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

Abiola Olaniran, Helen Abu, Ruth Afolabi, Charles Okolie, Akinyomade Owolabi, Oghenerobor Akpor

ABSTRACT
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 citric acid 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 for 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 (Igbinedolor 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 Ezekiaku, 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, ta'fanuwa in Hausa, ayo-ishii 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, allin 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 improve their organoleptic properties, when compared 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 filtrate and homogenized for 60 s (Olaniran et al., 2019b).

The preservatives used were 1% garlic 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 after 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 (Anejja 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\(^b\) | 8.94 ±0.01\(^a\) | 8.82 ±0.04\(^a\) | 8.86 ±0.01\(^a\) | 8.77 ±0.02\(^a\) | 8.86 ±0.03\(^a\) |
| Color               | 8.00 ±0.01\(^b\) | 8.64 ±0.04\(^a\) | 8.22 ±0.02\(^b\) | 8.88 ±0.01\(^c\) | 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\(^c\) | 7.44 ±0.02\(^a\) | 6.82 ±0.01\(^c\) | 8.33 ±0.01\(^c\) | 7.22 ±0.04\(^b\) | 5.82 ±0.01\(^c\) |
| 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 watermelon juice blends with the different preservatives during the period of storage.

| Preservative type            | Storage period (weeks) | % decrease |
|-----------------------------|------------------------|------------|
| No added preservative       | 0                     |            |
| 1% ginger                   | 1                     | 31.6       |
| 1% garlic                   | 2                     | 25.1       |
| 1% garlic – ginger          | 3                     | 30.8       |
| 1% ascorbic acid            | 4                     | 20.7       |
| 1% Sodium benzoate          | 5                     | 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 watermelon juice blends with the different preservatives during the period of storage.

| Preservative type            | Storage period (weeks) | % increase |
|-----------------------------|------------------------|------------|
| No added preservative       | 0                     |            |
| 1% ginger                   | 1                     | 90.9       |
| 1% garlic                   | 2                     | 133        |
| 1% garlic – ginger          | 3                     | 240        |
| 1% ascorbic acid            | 4                     | 35.7       |
| 1% Sodium benzoate          | 5                     | 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 watermelon juice blends with the different preservatives during the period of storage.

| Preservative type            | Storage period (weeks) | % increase |
|-----------------------------|------------------------|------------|
| No added preservative       | 0                     |            |
| 1% ginger                   | 1                     | 44.7       |
| 1% garlic                   | 2                     | 8.4        |
| 1% garlic – ginger          | 3                     | 4.5        |
| 1% ascorbic acid            | 4                     | 6.0        |
| 1% Sodium benzoate          | 5                     | 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 ±0.00a | 5.77 ±0.01b | 5.60 ±0.01c | 5.38 ±0.02d | 5.28 ±0.02d | 5.09 ±0.01e | 12.1       |
| 1% ginger               | 5.90 ±0.05a | 5.82 ±0.01b | 5.60 ±0.03c | 5.60 ±0.04d | 5.53 ±0.01c | 5.53 ±0.01d | 6.3        |
| 1% garlic               | 5.82 ±0.01b | 5.78 ±0.02b | 5.72 ±0.00a | 5.69 ±0.00b | 5.67 ±0.02a | 5.61 ±0.05a | 3.6        |
| 1% garlic-ginger        | 5.98 ±0.01b | 5.88 ±0.00a | 5.78 ±0.03b | 5.75 ±0.01c | 5.66 ±0.02a | 5.65 ±0.03a | 5.5        |
| 1% ascorbic acid        | 5.81 ±0.02b | 5.79 ±0.01b | 5.65 ±0.01b | 5.51 ±0.02a | 5.60 ±0.04a | 5.20 ±0.02c | 10.5       |
| 1% Sodium benzoate      | 5.83 ±0.02b | 5.80 ±0.01b | 5.74 ±0.00a | 5.71 ±0.02a | 5.45 ±0.02c | 5.28 ±0.01e | 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    |                        |            |            |            |            |            |
| Preserved 1% ginger      | 80×10⁶                 | 25×10⁴     | 43×10⁵     | 30×10⁵     | 10×10⁸     | 25×10⁶     |
| Preserved 1% garlic-garlic | 12×10⁴             | 20×10⁴     | 24×10⁴     | 10×10⁴     | 15×10⁵     |
| Preserved 1% ascorbic acid | 12×10⁴            | 22×10⁴     | 39×10⁵     | 24×10⁴     | 75×10⁵     |
| Preserved 1% sodium benzoate | 12×10⁴        | 25×10⁴     | 43×10⁵     | 84×10⁴     | 90×10⁵     |
| Total fungal count       |                        |            |            |            |            |            |
| Preserved 1% garlic-garlic | 36×10⁴            | 39×10⁴     | 54×10⁴     | 25×10⁴     | 25×10⁶     |
| Preserved 1% ascorbic acid | 60×10²             | 58×10²     | 40×10⁵     | 56×10³     | 46×10⁴     |
| Preserved 1% sodium benzoate | 34×10²        | 60×10²     | 39×10⁴     | 47×10³     | 15×10⁵     |

