Original Research Article

Characterization of fruit wines from baobab (*Adansonia digitata*), pineapple (*Ananas sativus*) and carrot (*Daucus carota*) tropical fruits

Abstract

Juices were extracted from baobab, pineapple and carrot fruit pulps, ameliorated to 23^{o}Brix with sucrose and seeded with 3% (v/v) Baker's yeast (*Saccharomyces cerevisae*). The juices were fermented at 30^{0}C for 21 days. Changes in pH, titratable acidity and soluble solids of the juices during fermentation were assessed. The pH, soluble solids and specific gravity of the juices decreased while titratable acidity increased with fermentation period. The pH values of the baobab, pineapple and carrot wines are 3.30, 3.52 and 4.4, respectively. The baobab, pineapple and carrot wines have titratable acidities of 0.06, 0.90 and 0.72 %, respectively. The soluble solids vary from 3% in pineapple wine to 6 ^{0}Brix in baobab wine. The volatile acidities of the wines range between 0.050 and 0.113 %. The vitamin C contents of the baobab, pineapple and carrot wines are 285, 43.74 and 6.00 mg/100g, respectively. The beta carotene contents of baobab, pineapple and carrot wines are 0.60, 6.40 and 1880 mg/100g, respectively. The baobab, pineapple and carrot wines contain 11.0, 12.0 and 7.60 %(v/v) alcohol, respectively .The pineapple wine is rated significantly higher ($p<0.05$) in all the sensory attributes than the baobab and carrot wines.

Key word: Baobab, carrot, juice, fermentation, pineapple, wine

1.0 Introduction

The baobab (*Adansonia digitata*) tree is common in many parts of Africa and other tropical countries. However, in Nigeria, they are commonly found wild in the Northern states. The tree produces fruit pods. The pod is round in shape and has hard pericarp which contains the pulp and the seed. The pulp has fibrous structure which has high affinity for water. The pulp has whitish –yellow color which closely resembles the milk

color .The raw and processed pulp is sweet and edible. The Hausa-speaking and cattle Fulani farmers who live in the Savanna regions of Northern Nigeria make use of every part of the baobab tree. The leaves, either fresh or dried and pulverized, are used for preparing soup which is poured over dish of porridge made from sorghum or millet flour (Addy et al., 1984). Fermented seeds of baobab are made into cake and used to flavor soups. However, unlike the pulp and the leaves, the seed is not a popular item of food in Nigeria. The stem is used as rope. The pulp is the richest source of ascorbic acid in the Savanna belt of Nigeria (Addy and Eka, 1984, Amaechi and Obizoba, 1992).When the fruit pod is ripe; the pulp is removed from the fibers and seeds by kneading in cold water. The mixture is passed through a sieve. The resulting liquid called *gubdi* in Hausa or *omi obobo* in *Igala* is used by the farmers to dilute thick millet dough (*fura*) to thin gruel (*kunu*). Kunu is the traditional breakfast or mid-day meal in Northern Nigeria. The cattle owning Fulani used the *gubdi* to mix with cow,s milk (Amaechi and Orizaba, 1992). Milk and baobab fruit juice mixture is a popular drink with Hausa farmers. The drink is always available for purchase; particularly during the hot period of the year (October to April) when new farms are being cleared or hoeing of old farms is taking place preparatory to sowing. Baobab fruit juice may be suitable as a fermentation substrate for wine preparation.

