

Effect of Ginger on the Quality Attributes of Pineapple Juice During Storage

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Abstract

Homemade pineapple juice usually prepared without pasteurization and stored at room temperature could significantly influence the quality of the juice. This study aimed at assessing the effect of ginger (*Zingiber officinale* Rosc.) on bacteriological, physicochemical and nutritional quality of pasteurized and unpasteurized pineapple juice during storage at ambient temperature (28 ± 2 °C) for 7 days. Unpasteurized; pineapple juice + 10 ml ginger; pineapple juice + 20 ml ginger; pineapple juice + 10 ml ginger; pineapple juice (control) were evaluated. The results obtained showed that total heterotrophic bacterial count, pH, titratable acidity and total soluble solids of the samples treated with ginger were within the range of 2.23-4.60 \log_{10} CFU/mL, 4.0-4.9, 0.51-1.86 g/l and 6.9-13.4 % while the corresponding values for the control was 2.0-4.14 \log_{10} CFU/mL, 3.5-4.8, 0.63-1.5 g/l, and 9.1-13.2 %, respectively. All the pineapple juice preparations met the National Agency for Food Drug Administration and Control (NAFDAC) requirements. The sample that had the highest vitamin C and ash content was unpasteurized pineapple juice mixed with 30 mL of ginger (7.46 mg/10 mL) and the control which was pasteurized (4.3 %) respectively. Based on the results obtained from this study, pasteurization of pineapple juice as well as addition of ginger to the juice are recommended for the production of a safe product for human consumption

Keywords: Pineapple, Fruits, Spices, Pasteurization, Shelf life

INTRODUCTION

Fruits are essential in human nutrition which also enhances human health. Nutritionally, consumption of fruits brings about hydrating, diuretic, alkalizing and laxative effect (Montenegro-Bethancourt et al., 2013; Kasa, & Yohanis, 2017). It is highly recommended for everyone (Saad, 2017; Iqbal et al., 2019). The consumption of fruit juices increases appetite, quenches thirst and highly refreshing (Saad, 2017). Fruits are helpful in the maintenance of acid-alkaline balance in the body (Kasa and Yohanis, 2017). Each fruit has a peculiar taste, texture and colour (Barrett et al., 2010; Iqbal et al., 2019). Fruits serve as a rich source of vitamins, minerals and dietary fiber (Iqbal et al., 2019). Globally, pineapple (*Ananas comosus* (L.) Merr. Family: Bromelinaceae) is ranked third among tropical fruits after banana and citrus. The taste and flavour of pineapple is superb (Zhu and Yu, 2020). Therefore, it is regarded as the queen of fruits (Hossain et al., 2015). Several products obtained from processing fresh pineapple include pineapple juice concentrate, canned pineapple slices, dried pineapple, pasteurized pineapple juice and pineapple pulp (Hounhouigan et al., 2014). Pineapple juice has a sweet taste and low pH (Chadaré et al., 2021).

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Pineapple is rich in vitamin C which is a strong antioxidant that fights free radicals responsible for attacking and damaging cells. The water, protein, total lipid (fat), total dietary fibre and ash content of pineapple are 49/100, 0.43/100, 12.39/100 and 12/100 and 0.29 g/100 g, respectively. Pineapple is a good source of minerals such as magnesium (14 mg/100 g), phosphorus (7 mg/100 g), calcium (7 mg/100 g), potassium (113 mg/100 g), sodium (1 mg/100 g), zinc (0.08 mg/100 g), copper (0.110 mg/100 g) and iron (0.37 mg/100 g). It also contains vitamin A, B₁, B₂, C and niacin (Couto *et al.*, 2010; Kasa *et al.*, 2017).

