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Research Article

Production and Shelf-Life Extension of Grape Juice Sweetened with Honey and Preserved with Ginger

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Abstract

Grape fruit juice was processed with different concentrations of honey and ginger and physicochemical, nutritional and microbial quality of the juice was investigated. Samples (T_2, T_3, T_4, T_5 and T_6) were processed with some levels of honey and ginger whereas T_1 and T_7 served as control. The results of the analysis showed that there was a significant difference ($P<0.05$) in the protein content. The percentage moisture content (91.47- 94.76%), carbohydrate (3.06 -6.71%), Crude fibre (0.18 -0.78%), fat (0.13 -0.29%) and ash content (0.45 -0.84%) recorded some level of difference on the juice samples ($P<0.05$). The physicochemical results showed that there was no significant different in the pH, specific gravity, titratable acidity on the sixth day whereas significant difference was observed on the sugar content. There was no significant difference on vitamins B_1, B_2 and B_3 on each day of analysis but differences exist between 1st, 3rd and 6th day respectively. Vit C showed a level of difference significantly ($P<0.05$). Sensory scores show that samples 513, 417 and 283 were more preferred than other samples. Results of microbial analysis showed that microbial growth at the 1st day (1.8×10^4 -3.8×10^4) cfu/ml increased slightly during the 3rd day of juice storage ($2.7 \times 10^4 - 5.8 \times 10^4$) cfu/ml. The load of microorganisms increased during the sixth day (6.3×10^4-10.2×10^4 cfu/ml). Samples without ginger (T_1 and T_7) recorded the highest microbial growth and juice deterioration. All samples with different concentrations of ginger and honey recorded lesser level of deterioration. Samples with highest concentration of ginger (2%) and honey (2%) preserved more than others. This study show that ginger has antioxidative and anti-microbial properties capable of prolonging the shelf life of processed grape fruit juice.

INTRODUCTION

The grape fruit is a subtropical citrus tree known for possessing sour fruits, they are given the name grapefruit due to the way they grew in clusters similar to grapes [1]. Grape belongs to the *Rutaceae* family with binomial name *Citrus paradis* [2]. The trees of grape usually grow to a height ranging from 5-15 meters (16-49ft). The fruit is yellow-orange skinned and largely ablate spheroid, the diameter ranges from 10-15cm. The fruit is also known to posses a bitter taste as a result of a flavonone present in it known as Naringin [3]. Honey is a natural substance produced from honeybees (*Apis mellifera*) from the nectar of flowers which are very sweet, flavourful and viscous [4]. Honey is a sweet, viscous food substance made by honeybees and other bees [5]. It has been used as a food and also in medicine. Honey is a complex mixtures and possess great variations in composition and characteristics due to its geographical and botanical origin, their real features depends on the floral origin or the nectar foraged by the bees [6]. Honey is crucial food that gives energy, ingredients in many food manufacturing industries mainly in cereal and cereal products. They can be used as sweetners, color enhancers, flavor, caramelization, pumpability and viscosity [5]. Honey can be used in the area of food, medicine, pharmaceutical, traditional healing, religious and margical area [4]. Ginger *(Zingiber officinale),* a member of the *Zingiberaceae* family, is a popular spice used globally especially in most of the Asian countries [7]. Chemical analysis of ginger shows that it contains over 400 different compounds and the major constituents in ginger rhizomes are carbohydrates (50-70%), lipids (3-8%), terpenes, and phenolic compounds [8]. Terpene components of ginger include zingiberene, β-bisabolene, α-farnesene, β-sesquiphellandrene, and α-curcumene, while phenolic compounds include gingerol, paradols, and shogaol [9]. These gingerols (23-25%) and shogaol (18-25%) are found in higher quantity in *Zingibber officinale* than others. Besides these, amino acids, raw fiber, ash, protein, phytosterols, vitamins (e.g., nicotinic acid and vitamin A), and minerals are also present in ginger [10]. Ginger is one of the most widely used species of Rhizome which is widely found in several foods and beverages. It is a widely used herbs in traditional Chinese, Europe and America [11].

