

## Research Article

# Effects of *Ocimum gratissimum* and Citric Acid on the Nutritive and Sensory Qualities of Stored Pineapple Juice

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### Abstract

Fruit juices values are reduced during the storage, its effect is of great concern to the consumer as well as to the economy of our great nation. Effects of leaf extract *Ocimum gratissimum* and citric acid on the proximate and sensory properties of stored at  $30 \pm 2^\circ\text{C}$  pineapple juice was investigated using standard techniques. The extracted juice was divided into two-part, one part was treated with leaf extract *O. gratissimum* ranged from 5% - 40% while; the second part was treated with citric acid ranged from 0.2% - 0.5% and untreated one served as control. They were stored 10 days at ambient temperature. The results obtained revealed the concentration 40% leaf extract and 0.5% citric acid were able to stabilize the nutritional qualities during the storage. The moisture content for the best leaf extract at

40% concentration ranged from  $77.95 \pm 0.08\%$  -  $78.34 \pm 0.05\%$  while citric acid (0.5%) moisture effect ranged from  $85.42 \pm 0.00\%$  -  $85.72 \pm 0.06\%$  and the untreated moisture content ranged from  $85.42 \pm 0.02\%$  to  $93.19 \pm 0.00\%$ . The ash content of leaf extract and citric acid-treated pineapple ranged from  $1.10 \pm 0.01\%$  -  $1.11 \pm 0.01\%$  and  $0.30 \pm 0.00\%$  -  $0.32 \pm 0.00\%$  while untreated juice ranged from  $0.17 \pm 0.00\%$  to  $0.32 \pm 0.00\%$ . The protein content of leaf extract and citric acid-treated pineapple ranged from  $2.24 \pm 0.01\%$  -  $2.29 \pm 0.01\%$  and  $1.07 \pm 0.01\%$  -  $1.08 \pm 0.01\%$  while untreated juice ranged from  $0.95 \pm 0.00\%$  to  $1.09 \pm 0.00\%$ . The carbohydrate content of leaf extract and citric acid-treated pineapple ranged  $15.38 \pm 0.00\%$  -  $15.46 \pm 0.00\%$  and  $11.81 \pm 0.00\%$  -  $11.95 \pm 0.00\%$  while untreated

juice ranged from  $5.10 \pm 0.01\%$  to  $11.94 \pm 0.00\%$ . The fibre content of leaf extract and citric acid-treated pineapple ranged  $2.41 \pm 0.00\%$  -  $2.43 \pm 0.01\%$  and  $0.95 \pm 0.01\%$  -  $1.03 \pm 0.01\%$  while untreated juice ranged from  $0.99 \pm 0.01\%$  to  $1.03 \pm 0.01\%$ . The fat content of leaf extract and citric acid-treated pineapple ranged  $0.51 \pm 0.01\%$  -  $0.61 \pm 0.00\%$  and  $0.11 \pm 0.00\%$  -  $0.20 \pm 0.01\%$  while untreated juice ranged from  $0.82 \pm 0.00\%$  to  $0.20 \pm 0.01\%$ . *Ocimum gratissimum* (40% w/v) leaf extract was the best to increase and stabilize the nutrients in pineapple juice than 0.5% citric acid. The panelists rated pineapple juice treated with *O. gratissimum* leaf extract (40%) the best in colour and general acceptability and slightly affected the taste and flavour while 0.5% citric acid concentration best in flavour and taste evaluated.

**Keywords:** Fruit juice; *Ocimum gratissimum* leaf extract; Citric acid; Nutritive and sensory values

## 1. Introduction

Pineapple (*Bromeliaceae* family) is amongst the major Nigeria fruits produced in large quantities but significantly wasted at the peak of harvesting. This fruit can be processed into some products; canned pineapple slice, pineapple pulp, dried pineapple, pasteurized pineapple juice, and concentrate. The day 1 pineapple juice is a popular product due to its pleasant aroma, flavor, and numerous functional properties [1]. The pineapple juice satisfies the “5 A Day” dietary requirement of fruits and vegetables set by many health agencies [2]. The juice contains a variety of minerals, especially manganese, as well as amino acids, various sugars, vitamins, and polyphenols [3-4]. It is considered as a vital drink due to its health-promoting properties and its anti-inflammatory, anti-atherosclerotic, anti-aging, and many other healing properties. The nutritional composition of pineapple juice depends on the geographical location, culture, harvest season, and

processing time. Studies have reported on the general composition of pineapple juice such as minerals, sugars, organic acids, and amino acids, as well as physical properties such as pH, Brix, ash, and titratable acidity [3]. The edible portion of pineapple fruit has been investigated and contains 81.2 to 86.2% moisture, and 13-19% total solids, of which sucrose, glucose, and fructose are the main components. Carbohydrates represent up to 85% of total solids whereas fibre makes up for 2-3%. The pulp has very low ash content, nitrogenous compounds and lipids (0.1%). From 25-30% of nitrogenous compounds are true proteins. Day 1 pineapple juice contains Calcium, Chlorine, Potassium, Phosphorus, and Sodium [5]. Pineapple juice contains ascorbic (Vitamin C) which assists the body in fighting bacterial and viral infections. It is an effective antioxidant and helps the body to absorb iron. Pineapples juice also contains copper (trace) which assists in the absorption of iron and regulates blood pressure and heart rate [6].

Tree basil *Ocimum gratissimum* Linn. is a small shrub, also known as clove basil African scent leaf, tea bush or fever plant [7]. The plant (*Ocimum gratissimum*) is called *Efinrin* in Yoruba, *Daidoya* in Hausa *Nchuwawu* in Igbo [7-8]. The typical characteristics of the family *Lamiaceae* to which *O. gratissimum* belongs have a square stem, opposite and decussate leaves with many gland dots. Extracts *O. gratissimum* is used in traditional medicines, and have been shown to contain biologically active constituents that are insecticidal, nematocidal, fungistatic, or antimicrobial [9]. Phytochemical analysis of *Ocimum gratissimum* leaf showed that it contains alkaloids, flavonoids, saponin, tannins, glycoside, cardiac glycoside, resin compounds, terpenoids, and essential oil. These classes of compounds have curative effects against microorganisms. Pasteurization is the conventional method of stabilizing fruit juice quality through its shelf

life. However, the concerns about the shortcomings inherent in the pasteurization method have called for the exploitation of alternative methods. The restriction imposed by the regulatory agencies on the use of some synthetic food additive is an impetus to finding alternative natural antimicrobial compounds that could be used for the preservation of fruit juices [10].

The present study therefore aimed at exploring the plant leaf aqueous extract of (*Ocimum gratissimum*) to preserve the nutritive and sensory qualities of pineapple juice for a longer period of time at ambient temperature.

## 2. Materials and Methods

Mature and healthy, pineapple fruits were bought at the Oba Adesida market in Akure, Ondo State Nigeria while, citric acid was collected from Microbiology Department, Federal University of Technology Akure, Ondo State Nigeria. *Ocimum gratissimum* Linn. leaf was obtained from a garden at Ede in Osun State Nigeria. The *O. gratissimum* leaf was authenticated by a Botanist at the Forestry and Wood Technology Department, Federal University of Technology Akure.

