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COMPARATIVE ASSESSMENT OF STORAGE STABILITY OF GINGER-GARLIC AND CHEMICAL PRESERVATION ON FRUIT JUICE BLENDS

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ABSTRACT

The study aimed at reduction of wastage of fruit, encourage production, consumption and preservation of fruit juice blends using garlic ginger filtrate with health benefits as biopreservative thus providing alternatives with biological advantage over chemical preservatives (ascorbic and benzoate acids) without altering the organoleptic and physicochemical properties of fruit juice blends. The study evaluated the potential of natural preservatives (ginger, garlic and ginger-garlic filtrates) in comparison with two conventional chemical preservatives (ascorbic and benzoate acids) for fruit juice blends preservation. The juice blend used was cashew, pineapple and watermelon. In terms of flavor and mouth feel, the order of preference of the juice were the preserved with 1% garlic-ginger > 1% ginger > 1% garlic > 1% ascorbic acid > and preserved with 1% sodium benzoate at ambient temperature. Maximum decrease in pH was observed in the juice sample that had no added preservative. Generally, all the fruit blends (preserved and unpreserved), with the exception of the one preserve with 1% ginger-garlic showed growth of bacteria after one week of storage. Juice blends preserved with the 1% ginger-garlic were most acceptable compared to other preservatives. The synergistic biopreservative ability observed with the ginger-garlic may be a preferable alternative to conventional preservatives.

Keywords: juice blends; ginger; garlic; stability; preservatives

INTRODUCTION

Juices are the extractable fluid contents of cells or tissues intended for direct consumption obtained by the mechanical process from sound, ripe fruits **(Naz, 2018)**. They are non-alcoholic liquid products with diverse degree of clarity and viscosity **(Sádecká et al., 2014)**. Fruit juices are rich in lycopene, ascorbic acid and citrulline that have been reported to have protection against cancer and cardiovascular disorders. The functionality of fruit juices have been attributed to their antioxidative properties **(Okwori et al., 2017)**. Water melon is a common staple fruit in the world consumed as a dessert, fruit salad or used fo garnishing drinks **(Mohammad, 2016)**. Cashew is a hard, drought-resistant, tropical tree, widely grown primarily for its nuts. Cashew apple, the pseudo-fruit, is fibrous, juicy and weighs approximately 8 times of the nut **(Afolayan et al., 2016)**. Much (90%) of the harvest is wasted after harvesting **(Igbinadolor et al., 2017)**. Because, cashew apple has a characteristic astringent taste with biting sensation on the tongue and throat, blending it with other fruits may lessen its astringency **(Rebouças et al., 2016)**. Raw pineapple juice is an excellent source of calcium, magnesium and manganese; however, pineapple mostly consumed around the world as canned products **(Kaddumukasa et al., 2017)**. The demand for pineapple and its juice rises continually most especially due to its health benefits **(Nwachukwu and Ezejiaku, 2014).** It is usually used for blend composition to obtain new flavors in drinks. Most juice if not refrigerated has a very short shelf life **(Okwori et al., 2017)**. Ginger is a spice with characteristic flavor due combination of zingerone, shogaols and gingerols and volatile oils. Fresh ginger is composed of 80.9% moisture, 23% protein, 0.9% fat, 1.2% minerals, 2.4% fibre and 12.3% carbohydrates **(Olaniran and Abiose, 2018)**. Ginger has antibacterial effect and exhibits antifungal activity and extended the shelf life for 8 weeks in tomato paste. Ginger powder has been compared with synthetic antimicrobial agents such as potassium sorbate and citric acid in smoked fish **(Oduah et al., 2015)**. Ginger is a commonly added to beverages for flavor. Garlic (*Allium sativum*) also regarded as Russian penicillin, stinky rose, *tafanuwa* in Hausa, *ayo-ishi* in Igbo and *ayu* in Yoruba **(Neeraj et al., 2014; Olaniran et al., 2019a)**. Garlic comprises of sulphur containing compounds, the fresh bulb contains allicin, alliin and volatile oil. Garlic has exhibited antibacterial activity against Gram positive and Gram-negative bacteria **(Olaniran et al., 2015)**. Fruit juice blends produced from different fruits combines basic nutrients present in these different fruits to provide a better quality juice nutritionally and organoleptically **(Eke-Ejiofor, 2016)**. The inhibition of microbial growth and activity of microorganisms is one of the main purposes of the use of chemical preservatives such as benzoic, sorbic, lactic and acetic acid **(Piper, 2018)**. Benzoic acid has been used in different forms as preservative in foods because of its established antimicrobial properties against yeasts and molds. They can denature protein, inhibit enzymes and alter or destroy the cell walls or cell membranes **(Reut et al., 2004)**. Current reduction in consumption of chemically preserved foods is due to consumer's awareness of the health implication of consumption of synthetic preservatives **(Pongsavee, 2015)**. Replacing chemicals with natural preservatives (bio-preservatives) which have no side effects to the consumer is of interest. To provide alternatives with biological advantage over chemical preservatives without altering the organoleptic and physicochemical properties of fruit juice blends, the need to explore natural preservatives has been highlighted recently in scientific literature. In this regard therefore, the current study aimed to apply ginger-garlic mix; exploring their effectiveness as preservatives and assessing organoleptic acceptability of the new combination in fruit juice blends using cashew, pineapple and watermelon fruit for the storage study.

