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Potentials of Fruit Waste

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ABSTRACT: In the present world, modernization has brought about increase in drinking habits of people and most of the available drinks are made of concentrate, hence the need for making this wine from natural products which is enriched for medicinal purpose. Thus, the study investigated the production of spice-enriched wine using banana peels, pineapple peels, ginger, orange and lemon peels in order to improve its antioxidant and preservative properties. Wine production from banana and pineapple peels (Musa acuminataand Ananascomosus) was carried out by controlled fermentation for 3 days. Fermentation of these peels was done in three different proportions and one control: Sample A, B and C (pineapple peels only, banana and pineapple peels and banana peels only). Ginger, lemon and orange peels were macerated and added to the samples. The mixtures were inoculated with Saccharomyces cerevisia and fermented for 3 days at room temperature, the filtrates obtained was pasteurized at 65°C for 30 minutes. The product was bottled in air tight bottles and stored in an ambient environment for weeks. A market sample was used as Control and was stored in the same environment during storage,physio-chemical properties, minerals, antioxidant,microbial population and sensory properties of the spice-enriched wine were investigated using standard methods. During the duration of the storage, it was observed that there was little increase in alcohol content in sample A, B and C (0.00 - 0.086**),** **(**0.00 -0.064) and (0.00 - 0.043) respectively, while the control had no alcohol content(0.00)There was significant decrease in pH, brix, TSS and increase in TTA, antioxidant and minerals..The results of organoleptic properties showed significant differences ($p < 0.05$) in all the parameters evaluated for, where by sample A gave me the best result.

Keywords: Banana, pineapple, ginger, fermentation, wine

I. INTRODUCTION

In the present world, modernization has brought about increase in drinking habits of people and most of the available drinks are made of concentrate, hence the need for making this wine from natural products which is enriched for medicinal purpose. Wine has been considered as a safe and healthy drink (Tiariet al., 2017). Wine is a beverage with a flower-like fresh fruit which could be stored or transported under the existing conditions. Being fruit based the fermented and undistilled product; wine contains most of the nutrients present in the original fruit juice. The nutritive value of wine is increased due to release of amino acid and other nutrients from yeast during fermentation (Swami et al., 2014). A typical wine contains ethyl alcohol, sugar, acids, alcohols, tannins, aldehydes, esters, amino acids, minerals, vitamins, anthocyanin, minor constituents like flavoring compounds etc. (Swami et al., 2014). In the processing of fruits, peel is a major by-product and represents a serious disposal problem. The use of fruit peels for the production of biogas and dietary fiber has been described; however, the studies on peels are scarce. Their use as animal feed is known, although they can also be used for obtaining more valuable products like good quality pectins(Pedroza-Islas et al., 1994; Kumar et al., 2010).

Banana peels is rich in potassium, calcium, sodium, iron and manganese. It also contains vitamin C and E. It has antifungal and antibiotic properties, it is rich in fibre which makes digestion easy, it lowers the risk of cataract, helps to provide a better sleep, lowers cholesterol and boost moods.

Ananascomosus, pineapple is an edible fruit from Bromeliaceae family (Okonkwo, 2016). Pineapple peels is gotten from pineapple, which serves as a covering to the pulp,it contains medicinal properties, which has numerous beneficial effects to our entire body. Most people usually throws the peels, without knowing the health benefits that give to the body. It contains vitamin B, C, folate, thiamin, pantothenic acid, bromelain, niacin, and fiber. It is also packed with mineral including magnesium, potassium, copper, manganese, calcium, iron, and other nutrients. It also contains antibacterial, anti-inflammatory, anti-

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aging, and anticancer properties. It is also an excellent source of antioxidants that can help the body to fight free radicals (Okonkwo, 2016). Ginger (ZingiberofficinaleRoscoe) is a root or an underground stem (rhizome) known to contain gingerols and oleoresin (combination of volatile oils and resin) that accounts for the characteristic aroma and therapeutic properties with several health benefits. It reduces the risk of colon cancer, obesity, cold related-diseases and arthritis. It has staring potential for treating a number of ailments including degenerative disorders (arthritis and rheumatism), digestive health (indigestion, constipation and ulcer), cardiovascular disorders (atherosclerosis and hypertension), vomiting, diabetes mellitus, and cancer. It also has anti-inflammatory and anti-oxidative properties for controlling the process of aging. (Bailey-Shaw et al., 2008). Lemon and orange peels are rich in vitamin C and healthful chemicals that may help to protect against cancer. These peels are good preservative ingredients. The main objective of this study is to utilize fruit peels for the production of spices-enriched wine and to improve the storage stability of natural wine making use of natural preservatives.

II. MATERIALS AND METHODS

2.1 Materials

The materials used for the research work include, banana peels and pineapple peels which were sourced from a local juice factory in Akure.Sugar, yeast, lemon peels, orange peels and ginger were sourced from the local market in Akure.All other chemicals, apparatus, and equipment used were of food quality grade and obtained from the Department of Food Science and Technology, Federal University of Technology Akure.

2.2 Methods

2.2.1 Production of banana peel wine

Bananas were peeled, the peels was sorted from the bananas. The peels were weighed and recorded in grams. The peels were rinsed in saline water to remove extraneous matter and then macerated to increase the surface area.All equipment were sterilized, potable water was heated to 100°C to kill micro-organisms present and then cooled to 25°C. Macerated banana peels were introduced into the treated water, followed by addition of measured amount of sugar, ginger, orange peels, lemon peels and yeast. The mixture was left for fermentation for 3days at room temperature, it was sieved, bottled and pasteurized at 65°c for 30mins.

