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THE EFFECT OF PRESERVATIVES AND STORAGE TEMPERATURE ON THE ORGANOLEPTIC AND MICROBIAL LOAD OF HOMEMADE FRESHLY PREPARED HEALTHY NATURAL JUICES

***[1]Fakile, O. D., [1]Oladiti, A.A., [1]Solana, O.I. and [1]Okolosi, J.E.**
[1]Department of Home Science and Hospitality Management, College of Agricultural Sciences, OlabisiOnabanjo University, Yewa Campus, Ayetoro, Nigeria
*Corresponding Author Email:oluwapamilerin.yangomodou@agoiwoye.edu.ng

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ABSTRACT

Julie mango (Mangifera indica L.) and pawpaw (Carica papaya L.) fruit juice was treated with natural (ginger, cinnamon) and chemical (sodium benzoate, ascorbic acid) preservatives. The effect of these preservatives on Julie mango and pawpaw fruit juices were evaluated during the period of 8 days storage in the refrigerator (4 °C) and room temperature (28 °C). The total bacterial count in Julie mango fruit juice treated with sodium benzoate and stored at refrigerator (4 °C) and room temperature (28 °C) ranged from 5.0 × 10^4 to 8.0 × 10^3 CFU/ml and 5.0 × 10^4 to 7.0 × 10^3CFU/ml respectively. Total bacterial count in Julie mango fruit juice treated with ginger and cinnamon and stored at refrigerator (4 °C) and room temperature (28 °C) ranged from 1.9 × 10^4 to 5.2 × 10^3 CFU/ml and 1.9 × 10^4 to 5.0 × 10^3 CFU/ml. Total bacterial count in pawpaw fruit juice treated with ascorbic acid ranged from 5.2 × 10^4 to 7.0 × 10^3CFU/ml and 5.3 × 10^4 to 6.0 × 10^3CFU/ml for juice during storage at (4 °C) and room temperature (28 °C).While the total bacterial count in pawpaw fruit juice treated with ginger and cinnamon and stored at refrigerator (4 °C) and room temperature (28 °C) ranged from 1.3 × 10^4 to 5.2 × 10^3 CFU/ml and 1.9 × 10^4 to 5.1× 10^3 CFU/ml, respectively. Treatment of Julie mango and pawpaw fruit juices with sodium benzoate and ascorbic acid reduced the bacterial and fungal counts of the juices during the 8 day period of storage. The fungal count in Julie mango and pawpaw fruit juice treated with sodium benzoate and ascorbic then stored at refrigerator (4 °C) and room temperature (28 °C) ranged from 2.9 × 10^4 to 4.0 × 10^3 CFU/ml, 3.0 × 10^4 to 7.0× 10^3 CFU/ml, 2.0 × 10^4 to 6.0 × 10^3 CFU/ml and 2.2 × 10^4 to 3.0× 10^3 CFU/ml respectively. Sensory analysis results show that Julie mango and pawpaw fruit juices without any preservative added were most accepted. Refrigerator storage temperature (4 °C) was good and is the most recommended temperature for fruit producers.

Key words: Julie mango juice, microbial load, organoleptic, pawpaw juice

INTRODUCTION

Fruits grow in abundance in people's compounds and gardens in the tropics (Chikwendu *et al*., 2016). Healthy fruits are usually processed into fruit juices for easy consumption. Fruit juices are prepared from one fruit or from the combination of two or more fruits (Chikwendu *et al*., 2016; Oladapo *et al*., 2022). Fruit juices when prepared are liquids which could be fermented or unfermented and once produced it will have

the characteristic colour, taste, aroma of the fruit from which it was derived (Oladipo *et al*., 2022). Nowadays, freshly prepared fruit juices are popular drinks in tropical countries across the globe and are sold in public places as well as road side stores. Fruits are rich in phytochemicals and micronutrients such as vitamin A and ascorbic acids (Chikwendu *et al*., 2016). Fruit consumption provides the body with vital minerals, dietary fiber and antioxidants (Saputri *et al*., 2022). As of today, many people take fruit juice on a daily basis and it has increasingly become a major part of modern diets in most communities because it acts as a highly nutritious drink able to supply all the necessary natural nutrients in humans (Godswill *et al*., 2020). However, it may contain high amount of sugar which may have adverse effect on the health effects such as obesity, diabetes, heart related issues, acne, cancer and depression on the consumers (Godswill *et al*., 2020; Halvorsen *et al*., 2021; Ren *et al*., 2023). The natural sugar in fruits is good for health. Adding refined sugar in large quantity to fruit juice by manufacturer might have health implications. This has made companies involved in the production of fruit juices to now produce and sell fruit juices with captions such as 'no added sugar' or 'low sugar' or 100% fruit juice to address the worries of consumers about their health and encourage consumers to keep buying them (Lartey *et al*., 2018).

Mostly, fruit juices have no additives but today we see fruit juices with ascorbic acid added to them to prevent browning, citric acid added to increase the acidity. In most countries worldwide, especially the European Union, producers of fruit juices are not permitted to use chemical preservatives whereas in some countries, they are permitted to use them because of their good climatic conditions, packaging requirements and adherence to food regulations. Preservatives are substances added to food to inhibit the growth of microorganisms (Abdulmumeen *et al*., 2012). Shelf life is simply a time food products continue to remain safe and retain its nutritional qualities which must meet up with the governmental food standard regulations (Ghosh, 2014). But the shelf-life of food products are adversely affected by internal and external factors which interacts to reduce the keeping quality (Awuchi *et al*., 2020)

There are increasing reports of food borne infections arising from the consumption of fruit juices (Danyluk *et al*., 2012; Aneja *et al*., 2014a; Adaora *et al*., 2022; Dominguez-Gonzalez *et al*., 2022; Oladipo *et al*., 2022). Food poisoning is a harmful illness caused by the consumption of contaminated food and juice and fruit juice has emerged as the main sources of pathogenic bacteria (Dominguez-Gonzalez *et al*., 2022). Many fruit juice consumers have suffered gastro intestinal diseases and a lot of outbreaks resulting from bacterial species such as *Salmonella* species, *Escherichia coli* and *Cryptosporidium* (Noel *et al*., 2010). Many cafes and restaurants prepare and serve their juice to consumers under seemingly hygienic conditions but their microbial properties are largely unknown. This extends to roadside sellers, parks, bus stops, malls. In Nigeria, a developing country, fruit juices are produced and sold by vendors on the street who do not attach much importance to the safety and health of consumers. Most of the fruit juices sold on the streets are not prepared hygienically, the producers often do not follow the government regulations guiding the use of preservatives and proper packaging due to incessant power failures during storage of fruits juices which allows the proliferation of food poisoning organisms in the product that could affect its nutrient composition and shelf life (Aneja *et al*., 2014b). In recent years, consumers of fruit juices are interested in knowing the nutritional and health benefits of products they purchase. Therefore, the objective of the study is to assess the effects of commonly used food preservatives on sensory and microbiological quality of fruit juices prepared from mango (*Mangifera indica L*) and pawpaw (*Carica papaya L*.) and stored at different temperatures.

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Mango (*Mangifera indica L*) is a deciduous tree that produces sweet juicy and succulents fruits. The fruits are usually green when unripe but turn to yellowish colour when ripe (Ubwa *et al*., 2014). Mango is a member of the *Anacardiaceace* family and is the most economical (Frances *et al*., 2023).Mango is of several species and they all bear sweet edible fruits. Majority of the mango fruit trees belong to the *Mangifera indica L*. species. Other edible species of *Mangifera* are the wild mangos (Frances *et al*., 2023).

Mango originated many years ago in Asia and the trees grow well in the tropical and subtropical regions. They grow to approximately 19m and bear fruits between periods of 4 to 6 years after planting. Mango is a preferred fruit across the globe because it is ranked second among the commercially traded fruit internationally. World output of mango is estimated to be above 27 million tons. Major countries known to produce mangoes are China, Mexico, Thailand and Nigeria (Badsha *et al*., 2020).

Mango is a drupe with a fleshy mesocarp that is usually sweet with a turpentine flavour when ripe (Okokon and Okokon, 2019). Its colour and texture varies when ripe (Okokon and Okokon, 2019). Mango is rich in nutrients and plays a lot of significant role in maintain good health in humans. It has high percentages of macronutrients, micronutrients and phytochemicals which makes it generally acceptable and increase its wide consumption across the globe. Mango is consumed in different ways. It can be consumed raw as a sweet delicious snack or incorporated into other foods such as smoothies, yoghurts, salads and desserts (Okokon and Okokon, 2019).

Pawpaw (*Carica papaya L.*) is a herbaceous and semi-perennial succulent plant. It is a plant known to possess self-supporting stems (Harionoet *al*., 2021). Pawpaw belongs to the genus *Carica.* It possesses an enzyme called papain which is present in appreciable amounts in its various parts. In addition, pawpaw contains vital biological compounds (chymogen), phytochemicals (glucosinolates carotenoids, enzymes, alkaloids, phenolics and glucosinolates) (Koul *et al*., 2022).These phytochemicals are present in the seeds and fruits, latex, leaves and shoots. Health benefits of consuming pawpaw include aiding of digestion, destruction of cancer tumors and asthma prevention (Hariono *et al*., 2021; Koul *et al*., 2022).