Scientific hypothesis

Biopreservatives are as effective as chemical preservatives in the preservation of fruit blends. The presence of biopreservatives in fruit blends can improved their organoleptic properties, when compare to chemical preservatives.

MATERIAL AND METHODOLOGY

Preparation of preservative filtrates

Garlic, ginger and ginger-garlic filtrates were used as preservatives in this study. For preparation of the filtrates, fresh ginger rhizomes and garlic cloves obtained from a local market in Kwara State, Nigeria. Prior to use, they were washed under running water, peeled and diced into cubes separately. The respective diced cubes (100 g) were blended with 100 mL of distilled water using a grinder (Marlex Appliances PVT, Mumbai, India) for 5 min and allowed to stay for 30 min. The suspensions were then filtered and the filtrates were poured into labelled clean bottles. Garlic-ginger mix was obtained by mixing equal volume of garlic and ginger filterate and homogenized for 60 s **(Olaniran et al., 2019b)**.

The preservatives used were 1% ginger filtrate, 1% garlic filtrate, 1% ginger-garlic, 1% ascorbic acid and 1% sodium benzoate**.**

Preparation of the juice blend

For preparation of the juice blend, pineapple, watermelon and cashew fruits were used. Three kilograms of each of the fresh, ripe fruits were respectively washed under running water, drained in colanders, peeled and diced into cubes. Each juice of the edible parts of the respective fruits was extracted separately using juice extractor (Imarflex IM-3180, Quezon City, Philippines).

Following extraction, the cashew, pineapple and watermelon (CPW) juice were mixed in ratio of 10:50:40 (v/v) respectively to obtain the blends which was homogenized for 10 sec. A glass jar of CPW juice, containing no preservative was maintained as positive control. Five other separate jars were engaged with five different pretreatments.

Sensory analysis

To estimate consumers' acceptability, the following sensory attributes were investigated: aroma, color, flavor, sweetness, mouth feel and overall impression. A nine-point structured hedonic scale test (9 = "extremely like"; 5 = "neither like nor dislike"; 1 = "extremely dislike") was used for the assessment of overall acceptance of the freshly prepared juice blend, with and without the respective preservatives.

For investigation, the samples were served in a sequential manner in cups containing 25 mL of the respective juice treatments and codified with three random digits. The sensory evaluation was conducted with 45 panelists (25 females and 20 males) comprising of students and staff of a university and aged between 18 and 50 years. The inclusion criteria in being selected as a panelist on condition of regular consumption of the juice blend. Approval was granted by the University research ethics boards (LUAC-0046B).

Determination of physical characteristics

pH was determined using a pH meter (Jenway model 6505). Before use, the pH meter was calibrated using standard buffers of 7.0, 4.0 and 9.2. After calibration, pH readings were read and documented only when equilibrium pH was reached.

Titratable acidity and specific gravity were determined as described in **AOAC (2010)**. For determination of total soluble solids, a refractometer (Hanna HI 96801) was used. Values were measured in % Brix as described elsewhere **(Makebe et al., 2017)**.

Microbiological enumeration

During the storage period, microbial analysis was carried out on a weekly basis for 5 weeks, using nutrient agar (Oxoid limited, UK), De Man, Rogosa and Sharpe agar for enumeration of lactic acid bacteria incubated at 37 °C for total bacterial and lactic acid bacteria count for 24 and 72 hours respectively and potato dextrose agar incubated at 28 °C for 3 days, for estimation of fungal count, using the standard pour-plating method **(APHA, 2015)**.

