PINEAPPLE FLAVOURED ROSELLE DRINK CONCENTRATES: NUTRITIONAL, PHYSICOCHEMICAL AND SENSORY PROPERTIES

Gbadegesin, Adewumi Ronke*, **Gbadamosi**, Saka Olasunkanmi
Department of Food Science and Technology, Obafemi Awolowo University, Ile-Ife, Nigeria
* Email: ronkeadewumi@gmail.com

Abstract
The roselle drink concentrate was produced by reducing the amount of water used for extraction and increasing the amount of sucrose used. Pineapple juice was added in the proportion of 0, 15, 20 and 25% to the roselle drink concentrate. Proximate composition, vitamin C, some minerals and physicochemical properties were evaluated using standard methods. The carbohydrate, crude fat, crude fibre, ash, vitamin C, calcium, potassium and magnesium contents increased significantly ($p < 0.05$) while the moisture and sodium contents decreased significantly ($p < 0.05$) with increase in the level of incorporation of pineapple juice to roselle drink concentrate. The protein, carbohydrate, fat, fibre, ash and moisture contents of the samples were 0.24 to 0.28%, 10.73 to 12.57%, 0.21 to 0.28%, 0.21 to 0.33%, 0.52 to 0.57% and 86.01 to 88.05%, respectively. The vitamin C contents ranged between 35.62 and 37.24 mg/100 g. There was no significant difference ($p > 0.05$) in the protein, iron content and viscosity of the samples. The pH, total soluble solids and reducing sugar increased significantly ($p < 0.05$) while the titratable acidity and colour intensity decreased significantly ($p < 0.05$) with increase in addition of pineapple juice. The sample with 25% pineapple juice was the most preferred based on sensory evaluation.

Key words: Extraction, proportion, incorporation, proximate, physicochemical

Received: 08.03.2017 Received in revised form: 12.05.2017 Accepted: 17.05.2017

1. INTRODUCTION

In the goal towards achieving food security and nil import dependence in Nigeria, the food drink industry has come under surveillance, as many imported drinks (especially 'energy drinks') have almost no food value, contain unsafe or even carcinogenic chemicals and have been shown to upsurge the risk of certain diseases e.g. diabetes and hypertension (Omemu *et al.*, 2006). This has increased research of local drinks, for example, *burukutu*, *kunu* and *zobo* (roselle drink). Roselle drink is a non-intoxicating water extract of the reddish purple, acid-tender *Hibiscus sabdariffa* calyces that is produced by boiling and percolation (Okeniyi and Kolawole, 2007; Ogiehor *et al*., 2008). The word *zobo* is a northern Nigeria (Hausa) name for roselle plant. It is acquiring wide acceptance, being consumed by millions of people from distinct socio-economic classes and background in the West Africa Sub-region (Ogiehor and Nwafor, 2004). The production of roselle drink is tedious and time consuming (Gbadegesin *et al*., 2017). The drink enjoys high benefaction from the standpoints of economical, nutritive and medicinal values. Economically, it is inexpensive when evaluated with other available soft drinks. It is richer in carotenoids (especially beta-carotene), vitamin C, minerals and antioxidants. Medicinal value of the extracts from the roselle plant has been reported to include anti-diabetic, antiseptic, astringent, diuretic and purgative activities, remedy for cancer, abscesses, cough, dysuria, laxative, scurvy and fever (Osueke and Ehirim, 2004). Its medicinal values also include avoidance and remedy of hypertension and inflammation of the bladder (Qi *et al.*, 2005). It also has the potential of relieving the biochemical trait of metabolic syndrome caused by consumption of alcohol (Onyesom *et al*., 2008).
Pineapple (*Ananas comosus*) is a significant tropical and subtropical plant widely grown in the tropical areas of the world. Its fruit is taken fresh or canned in many countries (Avallone *et al*., 2003). Pineapple is a delightful tropical fruit having unique juiciness, exciting tropical flavor and enormous health benefits. Pineapple have considerable amount of ascorbic acid,

carbohydrates, crude fibre, water and different minerals such as calcium and potassium that are good for the digestive system and aids maintaining ideal weight and balanced nutrition (Hossain *et al*., 2015). This work aims to establish the nutritional, physicochemical and sensory properties of roselle drink concentrates that are flavoured with natural pineapple juice.