2.2.2 Production of pineapple peel wine

Pineapples were peeled, the peels was sorted from the pineapples. The peels was weighed and recorded in grams. The peels were rinsed in saline water to remove extraneous matter and then macerated to increase the surface area.All equipment were sterilized, portable water was heated to 100°C to kill micro-organisms present and then cooled to 25°C. Macerated pineapple peels were introduced into the treated water, followed by addition of measured amount of sugar, ginger, orange peels, lemon peels and yeast. The mixture was left for fermentation for 3days at room temperature, it was sieved, bottled and pasteurized at 65°C for 30mins .

2.2.3 Production of banana and pineapple peel wine

Bananas and pineapples were peeled, the peels were sorted from the bananas and pineapples. The peels were weighed and recorded in grams. The peels were rinsed in saline water to remove extraneous matter and then macerated to increase the surface area.All equipment were sterilized, portable water was heated to 100°C to kill micro-organisms present and then cooled to 25°C. Macerated banana and pineapple peels was introduced into the treated water, followed by addition of measured amount of sugar, ginger, orange peels, lemon peels and yeast. The mixture was left for fermentation for 3days at room temperature, it was sieved, bottled and pasteurized at 65°C for 30mins as shown in the figure (2.1) below.

Table 1.0: Composition of Spice-enriched Wine

Samples	A%	B%	C%	D%
Banana peel	0	25	25	0
Pineapple peel	50	25	0	0
Lemon peel	8.5	8.5	8.5	0
Orange peel	8.5	8.5	8.5	0
Ginger	12.5	12.5	12.5	0
Yeast	0.5	0.5	0.5	0
Sugar	20	20	20	0

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A = PINEAPPLE PEEL WINE, 0%banana, 50% pineapple peel, 8.5% lemon peel, 8.5%orange peel, 12.5% ginger, 0.5%yeast and 20% sugar.
B= PINEAPPLE AND BANANA PEEL WINE, 25%banana, 25% pineapple peel, 8.5% lemon peel, 8.5%orange peel, 12.5% ginger, 0.5%yeast and 20% sugar.
C= BANANA PEEL WINE, 50%banana, 0% pineapple peel, 8.5% lemon peel, 8.5%orange peel, 12.5% ginger, 0.5%yeast and 20% sugar.
D= GLAMOUR SYNTHETIC WINE, 0%banana, 0% pineapple peel, 0% lemon peel, 0%orange peel, 0% ginger, 0%yeast and 0% sugar**.**

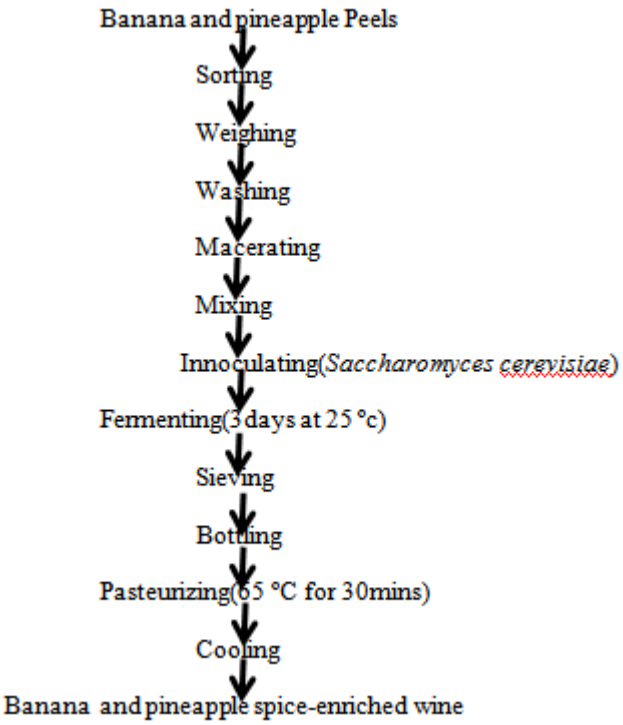

Figure 2.1 Flow chart for the production of banana and pineapple spice-enriched wine.

2.3 Determination of Physiochemical Properties
2.3.1 Determination of brix

The brix level was determined using a hand held refractometer method described by A.O.A.C (2012) .The handheld refractometer was cleaned with distilled water, 1-2 drops was applied on the surface and the readings were taken and recorded. This was done in triplicates and the average was taken.

2.3.2 Determination of pH

The pH of the wine was determined using a pH meter as described by (Tiari, 2017).the pH meter was standardized using distilled water and then used to take the pH reading. The pH meter was dipped into the samples separately and the readings were taken in triplicates.

2.3.3 Determination of total soluble solids

The total soluble solid was determined using A.O.A.C (2012). 3 empty petri-dishes were weighed ,15g of the sample was put in each, the weight of both the samples and petri-dishes was weighed ,the samples were put in the oven dryer ,the dried samples were weighed, and the total soluble solids was calculated.

2.3.4 Determination of total titratable acidity

200 ml of boiling distilled water was put in a 500 ml Erlenmeyer flask, 1ml of 1% phenolphthalein indicator was added. The solution was titrated against 0.1M sodium hydroxide solution to a faint but definite pink color; 5mls of the sample was titrated to a pink color with the 0.1m NaOH, using 3 drops of 1% phenolphthalein as indicator.
Total Acidity =(g/ml) = $0.075 \times M1 \times M2v1M1$
Where M1 = Molarity of NaOH

2.4 Determination of Alcohol Content of Wine

Percentage of alcohol by volume from specific gravity was determined according to

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AOAC (1990). Hundred millimeters of spiced-enriched wine was diluted with 50ml of water, and distilled. After collecting the 100ml of distillate, its relative specific gravity was determined by dividing the weight of 25ml of the distillate by equal volume of water using a 25-ml specific gravity bottle and referring to the reference table.