With respect to sensory acceptability, the fruit blend preserved with the 1% garlic-ginger blend was the most acceptable (p < 0.05). In presence of the biopreservatives, the phyichochemical parameters 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 ascorbic 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 biopreservatives used.

REFERENCES

Afolayan, G., Babajide, A. A., Adebayo, S. O. 2016. An evaluation of the possibility of incorporating waste cashew apple bagasse into fish diet so as to reduce its wastage. International Journal of Agricultural Sciences, vol. 6, no. 2, p. 909-912.

Aneja, K. R., Dhiman, R., Aggarwal, N. K., Kumar, V., Kaur, M. 2014. Microbes associated with freshly prepared juices of citrus and carrots. International Journal of Food Science, vol. 4, p. 1-8. https://doi.org/10.1155/2014/408085.

APHA. 2015. Compendium of Methods for the Microbiological Examination of Foods, Fifth edition, American Public Health Association Washington, DC., USA, p. 769-774.

AOAC. 2010. W., Horwitz, W., Latimer, G. W. 2010. Official methods of analysis of AOAC International.
Potravinarstvo Slovak Journal of Food Sciences

Gaithersburg MD.: AOAC International. Retrieved from https://www.worldcat.org/title/official-methods-of-analysis-of-aoc-international/oclc/649275444

Mohammad, A. I. 2016. Effect of Different Storage Condition on pH and Vitamin C Content in Some Selected Fruit Juices (Pineapple, Pawpaw and Watermelon). International Journal of Biochemistry Research and Review, vol. 11, no. 2, p. 1-5. https://doi.org/10.9734/IJBCCR/2016/23462

Baskaran, S. A., Amalaradjou, M. A. R., Hoagland, T., Venkatanarayanan, K. 2010. Inactivation of Escherichia coli O157:H7 in apple juice and apple cider by trans-cinnamaldehyde. International Journal Food Microbiology, vol.141, no. 1, p. 126-129. https://doi.org/10.1016/j.ijfoodmicro.2010.04.002

Borode, O. F. 2017. The Effect of Water and Ethanol Extracts of Ginger and Garlic on the Nutritional Quality and Physico-Chemical Properties of Stored Soymilk. International Journal of Food Science and Biotechnology, vol. 2, no. 2, p. 43-50.

Chia, S. L., Rosnaih, S., Noranizan, M. A., Ramli, W. 2012. The effect of storage on the quality attributes of ultraviolet-irradiated and thermally pasteurised pineapple juices. International Food Research Journal, vol. 19, p. 1001-1010.