In pregnant women, consumption of pineapple helps to slow down the progress of urinary tract infections (Hossain *et al.*, 2015). The calorie content of pineapple is low which makes it suitable for people who are mindful of being overweight (Zdrojewicz *et al.*, 2018). The fruit lowers blood pressure, prevent diabetes, a good remedy against inflammation disease, promote strong and healthy teeth (Hossain *et al.*, 2015; Iqbal *et al.*, 2019). Pineapple is rich in manganese which is beneficial to the skin, cartilage, collagen and bone material (Khalid *et al.*, 2016). Malic acid which is a part of the acidity of the juice help the skin to be firm and smooth. Bromelanin present in pineapple aids protein digestion. It also helps athletes to recover from physical aches and injuries (Hossain *et al.*, 2015). Pineapple is helpful in reducing blood clotting and removal of plaque in the arterial walls (Joy, 2010).

The presence of osmophilic microflora in pineapple juice is associated with spoilage of the product (Wardhani, 2019). Addition of preservatives to pineapple fruit juice will extend the shelf life by inhibiting the activities of spoilage microorganisms (Kumari *et al.*, 2019). Because of negative health effect of chemical preservatives, the use of natural preservatives such as ginger is strongly advocated (Kumari *et al.*, 2019). A study carried out by Pandhare *et al.* (2018) involved the use of natural preservatives comprising of nisin, clove oil and thyme oil to preserve pineapple juice. Lemon grass essential oil has also been added to pineapple juice as a natural preservative (Celina *et al.*, 2018).

Ginger (*Zingiber officinale* Rosc.) is a popular natural spice people add to food and drinks depending on their choice (Indiarto *et al.*, 2021). Ginger is known for its pungent and distinct flavour (Bhatt *et al.*, 2013). Therefore, it is commonly used to add flavour to confectioneries, soft drinks, alcoholic and non-alcoholic beverages (Sangwan *et al.*, 2012). It has age-long use in folk medicine in South-East Asia (Bhatt *et al.*, 2013). Ginger is helpful in the management of sprains, arthritis, cramps, sore throats, vomiting, pains, rheumatism, muscle aches, constipation, hypertension, indigestion, dimension, dementia and fever (Shahrajabian *et al.*, 2019). In northern parts of Nigeria, farmers cultivate ginger in commercial quantity (Dominic *et al.*, 2018). Omodamiro *et al.* (2012), Akponah *et al.* (2013), Vwioko *et al.* (2013), Nwachukwu & Ezejiaku (2014), Okoronkwo *et al.* (2022) and Prisacaru *et al.* (2023) have used ginger as a natural preservative to inhibit the growth of spoilage microorganisms in fruit juices and beverages. In this study, the effect of adding ginger on the bacteriological, physicochemical and nutritional quality of pasteurized and unpasteurized pineapple juice was determined.

MATERIALS AND METHODS

Sample Collection

Mature and ripe pineapple fruit together with fresh ginger were purchased from Choba main market, Obio-Akpor Local Government Area, Rivers State. Rotten pineapple fruit and ginger were removed from the lot to avoid bacterial contamination of the juice. The samples were transported in a polythene bag to Microbiology Laboratory, University of Port Harcourt, for laboratory analysis.

Production of Pineapple Juice

The method described by Akinoson (2010) with slight modification was adopted. Five (5) kilograms of fresh pineapple fruit was washed with clean tap water and rinsed twice with distilled water. It was then peeled with sterile stainless knife, cut into small pieces of about 3 - 4 mm thickness and homogenized using electric juice extractor. The extracted juice was filtered by passing it through a sterilized sieve into a transparent bowl which was also sterilized. After filtration, about 1 litre of the pineapple juice was obtained. Five hundred millilitre (500 mL) of the extracted pineapple juice was pasteurized. The procedure involved pouring 500 mL of the pineapple juice into a clean sterilized pot. The pot was placed on a Bunsen burner and heated to a temperature of 62 °C for 15 minutes. A thermometer was used to obtain an accurate temperature during pasteurization. Thereafter, the pasteurized pineapple juice was dispensed into 4 sterilized sample bottles. Each of the bottles contained 100 mL of pasteurized pineapple juice. Similarly, the unpasteurized pineapple juice was dispensed into 4 sterilized sample bottles. Each of the sample bottles contained 100 mL of the unpasteurized pineapple juice.

