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Effect of storage condition and preservatives on the microbial, physicochemical and sensory quality of cucumber juice and carrots juice.

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Abstract

Fruit juices are prone to spoilage without the use of preservatives. This study evaluated the effect of preservatives on the microbial, physicochemical and sensory quality of cucumber and carrots juices. Carrot and cucumbers fruits were extracted, filtered and treated with garlic and ginger powder and sodium benzoate. Carrot and cucumber juices without preservatives served as control. The microbial qualities of the fruit juice were determined using standard methods. Total viable count for Cucumber and carrot juices stored at ambient and refrigerated temperature increased from day 3 to day 6. Cucumber and carrot Juices with Ginger + Garlic and sodium benzoate had the least microbial count in most cases. The microbial count for refrigerated cucumber and carrot juice were less than that of juice at ambient temperature on day 3 and day 6. The sensory quality of both juices deteriorated with a longer time of storage. The organisms isolated from both cucumber and carrot juices include *Staphylococcus sp*, *Bacillus sp*, *E. coli*, *Klebsiella sp* and *Salmonella sp*. *Bacillus* had the highest frequency of occurrence of 32%, while *Salmonella sp* 3.5% had the least occurrence. This study has shown that microorganisms are present in fresh fruit juices, microbial spoilage occurs with longer storage time but refrigeration slows down spoilage of fruit juices, chemical preservative benzoate and ginger + garlic in combination can slow down microbial spoilage. Also, the sensory quality of juices declines with longer storage but refrigeration improves sensory quality. However, preservation of fruit juice at ambient temperature for a long duration should be discouraged to reduce microbial contamination.

Keywords: Microbial Quality; Physicochemical Quality; Storage Condition; Preservatives; Fruit Juices

1. Introduction

Fruits and vegetables could be described as fleshy portions of plants with edible characteristics, which could be eaten wholly, precut, or sliced. Fresh fruits and vegetables are widely available in various cities, towns, and villages in Nigeria (Erhirhie *et al*., 2020). Consumption of fresh fruits and vegetables is encouraged world-wide by both government and privately-owned health agencies or groups. The high moisture content in fruit juices makes them highly susceptible to being spoiled by microorganisms that can survive in acidic conditions at normal temperature or refrigeration conditions, even when appropriately packaged (Erukainure *et al*., 2010). Moreover, physiochemical changes affect the safety and quality of fruits. All of these changes may be prevented by supplementation with preservatives that maintain the nutritional value of juices, extend its lifetime and keep it safe (Saguy and Peleg, 2009).

Recently, consumers demand for foods with a long lifetime, high quality, and a suitable price has increased. Therefore, food producers and manufacturers are in quest of additives to increase food storage life, while maintaining nutrition value, quality, and safety. Many chemicals, such as nitrates, organic acids and their salts, butylated hydroxytoluene (BHT) formaldehyde, and butylated hydroxyanisole (BHA) are effectively used as food preservatives, to reduce the microbial load and prolong food lifetime and vitality (El-Saadony *et al*., 2020).

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Despite their antioxidant and antimicrobial activity (Anyasi *et al*., 2017), preservatives have various undesirable effects on human health, including allergy, headache, asthma, hyperactivity, hypersensitivity, cancer, neurological damage, and dermatitis which have been investigated (Bondi *et al*., 2017). Carocho *et al*. (2014) confirmed that the extreme consumption of chemical additives results to gastrointestinal, respiratory, dermatological, and neural opposing responses. Hence, consumers are increasingly concerned about the harmful effects of chemical preservatives and have preference for natural additives. Researchers have therefore focused on producing natural preservatives that exhibit antioxidant and microbial activity for use in food processing (Osman *et al*., 2013).

Cucumber (*Cucumis sativus* L.) is a member of Cucurbitaceae seasonal vegetable crops, which are native to India and cultivated all over the world (Mukherjee *et al*., 2013). During the harvest season, a large amount of cucumber spoils due to overproduction. This problem can be minimized by saving the cucumber as a drink or juice as functional beverages. In Central Asia, people drink cucumber juice on hot days, for recovery. Cucumber juice has health benefits for skin, nails, and hair; it maintained an ideal weight and cures some kidney disease and blood pressure issues. The cucumber is distinguished by its high content of water and satisfies all appetites (El-Saadony *et al*., 2020).

Carrot (*Daucus carota* subsp. *sativus*) is of the most popular vegetables grown and consumed in numerous countries all over the world. It is a root vegetable, typically orange in color. Carrot is a biennial plant in the umbellifer family, Apiaceae. Different cultivars exist including white, orange, red, and purple cultivars. Carrots contain an impressive selection of phytochemicals, including carotenoids, anthocyanins, and other phenolic compounds. This makes the vegetable a good source of dietary antioxidants, when included in the diet. The most abundant antioxidant compounds found in carrots are α- and β-carotene, vitamin E, and anthocyanin. Interestingly, the levels of these antioxidant pigments found different cultivars are responsible for the coloring of the carrots. Carrots are believed to possess various health benefits due to their nutritional composition and antioxidant capacity, including the potential to prevent cardiovascular disease and certain types of cancers (Nagraj and Jaiswal, 2020).