Pineapple is one of the most popular of the non-citrus tropical and subtropical fruits because of its attractive flavor and refreshing sugar-acid balance (Arthey, 2005). Pineapple fruit is available in almost all parts of rural Nigeria at affordable prices (Oyem et al., 2010). Pineapple may be available fresh, canned and as juice. Pineapple juice contains high amounts of vitamins C, B_2 and $B_{6,}$ in addition to other essential nutrients and phytochemicals (Akubor, 2016). Pineapple juice has been reported to have laxative and tonic effects (Arthey, 1995). The juice helps to soothes gastric irritability and is also used for treatment of jaundice and fever (Hale et al., 2002). In Nigeria, little industrial value is attached to pineapple in spite of its high phytochemical content.. It is only consumed in the fresh state. The qualities of pineapple juice make it suitable for use in wine making (Sampson, 1980). Pineapple juice contain 54 mg/100g vitamin C, 12% total sugars, 0.03% protein,, 0.1% fat, 12 mg calcium, 0.3 mg iron, 0.08% thiamine and 0.1% mg niacin (Ihekoronye and Ngoddy, 1985; Akubor, 2016)

Carrots (*Daucus carota* L) fruits are cultivated in various parts of West Africa, particularly in the Northern States of Nigeria. Carrot is a significant source of phenolics, polyacetylenes and carotenoids (Adegunwa et al., 2002). Carrot is rich in beta carotene, vitamin C and tocopherol (Adegunwa et al.,2002).Carrot contains oxycarotenoids such as leutin which is very protective against colon cancer in men and women (Slattery et al., 2000).The importance of beta carotene to human health is well documented especially in the reduction of the risk of skin cancer, increase in immune response and protection against liver damage (Prabhala et al.,1990).The consumption of carrot in Nigeria has increased tremendously in recent years due to the increased awareness of its health importance. In Nigeria, fresh carrots are eaten raw or cooked, used as vegetables in stews and salads and sometimes crushed and preserved for the juice. In Taiwan, where carrot is cultivated extensively, carrot fruit is commercialized by processing into frozen, dried, canned and fermented products. Carrot pickle that could store for four months was reported by Chawla et al., (2005).In Nigeria, processing of carrot fruit into wine has been reported(Asagbra and Oyewole, 2002, Omole, 2005).

Wine is any product obtained from the alcoholic fermentation of juice of grape by yeast followed by aging process (Ethoirai et al., 1982, Zoecklein, 1990). However, the term is extended to include all fermented liquors obtained from sweet fruits and vegetables. Good quality wines have been produced from a number of tropical fruits (Maldonado et al, 1975, Aderiye et al., 1991; Obanyaju and Ademokoya, 1991, Ogutimein, 1994, Akubor, 1996, Egbekun and Okai, 2005, Okoro, 2007 Akoma et al., 2007, Savda and odrigues,2011a,b,2015,Savdva et al.,2011).The stimulated interest in the use of tropical fruits was to reduce the high import duty on imported wines and to benefit from the array of phytochemicals in the fruits. The composition of substance is one of the critical factors which determine its suitability for wine production. Tropical fruits such as those evaluated in this study are not only low in sugar and nutrients but are high in acidity. These properties do not favor their utilization for wine making, thus, amelioration with sugar, dilution with water to reduce acidity and mineral supplementation have been widely practiced(Akoma et al., 2007). Improved method was reported for extraction and optimization of guava juice for wine production (Sedva et al.,2102) Control of temperature is a critical factor in wine production particularly in hot climate like Nigeria.

The use of *Saccharomyces cerevisae* and ambient temperature fermentation has been recommended and practiced (Aderiye et al., 1991, Sevda and Rodrigues, 2011a, b, 2015, Sedva et al.,2012). The production of wines from baobab, pineapple and carrot fruits would be a way of expanding the utilization of these fruits. The quality of wine varies with the fruit type, soil, yeast strain, fermentation temperature and period. Comparative studies on tropical fruit wines are scarce in the literature. Thus, the objective of this study was to compare the chemical composition, physicochemical and sensory properties of wines from baobab, pineapple and carrot tropical fruits. This will bring together in a single report the qualities of these tropical fruit wines that are scattered in the literature.