Statistical analysis

All data from sensory evaluation, variation in pH, titratable acidity, specific gravity and total soluble solid of the juice blend containing different preservatives during storage were analysed using analysis of variance (ANOVA) and differences in mean values were assessed using Duncan's multiple range test. A value of p <0.05 was used to indicate statistical significance. Using Microsoft Excel (Microsoft Corporation, Redmond, WA, USA) means of the replicates were all calculated and separated.

RESULTS AND DISCUSSION

All samples were acceptable in terms of color, taste, flavor and texture. In terms of flavor and mouth feel, the order of preference of the juice were the preserved with 1% garlic-ginger > preserved with 1% ginger > preserved with 1% garlic > preserved with 1% ascorbic acid > and preserved with 1% sodium benzoate at ambient temperature of blends. Addition of preservatives enhanced the colour of the juice blends with the preserved with 1% ginger-garlic having the highest mean score of 8.88. There was no significant difference (p <0.05) in the sweetness of all the juice blends and the scores were in-between 8.77 to 8.94. Combination of ginger and garlic significantly (p <0.05) improved the mouth feel of the juice blends. In terms of overall impression, the most acceptable juice blend was the one preserved with 1% ginger-garlic (Table 1). In this the study all the juice blends that was garlic-ginger preserved was most acceptable and preferred. This observation may be due tempering of the pungent taste of garlic with pleasant scent of ginger resulting from mixing of equal volume of garlic and ginger filtrates. A similar observation has been reported by **Mancini et al. (2019)**. The least preference for the garlic preserved juice blend, as observed in this study may be due to the strong pungent taste of garlic compared to that of those with ginger due to its pleasant **(Mancini et al., 2019)**. In a study on the preservation of soymilk, **Borode (2017)** however reported low preference for garlic preserved soymilk.

In all the juice samples, pH was observed to show consistent decreases with period of storage. Maximum decrease in pH was observed in the juice sample that had no added preservative. At end of the five weeks storage period, pH decreases of 31.6, 25.1, 30.8, 30.9, 20.7 and 25.1% were observed in the juice samples without preservative, preserved with 1% ginger, 1% garlic, 1% garlic-ginger, 1% ascorbic acid and 1% sodium benzoate, respectively
(Table 2).

For the titratable acidity, consistent increases were observed in the juice sample throughout the period of storage. Increases of 90.9, 133, 240, 35.7, 200 and 80% were observed in juice samples the juice samples without preservative, preserved with 1% ginger, 1% garlic, 1% garlic-ginger, 1% ascorbic acid and 1% sodium benzoate, respectively (Table 3). The consistent decrease in pH with period of storage as reported in this study is indicated to be vital to retaining the quality of tartness to the product. Decrease in pH with period of storage has been also been reported by previous investigators **(Kaddumukasa et al., 2017; Olaniran et al., 2019b)**. It is opined that that low pH could enhance the stability of bioactive compounds during storage, thus extending shelf life **(Chia et al., 2012)**.