2. MATERIAL AND METHODS

Materials
Dried roselle calyces, ripe pineapples and sucrose were bought from Modakeke market, Osun State, Nigeria.

Methods
Production of pineapple juice
The ripe pineapples were washed with water, peeled and sliced manually with kitchen knife. The pineapple slices were blended using Kenwood blender at max speed for 30 secs and then sieved with a clean muslin cloth.

Production of pineapple flavoured roselle drink concentrate
A modified method of Braide *et al.* (2012) was used to produce pineapple flavoured roselle drink concentrate. Dirts and extraneous materials were removed from dried roselle calyces by manual sorting and winnowing. Roselle calyces (800 g) were rinsed with water. The calyces were boiled in 8000 ml water for 30 mins. It was then filtered into a sterilized bowl using a washed muslin cloth to get roselle drink concentrates.
Pineapple juice was incorporated at different percentages (0, 15, 20 and 25% [v/v]) to serve as flavour. 20% (w/v) sucrose was added to with 0.1 N NaOH to a pH endpoint of 8.2. the equation below was used to calculate the tritatable acidity of the samples (Meei *et al*., 2012).

$$\text{Tritatable acidity (\% malic acid)} = \left(\frac{\text{volume of titration} \times 0.1\text{ N NaOH} \times 0.067 \times 100}{\text{volume of juice}}\right)$$

Determination of total soluble solids
Hand refractometer was used to determine the total soluble solids. The refractometer prism

each pineapple flavoured roselle drink concentrate and then mixed. The samples were pasteurized at 70 ºC for 15 min.

Proximate Analysis
The proximate composition (moisture, protein, crude fat, ash, crude fibre and carbohydrate contents) were determined following the methods described by AOAC (2000).

Determination of vitamin C
Titrimetric method (using 2, 6-dichlorophenol indophenol dye) was used to determine the vitamin C content of each sample (Hassan and Hassan, 2008).

Mineral analysis
Minerals were analyzed according to the method by Fashakin *et al*. (1991). Sample (2 ml) was measured into digestion flask, 10 ml of nitric acid and 10 ml of HCl were added. Digestion was done for 10 min. It was made up to 50 ml with distilled water. Calcium, iron, sodium, potassium and magnesium were quantified by Flame Atomic Absorption Spectrophotometer.

Physicochemical Properties
Determination of pH
A digital pH meter was used to determine the pH of the samples (Hanna checker Model HI1270, USA). The pH electrode was placed in a beaker filled with 10 ml of the drink concentrate (Meei *et al*., 2012).

Determination of titratable acidity
Titrimetric method was used to determine the titratable acidity using 0.1 N NaOH. 10 ml of sample was pipette into a beaker and titrated

surface was cleaned with distilled water and tissue paper. The sample (a drop) was placed on the prism of the refractometer. The readings were expressed in °Brix (AOAC, 2000).

Determination of reducing sugars
The reducing sugars of the samples were determined according to the method of James (1996) with some modifications. Sugar solution

for titration was prepared from each sample by measuring 50 ml of sample into a beaker and adding 200 ml of distilled water. It was stirred to ensure thorough mixing. This solution was filled into the burette for titration. Fehling's solution (10 ml) was pipetted into a conical flask and 4 drops of 1% methylene blue was added. The solution was brought to boil and while boiling, sugar solution (sample) was added from the burette until the blue colour disappeared. Reducing sugar was calculated using the equation below.

$$\% \text{ Reducing sugars (as glucose)} = \frac{49.5 \times 250}{T \times W \times 10}$$

T = titre of non-hydrolysed sugar solution
W = weight of sample used

Determination of viscosity

Viscosities of the samples were determined using the method of Karangwa *et al.* (2010) with some modifications. Viscosity measurements were carried out using a digital viscometer (NDJ-85, Shangai Nirun Intelligent Tech. Co Ltd). 200 ml of the sample was poured into a 250 ml volumetric flask. The viscosity in mPa.s was measured at 60 rpm using spindle 2.

Determination of colour intensity and turbidity

The colour intensity and the turbidity of the samples were determined using a UV-VIS spectrophotometer (model SP9, Pye Unicam, UK) set at wavelength of 420 nm. The absorbance was taken as colour intensity while the transmittance was taken as the turbidity of the sample (Idolo *et al*., 2012).