2.5 Determination of Anti-oxidant

2.5.1 Determination of Vitamin C

The vitamin C content was determined using the ascorbic acid as the reference compound. 200ul of the extract was pipette and mixed with 300ul of 13.3% of TCA and 75microliter of DNPH. The mixture was incubated at 37ºC for 3hrs and 500ml of 65% H_2SO_4 was added and the absorbance was read at 520nm (Benderitter et al 1998).

2.5.2 Determination of total phenol

The total phenolic content was determined according to the method described by Singleton et al. (1999). Appropriate dilution of the extracts was oxidized with 2.5 ml 10 % Folin-Ciocalteau's reagent (v/v) and neutralized by 2.0 ml of 7.5 % sodium carbonate. The reaction mixture was incubated for 40 min at 45 oC, and absorbance was measured at 700 nm in the spectrophotometer. Gallic acid was used as standard phenol and the total phenolic content was subsequently calculated as gallic acid equivalent (GAE).

2.5.3 Determination of DPPH

The free radical scavenging ability of the extracts against DPPH (1,1-diphenyl-2 picrylhydrazyl) radical was evaluated as described by Gyamfiet al. (1999). An appropriate dilution of the extracts (1 ml) was mixed with 1 ml of 0.4 mM/L methanol solution containing DPPH radicals. The mixture was left in the dark for 30 min and the absorbance was measured at 516 nm in the spectrophotometer. The DPPH free radical scavenging ability was subsequently calculated with respect to the reference, which contained all the reagents without the test sample.

2.6 Determination of Mineral Content

2.6.1 Determination of sodium

The sodium content of the samples was determined by photometric method. The instrument was set up according to the manufacture's instruction. The equipment was switched on and allowed to stay for about 10min. The gas and air inlets were opened as the start knob was turned on. The equipment being self-igniting, the flame was adjusted to a non-luminous level until a blue color was obtained. Meanwhile a standard Na solution was prepared and was diluted to concentrations of 2, 4, 6, 8, 10 ppm. Starting with the least concentration of 2ppm, all the standard solutions were sucked into the instrument and caused to spray over the non-luminous flame. The readings were recorded and later plotted into a standard curve and used to extrapolate to Na level in the sample. After the standard, the sample solutions were siphoned in turns into the instrument with their reading recorded. The concentration of the test mineral in the sample was calculated with reference to the curve and obtained as follows:

Na (mg/100g) = 100 x Vt x Xx D

Where,

W = Weight of sample used

Vt = Total extract volume

2.6.2 Determination of iron and calcium

These were determined by Flame Atomic Absorption spectrophotometer, as described by AOAC, (2005). 0.5ml of each sample was digested in 20 ml each of acid solution of HNO3, H2SO4. The corresponding solution was heated until white fumes appeared. The clear solution was diluted up to 50 ml with distilled water and filtered with Whatman filter paper no.1. The standard working solutions of elements of interest were prepared to make the standard calibration curve. Absorption for a sample solution uses the calibration curves to determine the concentration of particular element in that sample. Cathode lamps used as radiation source. Air acetylene gas was used for all the experiments. This method provides both sensitivity and selectivity since other elements in the sample will not generally absorb the chosen wavelength and thus, will not interfere with the measurement.

2.6.3 Determination of potassium

Potassium in the samples was determined by the vanadomohydate (yellow) spectrometry described by James (1995).

2.6.4 Determination of phosphorus

Phosphorus in the samples was determined by the vanadomohydate (yellow) spectrometry described by James (1995).

2.6.5 Determination of magnesium

Magnesium in the samples was determined by the vanadomohydate (yellow) spectrometry described by James (1995).

2.7 Microbial Analysis

Total viable count was determined according to the method of Adams and Moss

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(2008). The total viable count was determined according to the method of Adams and Moss (2008). 1 ml of the sample was pipetted into a sterile Petri dish and mixed with an appropriate volume of molten agar (nutrient agar) using pour plate method with incubation period of 24 h at 37°C. The plate was observed under electronic colony counter for microbial growth. The bacteria count was also determined using the same method. 1 ml of the sample was pipetted into a sterile Petri dish and mixed with an appropriate volume of EMB agar using pour plate method with incubation period of 48 h at 37°C inside an incubator. The plate was observed under electronic colony counter for microbial growth. 1 ml of the sample again was pipetted into a sterile Petri dish and mixed with an appropriate volume of MSA agar using pour plate method with incubation period of 48 h at 37°C inside an incubator. The plate was observed under electronic colony counter for microbial growth.

2.8 Sensory Evaluation

The beverage samples were presented as coded samples to 15 semi -trained panelists according to the method reported by (Meilgaardet al., 1991). The panelists were asked to indicate their observations using a 9- point hedonic scale for taste, appearance, flavour/aroma, colour, and overall acceptability. The coded samples were served in clean transparent bottles at room temperature (25 °C). Samples presented to the panelists were at random and one at a time. The panelists were given enough water to rinse their mouths between each sample. Like extremely and dislikes extremely were ranked 9 and 1 respectively. Data obtained were subjected to analysis of variance (ANOVA) and means were separated by Duncan Multiple range test (Duncan, 1955).