MATERIALS AND METHODS

Source of raw materials

Five (5.0) kilograms each of healthy mature ripe Julie mango *(Mangifera indica L.*) and pawpaw (*Carica papaya L.*) fruits were harvested from a specific mango and pawpaw trees in a farmland situated in Imoru, a village in Ijebu-Ode, Ogun-State Nigeria. This was done to ensure homogeneity of the fruit samples. Two spices namely ginger rhizome and cinnamon powder used as natural preservatives were purchased from Oyingbo Market, Lagos –State, Nigeria. Other ingredients such as sodium benzoate and ascorbic acid used as chemical preservatives were of analytical grade and obtained from Food Technology Laboratory, Federal University of Agriculture Abeokuta, Ogun-State, Nigeria.

Processing and preparation of Julie mango and pawpaw fruit juices

The fruit juices were prepared using the method of Chikwendu *et al*. (2016) with minor modifications. The mango and pawpaw fruits were sorted for wholesomeness and washed with distilled water and little salt to remove adhering soils, dirts, extraneous materials and microbial contaminants from the surface of the fruits. The washed mango and pawpaw fruit samples were peeled, deseeded and cut into pieces, using a sterile knife followed by blending in an electric food processor (Sony, Model No. HS-200D, manufactured in China) to produce fruit pulps which were sieved using clean white muslin cloths into sterile conical flasks to obtain filtrated fruit juices.

Preparation of fruit spices/preservatives

The ginger rhizomes were washed with sterile water repeatedly. Their outer coverings were peeled off with a sterile knife and then sliced into pieces and dried using an oven at 65°C for 48 h. The dried ginger rhizomes were blended using an electric blender that was sterilized to pulverize them into powder.

Treatment of Julie mango and pawpaw juices with natural and artificial/chemical preservatives

The natural and chemical preservatives were all aseptically added to the fruit juices following the method of Okokon and Okokon, (2019). Table 1 shows how the additions of the preservatives to the juices were made.

Table 1: Julie Mango and pawpaw juice preparation

Samples	Treatment
Mango	
Julie mango juice	No treatment (control)
Julie mango juice with ginger rhizome powder	0.5 g of ginger rhizomes powder was added into 100 ml of Julie mango juice.
Julie mango juice with cinnamon powder	0.5 g of cinnamon powder was added into 100 ml of Julie mango juice.
Julie mango juice with ginger rhizome and cinnamon powder	0.25g of ginger rhizomes powder and 0.25g of cinnamon powder was added into 100 ml of Julie mango juice.
Julie mango juice with sodium benzoate	0.05 % (w/v) of sodium benzoate was added to 100 ml of Julie mango juice
Julie mango juice with ascorbic acid	0.05 % (w/v) ascorbic acid was added to 100 ml of Julie mango juice.
Pawpaw	
Pawpaw juice	No treatment (control)
Pawpaw juice with ginger rhizome powder	0.5 g of ginger rhizomes powder was added into 100 ml of pawpaw juice.
Pawpaw juice with cinnamon powder	0.5 g of cinnamon powder was added into 100 ml of pawpaw juice.
Pawpaw juice with ginger rhizome and cinnamon powder	0.25g of ginger rhizomes powder and 0.25g of cinnamon powder was added into 100 ml of pawpaw juice.
Pawpaw juice with sodium benzoate	0.05 % (w/v) of sodium benzoate was added to 100 ml of pawpaw juice.
Pawpaw juice with ascorbic acid	0.05 % (w/v) ascorbic acid was added to 100 ml of pawpaw juice.

Storage of fruit juices

After the addition of the natural and chemical preservatives, the juices were filled into sterile bottles, corked, stored at room temperature 28 °C for a period of 8 days each. Another set of the juices poured inside sterile bottles were stored inside a refrigerator (4 °C) for 8 days. The temperature of the room was monitored using a digital thermo-hygrometer.

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Proximate analysis

The proximate parameters determined in the mango and pawpaw fruit juices include moisture, protein, fat, ash crude fibre and carbohydrate. Protein was determined using micro Kjedhal method while fat was determined using solvent extraction method. The moisture, ash, and crude fibre contents of the treated juices were determined using AOAC (2005) while carbohydrate was determined by difference using Pearson (1976) method of analysis. Proximate analysis of the fruit juices was carried out on the first day.

Physicochemical analysis

The pH values of the Julie mango and pawpaw juices treated with natural and chemical preservatives and stored for eight (8) days were determined using the modified method of Adebayo-Oyetoro *et al*., (2016). The pH of the treated fruit juices was determined with a pH meter (Jenway pH meter). The pH of the juices was carried out at intervals during the period of storage. The pH meter used for the analysis was first calibrated with a phosphate buffer solution of pH 4 and 9. The pH values of mango and pawpaw juice samples were measured with a pH meter fitted with a glass electrode that was dipped into 20 mL of each treated juice in a 25 mL beaker and readings were taken and recorded.

Sensory evaluation

A sensory panel consists of twenty five (25) semi-trained panelists of staff and students selected from the Department of Home Science and Hospitality Management, Olabisi Onabanjo University, Ago-Iwoye assessed the treated fruit juice samples. The 9 point hedonic scale ranging from nine (9) like extremely to one (1) dislike extremely was used. The sensory properties evaluated were colour, flavour, taste and general acceptability of the fruit juices. Sensory analysis of the juices was carried out at intervals during the period of storage.

Microbiological analysis of fruit juices

The cookies samples were analyzed for bacterial and fungal counts using spread plate method described by Mat Nwawi *et al*. (2016) and Ike *et al*. (2020). Tenfold serial dilution of fruit juice samples were carried out using sterile peptone water. For the analysis, 0.1 ml of each juice sample was aseptically transferred into a sterile test tube containing nine milliliter (9 mL) of sterile peptone water. The resultant sample juice solutions were shaken vigorously to allow proper disengagement of microorganisms to 10^1 dilutions. Serial dilutions of the homogenates were continued and made up to 10^5 dilutions. Then 0.1 ml of the 10^5 dilutions was spread on plate count agar and sabouraud dextrose agar. The plates were incubated at 37 °C for 24 - 48 hours for mean bacterial counts and 25 °C for 120 hours for mean fungal counts. The process was carried out at two days intervals for a period of 8 days.

Statistical analysis

One-way analysis of variance was carried out using SPSS version 23.0. Duncan multiple range test (DMRT) was used to separate the treatment means and calculated at 95 % confidence level ($p<0.05$).

RESULTS AND DISCUSSION

Proximate and physicochemical compositions

The proximate and physicochemical compositions of Julie mango and pawpaw fruit juices are presented in Table 2. There were significant differences ($p<0.05$) in the results of the fruit juices examined.

The result showed that Julie mango fruit juice had high moisture (76.60 %), carbohydrate (19.90 %) contents and low concentrations of protein (1.70 %), fat (0.05 %), ash (1.60 %), crude fiber(1.15%), and pH (5.00 %). Pawpaw fruit juice had high moisture (90.0 %), low concentrations of protein (4.45 %), fat (1.87 %), ash (1.52 %), crude fiber (0.04%), carbohydrate (3.40 %) and pH (2.10 %).

Moisture content of Julie mango (76.60 %) and pawpaw juices (90.0 %), were high. This compares well with report of Abdualrahman (2013) who reported high moisture values in different varieties of mango. The high content of moisture in the fruit juices shows that they do not have high shelf life (Frances *et al*. 2023). The presence of moisture in food indicates its water activity (Badsha *et al*. 2020) and is used to measure the stability and susceptibility to spoilage by microorganisms.

The ash content of Julie mango (1.60 %) and pawpaw juice (1.52 %) samples was low but still within the acceptable value of minerals expected in fruits. Ash content of any food gives an idea of the total quantity of mineral elements present in the food. This result agrees with that of Abdualrahman (2013) who reported 1.35 -1.7 % ash content for different types of mango juice.

The fat content of Julie mango (0.05 %), and pawpaw (1.87 %) juice samples was low. This could be attributed to the fact that the two fruits are not good sources of fat. This report correlates with the report of Ubbor *et al*. (2022) who stated that most fruits are poor sources of fat.

The protein content of Julie mango (1.70 %), and pawpaw (4.45 %) juice samples was also low but was within the acceptable limit for fruits. Similar observation was reported by Chikwendu *et al*. (2016). Proteins are important food components necessary for growth and repair of worn out tissues in the human body (Ubbor *et al*. 2022)

The crude fiber content of Julie mango (1.15 %), and pawpaw (0.04 %) juice samples was also low. This is in line with the report of Etong *et al*.(2014) who reported similar observation for banana juice. According to Ubbor *et al*. (2022) foods rich in fiber have the ability of cleansing the digestive tract of human.

The carbohydrate content of Julie mango fruit juice was high (19.90 %) while pawpaw juice had low value (3.40 %) but both are still within the acceptable limit of fruits. This suggests that both fruits are rich sources of carbohydrate, thus will serve as a source of energy to its consumers.