Sensory Evaluation

Drinks were prepared from the samples. The roselle drink concentrates samples were diluted with 500% water. The samples were presented to 15 semi-trained panelists who are used to roselle drink. The drinks were ranked by colour, flavour, taste and overall acceptability using a 9-point hedonic scale where 9 represents like extremely and 1 indicates dislike extremely.

Statistical Analysis

Statistical analysis of all data was carried out using the Statistical Package for the Social Sciences software version 17.0. Statistically significant differences ($p < 0.05$) in all data obtained were determined using one-way Analysis of Variance (ANOVA) procedure and the means were separated using Duncan's multiple range tests. Values were expressed as means ± standard deviation of triplicate measurements.

3. RESULTS AND DISCUSSION

Proximate Composition

The proximate composition of the roselle drink concentrate and pineapple flavoured roselle drink concentrates are presented in Table 1. The crude fat contents of the roselle drink and pineapple flavoured roselle drink concentrates ranged between 0.21 and 0.28%. The fat content increased significantly ($p < 0.05$) as the concentration of pineapple juice to roselle drink concentrate increased. Sample RC25 was significantly ($p < 0.05$) higher than other samples. Sample RC20 and RC15 were not significantly different while sample RC0 was significantly lower than other samples. The fat content of the unflavoured sample (0.21%) was similar to 0.24% reported for roselle calyces extract by Egbere *et al*. (2007) but lower than 0.38% reported for roselle calyces extract by Ezearigo *et al.* (2014). The low fat content of the drink would make it a suitable drink for the obese or those controlling their weight.

The crude fibre contents of the roselle drink concentrate and pineapple flavoured roselle drink concentrates ranged between 0.21 and 0.33%. The fibre content increased significantly ($p < 0.05$) as the level of incorporation of pineapple juice to roselle drink concentrate increased. The fibre content of sample RC0 (0.21%) was similar to 0.20 and 0.24% reported for roselle calyces extract by Egbere *et al*. (2007) and Fasoyiro *et al.* (2005), respectively. The ash contents of the samples ranged between 0.52 and 0.57%.

Table 1 **Proximate compositions (%) of roselle drink concentrates**

Sample	Protein	Carbohydrate	Crude fat	Crude fibre	Ash	Moisture
RC0	0.28 ± 0.06^{a}	10.73 ± 0.02^{b}	0.21 ± 0.01^{c}	0.21 ± 0.02^{d}	0.52 ± 0.01^{d}	88.05 ± 0.04^{a}
RC15	0.27 ± 0.07^{a}	12.12 ± 0.21^{a}	0.25 ± 0.01^{b}	0.27 ± 0.01^{c}	0.53 ± 0.00^{c}	86.56 ± 0.14^{b}
RC20	0.25 ± 0.04^{a}	12.33 ± 0.16^{a}	0.26 ± 0.00^{b}	0.31 ± 0.01^{b}	0.55 ± 0.01^{b}	86.30 ± 0.06^{c}
RC25	0.24 ± 0.03^{a}	12.57 ± 0.26^{a}	0.28 ± 0.01^{a}	0.33 ± 0.00^{a}	0.57 ± 0.00^{a}	86.01 ± 0.07^{d}

Values are means ± standard deviation of triplicate determinations.
The mean values along the same column with different superscripts are significantly different ($p < 0.05$)
RC0: 100% roselle drink concentrate, **RC15:** 85% roselle drink concentrate and 15% pineapple juice, **RC20:** 80% roselle drink concentrate and 20% pineapple juice, **RC25:** 75% roselle drink concentrate and 25% pineapple juice

The ash in sample RC0 (0.52%) was similar to 0.54 and 0.50% reported by Egbere *et al.* (2007) and Ezearigo *et al.* (2014) for roselle calyces extract respectively. Ash content is an index of inorganic mineral elements in food (Onyeka, 2008).

The roselle drink concentrate and pineapple flavoured roselle drink concentrates were relatively high in moisture content. The values ranged between 86.01 and 88.05%. The moisture decreased significantly ($p < 0.05$) as the addition of pineapple juice to roselle drink concentrate increased. Higher moisture content reported by some researchers might be attributed to the high amount of water used for extraction. The high moisture content underpins its role in thirst quenching characteristics for which it is known (Bola and Aboaba, 2004; Egbere *et al.*, 2007).The protein contents of the roselle drink concentrate and pineapple flavoured roselle drink concentrates ranged between 0.24 and 0.28%. There was no significant difference ($p > 0.05$) in the protein content of the samples as the concentration of pineapple juice to roselle drink concentrate increased.