2.0 Materials and methods

2.1 Preparation of baobab fruit juice

Mature, ripe and healthy baobab fruits were harvested from a tree in a local farm in Idah Township, Kogi state, Nigeria. The fruits were sorted as described by Amaechi and Obizoba (1992) and cleaned of extraneous materials. The woody pericarp of the fruit was broken with a sharp kitchen knife and the dry pulp was scraped out. The pulp was then soaked in water (pulp: water, 1:3) for 3h. The mixture was filtered through a double fold cheese cloth (0.1mm) to obtain the juice (7^0Brix). Thereafter, the juice was further diluted with water (juice: water, 1:10) and then ameliorated to 23^0Brix with sucrose. Potassium metabisulphite (0.1%, w/v) was added and the juice was pasteurized (60^oC, 10 min) and stored in deep freezer prior to use.

2.2 Preparation of pineapple juice

Mature, ripe and healthy pineapple fruits were harvested from a local farm in Idah Township, Kogi State, Nigeria. The fruits were washed in tap water contained in a basin, peeled with a sharp sterile knife. One hundred gramme of the pulp was blended with 300 ml hot distilled water (1:3, pulp: water) in a Kenwood food processor operated at full speed (1200 rpm) for 10 min. The slurry was filtered through a double folded muslin cloth. The juice was ameliorated to 23^oBrix with sucrose. Potassium metabisulphite (0.1%, w/v) was added and the juice was pasteurized (60^oC, 10 min) and stored in deep freezer prior to use.

2.3 Preparation of carrot juice

Carrot fruits (4kg) were purchased from a local market in Idah Township, Kogi State, Nigeria. The fruits were washed in tap water contained in a basin and then sorted as described by Stephens et al. (1979). The edible portions were cut into thin slices with a sharp sterile knife, blanched in hot water at 80^{O}C for 20 min and then blended with 300 ml hot distilled water(1:3, pulp :water) in a Kenwood food processor operated at full speed(1200 rpm) for 10 min (Stephens, 1979). The slurry was filtered through a double folded muslin cloth. The juice was ameliorated to 23^{o}Brix with sucrose. Potassium metabisulphite (0.1%, w/v) was added and the juice was pasteurized (60^{o}C, 10 min) and stored in deep freezer prior to use.

2.4 Preparation of yeast culture

Ten gramme dry commercial baker's yeast (*Saccharomyces cerevisae*) was dissolved in 500ml baobab juice preheated at 37^{0}C. Diammonium sulphate (0.3%, w/v) was added as yeast food and the mixture was held in a culture propagating bottle at 30^{0}C for 48h.

2.5 Fermentation of fruit juices

Each of the treated baobab, pineapple and carrot juices (5liters) was poured into each of the sterilized 6 liter plastic fermenters equipped with taps and then seeded with 3% (v/v) of the 48h yeast inoculum. The fermenters were closed with robber stoppers fitted with fermentation locks containing 200ml potassium metabisulphite solution. Each of the mixtures was incubated at ambient temperature (30 ^{o}C) for 21 days. The titratable acidity, pH and soluble solids of the juices were monitored daily during the fermentation period. Each of the fermenting juice (young wine) was racked when the evolution of gas diminished at the end of the primary fermentation. The racked young wine samples were transferred to clean sterile aspirator bottles with fermentation locks containing 200ml potassium metabisulphite. Chemical changes (pH, titratable acidity, soluble solids) in the young wines were monitored daily until gas evolution stopped. The wine samples were then transferred into wine bottles and stored in a refrigerator at $10+2^{0}$C for 10 days prior to analysis.

2.6 Analytical methods

The titratable acidity (% citric acid) was measured by the method of Amerine et al. (1980). Total soluble solids (^{0}Brix) were determined using Abbe refractometer. The pH was measured with a Pye Unican pH meter standardized with buffer 4 according to AOAC (2010) method. Moisture was determined by the oven drying at 105^{o}C to constant weight. Ash, fat, crude fiber, volatile acidity and fixed acidity were determined by the methods of AOAC (2010). The protein (N x 6, 25) was estimated by the Kjeldahl method (AOAC, 2010). Carbohydrate was by simple difference (100 – (% (Moisture +Fat +Ash+Protein+Crude fiber). Isopropanol, alcohol and methanol contents were determined as outlined by Amerine and Ough (1980). Ascorbic acid was determined by the 2, 6-dichloiophenol indophenol dye method following the AOAC (2010).