Fruit juice is unfermented but fermentable juice intended for direct consumption obtained by mechanical process from mesocarp of sound ripe fruit [12]. It can be referred as the liquid expressed by pressure or other mechanical means from the edible portion of a fruit which can be single strength or concentrated drinks [13]. Fruit juices are good sources of vitamins and minerals. Most tropical fruits are seasonal and when they are in season, they are found in abundance. Many people consume the juice when they are in the season and a lot of postharvest losses make them unavailable during the off-season.

Therefore, in a way to make these fruit juices available all year round, the postharvest losses can be reduced or eradicated

by processing and preservation [14]. Many chemicals are used today as a preservative for fruits and juices but their effectiveness for these tropical fruits are not readily available even though they are being used. Therefore, there is the need to consider our natural plant preservatives such as ginger to preserve grapefruit juice and honey to improve its sour test (sweetner). Hence, the objective of this study.

MATERIALS AND METHODS

Good quality ripe grapefruit (*Citrus paradisi*) were obtained from Nkwo Achara market, Uturu, Isuikwuato Local Government Area, Abia State, Nigeria and transported to the Food Science and Technology Laboratory of Abia State University, Uturu for preparation and analysis.

Sample Preparation

The method of grape fruit extraction described by [15], was used in the preparation of grape fruit juice. Fully matured (ripe) grapefruit were cleaned and washed with tap water. It was weighed, peeled and extracted with a table juice extractor (chopper and mixer/Y48/stainless steel). The juice was filtered through Reusable filtration cloth and different concentrations of ginger and honey were added before deaeration, pasteurization, filling of cans and cooling. The processed grape juice sweetened with honey and preserved with ginger were stored at room temperature and analyzed on the 1st, 3rd and 6th days respectively.

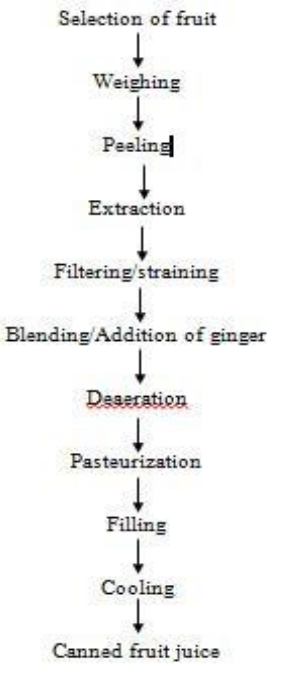

Figure 1 Flow chart for grape fruit juice extraction.

Concentrations of Ginger/ Honey Used

T_1 = No ginger and honey, T_2 = 0.5% ginger without honey, T_3 = 0.5% ginger + 0.5% honey, T_4 = 1.5% ginger + 1.5% honey, T_5 = 1.5% ginger + 2.0% honey, T_6 = 2% ginger + 2.0% honey, T_7 = No ginger + 1.5% honey.

Proximate Composition

The moisture content of each sample was determined by the gravimetric method according to [16]. Ash content was determined by the [17], Crude fibre was determined by the method described by [18], Fat content was determined by the continuous solvent extraction (soxhlet reflux) apparatus described by [19], crude protein was determined by the Kjeldahl method of [20] and carbohydrate content was determined by difference.

Determination of Vitamins

Determination of vitamin B_1 was done according to the spectrophotometric method adopted by [21], vitamin B_2 content of the samples was determined by the method adopted by [22]. Vitamin B_3 content was determined by the high performance liquid chromatography [23] and vitamin C content of the fruit sample was determined by oxidative reduction reaction adopted by [24].

Determination of Physical Properties of the Samples

Determination of Total Titratable Acidity (TTA): Total Titratable Acidity (TTA) and sugar content was determined according to the method described by [17]. pH was measured directly using a pH meter (Jenway model SM 60ml Surgifield England). Specific gravity was determined by the pyconometer gravimetric method described by [19].

Sensory Evaluation

Sensory evaluation was carried out using nine (9) point hedonic scale described by [25], where 15 untrained panelists were used taste and score the coded samples.