The protein content (0.28%) of sample RC0 compared favourably with 0.26 and 0.31% reported by Fasoyiro *et al.* (2005) and Egbere *et al.* (2007) for roselle calyces extract, respectively. The low protein content of the roselle drink samples could be an ideal diet for a select people with liver problems (hepatic cirrhosis, hepatisis or hepatoma) who need little or no protein in their menu (Egbere *et al.*, 2007). The carbohydrate contents of the samples ranged between 10.73 and 12.57%. The carbohydrate content of sample RC0 was significantly lower ($p < 0.05$) than those containing pineapple juice. The carbohydrate contents of the samples that contained pineapple juice were not significantly different. The carbohydrate content (10.73%) of sample RC0 was comparable to 10.60 and 10.99% reported by Egbere *et al*. (2007) and Ezearigo *et al*. (2014) for roselle calyces extract, respectively. It was however higher than 6.31% reported by Fasoyiro *et al.* (2005) for roselle calyces extract. Carbohydrates are important in foods as a major source of energy (Mudambi *et al*., 2006).

Vitamin C contents of roselle drink concentrates

The vitamin C contents of the samples are presented in Table 2. The values ranged between 35.62 and 37.24 mg/100 g. The ascorbic acid content increased significantly ($p < 0.05$) as the concentration of pineapple juice to roselle drink concentrate increased. Vitamin C contents of all the drink concentrates with pineapple juice were higher than the ascorbic acid content present in unflavoured roselle drink concentrate.

The vitamin C (35.62 mg/100 g) of sample RC0 was slightly higher than 31.33 mg/100 g reported by Fasoyiro *et al*. (2005) for roselle calyces extract. Vitamin C is a powerful water-soluble antioxidant. It helps to protect other naturally occurring antioxidants which may or may not be water soluble. The RDA ranged between 30 and 60 mg per day for infants, children and adults.

Drinking of roselle drink can be used to meet the Recommended Daily Intake (RDI), the surplus could be excreted from the body through urination (Bamishaiye *et al*., 2011).

Table 2 Vitamin C contents of roselle drink concentrates

Sample	Vitamin C (mg/100 g)
RC0	35.62 ± 0.03[d]
RC15	36.44 ± 0.01[c]
RC20	36.94 ± 0.02[b]
RC25	37.24 ± 0.07[a]

Values are means ± standard deviation of triplicate determinations.
The mean values along the same column with different superscripts are significantly different ($p < 0.05$).
RC0: 100% roselle drink concentrate, **RC15:** 85% roselle drink concentrate and 15% pineapple juice, **RC20:** 80% roselle drink concentrate and 20% pineapple juice, **RC25:** 75% roselle drink concentrate and 25% pineapple juice

Table 3 Mineral composition (mg/100 g) of roselle drink concentrates

Sample	Ca	K	Na	Fe	Mg
RC0	14.22 ± 0.10[d]	28.63 ± 0.05[d]	10.70 ± 0.13[a]	0.82 ± 0.01[a]	23.84 ± 0.08[d]
RC15	16.07 ± 0.20[c]	30.98 ± 0.10[c]	10.32 ± 0.05[b]	0.81 ± 0.01[a]	24.73 ± 0.06[c]
RC20	16.84 ± 0.14[b]	31.96 ± 0.08[b]	10.18 ± 0.03[c]	0.81 ± 0.01[a]	25.37 ± 0.12[b]
RC25	17.85 ± 0.08[a]	32.79 ± 0.04[a]	10.07 ± 0.03[c]	0.81 ± 0.01[a]	25.77 ± 0.08[a]

Values are means ± standard deviation of triplicate determinations.
The mean values along the same column with different superscripts are significantly different ($p < 0.05$)
RC0: 100% roselle drink concentrate, **RC15:** 85% roselle drink concentrate and 15% pineapple juice, **RC20:** 80% roselle drink concentrate and 20% pineapple juice, **RC25:** 75% roselle drink concentrate and 25% pineapple juice

Mineral composition of roselle drink concentrates

The results of some minerals analyzed are shown in Table 3. The calcium contents of the roselle drink concentrate and pineapple flavoured roselle drink concentrates ranged between 14.22 and 17.85 mg/100 g. The values increased significantly ($p < 0.05$) as the level of incorporation of pineapple juice to roselle drink concentrate increased. This increase could be attributed to higher content of calcium in pineapple juice than roselle drink. Sample RC0 had the lowest value (14.22 mg/100 g) while RC25 had the highest value (17.85 mg/100 g). The calcium content of the unflavoured sample (14.22 mg/100 g) was comparable to 14.60 mg/100 g) reported by Okeniyi and Kolawole (2007) but slightly higher than 12.70 mg/100 g reported by Bamishaiye *et al.* (2011) for roselle calyces extract. Calcium is vital for healthy teeth, bones, aids muscles growth and prevents muscles cramps.