Table 2: Proximate and physicochemical composition of Julie mango and pawpaw fruit juices

Compositions (%)	Julie mango juice	Pawpaw juice
Moisture	$76.60^{b} \pm 0.02$	$90.0^{a} \pm 0.06$
Protein	$1.70^{b} \pm 0.02$	$4.45^{a} \pm 0.02$
Fat	$0.05^{b} \pm 0.01$	$1.87^{a} \pm 0.02$
Ash	$1.60^{a} \pm 0.01$	$1.52^{a} \pm 0.01$
Crude fibre	$1.15^{a} \pm 0.00$	$0.04^{b} \pm 0.00$
Carbohydrate	$19.90^{a} \pm 0.03$	$3.40^{b} \pm 0.01$
pH	$5.00^{a} \pm 0.00$	$2.10^{b} \pm 0.00$

Alphabets a-b: Means ± standard deviation of triplicate determination. Means bearing the same superscripts along the row are significantly different ($p<0.05$).

Sensory evaluation of fruit juices

The mean sensory scores of Julie mango and pawpaw fruit juice samples with different preservatives stored in the refrigerator at 4 °C and room temperature (28 °C) for a period of 8 days are presented in Table 3 - 4 and 5 - 6.

Table 3 shows the mean sensory scores of Julie mango fruit juice samples with different preservatives stored in the refrigerator at 4 °C for a period of 8 days.

There were significant differences ($p<0.05$) in the results of the fruit juice samples examined. The mean taste scores for the samples ranged from 7.10 – 8.00 in day 0 (Table 3). The pure Julie mango juice sample had the highest score (8.00) and Julie mango

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juice with ginger had the least (7.10). Julie mango fruit sample with ginger and cinnamon, cinnamon, sodium benzoate and ascorbic acid alone had comparable taste scores (7.82, 7.22, 7.61 and 7.41). At day 2 and 4, the mean taste score of the pure Julie mango fruit juice was significantly higher than the scores of Julie mango fruit juice with ginger rhizome powder, cinnamon powder, ginger and cinnamon powder, sodium benzoate and ascorbic acid.

The mean score for flavour of Julie mango juice samples ranged from 6.30 – 8.20 in day 0. The Julie mango juice sample without any added preservative had the highest score (8.20) and Julie mango juice with cinnamon powder had the least (6.30). The Julie mango juice sample without any added preservative was significantly different ($p<0.05$) from the other mango fruit juice samples except Julie mango juice with ginger and cinnamon powder which also had a high score (8.02). There was significant change in flavour of the Julie mango fruit juice samples as the storage period increased. Also, the mean score for flavour was low in Julie mango fruit juice treated with sodium benzoate (4.41) and ascorbic acid (4.52) at storage day 8.

The mean score for colour of Julie mango juice samples ranged from 7.12 – 8.70 at day 0. The Julie mango juice treated with sodium benzoate had the highest score (8.70) while Julie mango juice treated with ascorbic acid had the least (7.32). During the storage period from day 0 to 4, Julie mango fruit juice samples had a high mean score colour which decreased progressively from day 6 to 8 with much decrease in Julie mango juice with ginger rhizome (4.92), cinnamon (4.31), sodium benzoate (4.24) and ascorbic acid (4.62).

The mean score for overall acceptance of the juice varied from 7.02 – 8.22 at day 0. The Julie mango juice without any preservative added had the highest score (8.21) while Julie mango juice with ginger rhizome had the least (7.02). During the storage period from day 0 to 2 the mean score for overall acceptance of Julie mango fruit juice with the different preservatives was high but progressive decrease of the mean score from day 6 – 8.The mean score of overall acceptance for mango juice with ginger and cinnamon compare well with the mean score for Julie mango juice without preservative (8.11).

The mean sensory results obtained showed that mango fruit juice differed significantly in taste, flavor, colour, general acceptance (Table 3). There was progressive decrease in taste, flavor, colour, general acceptance which was observed from day 6. This may be due to fermentation of the juices during the period of storage. Results also indicated that the panelists preferred the pure mango fruit juice as well as the mango juice with ginger and cinnamon.

Table 3: Mean sensory evaluation score for Julie mango fruit juices stored at 4°C

Parameter	No of panelist	Treatment type	Day 0	Day 2	Day 4	Day 6	Day 8
Taste	25	Pure Julie mango juice	$8.00^{a}\pm 0.11$	$7.40^{b}\pm 0.01$	$7.61^{b}\pm 0.02$	$6.84^{c}\pm 0.02$	$6.04^{c}\pm 0.04$
	25	Julie mango juice with ginger rhizome powder	$7.10^{a}\pm 0.02$	$6.00^{b}\pm 0.05$	$6.71^{b}\pm 0.02$	$5.52^{c}\pm 0.03$	$6.75^{a}\pm 0.02$
	25	Julie mango juice with cinnamon powder	$7.22^{a}\pm 0.03$	$6.31^{b}\pm 0.05$	$6.82^{b}\pm 0.01$	$5.33^{c}\pm 0.03$	$6.12^{b}\pm 0.13$
	25	Julie mango juice with ginger rhizome and cinnamon powder	$7.82^{a}\pm 0.03$	$6.11^{b}\pm 0.02$	$6.01^{b}\pm 0.21$	$6.53^{b}\pm 0.01$	$6.17^{b}\pm 0.13$
	25	Julie mango juice with sodium benzoate	$7.61^{a}\pm 0.01$	$6.42^{b}\pm 0.01$	$6.60^{b}\pm 0.13$	$6.31^{b}\pm 0.12$	$6.32^{b}\pm 0.05$
	25	Julie mango juice with ascorbic acid	$7.41^{a}\pm 0.05$	$6.52^{b}\pm 0.03$	$6.70^{b}\pm 0.02$	$6.11^{b}\pm 0.13$	$6.11^{b}\pm 0.04$
Flavour	25	Pure Julie mango juice	$8.20^{a}\pm 0.02$	$7.13^{b}\pm 0.13$	$6.15^{c}\pm 0.03$	$5.61^{d}\pm 0.03$	$5.71^{d}\pm 0.03$
	25	Julie mango juice with ginger rhizome powder	$7.64^{a}\pm 0.01$	$6.52^{b}\pm 0.01$	$5.73^{c}\pm 0.03$	$5.41^{c}\pm 0.04$	$5.66^{c}\pm 0.03$

	25	Julie mango juice with cinnamon powder	6.30^{a} ±0.10	5.81^{c} ±0.01	5.32^{c} ± 0.03	5.02^{c} ± 0.03	6.72^{b} ± 0.03
	25	Julie mango juice with ginger rhizome and cinnamon powder	8.02^{a} ± 0.03	7.20^{b} ±0.03	7.96^{b} ± 0.06	6.43^{c}± 0.04	6.74^{c} ± 0.03
	25	Julie mango juice with sodium benzoate	7.31^{a} ± 0.10	7.10^{a} ±0.00	6.43^{b} ± 0.02	6.32^{b} ± 0.04	4.41^{c} ± 0.01
	25	Julie mango juice with ascorbic acid	7.42^{a} ± 0.02	7.50^{a} ±0.00	6.20^{b} ± 0.02	5.24^{c} ± 0.03	4.52^{c} ± 0.01
Colour	25	Pure Julie mango juice	7.32^{a} ± 0.14	7.32^{a} ±0.10	6.74^{b} ± 0.05	5.41^{c} ± 0.03	5.01^{c}± 0.03
	25	Julie mango juice with ginger rhizome powder	7.33^{a} ± 0.14	6.41^{b} ±0.03	6.40^{b} ± 0.05	5.92^{a} ± 0.02	4.92^{d} ± 0.01
	25	Julie mango juice with cinnamon powder	7.14^{a} ± 0.03	6.82^{b} ±0.13	6.30^{b} ± 0.04	5.34^{c} ± 0.03	4.31^{d} ± 0.01
	25	Julie mango juice with ginger rhizome and cinnamon powder	8.23^{a} ± 0.03	5.34^{b} ±0.03	5.35^{b} ± 0.12	5.09^{b} ± 0.02	5.22^{b}± 0.03
	25	Julie mango juice with sodium benzoate	8.70^{a} ± 0.03	7.22^{b} ±0.10	5.00^{c} ± 0.12	4.83^{d} ± 0.03	4.24^{d}± 0.01
	25	Julie mango juice with ascorbic acid	7.12^{a} ± 0.14	7.43^{a} ±0.03	6.96^{b} ± 0.03	5.07^{c} ± 0.02	4.62^{d} ± 0.04
Overall acceptance	25	Pure Julie mango juice	8.22^{a} ± 0.13	7.46^{b} ±0.03	6.75^{c} ± 0.07	5.41^{d} ± 0.02	5.02^{d} ± 0.03
	25	Julie mango juice with ginger rhizome powder	7.02^{a} ± 0.03	7.00^{a} ±0.22	6.44^{b} ± 0.07	6.34^{b} ± 0.13	5.91^{c} ± 0.02
	25	Julie mango juice with cinnamon powder	7.41^{a} ± 0.04	6.60^{b} ±0.23	6.61^{b} ± 0.03	5.74^{c} ± 0.07	5.41^{c}± 0.03
	25	Julie mango juice with ginger rhizome and cinnamon powder	8.11^{a} ± 0.13	6.70^{b} ±0.03	6.53^{b} ± 0.23	4.02^{d} ± 0.03	5.21^{c} ± 0.02
	25	Julie mango juice with sodium benzoate	7.23^{a} ± 0.06	6.83^{b} ±0.02	6.22^{b} ± 0.05	5.01^{c} ± 0.03	4.45^{d} ± 0.02
	25	Julie mango juice with ascorbic acid	7.04^{a} ± 0.05	7.92^{a} ±0.01	7.32^{a} ± 0.13	6.35^{b} ± 0.13	4.83^{c} ± 0.02

Alphabets a-b: Means ± standard deviation of triplicate determination. Means bearing the same superscripts along the row are not significantly different ($p<0.05$).