Production of Ginger Extract

The method described by Adubofuor *et al.* (2010) and Philips (2008) with slight modifications was adopted. Five hundred grams (500 g) of ginger was washed and rinsed with distilled water. The rhizomes of the ginger were removed to ensure that soil particles attached to the rhizomes were completely removed. The ginger was chopped into smaller sizes. Exactly 0.2 kg of ginger was weighed and blended with 200 mL of distilled water using electric blender. The juice from the ginger was squeezed and filtrated to remove the chaff.

Pineapple juice mixed with ginger extract

The method described by Obashola (2011) was adopted with slight modification. Exactly 10 mL of the ginger extract was measured and added into 100 mL of pasteurized pineapple juice. Similarly, 100 mL of unpasteurized pineapple juice was mixed with 10 mL of ginger. Twenty millilitre (20 mL) of the ginger extract was measured and added into another 100 mL of pasteurized pineapple. The same volume of ginger extract (20 mL) was added to unpasteurized 100 mL pineapple juice. Finally, 30 mL of the ginger extract was measured and added to 100 mL of pasteurized pineapple juice. Another portion of ginger extract (30 mL) was added to 100 mL of unpasteurized pineapple juice. One hundred millilitre (100 mL) of pasteurized pineapple juice and 100 mL of unpasteurized pineapple juice without preservatives was the control. Table 1 shows the code assigned to the pineapple juice preparations.

Table 1. Labeling of the Pineapple Juice Samples

| Pineapple Juice Preparations | Code |
|--|------|
| 10 mL of the ginger extract +100 mL of pasteurized pineapple juice | PSO |
| 10 mL of ginger + 100 mL of unpasteurized pineapple juice | USO |
| 20 mL of ginger extract + 100 mL of pasteurized pineapple juice. | PST |
| 20 mL of ginger extract + 100 mL of unpasteurized pineapple juice. | UST |
| 30 mL of ginger extract + 100 mL of pasteurized pineapple juice | PSTH |
| 30 mL of ginger extract + 100 mL of unpasteurized pineapple juice | USTH |
| 100 mL of unpasteurized pineapple juice | CUS |
| 100 mL of pasteurized pineapple juice | CPS |

Storage of Pineapple Juice Treated with Ginger

Eight (8) sample bottles comprising of 4 pasteurized samples and 4 unpasteurized samples mixed with different concentrations of ginger extract were stored at 28±2 °C for 7 days.

Enumeration and Isolation of Bacteria

A ten-fold serial dilution of each of the samples was carried out using the procedure described by Ire et al. (2020). Spread plate technique was employed by inoculating 0.1 mL of the appropriate dilutions on the plate count agar plate for enumeration of bacteria. The agar plates were incubated at 30 °C for 24 h for bacterial count. Each sample was inoculated in duplicate agar plates and the mean values of bacterial counts were recorded as colony forming unit per ml (CFU/mL). Bacterial isolates were identified after carrying out Gram staining, motility test and biochemical tests (Cheesbrough, 2000; Shoaib et al., 2020).

Determination of pH

The pH of the samples was determined using pH meter (Model PHS-25C precision pH/mV). Standard pH buffer 7.0 was used to standardize the electrode before aseptically immersing glass electrode of the pH meter into the juice samples and the pH meter reading were recorded.

Determination of Titratable Acidity

Titrate acidity (TA) was determined using the alkaline titrimetric method described by Bello et al. (2014) with slight modification. Exactly 25 mL of the sample was dispensed into a conical flask and 3 drops of phenolphthalein indicator was added and titrated against 0.05 m NaOH. Total titrate acidity was calculated using the general formula below:

$$TA = (M_{NaOH} \times C_{NaOH} \times 100) / V$$

Where: M_{NaOH} is the molarity of NaOH used

V is the volume of juice titrated

Determination of Total Solids

The procedure described by Tiencheu et al. (2021) was adopted in determining total solids of the juices. Total solids of the juice treated with ginger extract was determined by weighing an empty filter paper and then passing a known weight of juice through a Whatman filter paper that retained particles or solids. After the content of the Whatman filter paper was dried inside a ventilated oven at 103 °C for 2 h, the solid left on the filter paper after evaporation was weighed using an electronic weighing balance. The total solids of the samples was calculated using the formula below.