The potassium contents ranged between 28.63 and 32.79 mg/100 g. The values increased significantly ($p < 0.05$) with increasing additions of pineapple juice to roselle drink concentrate. The potassium content of the unflavoured sample (28.63 mg/100 g) was lower than 35.40 and 32.40 mg/100 g reported by Okeniyi and Kolawole (2007) and Bamishaiye *et al.* (2011) for roselle calyces extract, respectively. However, the value obtained was substantially higher than the 10.03 mg/100 g reported by Ezearigo *et al.* (2014) for roselle calyces extract. This might be attributed to the source of the roselle calyces and the amount of water used for extraction. Potassium plays a large function in supporting the nervous system and natural heart rhythm. It contributes in a number of essential physiological activities, such as transmission of nerve impulses, narrowing of cardiac, skeletal and smooth muscles (Shahnaz *et al.*, 2003).

The sodium contents of the roselle drink concentrates and pineapple flavoured roselle drink concentrates ranged between 10.07 and 10.70 mg/100 g. The values decreased significantly ($p < 0.05$) as the concentration of pineapple juice to roselle drink concentrate increased but there is no significant difference ($p > 0.05$) between samples RC20 and RC25. The sodium content of the unflavoured sample (10.70 mg/100 g) was similar to 9.98 and 10.98 mg/100 g reported by Bamishaiye *et al.* (2011) and Ezearigo *et al.* (2014) for roselle calyces extract, respectively. It was however higher than 5.39 mg/100 g reported by Okeniyi and Kolawole (2007) for roselle calyces extract.

For iron, the values ranged between 0.81 and 0.82 mg/100 g. There was no significant difference ($p > 0.05$) in the values as the proportion of pineapple juice to roselle drink concentrate increased. This indicated that the substitution of roselle extract with pineapple juice did not substantially affect the iron content of the roselle drink. The iron content (0.82 mg/100 g) of the control sample was similar to 0.84 and 0.96 mg/100 g reported by Okeniyi and Kolawole (2007) and Bamishaiye *et al.* (2011) for roselle calyces extract, respectively. Iron contents in all the samples were low. Iron is vital for manufacturing haemoglobin and the oxygenation of red blood cells (Bamishaiye *et al.*, 2011).

The magnesium values ranged between 23.84 and 25.77 mg/100 g. The values increased significantly ($p < 0.05$) as the level of incorporation of pineapple juice to roselle drink concentrate increased. The magnesium content (23.84 mg/100 g) of the control sample was substantially higher than 7.80 mg/100 g reported by Bamishaiye *et al.* (2011) for roselle calyces extract. Magnesium is rated the third highest among the minerals in roselle drink (Okeniyi and Kolawole, 2007). It is a co-factor in a number biochemical catalyst system and is required in neuro-chemical transmission and muscular nervousness along with calcium and ascorbic acid (Bamishaiye *et al.*, 2011).