### 2.1 Preparation of plant leaf extract and juice

The mature and healthy leaves of *Ocimum gratissimum* were manually separated cleaned, air-dried and pulverized. The leaf powdered was extracted at  $70 \pm 2^\circ\text{C}$  with sterile distilled water for 48 hours in a shaker water bath. The resulting mixture was filtered by passing through the *Watman* No1 filter paper and filtrate collected was dried at ambient temperature ( $30 \pm 2^\circ\text{C}$ ) and grounded into a fine powder using mortar and pestle. The obtained dried crude extracts were kept into an airtight plastic container and labeled. Different concentrations of the crude plant extract (5% to 40%) and citric acid (0.2% to 0.5%) was prepared using sterile distilled water [11-12]. The pineapple fruit for the study was washed, peeled and cut into smaller

pieces and poured into a blender in an aseptic condition. The extracted fruit juice was divided into 24 pet bottles (100 ml) and each was preserved with different concentrations (5.0% - 40%) of *O. gratissimum* aqueous solutions and citric acid 0.2% - 0.5%.

### 2.2 Proximate and Sensory Analysis

The proximate parameters (Crude protein, crude fibre, fat and dry matter) of the pineapple juice were determined using the official methods of analysis [13]. The carbohydrate content was calculated by difference. A sensory evaluation was carried out on the juice samples. A nine-point Hedonic scale and Analysis of variance (ANOVA) [14] were utilized. Ten semi-trained panelists were recruited. They were served the juice samples in coded cups. The panelists assessed the taste, colour, flavors and general acceptability of the samples using a nine-point Hedonic scale where 1 = dislike extremely and 9 = like extremely.

## 3. Results

### 3.1 Effect of different concentrations *O. gratissimum* leaf extract of citric acid on the moisture content of pineapple juice stored at $30 \pm 2^\circ\text{C}$ for 10 days

Prior to the addition of different concentrations *O. gratissimum* leaf extract and citric acid to pineapple juice, the moisture content ranged from  $85.42 \pm 0.02\%$  to  $93.19 \pm 0.00\%$  for the day 1 prepared juice by 10 days of storage at  $30 \pm 2^\circ\text{C}$ . Addition of the concentration 5% of *O. gratissimum* leaf extract and 0.2% citric acid did not significantly ( $p \leq 0.05$ ) reduce the moisture content of pineapple juice during the storage so also increase in the percentage of leaf extract and citric acid up to 30% and 0.4%. However, the addition of the *O. gratissimum* (40%) and citric acid up to 0.5% significantly ( $p \leq 0.05$ ) reduces the moisture content to  $77.95 \pm 0.08\%$  on day 1 and  $78.34 \pm 0.05\%$  of the juice stored for 10 days while 0.5% concentration of citric acid significantly ( $p \leq 0.05$ ) reduce the MC to

85.42 ± 0.00% for day 1 and 85.72 ± 0.06% for day 5 of storage at the ambient temperature of 30 ± 2°C. The concentration of 40% *O. gratissimum* leaf extract was the most effective in reducing the MC content thereby increase the shelf life. The results of different concentrations of *O. gratissimum* plant leaf extract on the moisture content (MC) of pineapple juice stored at 30 ± 2°C for 10 days are shown in Figure 1.

### 3.2 Effect of different concentrations of *Ocimum gratissimum* leaf extract and citric acid on the ash content of pineapple juice stored at 30 ± 2°C for 10 days

Prior to the addition of different concentrations *O. gratissimum* leaf extract and citric acid to pineapple juice, the ash content ranged from 0.17 ± 0.00% to 0.32 ± 0.00% for the day 1 prepared juice by 10 days of storage at 30 ± 2°C. Addition of the concentration 5% of *O. gratissimum* leaf extract and 0.2% citric acid significantly ( $p \leq 0.05$ ) reduce the ash content of pineapple juice during the storage so also increase in the percentage of leaf extract and citric acid up to 30% and 0.4%. However, the addition of the *O. gratissimum* (40%) and citric acid up to 0.5% significantly ( $p \leq 0.05$ ) increases and stabilizes the ash content to 1.10 ± 0.01% on day 1 and 1.11 ± 0.01% of the juice stored for 10 days while 0.5% concentration of citric acid significantly ( $p \leq 0.05$ ) stabilizes the ash content 0.32 ± 0.00% for day 1 and .10 days 0.30 ± 0.00% of storage at the ambient thof 30 ± 2°C. As the concentration *O. gratissimum* leaf extract increases there was an increase in ash content of the stored pineapple juice. The results of different concentrations of *O. gratissimum* plant leaf extract and citric acid on the ash content of pineapple juice stored at 30 ± 2°C for 10 days are shown in Figure 2.

### 3.3 Effect of different concentrations of *Ocimum gratissimum* leaf extract and citric acid on the

### carbohydrate content of pineapple juice stored at 30 ± 2°C for 10 days

Prior to the addition of different concentrations *O. gratissimum* leaf extract and citric acid to pineapple juice, the carbohydrate content ranged from 11.94 ± 0.00% to 5.10 ± 0.01% for the day 1 prepared juice by 10 days of storage at 30 ± 2°C. Addition of the concentration 5% of *O. gratissimum* leaf extract and 0.2% citric acid significantly ( $p \leq 0.05$ ) reduce the carbohydrate content of pineapple juice during the storage so also increase in the percentage of leaf extract and citric acid up to 30% and 0.4%. However, the addition of the *O. gratissimum* (40%) and citric acid up to 0.5% significantly ( $p \leq 0.05$ ) increases and stabilizes the carbohydrate content to 15.46 ± 0.00% on day 1 and 15.38 ± 0.00% of the juice stored for 10 days while 0.5% concentration of citric acid significantly ( $p \leq 0.05$ ) reduces the carbohydrate content 11.95 ± 0.00% for day 1 and 10 days 11.81 ± 0.00% of storage at ambient temperature of 30 ± 2°C. As the concentration *O. gratissimum* leaf extract increases there was an increase in carbohydrate content of the stored pineapple juice. The results of different concentrations of *O. gratissimum* plant leaf extract on the carbohydrate content of pineapple juice stored at 30 ± 2°C for 10 days are shown in Figure 3.

### 3.4 Effect of different concentrations of *Ocimum gratissimum* leaf extract and citric acid on the protein content of pineapple juice stored at 30 ± 2°C for 10 days

Prior to the addition of different concentrations *O. gratissimum* leaf extract and citric acid to pineapple juice, the protein content ranged from 0.95 ± 0.00% to 1.09 ± 0.00% for day 1 prepared juice by 10 days of storage at 30 ± 2°C. Addition of the concentration 5% of *O. gratissimum* leaf extract and 0.2% citric acid significantly ( $p \leq 0.05$ ) reduce the protein content of pineapple juice during the storage so also increase in the

percentage of leaf extract and citric acid up to 30% and 0.4%. However, the addition of the *O. gratissimum* (40%) and citric acid up to 0.5% significantly ( $p \leq 0.05$ ) increases and stabilizes the protein content to  $2.29 \pm 0.00\%$  on day 1 and  $2.24 \pm 0.00\%$  of the juice stored for 10 days while 0.5% concentration of citric acid significantly ( $p \leq 0.05$ ) reduces the protein content  $1.08 \pm 0.01\%$  for day 1 and  $1.07 \pm 0.01\%$  for 10 days of storage at an ambient temperature of  $30 \pm 2^\circ\text{C}$ . As the concentration *O. gratissimum* leaf extract increases there was an increase in protein content of the stored pineapple juice. The results of different concentrations of *O. gratissimum* plant leaf extract on the protein content of pineapple juice stored at  $30 \pm 2^\circ\text{C}$  for 10 days is shown Figure 4.