In some regions of the developing countries, refrigeration storage is difficult to use due to the high costs of operation and the deficiency of electricity supplies. Alemu and Girma (2018) developed a novel technique for food storage called "Hyperbaric storage", which is usually not higher than 100 MPa at ambient or low temperature, for up to months. Recent studies showed that the storage with low pressure at room temperature can be an effective technique to fruit and vegetable juices' storage, as pressure inhibits the microbial content of fresh juice, besides enhancing sensory characteristics and the quality of the juice. Reports indicated that low-pressure storage prolonged vegetable and fruit juices' shelf life; it also reduced energy costs more than refrigeration storage (Pinto *et al*., 2017; Otero, 2019).

The usage of natural antimicrobial and antioxidants, such as herbal extracts and essential oils, has improved storage capacity and safety in the food industry (Zhang *et al*., 2016). Preservatives are thought to reduce microbial spoilage and affect the physicochemical and sensory quality of fruits. Natural preservatives are also thought to be safer than artificial preservatives. This study will identify the various effects of natural and artificial preservatives on cucumber and carrot fruit juices.

Fruit juices are prone to spoilage without the use of preservatives. Even if these juices are refrigerated for long periods without preservatives, they are still susceptible to microbial spoilage. Chemical preservatives reduce the risk of microbial spoilage in fruit juices but have various undesirable effects on human health. Natural preservatives with antimicrobial qualities therefore represent a safer alternative. There is therefore need to find out how these preservatives effect the physicochemical, microbial and sensory quality of Cucumber and Carrot juices. This current study is aimed at investigating the effect of preservatives and storage condition on the physicochemical, microbial and sensory quality of Cucumber and Carrot juices.

2. Material and methods

2.1. Collection and Processing of Fruits

Carrot and cucumbers fruits were purchased from different sales point in Port Harcourt metropolis, Rivers State, Nigeria and transported to the Laboratory where research was carried out. The fruits were washed with distilled water to remove dirts. The fruits were trimmed, peeled and cut into smaller pieces before juice extraction.

2.2. Preparation of Fruit Additives and Preservatives

The ginger rhizomes and garlic bulbs were washed with potable water repeatedly. Their outer covering was peeled off with a sterile knife and then sliced into cutlets and dried using a hot air oven at 65°C for 48hrs. An electric blender will be used to pulverize the dried ginger and garlic bulb into powder.

2.3. Production of Cucumber and Carrot Juices

The pieces of Cucumber and Carrots were introduced into a juice extractor separately and their juices extracted. The extracted juices were filtered using clean cloth into sterile conical flasks.

Treatment of Cucumber and Carrot Juices with Natural and Chemical Preservatives.

2.3.1. Natural Preservatives

0.5 g of ginger powder were added to ''100 ml'' of cucumber juice. ''0.5 g ''of garlic powder will also be added to 100 ml of cucumber juice. 0.25 g of ginger powder and 0.25g of garlic powder will be combined and added to 100 ml of cucumber juice.

0.5 g of ginger powder will be added to 100ml of carrot juice''. 0.5 g ''of garlic powder were also be added to 100 ml of carrot juice.'' 0.25 g'' of ginger powder and'' 0.25 g'' of garlic powder will be combined and added to'' 100 ml ''of carrot juice.

2.3.2. Chemical Preservatives

0.05 % (w/v) sodium benzoate (sigma chemical company) was aseptically added to'' 100 ml '' of cucumber juice. 0.05 %(w/v) sodium benzoate (sigma chemical company) was aseptically added to'' 100 ml '' of carrot juice. 100 ml each of cucumber and carrot juices without preservatives served as control.

2.4. Microbiological Analysis of Fruit Juice

2.4.1. Microbiological Analysis

The number of microorganisms present in the fruit juice was determined using the spread plate count method. Plate count Agar was used for the enumeration of total aerobic bacteria. Mannitol salt agar for total staphylococcus count and MacConkey agar for total coliform counts while potato dextrose agar was used for fungal count. The fruit juice sample was serially diluted up to the 5^{th} dilution and the agar was allowed to cool to 15°C. Each experiment was carried out in duplicates.

Exactly 0.1ml of each of the dilution was aseptically introduced into sterile petri dishes containing respective agars using spread plate technique. The plates were inverted and incubated at 37°C for 24-48hrs for bacterial count and at 25^0C for 3-5 days for fungal count. Colonies that develop on the plates was counted and expressed as colony forming units per milliliter (cfu/ml) of the sample.

All the suspected colonies were identified based on standard morphological/cultural characteristics (colour, shape, elevation, capacity, consistency and edge), gram reaction and biochemical tests (citrate, oxidase, indole, catalase, coagulase) Identification of Fungi was done by staining the fungi lacto phenol cotton blue, then the specimen will be viewed under the microscope using x40 objective lens

2.5. Determination of Physicochemical Parameters

2.5.1. Determination of pH

Ten milliliters of the juice were dispensed into a beaker and the pH was determined with a previously calibrated pH meter. The pH meter was calibrated using phosphate buffer of pH 4.0 and 7.0 (AOAC, 2005) Dauda et al., (2017)..