In the case of specific gravity, increases were observed at the end of the five weeks period of storage. However, only minute increases of 8.4, 4.5 and 6.0 were observed were observed in juice samples preserved with, preserved with 1% ginger, 1 % garlic and 1 % garlic-ginger, respectively. Remarkable increase of 44.7% in specific gravity was observed in the unpreserved juice sample (Table 4). The total soluble solids in the preserved juice blends were observed to show consistent decreases with time. This observation was irrespective of the preservative used. Highest increase (12.1%) in total solids was however observed in the unpreserved juice blend at the end of the five weeks storage period. At the end of storage, increases in total soluble solids of 6.3, 3.6, 5.5, 10.5 and 9.4% were observed for juice blends that were preserved with 1% ginger, 1% garlic, 1% garlic-ginger, 1% ascorbic acid and 1% sodium benzoate, respectively (Table 5). The stability documented in the study in the values of total soluble solids and specific gravity of preserved juice blends for weeks might be due to the presence of garlic, ginger, garlic-ginger filtrates, sodium benzoate and ascorbic acid added as preservatives. The preservatives slowed down the rate of fermentation of sugars present in the juices blends to water, carbon dioxide and ethyl alcohol at room temperature during storage **(Kaddumukasa et al., 2017)**. In this study, the concentration of total soluble solid in the juice blends showed consistent increases with period of storage. Increase in soluble solids is an indicator of the rate of deterioration. The minimal increase soluble solid level observed in the preserved juice during storage could be due to decrease in the rate of conversion of organic acid to sugar thus increasing the shelf life of the juice. Similar observations have been reported by earlier researchers in related studies **(Samad et al., 2019; Rapisarda et al., 2008)**. Generally, all the fruit blends (preserved and unpreserved), with the exception of the one preserve with 1% ginger-garlic showed growth of bacteria after one week of storage. Growth was only observed in the 1% ginger-garlic preserved juice from the third week of storage. At the end of the 5-week storage period, the bacterial count in the unpreserved juice was however remarkably higher than those of the preserved samples. The growth of lactic acid bacteria was observed in all the juice samples throughout the period of storage, except the 1% garlic and 1% ginger-garlic preserved samples where growth was observed only after 2 and 3 weeks of storage, respectively. For the total fungal counts, no growth was observed for the ginger-garlic preserved juice until after 5 weeks of storage. The 1% ginger and 1% garlic preserved juice showed growth after 2 weeks and 3 weeks of storage, respectively (Table 6). Combining the garlic-ginger as preservative in the study was the most effective during storage as microbial growth was greatly inhibited. This could be as result of a synergistic effect of ginger and garlic **(Juan et al., 2017)**. It is opined that the major challenge in spoilage of fresh juice is the stability of the pH, natural microflora; chemical composition fruit juice **(Ephrema et al., 2018)**. From the results from the study, addition of 1% garlic-ginger as preservative was effective in reduction of the microbial load and other physicochemical parameters. This may be due to the presence of essential oil from garlic and ginger, which are reported to have health promoting bioactive components offering consumers health benefits **(Aneja et al., 2014; Baskaran et al., 2010)**. Thus, if 1% garlic-ginger is incorporated into industrial production of cashew apple, pineapple and water melon juice blends; it has better potential replacement for the chemical preservative during storage.

Table 1 Sensory Evaluation of freshly prepared Cashew, pineapple and watermelon blends.

Attributes	CPW	CPW-GIN	CPW-GAR	CPWGG2	CPW-ASC	CPW-SBZ
Sweetness	8.89 ±0.02[bc]	8.94 ±0.01[a]	8.82 ±0.04 [ab]	8.86 ±0.01 [a]	8.77 ±0.02[c]	8.86 ±0.03 [a]
Color	8.00 ±0.01[b]	8.64 ±0.04[aa]	8.22 ±0.02 [b]	8.88 ±0.01[a]	8.15±0.03 [b]	8.25 ±0.01[b]
Flavor	7.78 ±0.03[a]	7.75 ±0.01[a]	7.22 ±0.03[bc]	7.92 ±0.02[b]	7.33 ±0.01[a]	7.67 ±0.02[c]
Mouth feel	7.42 ±0.01[b]	7.44 ±0.02[b]	6.82 ±0.01[c]	8.33 ±0.01[a]	7.22 ±0.04[b]	5.82 ±0.01[d]
Overall impression	8.88 ±0.02[a]	8.84 ±0.03[a]	8.58 ±0.01[ab]	8.87 ±0.04[a]	8.66 ±0.01[ab]	8.56 ±0.04[ab]

Note: Values are means (n = 45) ± standard deviation. Means followed by different superscripts are significantly different (*p* <0.05) along column according to Duncan multiple range test: CPW, CPW-GIN, CPW-GAR, CPWGG2, CPW-ASC and CPW-SBZ represent juice that was unpreserved juice blend, preserved with 1% ginger, preserved with 1% garlic, preserved with 1% ginger-garlic, preserved with 1% ascorbic acid and preserved with 1% benzoate acid, respectively

Table 2 Variation in pH of the cashew, pineapple and water melon juice blends with the different preservatives during the period of storage.

Preservative type	Storage period (weeks)						% decrease
	0	1	2	3	4	5	
No added preservative	4.53 ±0.01[a]	4.53 ±0.02[a]	4.46 ±0.02[a]	3.10 ±0.01[c]	3.10 ±0.01[b]	3.10 ±0.01[b]	31.6
1% ginger	4.06 ±0.01[b]	3.61 ±0.03[d]	3.48 ±0.05[d]	3.14 ±0.01[c]	3.04 ±0.01c	3.04 ±0.01[c]	25.1
1% garlic	4.51 ±0.02[a]	4.38 ±0.01[b]	4.28 ±0.02[b]	3.42 ±0.01[a]	3.13 ±0.03[b]	3.12 ±0.01[b]	30.8
1% garlic – ginger	4.47 ±0.04[a]	4.43 ±0.01[ab]	3.59 ±0.02[d]	3.10 ±0.03[c]	3.09 ±0.02[b]	3.09 ±0.04[b]	30.9
1% ascorbic acid	4.06 ±0.01[b]	4.05 ±0.01[c]	4.02 ±0.02[c]	3.33 ±0.01[b]	3.28 ±0.01[a]	3.22 ±0.01[a]	20.7
1% Sodium benzoate	4.03 ±0.02[b]	4.02 ±0.04[c]	3.52 ±0.02[d]	3.06 ±0.04[c]	3.02 ±0.03[c]	3.02 ±0.01[c]	25.1

Note: Values are means (n = 3) ± standard deviation. Means followed by different superscripts are significantly different (*p* <0.05) along column according to Duncan multiple range test.

