients and individuals when consumed as either appetizer and/or dessert.

**Subjects: Food Science & Technology; Food Additives & Ingredients; Food Chemistry**

**Keywords: food security; safety; health promotion; new product development**

## 1. Introduction

Under nutrition and micronutrient deficiencies continue to be a problem worldwide. Thus, it was estimated that two billion people suffer from at least one form of micronutrient deficiencies or the other (Sanghvi et al., 2007). Micronutrient malnutrition otherwise known as "hidden hunger" is still a major public health problem in Nigeria (Nzeagwu & Udugwu, 2009). Long term sustainable intervention programmes that would combat micronutrient deficiencies are needed. Food base approach; especially dietary diversification to increase consumption of locally available foods could be very valuable in the fight against this hidden hunger (Nnam & Njoku, 2005). Fruits, example pawpaw are rich in some micronutrients especially ascorbic acid (vitamin C) and the precursor of vitamin A (β-carotene and pro-vitamin A) (Enwere, 1998; Okaka, 1997). Most fruits are perishable and some are seasonal and will not be available during off-season (Okegbile & Taiwo, 2000). Most of the fruits grown in the tropics, including pawpaw are under-utilized as a result of some economic, climatic, environmental and biological problems which include inconsistent rainfall, high cost of preservation, storage and transportation, pest and insect attack (Akubor & Ogbadu, 2005; Shubhangini, 2002).

Dairy products are also essential sources of nutrients including vitamins and minerals. Milk which is a major dairy product is often described as nature most nearly perfect single food. It is the basis for all other dairy products including yoghurt, cheese, kefir and ice-milk. Milk is balanced in its nutritional content and can be a good source of energy as well as protein (Okoro & Isa, 2007). Skimmed milk is that type of milk that has being defatted. This is of health importance as some of the prevailing disease conditions such as obesity and arthrosclerosis are related to increased consumption of fat.

There is need to increase the consumption of fruit juices and dairy products in varied forms especially before and after meals to improve nutritional and health status of the populace. Thus, the production of pawpaw juice-milk drink could provide an alternative means of increasing their consumption and reducing losses while at the same time provide alternative source of meeting minerals and vitamins requirement of the populace.

Therefore, this study aims at assessing the chemical properties, storage stability and consumer acceptability of a drink (functional food) from ripe pawpaw juice blended with milk and sugar. This will introduce diversification in the use of pawpaw and provide a safe nutrient-rich drink with health benefit that guarantees food security and provide solution to micronutrient deficiency.

## 2. Methods

### *2.1. Materials*

The raw material, mature and ripe pawpaw (*Carica papaya*) fruits were obtained from Ketu market in Lagos State while skimmed dried powdered milk and sugar were obtained from Ojuwoye market in Mushin, Lagos State, Nigeria. Other ingredients such as sodium benzoate (SB) and CMC (E466) of analytical grade were obtained from Food Technology laboratory, Yaba College of Technology, Lagos State, Nigeria.

#### *2.1.1. Preparation of pawpaw juice*

The samples were produced using the modified method of Daramola and Asunni (2007) as shown in Figure 1. Mature and ripe pawpaw fruit was thoroughly washed, peeled, sliced, deseeded and diced followed by blending in an electric food processor (Sony, Model No. HCD-GN90D, manufactured in China) to produce pulp which was further sieved using a clean cheese cloth to obtain the juice.

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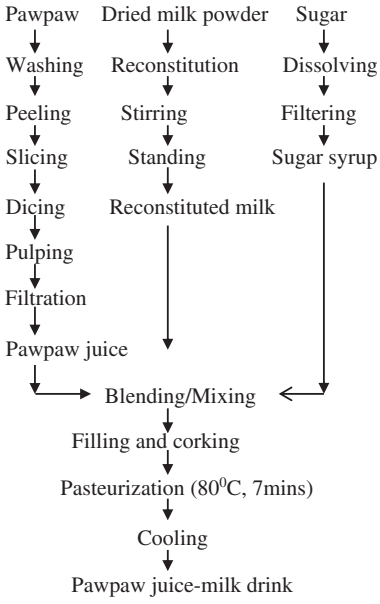


**Figure 1. Flowchart for preparation of pawpaw juice-milk drink.**

Source: Modified method of Daramola and Asunni (2007).