III. RESULTS AND DISCUSSIONS

3.1 pH of Spice-enriched Wine

Table 4.1 shows that the pH of the samples A, B and C reduced over the weeks (4.73 ± 0.06^{c} -4.31 ± 0.06^{c}), (4.87 ± 0.06^{b} - 4.50 ± 0.06^{b}) and (5.47 ± 0.06^{a}- 5.20 ± 0.06^{a}) while sample D remained constant 2.90 ± 0.00^{d}. There is significant difference between the samples ($P\geq0.05$). This is due to the fact fermentation is still taking place and the sugars are still being consumed by the yeast, hence the reduction in pH (Tiwariet al., 2017). The higher the acidity, the lower the pH of the wine. A similar study conducted by (Fotakis, 2012) revealed that there is a corresponding reduction in pH as the acidity increased in sour wine. The observed decline of pH value could be due to increased microbial activities which led to the production of H+ ions and the formation of carbonic acid from the reaction of CO_2 and water. Sample A had a low pH compared to sample B and C due to the high acidity of pineapple fruits. Sample D had the least pH because citric acid was added and also it is a synthetic wine. The slight reduction in pH shows fermentation was still taking place.

Table 3.1; pH of Spice-enriched Wine

WEEKS	A	B	C	D
BEFORE FERMENTATION	4.73 ± 0.06^{c}	4.87 ± 0.06^{b}	5.47 ± 0.06^{a}	2.90 ± 0.00^{d}
0	4.43 ± 0.06^{c}	4.67 ± 0.06^{b}	5.33 ± 0.06^{a}	2.90 ± 0.00^{d}
1	4.33 ± 0.06^{c}	4.50 ± 0.01^{b}	5.32 ± 0.06^{a}	2.90 ± 0.00^{d}
2	4.32 ± 0.06^{c}	4.48 ± 0.06^{b}	5.22 ± 0.06^{a}	2.90 ± 0.00^{d}
3	4.31 ± 0.06^{c}	4.47 ± 0.06^{b}	5.21 ± 0.06^{a}	2.90 ± 0.00^{d}
4	4.31 ± 0.06^{c}	4.46 ± 0.06^{b}	5.20 ± 0.06^{a}	2.90 ± 0.00^{d}
5	4.31 ± 0.06^{c}	4.50 ± 0.06^{b}	5.20 ± 0.06^{a}	2.90 ± 0.00^{d}

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A = PINEAPPLE PEEL WINE, 0%banana, 50% pineapple peel, 8.5% lemon peel, 8.5%orange peel, 12.5% ginger, 0.5%yeast and 20% sugar.
B= PINEAPPLE AND BANANA PEEL WINE, 25%banana, 25% pineapple peel, 8.5% lemon peel, 8.5%orange peel, 12.5% ginger, 0.5%yeast and 20% sugar.
C= BANANA PEEL WINE, 50%banana, 0% pineapple peel, 8.5% lemon peel, 8.5%orange peel, 12.5% ginger, 0.5%yeast and 20% sugar.
D= GLAMOUR SYNTHETIC WINE, 0%banana, 0% pineapple peel, 0% lemon peel, 0%orange peel, 0% ginger, 0%yeast and 0% sugar

3.2 Brix of Spice-enriched Wine

Table 3.2 shows that the brix reduced in sample A, B and C over the weeks ($4.03\pm O.06^{a}$ - 3.60 ± 0.06^{b}), (3.57 ± 0.06^{b} - 3.30 ± 0.06^{c}) and (3.43 ± 0.06^{d} - 3.10 ± 0.06^{d}) while sample D remained constant 4.00 ± 0.00^{a}. Brix is inversely related to pH. This shows that the sugars are being utilized by the yeast and converted to alcohol, hence the reduction in brix level. By the end of fermentation, there was a significant difference ($P < 0.05$).Sample A had the highest brix level initially, showing that pineapple peels contains higher amount of inherent sugar compared to banana peels. After fermentation sample D had the highest brix, showing that it was the sweetest and the brix remained constant. The sugar content of the juice is represented in terms of °Brix (Murli, 2014). There was decrease in brix level as storage period increased which agreed with (Omowaye-Taiwo and Oluwamukomi, 2015).

Table 3.2; Brix of Spice-enriched Wine

WEEKS	A	B	C	D
BEFORE FERMENTATION	$4.03\pm O.06^{a}$	3.57 ± 0.06^{b}	3.43 ± 0.06^{d}	4.00 ± 0.00^{a}
0	3.73 ± 0.06^{b}	3.43 ± 0.06^{c}	3.23 ± 0.06^{d}	4.00 ± 0.00^{a}
1	3.63 ± 0.06^{b}	3.33 ± 0.06^{c}	3.13 ± 0.06^{d}	4.00 ± 0.00^{a}
2	3.62 ± 0.06^{b}	3.32 ± 0.06^{c}	3.13 ± 0.06^{d}	4.00 ± 0.00^{a}
3	3.61 ± 0.06^{b}	3.31 ± 0.06^{c}	3.12 ± 0.06^{d}	4.00 ± 0.00^{a}
4	3.60 ± 0.06^{b}	3.30 ± 0.06^{c}	3.10 ± 0.06^{d}	4.00 ± 0.00^{a}
5	3.60 ± 0.06^{b}	3.30 ± 0.06^{c}	3.10 ± 0.06^{d}	4.00 ± 0.00^{a}

A = PINEAPPLE PEEL WINE, 0%banana, 50% pineapple peel, 8.5% lemon peel, 8.5%orange peel, 12.5% ginger, 0.5%yeast and 20% sugar.
B= PINEAPPLE AND BANANA PEEL WINE, 25%banana, 25% pineapple peel, 8.5% lemon peel, 8.5%orange peel, 12.5% ginger, 0.5%yeast and 20% sugar.
C= BANANA PEEL WINE, 50%banana, 0% pineapple peel, 8.5% lemon peel, 8.5%orange peel, 12.5% ginger, 0.5%yeast and 20% sugar.
D= GLAMOUR SYNTHETIC WINE, 0%banana, 0% pineapple peel, 0% lemon peel, 0%orange peel, 0% ginger, 0%yeast and 0% sugar**.**