Microbial Analysis

The method of International Commission for Microbiological Specifications for Foods [26] was adopted. 1ml of the sample was diluted with 9ml of sterile distilled water and mixed very well. 1ml of the resultant mixture was aseptically transferred to 9ml of sterile distilled water in a test tube. It was repeated till the sixth dilution was attained. 0.1ml of the 4th and 6th dilution was inoculated onto a sterile Potato Destrose Agar (PDA) and Nutrient Agar (NA) plates respectively. A flamed glass hockey stick shaped rod was used to spread the inoculums evenly over the surface of the agar in the plate. This was done in triplicate for each of the samples. The plates were incubated at room temperature (28-32°C) for 2-5 days and at 37°C for 24-48hrs respectively. All the plates were observed daily and the number of colonies formed in each culture plates were counted using Gallenkamp electronic colony counter. A mean of the count from the triplicate were obtained and multiplied with the dilution factors to obtain the microbial load as the viable microbial colonies per unit weight of the sample expressed as the colony forming unit (Cfu)/g.

Enumeration of Total Bacterial Count

Inoculum from the 3rd dilutions was pour plated onto nutrient agar and incubated at 37°C for 24hrs. A representation of typical colonies from well isolated colonies showing 30-300 colonies

were picked at random, subcultured on selective growth media for purification, stored in slops at refrigeration temperature and were used for morphological, gram test and biochemical test [27].

Statistical Analysis

Results obtained from this work were subjected to a two-way analysis of variance (ANOVA). Values are means of triplicate determination + standard deviation and level of confidence/ significance were taken at (P<0.05) degree of freedom.

RESULTS AND DISCUSSION

The values of moisture content of grape fruit juice sweetened with honey were high on the 1st (91.47-93.50%), 3rd day (92.63-94.66%) and 6th day (92.61-94.76%) respectively. This results represents the high perishable nature of these fruits and their short shelf-life under normal condition. This is in agreement with the characteristics of most tropical fruits as reported by [28]. Protein (0.80-0.36%), fat (0.24-0.13%) decreased alongside with ash (0.84-0.45%) content which ranged from day one to the sixth day of the examination. Crude fibre and carbohydrate content increased and decreased interchangeably which may be attributed to different concentrations of ginger and honey added to the samples.

This study showed that protein content was low and decreased in order of 1st day, 3rd day and 6th days respectively. The low percentage of protein observed in all the samples is in line with a low protein content of orange juice (0.74%) as reported by [29].

Table 2 recorded the physico-chemical analysis of grape fruit juice sweetened with honey and preserved with ginger. The pH reduced (3.67-3.35) from the first day, 3rd and sixth day. Total titratable acidity increased (0.49-0.83%) from the first day to the sixth day. There was no significant difference (P<0.05) on the pH of the juice samples at the sixth day of the study. The decrease in the pH accounted for its acidic medium and this can help to

Table 1: Proximate composition of grape fruit juice sweetened with honey and preserved with ginger (%).