2.5.2. Determination of Total Soluble Solid (TSS) Content

The total soluble solid content of the fruit juice samples was determined using a refractometer as described by Jasmine (2012) and Hossain et al. (2012). The refractometer was calibrated to 0% mark using water. The TSS content of each of the fruit juices was determined using the refractometer by placing a drop of the sample on its prism. The percentage of TSS was obtained from direct reading of the refractometer

2.5.3. Determination of Total Solids:

Total solids content was determined by evaporating a known weight of juice in an oven (Fisher Isotherm 175) at ''105 °C'' for 2-3 h. The solid left after evaporation was weighed and used to calculate the total solids. The total solids content is a measure of the amount of material remaining after all the water has been evaporated (AOAC, 2005)

2.5.4. Determination of Vitamin C.

Vitamin C content was determined with the dichlorophenol-indophenol (DCP) method with a (AOAC, 2005) Dauda et al., (2017)

2.5.5. Determination of Total Dissolved Solids (TDS)

Ten millilitres (10ml) of the juice sample were weighed into a cleaned and dried conical flask and was heated for an hour with a Bunsen burner until all liquid evaporated, remaining the solids and this was transferred immediately into an oven at'' 500 ^{0}C'' for 2hrs and was later weighed. This was done severally until constant weight was obtained.

2.5.6. Determination Of Electrical Conductivity

The conductivity of the juice was measured using a conductivity meter (MP526 Conductivity & DO Meter)''.20 ml ''of juice sample was measured into a beaker and the conductivity meter electrode was dipped into the beaker to measure the electrical conductivity of the sample. The conductivity values were then recorded.

2.5.7. Sensory Evaluation of Carrot and Cucumber Samples

Ready to serve juice (carrot and cucumber juices) was presented to a panel of judges for sensory evaluation of colour, taste, flavour and overall acceptability using a 9-point hedonic scale in accordance with the method described by Larmond (1977). The 10 trained panel members were selected based on their ability to discriminate and scale a broad range of attributes of carrot and cucumber juices. Members of the panel were briefed on the objectives of the study. Panel members were served with the juice samples and prescribed questionnaires was provided to record their observation whereby the scores will range from dislike extremely (1) to like extremely (9). The room was illuminated with white light and water provided to each panelist for mouth-rinsing after testing each product, to avoid the carry-over effect. The experiment was repeated twice.

3. Results

3.1. Microbial Count for Juice Samples on Day 1

Microbial count for Day 1 cucumber and carrot juice is shown in Table 1

Table 1 Microbial Counts for Cucumber and Carrot Juice (Day 1)

Sample	Cucumber (Cfu/ml)	Carrot (Cfu/ml)
Total Viable Count	2.4×10^6	1.46×10^7
Total Fungal Count	2×10^4	3.7×10^5
Total Coliform Count	1.0×10^2	1.1×10^2
Total Staphs. Count	2.0×10^4	4.7×10^5

3.2. Microbial Count of Samples at Different Storage Conditions at Day3

Table 2 shows the microbial counts cucumber juice (Day 3) at ambient temperature, Total viable count for all the samples ranges from1.7×10^6 to 6.4×10^6cfu/ml, Total fungi count for all the samples ranges from 3×10^4 to 5.4×10^4cfu/ml, Total coliform count ranges from$1.2 \times 10^{2\ \mathrm{to}}$ 2.3×10^3 cfu/ml, Staph count ranges from1.5×10^4 to 3.7×10^4 cfu/ml.

Table 2 Microbial Count for Cucumber Juice (Day 3) at Ambient Temperature

Sample(cfu/ml)	**TVC**	**TFC**	**TCC**	**Staph count**
Cucumber + Ginger	2.4×10^6	5.4×10^4	2.3×10^3	1.5×10^4
Cucumber + Garlic	6.4×10^6	4×10^4	1.8×10^3	1.7×10^4
Cucumber + Ginger + Garlic	1.7×10^6	3×10^4	1.3×10^2	2.6×10^4
Cucumber + Benzoate	3.0×10^6	5×10^4	1.2×10^2	3×10^4
Cucumber Juice Alone	2.4×10^6	5×10^5	2.2×10^2	3.7×10^4

Legends; TVC- Total viable count, TFC-Total fungi count, TCC-Total coliform count

Table 3 shows the microbial counts of cucumber juice (Day 3) at Refrigerated temperature, Total viable count for all the samples ranges from1.1×10^6 to 7.0×10^6cfu/ml, Total fungi count for all the samples ranges from2.4×10^4 to 4.2×10^4cfu/ml, Total coliform count ranges from$1.2 \times 10^{2\ \text{to}}$ 2.3×10^3 cfu/ml, Staph count ranges from2.5×10^4 to 2.3×10^5cfu/ml.

Table 3 Microbial Count for Refrigerated Cucumber Juice (Day 3)

Sample	**TVC**	**TFC**	**TCC**	**Staph count**
Cucumber + Ginger	1.9×10^6	4.2×10^4	1.9×10^3	1.1×10^5
Cucumber + Garlic	5.9×10^6	3.6×10^4	1.2×10^2	1.2×10^5
Cucumber + Ginger + Garlic	1.1×10^6	2.4×10^4	1.0×10^2	3.4×10^4
Cucumber + Benzoate	2.6×10^6	4×10^4	1.9×10^2	2.5×10^4
Cucumber Juice Alone	7.0×10^6	3×10^5	2.3×10^3	2.3×10^5

Legends; TVC- Total viable count, TFC-Total fungi count, TCC-Total coliform count

Table 4 shows the microbial counts cucumber juice (Day 6) at Ambient temperature, Total viable count for all the samples ranges from2.1×10^7 to 2.4×10^6cfu/ml, Total fungi count for all the samples ranges from 4.3×10^4 to 7.2×10^4cfu/ml, Total coliform count ranges from $2.1 \times 10^{3\ \text{to}}$ 3.6×10^4 cfu/ml, Staph count ranges from 5.1×10^4 to 4.6×10^5cfu/ml