3.3; TSS of Spice-enriched Wine

Table 4.3 shows the TSS of sample A, B and C decreased over the weeks (0.97 ± 0.01^{d} - 0.91 ± 0.01^{d}), (0.99 ± 0.01^{c} - 0.92 ± 0.01^{c}) and (1.10 ± 0.01^{b} - 1.04 ± 0.01^{b}) respectively while sample D remained constant (3.65 ± 0.00^{a}). The pH is inversely related to TSS. The sugar content of the juice is often expressed in terms of °Brix. The unit °Brix represents grams of sugar per 100 grams of juice. Commonly, it is interpreted as grams of sugar per 100 ml of juice (Murli, 2014). The higher decrease in TSS during initial fermentation is attributed to the higher fermentability of the peels of different treatments because of more availability of sugar and less ethyl alcohol in the medium.

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Table 3.3; TTS of Spice-enriched Wine

WEEKS	A	B	C	D
BEFORE FERMENTATION	0.97 ± 0.01^{d}	0.99 ± 0.01^{c}	1.10 ± 0.01^{b}	3.65 ± 0.00^{a}
0	0.94 ± 0.01^{d}	0.96 ± 0.01^{c}	1.07 ± 0.01^{b}	3.65 ± 0.00^{a}
1	0.93 ± 0.01^{d}	0.94 ± 0.01^{c}	1.06 ± 0.01^{b}	3.65 ± 0.00^{a}
2	0.92 ± 0.01^{d}	0.93 ± 0.01^{c}	1.05 ± 0.01^{b}	3.65 ± 0.00^{a}
3	0.91 ± 0.01^{d}	0.92 ± 0.01^{c}	1.04 ± 0.0^{b}	3.65 ± 0.00^{a}
4	0.91 ± 0.01^{d}	0.92 ± 0.01^{c}	1.04 ± 0.01^{b}	3.65 ± 0.00^{a}
5	0.91 ± 0.01^{d}	0.92 ± 0.01^{c}	1.04 ± 0.01^{b}	3.65 ± 0.00^{a}

A = PINEAPPLE PEEL WINE, 0%banana, 50% pineapple peel, 8.5% lemon peel, 8.5%orange peel, 12.5% ginger, 0.5%yeast and 20% sugar.
B= PINEAPPLE AND BANANA PEEL WINE, 25%banana, 25% pineapple peel, 8.5% lemon peel, 8.5%orange peel, 12.5% ginger, 0.5%yeast and 20% sugar.
C= BANANA PEEL WINE, 50%banana, 0% pineapple peel, 8.5% lemon peel, 8.5%orange peel, 12.5% ginger, 0.5%yeast and 20% sugar.
D= GLAMOUR SYNTHETIC WINE, 0%banana, 0% pineapple peel, 0% lemon peel, 0%orange peel, 0% ginger, 0%yeast and 0% sugar**.**

3.4 TTA of Spice-enriched Wine

Table 4.4 shows the TTA increased for Sample A, B and C during the weeks (0.017 ± 0.00^{b} - 0.022 ± 0.01^{b}),(0.016 ± 0.01^{b} -0.021 ± 0.01^{b}) and (0.014 ± 0.01^{c} - 0.018 ± 0.01^{c}) respectively while sample D remained constant 0.028 ± 0.00^{a}. TTA is inversely related to pH. As the storage period increased, there was increase in total titrable acidity as the week progressed. The high rate of total titrable acidity acidity of samples could be due decomposition of fermentable substrate especially the fermentable sugars thereby increasing the acidity. This is consistent with the findings of (Fasoyiro et al., 2005) for storage of Hibiscus sabdariffa) drinks. The trend obtained showed that it is consistent with the reported by (Amoa-Awuaet al., 2006). The pH values are the range of acidic medium which corroborates with (Obahiagbon and Osagie, 2007). The decrease in pH could be attributed to the storage condition. Abiodunet al., 2017 reported the effect of storage temperature on the pH, total tirable acidity on kunuzaki beverage and stated that refrigeration maintained the physio-chemical properties but ambient caused changes.

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Table 3.4; TTA of Spice-enriched Wine

WEEKS	A	B	C	D
BEFORE FERMENTATION	0.017±0.00^{b}	0.016±0.01^{b}	0.014±0.01^{c}	0.028±0.00^{a}
0	0.018±0.01^{b}	0.017±0.01^{b}	0.015±0.01^{c}	0.028±0.00^{a}
1	0.019±0.01^{b}	0.018±0.01^{b}	0.016±0.01^{c}	0.028±0.00^{a}
2	0.020±0.01^{b}	0.019±0.01^{b}	0.017±0.01^{c}	0.028±0.00^{a}
3	0.021±0.01^{b}	0.020±0.01^{b}	0.017±0.01^{c}	0.028±0.00^{a}
4	0.022±0.01^{b}	0.021±0.01^{b}	0.017±0.01^{c}	0.028±0.00^{a}
5	0.022±0.01^{b}	0.021±0.01^{b}	0.018±0.01^{c}	0.028±0.00^{a}

A = PINEAPPLE PEEL WINE, 0%banana, 50% pineapple peel, 8.5% lemon peel, 8.5%orange peel, 12.5% ginger, 0.5%yeast and 20% sugar.
B= PINEAPPLE AND BANANA PEEL WINE, 25%banana, 25% pineapple peel, 8.5% lemon peel, 8.5%orange peel, 12.5% ginger, 0.5%yeast and 20% sugar.
C= BANANA PEEL WINE, 50%banana, 0% pineapple peel, 8.5% lemon peel, 8.5%orange peel, 12.5% ginger, 0.5%yeast and 20% sugar.
D= GLAMOUR SYNTHETIC WINE, 0%banana, 0% pineapple peel, 0% lemon peel, 0%orange peel, 0% ginger, 0%yeast and 0% sugar**.**