Physicochemical properties of the roselle drink concentrates

The physicochemical properties of the samples are shown in Table 4. The pH values ranged between 1.89 and 2.12. The pH values increased significantly ($p < 0.05$) as the proportion of pineapple juice to roselle drink concentrate increased. The pH of the roselle drink concentrate was lower than the pH values reported by Fasoyiro *et al.* (2005), Abiose and Adeniran (2010), Adeleke and Abiodun (2010) and Mgaya *et al.* (2014) for roselle drink samples. This might be due to the reduced amount of water used for the calyx extraction in this study. People with peptic and gastric ulcers should be discouraged from high and frequent consumption of the drink because of the low pH. Alternatively, the reconstitution should be reconstituted such that the ratio of concentrate to water is very low to reduce the level of acidity. The titratable acidity of the roselle drink concentrate and pineapple flavoured roselle drink concentrates ranged between 1.26 and 1.44% malic acid. The values decreased significantly ($p < 0.05$) as the addition of pineapple juice to roselle drink concentrate increased. The total soluble solids of the roselle drink concentrates ranged between 18.80 and 23.50 °Brix. The values increased significantly ($p < 0.05$) as the concentration of pineapple juice to roselle drink concentrate increased. The increase observed could be due to the fact that pineapple juice contains more sugar than roselle drink concentrate. The total soluble solids of the roselle drink concentrate (RC0) was higher than 8.2, 9.6, 6.2 and 5.7 °Brix reported by Fasoyiro *et al.* (2005), Abiose and Adeniran (2010), Adeleke and Abiodun (2010) and Mgaya *et al.* (2014), respectively. This is because reduced amount of water was used for extraction and higher amount of sucrose was used for the production of the roselle drink concentrate.

Table 4 Physicochemical properties of the roselle drink concentrates

Sample	Titratable acidity (% malic acid)	pH	Total Soluble Solids (°Brix)	Reducing sugar (% glucose)	Viscosity (mPa.s)	Colour intensity	Turbidity
RC0	1.44 ± 0.01[a]	1.89 ± 0.00[d]	18.80 ± 0.00[d]	2.02 ± 0.02[d]	168.73 ± 9.41[a]	2.224 ± 0.02[a]	2.20± 0.00[a]
RC15	1.37 ± 0.01[b]	2.01 ± 0.01[c]	20.60 ± 0.00[c]	3.64 ± 0.02[c]	169.37 ± 7.92[a]	2.219 ± 0.01[b]	2.10 ± 0.00[b]
RC20	1.33 ± 0.00[c]	2.08 ± 0.01[b]	21.80 ± 0.00[b]	4.01 ± 0.01[b]	170.27 ± 4.03[a]	2.192 ± 0.01[c]	2.05 ± 0.05[b]
RC25	1.26 ± 0.01[d]	2.12 ± 0.01[a]	23.50 ± 0.00[a]	4.55 ± 0.02[a]	170.83 ± 5.62[a]	2.166 ± 0.00[d]	2.00 ± 0.00[b]

Values are means ± standard deviation of triplicate determinations.
The mean values along the same column with different superscripts are significantly different ($p < 0.05$).
RC0: 100% roselle drink concentrate, **RC15:** 85% roselle drink concentrate and 15% pineapple juice, **RC20:** 80% roselle drink concentrate and 20% pineapple juice, **RC25:** 75% roselle drink concentrate and 25% pineapple juice

The reducing sugar (% glucose) of the samples were between 2.02 and 4.55%. The values increased significantly ($p < 0.05$) as the level of incorporation of pineapple juice to roselle drink concentrate increased. Sample RC0 had the lowest reducing sugar (2.02%) while RC25 had the highest (4.55%). The proportion of the reducing sugar of sample RC0 which was 2.02% glucose was higher than 0.8% reported by Adeleke and Abiodun (2010). This might be attributed to the degree of concentration of the roselle extract.

Colour was objectively measured using pigment concentration based on Wrolstad *et al.* (2005) approach. The colour intensity, measured at 420 nm, of the roselle drink concentrate and pineapple flavoured roselle drink concentrates is presented in Table 4. The values were between 2.166 to 2.224. The colour intensity decreased significantly ($p < 0.05$) as the proportion of pineapple juice to roselle drink concentrate increased. The reduction might be due to the reduction in the pigment of the extract with increase in addition of pineapple juice. The absorbance (2.224) of sample RC0 was 10 to 25 times higher than 0.088 to 0.218 reported by Bolade *et al*. (2009) for roselle drinks obtained from different dried calyces/water ratios and boiling durations. This might be due to the reduced amount of water used for extraction. The pigment of the extract, anthocyanins possesses medicinal values (Haji and Haji, 1999). Wang *et al*. (1997) reported anti-oxidative capacity of anthocyanins via absorption of free radicals in the living system. Anthocyanin is also effective as anti-inflammatory, antihepatoxic, antibacterial, antiviral, and antiallergenic (Mazza, 2000).