Table 3 Variation in titratable acidity of the cashew, pineapple and water melon juice blends with the different preservatives during the period of storage.

Preservative type	Storage period (weeks)						% increase
	0	1	2	3	4	5	
No added preservative	0.11 ±0.02[a]	0.17 ±0.01[a]	0.17 ±0.02[a]	0.19 ±0.01[a]	0.21 ±0.01[a]	0.21 ±0.01[a]	90.9
1% ginger	0.09 ±0.01[b]	0.09 ±0.01[c]	0.17 ±0.01[a]	0.17 ±0.03[a]	0.17 ±0.02[a]	0.21 ±0.00[a]	133
1% garlic	0.05 ±0.01[c]	0.09 ±0.02[c]	0.13 ±0.01[b]	0.13 ±0.01[b]	0.13 ±0.02[b]	0.17 ±0.01[b]	240
1% garlic – ginger	0.14 ±0.01[a]	0.14 ±0.00[b]	0.20 ±0.01[a]	0.20 ±0.01[a]	0.19 ±0.01[a]	0.19 ±0.01[a]	35.7
1% ascorbic acid	0.07 ±0.02[c]	0.12 ±0.01[b]	0.14 ±0.00[b]	0.18 ±0.02[a]	0.18 ±0.02[a]	0.21 ±0.01[a]	200
1% Sodium benzoate	0.10 ±0.02[a]	0.13 ±0.01[b]	0.18 ±0.01[a]	0.18 ±0.03[a]	0.18 ±0.01[a]	0.18 ±0.02[a]	80

Note: Values are means (n = 3) ± standard deviation. Means followed by different superscripts are significantly different (*p* <0.05) along column according to Duncan multiple range test.

Table 4 Variation in specific gravity of the cashew, pineapple and water melon juice blends with the different preservatives during the period of storage.

Preservative type	Storage period (weeks)						% increase
	0	1	2	3	4	5	
No added preservative	1.32 ±0.04[b]	1.38 ±0.01[c]	1.70 ±0.00[a]	1.75 ±0.00[a]	1.85 ±0.01[a]	1.91 ±0.00[a]	44.7
1% ginger	1.55 ±0.01[a]	1.57 ±0.01[a]	1.61 ±0.01[b]	1.63 ±0.01[b]	1.65 ±0.02[b]	1.68 ±0.02[b]	8.4
1% garlic	1.56 ±0.00[a]	1.57 ±0.00[a]	1.58 ±0.03[b]	1.61 ±0.03[b]	1.63 ±0.03[b]	1.63 ±0.02[b]	4.5
1% garlic-ginger	1.49 ±0.03[a]	1.51 ±0.04[a]	1.52 ±0.02[c]	1.54 ±0.02[c]	1.56 ±0.01[c]	1.58 ±0.05[b]	6.0
1% ascorbic acid	1.37 ±0.01[b]	1.37 ±0.02[c]	1.54 ±0.01[c]	1.57 ±0.02[b]	1.59 ±0.00[b]	1.62 ±0.03[b]	18.2
1% Sodium benzoate	1.34 ±0.02[b]	1.45 ±0.01[b]	1.55 ±0.00[c]	1.57 ±0.02[b]	1.57 ±0.02[b]	1.58 ±0.02[b]	17.9

Note: Values are means (n = 3) ± standard deviation. Means followed by different superscripts are significantly different (*p* <0.05) along column according to Duncan multiple range test.

Table 5 Variation in total soluble solids of the cashew, pineapple and water melon juice blends with the different preservatives during the period of storage.