3.5 Alcohol Content of Spice-enriched Wine

Table 4.5 shows that sample sample A, B and C alcohol content increased as the weeks progressed (0.00±0.00 - 0.086±0.01^{a}**),** (0.00±0.00 -0.064±0.01^{b}) and (0.00±0.00 - 0.043±0.01^{c}) respectively, but sample D had no alcohol present. There was significant difference between the samples (P≥0.05). Alcohol increased due to the utilization of the sugar by the yeast. The fermentation process yielded wine with different alcoholic content. The difference in alcoholic content may be due to difference in amount of fermentable sugars in the raw materials and perhaps difference in the availability of the sugars for bioconversion by the fermenting yeast. This finding suggests that pineapple waste had more sugar content than the banana waste. This result agrees with the report of (Igue, 1995) which showed that pineapple waste contains almost twice as much sugar as plantain peels.

Table 3.5; alcohol content Spice-enriched Wine

WEEKS	A	B	C	D
BEFORE FERMENTATION	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00
0	0.070±0.01^{a}	0.050±0.01^{b}	0.030±0.01^{c}	0.000±0.00^{d}
1	0.079±0.01^{a}	0.055±0.01^{b}	0.032±0.01^{c}	0.000±0.00^{d}
2	0.083±0.01^{a}	0.057±0.01^{b}	0.034±0.01^{c}	0.000±0.00^{d}
3	0.085±0.01^{a}	0.058±0.01^{b}	0.037±0.01^{c}	0.000±0.00^{d}
4	0.086±0.01^{a}	0.063±0.01^{b}	0.041±0.01^{c}	0.000±0.00^{d}
5	0.086±0.01^{a}	0.064±0.01^{b}	0.043±0.01^{c}	0.000±0.00^{d}

A = PINEAPPLE PEEL WINE, 0%banana, 50% pineapple peel, 8.5% lemon peel, 8.5%orange peel, 12.5% ginger, 0.5%yeast and 20% sugar.
B= PINEAPPLE AND BANANA PEEL WINE, 25%banana, 25% pineapple peel, 8.5% lemon peel, 8.5%orange peel, 12.5% ginger, 0.5%yeast and 20% sugar.
C= BANANA PEEL WINE, 50%banana, 0% pineapple peel, 8.5% lemon peel, 8.5%orange peel, 12.5% ginger, 0.5%yeast and 20% sugar.
D= GLAMOUR SYNTHETIC WINE, 0%banana, 0% pineapple peel, 0% lemon peel, 0%orange peel, 0% ginger, 0%yeast and 0% sugar**.**

3.6 Antioxidant of Spice-enriched Wine

Table 4.6 shows that sample A, B and C antioxidants increased as the weeks progressed .Sample A had the highest DPPH , total phenol and vitamin C values, which all increased over the storage weeks .it ranged from (81.25±0.62^{a} - 81.50±0.06^{a}**),**(2.77±0.05^{a} - 3.03±0.01^{a}) and (3.91±0.62^{b} -4.51±0.06^{b}) respectively while sample D had the least antioxidant in terms of DPPH ,total phenol and vitamin C ,which was 54.99±0.00^{d}, 0.15±0.00^{d} and 4.93±0.00^{a} respectively. The higher DPPH content of sample A, B and C could be attributed to the antioxidant potential of ginger. Ginger is used as a spice and as

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natural additives for more than 2000 years (Bartley and Jacobs, 2000). Ginger has many medicinal properties and has been reported to be a good source of antioxidants which exhibit high activities (Shirin and Prakash, 2010). The values reported in this study revealed that wine has high antioxidant which helps fight the body over whelming free radicals. Vitamin content is an important factor in the overall nutritional value of food because of its antioxidant and therapeutic properties, ascorbic acid (vitamin C) is a valuable food component.

Table 3.6; Antioxidant of Spice-enriched Wine

WEEKS	DPPH A%	DPPH B%	DPPH C%	DPPH D%
0	81.25±0.62^{a}	78.73±0.03^{b}	75.46±0.07^{c}	54.99±0.00^{d}
3	81.33±0.01^{a}	78.78±0.03^{b}	75.85±0.03^{c}	54.99±0.00^{d}
5	81.50±0.06^{a}	78.95±0.03^{b}	75.99±0.01^{c}	54.99±0.00^{d}
Weeks	**VITC A mg/ml**	**VITC B mg/ml**	**VITC C mg/ml**	**VITC D mg/ml**
0	3.91±0.62^{b}	3.82±0.03^{c}	3.48±0.07^{d}	4.93±0.00^{a}
3	4.51±0.01^{b}	3.92±0.03^{c}	3.64±0.03^{d}	4.93±0.00^{a}
5	4.51±0.06^{b}	3.99±0.03^{c}	3.85±0.04^{d}	4.93±0.00^{a}
Weeks	**TPHE A mg/ml**	**TPE B mg/ml**	**TPHE C mg/ml**	**TPHE D mg/ml**
0	2.77±0.05^{a}	2.49±0.02^{b}	2.04±0.02^{c}	0.15±0.00^{d}
3	2.82±0.01^{a}	2.55±0.00^{b}	2.28±0.10^{c}	0.15±0.00^{d}
5	3.03±0.01^{a}	2.76±0.05^{b}	2.43±0.01^{c}	0.15±0.00^{d}