Table 4 Microbial Count for Cucumber Juice (Day 6) at Ambient Temperature

Sample	**TVC**	**TFC**	**TCC**	**Staph Count**
Cucumber + Ginger	3.5×10^6	7.2×10^4	4.3×10^3	2.8×10^5
Cucumber + Garlic	7.3×10^6	6.5×10^4	3.2×10^3	3.3×10^5
Cucumber + Ginger + Garlic	2.4×10^6	4.3×10^4	2.1×10^3	7.1×10^4
Cucumber + Benzoate	4.9×10^6	6.7×10^4	2.5×10^3	5.1×10^4
Cucumber Juice Alone	2.1×10^7	5.9×10^5	3.6×10^4	4.6×10^5

Legends; TVC- Total viable count, TFC-Total fungi count, TCC-Total coliform count

Table 5 shows the microbial counts cucumber juice (Day 6) at Refrigerated temperature, Total viable count for all the samples ranges from1.4×10^6 to 9.9×10^6cfu/ml, Total fungi count for all the samples ranges from 2.9×10^4 to 3.7×10^5cfu/ml, Total coliform count ranges from$1.6 \times 10^{2\ \text{to}}$ 4.3×10^3 cfu/ml, Staph count ranges from 2.9×10^4 to 3.2×10^5cfu/ml

Table 5 Microbial Count for Refrigerated Cucumber Juice (Day 6)

Sample	TVC	TFC	TCC	Staph Count
Cucumber + Ginger	2.2×10^6	4.7×10^4	2.3×10^2	1.6×10^5
Cucumber + Garlic	6.3×10^6	3.9×10^4	1.8×10^2	1.7×10^5
Cucumber + Ginger + Garlic	1.4×10^6	2.9×10^4	1.6×10^2	3.8×10^4
Cucumber + Benzoate	2.9×10^6	4.8×10^4	1.9×10^3	2.9×10^4
Cucumber Juice Alone	9.9×10^6	3.7×10^5	4.3×10^3	3.2×10^5

Legends; TVC- Total viable count, TFC-Total fungi count, TCC-Total coliform count

Table 6 shows the microbial counts carrot juice (Day 6) at Ambient temperature, Total viable count for all the samples ranges from2.4×10^6 to 3.0×10^7cfu/ml, Total fungi count for all the samples ranges from 2×10^4 to 5×10^5cfu/ml, Total coliform count ranges from0 ^{to} 4.1×10^3 cfu/ml, Staph count ranges from 7.4×10^4 to 6.2×10^5cfu/ml

Table 6 Microbial Count for Carrot Juice (Day 3) at Ambient Temperature

Sample	TVC	TFC	TC	Staph Count
Carrot + Ginger	2.4×10^6	3.7×10^4	2.7×10^3	2.6×10^5
Carrot + Garlic	3.5×10^6	2×10^4	2.6×10^3	7.4×10^4
Carrot+Ginger + Garlic	6.1×10^5	3.2×10^4	2.2×10^3	9.6×10^4
Carrot + Benzoate	6.0×10^5	4.6×10^4	0	5.6×10^4
Carrot Juice Alone	3.0×10^7	5×10^5	4.1×10^3	6.2×10^5

Legends; TVC- Total viable count, TFC-Total fungi count, TCC-Total coliform count

Table 7 shows the microbial counts carrot juice (Day 3) at Refrigerated temperature, Total viable count for all the samples ranges from4.8×10^5 to1.8×10^7cfu/ml, Total fungi count for all the samples ranges from 1.4×10^4 to 4.2×10^5cfu/ml, Total coliform count ranges from0 ^{to} 2.1×10^5 cfu/ml, Staph count ranges from 5.1×10^4 to 5.3×10^5cfu/ml

Table 7 Microbial Count for Refrigerated Carrot Juice (Day 3)

Sample	TVC	TFC	TCC	Staph Count
Carrot + Ginger	1.7×10^6	3.4×10^4	2.1×10^2	1.7×10^5
Carrot + Garlic	2.4×10^6	1.4×10^4	1.9×10^2	6.1×10^4
Carrot+Ginger + Garlic	4.9×10^5	2.7×10^4	1.8×10^2	8.2×10^4
Carrot + Benzoate	4.8×10^5	3.9×10^4	0	5.1×10^4
Carrot Juice Alone	1.8×10^7	4.2×10^5	1.6×10^4	5.3×10^5

Legends; TVC- Total viable count, TFC-Total fungi count, TCC-Total coliform count

Table 8 shows the microbial counts carrot juice (Day 6) at ambient temperature, Total viable count for all the samples ranges from4.6×10^6 to5.1×10^7cfu/ml, Total fungi count for all the samples ranges from 2.4×10^4 to 7.1×10^5cfu/ml, Total coliform count ranges from0 ^{to} 4.4×10^4 cfu/ml, Staph count ranges from 5.4×10^4 to 8.3×10^5cfu/ml.