*2.1.2. Preparation of reconstituted skimmed milk*

Powdered skimmed milk (200 g) was reconstituted in 500 mL of cool boiled water with constant stirring until no lump was noticed.

*2.1.3. Preparation of sugar syrup*

Sugar syrup was prepared by dissolving 50 g sugar into 250 mL water.

*2.1.4. Preparation of pawpaw juice-milk-blend*

The fruit juice, reconstituted skimmed milk and sugar syrup were thoroughly blended in the electric food processor (Sony, Model No. HCD-GN90D, manufactured in China) at low speed in ratios 45:50:5, 55:40:5, 65:30:5, 75:20:5 and 85:10:5 and coded ADE, YEM, GBO, LAH and ISM respectively while the control was 95:0:5.The blends were filled into properly cleaned plastic bottles, corked and pasteurized at 80°C for 7 min followed by gradual cooling as shown in Figure 1.

## 3. Chemical analysis of samples

### *3.1. Determination of total acidity*

This was determined by the method described by AOAC (2000). Fifteen millilitres of each juice was measured into a conical flask and 10 mL of distilled water was added together with a drop of phenolphthalein indicator and was titrated with 0.1 mL of NaOH to an end point of colour change.

$$\text{Total titratable acidity (TTA)}: \frac{\text{Titre value} \times 100}{\text{Weight of sample used}}$$

### *3.2. Determination of moisture content*

This was determined by the method described by Owoso, Aluko, and Banjoko (2000). Dry the material at a temperature of 105°C to a constant mass in a temperature controlled oven at atmospheric pressure. Each dried labelled clean petri dish was weighed as ($W_1$) and 50 mL of the sample was weighed into the petri dish and read as ($W_2$). The petri dish and the weighed sample were placed in the oven at 105°C to dry to constant weight. After drying the weight of the dried sample and petri dish was recorded as ($W_3$). This was repeated for all other samples.

Moisture content can be expressed mathematically as:

$$\%\ \text{Moisture content} = \frac{\text{Loss in weight} \times 100}{\text{Initial weight}}$$

or

$$\frac{W_3 - W_1}{W_2 - W_1} \times 100$$

### *3.3. Sugar content of the samples*

This was determined by refractometry method using ABBE 60 refractometer (Bellingham-Stanley Limited, Kent, United Kingdom) (Van Hal, 2000). A drop of the fruit-milk drink sample was dropped on the lower prism. The brix level was then read out on the graduated scale of the refractometer. The determination was carried out in a position such that light was able to penetrate into the refractometer to ensure clarity in the reading of the scale.

### *3.4. Measurement of pH of the samples*

The pH of the samples was determined using a pH meter (PHS-25, Jenway, made in England). Five (10 mL) of the sample was weighed into a beaker containing 25 mL of distilled water. It was allowed to stand for 30 min with constant stirring. This was repeated for each of the samples. The pH meter was standardized using buffer solution but the electrode was inserted into the samples and the reading taken.

### *3.5. Evaluation of ascorbic acid*

This was determined by the method described by AOAC (2000). Standard indophenols solution was prepared by dissolving 0.5 g of 2,6 dichloroindophenol in water. It was diluted to 100 mL and filtered. To make standard ascorbic acid solution, 0.05 g of pure ascorbic acid was dissolved in 60 mL of 20% metaphosphoric acid was diluted to 25 mL with water. Ten millilitres of this solution was pipetted into conical flask and was titrated with solution until a faint colour which persisted for 15 s and dye factor was determined.

$$\text{Dye factor} = \frac{0.05}{\text{Litre}}$$

Titration of 50 mL of unconcentrated juice was pipetted into a 100 mL volumetric flask. 25 mL of 20% metaphosphoric acid was added which acted as a stabilizing agent and made up to mark with water. Ten millilitres of this solution was pipetted into a conical flask and titrated with indophenol solution until a faint pink colour was observed which persisted for 15 s. The vitamin C content was calculated using the formula:

$$\text{Mg ascorbic acid per 100 gm or } \text{cm}^3 = \frac{\text{Titre value} \times \text{dye factor} \times \text{volume made up to 100}}{\text{Aliquot of extract} \times \text{volume of sample taken}}$$

### *3.6. Determination of protein content*

The protein content was carried out on the samples using the Kjedahl method as described by Owoso et al. (2000).