Ephrema, E, Najjara, A., Charcosset, C., Greige-Gergesa, H. 2018. Encapsulation of natural active compounds, enzymes, and probiotics for fruit juice fortification, preservation, and processing: An overview. Journal of Functional Foods, vol. 48, p. 65-84. https://doi.org/10.1016/j.jff.2018.06.021

Eke-Ejiofor, J., 2016. Microbial population and shelf life study of spiced water. European Journal of Food Science and Technology, vol. 4, no. 4, p. 1-11.

Igbinedolor, R., Yahaya, L., Jayeola, C. A. S. 2017. Addressing the Post-harvest Wastages and Under-utilization of Cashew Apple in Nigeria-A Review. The International Journal of Science and Technoloege, vol. 5, no. 7, p. 5-8.

Juan, G., Joana A., Ana Luisa P., Luciana S, Virgílio, F., Maria, J. F., Luís, P. 2017. Influence of Food Characteristics and Food Additives on the Antimicrobial Effect of Garlic and Oregano. Journal of Health Science and Nutrition, vol. 6, no. 44, p. 10. https://doi.org/10.3390/foods6060044

Kaddumukasa, P. P., Imathiu, S. M., Mathara, J. M., Nakavuma, J. L., Kaddumukasa, C. P. 2017. Influence of physicochemical parameters on storage stability: Microbiological quality of fresh unpasteurized fruit juices. Food Science and Nutrition, vol. 5, p. 1098-1105. https://doi.org/10.1002/fsn3.500

Makebe, C., Desobgo, Z., Nso, E., Makebe, C. W., Desobgo, Z. S. C., Nso, E. J. 2017. Optimization of the Juice Extraction Process and Investigation on Must Fermentation of Overripe Giant Horn Plantains. Beverages, vol. 3, no. 4, p. 19. https://doi.org/10.3390/beverages3020019

Mancini, S., Nuvoloni, R., Pedonese, F., Paci, G. 2019. Effects of garlic powder and salt additions in rabbit meat burgers: Preliminary evaluation. Journal of Food Processing and Preservation, vol. 43, no. 3, p. e13894. https://doi.org/10.1111/jfpp.13894

Naz, R., 2018. Storage in Polyethylene Terephthalate Bottles: Changes and Shelf Life. In Rajauria, G., Tiwari, B. K. Fruit Juices. Cambridge, USA : Academic Press, p. 621-635. ISBN 978-0-12-802230-6. https://doi.org/10.1016/B978-0-12-802230-6.00031-X

Neeraj, S., Sushila, K., Neeraj, D., Milind, P., Minakshi, P. 2014. Garlic: A Pungent wonder from nature. International Research Journal of Phamarcy, vol. 5, no. 7, p. 523-529. https://doi.org/10.7897/2230-8407.0507106

Nwachukwu, E., Ezejiaju, F. C. 2014. Microbial and Physicochemical characteristics of Locally produced Pineapple juice treated with Garlic and Ginger. International Journal of Current Microbiology and Applied Science, vol. 3, no. 6, p. 895-901.

Oduah, N. O., Longe, O. A., Elemo, G. N., Oke, O. V. 2015. Effects of fermentation on the Quality and composition of Cassava mash (Gati). International Journal of Food Nutrition and Safety, vol. 6, no. 1, p. 30-41.

Okwori, E., Onu, R., Adamu, M. O., Chindo, H., Dikko, H., Oduenze, I. I., Baidu, A. L., Natala, C., Eze, P. 2017. Production and shelf life determination of fruit/vegetable juices using watermelon, cucumber, pineapple and carrot. African Journal of Food Science and Technology, vol. 8, no. 3, p. 34-39. https://doi.org/10.14303/ajfst.2017.015

Olaniran, A. F., Abiose, S. H. 2018. Proximate and antioxidant activities of bio-preserved ogi flour with garlic and ginger. F1000Research, vol. 7, no. 1936, p. 1-13. https://doi.org/10.12688/F1000research.17059.1