$$\% \text{ total solids} = \frac{W_2 \times 100}{W_1} = (100 - \% \text{ moisture})$$

Where: W_1 is the initial weight

W_2 is the dried weight

Chemical Composition Determination

Ash content of pineapple juice treated with ginger extract was determined according to the AOAC (2000) method. Total available vitamin C was determined by a dye solution of 2, 6 dichloroidophenol (DCIP) titration method. Exactly 9.7 mg of pure vitamin C was accurately weighed and dissolved in 50 mL of distilled water. The mixture was continuously stirred until all the particles of ascorbic acid have been dissolved. Five millilitre (5 mL) of DCP was accurately pipetted into a 50 mL Erlenmeyer flask followed by addition of 1 drop of acetic acid (30 %) to change the blue colour of DCP to pink. Ascorbic acid solution was used to titrate the DCP until a colourless endpoint (or equivalence point) was achieved using a burette. The volume of ascorbic acid used was recorded and the titration was repeated. The quantity of vitamin C that changed the colour of DCP was then calculated. Standardization process was repeated by replacing ascorbic acid solution with 5mL of pineapple juice treated with ginger extract mixed with 10 mL of distilled water. After repeating the titration twice, the vitamin C

content of the sample was calculated using standard volume and expressed as mg ascorbic acid/100 mL of pineapple juice treated with ginger extract.

Statistical Analysis

Each of the tests were repeated in duplicates and the average were calculated, accordingly.

RESULTS

Figure 1 shows the total heterotrophic bacterial count (THBC) of pineapple juice treated with ginger extract and the control. The THBC of unpasteurized pineapple juice samples treated with ginger extract was within the range of 2.38 - 4.6 log₁₀CFU/mL while the pasteurized samples were 2.23 - 4.37 log₁₀CFU/mL. Meanwhile, the THBC of the control (pasteurized) and control (unpasteurized) was within the range of 2.0 - 3.79 and 3.1 - 4.14 log₁₀CFU/mL, respectively. Table 2 shows the results of biochemical characterization of the bacterial isolates and probable bacteria encountered in the samples of pineapple juice treated with ginger extract and the control.

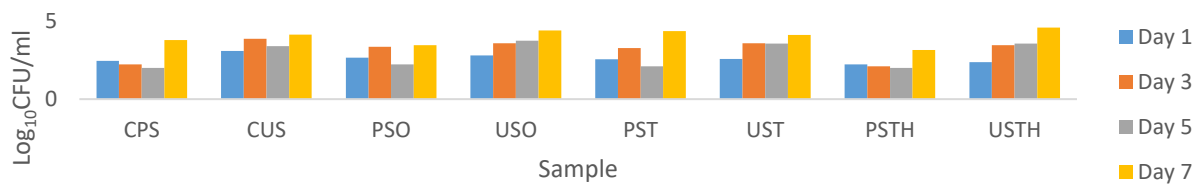


Figure 1 Total heterotrophic bacterial count of pineapple juice treated with ginger extract and the control during storage