Table 4 shows the mean score for sensory attribute of Julie mango fruit juice samples with different preservatives stored in the room temperature at 28 °C for a period of 8 days.

There were significant differences ($p<0.05$) in the results of the Julie mango fruit juice samples examined. The mean scorefor taste of Julie mango fruit juice ranged from 5.11 – 8.20 at day 0. The Julie mango juice without any preservative added had the highest score (8.20) and Julie mango juice with ginger had the least (5.11). The mean score for taste of Julie mango juice with ginger and cinnamon was 7.51. It was observed that as the days of storage increased, the mean score for taste of Julie mango juice without any added preservative and mango juice samples treated with different preservatives decreased progressively.

The mean score for flavor of Julie mango juice samples treated with the different preservatives ranged from 6.04 – 7.78 at day 0. The Julie mango juice sample without any added preservative had the highest score (7.78) while Julie mango juice treated with sodium benzoate had the least (6.04).

The mean score for colour of Julie mango juice samples treated with different preservatives ranged from 6.22 – 7.15 at day 0. The Julie mango juice with ginger and cinnamon had the highest score (7.15) while Julie mango juice with cinnamon had the least score (6.22).

The mean score for general acceptance of Julie mango fruit juices with preservatives varied from 7.22 – 8.51 at day 0. The Julie mango juice without any added preservative had the highest score (8.51) while Julie mango juice treated with ascorbic acid had the least score (7.22).

The mean sensory scores obtained from this study shows that mango fruit juice differed

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significantly in taste, flavour, colour and overall acceptance during the period of storage with different preservatives (Table 4). There was a progressive decrease in all the sensory attributes of the juice samples tested from day 4 of storage at room temperature which could be as a result of favourable storage condition for the growth and multiplication microorganisms in the juice samples. It is worthy to note that the sensory panelist preferred the mango fruit juice without any added preservatives as well as the mango juice treated with ginger and cinnamon.

Table 4: Mean sensory evaluation score for Julie mango fruit juices stored at room temperature (28°C)

Parameter	No of panelist	Treatment type	Day 0	Day 2	Day 4	Day 6	Day 8
Taste	25	Pure Julie mango juice	8.20 ^{a} ± 0.14	6.02 ^{b} ±0.05	5.23^{c} ± 0.03	3.82 ^{d} ±0.11	3.02 ^{d} ± 0.03
	25	Julie mango juice with ginger rhizome powder	5.11^{a} ± 0.03	4.31^{b} ±0.08	5.74 ^{a} ± 0.03	4.52^{b} ±0.03	3.71 ^{c} ± 0.14
	25	Julie mango juice with cinnamon powder	5.22^{b} ± 0.23	6.31^{a} ±0.04	4.82 ^{c} ± 0.01	3.31^{d} ±0.04	2.22 ^{d} ± 0.04
	25	Julie mango juice with ginger rhizome and cinnamon powder	7.51^{a} ± 0.01	5.23^{bc}±0.3	3.01^{c} ± 0.01	2.59 ^{d} ±0.00	2.05 ^{d}± 0.14
	25	Julie mango juice with sodium benzoate	6.44^{a} ± 0.05	5.44^{b} ±0.02	3.21 ^{c} ± 0.02	3.37 ^{c} ±0.04	2.32 ^{d}± 0.12
	25	Julie mango juice with ascorbic acid	6.52 ^{a} ± 0.05	4.57 ^{b} ±0.04	3.01 ^{c}± 0.05	3.22^{c}±0.0	2.27 ^{d} ± 0.03
Flavour	25	Pure Julie mango juice	7.78^{a} ± 0.10	6.12 ^{b} ±0.04	5.21 ^{c} ± 0.05	4.54^{d} ±0.01	3.44^{e} ± 0.04
	25	Julie mango juice with ginger rhizome powder	6.91^{a} ± 0.04	5.51^{b} ±0.03	5.04^{b} ± 0.04	5.31^{b}±0.04	5.62^{b} ± 0.04
	25	Julie mango juice with cinnamon powder	6.22 ^{a} ± 0.02	5.14^{b} ±0.02	3.34 ^{c} ± 0.04	3.21 ^{c} ±0.02	2.62 ^{d} ± 0.01
	25	Julie mango juice with ginger rhizome and cinnamon powder	6.21^{a} ± 0.06	5.24^{b}±0.01	3.04^{c} ± 0.04	2.61^{d}±0.4	2.36 ^{d} ± 0.02
	25	Julie mango juice with sodium benzoate	6.04^{a} ± 0.07	5.14^{b} ±0.00	2.41^{c} ± 0.02	2.32^{c} ±0.01	2.35^{c} ± 0.01
	25	Julie mango juice with ascorbic acid	6.44^{a} ± 0.07	5.51^{b} ±0.04	3.23 ^{c} ± 0.04	2.14 ^{d} ±0.03	2.19 ^{d} ± 0.11
Colour	25	Pure Julie mango juice	6.35^{a} ± 0.14	6.32^{a} ±0.01	5.75^{b} ± 0.01	5.36 ^{b} ±0.04	5.00 ^{b}± 0.11
	25	Julie mango juice with ginger rhizome powder	6.55^{a} ± 0.14	4.83 ^{c} ±0.01	4.24 ^{c} ± 0.07	5.05^{b} ±0.02	4.40^{c} ± 0.04
	25	Julie mango juice with cinnamon powder	6.22^{a} ± 0.05	5.52^{b} ±0.14	4.25^{c} ± 0.02	3.52 ^{c} ±0.00	4.22^{c} ± 0.04
	25	Julie mango juice with ginger rhizome and cinnamon powder	7.15^{a} ± 0.06	5.52 ^{b} ±0.04	5.33^{b} ± 0.07	5.56^{b} ±0.03	4.21^{c} ± 0.01
	25	Julie mango juice with sodium benzoate	6.91^{a} ± 0.03	5.26^{b} ±0.10	4.47^{c}± 0.04	3.62^{d} ±0.02	3.52^{d} ± 0.04
	25	Julie mango juice with ascorbic acid	6.37^{a} ± 0.03	6.64^{a} ±0.05	4.37^{b} ± 0.04	4.54^{b} ±0.05	4.33^{b} ± 0.01
Overall	25	Pure Julie mango juice	8.51 ^{a} ± 0.04	7.87 ^{a} ±0.12	4.24 ^{b} ± 0.04	3.14 ^{c} ±0.04	3.21^{c} ± 0.04
acceptance	25	Julie mango juice with ginger rhizome powder	7.44 ^{a} ± 0.12	6.72 ^{b} ±0.14	4.38 ^{c} ± 0.08	2.36 ^{d} ±0.04	3.44^{c}± 0.01
	25	Julie mango juice with cinnamon powder	7.85^{a} ± 0.14	6.14 ^{b} ±0.14	4.03 ^{c} ± 0.08	2.68 ^{d} ±0.12	2.44 ^{d} ± 0.04
	25	Julie mango juice with ginger rhizome and cinnamon powder	8.44 ^{a} ± 0.14	6.36 ^{b} ±0.04	3.58 ^{c} ± 0.02	4.39 ^{c} ±0.11	2.36 ^{d} ± 0.02
	25	Julie mango juice with sodium benzoate	7.41 ^{a} ± 0.24	7.27 ^{a} ±0.15	4.24 ^{b} ± 0.01	4.04 ^{b} ±0.01	2.02 ^{c} ± 0.05
	25	Julie mango juice with ascorbic acid	7.22 ^{a} ± 0.02	7.37 ^{a} ±0.02	4.36 ^{b} ± 0.01	4.36 ^{b} ±0.01	2.25 ^{c} ± 0.03

Alphabets a-b: Means ± standard deviation of triplicate determination. Means bearing the same superscripts along the row are not significantly different ($p<0.05$).

Table 5 shows the mean sensory scores of pawpaw fruit juice samples treated with different preservatives stored in the refrigerator at 4 °C for a period of 8 days.

There were significant differences ($p<0.05$) in the sensory scores of the fruit juice samples evaluated. The mean scores for taste of pawpaw fruit juice samples ranged from 6.43 – 8.69 at day 0 (Table 5). The pawpaw fruit juice without any preservative added had the highest score (8.69) while pawpaw fruit juice treated with ginger had the least (6.43). Pawpaw fruit juice sample treated with ginger and cinnamon had comparable taste scores (8.02).