Table 8 Microbial Count for Carrot Juice (Day 6) at Ambient Temperature

Sample	TVC	TFC	TCC	Staph Count
Carrot + Ginger	4.6×10^6	5.8×10^4	2.8×10^4	4.8×10^5
Carrot + Garlic	5.7×10^6	4.3×10^4	3.7×10^4	8.7×10^4
Carrot+Ginger + Garlic	8.1×10^5	5.3×10^4	2.0×10^4	5.4×10^4
Carrot + Benzoate	8.4×10^5	2.7×10^4	0	7.5×10^4
Carrot Juice Alone	5.1×10^7	7.1×10^5	4.4×10^4	8.3×10^5

Legends; TVC- Total viable count, TFC-Total fungi count, TCC-Total coliform count

Table 9 shows the microbial counts carrot juice (Day 6) at Refrigerated temperature, Total viable count for all the samples ranges from2.8×10^6 to2.7×10^7cfu/ml, Total fungi count for all the samples ranges from 2.5×10^4 to 5.3×10^5cfu/ml, Total coliform count ranges from0 ^{to} 4.3×10^4 cfu/ml, Staph count ranges from 6.2×10^4 to 6.4×10^5cfu/ml

Table 9 Microbial Count for Refrigerated Carrot Juice (Day 6)

Sample	TVC	TF	TCC	Staph
Carrot + Ginger	2.8×10^6	4.5×10^4	3.3×10^3	2.8×10^5
Carrot + Garlic	3.6×10^6	2.5×10^4	2.8×10^3	7.4×10^4
Carrot+Ginger + Garlic	5.8×10^5	3.8×10^4	4.3×10^3	9.1×10^4
Carrot + Benzoate	5.6×10^5	5.0×10^4	0	6.2×10^4
Carrot Juice Alone	2.7×10^7	5.3×10^5	2.7×10^4	6.4×10^5

Legends; TVC- Total viable count, TFC-Total fungi count, TCC-Total coliform count

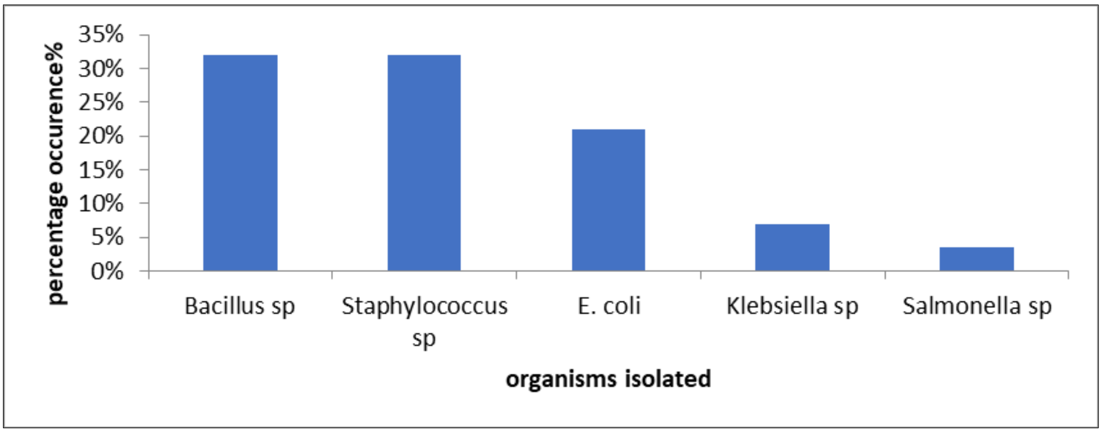

Figure 1 Percentage of Occurrence of Bacteria from Cucumber and Carrot Juices

Fig 1 shows the percentage of occurrence of bacteria from cucumber and carrot juices, *Bacillus* and *Staphylococcus spp* had the highest occurrence while Salmonella *sp* had the least occurrence.

3.3. Physicochemical analysis

The physicochemical analysis are shown in Tables 10 and 11. For Cucumber juice, Fresh Juice had a pH of 7.5, Vitamin C Content of 2.8 mg/dl, Total Solids of 645.3 mg/L, electrical conductivity of 1002 us/cm, total dissolved solids of 641.3 mg/L and total soluble solids of 0.04 mg/L.For Carrot juice, Fresh Juice had a pH of 6.6, Vitamin C Content of 5.8 mg/dl, Total Solids of 716.2 mg/L, electrical conductivity of 1116 us/cm, total dissolved solids of 714.2 mg/L and total soluble solids of 0.02 mg/L.

Table 10 Physicochemical Test Results for Cucumber Juice

Day	Samples	pH	Vitamin C (mg/dl)	Total Solids (mg/L)	Electrical Conductivity (us/cm)	Total Dissolved Solids (mg/L)	Total Soluble Solids (mg/L)
0	Fresh Juice	6.5	2.8	645.3	1002	641.3	0.04
3	Fresh Juice	6.9	2.1	720.7	987	718.7	0.06
	Juice + Ginger	6.4	2.0	733.4	1113	723.4	0.03
	Juice + Garlic	6.7	2.0	725.9	976	703.7	0.03
	J + Ging + Gar	6.7	2.1	729.8	1080	715.3	0.03
	Juice + Benzoate	6.6	2.0	727.1	982	711.6	0.03
6	Fresh Juice	6.1	1.6	725.4	976	730.9	0.08
	Juice + Ginger	6.6	1.4	738.8	1109	735.4	0.06
	Juice + Garlic	6.9	1.2	730.4	964	715.2	0.05
	J + Ging + Gar	6.8	1.5	734.5	1068	725.7	0.06
	Juice + Benzoate	6.9	1.3	732.9	971	721.9	0.06