Table 2 Biochemical characteristics of the bacterial isolates

| Isolate | Catalase | Oxidase | Indole | Methyl red | Voges Proskaeurr | Citrate | Methyl | Sucrose | Starch | Glucose | Lactose | Sucrose | Butt | H ₂ S | Gas | Gram reaction | Shape | Probable bacteria |
|---------|----------|---------|--------|------------|------------------|---------|--------|---------|--------|---------|---------|---------|------|------------------|-----|---------------|-------|----------------------------|
| A2 | - | - | + | + | - | - | - | - | + | - | - | - | - | - | - | - | Rod | <i>Escherichia coli</i> |
| B2 | + | - | + | + | - | - | + | - | - | - | - | - | - | - | - | + | Cocci | <i>Staphylococcus</i> spp. |
| G1 | + | + | + | - | - | - | + | - | - | A | - | - | + | + | - | + | Cocci | <i>Staphylococcus</i> spp. |
| D | + | - | + | + | - | + | + | A | - | A | - | + | + | - | - | + | Rod | <i>Klebsiella</i> spp. |
| C3 | + | - | + | - | - | + | + | - | - | A | - | - | - | - | - | + | Rod | <i>Pseudomonas</i> spp. |
| E3 | + | - | + | - | - | + | + | - | - | - | - | - | - | - | - | + | Cocci | <i>Staphylococcus</i> spp. |
| G5 | + | - | + | + | + | - | - | - | + | - | - | + | + | - | - | + | Cocci | <i>Staphylococcus</i> spp. |
| B1 | + | - | + | + | - | - | + | - | + | A | A | + | + | - | - | + | Rod | <i>Klebsiella</i> spp. |
| E3 | + | - | + | - | + | + | + | A | + | - | A | - | + | - | - | + | Cocci | <i>Klebsiella</i> spp. |
| H2 | + | - | + | + | - | - | + | A | + | A | - | - | + | - | - | + | Cocci | <i>Pseudomonas</i> spp. |
| G4 | + | - | + | + | - | + | + | - | - | A | - | - | + | - | - | + | Rod | <i>Klebsiella</i> spp. |
| G3 | + | - | + | - | - | + | + | - | - | - | - | - | + | + | - | + | Cocci | <i>Pseudomonas</i> spp. |
| A1 | + | - | + | + | - | + | + | - | + | A | - | + | + | - | - | + | Cocci | <i>Pseudomonas</i> spp. |
| D3 | + | - | + | - | - | + | + | A | + | A | - | - | + | - | - | + | Cocci | <i>Staphylococcus</i> spp. |
| F | + | - | + | - | - | - | + | - | - | A | - | - | - | - | - | + | Rod | <i>Escherichia coli</i> |
| C | + | - | + | + | - | + | + | - | - | A | - | - | - | - | - | + | Rod | <i>Escherichia coli</i> |
| E2 | + | - | + | - | - | + | + | A | + | - | - | - | + | - | - | + | Cocci | <i>Klebsiella</i> spp. |
| B3 | + | - | + | + | - | - | + | - | + | A | - | - | - | - | - | + | Cocci | <i>Pseudomonas</i> spp. |
| H3 | + | - | + | + | - | - | + | - | + | - | - | - | + | - | - | + | Cocci | <i>Escherichia coli</i> |
| E1 | + | - | - | + | - | - | + | - | + | A | - | - | + | - | - | + | Rod | <i>Pseudomonas</i> spp. |
| G2 | + | - | - | + | - | - | + | - | + | A | - | - | + | - | - | + | Cocci | <i>Klebsiella</i> spp. |
| C5 | + | - | + | + | + | + | + | A | - | A | - | + | + | - | - | + | Cocci | <i>Escherichia coli</i> |
| H1 | + | - | + | + | - | + | + | - | - | - | - | - | + | - | - | + | Cocci | <i>Staphylococcus</i> spp. |

Key: +positive; - negative; A - Acid

Figure 2 shows the pH of pineapple juice treated with ginger extract and the control during storage. The pH of pasteurized and unpasteurized pineapple juice treated with ginger extract was within the range of 4.0 - 4.9 and 4.1 - 4.6, respectively. The control (pasteurized) and control (unpasteurized) had a pH within the range 3.5 - 4.8 and 3.8 - 4.3, respectively. Figure 3 shows the TA of pineapple juices treated with ginger extract and the control during storage. The TA of unpasteurized pineapple juice samples treated with ginger extract was within the range of 0.6 - 1.86 g/l while the pasteurized samples were 0.51 - 1.05 g/l. Meanwhile, the TA of the control (pasteurized) and control (unpasteurized) was within the range of 0.63 - 0.72 g/l and 0.72 - 1.5 g/l, respectively.