2.7 Sensory evaluation of wines

A panel of 20 judges (males and females) randomly selected from The Federal Polytechnic, Idah community evaluated the baobab, pineapple and carrot fruit wines and a commercial (Capel) wine for taste, color, clarity, flavor and overall acceptability on a 6-point scale (1=disliked extremely and 6=liked extremely) as described by Ihekoronye and Ngoddy (1985). The wine samples were presented in 3-digit coded white plastic cups. The evaluation was carried out in a sensory evaluation laboratory under white light in the mid morning. Tap water was provided for the judges to rinse their mouths in between evaluations

2.8 Statistical analysis

The experiments were laid out in completely randomized design. All determinations were replicated three times. Analysis of variance was performed using statistical package for Social Sciences software (version 20). Means where significantly different were separated by the least significant difference (LSD).Significance was accepted at $p<0.05$.

3.0 Results and Discussion

3.1 Physicochemical properties of juices

The physicochemical properties of baobab, pineapple and carrot juices are presented in Tables1. The pH values of baobab, pineapple and carrot juices were 3.70, 4.01 and 5.30, respectively. The titratable acidities of baobab, pineapple and carrot juices were 0.68, 0.80 and 0.3 %, respectively. The juices have the same soluble solids contents of 23 ^{o}Brix. .The specific gravities of baobab, pineapple and carrot juices were 1.01, 1.06 and 1.09, respectively. These properties of the juices make them suitable substrate for wine production (Akubor, 1996, Omole, 2005)

Table 1: Physicochemical properties of baobab, pineapple and carrot juices

Property	Baobab juice	Pineapple juice	Carrot juice
pH	3.70^{b}	4.01^{b}	5.30^{a}
Titratable acidity(%)	0.68^{a}	0.80^{a}	0.30^{a}
Soluble solids(^{o}Brix)	16.0^{a}	16.0^{a}	3.00^{b}
Specific gravity	1.01^{a}	1.06^{a}	1.09^{a}

Means within a row with the superscript were not significantly different (p>0.5)

3.2 Chemical composition of the juices

The chemical composition of baobab, pineapple and carrot juices fruit juices are presented in Table 2. The moisture content of carrot juice was 94 %, a value which was higher than 86 % for pineapple juice and 89 % for baobab juice. The ash contents of the juices varied from 0.30 % in carrot juice to 1.5 % in baobab juice. The ash content of

pineapple juice was 1.00 %. The baobab juice and pineapple juice had protein contents of 1.00 and 1.40 %, respectively while carrot juice has the lowest protein content of 0.40 %. The crude fat contents of the juices were low where values ranged between 0.10 and 0.50 %. The carrot juice has the lowest crude fiber content of 0.08% in relation to 1.70 % for baobab juice and 1.50 % for pineapple juice. The carbohydrate content of PJ was 10.5%, a value which was significantly ($p<0.05$) higher than 6.30 and 5.00 % for BJ and CJ, respectively. Baobab juice contained 350 mg/100 ml vitamin C. This amount was significantly($p<0.05$) higher than 46.0 mg/100g for pineapple and 10.0 mg/100 ml for carrot juice. On the other hand, the beta carotene content of 1900 mg/100ml for the carrot juice was significantly higher ($p<0.05$) than those of the pineapple juice (10.0 mg/100g) and baobab (1.00 mg/100ml). The chemical composition and physicochemical properties of the baobab, pineapple and carrot juices were similar to those reported by the other workers (Akubor, 1996, 2011, 2016, Amaechi and Obizoba, 1992). The composition of these fruit juices make them suitable for wine making. The amounts of vitamin C in baobab and pineapple juices were high and the high contents of beta-carotene in carrot juice lend them for use as functional ingredients. Foods containing large quantities of phytochemicals are associated with reduced risk of cancer, atherosclerosis, heart disease, osteoporosis, and obesity (Onimawo and Akubor, 2012). The protective role of these foods is partly attributed to constituents such as phenolic compounds, dietary fiber etc (Rice-Evans and Packer, 1998).