SAMPLES	MOISTURE	PROTEIN	FAT	CRUDE FIBRE	ASH	CARBOHYDRATE
DAY 1						
T_1	92. 79^b ± 0.16	0.60^a ± 0.00	0.18^a+0.00	0.19^a+0.00	0.69^a+0.00	5..51^d+0.02
T_2	92.76^b+0.03	0.68^a+0.00	0.23^a+0.28	0.16^b +0.01	0.72^b+0.00	5..54^d+0.02
T_3	91.47^c+0.03	0.69^a+0.00	0.24^a+0.00	0.15^b+0.28	0.75^b+0.00	6.71^a+0.09
T_4	92.19^d+0.01	0.71^a+0.00	0.24^c+0.02	0.18^b+0.02	0.78^a+0.00	5.90^b+0.04
T_5	92.77^b+0.05	0.73^b+0.00	0.21^a+0.02	0.17^b+0.02	0.81^a+0.00	5.30^a+0.075
T_6	92.39^b+0.12	0.80^b+0.00	0.19^b+0.00	0.21^a+0.02	0.84+0.00	5.63^b+0.05
T_7	93.50^b+0.04	0.59^b+0.02	0.23^b+0.02	0.18^b+0.00	0.66^c+0.04	4.83^b+0.02
LSD (P<0.05)	0.155	0.35	0.03	0.031	0.0131	0.096
DAY 3						
T_1	93. 78^b ± 0.03	0.52^d ± 0.00	0.17^b+0.03	0.61^d+0.02	0.65^d+0.00	4.27^d+0.07
T_2	92.63^b+0.04	0.55^c+ 0.02	0.19^b+0.00	0.59^b +0.00	0.71^a+0.02	5.34^a+0.08
T_3	93.46^d+0.02	0.57^a+ 0.00	0.24^a+0.02	0.60^b+0.01	0.71^a+0.00	4.42^a+0.05
T_4	93.04^b+0.06	0.60^a+ 0.00	0.22^a+0.03	0.62^d+0.00	0.75^a+0.00	4.77^b+0.05
T_5	93.47^d+0.02	0.67^b+ 0.03	0.23^a+0.01	0.65^c+0.00	0.74^a+0.00	4.24^a+0.06
T_6	93.62^b+0.14	0.68^b+ 0.00	0.19^b+0.00	0.78^a+0.02	0.45+0.04	4.05^b+0.06
T_7	94.66^b+0.09	0.50^d+ 0.02	0.29^b+0.02	0.71^a+0.00	0.62^c+0.04	3.06^b+0.27
LSD (P<0.05)	0.12	0.026	0.029	0.017	0.38	2.41
DAY 6						
T_1	92. 76^a ± 0.06	0.37^d ± 0.00	0.14^b+0.03	0.39^d+0.02	0.46^d+0.00	5.88^d+0.07
T_2	92.68^b+0.04	0.38^a+0.00	0.13^b+0.00	0.43^b +0.00	0.48^a+0.02	5.88^a+0.04
T_3	93.57^a+0.04	0.45^a+0.022	0.18^b+0.01	0.47^b+0.02	0.53^b+0.00	4.81^a+0.04
T_4	93.17^a+0.04	0.49^a+0.00	0.21^a+0.01	0.49^b+0.00	0.53^a+0.00	5.11^b+0.05
T_5	92.61^a+0.24	0.52^b+0.00	0.19^a+0.00	0.48^b+0.01	0.58^a+0.00	5.62^a+0.21
T_6	93.69^a+0.02	0.56^b+0.00	0.21^b+0.00	0.52^a+0.01	0.61^a+0.00	4.41^b+0.01
T_7	94.76^a+0.05	0.36^b+0.02	0.17^b+0.02	0.49^b+0.00	0.45^c+0.00	3.77^b+0.09
LSD (P<0.05)	Nil	0.02	0.025	0.018	0.016	2.16

Values are means of Triplicate determination ± standard deviation
Means in columns with different superscripts are significantly different (P<0.05)., T_1 = No ginger and honey, T_2 = 0.5% ginger without honey, T_3 = 0.5% ginger + 0.5% honey, T_4 = 1.5% ginger + 1.5% honey, T_5 = 1.5% ginger + 2.0% honey, T_6 = 2% ginger + 2.0% honey, T_7 = No ginger + 1.5% honey

Table 2: Physico-chemical analysis of grape juice sweetened with honey and preserved with ginger.