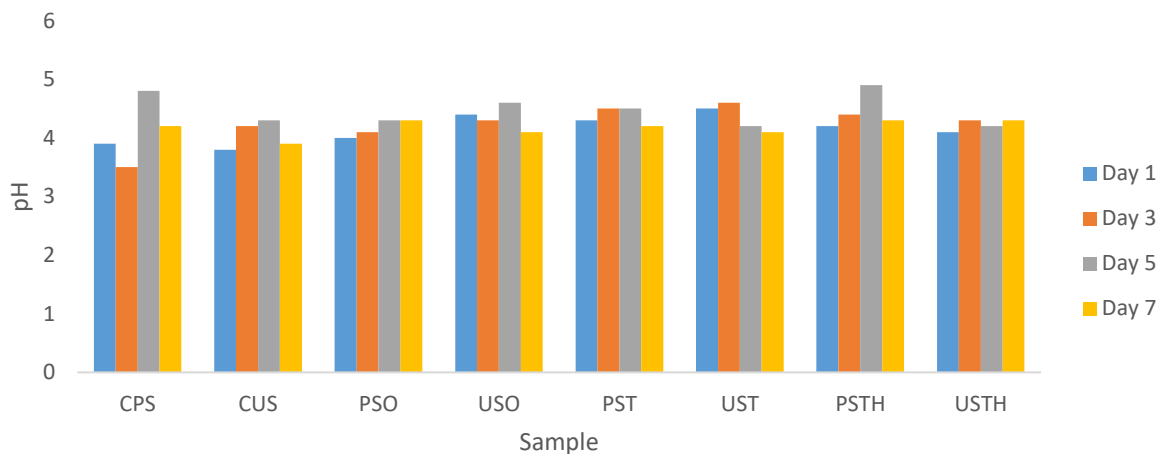


Figure 2 pH of pineapple juice treated with ginger extract and the control during storage

Figure 4 shows the total soluble solids in pineapple juice treated with ginger extract and the control during storage. At Day 1 and 7, the total soluble solids in pasteurized pineapple juice treated with ginger extract was between the range of 10.5-13.4% while the unpasteurized ranged from 6.9-8.8%. The TSS of the control (pasteurized) and control (unpasteurized) ranged from 13-13.2 and 9.1-9.6%, respectively. Table 3 shows the vitamin C and ash content of pineapple juice treated with ginger extract and the control.

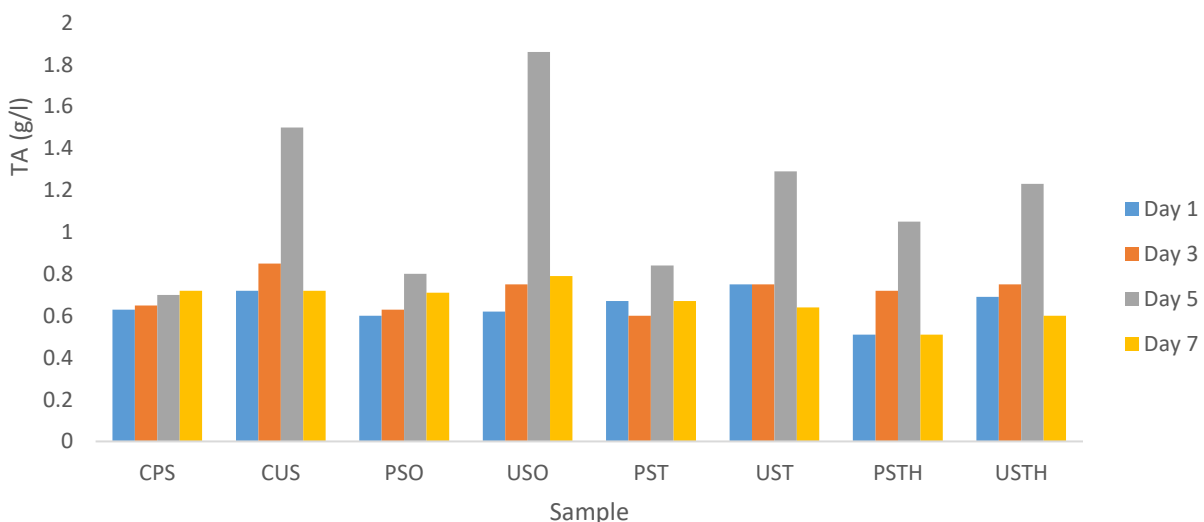


Figure 3 Titratable acidity (TA) of pineapple juice treated with ginger extract and the control during storage