The mean score of flavor for pawpaw fruit juice samples ranged from 6.31 – 8.23 at day 0. The pawpaw fruit juice without any preservative added had the highest score (8.23) while pawpaw fruit juice treated with cinnamon powder had the least (6.31). The pawpaw fruit juice without any preservative added was significantly different ($p<0.05$) from the other pawpaw fruit juice samples except pawpaw fruit juice treated with ginger and cinnamon powder which also had a high score (8.20). There was significant change in flavour of the pawpaw fruit juice samples as the storage days increased.

The mean score for colour of pawpaw fruit juice samples ranged from 5.30 – 7.36 at day 0. The pure pawpaw fruit juice had the highest score (8.70) while pawpaw fruit juice with ginger powder had the least (7.32).

The mean general acceptability score varied from 6.00 – 7.26 at day 0. The pure pawpaw fruit juice had the highest score (7.26) and pawpaw juice with ginger had the least (6.00).

The mean sensory results obtained showed that pawpaw fruit juice differed significantly in taste, flavour, colour and overall acceptance during the period of storage with different preservatives (Table 5). There was progressive decrease in all the sensory attributes of the juice samples at day 2 of storage which could be as a result of microbial activities of spoilage microorganisms which negatively impacted the sensory attributes of the juice samples. Overall, the sensory evaluation results shows that pawpaw fruit juice without any preservative added to it was the most preferred product.

Table 5: Mean sensory evaluation score for pawpaw fruit juices stored at 4 °C

Parameter	No of panelist	Treatment type	Day 0	Day 2	Day 4	Day 6	Day 8
Taste	25	Pure pawpaw juice	$8.69^{a} \pm 0.21$	$7.01^{b} \pm 0.13$	$5.11^{c} \pm 0.01$	$4.86^{d} \pm 0.03$	$4.54^{d} \pm 0.03$
	25	Pawpaw juice with ginger rhizome powder	$6.43^{a} \pm 0.04$	$5.15^{b} \pm 0.02$	$5.52^{b} \pm 0.01$	$4.51^{c} \pm 0.03$	$4.46^{b} \pm 0.03$
	25	Pawpaw juice with cinnamon powder	$7.14^{a} \pm 0.02$	$5.36^{b} \pm 0.01$	$5.12^{b} \pm 0.01$	$4.61^{c} \pm 0.03$	$4.02^{c} \pm 0.02$
	25	Pawpaw juice with ginger rhizome and cinnamon powder	$8.02^{a} \pm 0.06$	$6.13^{b} \pm 0.13$	$6.44^{b} \pm 0.06$	$5.46^{c} \pm 0.02$	$5.14^{c} \pm 0.01$
	25	Pawpaw juice with sodium benzoate	$7.15^{a} \pm 0.06$	$6.47^{b} \pm 0.23$	$6.26^{b} \pm 0.06$	$5.23^{c} \pm 0.02$	$4.36^{d} \pm 0.03$
	25	Pawpaw juice with ascorbic acid	$7.33^{a} \pm 0.03$	$6.35^{b} \pm 0.03$	$6.33^{b} \pm 0.05$	$5.26^{c} \pm 0.06$	$5.93^{c} \pm 0.03$
Flavour	25	Pure pawpaw juice	$8.23^{a} \pm 0.01$	$7.23^{b} \pm 0.01$	$6.11^{c} \pm 0.03$	$6.35^{c} \pm 0.02$	$5.70^{c} \pm 0.03$
	25	Pawpaw juice with ginger rhizome powder	$7.65^{a} \pm 0.03$	$6.45^{b} \pm 0.03$	$5.12^{b} \pm 0.03$	$5.22^{c} \pm 0.03$	$5.01^{c} \pm 0.03$
	25	Pawpaw juice with cinnamon powder	$6.31^{a} \pm 0.03$	$5.82^{b} \pm 0.02$	$5.13^{b} \pm 0.04$	$5.23^{b} \pm 0.03$	$5.40^{b} \pm 0.01$
	25	Pawpaw juice with ginger rhizome and cinnamon powder	$8.20^{a} \pm 0.01$	$7.13^{b} \pm 0.01$	$5.38^{c} \pm 0.00$	$4.34^{d} \pm 0.00$	$4.42^{d} \pm 0.05$
	25	Pawpaw juice with sodium benzoate	$7.30^{a} \pm 0.01$	$6.11^{b} \pm 0.01$	$5.20^{c} \pm 0.03$	$4.01^{d} \pm 0.00$	$4.24^{d} \pm 0.03$
	25	Pawpaw juice with ascorbic acid	$7.40^{a} \pm 0.03$	$6.51^{b} \pm 0.03$	$5.44^{c} \pm 0.03$	$5.27^{c} \pm 0.03$	$4.24^{d} \pm 0.03$
Colour	25	Pure pawpaw juice	$7.36^{a} \pm 0.10$	$7.06^{a} \pm 0.01$	$6.71^{b} \pm 0.03$	$4.22^{c} \pm 0.05$	$4.01^{c} \pm 0.03$
	25	Pawpaw juice with ginger rhizome powder	$5.30^{b} \pm 0.03$	$6.00^{a} \pm 0.02$	$5.24^{b} \pm 0.00$	$4.42^{c} \pm 0.01$	$4.32^{c} \pm 0.01$
	25	Pawpaw juice with cinnamon powder	$6.10^{a} \pm 0.03$	$6.20^{a} \pm 0.01$	$6.36^{a} \pm 0.04$	$5.52^{b} \pm 0.03$	$4.32^{c} \pm 0.01$

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	25	Pawpaw juice with ginger rhizome and cinnamon powder	7.26 ^{a} ± 0.03	6.33 ^{b} ± 0.00	5.31^{c} ± 0.02	5.51 ^{c} ± 0.05	4.25^{d}± 0.01
	25	Pawpaw juice with sodium benzoate	6.00 ^{a} ± 0.03	6.54 ^{a} ± 0.00	5.00 ^{b} ± 0.02	5.20 ^{b} ± 0.03	4.27^{c}± 0.01
	25	Pawpaw juice with ascorbic acid	6.07 ^{a} ± 0.03	6.61 ^{a} ± 0.03	6.92 ^{b} ± 0.03	5.83 ^{c} ± 0.03	4.64^{d} ± 0.01
Overall acceptance	25	Pure pawpaw juice	7.26 ^{a} ± 0.05	6.33^{b} ± 0.02	5.46 ^{c} ± 0.05	5.31^{c} ± 0.05	4.01^{d} ± 0.03
	25	Pawpaw juice with ginger rhizome powder	6.00 ^{a} ± 0.03	4.36^{c} ± 0.03	5.40 ^{b} ± 0.03	5.32^{b}± 0.03	4.07^{c}± 0.03
	25	Pawpaw juice with cinnamon powder	6.11^{a} ± 0.03	4.61^{b} ± 0.03	4.65^{b}± 0.03	4.74^{b} ± 0.03	4.21^{b}± 0.03
	25	Pawpaw juice with ginger rhizome and cinnamon powder	6.26 ^{a} ± 0.04	6.30 ^{a} ± 0.03	4.57 ^{c} ±0.02	4.03 ^{c} ± 0.03	5.22^{b}± 0.01
	25	Pawpaw juice with sodium benzoate	6.12 ^{a} ±0.03	5.43 ^{b} ± 0.03	3.20 ^{c} ± 0.01	3.03^{c} ± 0.01	3.46 ^{c} ± 0.01
	25	Pawpaw juice with ascorbic acid	6.14^{a}± 0.01	5.90^{b}± 0.05	3.64^{c}±0.02	3.32^{c}± 0.03	3.81^{c} ± 0.03

Alphabets a-b: Means ± standard deviation of triplicate determination. Means bearing the same superscripts along the row are not significantly different ($p<0.05$).

Table 6 shows the mean sensory scores of pawpaw fruit juice samples with different preservatives stored in the room temperature (28 °C) for a period of 8 days.

There were significant differences ($p<0.05$) in the sensory results of the fruit juice samples examined. The mean score for taste of pawpaw fruit juice samples ranged from 7.00 – 8.69 at day 0 (Table 6). The pawpaw fruit juice sample without any preservative added to it had the highest score (8.69) and pawpaw fruit juice treated with ginger had the least (7.00).

The mean score for flavour of pawpaw fruit juice samples ranged from 5.27 – 7.20 at day 0. The pawpaw fruit juice sample without any preservative added to it had the highest score (7.20) while pawpaw fruit juice treated with cinnamon powder had the least (5.27).

The mean score for colour of pawpaw fruit juice samples ranged from 5.23 – 7.21 at day 0. The pawpaw fruit juice had the highest score (7.21) and pawpaw fruit juice treated with ginger powder had the least (5.21).

The mean score for overall acceptability varied from 6.04 – 7.06 at days 0. The pawpaw fruit juice without any preservative added to it had the highest score (7.26) while pawpaw juice treated with ginger rhizome had the least (6.04).