### 3.5 Effect of different concentrations of *Ocimum gratissimum* leaf extract and citric acid on the fat content of pineapple juice stored at $30 \pm 2^\circ\text{C}$ for 10 days

Prior to the addition of different concentrations *O. gratissimum* leaf extract and citric acid to pineapple juice, the fat content ranged from  $0.08 \pm 0.00\%$  to  $0.20 \pm 0.01\%$  for day 1 prepared juice by 10 days of storage at  $30 \pm 2^\circ\text{C}$ . Addition of the concentration 5% of *O. gratissimum* leaf extract and 0.2% citric acid significantly ( $p \leq 0.05$ ) reduce the fat content of pineapple juice during the storage so also increase in the percentage of leaf extract and citric acid up to 30% and 0.4%. However, the addition of the *O. gratissimum* (40%) and citric acid up to 0.5% significantly ( $p \leq 0.05$ ) increases and stabilizes the fat content to  $2.29 \pm 0.00\%$  on day 1 and  $2.24 \pm 0.00\%$  of the juice stored for 10 days while 0.5% concentration of citric acid significantly ( $p \leq 0.05$ ) reduces the fat content  $0.61 \pm 0.00\%$  for day 1 and  $0.51 \pm 0.01\%$  for 10 days of storage at the ambient temperature of  $30 \pm 2^\circ\text{C}$ . As the concentration *O. gratissimum* leaf extract increases, there was an increase in fat content of the stored

pineapple juice. The results of different concentrations of *O. gratissimum* plant leaf extract on the fat content of pineapple juice stored at  $30 \pm 2^\circ\text{C}$  for 10 days are shown in Figure 5.

### 3.6 Effect of different concentrations of *Ocimum gratissimum* leaf extract and citric acid on fibre content of pineapple juice stored at $30 \pm 2^\circ\text{C}$ for 10 days

Prior to the addition of different concentrations *O. gratissimum* leaf extract and citric acid to pineapple juice, the fibre content ranged from  $0.52 \pm 0.01\%$  to  $1.03 \pm 0.01\%$  for the day 1 prepared juice by 10 days of storage at  $30 \pm 2^\circ\text{C}$ . Addition of the concentration 5% of *O. gratissimum* leaf extract and 0.2% citric acid significantly ( $p \leq 0.05$ ) reduce the fibre content of pineapple juice during the storage so also increase in percentage of leaf extract and citric acid up to 30% and 0.4%. However, the addition of the *O. gratissimum* (40%) and citric acid up to 0.5% significantly ( $p \leq 0.05$ ) increases and stabilizes the fibre content to  $2.43 \pm 0.01\%$  on day 1 and  $2.41 \pm 0.00\%$  of the juice stored for 10 days while 0.5% concentration of citric acid significantly ( $p \leq 0.05$ ) reduces the fibre content  $1.03 \pm 0.01\%$  for day 1 and  $0.95 \pm 0.01\%$  for 10 days of storage at an ambient temperature of  $30 \pm 2^\circ\text{C}$ . As the concentration *O. gratissimum* leaf extract increases there was increase in fibre content of the stored pineapple juice at day 1. The results of different concentrations of *O. gratissimum* plant leaf extract on the fibre content of pineapple juice stored at  $30 \pm 2^\circ\text{C}$  for 10 days are shown Figure 6.

### 3.7 Effect of different concentrations of *Ocimum gratissimum* leaf extract and citric acid on taste of pineapple juice stored at $30 \pm 2^\circ\text{C}$ for 10 days

Prior to the addition of different concentrations *O. gratissimum* leaf extract and citric acid to pineapple juice, the taste content ranged from  $2.89 \pm 0.78$  to 8.33

$\pm 0.50$  for day 1 prepared juice by 10 days of storage at  $30 \pm 2^\circ\text{C}$ . Addition of the concentration 5% of *O. gratissimum* leaf extract and 0.2% citric acid significantly ( $p \leq 0.05$ ) reduce the taste content of pineapple juice during the storage so also increase in the percentage of leaf extract and citric acid up to 30% and 0.4%. However, the addition of the *O. gratissimum* (40%) and citric acid up to 0.5% significantly ( $p \leq 0.05$ ) increases and stabilizes the taste content to  $7.78 \pm 0.67$  on day 1 and throughout of the juice stored for 10 days while 0.5% concentration of citric acid significantly ( $p \leq 0.05$ ) reduce the taste content to  $7.22 \pm 1.20$  for day 1 and  $7.11 \pm 1.45$  for 10 days of storage at ambient temperature of  $30 \pm 2^\circ\text{C}$ . As the concentration As the *O. gratissimum* leaf extract increases, there was a decrease in the taste content of the stored pineapple juice on day 1. The *O. gratissimum* leaf extract did not compare favourable with the citric acid on the taste of pineapple juice. The results of different concentrations of *O. gratissimum* leaf extract and citric acid on the taste content of pineapple juice stored at  $30 \pm 2^\circ\text{C}$  for 10 days are shown in Figure 7.

### 3.8 Effect of different concentrations of *Ocimum gratissimum* leaf extract and citric acid on colour of pineapple juice stored at $30 \pm 2^\circ\text{C}$ for 10 days

Prior to the addition of different concentrations *O. gratissimum* leaf extract and citric acid to pineapple juice, the colour content ranged from  $2.44 \pm 0.53$  to  $7.78 \pm 0.44$  for the day 1 prepared juice by 10 days of storage at  $30 \pm 2^\circ\text{C}$ . Addition of the concentration 5% of *O. gratissimum* leaf extract and 0.2% citric acid significantly ( $p \leq 0.05$ ) reduce the colour content of pineapple juice during the storage so also increase in percentage of leaf extract and citric acid up to 30% and 0.4%. However, the addition of the *O. gratissimum* (40%) and citric acid up to 0.5% significantly ( $p \leq 0.05$ ) increases and stabilizes the colour content to  $5.22 \pm 0.83$  on day 1 and  $7.33 \pm 0.87$  of the juice stored for 10 days

while 0.5% concentration of citric acid significantly ( $p \leq 0.05$ ) stabilizes the colour content to  $7.89 \pm 0.60$  for 10 days of storage at the ambient temperature of  $30 \pm 2^\circ\text{C}$ . As the concentration As the *O. gratissimum* leaf extract increases, there was decrease in colour content of the stored pineapple juice at day 1. The *O. gratissimum* leaves extract compare favourable with the citric acid on the colour of pineapple juice. The results of different concentrations of *O. gratissimum* leaf extract and citric acid on the colour content of pineapple juice stored at  $30 \pm 2^\circ\text{C}$  for 10 days are shown in Figure 8.