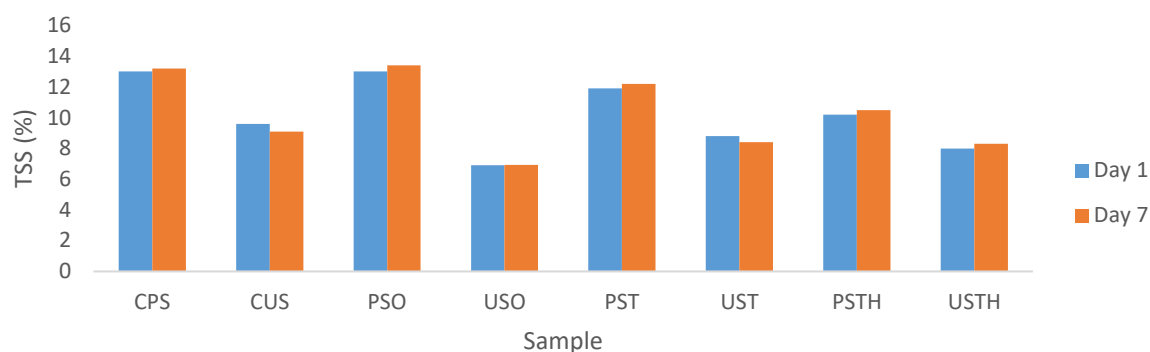


Figure 4. Total soluble solids (TSS) in pineapple juice treated with ginger extract and the control during storage

Table 3 Vitamin C and ash content of pineapple juice treated with ginger extract and the control

| Sample | Vitamin C (mg/10 mL) | Ash content (%) |
|--------|----------------------|-----------------|
| CPS | 6.444 | 4.3 |
| CUS | 6.345 | 3.8 |
| PSO | 6.705 | 3.2 |
| USO | 6.690 | 2.1 |
| PST | 7.040 | 2.5 |
| UST | 7.190 | 2.2 |
| PSTH | 7.435 | 2.0 |
| USTH | 7.460 | 1.8 |

DISCUSSION

The study revealed that the samples of pasteurized and unpasteurized pineapple juice treated with ginger and the control (pineapple juice only) stored for 7 days at 27 °C were contaminated with microorganisms. Possible sources of microorganisms in the samples is pineapple (Adesetan *et al.*, 2013), ginger (Ahaotu *et al.*, 2021), food handler, utensils and environment. The THBC of all the samples of pineapple juice treated with ginger and the control was within the range of 2.0 - 4.60 log₁₀CFU/mL while the control was within the range of 2.0 - 4.14 log₁₀CFU/mL. It was observed that THBC of the control (unpasteurized) was higher than the control (pasteurized). Application of heat to the pineapple juice could be responsible for lower bacterial count in the pasteurized samples compared with the unpasteurized juice (Chardaré *et al.*, 2021). This observation is in agreement with the report by Nwachukwu & Ezejiaku (2014). The researchers reported that total viable bacterial counts of pineapple juice steadily increased from 4.8x 10⁴ to 5.2 x 10⁶ CFU/mL during 21 day storage at ambient temperature. It was generally observed that bacterial counts of pineapple juice treated with ginger were lower than the control (pineapple juice only). This observation is corroborated by Ouattara *et al.* (2017) from a related study which the researchers attributed to antimicrobial effect of ginger. According to Ire *et al.* (2020), National Agency for Food Drug Administration and Control (NAFDAC) recommends that locally prepared beverage should not have mesophilic bacterial count beyond 5.0 log₁₀CFU/mL. It is interesting to note that all the samples of pasteurized and unpasteurized pineapple juice treated with ginger extract and the control met the NAFDAC requirement.

Bacteria detected in the samples of pineapple juice include *Escherichia coli*, *Staphylococcus* spp., *Klebsiella* spp. and *Pseudomonas* spp. This is in agreement with the report of Nwachukwu & Ezejiaku (2014) from a related study. According to Ire *et al.* (2020), *Staphylococcus aureus* is part of the normal flora of human skin. The bacterium is associated with certain diseases which

include Folliculitis, Furuncles, Erysipelas, Carbuncles, Meningitis, Staphylococcal food poisoning and scalded skin syndrome (Toxemia). The presence of *Escherichia coli* in the pineapple juices is an indication of faecal contamination from the environment, dirty utensils and humans. *Pseudomonas* sp. and *Klebsiella* sp. are associated with urinary tract infections (Abdulfatai et al., 2023).