The viscosity of the roselle drink concentrate and pineapple flavoured roselle drink concentrates is shown in Table 4. The viscosities ranged between 168.73 and 170.83 mPa.s. The values were not significantly different ($p > 0.05$). This showed that the additions of pineapple juice to roselle drink concentrate did not affect the viscosity of the samples. The viscosity measurement of food product is much useful behaviour and predictive information to take guidelines in formulation, processing and product development (Muhammad and Saghir-Ahmed, 2011).

The turbidity (transmittance at 420 nm) of roselle drink and pineapple flavoured roselle drink concentrates is presented in Table 4.8. The turbidities ranged between 2.00 and 2.20. The turbidity of sample RC0 is significantly higher ($p < 0.05$) than other samples with pineapple juice. The turbidity of the sample was observed to decrease with increase in the addition of pineapple juice to roselle drink concentrates. This could be attributed to the increase in pH of the flavoured samples. pH had been directly linked with turbidity in that increase in pH causes decrease in turbidity (Karangwa *et al.*, 2010).

Sensory evaluation

The result obtained from sensory evaluation of the drinks produced from the roselle drink concentrate and pineapple flavoured roselle drink concentrates is shown in Table 5. Drinks were prepared from the samples by diluting them with water at 1:5. In terms of colour, there was no significant difference ($p > 0.05$) in the samples. In terms of flavour, taste and overall acceptability, sample RC25 was mostly preferred. The mean score increased significantly ($p < 0.05$) with increase in the level of incorporation of pineapple juice.

Table 5 Sensory evaluation

Sample	Colour	Flavour	Taste	Overall acceptability
RC0	7.5 ± 1.07^a	6.0 ± 1.15^c	6.0 ± 1.50^c	6.2 ± 1.23^c
RC15	7.6 ± 1.02^a	6.8 ± 0.42^b	6.8 ± 0.79^b	7.2 ± 0.78^b
RC20	7.6 ± 0.78^a	7.4 ± 0.52^{ab}	7.8 ± 0.42^a	7.6 ± 1.51^{ab}
RC25	7.6 ± 0.77^a	8.0 ± 0.24^a	8.4 ± 0.52^a	8.4 ± 0.52^a

The mean values along the same column with different superscripts are significantly different ($p < 0.05$)
RC0: 100% roselle drink concentrate, **RC15:** 85% roselle drink concentrate and 15% pineapple juice, **RC20:** 80% roselle drink concentrate and 20% pineapple juice, **RC25:** 75% roselle drink concentrate and 25% pineapple juice

4. CONCLUSIONS

The addition of pineapple juice to the roselle drink concentrates did not only impact flavour but also improved some nutritional values of the extracts. These include vitamin C, calcium, potassium, magnesium, and fibre. The preparation of roselle drink from pineapple flavoured roselle drink concentrates which can be diluted with at least 500% water would improve the convenience of production of the drink.

5. REFERENCES

[1] Abiose, S. H. and Adeniran, H. A. (2010). Studies on the extension of shelf-life of roselle *(Hibiscus sabdariffa)* extract. *Ife Journal of Technology*, 19 (1): 34-39.

[2] Adeleke, R. O. and Abiodun, O. A. (2010). Physico-chemical properties of commercial local beverages in Osun State, Nigeria. *Pakistan Journal of Nutrition*, 9 (9): 853-855.

[3] AOAC (2000). Official methods of analysis of AOAC International. 17th Edition. Association Official Analytical Chemists, Arlinton, United State of America.

[4] Avallone, S., Guiraud, J. P., Brillouet, J. M. & Teisson, C. (2003). Enzymatic browning and biochemical alterations in black spots of pineapple, [Ananas comosus (L.) Merr.] *Current Microbiological*, 47, 113-118.

[5] Bamishaiye, E. I., Olayemi, F. F. and Bamishaiye, O. M. (2011). Effect of boiling time on minerals and Vitamin C content of three varieties of *Hibiscus sabdariffa* drink in Nigeria. *World Journal of Agricultural Science*, 7 (1): 62-67.

[6] Bola, O. and Aboaba, O. O. (2004). Microbiological and physicochemical evaluation of some non-alcoholic beverages. *Pakistan Journal of Nutrition*, 3: 188-192.

[7] Bolade, M. K., Oluwalana, I. B. and Ojo, O. (2009). Commercial Practice of roselle (*Hibiscus sabdariffa* L.) Beverage production: optimization of hot water extraction and sweetness level. *World Journal of Agricultural Sciences*, 5 (1): 126-131.