Table 11 Physicochemical Test Results for Carrot Juice

Day	Sample	pH	Vitamin C (mg/dl)	Total Solids (mg/L)	Electrical Conductivity (us/cm)	Total Dissolved Solids (mg/L)	Total Soluble Solids (mg/L)
0	Fresh Juice	6.6	5.8	716.2	1116	714.2	0.02
3	Fresh Juice	6.9	5.4	718.4	1109	720.8	0.02
	Juice + Ginger	7.2	5.4	702.8	1095	700.8	0.02
	Juice + Garlic	6.6	5.3	896.0	895.0	572.8	0.01
	J + Ging + Gar	5.8	5.3	722.3	1127	721.3	0.01
	Juice + Benzoate	6.1	5.4	727.0	1125	720.0	0.07
6	Fresh Juice	6.2	5.0	723.8	1008	731.2	0.03
	Juice + Ginger	6.5	5.0	708.7	990	713.4	0.03
	Juice + Garlic	6.8	4.9	901.2	797	585.8	0.02

	J + Ging + Gar	6.1	5.1	727.8	1014	715.7	0.02
	Juice + Benzoate	6.4	5.0	732.2	1034	734.9	0.09

3.4. Sensory Quality of Cucumber and Carrot Juices Stored at different storage temperature.

The sensory quality results for refrigerated and room temperature stored fruit juices are shown in the tables 12-15.

Table 12 Sensory Quality of Cucumber Juices at ambient temperature

Days	Attributes	Fresh Juice	Juice + Ginger	Juice + Garlic	Juice + Ginger + Garlic	Juice + Benzoate
0	Taste	8	9	7	7	7
	Colour	8	7	7	7	7
	Aroma	8	9	9	9	7
3	Taste	6	8	6	7	6.5
	Colour	6	6	6	7	6.5
	Aroma	6	8	8	7	6.5
6	Taste	2	5	5	6	6
	Colour	2	4	5	6	6
	Aroma	2	5	5	6	6

Table 13 Sensory Quality of Cucumber Juices stored at refrigerated temperature

Days	Attributes	Fresh Juice	Juice + Ginger	Juice + Garlic	Juice + Ginger + Garlic	Juice + Benzoate
0	Taste	9	9.5	8.5	9	8
	Colour	8	7	7	7	8
	Aroma	8	9	9	9	8
3	Taste	8	9	8	8.5	7
	Colour	7	6.5	6	6.5	7
	Aroma	7	8.5	8	7	7.5
6	Taste	6	8	7	8	6.5
	Colour	5	6	5	6	6.5
	Aroma	5	8	7	6	6

Table 14 Sensory Quality of Carrot Juices stored at ambient temperature

Days	Attributes	Fresh Juice	Juice + Ginger	Juice + Garlic	Juice + Ginger + Garlic	Juice + Benzoate
0	Taste	6	7	6	7	5
	Colour	6	6	6	6	6
	Aroma	6	7	7	7	6
3	Taste	4	5	5	5	4.5

	Colour	4	5	4	5	5.5
	Aroma	4	5	5	5	5.5
6	Taste	1	4	4	5	5.5
	Colour	1	4	3	3	5.5
	Aroma	1	4	4	4	5.5

Table 15 Sensory Quality of Carrot Juices stored at refrigerated temperature

Days	Attributes	Fresh Juice	Juice + Ginger	Juice + Garlic	Juice + Ginger + Garlic	Juice + Benzoate
0	Taste	7	8	8	8.5	7.5
	Colour	7	6	6	6	6
	Aroma	7	8	8	8.5	6
3	Taste	6	7	7	7.5	7
	Colour	6	6	6	6	6
	Aroma	6	7	7	7	6
6	Taste	5	6	6	6	6.5
	Colour	5	5	5	5	6
	Aroma	5	6	6	6	6

4. Discussion

4.1. Microbial Quality of Fruit Juices During Storage

Juice is a liquid that is found naturally in fruits. It is usually consumed as a beverage or as a food component or flavoring. It is also ingested because of its alleged health benefits. The study looked at the microbial and physicochemical quality, as well as the effect of four different treatments (ginger, garlic, garlic+ ginger, and sodium benzoate) on the sensory parameters of cucumber and carrot juice stored at room temperature (23^{o}C) and refrigerating temperature (4^{o}C). The effects of various treatments were studied in order to extend the shelf-life of cucumber and carrot juice. Temperature, pH, chemical makeup, and microbial load all have an impact on fruit bio deterioration. The effect of various treatments and temperatures on the microbiological load of carrot and cucumber juice throughout the period of storage is shown in Table2-9.

Preservatives aid to minimize bacterial load in all juice sample treatments held at 4^{o} C and ambient temperature 28^{o} C. Sodium benzoate showed the highest reduction in carrot juice and Ginger/garlic treatment showed the highest reduction in cucumber juice. Fruit juice contamination is caused by a number of factors. Most fruits have a high bacterial population, and inappropriate treatment can introduce bacterial and microorganisms into the juice, resulting in contamination. Fruit juices that have been properly pasteurized are typically considered safe and are only rarely involved with foodborne disease outbreaks. Weak acid preservatives (citric acid, benzoic acid, sulfur dioxide, or their combination) are commonly used to reduce the usage of heat. Furthermore, to limit spoilage microorganism that survive pasteurization, cooling at 5oC or lower is required. Cucumber juice deteriorated during a prolonged period of storage without preservatives. The combination of ginger and garlic had the greatest preservation effect in cucumber juice, while garlic alone had the least. Antimicrobial activity of ginger and garlic against gram positive and gram negative bacteria has been demonstrated (Olaniran et al., 2015). So, while the combination of these two natural preservatives had a synergistic preservation effect, the synthetic sodium benzoate preservative was more efficient in extending the shelf-life of the fruit juice.