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229 Table 2: Chemical composition of baobab, pineapple and carrot fruit juices

Composition	Baobab juice	Pineapple juice	Carrot juice
Moisture (%	89.0[b]	86.0[c]	94.0[a]
Ash (%)	1.50[a]	1.00[b]	0.30[c]
Protein (%)	1.00[a]	1.40[a]	0.40[b]
Crude fat (%)	0.50[a]	0.20[a]	0.10[a]
Crude fiber (%)	1.70[a]	1.50[a]	0.08[b]
Carbohydrate (%)	6.30[b]	9.90[a]	5.12[c]
Ascorbic acid(mg/100g)	350.0[b]	460.0[a]	10.0[c]
Beta-carotene(mg/100g)	2.0[c]	10.0[b]	1900.0[a]

230 Means within a row with the superscript were not significantly different ($p>0.5$)

231 **3.3 Fermentation profile of juice**

232 The fermentation profiles of the baobab, pineapple and carrot juices are shown in
233 Tables 3, 4 and 5, respectively. The titratable acidities increased while the pH decreased
234 steadily with the fermentation period. .The soluble solids contents were reduced from
235 23^{o}Brix to 6.00, 3.00 and 5.00 ^{o}Brix for the baobab, pineapple and carrot wines,
236 respectively at the end of the 21 days of fermentation. The increase in the titratable
237 acidity of the wines on fermentation was consistent with the fall in pH. Similar
238 observations were made for wines produced from tropical fruits (1996, Akubor; Egbekun

239 and Ede, 2005). The decrease in pH was desirable as it helped to maintain the pH of the
240 wine low enough to inhibit the growth of undesirable microorganisms. The sugars were
241 used for alcohol and organic acids production. Although, the fermenting juice was left for
242 21days, the fermentation was over at the 7th day.

243 Table 3: Fermentation profile of baobab juice

Period(day)	**pH**	**Titratable acidity(%Citric acid)**	**Soluble solids(°Brix)**
0	4.00[a]	0.68[a]	23.0[a]
2	4.01[a]	0.69[a]	22.0[b]
4	4.37[a]	0.72[a]	21.0[c]
6	3.60[b]	0.75[a]	20.0[d]
8	3.50[b]	0.78[a]	18.8[e]
10	3.3[b]	0.80[a]	16.0[f]
12	3.2[b]	0.81[a]	15.0[g]
14	3.1[b]	0.81[a]	13.0[h]
16	3.1[b]	0.83[a]	12.0[i]
18	3.0[b]	0.85[a]	11.0[j]
20	3.0[b]	0.87[a]	10.0[k]

244 Means(n=3) within a row with the superscript were not significantly different (p>0.5).

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Table 4 : Fermentation profile of pineapple juice

Period(day)	pH	Titratable acidity(%Citric acid)	Soluble solids(^{o}Brix)
0	3.76[a]	0.80[a]	23.0[a]
2	3.70[a]	0.82[a]	22.0[b]
4	3.60[a]	0.84[a]	21.0[c]
6	3.56[a]	0.86[a]	18.0[d]
8	3.54[a]	0.89[a]	14.5[e]
10	3.83[a]	0.90[a]	11.0[f]
12	3.53[a]	0.91[a]	8.00[g]
14	3.52[a]	0.94[a]	6.00[h]
16	3.51[a]	0.96[a]	5.0[i]
18	3.51[a]	0.97[a]	4.00[j]
20	3.50[a]	0.98[a]	3.00[k]

Means (n=3) within a column with the superscript were not significantly different ($p>0.5$).