A = PINEAPPLE PEEL WINE, 0%banana, 50% pineapple peel, 8.5% lemon peel, 8.5%orange peel, 12.5% ginger, 0.5%yeast and 20% sugar.
B= PINEAPPLE AND BANANA PEEL WINE, 25%banana, 25% pineapple peel, 8.5% lemon peel, 8.5%orange peel, 12.5% ginger, 0.5%yeast and 20% sugar.
C= BANANA PEEL WINE, 50%banana, 0% pineapple peel, 8.5% lemon peel, 8.5%orange peel, 12.5% ginger, 0.5%yeast and 20% sugar.
D= GLAMOUR SYNTHETIC WINE, 0%banana, 0% pineapple peel, 0% lemon peel, 0%orange peel, 0% ginger, 0%yeast and 0% sugar**.**

3.7 Minerals of Spice-enriched Wine

Table 4.7 shows the mineral values of the enriched wine after fermentation. Magnesium increased in sample A, B and C in the range of (15.82±0.01^{c} - 15.86±0.01^{c}), (23.32±0.01^{b} - 23.38±0.01^{b}) and (28.83±0.01^{a} -28.89±0.01^{a}) respectively, but sample D remained constant 7.82±0.00$^{d.}$. There is significant difference between the samples (P≥0.05).There was also an increase in potassium where sample A, B and C increased over the weeks, sample D remained constant. Sample C had the highest value of potassium (305.00±0.01^{c} - 306.02±0.01^{c}) while sample D has the lowest value (52.81±0.00^{d}).this is due to the fact that banana peels are very rich in potassium. it was also observed that calcium, phosphorus , iron and sodium also increased as the weeks progressed, sample D had the least values of all the minerals ,this is due to the fact that sample D is a synthetic wine composed of artificial chemicals hence the reason for the reduced minerals. Sample A, B and C had high minerals due to the fermentation of the peels. Generally, the presence of minerals such as calcium and iron at acceptable levels will contribute to the normal functioning of the body (Enidiok and Attah, 2010).

Table 3.7; Minerals of Spice-enriched Wine

WEEKS	Mg A mg/g	Mg B mg/g	Mg C mg/g	Mg D mg/g
0	15.82±0.01^{c}	23.32±0.01^{b}	28.83±0.01^{a}	7.82±0.00^{d}
3	15.85±0.01^{c}	23.37±0.01^{b}	28.89±0.01^{a}	7.82±0.00^{d}
5	15.86±0.01^{c}	23.38±0.01^{b}	28.89±0.01^{a}	7.82±0.00^{d}
Weeks	**K A mg/g**	**K B mg/g**	**K C mg/g**	**K D mg/g**
0	102.05±0.01^{a}	205.81±0.01^{b}	305.00±0.01^{c}	52.81±0.00^{d}
3	102.68±0.01^{a}	206.21±0.01^{b}	305.81±0.01^{c}	52.81±0.00^{d}
5	102.92±0.01^{a}	206.89±0.01^{b}	306.02±0.01^{c}	52.81±0.00^{d}

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Weeks	Ca A mg/g	Ca B mg/g	Ca C mg/g	Ca D mg/g
0	6.00±0.01[a]	5.55±0.01[b]	5.00±0.01[c]	3.00±0.00[d]
3	6.05±0.01[a]	5.58±0.01[b]	5.08±0.01[c]	3.00±0.00[d]
5	6.06±0.01[a]	5.58±0.01[b]	5.09±0.01[c]	3.00±0.00[d]
Weeks	**P A mg/g**	**P B mg/g**	**P C mg/g**	**P D mg/g**
3	7.29±0.04[c]	13.87±0.01[b]	19.88±0.04[a]	3.02±0.00[d]
5	7.30±0.05[c]	13.89±0.02[b]	19.89±0.03[a]	3.02±0.00v
Weeks	**Fe A mg/g**	**Fe B mg/g**	**Fe C mg/g**	**Fe D mg/g**
0	0.31±0.03[a]	0.27±0.01[b]	0.25±0.03[c]	0.15±0.00[d]
3	0.34±0.04[a]	0.29±0.01[b]	0.27±0.04[c]	0.15±0.00[d]
5	0.35±0.05[a]	0.30±0.02[b]	0.28±0.03[c]	0.15±0.00[d]
Weeks	**Na A mg/g**	**Na B mg/g**	**Na C mg/g**	**Na D mg/g**
0	0.31±0.03[a]	0.27±0.01[b]	0.25±0.03[c]	0.15±0.00[d]
3	0.34±0.04[a]	0.29±0.01[b]	0.27±0.04[c]	0.15±0.00[d]
5	0.35±0.05[a]	0.30±0.02[b]	0.28±0.03[c]	0.15±0.00[d]

A = PINEAPPLE PEEL WINE, 0%banana, 50% pineapple peel, 8.5% lemon peel, 8.5%orange peel, 12.5% ginger, 0.5%yeast and 20% sugar.
B= PINEAPPLE AND BANANA PEEL WINE, 25%banana, 25% pineapple peel, 8.5% lemon peel, 8.5%orange peel, 12.5% ginger, 0.5%yeast and 20% sugar.
C= BANANA PEEL WINE, 50%banana, 0% pineapple peel, 8.5% lemon peel, 8.5%orange peel, 12.5% ginger, 0.5%yeast and 20% sugar.
D= GLAMOUR SYNTHETIC WINE, 0%banana, 0% pineapple peel, 0% lemon peel, 0%orange peel, 0% ginger, 0%yeast and 0% sugar**.**

3.8 Microbial Analyses of Spice–enriched Wine

Table 4.9.1 shows the microbial analysis of spice-enriched wine. The bacteria count reported in this study shows that there was no bacteria count in all samples for EMB and MSA agar. This could be as a result of ginger present. This observation agreed with the report of (Ogbulieet al., 2007) who studied the effect of preservatives such as lemon and orange peels. On day zero, Sample A, B, C and D had 1×10^{-3}, 2×10^{-3}, 4×10^{-3} and 1×10^{-3}cfu/ml for NA. On the third week, sample A, B and C had 4×10^{-3}, 6×10^{-3} and 8×10^{-3}cfu/ml, sample D had no microbial count for NA. On the fifth week, sample A, B and C had 6×10^{-3}, 9×10^{-3}, and 13×10^{-3}cfu/ml for NA.