The high contamination of cucumber and carrot juices could be attributed in part to their high pH levels, which favored microbial development. Poonam (2013) discovered that high pH combined with high ambient temperatures (> 28°C) appeared to favor bacterial growth and shorten juice shelf life. Yigeremu et al. (2001) and Mesfin (2011) observed similar findings. As a result, the quality of fresh juice is mostly determined by cautious fruit handling and proper processing hygiene. Steven and Davis (2001) investigated microorganism transfer rates during the juice extraction process and discovered that around 1.7 - 2.6% of total aerobic organisms and 2.3 - 2.6% of aciduric organisms from washed fruits were introduced into the fresh juice. Contamination may occur by spoilage organisms and/or by food borne pathogens. This is line with another studies Sandeep *et al*., (2001) Ahmed *et al.,* (2009), Sharma (2013) and Olorunjuwon *et al*., (2014). The organisms isolated from both cucumber and carrot juices include *Staphylococcus sp*, *Bacillus sp*, *E. coli*, *Klebsiella sp* and *Salmonella sp*. *Bacillus* and *Staphylococcus* had the highest frequency of occurrence of 32%, and *Salmonella sp* had the least occurrence of 2% as shown in Fig1 . The presence of *E. coli, Salmonella*, and *S.aureus* in fruit juices is primarily concern because these pathogens were implicated in a number of outbreaks associated with fruit juices Raybaudi-Massilia etal.,(2009). The observation of these organisms in fruit juices examined goes to confirm that bacteria was associated with fruit juice spoilage in Nigeria as well as other parts of the world. Frazier and Westhoff 1986*. Staphylococcus* species present may have been introduced during processing, since the organism is among normal flora of skin, mouth and upper nasopharyngeal cavity. Fox and Cameroon (1989). *Bacillus* species are spore formers whose spores could survive high temperatures of processing Essien et al., (2011). Escherichia coli and other coliform bacteria could be present because food workers didn't wash their hands enough or because good manufacturing practices weren't followed. They are the indicators of hygienic conditions. Coliforms in fruit juices are prohibited by the safe food consumption standard. Andres et al. , (2004) .

. The fungal isolates identified from this study include *Penicillium spp*(30%), *Aspergillus spp*(35%). and *Saccharomyces spp*(35%). This result is accordance to the work reporting the presence of *Aspergillus spp., Rhizopus spp*. and *Saccharomyces spp*. in fruit juices sold in Nigeria. Braide et al., (2012) also reported the presence of *Saccaharomyces cerevisiae*, *Saccharomyces cerevisiae var ellipsoides, Penicillium casecolium, Penicillium notatum and Rhizopus stolonifer* in packaged fruit juices sold in Onitsha, Nigeria. The presence of yeast and molds in many of the juices suggest that handling of the fruits and extraction of the juice's methods may fall short of acceptable standards. Al-jedah and Robinson (2002). The isolation of *Penicillium spp.* and *Aspergillus spp*. gives serious cause for concern because these species are specially known to produce mycotoxins Adams and Moss (1995). The presence of Saccharomyces spp. is expected due to its preference for sugar which highly favour yeast proliferation. Adams and Moss (1995)

4.2. Variation in pH of fruit juices during storage

The pH of fruit juice is a negative function of the juice's inherent acidity, therefore when pH rises during storage, the acidity of the juice also decreases (Rehman et al., 2014). Rehman et al. (2014) suggested that the acid hydrolysis of the poly-saccharides into mono- and di-saccharides, which are responsible for increasing sweetness and decreasing sourness, may be the cause of the pH increase with prolonged storage of juice (Dhaka etal., 2016). The results of present investigation are in line with the findings of Alaka et al. (2003). The acidity of juice is also influenced by preservatives added and storage condition. pH ranges from 7.4-8.1 for cucumber juice and pH of 5.8-7.5 for carrot juice respectively as shown in tables 10 and 11. Low pH generally tends to inhibit bacterial growth in fresh unpasteurized fruit juices (Nwachukwu and Ezeigbo, 2013), allowing acid-tolerant pathogenic bacteria including *Salmonella* spp, *Staphylococcus aureus, and Listeria monocytogenes* to survive in the juice(Alonzo,2009). Because they could control their internal pH at neutral pH using active and passive homeostasis, pathogens were able to survive in the acidic environment of juices (Aneja et al., 2014). According to Aneja et al. (2014), enteric bacteria cause enzymes that increase internal pH and activate enzymes involved in the maintenance and repair of proteins and DNA. The bacteria' adaptive capabilities allow them to multiply, which can deplete nutrients and lead to the formation of spores and toxic compounds. High numbers may likely result in the accumulation of metabolic by-products that degrade and contaminate the juices, decreasing their storage stability.