### 3.9 Effect of different concentrations of *Ocimum gratissimum* leaf extract and citric acid on the flavour of pineapple juice stored at $30 \pm 2^\circ\text{C}$ for 10 days

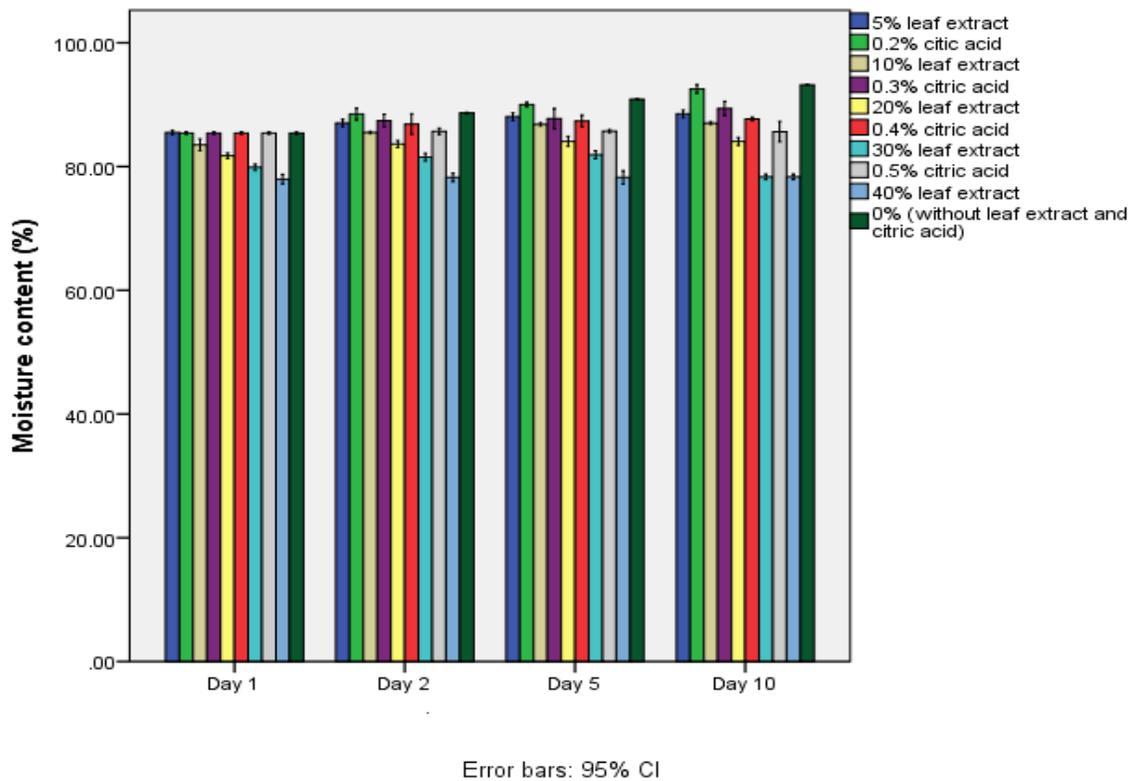
Prior to the addition of different concentrations *O. gratissimum* leaf extract and citric acid to pineapple juice, the flavour content ranged from  $2.44 \pm 0.53$  to  $8.11 \pm 1.05$  for the day 1 prepared juice by 10 days of storage at  $30 \pm 2^\circ\text{C}$ . Addition of the concentration 5% of *O. gratissimum* leaf extract and 0.2% citric acid significantly ( $p \leq 0.05$ ) reduce the flavour content of pineapple juice during the storage so also increase in percentage of leaf extract and citric acid up to 30% and 0.4%. However, the addition of the *O. gratissimum* (40%) and citric acid up to 0.5% significantly ( $p \leq 0.05$ ) increases and stabilizes the flavour content to  $6.56 \pm 0.53$  on day 1 and  $6.56 \pm 0.53$  of the juice stored for 10 days while 0.5% concentration of citric acid significantly ( $p \leq 0.05$ ) reduce the flavour content to  $8.11 \pm 1.05$  for day 1 and  $7.56 \pm 0.88$  for 10 days of storage at ambient temperature of  $30 \pm 2^\circ\text{C}$ . As the concentration As the *O. gratissimum* leaf extract increases, there was a decrease in flavour content of the stored pineapple juice on day 1. The *O. gratissimum* leaves extract did not compare favourable with the citric acid on the flavour of pineapple juice. The results of

different concentrations of *O. gratissimum* leaf extract and citric acid on the flavour content of pineapple juice stored at  $30 \pm 2^\circ\text{C}$  for 10 days are shown in Figure 9.

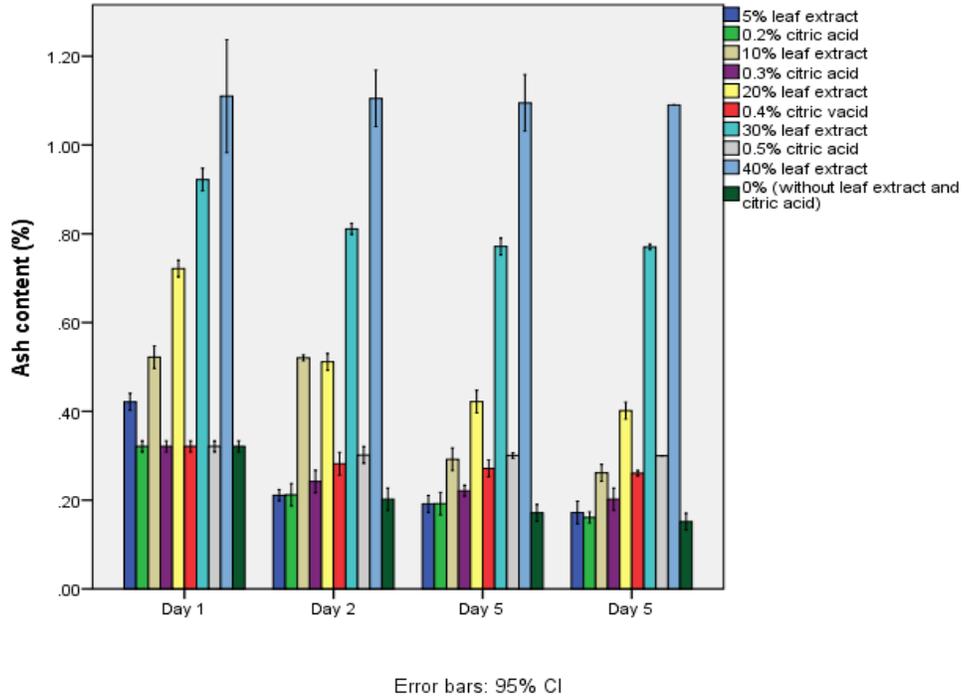
**3.10 Effect of different concentrations of *Ocimum gratissimum* leaf extract and citric acid on the general acceptability of pineapple juice stored at  $30 \pm 2^\circ\text{C}$  for 10 days**