It can be calculated by:

$$\%\ \text{Nitrogen (N)} = \frac{14.01 \times (\text{Sample titre} - \text{blank titre} \times n)}{10 \times \text{sample weight}}$$

$$\%\ \text{protein} = \text{N}\% \times \text{conversion factor}$$

where conversion factor = 6.25

### *3.7. Determination of calcium and magnesium*

This was determined by the method described by Egan, Kirk and Sawyer (1981) using Atomic Absorption Spectrophotometer (450 nm)

## 4. Microbial analysis

### *4.1. Standard plate count*

This was determined by the method described by (Fawole & Oso, 1998). One mL (1 mL) of pawpaw-milk juice was transferred into 9 mL of distilled water in test-tube and serial dilution was done. One millilitres of the sample was transferred from test-tube for the entire sample i.e. all the five samples. The plate count agar was then poured into each petri dish containing the sample and was allowed to solidify before inverted and placed in the incubator for 24 h at 35°C, the colony found was counted at exactly 24 h.

## 5. Sensory evaluation

All the coded samples of pawpaw juice-milk blend were presented to 20 untrained panelists selected from staff and students of Yaba College of Technology, Lagos, Nigeria. They were asked to evaluate the samples for colour, taste, mouth-feel, flavour and overall acceptability on a 9-point hedonic scale where 9 stands for "like extremely" and 1 stands for "dislike extremely". The panellists were given questionnaire to determine these parameters and record their observations (Akinjayeju, 2009). They were also asked to evaluate and compare the entire coded samples with each other and determine the degree of difference. The evaluation was carried out under full illumination. The samples were presented in randomized order in coded transparent glass cups. Table water was provided for the judges to rinse their mouth as they evaluate the samples.

### *5.1. Statistical analysis*

All data analyses were done in triplicates. The data were subjected to descriptive statistics using IBM SPSS version 21.0 software. One way ANOVA was done on colour, taste, mouth-feel, flavour and overall acceptability using Duncan's Multiple Range Test ($p < 0.05$) to establish the difference between the mean.

## 6. Storage stability test

After production, 5 samples of pawpaw-juice-milk drink were obtained, packaged in pet bottles which were properly corked. The samples were subjected to refrigeration temperature and weekly analysis for eight weeks to determine the shelf stability. Analyses carried out on each sample on a weekly basis include both chemical and microbiological analysis.

## 7. Results and discussion

### *7.1. Chemical analysis*

The results of the chemical analysis on the samples were shown in Table 1. Total titratable acidity of samples ranged between 0.41 and 0.70%. This value decreased as the proportion of milk added decreased. Despite the variation in total titratable acidity of the samples, values were all relatively low, showing that all blends formulated could be recommended for consumption by children and by the elderly as reported by Matsuura, Folegatti, Cardoso, and Ferreira (2004) for papaya pulp. The samples had pH values from 4.88 to 6.19. A decrease in acidity was observed as the amount of pawpaw juice in the blends increased. The samples pH ranges were within the pH range recommended by Daramola and Asunni (2007) to achieve prolong shelf-stability in products of this nature. The total soluble solids contents of the products varied mainly as a function of the amount of milk added. The reduction in soluble solids might be due to mild fermentation caused by indigenous yeast present in pawpaw juice. These contents were similar to nectars produced from mango pulp, acerola pulp and milk and with papaya pulp and acerola pulp reported by Matsuura, Folegatti, Cardoso, and Da Silva (1999) and Mostafa, Abd El-Hady and Askar (1997) respectively.