4.3. Vitamin C Variation in Fruit Juices During Storage

All consumables degrade ascorbic acid during storage, and this can happen both aerobically and anaerobically. Although aerobic degradation happens 100–1000 times more quickly than anaerobic degradation. Given that vitamin C is heat- and light-sensitive and that its concentration follows first order kinetics, storage duration has an impact on the vitamin's content (Heldman and Singh, 1981). Blasco et al., (2004) had also reported two different degradation pathways of vitamin C during storage. Vitamin C Content ranges from 1.2- 2.8 mg/dl for Cucumber and 4.5-5.8 for carrot juice respectively as shown in tables 10 and 11. Temperature, pH, sunshine, and the presence of metals like copper and iron all have an impact on the stability of ascorbic acid in consumables Bhargawa et al.,(2014). Ascorbic acid retention in food components is thus more impacted by storage conditions. Ascorbic acid is oxidized to dehydroascorbic acid in the presence of light and warmth, resulting in a considerable loss in drinks and nectars (Ahmed et al., 2008; Kalra and Tondon, (1984). Cucumber juice in this study followed a similar trend to that seen in Ahmed et al.'s (2008) study on the storage quality of citrus juice, which found that ascorbic acid concentrations fell considerably at all storage intervals and depended on processing techniques, storage time, and light exposure. Since ascorbic acid is extremely thermally sensitive, storage temperature is one of the major contributing factors to ascorbic acid degradation during storage. Vikram et al. (2005) noted that the degradation occurred quick at higher temperatures. According to Torregrosa et al. (2006), the ascorbic acid degradation rate in cucumber and carrot juice stored at room temperature was lower than that of juice stored under refrigeration. Torregrosa et al., (2006)

4.4. Total Soluble Solid variation in fruit juices during storage

Increasing TSS values during juice storage have been reported under all storage conditions possibly related to the continued increase in polysaccharide and acid hydrolysis. Bhardwaj (2013) proposed to gradually increase the storage time depending on the increase in TSS, which may be due to more hydrolysis of polysaccharides. However, this increase in TSS is a function of storage temperature and a direct relationship has been reported between TSS increase and storage temperature. This can be correlated with lower rates of hydrolysis of sugars, polysaccharides and organic acids at low temperatures according to La Chatelier's chemical reaction principle. TSS ranges from 0.03-0.08 mg/dl for Cucumber and 0.01-0.09 mg/dl for carrot juice respectively as shown in tables 10 and 11.

4.5. Electrical Conductivity Variation in Fruit Juices During Storage

Electrical conductivity ranges from 9.64- 1113 us/cm for Cucumber and 797-1116 us/cm for carrot juice respectively as shown in tables 10 and 11. This may be due to the systematic release of mineral elements or other types of ions in the juice through decomposition reactions involving carbohydrates, vitamins and proteins (Abid et al., 2014).

4.6. Total Solid Variation in Fruit Juices During Storage

The Total solid was high in the cucumber and carrot juice which is in agreement with the work reported by Ijah et al. (2015) . Total Solid ranges from 645.3 - 733mg/L for Cucumber and702.8 – 901mg/L for carrot. The high amount of total solids in carrots and cucumbers can also be due to the conversion of polysaccharides and other juice components. Total solids and juice content are used to describe the quality of juices and other beverages (Adubofuor et al., 2010).

4.7. Total Dissolved Solid Variation In Fruit Juices During Storage

The total sugar of the fruit increases due to the hydrolysis of the starch content into simple sugars. If the sugar content predominates over its acid content, the flavor emerges as sweet. Total soluble solids contribute to the increased sugar content of the fruit during ripening. Abu-Bakr et al., 2017). The conversion of carbohydrates or starches to sugars, organic acids, fats, phenolic compounds and folate contributes to the total soluble solids during storage. Sikora and Świeca 2018. Total Dissolved Solid ranges from 641.3 -735 for cucumber 572.8-734.9 for carrot juice in this study.

4.8. Sensory Quality for Refrigerated and Ambient Temperature Stored Fruit Juices.

The results from tables 12-15 showed the sensory quality results for refrigerated and ambient temperature stored fruit juices. The taste, colour and aroma of fresh cucumber juice at ambient temperature was 8, 8 and 8 respectively; juice + ginger was 9, 7 and 9 respectively, juice + garlic was 7, 7 and 9 respectively; Juice + ginger and garlic was 7, 7 and 9 respectively and sodium benzoate was 7, 7 and seven respectively. The taste, colour and aroma of refrigerated fresh cucumber juice was 9, 8, 8 respectively; juice + ginger was 9.5, 7 and 9 respectively, juice + garlic was 8.5, 7 and 9 respectively; Juice + ginger and garlic was 9, 7 and 9 respectively and sodium benzoate was 8, 8, 8 respectively. The taste, colour and aroma of fresh carrot juice at room temperature was 6, 6, 6 respectively; juice + ginger was 7, 6, 7 respectively, juice + garlic was 6, 6, 7 respectively; Juice + ginger and garlic was 7, 6, 9 respectively and sodium benzoate was 5, 6, 5 respectively. The taste, colour and aroma of refrigerated fresh carrot juice was 7, 7, 7 respectively; juice + ginger was 8, 6, 8 respectively, juice + garlic was 8, 6, 8 respectively; Juice + ginger and garlic was 8.5, 6, 8.5 respectively and sodium benzoate was 7.5, 6, 6 respectively. The sensory quality of both juices deteriorated with a longer time of storage but refrigeration preserved sensory quality more than storage at ambient temperature.

5. Conclusion

This study shows that microbial spoilage occurs with longer storage, but refrigeration slows down the spoilage of the juice. In addition, synthetic preservatives such as sodium benzoate have been shown to be effective in carrot juice, while natural preservatives such as ginger and garlic combined can slow down the spoilage of juice. In addition, the organoleptic quality of the juice decreases with longer storage, but refrigeration improves organoleptic quality.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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