Prior to the addition of different concentrations *O. gratissimum* leaf extract and citric acid to pineapple juice, the general acceptability by the panelists ranged from  $2.44 \pm 0.53$  to  $8.11 \pm 1.05$  for the day 1 prepared juice by 10 days of storage at  $30 \pm 2^\circ\text{C}$ . Addition of the concentration 5% of *O. gratissimum* leaf extract and 0.2% citric acid significantly ( $p \leq 0.05$ ) reduce the general acceptability content of pineapple juice during the storage so also increase in the percentage of leaf extract and citric acid up to 30% and 0.4%. However,

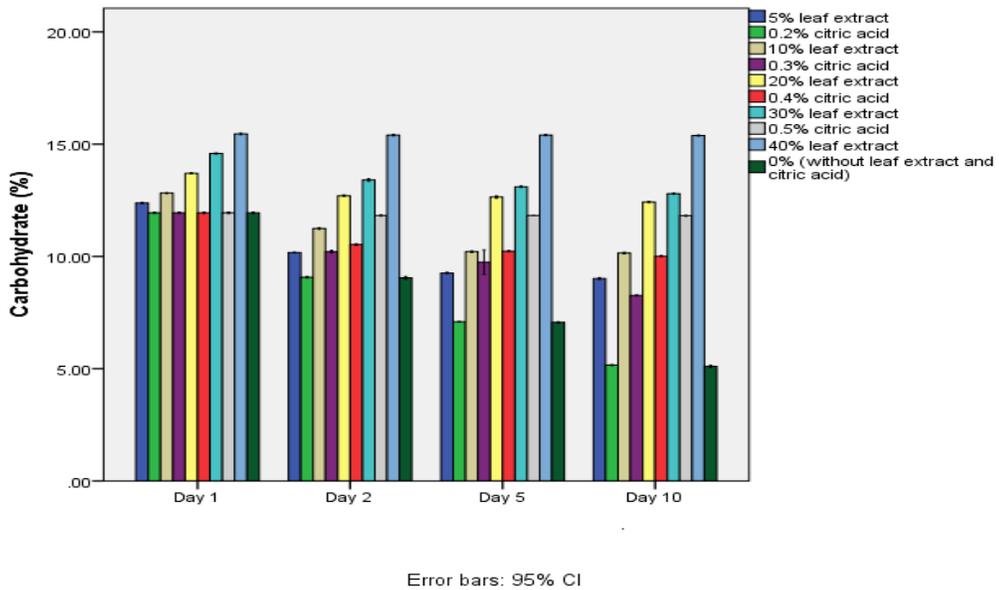
the addition of the *O. gratissimum* (40%) and citric acid up to 0.5% significantly ( $p \leq 0.05$ ) increases and stabilizes the general acceptability content to  $8.11 \pm 1.05$  on day 1 and through out of the juice stored for 10 days while 0.5% concentration of citric acid significantly ( $p \leq 0.05$ ) reduce the general acceptability content to  $7.78 \pm 0.97$  for day 1 and  $6.11 \pm 1.27$  for 10 days of storage at the ambient temperature of  $30 \pm 2^\circ\text{C}$ . As the *O. gratissimum* leaf extract increases, there was general acceptability by the panelists of the stored pineapple juice at day 1 and 40% leaf extract concentration till 10 days. The *O. gratissimum* leaves extract compare favourable well with the citric acid on the general acceptability of pineapple juice. The results of different concentrations of *O. gratissimum* plant leaf extract and citric acid on the general acceptability of pineapple juice stored at  $30 \pm 2^\circ\text{C}$  for 10 days are shown in Figure 10.



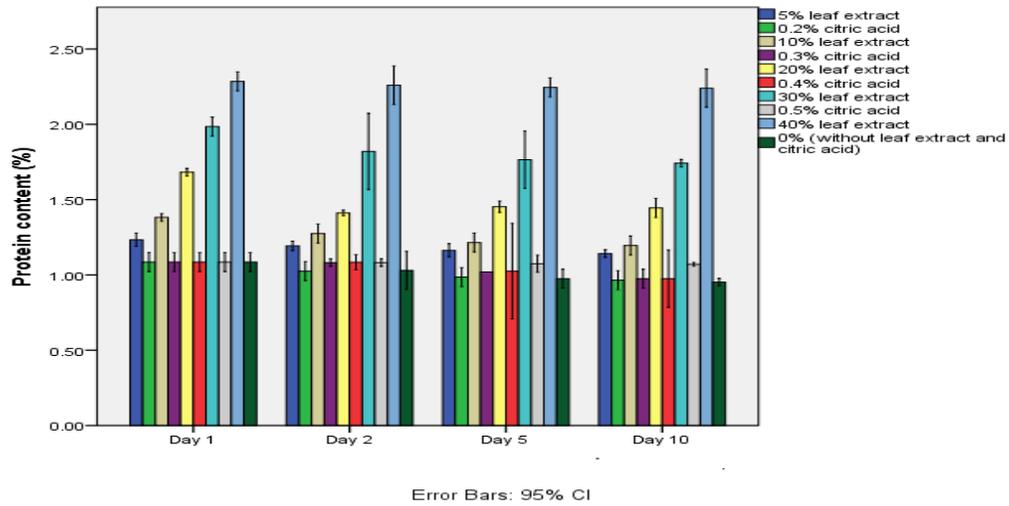
**Figure 1:** Effect of different concentrations of *Ocimum gratissimum* leaf extract and citric acid on the moisture content of pineapple juice stored at  $30 \pm 2^\circ\text{C}$  for 10 days.



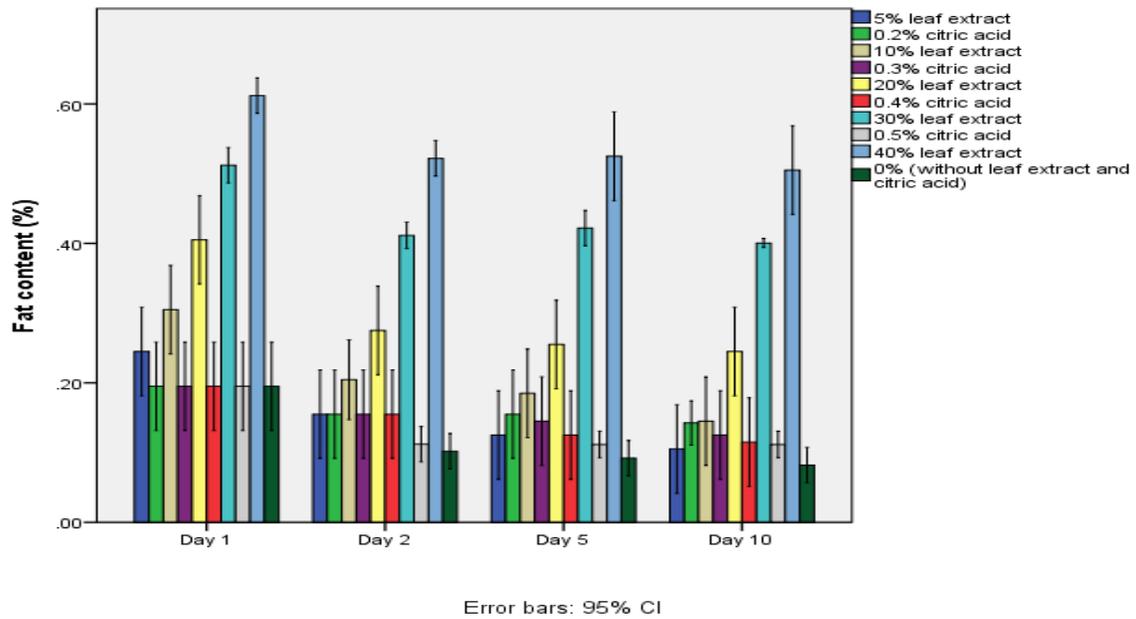
**Figure 2:** Effect of different concentrations of *Ocimum gratissimum* leaf extract and citric acid on the ash content of pineapple juice stored at 30 ± 2°C for 10 days.