Table 6: Mean score of sensory evaluation for pawpaw fruit juices stored at room temperature (28 °C)

Parameter	No of panelist	Treatment type	Day 0	Day 2	Day 4	Day 6	Day 8
Taste	25	Pure pawpaw juice	8.69 ^{a} ± 0.10	7.43 ^{b} ± 0.08	5.01^{c} ±0.08	4.06 ^{d} ± 0.02	3.89 ^{d} ± 0.00
	25	Pawpaw juice with ginger rhizome powder	7.00^{a} ± 0.02	5.05^{b}± 0.02	5.02 ^{b} ±0.01	4.41 ^{c} ± 0.01	4.32 ^{c} ± 0.01
	25	Pawpaw juice with cinnamon powder	7.06^{a}± 0.02	5.06^{b} ± 0.01	5.02 ^{b} ±0.03	4.41 ^{c} ± 0.01	4.12 ^{c} ± 0.01
	25	Pawpaw juice with ginger rhizome and cinnamon powder	7.38^{a} ± 0.03	5.19 ^{b} ± 0.05	5.54 ^{b} ±0.06	5.32 ^{b} ± 0.02	4.09^{c}± 0.01
	25	Pawpaw juice with sodium benzoate	7.04 ^{a} ± 0.06	6.07 ^{b} ± 0.23	5.16^{c} ±0.06	5.32^{c} ± 0.02	4.06^{d} ± 0.03
	25	Pawpaw juice with ascorbic acid	7.13^{a} ± 0.03	6.13^{b} ± 0.05	5.43^{c} ±0.03	5.16^{c} ± 0.06	4.61^{d} ± 0.00
Flavour	25	Pure pawpaw juice	7.20 ^{a} ± 0.01	7.45 ^{a} ± 0.01	5.11^{c} ±0.03	6.15^{b} ± 0.02	4.30^{d} ± 0.03
	25	Pawpaw juice with ginger rhizome powder	7.21^{a} ± 0.03	5.40^{b} ± 0.02	5.17 ^{b}±0.02	5.12^{b}± 0.03	5.00^{b}± 0.01
	25	Pawpaw juice with cinnamon powder	5.27^{a} ± 0.03	5.73^{a}± 0.02	5.12^{a}±0.02	5.03^{a} ± 0.02	5.01^{a}± 0.01
	25	Pawpaw juice with ginger rhizome and cinnamon powder	7.30^{a} ± 0.04	6.12 ^{b} ± 0.01	5.09^{c} ±0.02	3.34 ^{d} ± 0.00	4.23^{d}± 0.05
	25	Pawpaw juice with sodium benzoate	7.20 ^{a} ± 0.02	6.12 ^{b} ± 0.03	5.10 ^{c} ± 0.03	3.00 ^{d} ± 0.00	4.23^{d}± 0.03
	25	Pawpaw juice with ascorbic acid	7.20 ^{a} ± 0.03	6.33 ^{b} ± 0.02	5.65^{c} ± 0.03	5.17^{c} ± 0.04	4.22^{d}± 0.02
Colour	25	Pure pawpaw juice	7.21 ^{a} ± 0.10	6.46^{b} ± 0.01	5.65 ^{c} ± 0.03	3.33 ^{d}± 0.05	4.11^{c}± 0.03
	25	Pawpaw juice with ginger rhizome powder	5.23 ^{d} ± 0.03	6.06 ^{a} ± 0.02	5.14 ^{b} ± 0.03	4.24^{c}± 0.01	4.01^{c}± 0.01
	25	Pawpaw juice with cinnamon powder	6.00 ^{a}± 0.06	6.06^{a}± 0.06	6.21^{a}± 0.04	5.12 ^{b} ± 0.03	4.04 ^{b}± 0.01

	25	Pawpaw juice with ginger rhizome and cinnamon powder	6.28 [a] ± 0.03	6.43[a] ± 0.05	5.41 [b] ± 0.04	5.61 [b] ± 0.04	4.05[c]± 0.01
	25	Pawpaw juice with sodium benzoate	6.10 [a] ± 0.03	6.31[a] ± 0.00	5.20 [b] ± 0.02	5.62 [b] ± 0.03	4.05[c]± 0.01
	25	Pawpaw juice with ascorbic acid	6.08[a] ± 0.03	6.31[a] ± 0.02	5.42 [b] ± 0.01	4.33 [c] ± 0.01	4.24[c] ± 0.01
Overall acceptance	25	Pure pawpaw juice	7.06[a] ± 0.05	6.37 [b] ± 0.02	4.40 [c] ± 0.05	4.26 [c] ± 0.05	4.11[c] ± 0.03
	25	Pawpaw juice with ginger rhizome powder	6.04[a] ± 0.03	4.22 [b] ± 0.03	4.40 [b] ± 0.03	4.21[b]± 0.01	4.17[b]± 0.01
	25	Pawpaw juice with cinnamon powder	6.21[a] ± 0.03	4.22 [b] ± 0.03	4.25 [b] ± 0.03	3.85[c] ± 0.03	4.51[b]± 0.03
	25	Pawpaw juice with ginger rhizome and cinnamon powder	6.18 [a] ± 0.04	6.10 [a] ± 0.03	3.17 [c] ±0.02	3.01[c] ± 0.03	4.03[b] ± 0.01
	25	Pawpaw juice with sodium benzoate	6.10 [a] ±0.03	4.41 [b] ± 0.03	3.20 [c] ± 0.01	3.12 [c] ± 0.01	3.36 [c] ± 0.01
	25	Pawpaw juice with ascorbic acid	6.20 [a] ± 0.01	5.08 [b] ± 0.02	3.54 [c] ±0.02	3.23 [c] ± 0.01	3.22 [c] ± 0.03

Alphabets a-b: Means ± standard deviation of triplicate determination. Means bearing the same superscripts along the row are not significantly different ($p<0.05$)

The results obtained for the sensory evaluation of Julie mango juice and pawpaw fruit juices treated with different preservatives and stored in refrigerator (4 °C) for 8 days as shown in Tables 3-6 above indicate that sensory parameters tested; taste, colour, flavor of both the Julie mango and pawpaw fruit juices were acceptable throughout the storage period in the refrigerator at 4 °C.

The results obtained for the sensory evaluation of Julie mango juice and pawpaw fruit juices treated with different preservatives and stored at room temperature (28 °C) for 8 days as shown in Tables 3-6 above indicate that juice samples stored at room temperature 28 °C were not acceptable since they had started to develop off flavors and taste after storage for 3 days.

The result also showed that the colour, flavour and overall acceptance of Julie mango and pawpaw fruit juices treated with chemical preservatives varied. In addition, it was shown that temperature had significant effect on keeping quality of fruit juices. This result is in agreement with the report by Pandhare *et al*. (2018) that pineapple could be preserved with the incorporation of natural preservatives. This result also compares well with the report of El-Saadony *et al*. (2020) that the addition of different preservatives to cucumber juice prolonged its shelf life.

Microbial counts of Julie mango and pawpaw fruit juice samples

The effect of different preservatives and storage temperatures on the microbial load of Julie mango and pawpaw fruit juices are presented in Figures 1 A- D and Figures 2 A - D.

Microbial load of Julie mango fruit juice

The addition of different preservatives to Julie mango fruit juice helped to reduce the bacterial load in all the juice sample treatments stored in the refrigerator at 4 °C and room temperature at 28 °C. Details of the result shows that juice with sodium benzoate had the highest reduction from 5.0×10^4 to 8.0×10^3CFU ml^{-1} and 5.0×10^4 to 7.0×10^3CFU/ml^{-1} for juice stored in the refrigerator at 4 °C and room temperature (28 °C), respectively. With regards to the Julie mango juice without any preservative added to it and stored at 4 °C, there was a slight reduction in bacterial load (5.5×10^4 to 5.0×10^4CFU/ml^{-1}) of mango fruit juice without any preservative added to it which was stored at 4 °C. A similar sample of fruit juice stored at room temperature (28 °C) had an increase in bacterial load from 5.2×10^4 to 7×10^4 CFU/ ml^{-1} (Figure 1 A and B).

The addition of different preservatives to Julie mango fruit juice also helped to reduce the fungal load in all the juice sample treatments stored in the refrigerator at 4 °C and room temperature at 28 °C, Julie mango

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juice treated with sodium benzoate showed the highest reduction from 2.9×10^4 to 4.0×10^3CFU ml^{-1} and 3.0×10^4 to 7.0×10^3CFU/ml^{-1} for samples stored at 4 °C and room temperature (28 °C), respectively. With regards to the Julie mango juice without any preservative added to it and stored at 4 °C the result obtained showed that fungal load in the product slightly increased from 3.0×10^4 to 3.2×10^4 CFU/ml^{-1}. A considerable increase in fungal load 3.0×10^4 to 3.2×10^4 CFU/ml^{-1} occurred in the control sample stored at room temperature (3.2×10^4 to 4.2×10^4CFU/ml^{-1}) (Figure 1 C and D).