Preservative type	Storage period (weeks)						% increase
	0	1	2	3	4	5	
No added preservative	5.79 ±0.00[c]	5.77 ±0.01[b]	5.60 ±0.01[c]	5.38 ±0.02[d]	5.28 ±0.02[d]	5.09 ±0.01[d]	12.1
1% ginger	5.90 ±0.05[a]	5.82 ±0.01[b]	5.60 ±0.03[c]	5.60 ±0.04[b]	5.53 ±0.01[b]	5.53 ±0.01[b]	6.3
1% garlic	5.82 ±0.01[b]	5.78 ±0.02[b]	5.72 ±0.00[b]	5.69 ±0.00[b]	5.67 ±0.02[a]	5.61 ±0.05[a]	3.6
1% garlic-ginger	5.98 ±0.01[a]	5.88 ±0.00[a]	5.78 ±0.03[a]	5.75 ±0.01[a]	5.66 ±0.02[a]	5.65 ±0.03[a]	5.5
1% ascorbic acid	5.81 ±0.02[b]	5.79 ±0.01[b]	5.65 ±0.01[c]	5.51 ±0.02[c]	5.60 ±0.04[a]	5.20 ±0.02[c]	10.5
1% Sodium benzoate	5.83 ±0.02[b]	5.80 ±0.01[b]	5.74 ±0.00[b]	5.71 ±0.02[a]	5.45 ±0.02[c]	5.28 ±0.01[c]	9.4

Note: Values are means (n = 3) ± standard deviation. Means followed by different superscripts are significantly different (p <0.05) along column according to Duncan multiple range test.

Table 6 Microbial Counts of the Fruit Juice during Storage.

Samples	Storage period (weeks)				
	1	2	3	4	5
Total bacterial count (colony-forming units.mL^{-1})					
Unpreserved	80×10^3	25×10^3	43×10^3	30×10^5	10×10^8
Preserved 1% ginger	12×10^3	20×10^3	24×10^3	10×10^4	15×10^5
Preserved with 1% garlic	11×10^3	18×10^3	17×10^3	29×10^3	11×10^4
Preserved with 1% ginger-garlic	Nil	Nil	12×10^3	20×10^3	35×10^3
Preserved with 1% ascorbic acid	12×10^3	22×10^3	39×10^3	24×10^3	75×10^5
Preserved with 1% sodium benzoate	12×10^3	25×10^3	43×10^3	84×10^4	90×10^5
Lactic acid bacterial count (colony-forming units.mL^{-1})					
Unpreserved	36×10^3	39×10^3	54×10^3	25×10^4	25×10^6
Preserved 1% ginger	24×10^2	38×10^2	51×10^2	45×10^3	65×10^3
Preserved with 1% garlic	Nil	21×10^2	29×10^2	33×10^2	40×10^3
Preserved with 1% ginger-garlic	Nil	Nil	12×10^2	16×10^2	52×10^2
Preserved with 1% ascorbic acid	60×10^2	58×10^2	40×10^3	56×10^3	46×10^4
Preserved with 1% sodium benzoate	34×10^2	60×10^2	39×10^3	47×10^3	15×10^4
Total fungal count (spore-forming units.mL^{-1})					
Unpreserved	14×10^3	29×10^3	40×10^3	25×10^5	34×10^6
Preserved 1% ginger	Nil	15×10^3	33×10^3	42×10^3	15×10^4
Preserved with 1% garlic	Nil	Nil	25×10^2	10×10^2	60×10^2
Preserved with 1% ginger-garlic	Nil	Nil	Nil	Nil	11×10^2
Preserved with 1% ascorbic acid	10×10^2	31×10^2	46×10^3	30×10^4	35×10^4
Preserved with 1% sodium benzoate	15×10^2	43×10^2	20×10^3	18×10^4	30×10^4

With respect to sensory accetability, the fruit blend preseved with the 1% garlic-ginger blend was the most accepatble (p <0.05). In presence of the biopreseravtives, the phyicochemical patrameters of the fruit blend showed stability during storage.

The study concluded that ginger and garlic could be used as effective biopreservatives in fruit juice blends at a minimum concentration at 1% and recommended as potential replacement for the chemical preservative during storage juice blends from cashew water melon and pineapple. The outcome of this study may expand the utilization of ginger and garlic more often in fruit juice production, create more job opportunities and reduce seasonal losses and wastage of fruits like cashew.

CONCLUSION

From the findings of this study, the biopreservatives (1% ginger, 1% garlic and 1% garlic-ginger extracts) compared favourably with the chemical preservatives (1% sodium benzoate and ascobic acid) used for preservation of the cashew water melon and pineapple juice blend. In addition, the study revealed 1% garlic-ginger extract as the most effective biopreservatives of all the biopresevatives used.

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