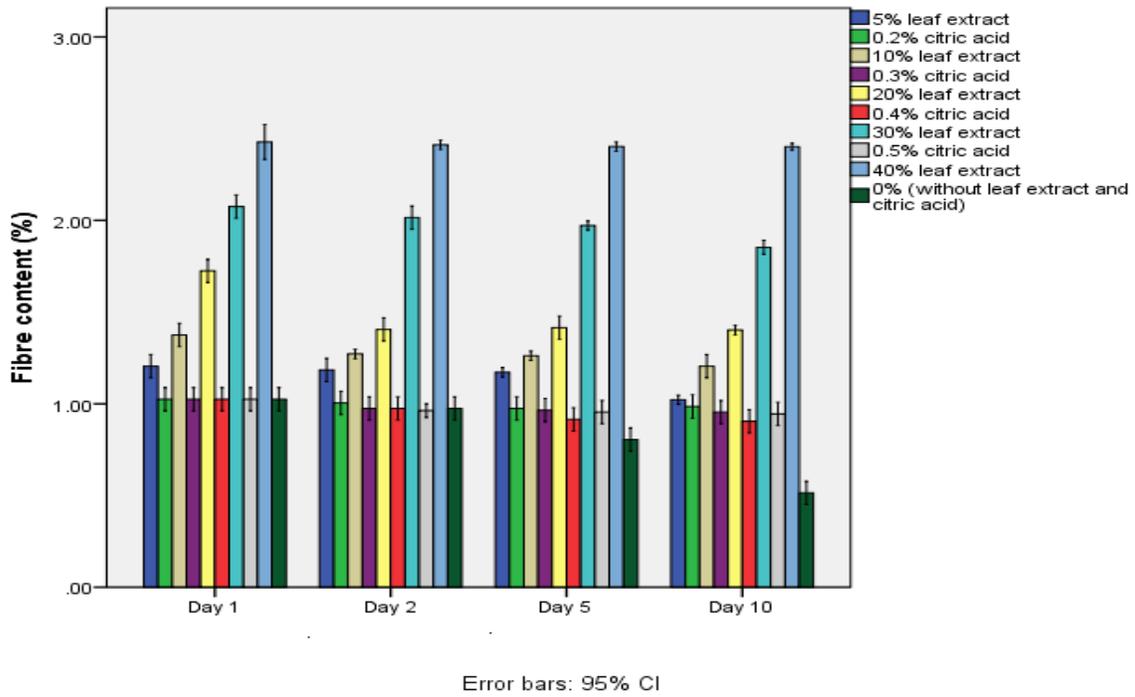
**Figure 3:** Effect of different concentrations of *Ocimum gratissimum* leaf extract and citric acid on the carbohydrate content of pineapple juice stored at 30 ± 2°C for 10 days.



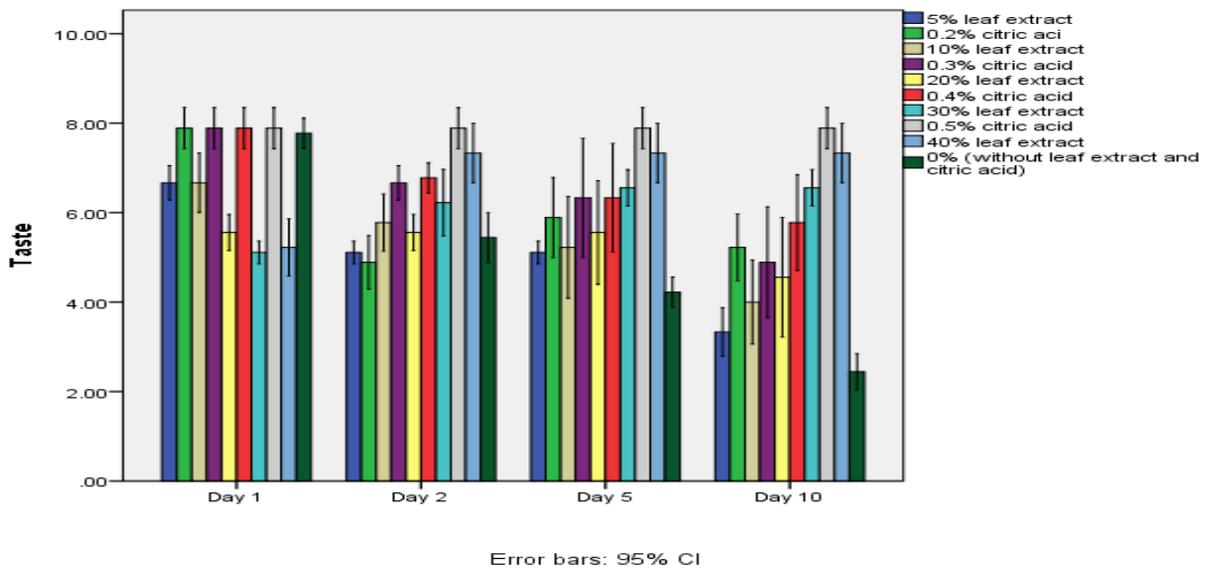
**Figure 4:** Effect of different concentrations of *Ocimum gratissimum* leaf extract and citric acid on the protein content of pineapple juice stored at 30 ± 2°C for 10 days.