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257 Table 5: Fermentation profile of carrot juice

Period(day)	pH	**Titratable acidity(%c**itric acid)	Soluble solids(^{o}Brix)
0	5.30[a]	0.30a	23.0[a]
2	5.00[a]	0.49[a]	21.0[b]
4	4.80[a]	0.58[a]	18.0[c]
6	4.50[ab]	0.62[a]	10.0[d]
8	4.40[b]	0.72[a]	5.00[e]
10	4.20[b]	0.75[a]	4.90[f]
12	4.10[b]	0.81[a]	4.70[g]
14	4.00[b]	0.83[a]	4.50[h]
16	3.80[b]	0.84[a]	4.2[i]
18	3.70[b]	0.85[a]	4.00[j]
20	3.60[b]	0.87[a]	3.50[j]

258 Means(n=3) within a column with the superscript were not significantly different ($p>0.5$).

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3.4 Physicochemical properties of the wines

The physicochemical properties of the wines are shown in Table 6. The pH of the baobab, pineapple and carrot juices fruit wines were 3.30, 3.52 and 4.40, respectively. The baobab, pineapple and carrot fruit wines have titratable acidities of 0.83, 0.90 and 0.72, respectively. The baobab wine has soluble solids content of 6.00^{o}Brix. This was closely followed by carrot wine with soluble solids content of 5.00^{o}Brix and then pineapple wine with 3.00 ^{o}Brix. The specific gravities of baobab, pineapple and carrot wines were 0.86, 0.98 and 1.02, respectively. The volatile acidity of 0.11 % for carrot wine was higher than 0.06 % for baobab wine and 0.05 % pineapple wine. The baobab, pineapple and carrot fruit wines have fixed acidities of 0.52, 0.46 and 0.58 %, respectively. The pH values of the wines were comparable to 3.1 reported for African bush mango fruit wine (Akubor, 1996), 3.3 reported for banana wine but less than that of the cashew wine (4.18) (Aderiye et al., 1991). A range of 3.10 to 3.6 was recommended for wines (Amerine et al., 1980). High acidity would ensure high levels of organic acids in the wine. Organic acids have been reported to inhibit the growth of undesirable bacteria (Amerine et al, 1980). The low pH of the wines may contribute to high quality products. The specific gravity, volatile, fixed and titratable acidities were within the Amerine et al. (1980) range of values for wines. Amerine et al. (1980) had recommended that the volatile acidity of a young wine should be less than 0.07g/100ml. Acids are the skeleton of wine (Bruno et al, 1992). Without acids, wine would be flat and flabby (Bruno et al., 1992) . Malic acid, a fixed acid in wine, gives freshness and sometimes flavor in wine (Bruno, 1992)

Table 6: Physicochemical properties of baobab, pineapple and carrot wines

Properties	**Baobab wine**	**Pineapple wine**	**Carrot wine**
pH	3.30^{b}	3.52^{b}	4.40^{a}
Titratable acidity(% citric acid)	0.83^{a}	0.90^{a}	0.72^{a}
Soluble solids(^{o}Brix)	6.00^{a}	3.00^{c}	5.00^{b}
Specific gravity	0.86^{a}	0.98^{a}	1.02^{a}
Volatile acidity (%)	0.06^{a}	0.05^{a}	0.11^{a}
Fixed acidity (%)	0.52^{a}	0.46^{a}	0.58^{a}

Means (n=3) within a row with the superscript were not significantly different (p>0.5).