**Table 1. Chemical analysis of pawpaw juice-milk drink**

| Samples | Total acidity (%) | pH | Sugar (°Brix) | Protein (%) | Vitamin C (mg/100 mL) | Moisture (%) | Ca (mg/100 mL) | Mg (mg/100 mL) |
|---|---|---|---|---|---|---|---|---|
| Control | $0.3^{c}$ | $4.8^{cd}$ | $9.8^{a}$ | $24.8^{d}$ | $19.3^{a}$ | $90.2^{c}$ | $26.28^{a}$ | $10.20^{a}$ |
| ADE | $0.6^{a}$ | $6.3^{a}$ | $5.6^{d}$ | $29.0^{a}$ | $15.0^{c}$ | $96.6^{a}$ | $21.00^{c}$ | $7.50^{c}$ |
| YEM | $0.5^{b}$ | $5.9^{b}$ | $5.6^{d}$ | $29.1^{a}$ | $15.7^{c}$ | $95.6^{b}$ | $22.00^{b}$ | $8.10^{b}$ |
| GBO | $0.4^{bc}$ | $5.7^{b}$ | $6.4^{cd}$ | $28.7^{b}$ | $17.5^{b}$ | $95.7^{b}$ | $23.50^{ab}$ | $9.20^{a}$ |
| LAH | $0.3^{c}$ | $5.5^{bc}$ | $7.4^{c}$ | $28.0^{b}$ | $18.4^{ab}$ | $94.8^{b}$ | $23.70^{ab}$ | $9.70^{a}$ |
| ISM | $0.4^{bc}$ | $5.0^{c}$ | $9.3^{b}$ | $26.2^{c}$ | $18.7^{ab}$ | $90.9^{c}$ | $24.72^{ab}$ | $9.80^{a}$ |

Notes: All data are means of three replicates expressed. Means with the same superscript are not significantly different at $p \leq 0.05$.

The ascorbic acid content (Vitamin C) also varied amongst the samples and including the control sample, ranging from 17.06 to 21.88 mg/mL; these values were lower than those found in whole orange juice, considered to be a good source of vitamin C, guava and papaya nectar (Tiwari, 2000). The low ascorbic acid content in the products could be due to pasteurization temperature that the samples were subjected to. Also, the period of storage allows oxidation and eventual reduction on the ascorbic acid present in the blends. This was in line with AOAC (2000).

The protein content of most of the samples was similar ranging from 30.88 to 33.9 mg/mL, while sample ISM had the least protein content of 29.08 mg/mL. These could be due to proportion of milk used in different blends as milk has been confirmed to be rich source of protein. Protein are essential component of the diet needed for survival of animals and humans, their basic function in nutrition is to supply adequate amount of required amino acids (Pugalenthi, Vadivel, Gurumoorthi, & Janardhanan, 2004). The relative reducing sugar of the blends ranging from 1.48 to 1.22 may be due to the mild fermentation caused by indigenous yeast which has been said to be to survive low pH and can cause spoilage of foods (Arias, Burns, Friedrich, Goodrich, & Parish, 2002).

Calcium and magnesium are important minerals that play important roles in bone health and normal functioning of the heart, muscle and kidney respectively. Calcium with vitamin D has been found to lower the risk of type-2 diabetes, regulate the immune system and support healthy body weight. The results obtained for calcium and magnesium in the samples were found to range from 21.00 to 24.20 mg/100 mL and 7.50 to 9.80 respectively. These values are comparable with the calcium and magnesium content of cranberry juice cocktail stated by USDA (1982) while the amount of calcium (mg/100 mL) is lower than that of Maireva, Usai, and Manhokwe (2013) and the amount of magnesium (mg/100 mL) is higher than their finding.

### *7.2. Sensory evaluation*

Scores of sensory evaluation were subjected to ANOVA and the mean values are as shown in Table 2. There was no significant difference in the colour of samples ADE, YEM and GBO; however, there was significant difference between sample LAH and ISM including the control sample as they appeared

**Table 2. Mean score for sensory parameter for pawpaw juice milk drink**

| Samples | Colour | Taste | Mouth-feel | Flavour | Overall acceptability |
|---|---|---|---|---|---|
| Control | $4.8^{d}$ | $5.2^{c}$ | $4.4^{d}$ | $4.5^{c}$ | $5.0^{d}$ |
| ADE | $5.6^{a}$ | $5.3^{b}$ | $5.4^{b}$ | $5.9^{a}$ | $5.7^{b}$ |
| YEM | $5.7^{a}$ | $5.5^{a}$ | $5.7^{a}$ | $5.6^{b}$ | $5.4^{c}$ |
| GBO | $5.4^{b}$ | $5.0^{d}$ | $5.3^{bc}$ | $5.1^{b}$ | $6.0^{b}$ |
| LAH | $5.1^{c}$ | $5.5^{a}$ | $5.6^{ab}$ | $4.9^{bc}$ | $6.4^{a}$ |
| ISM | $5.0^{c}$ | $5.4^{b}$ | $4.7^{c}$ | $4.7^{bc}$ | $5.0^{d}$ |

Notes: All data are means of three replicates expressed. Means with the same superscript are not significantly different at $p \leq 0.05$.