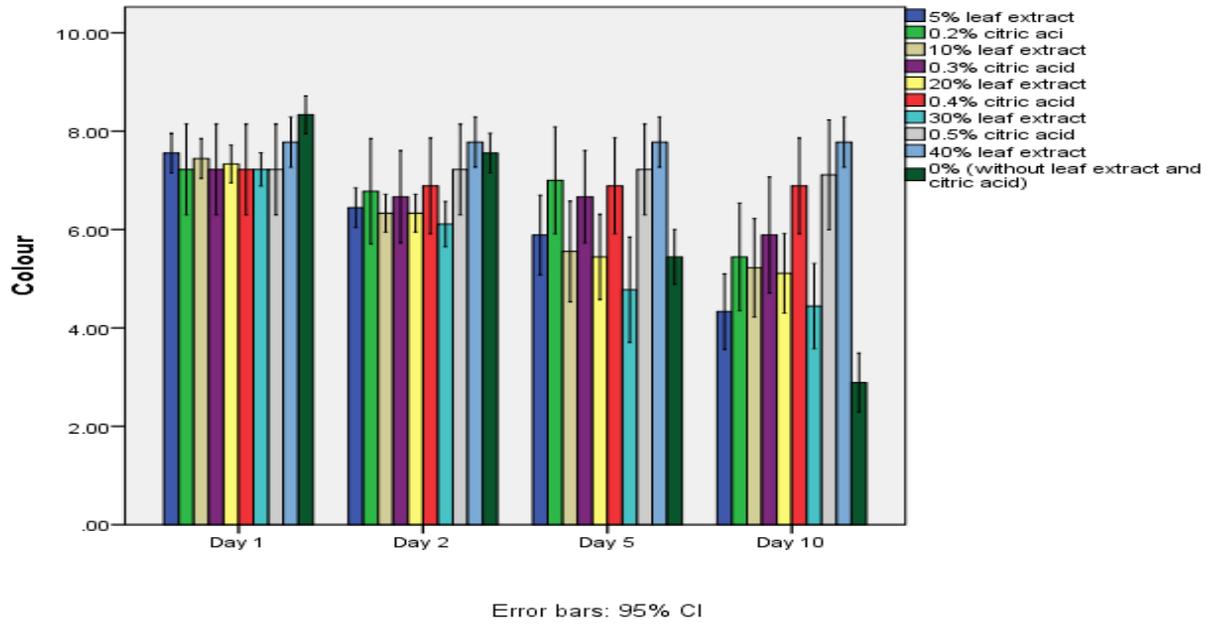
**Figure 5:** Effect of different concentrations of *Ocimum gratissimum* leaf extract and citric acid on the fat content of pineapple juice stored at 30 ± 2°C for 10 days.



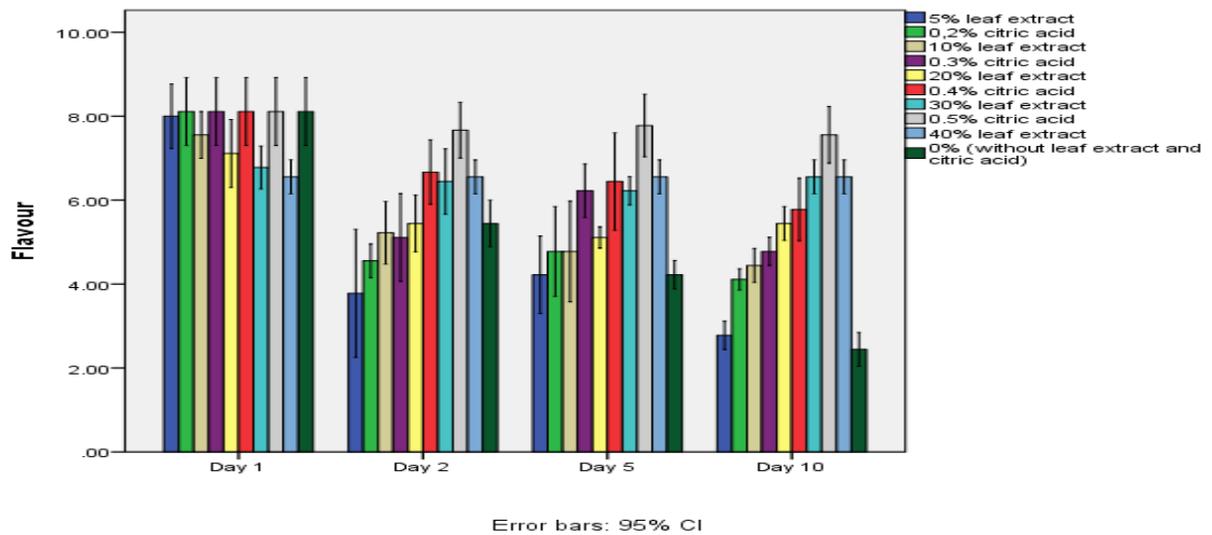
**Figure 6:** Effect of different concentrations of *Ocimum gratissimum* leaf extract and citric acid on the fibre content of pineapple juice stored at 30 ± 2°C for 10 days.



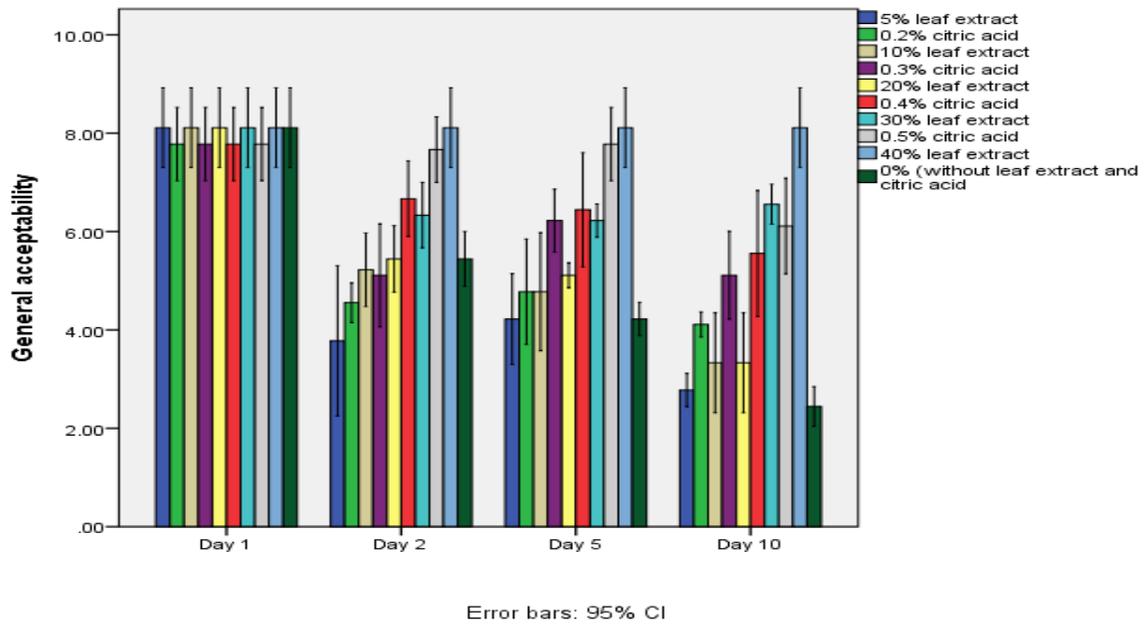
**Figure 7:** Effect of different concentrations of *Ocimum gratissimum* leaf extract and citric acid on the taste content of pineapple juice stored at 30 ± 2°C for 10 days.



**Figure 8:** Effect of different concentrations of *Ocimum gratissimum* leaf extract and citric acid on the colour content of pineapple juice stored at  $30 \pm 2^\circ\text{C}$  for 10 days.