3.5 Chemical composition of the wines

The chemical composition of baobab, pineapple and carrot juices fruit juices are presented in Table 7. The moisture content of carrot wine was 93.0 %, value which was higher than 89.0 % for pineapple wine but less than 95.0 % for baobab wine. The ash contents of the wines varied from 0.20 % in carrot wine to 1.00 % in baobab wine. The ash content of pineapple wine was 0.80%. The protein contents baobab wine, pineapple wine and carrot wine were 0.50, 0.70 and 0.30 %, respectively .The crude fat contents of

the wines like those of juices were low where values ranged between 0.10 and 0.20 %. Carrot wine has the lowest crude fiber content of 0.05% in relation to 0.70 % for baobab wine and 0.50 % for pineapple wine. The carbohydrate content of pineapple wine was 8.90 %, a value which was significantly ($p<0.05$) higher than 2.60 and 6.35 % for baobab and carrot wines, respectively. The baobab wine contained 285 mg/100 ml vitamin C. This amount was significantly higher ($p<0.05$) than 43.74 mg/100g for pineapple wine and 6.00 mg/100 ml for carrot wine. On the other hand, carrot wine (1800 mg/100ml) has significantly higher amount of beta carotene than pineapple wine (17 mg/100ml) and baobab wine (0.6 mg/100ml). The alcohol contents of baobab wine, pineapple wine and carrot wines were 11.0, 12.0 and 7.60 %(v/v). Isopropanol but not methanol was present in the wines. The high moisture contents of the wines would encouraged microbial growth. The low pH, high acidity and alcohol levels would help in preserving the wines. The lower ash contents of the wines indicated consumption of some of the minerals in the juice by yeast. Similarly, some of the proteins and carbohydrates in the juices may have been used by the yeast during fermentation. The low fat contents of the wines show that they have low risk of developing rancidity(Onimawo and Akubor, 2012).The low level of carbohydrates may have contributed to the low sensory scores for taste received by the wines. A 4.5% residual sugar was reported to improve the taste of bush mango fruit wine (Akubor, 1996). The sugars in the juice were probably utilized for alcohol and organic acids production. The alcohol contents of the wines (7.6- 11%) were within the range of 7.5-12.5% (v/v) reported for Clares, Burgundy and Hock wines (Pearson, 1976) and cashew wine (Aderiye et al., 1991). The fruit wines may be classified as table wines based on the recommendation that the alcohol content of table wines should range between 7 and 14 %(v/v) (Amerine et al., 1980). The retention of ascorbic acid is used as estimate for the overall retention of nutrients in food product. This is because it is the least stable nutrient (Onimawo and Akubor, 2012).The high content of ascorbic acid in the baobab and pineapple fruit wines is of nutritional significance. Ascorbic acid acts as an antioxidant in the blood and other body fluids. It regenerates the antioxidant form of vitamin E and enhances iron absorption by keeping iron in its more readily absorbable form (Ihekoronye and Ngoddy, 1985). Iron deficiency is the most wide spread micronutrient deficiency in the world today. The anemia it causes is a major problem

among women and young children. Epidemiological data have indicated possible role of ascorbic acid in the protection against caner (Rice-Evans and Packer, 1998) .The high beta-carotene content of the carrot wine is of importance to human health. Beta-carotene is the precursor of vitamin A and has preventive action against eye diseases and cancer (Onimawo and Akubor, 2012). Carotenes enhance immune response and protect skin cells against UN radiation. They help to lower the risk of cardiovascular diseases, age related vision diseases, asthma and reduce inflammation. Consumers are increasingly becoming interested in health benefits of foods and have begun to look beyond the basic nutritional benefits of foods to disease prevention and health enhancing compounds contained in many foods such the tropical wines assessed in this study. The presence of other alcohols such as propanol in the wines would add weight and body, hotness and sweetness to the wine (Pearson, 1976)

Table 7: Chemical composition of baobab, pineapple and carrot wines

Composition	Boabab wine	Pineapple wine	Carrot wine
Moisture(%)	95.0[a]	89.0[c]	93.0[b]
Ash(%)	1.00[a]	0.80[a]	0.20[b]
Protein(%)	0.50[a]	0.70[a]	0.30[a]
Fat(%)	0.20[a]	0.10[a]	0.10[a]
Crude fiber(%)	0.70[a]	0.50[a]	0.05[a]
Carbohydrate(%)	2.60[c]	8.90[a]	6.35[b]
Ascorbic acid(mg/100g)	285[a]	43.7[b]	6.00[c]
Beta-carotene(mg/100g)	0.60[c]	6.40[b]	1880[a]
Alcohol(% v/v)	11.0	12.0	7.60
Isopropanol	Present	Present	Present
Methanol	Absent	Absent	Absent

Means (n=3) within a row with the superscript were not significantly different ($p>0.5$).