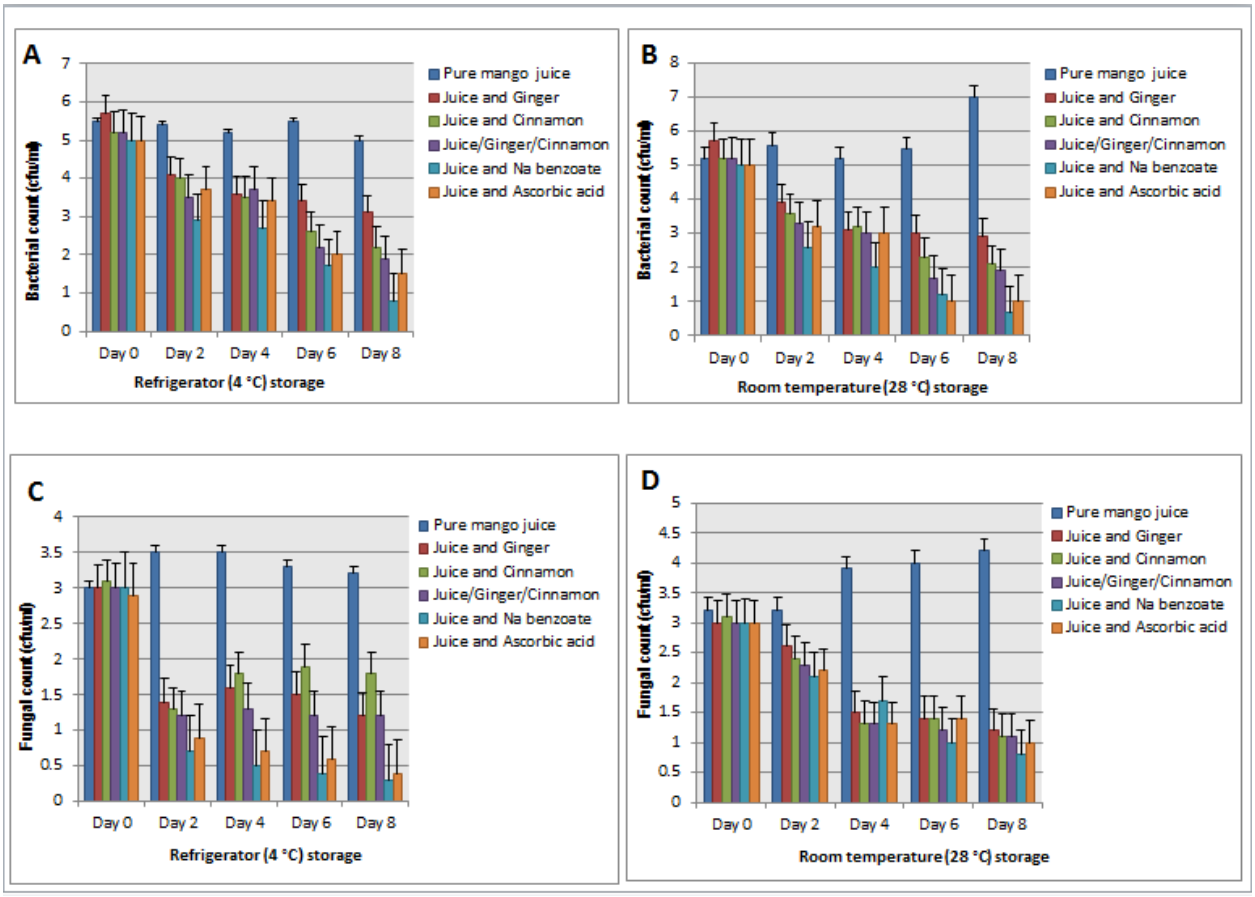

Figure 1.Effect of natural and artificial preservatives on the bacterial count (10^4) and fungal count (10^4) of Julie mango juice stored in the refrigerator at 4^OC and room temperature at 28 ^OC.

Figure 1 show (a) Effect of natural and artificial preservatives on the bacterial count (10^4) of Julie mango juice stored in the refrigerator (4°C) (b) Effect of natural and artificial preservatives on the bacterial count (10^4) of Julie mango juice stored at room temperature (28 °C) (c) Effect of natural and artificial preservatives on the fungal count (10^4) of Julie mango juice stored in the refrigerator (4°C) (d) Effect of natural and artificial preservatives on the fungal count (10^4) of Julie mango juice stored at room temperature (28 °C).

Microbial load of pawpaw fruit juice

The addition of different preservatives to pawpaw fruit juice helped to reduce the bacterial load in all the juice sample treatments stored at (4 °C) and room temperature (28 °C) with ascorbic acid showing the highest reduction from 5.2×10^4 to 7.0×10^3CFU ml^{-1} and 5.3×10^4 to 6.0×10^3CFU/ml^{-1} for juice stored at (4 °C) and room temperature (28 °C). With regards to pawpaw fruit juice without any preservative added to it stored at (4 °C), there was a slight

reduction in the bacterial load (5.6×10^4 to 5.0×10^4CFU/ml^{-1})whereas there was an increase in bacterial load of the sample stored at room temperature (28 °C) from (5.3×10^4 to 6.5×10^4CFU/ml^{-1}) (Figure 2 A and B).

The addition of different preservatives to pawpaw fruit juice also helped to reduce the fungal load in all the juice sample treatments stored at (4 °C) and room temperature (28 °C). The juice treated with ascorbic acid had the highest reduction in fungal load from 2.0 $\times 10^4$ to 6.0×10^3CFU ml^{-1} and 2.2×10^4 to 3.0×10^3CFU/ml^{-1} for juice stored at (4 °C) and room temperature (28 °C), respectively. Regarding pawpaw fruit juice without any preservative added to it (control sample) stored at (4 °C), there was a slight increase in the fungal load (2.0×10^4 to 2.8×10^4CFU/ml^{-1}) and a marginal increase in the sample stored at room temperature (28 °C) from 2.2×10^4 to 3.8×10^4CFU/ml^{-1} (Figure 2 C and D).

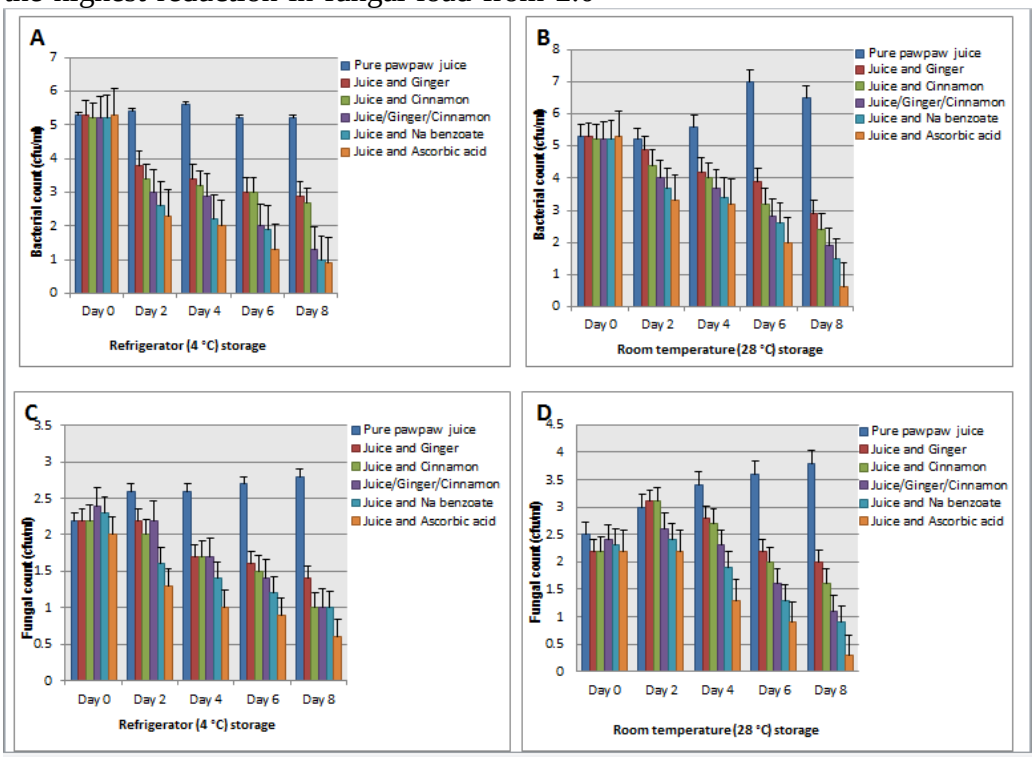

Figure 2.Effect of natural and artificial preservatives on the bacterial count (10^4) and fungal count (10^4) of pawpaw juice stored in the refrigerator at 4 °C **and room temperature at** 28 °C.

Figure 2 show (a) Effect of natural and artificial preservatives on the bacterial count (10^4) of pawpaw juice stored in the refrigerator (4°C) (b) Effect of natural and artificial preservatives on the bacterial count (10^4) of pawpaw juice stored at room temperature (28 °C) (c) Effect of natural and artificial preservatives on the fungal count (10^4) of pawpaw juice stored in the refrigerator (4 °C) (d) Effect of natural and artificial preservatives on the fungal count (10^4) of pawpaw juice stored at room temperature (28 °C).