	S.G	PH	TTA(%)	SUGAR(%)
Day 1				
T_1	$1.016^{a} \pm 0.000$	$3.71^{a} \pm 0.014$	$0.75^{a}+0.017$	$11.8^{a}+0.043$
T_2	$1.005^{b}+0.001$	$3.85^{a}+0.000$	$0.69^{a}+0.017$	$12.31^{c}+0.014$
T_3	$1.073^{a}+0.001$	$3.91^{a}+0.014$	$0.65^{a}+0.010$	$12.36^{c}+0.000$
T_4	$1.008^{a}+0.001$	$3.95^{a}+0.000$	$0.61^{a}+0.024$	$13.52^{a}+0.000$
T_5	$1.005^{b}+0.001$	$4.10^{b}+0.022$	$0.57^{a}+0.024$	$13.33^{a}+0.108$
T_6	$1.012^{a}+0.000$	$4.12^{a}+0.000$	$0.49^{a}+0.024$	$13.46^{a}+0.022$
T_7	$1.007^{b}+0.002$	$3.67^{c}+0.028$	$0.71^{a}+0.014$	$11.76^{d}+0.056$
LSD (P<0.05)	0.009	0.034	Nil	0.127
Day 3				
T_1	$1.011^{a} \pm 0.014$	$3.45^{a} \pm 0.000$	$0.75^{a}+0.000$	$9.61^{a}+0.014$
T_2	$1.013^{a}+0.002$	$3.61^{a}+0.014$	$0.70^{b}+0.000$	$9.79^{c}+0.014$
T_3	$1.016^{a}+0.001$	$3.65^{d}+0.000$	$0.68^{b}+0.014$	$9.83^{d}+0.036$
T_4	$1.018^{a}+0.001$	$3.80^{a}+0.000$	$0.64^{a}+0.022$	$9.94^{c}+0.000$
T_5	$1.017^{b}+0.001$	$3.85^{b}+0.000$	$0.60^{d}+0.000$	$10.17^{b}+0.014$
T_6	$1.019^{a}+0.000$	$4.06^{a}+0.000$	$0.54^{a}+0.014$	$10.45^{a}+0.000$
T_7	$1.009^{a}+0.001$	$3.48^{c}+0.014$	$0.77^{a}+0.024$	$9.50^{a}+0.022$
LSD (P<0.05)	Nil	0.164	0.029	0.045
Day 6				
T_1	$1.018^{a} \pm 0.001$	$3.35^{a} \pm 0.014$	$0.83^{a}+0.022$	$6.94^{a}+0.000$
T_2	$1.018^{b}+0.001$	$3.42^{a}+0.000$	$0.74^{b}+0.022$	$7.52^{a}+0.108$
T_3	$1.025^{a}+0.006$	$3.42^{a}+0.022$	$0.67^{c}+0.028$	$7.64^{a}+0.014$
T_4	$1.016^{a}+0.000$	$3.61^{a}+0.014$	$0.64^{c}+0.014$	$8.16^{a}+0.014$
T_5	$1.017^{a}+0.002$	$3.65^{a}+0.000$	$0.60^{d}+0.000$	$8.19^{a}+0.000$
T_6	$1.015^{a}+0.001$	$3.81^{a}+0.014$	$0.57^{d}+0.000$	$9.20^{a}+0.000$
T_7	$1.015^{a}+0.000$	$3.41^{a}+0.014$	$0.81^{a}+0.014$	$7.18^{a}+0.022$
LSD (P<0.05)	Nil	Nil	0.038	3.040

Values are means of triplicate determination ± standard deviation
Means in columns with different superscripts are significantly different (P<0.05)

Table 3: Vitamin content of grape fruit juice sweetened with honey and preserved with ginger (mg).