Table 3.8; Microbial Analyses of Wine Samples

WEEK / AGAR		A	B	C	D
0	**NA 10^{-3}**	1	2	4	1
3	**NA 10^{-3}**	4	6	8	NIL
5	**NA 10^{-3}**	6	9	13	NIL
0	**EMB 10^{-3}**	NIL	NIL	NIL	NIL
3	**EMB 10^{-3}**	NIL	NIL	NIL	NIL
5	**EMB 10^{-3}**	NIL	NIL	NIL	NIL
0	**MSA 10^{-3}**	NIL	NIL	NIL	NIL
3	**MSA 10^{-3}**	NIL	NIL	NIL	NIL
5	**MSA**	NIL	NIL	NIL	NIL

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A = PINEAPPLE PEEL WINE, 0%banana, 50% pineapple peel, 8.5% lemon peel, 8.5%orange peel, 12.5% ginger, 0.5%yeast and 20% sugar.
B= PINEAPPLE AND BANANA PEEL WINE, 25%banana, 25% pineapple peel, 8.5% lemon peel, 8.5%orange peel, 12.5% ginger, 0.5%yeast and 20% sugar.
C= BANANA PEEL WINE, 50%banana, 0% pineapple peel, 8.5% lemon peel, 8.5%orange peel, 12.5% ginger, 0.5%yeast and 20% sugar.
D= GLAMOUR SYNTHETIC WINE, 0%banana, 0% pineapple peel, 0% lemon peel, 0%orange peel, 0% ginger, 0%yeast and 0% sugar**.**

3.9: Sensory Analyses

Table 4.9 shows the sensory analysis of spice-enriched wine fortified with ginger and preserved with lemon and orange peels. The appearance and aroma showed that Sample A was the most liked and sample D was the least liked. Colour appears to be a very important criterion for the initial acceptability of the any product (Noorfarahzilahet al., 2014). Sample A had a better colour while sample C had the least colour acceptability. Sample D had the best taste because it had the highest brix, shows that sample D is the sweetest while sample C is the least in terms of sweetness. Sample A has the highest general acceptability while sample D had the least general acceptability.

Table 4.9; Sensory Evaluation of Spice-enriched Wine

	A	B	C	D
COLOUR	8.00 ± 0.76^{a}	6.47 ± 0.83^{c}	4.20 ± 0.78^{d}	7.60 ± 0.52^{b}
AROMA	7.13 ± 0.74^{a}	6.13 ± 0.64^{c}	3.60 ± 0.63^{d}	7.00 ± 0.94^{b}
APPEARANCE	7.07 ± 0.70^{a}	4.87 ± 0.52^{c}	2.07 ± 0.88^{d}	6.60 ± 0.83^{b}
TASTE	6.07 ± 0.88^{b}	5.53 ± 0.52^{c}	1.93 ± 0.46^{d}	8.80 ± 0.42^{a}
GENERAL ACCEPABILITY	7.73 ± 0.71^{a}	6.07 ± 0.79^{c}	1.71 ± 0.61^{d}	7.23 ± 0.46^{b}

Values are expressed as mean ± standard deviation of triplicate determination.
Means with same superscript on the same are not significantly different at $P\geq0.05$.
KEYS A = PINEAPPLE PEEL WINE, 0%banana, 50% pineapple peel, 8.5% lemon peel, 8.5%orange peel, 12.5% ginger, 0.5%yeast and 20% sugar.
B= PINEAPPLE AND BANANA PEEL WINE, 25%banana, 25% pineapple peel, 8.5% lemon peel, 8.5%orange peel, 12.5% ginger, 0.5%yeast and 20% sugar.
C= BANANA PEEL WINE, 50%banana, 0% pineapple peel, 8.5% lemon peel, 8.5%orange peel, 12.5% ginger, 0.5%yeast and 20% sugar.
D= GLAMOUR SYNTHETIC WINE, 0%banana, 0% pineapple peel, 0% lemon peel, 0%orange peel, 0% ginger, 0%yeast and 0% sugar.

IV. CONCLUSIONS

Spice-enriched wine was investigated under storage. Wine is a beverage with a flower-like fresh fruit, being fruit based the fermented and undistilledproduct, wine contains most of the nutrients present in the original fruit juice. The nutritive value of wine is increased due to release of amino acid and other nutrients from yeast during fermentation. This wine was enriched with ginger and preserved with orange and lemon peels. The study showed that the nutritional quality of the spiced- enriched wine was improved. Sample A showed that it had the highest antioxidants compared to the control sample and other samples. There was an improve in the antioxidant property as a result of ginger addition. The effect of substitution revealed increase in storage period and significant increase in the nutritional quality. The microbial load from this study showed a hygienic condition of the preparation and during storage there was an effect of inhibition of microorganism due to the anti-microbial property of ginger. Pasteurization, lemon and orange peels ensured a delay in the fermentation of the spice-enriched wine into an alcoholic beverage.

RECOMMENDATION

Further research is recommended, to proffer a solution to stop fermentation totally without the use of chemical preservatives and study should be done on optimizing the best temperature of storing the enriched palm wine.

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