**Table 3. Result for coliform test on the samples**

| Samples | Week 0 | Week 1 | Week 2 | Week 3 | Week 4 | Week 5 |
|---|---|---|---|---|---|---|
| Control | Nil | Nil | Nil | Nil | Nil | Nil |
| ADE | Nil | Nil | Nil | Nil | Nil | Nil |
| YEM | Nil | Nil | Nil | Nil | Nil | Nil |
| GBO | Nil | Nil | Nil | Nil | Nil | Nil |
| LAH | Nil | Nil | Nil | Nil | Nil | Nil |
| ISM | Nil | Nil | Nil | Nil | Nil | Nil |

**Table 4. Result for standard plate count (cfu/mL) on the samples**

| Samples | Week 0 | Week 1 | Week 2 | Week 3 | Week 4 | Week 5 |
|---|---|---|---|---|---|---|
| Control | $1.7 \times 10^1$ | $2.4 \times 10^1$ | $2.2 \times 10^1$ | $2.0 \times 10^1$ | $1.6 \times 10^1$ | $1.4 \times 10^1$ |
| ADE | $5.2 \times 10^1$ | $4.5 \times 10^1$ | $4.8 \times 10^1$ | $5.0 \times 10^1$ | $8.0 \times 10^1$ | $1.5 \times 10^2$ |
| YEM | $3.5 \times 10^1$ | $3.3 \times 10^1$ | $3.5 \times 10^1$ | $3.5 \times 10^1$ | $4.5 \times 10^1$ | $5.5 \times 10^1$ |
| GBO | $2.1 \times 10^1$ | $2.8 \times 10^1$ | $2.1 \times 10^1$ | $2.8 \times 10^1$ | $2.5 \times 10^1$ | $1.6 \times 10^2$ |
| LAH | $2.2 \times 10^1$ | $2.5 \times 10^1$ | $2.8 \times 10^1$ | $3.0 \times 10^1$ | $3.5 \times 10^1$ | $4.5 \times 10^1$ |
| ISM | $2.0 \times 10^1$ | $2.9 \times 10^1$ | $2.4 \times 10^1$ | $2.1 \times 10^1$ | $2.0 \times 10^1$ | $1.5 \times 10^1$ |

to be lighter in colour than other samples. In addition, there was no significant difference between the samples with respect to taste and mouth feel. The non-detection of significant difference in these attributes can be as a result of the sugar added to them. There existed a significant difference in overall acceptability and flavour. The significant difference detected in flavour can be as a result of variation in the amount of pawpaw juice added to the various samples.

### *7.3. Microbial analysis*

The results of microbial analysis on Tables 3 and 4 revealed that coliform was absent from the samples throughout the period of storage. This is because coliform belong to the group of enterobacterial and are mainly of feacal origin which indicated that the water used for processing was potable (Romano & Suzzi, 1990). However, all the samples had total plate counts below the 100 cfu/mL all through the storage period including the control sample. This is in line with the recommendation of World Health Organization (1984).

## 8. Conclusion

The study revealed that a good functional drink, a product of blends of juice from pawpaw and milk could be produced from ripe pawpaw and powdered milk which may possess health benefits and also reduce long term sustainable intervention programmes of micronutrient deficiency in patients and individuals when consumed as either appetizer and/or dessert in developing countries like Nigeria. The study concluded that the product is safe for human consumption since there was no yeast and mould count in the products during the period of this study.

**Funding**
The authors received no direct funding for this research.

**Competing Interests**
The authors declare no competing interest.

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**Citation information**
Cite this article as: Chemical, sensory and shelf life study of pawpaw juice–milk blend, A.O. Adebayo-Oyetoro, O.O. Ogundipe, I.G. Adeyemo, F.O. Ogundipe, F.A. Bamidele & S.A.O. Adeyeye, *Cogent Food & Agriculture* (2016), 2: 1271276.

**Cover image**
Source: Modified method of Daramola and Asunni (2007).

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