Samples	B1	B2	B3	VIT C
Day 1				
T_1	$1.12^{a} \pm 0.000$	$0.09^{c} \pm 0.000$	$0.36^{b}+0.000$	$44.29^{f}+0.040$
T_2	$1.15^{a}+0.000$	$0.12^{d}+0.000$	$0.41^{cd}+0.014$	$43.31^{d}+0.014$
T_3	$1.12^{a}+0.000$	$0.15^{c}+0.000$	$0.43^{c}+0.000$	$45.88^{c}+0.036$
T_4	$1.18^{a}+0.000$	$0.16^{c}+0.000$	$0.48^{b}+0.014$	$46.77^{b}+0.028$
T_5	$1.21^{a}+0.014$	$0.18^{b}+0.000$	$0.49^{a}+0.000$	$46.82^{a}+0.028$
T_6	$0.26^{a}+0.014$	$0.22^{a}+0.024$	$0.51^{a}+0.010$	$46.88^{a}+0.036$
T_7	$0.14^{a}+0.000$	$0.10^{c}+0.000$	$0.40^{d}+0.014$	$44.51^{c}+0.014$
LSD (P<0.05)	0.00368	0.0165	0.02	0.0628
Day 3				
T_1	$1.010^{a} \pm 0.000$	$0.07^{a} \pm 0.000$	$0.30^{f}+0.000$	$39.41^{a}+0.014$
T_2	$1.14^{a}+0.014$	$0.09^{a}+0.000$	$0.38^{d}+0.000$	$41.76^{a}+0.057$
T_3	$0.15^{a}+0.000$	$0.12^{a}+0.000$	$0.40^{c}/+0.000$	$42.85^{a}+0.000$
T_4	$0.16^{a}+0.000$	$0.14^{a}+0.000$	$0.45^{b}+0.000$	$42.94^{a}+0.014$
T_5	$0.19^{b}+0.000$	$0.16^{b}+0.000$	$0.48^{a}+0.014$	$43.83^{a}+0.022$
T_6	$0.23^{a}+0.014$	$0.18^{a}+0.000$	$0.48^{a}+0.000$	$43.61^{a}+0.014$
T_7	$0.13^{a}+0.014$	$0.09^{a}+0.000$	$0.34^{a}+0.014$	$38.78^{a}+0.028$
LSD (P<0.05)	0.00862	Nil	0.016	19.3
Day 6				
T_1	$0.03^{e} \pm 0.000$	$0.02^{e} \pm 0.000$	$0.23^{d}+0.000$	$22.73^{a}+0.036$
T_2	$0.09^{c}+0.000$	$0.07^{d}+0.000$	$0.31^{c}+0.000$	$29.78^{a}+0.028$
T_3	$0.13^{b}+0.014$	$0.10^{c}+0.000$	$0.34^{b}+0.000$	$31.52^{a}+0.108$
T_4	$0.14^{b}+0.000$	$0.11^{c}+0.000$	$0.36^{b}+0.000$	$35.66^{a}+0.050$

T_5	0.16[a]+0.000	0.13[b]+0.014	0.41[a]+0.014	39.46[a]+0.057
T_6	0.17[a]+0.000	0.15[a]+0.000	0.43[a]+0.022	42.81[a]+0.014
T_7	0.05[d]+0.000.	0.06[d]+0.000.	0.25[d]+0.000	25.76[a]+0.050
LSD (P<0.05)	0.0116	0.0116	0.00527	20.17
Key : Values are means of triplicate determination ±standard deviation . Means in columns with different superscripts are significantly different (P<0.05)				

Table 4: Sensory evaluation of grape fruit juice samples sweetened with honey and preserved with ginger.

Simple codes	Taste	Flavor	Color	General acceptability
582	7.6[a]	7.1[a]	7.4[b]	7.3[a]
417	7.9[a]	7.3[a]	7.4[b]	7.1[a]
283	7.8[a]	7.7[a]	8.0[a]	7.7[a]
316	6.5[b]	7.0[a]	7.8[a]	7.4[a]
371	7.9[a]	7.0[a]	7.4[b]	7.6[a]
513	7.9[a]	7.2[a]	8.2[a]	7.7[a]
312	5.7[b]	6.3[a]	7.8[a]	5.5[b]
LSD (P<0.05)	1.052	Nil	0.629	1.397
Values are means of triplicate determination ± standard deviation Means in columns with different superscript are significantly different				

enhance the keeping quality of the product. [30], reported a reduction of growth of *Staphylococcus aureus* and *Escherichia coli* treated with ascorbic acid, lactic acid, potassium sorbate extracts which are all content of citrus fruit.

The specific gravity was in appreciable level (1.005-1.025%) and also in agreement with specific gravity of fruit juices reported by [31]. Beverages with good specific gravity would be smooth in the mouth during drinking. Specific gravity measurement is used in characterizing juices, beverages and other products as it is linked to the concentration of soluble solid present in the material [32].

The sugar content of the juice was high at the first day and reduced progressively till the sixth day (13.52-6.94%). This could be attributed to the activities of microbial enzymes responsible for breakdown of sugar like invertase and amylases [33].