It was observed that pineapple juice treated with ginger and the control samples were slightly acidic (< 5.0). Low pH of the juice is an indicator of good quality product. A slight reduction in pH of the samples occurred as the storage time increased with few exceptions. The release of acids due to breakdown of glucose and fructose in the juice could be responsible for the reduction in pH of the samples. The result is in agreement with the report by Pandhare *et al.* (2018) which involved storage of pineapple juice treated with natural preservatives (clove and thyme oil). In a related study, Nwachukwu & Ezejiaku (2014) reported that pH of pineapple juice mixed with one gram of ginger stored for 21 days at ambient temperature (28 ± 2 °C) ranged from 4.60-2.10. During the storage period, there was a steady reduction in the pH of the samples.

During the period of storage of the pineapple juice samples, there was increase in TA with few exceptions. The TA of the pineapple juice treated with ginger was within the range of 0.51 – 1.86 while the control was within the range of 0.63 – 1.5 g/l. Research findings by Nwachukwu and Ezejiaku (2014) reported that total TA of pineapple juice mixed with 1 g of ginger steadily increased from 0.032 to 0.348 during storage at ambient temperature (28 ± 2 °C).

The results obtained from the study showed that slight increase in total solids of pineapple juice occurred during the period of storage of the samples with few exceptions. The values ranged between 6.9 and 13.4%. The result is in agreement with total soluble solids of fresh pineapple juice (11%) reported by Saad (2017). In a related study, Olaniran *et al.* (2020) also reported increase in total soluble solids during storage of a blend of watermelon, pineapple and orange juice containing chemical preservatives. According to the researchers, increase in TA of the juice will encourage the breakdown of carbohydrate into simple sugars.

Findings from this study have shown that vitamin C content of pineapple juice samples without ginger (6.35-6.44 mg/10 mL) was lower than the values (6.69-7.46 mg/ 10 mL) reported for pineapple juices treated with ginger. The results also indicate that vitamin C content of the samples increased as the proportion of ginger extract added to the product increased. The vitamin C content of ginger could be responsible for the increase in the value of vitamin C reported in pineapple juice samples treated with ginger. The values obtained from the samples were lower than 28.52 mg/100 mL and 35.93 mg/100 mL vitamin C content of fresh pineapple juice reported by Saad (2017) and Celina *et al.* (2018), respectively. According to Shirin and Prakash (2010), the vitamin C content of ginger root is 9.33 ± 0.08 mg. Vitamin C helps in repairing tissues found in all parts of the body. It is also useful in making protein which drives the formation of blood vessels, ligaments, skin and tendons. Fast healing of wounds, formation of scar tissue, repair and maintenance of cartilage, teeth and bones are enhanced by vitamin C (Devaki and Raveendran, 2017). It also boost iron absorption in the body (Teucher et al., 2004).

The ash content of pineapple juice samples without ginger added to it (3.8-4.3%) was higher than the values reported for pineapple juice samples (1.8-3.2%) treated with different proportions of ginger. In a study conducted by Saad (2017), a total ash content (0.290%), of pineapple juice was reported. The results obtained revealed that ash content of pineapple juice reduced with increase in the concentration of ginger added to it. Afify *et al.* (2017) reported that ash content of food materials is an indication of its mineral content.

CONCLUSION

The bacterial load of pineapple juice samples assayed treated with ginger was lower than what was reported for the control (pineapple juice only). Pasteurization of the samples contributed in reducing the bacterial load of the pineapple juice samples. The product were acidic which is unfavourable for the growth of many spoilage microorganisms. Based on the results obtained from this study, the pineapple juice samples contained reasonable amount of vitamin C and minerals.

COMPETING INTERESTS

The authors declare that no conflict of interests exist.

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