The results obtained for the microbial load of Julie mango juice and pawpaw fruit juices in Figures 1 A - D and Figure 2 A - D above indicate that the natural preservatives and their combination as well as the chemical preservatives which include sodium benzoate and ascorbic acid were effective in increasing the keeping quality of both fruit juices with sodium benzoate and ascorbic acid exhibiting bacteriostatic and fungistatic activity at refrigerator and room temperature storage. This may be due to the insolubility of the natural preservatives used for the study. Many researchers have reported the use of

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chemical preservatives such sodium sorbate, potassium sorbates and benzoates in prolonging the shelf life of fruit juices (Pandhare *et al*., 2018, Okokon and Okokon, 2019; Oladipo *et al*., 2022). Sodium benzoate is a preservative that is used in preserving acidic food products such as vinegar, carbonic acids and condiments. The inability for both fruit juices to be kept for a long time without the addition of preservatives synergized the nutrient quality of the juices creating a favourable environment for the colonization and proliferation of food microorganisms (Pandhare *et al*., 2018, Okokon and Okokon, 2019). Spices have long been reported to have antioxidant and antimicrobial potentials. Garlic and ginger for many years now, have wide application in food processing (Olaniran *et al*., 2013).Ginger has been reported to demonstrate bactericidal effect on *Streptococcus* and *E. coli* strains (Olaniran *et al*., 2013). Benzoates are more preferable in preserving fruit juices probably because of the solubility of their salts. Most times benzoates are used at minimal temperatures to prolong the shelf life of processed juices (Olaniran *et al*., 2013). The usage of benzoates may be attributed to their broad spectrum activity against some microorganisms and their inability to alter the organoleptic properties of food. The reduction in the microbial loads over storage period in Julie mango and pawpaw fruit treated with both natural and chemical preservatives could be attributed to the antimicrobial and phytochemical properties of the preservatives and juices (Aneja *et al*., 2014). Another preservative used in this study is ascorbic acid. Ascorbic acid is a powdered substance commonly referred to as vitamin C. It is an acidulant and a natural preservative that helps to prevent browning in fruit juices. It is used in preserving fruit juices because it is an important vitamin which is part of the nutritional content of fruit juices and other foods after processing. Ascorbic acid is good in preserving fruit juices as seen in this study. Its activity can be attributed to its broad spectrum activity.

Effect of preservatives on pH during storage

The effect of the different preservatives on pH of Julie mango and pawpaw fruit juices is presented in Figures 3 A – D.

Figure 3 A and B shows the effect of the different preservatives on the pH of Julie mango fruit juices. The pH of Julie mango fruit juice treated with ginger rhizome powder, cinnamon powder, ginger rhizome powder and cinnamon powder, sodium benzoate and ascorbic acid ranges were within the range of4.97 to 5.09, 4.47 to 4.77, 4.7 to 4.90, 4.45 to 4.66, and 4.6 to 4.8. Meanwhile, the pH of Julie mango juice control range between 4.50 to 4.75. For samples stored at room temperature (28 °C), the pH ranges were between 4.65 to 4.78, 5 to 5.09, 4.67 to 4.79, 4.57 to 4.91, 4.5 to 4.62 and 4.6 to 4.78 for control, ginger rhizome powder, cinnamon powder, ginger rhizome powder and cinnamon powder, sodium benzoate and ascorbic acid respectively.

Figure 3 C and D shows the effect of the different preservatives on the pH of pawpaw fruit juices. The pH of pawpaw fruit treated with ginger rhizome powder, cinnamon powder, ginger rhizome powder and cinnamon powder, sodium benzoate and ascorbic acid and stored in the refrigerator at 4 °C range between 5 to 5.19, 4.57 to 4.83, 4.79 to 4.94, 4.63 to 4.96, and 4.54 to 4.7 respectively. Meanwhile, the pH of pawpaw fruit juice without any preservative added to it range from 4.53 to 4.85. For samples stored at room temperature (28 °C), the pH ranges between 4.55 to 4.85, 5 to 5.23, 4.67 to 4.86, 4.7 to 4.98, 4.6 to 4.97 and 4.50 to 4.80 were reported for the control, Julie mango juice treated with ginger rhizome powder, cinnamon powder, ginger rhizome powder and cinnamon powder, sodium benzoate and ascorbic acid respectively.

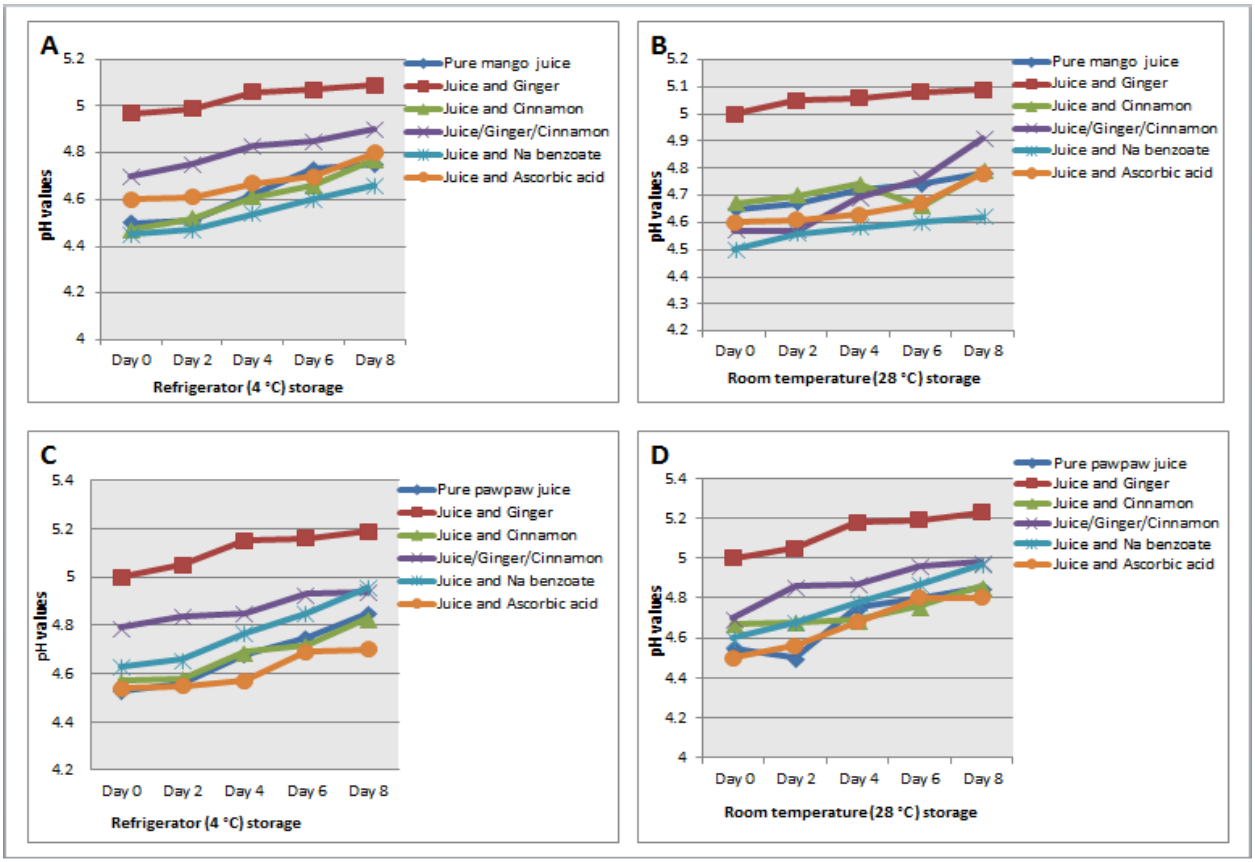

Figure 3.Effect of natural and artificial preservatives on pH of Julie mango juice and pawpaw juice stored in the refrigerator at 4 °C and room temperature at 28 °C.

Figure 3 show (a) Effect of natural and artificial preservatives on pH of Julie mango juice stored in the refrigerator at 4 °C (b) Effect of natural and artificial preservatives on pH of Julie mango juice stored in the room at 28 °C (c) Effect of natural and artificial preservatives on pH of pawpaw juice stored in the refrigerator at 4 °C (d) Effect of natural and artificial preservatives on pH of pawpaw juice stored in the room at 28 °C.

The pH results (Figure 3 A - D) showed a progressive acidic reduction for the storage periods in pawpaw juice samples stored in the refrigerator 4 °C and room (28 °C) except for fruit juice samples treated with ginger. This result correlates with the report of Okokon and Okokon (2018) which stated that the incorporation of both garlic and ginger into drinks tend to shift the pH towards acidity and reduces the microbial load in the fruit juice. Other factors responsible for a change in pH of fruit juice during storage include environmental factors, activities of microorganisms and incomplete dissolution of the natural preservatives (Olaniran *et al*., 2013).

CONCLUSION

Freshly home-made juices processed manually or with the aid of an electrical juice with or without pasteurization have a short shelf life and low sensory appeal. The findings from this study shows that the addition of natural or chemical preservatives to the fruit juices followed by storage of the product inside a refrigerator is a suitable method for preserving Julie mango and pawpaw juice for eight (8) days. Refrigeration is now expensive.

Competing Interests

The authors declare that there is no conflict of interests.

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