There was a decline in the vitamin contents of the samples from 1st day to the sixth day B_1 (0.26-0.03mg), B_2 (0.22-0.02mg) and B_3 (0.51-0.23mg) and difference exist from each day to the other for some Vitamins whereas there was no difference in some others at (P<0.05). The difference may be as a result of storage, chemical reaction on the juice and concentrations of ginger and or honey added to the samples. [34]., reported some vitamins content of grape fruit juice (Vit.C (54.31-1.20%, Vit.A (21.03-21.08%,Vit.B_1(0.21-0.25%) and Vit.B_2 (0.04-0.06%) which were closely related to our findings. Vitamins B play a vital role in maintaining good health and well -being, they also help to prevent infections [35]. Vitamin C help to protect against immune system deficiencies, cardiovascular diseases, prenatal health problems, eye disease and even skin wrinkling [36]. Vitamin A helps form and maintain healthy teeth, skeletal and soft tissue, mucus membranes, and skin. It is also known as retinol because it produces the pigments in the retina of the eye. Vitamin A promotes good eyesight, especially in low light. It also has a role in healthy pregnancy and breastfeeding [37]. Significant difference do not exist (P<0.05) on the vitamins C during the 3rd day and sixth day of the study at (P <0.05).

The sensory evaluation scores of grape fruit juice sweetened with honey and preserved with ginger is presented in table 4 above. There was no significant difference (P<0.05) on the flavor of the juice samples. A slight difference (P<0.05) was recorded on the taste, colour and general acceptability. Samples 582, 417, 283, 371,513 did not show any differences significantly (P<0.05) on taste of the juice.

Samples 513, 417 and 283 were preferred by the panelists in terms of its colour, flavor, taste and general acceptability. This might be as a result of the level of ginger used as a preservative and the honey used as a sweetener.

The results in table 5 above show a low microbial growth at the 1st day (1.8×10^4-3.8×10^4cfu/ml) which increased slightly during the third day of juice storage (2.7×10^4-5.8×10^4cfu/ml). The load of microorganisms increased during the sixth day (6.3×10^4-10.2×10^4) respectively. Samples without ginger (T_1 and T_7)

Table 5: Microbial load of grapefruit sweetened with honey and preserved with ginger (Cfu/ml).

Samples	Day 1	Day 3	Day 6
T_1	3.8×10^4	5.8×10^4	10.2×10^4
T_2	2.7×10^4	4.5×10^4	8.1×10^4
T_3	2.5×10^4	3.9×10^4	7.8×10^4
T_4	2.2×10^4	3.5×10^4	7.2×10^4
T_5	2.1×10^4	2.9×10^4	6.3×10^4
T_6	1.8×10^4	2.7×10^4	4.1×10^4
T_7	3.2×10^4	5.2×10^4	9.2×10^4
Key: Cfu/ml = coliform forming units per T_1 = No ginger and honey, T_2 = 0.5% ginger without honey, T_3 = 0.5% ginger + 0.5% honey, T_4 = 1.5% ginger + 1.5% honey, T_5 = 1.5% ginger + 2.0% honey, T_6 = 2% ginger + 2.0% honey, T_7 = No ginger + 1.5% honey.			

recorded the highest microbial growth and juice deterioration. All samples with different concentrations of ginger and honey (T_2, T_3, T_4, T_5,T_6) recorded lesser level of deterioration and they varied significantly ($P<0.05$).The lowest values recorded in sample T_6 could be implicated to the highest percentage of ginger (2%) and honey(2%) added to the juice which is in line with the findings of [37] who discovered that ginger can preserve foods up to 4 months at room temperature (250C). [38], also discovered that aqueous extract of ginger caused an increase in the protein and mineral content thereby reducing the microbial growth on juice samples.

CONCLUSION

This study has shown that ginger (*Zingiba officinale*) has some anti-oxidative and anti-microbial effects which can extend the shelf-life of grape fruit juice samples. Samples treated with higher concentrations of ginger inhibited the growth of bacteria and also increased the shelf-life of the grapefruit juice. Ginger has shown excellent antibacterial properties and effective in controlling virus, bacterial and fungal diseases. In many countries, gingers have been used to preserve foods [39-41]. In addition, 2% ginger and honey was most effective in the preservation of grape juice and taste enhancement.

Therefore, ginger should be incorporated in most fruit juice processing and honey should be used as a sweetener hence that both of them are natural ingredients that has no much side effect to human health.

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