**Figure 9:** Effect of different concentrations of *Ocimum gratissimum* leaf extract and citric acid on the flavour content of pineapple juice stored at  $30 \pm 2^\circ\text{C}$  for 10 days.



**Figure 10:** Effect of different concentrations of *Ocimum gratissimum* leaf extract and citric acid on the general acceptability content of pineapple juice stored at  $30 \pm 2^\circ\text{C}$  for 10 days.

#### 4. Discussion

The moisture content of pineapple juice treated with different concentrations of *O. gratissimum* leaf extract was found to be decreasing with increasing concentration of the extract and increasing storage intervals. The moisture content of control was found to be increasing with storage intervals. Both the *O. gratissimum* leaf extract and citric acid was able to maintain the water content stability of fruit juices compared to the control. Maintenance of stable water content of food items is necessary in order to maintain the nutritive quality of the food items through the shelf life. Increase in water content of food increase the vulnerability of microbial attack of food thereby decrease the shelf life as shown in Figure 1.

However, it was observed that the addition of *O. gratissimum* plant leaf extract as a preservative to pineapple juice progressively increase the ash content (inorganic mineral elements). It could be therefore be inferred while the addition of *O. gratissimum* leaf extract increase the mineral contents of fruit juice. It

may, therefore, be said that *O. gratissimum* leaf extract acts a positive effect on the inorganic mineral composition of pineapple juice [15-16]. *Ocimum. gratissimum* plant leaf extract at different concentrations was found to stabilize the carbohydrate of pineapple juice and the effects increase with increasing concentrations of leaf extract. The carbohydrate in the treated pineapple juice was found to progressively decrease with increasing storage intervals. This may be due to inactivation of microorganisms in the pineapple by the added *O. gratissimum* extracts which prevented the utilization of the treated pineapple juice sample [17-18].

Different concentrations of *O. gratissimum* leaf extract were found to be effective in preserving the amount of protein in the pineapple juice compared to the untreated. However, a slight decrease in the protein content of treated pineapple juice was observed with increasing storage intervals. The protein content of the treated pineapple juice with *O. gratissimum* leaf was observed to be higher than the control (untreated pineapple juice).

The increase noted in the treated sample might be the additional effect from the slight protein content present in the extract [16].

*Ocimum gratissimum* leaf is effective as a preservative in stabilizing the fat content of the pineapple juice sample at different concentrations. However, the fat content of the untreated sample was found to be progressively increased with storage intervals. The increase in the fat content of the control sample was observed with the storage intervals may be attributed to the formation of fatty degradation by-products formed from the biochemical reaction of the microorganisms in the pineapple juice while that of citric acid treated apple juice was found to remain constant with the control throughout the storage intervals. The *O. gratissimum* extract pineapple juice was observed to have higher fibre content than the untreated samples (control). This is because of the fibre content from the plant extract used for preservation. Therefore it could be inferred that usage of plant extract in pineapple juice preservation increase the fibre content of juice thus, improving the nutrient content [15].

It was noted that the concentration of fatty content in the pineapple fruit juice without preservatives (*O. gratissimum* leaf extract) ie the control increases as the storage interval progresses. However, the addition of different concentrations of *O.* extract was able to stabilize the fat content over the period of storage except at low concentration (5%) of the *O.* extract which was only able to stabilize the fat content of pineapple juice until 2<sup>nd</sup> day of storage. This percentage of extract fails to acts as a preservative after the 2<sup>nd</sup> day of storage as shown in Figure 5. The fibre content of preserved pineapple juice with extract (different concentrations) was noted to be higher than that of the control sample (unpreserved). The increase in concentration noted in the preserved pineapple juice

samples may be due to the fibre content of *O. gratissimum* extract used as a preservative. Fibre content adds to the nutritive quality of pineapple juice. Therefore, the increase in fibre content of the preserved juice with leaf extract can be said to be advantageous from the nutritive point of view. It was reported by Adebayo *et al.* [15] that dietary fibre content is important for lowering blood cholesterol and blood sugar and aids in the emptying of the bowel reduce the risk of diseases such as obesity, diabetes, etc [17]. The fibre content in foods was also been implicated in removing the ingested heavy metals contaminants in [18].

Food spoilage is a metabolic process that causes food to be undesirable or unacceptable for human consumption due to changes in sensory characteristics [19]. The effects of different concentrations of *O. gratissimum* leaf extract and citric acid on the organoleptic properties of fruit juices were considered. *O. gratissimum* leaf extract was found to have negative on the taste of pineapple juice and this effect increases with increasing concentrations. However, as storage intervals progress, the untreated pineapple juice is progressively regretted by the panelists due to its objectionable taste. The taste of the preserved pineapple juice became acceptable compared to the control from 2<sup>nd</sup> day through the 10<sup>th</sup> day of storage. This observation clearly indicated that *O. gratissimum* leaf extract was able to inhibit some biochemical reaction such as fermentation, enzymatic oxidation [20]. The objectionable taste noted in the untreated pineapple juice could be as a result of the production of alcohol, aldehyde, and ketone ad carboxylic acid through progressive fermentation of fruit juice from fructose.

It was noted that the colour acceptability of pineapple juice decreases with increasing concentration of *O. gratissimum* plant leaf extract on the day 1 sample

compared to control. The colour acceptability of the control decreases progressively with the storage intervals while preserved samples remain mostly acceptable in term of colour throughout the duration of storage [21]. The colour instability of the control could be attributed to biochemical processes in the juice sample which are more pronounced in the control sample. Such reactions include enzymatic browning and enzymatic oxidation amongst others which produces off colours. The acceptability of pineapple juice preserved with different concentrations of *O. gratissimum* extract decreases with increasing concentrations of the extract. The flavour of the unpreserved juice was noted to become progressively objectionable with increasing storage intervals as shown in Figure 9. The unacceptability of the pineapple flavour with increasing storage intervals could be attributed to the accumulation of biochemical products include alcohol, aldehydes, carboxylic acid, ethers, and ketones. The panelists indicated the alcohol taste in pineapple juice as a deterioration of taste evaluation. The alcohol taste might be appeared because of by-products (organic acids and acetaldehyde) released due to microorganisms such as yeast activity. Yeast spoilage in fruit juices is characterized by formation of CO<sub>2</sub> and alcohol. It could be due to non-enzymatic reactions in which sugar is used up, releasing a variety of end products leading to a reduction in the sweetness of the juice and contribute to a fermented flavor [21-23].

## 5. Conclusions

The results of these studied have shown that *Ocimum gratissimum* Linn. leaf extract contain some appreciable amount of nutrients which increase the nutritional content of pineapple juice and at same time phytochemicals which stabilize and shielded the nutrient present in juice. A 40% concentration of *Ocimum gratissimum* was the best to preserve pineapple juice for 10 days. It is therefore recommended as an alternative

method of keeping the storage quality of pineapple juice. The panelists rated pineapple juice treated with *O. gratissimum* leaf extract (40%) the best in terms of colour and general acceptability and slightly affected the taste and flavour while 0.5% citric acid concentration best in flavour and taste evaluated.

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## Conflicts of Interest

No conflicts of interest.

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