3.6 Sensory properties of the wines

The mean sensory scores of the baobab, pineapple and carrot wines as compared with those of the commercial wine (Capel) are presented in Table 8. The pineapple wine was rated significantly higher ($p<0.05$) for color than the other wines. This was followed by baobab and the reference wines. The carrot wine received significantly lower scores for all the sensory attributes evaluated. The scores for clarity of the baobab, pineapple and reference wine were not significantly different ($p<0.05$).

Table 8: Mean sensory scores of baobab, pineapple and carrot wines

Property	**Baobab wine**	**Pineapple wine**	**Carrot wine**	**Reference wine(Peach)**
Color	4.30^{b}	5.30^{a}	3.90^{c}	4.20^{b}
Clarity	4.30^{a}	4.90^{a}	2.80^{b}	4.60^{a}
Taste	3.40^{b}	4.30^{a}	3.60^{b}	4.90^{a}
Flavor	3.70^{c}	5.00^{a}	3.90^{c}	4.00^{b}
Mouthfeel	4.00^{b}	4.50^{b}	3.80^{b}	5.10^{a}
Overall acceptability	3.50^{c}	5.50^{a}	3.60^{c}	4.50^{b}

Means(n=20) within a row with the superscript were not significantly different ($p>0.5$).Wines were assessed on 6-point Hedonic scale where 1 =disliked extremely and 6=liked extremely

However, the reference and pineapple wine preferred to the other wines n taste. The pineapple wine received higher scores for flavor and overall acceptability than the other wines including the reference wine. The reference wine was rated higher in mouthfeel than the other wines. The pineapple was rated significantly higher than the other wines for all the attributes except mouthfeel. The low levels of residual sugars in the baobab wine may have contributed to the low palatability score for the taste. Most of the wines produced from tropical fruits have poor color (Ojeh, 1980). Red wines have not been produced from tropical fruits because of their low contents of extractable red pigments as in red variety of grapes (Teniola et al., 2012). Efforts on producing red wines by adding

synthetic red colorants or dyes are regulated to prevent toxicity in humans (Teniola et al., 2012).The pigments in pineapple juice contributed to high appreciation of the pineapple wine color. The high appreciation of the pineapple wine over the other tropical fruit wines and the control indicate that pineapple juice is suitable for wine production. The wine was not reported as unpleasant by any member of the panel. The high acidity and low soluble solids of pineapple may have contributed to its high sensory qualities. Acids present in foods not only improve palatability but also influence nutritive values. The acids influence the flavor, brightness of color, stability, consistency and keeping quality of the product (Okigbo, 2003).Soluble solids content is one of the most important quality parameter in fruit processing. About 55% of soluble solids are sugars such as glucose and fructose and their amounts and proportion influence organoleptic qualities of fruits and fruit products. Beyond the optimum amount of sugar, taste rating may be reduced.

CONCLUSION

Baobab, pineapple and carrot and fruits have high potential for wine making. The wines produced from baobab, pineapple and carrot fruit juices contained11, 12 and 7.6 %(v/v), respectively. The baobab and pineapple wines contained high amounts of ascorbic acid. The carrot wine contained significantly higher amount of beta- carotene than the other wines. The use of the fruits would conserve foreign exchange expended on the importation of wine. However, commercial production of these wines will depend on availability of the raw materials. The existing baobab trees do not grow rapidly and are poor yielding. If the potential of this tree is to be fully utilized, the need to improve on the existing varieties cannot be over emphasized. The beta carotene and vitamin C contents of the juices were reduced during fermentation of the juices. The fruit wines can be fortified with these constituents.

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