Olaniran, A. F., Abiose, S. H., Adeniran, A. H. 2015. Biopreservative Effect of Garlic (Zingoiber officinale) and Garlic Powder (Allium sativum) on Tomato Paste. Journal of Food Safety, vol. 35, no. 4, p. 440-452. https://doi.org/10.1111/jfs.12193

Olaniran, A. F., Abiose, S. H., Gbadamosi, S. O. 2019a. Quality attributes and acceptability of Ogi Flour Biofortified with Garlic and Ginger. Journal of Health Science, vol. 7, no. 2, p. 101-109. https://doi.org/10.17265/2328-7136/2019.02.005

Olaniran, A. F., Okolie, C., Abu, H. E., Afolabi, R. O., Owolabi, A. 2019b. Preservative Effect of Garlic-ginger, Sodium Benzoate and Ascorbic Acid in Unpasteurized Cashew Apple Juice. Asian Journal of Scientific Research, vol. 12, p. 414-420. https://doi.org/10.3923/ajar.2019.414.420

Piper, P. W. 2018. Potential Safety Issues Surrounding the use of Benzoate preservatives. Beverages, vol. 4, no. 33, p. 1-7. https://doi.org/10.3390/beverages4020033

Pongsavese, M. 2015. Effect of sodium benzoate preservative on micromunulcduction, chromosome break, and Ala40Thr superoxide dismutase gene mutation in lymphocytes. BioMed Research International., vol. 2015, p. 1-5 https://doi.org/10.1155/2015/103512

Rapisarda, P., Bellomo, S., Fabroni, S., Russo, G. I. 2008. Juice quality of two new mandarin-like hybrids (Citrus clementina Hort. ex Tan x Citrus sinensis L. Osbeck) containing anthocyanins. Journal of Agriculture and Food Chemistry, vol. 56, p. 2074-2078. https://doi.org/10.1021/jf072616e

Rebuças, M. C., Rodrigues, M. C. P., Freitas, S. M. De, Ferreira, B. B. A. 2016. The physicochemical optimization and acceptability of a Cashew Nut-based beverage varying in Mango juice and sugar : A pilot study. Beverages, vol. 2, no. 23, p. 1-7. https://doi.org/10.3390/beverages2030023

Reut, H., Alexandra, L., Hagai, A. 2004. Benzoic Acid, a Weak Organic Acid Food Preservative, Exerts Specific Effects on Intracellular Membrane Trafficking Pathways in Saccharomyces cerevisiae. Applied and Environmental Microbiology, vol. 70, no. 8, p. 4449-4457. https://doi.org/10.1128/AEM.70.8.4449-4457.2004

Sádecká, J., Polovka, M., Kolek, E., Belajová, E., Tobolková, B., Daško, E. U., Durec, J. Ě. N. 2014. Orange juice with pulp: impact of pasteurization and storage on flavour, polyphenols, ascorbic acid and antioxidant activity.
Acknowledgments:
I want to appreciate all the technologist in department of Microbiology and Agriculture of Landmark University for their supports during the research work.

Charles Okolie, Landmark University, College of Applied and Pure Sciences, Department of Microbiology, Staff quarters, postal code 370102 Omu-Aran, Nigeria, Tel: +2348060241166, E-mail: okolie.charles@lmu.edu.ng
ORCID: https://orcid.org/0000-0001-8212-862X

Helen Abu, Landmark University, College of Applied and Pure Sciences, Department of Microbiology, Staff quarters, postal code 370102 Omu-Aran, Nigeria, Tel: +2347033838366, E-mail: abu.helen@lmu.edu.ng
ORCID: https://orcid.org/0000-0001-5499-3210

Ruth Afolabi, Landmark University, College of Applied and Pure Sciences, Department of Microbiology, Staff quarters, postal code 370102 Omu-Aran, Tel: +2348153117749, E-mail: afolabi.ruth@lmu.edu.ng
ORCID: https://orcid.org/0000-0003-0620-0209

*Corresponding author.