[8] Braide, W., Oranusi, S. and Peter-Ikechukwu. A. I. (2012). Perspectives in the hurdle techniques in the preservation of a non alcoholic beverage, zobo. *African Journal of Food Science and Technology*, 3 (2): 46-52.

[9] Carolyn, D. Berdainer (1998). Advanced Nutrition and Micronutrients. CRC Press LLC, 172-193.

[10] Egbere O. J, Anuonye J. C., Chollom P. F. and Okpara P. V. (2007). Effects of some preservation techniques on the quality and storage stability of zobo drink (A Nigerian, non-alcoholic beverage from (*Hibiscus sabdariffa*). *Journal of Food Technology*, 5 (3): 225-228.

[11] Ezearigo, O. E., Adeniji, P. O. and Ayoade, F. (2014). Screening of natural spices for improving the microbiological, nutritional and organoleptic qualities of the 'Zobo' drink. *Journal of Applied Biosciences*, 76: 6397– 6410.

[12] Fashakin, J. B., Ilori, M. O. and Olarewaju, I. (1991). Cost and Quality Optimization of a Complementary diet from plant protein and corn flour using a computer aided linear programming model. *Nigerian Food Journal*, 9, 123-126.

[13] Fasoyiro, S. B., Babalola, S. O. and Owosibo, T. (2005). Chemical Composition and Sensory Quality of Fruit-Flavoured Roselle (*Hibiscus sabdariffa*) Drinks. *World Journal of Agricultural Sciences*, 1 (2): 161-164.

[14] Gbadegesin, A. R., Gbadamosi, S. O. and Odunlade, T. V. (2017). Physicochemical and Sensory Properties of Pineapple Flavoured Roselle Powders. *Cogent Food and Agriculture*, 3: 1292833. http://dx.doi.org/10.1080/23311932.2017.1292833

[15] Haji, F. M. and Haji, T. A. (1999). The effect of *Hibiscus sabdariffa* on essential hypertension. *Journal of Ethnopharmacology*, 65: 231-236.

[16] Hassan, A. S. and Hassan, H. S. (2008). Quantitative estimation of vitamin c in some local fruits. *Science World Journal*, 3 (2): 113-115.

[17] Hossain M. F., Akhtar, S. and Anwar, M. (2015). Nutritional Value and Medicinal Benefits of Pineapple. International Journal of Nutrition and Food Sciences. 4: (1), 84-88. doi: 10.11648/j.ijnfs.20150401.22

[18] Idolo, I., Taiwo, O. O. and Johnson O. A. (2012). Production and quality attributes of vegetable wine from *Hibiscus sabdariffa* Linn. 6 (7): 212-215.

[19] James, C. S., (1996). Analytical Chemistry of Foods, published by Blackie Academic and Professional, London, 118.

[20] Karangwa, E., Khizar, H., Rao, L., Nshimiyimana, D. S., Foh, M. B. K., Li., L., Xia, S. Q. and Zhang, X. M. (2010). Optimization of processing parameters for clarification of blended carrot-orange juice and improvement of its carotene content. *Advance Journal of Food Science and Technology*, 2 (5): 268-278.

[21] Mazza, G. (2000). Health aspects of natural colours. In: Lauro, G. J. and Francis, F.J. (Eds), Natural Food Colorants. New York, Marcel Dekker, 289-314.

[22] Meei, C. Q., Nyuk, L. C. and Yus, A. Y. (2012). Optimisation and comparative study on extraction methods of soursop juice. *Journal of Food, Agriculture and Environment*, 10 (3-4): 245-251.

[23] Mgaya, K. B., Remberg, S. F., Chove, B. E. and Wicklund, T. (2014). Physicochemical, mineral composition and antioxidant properties of roselle (*hibiscus sabdariffa* l.) extract blended with tropical

fruit juices. *African Journal of Food, Agriculture, Nutrition and Development*, 14 (3): 8963-8979.

[24] Mudambi, S. R., Rao, S. M. and Rajagopal, M. V. (2006). Food Science (Revised Second Edition). New Delhi, New Age International Limited Publisher, 19.

[25] Muhammad, S. and Saghir-Ahmed, S. (2011). Analysis of viscosity of juman fruit juice, squash and jam at different composition to ensure the suitability of processing applications. *International Journal of Plant Physiology and Biochemistry,* 3 (5): 89-94.

[26] Nwafor, O. E. and Ikenebomeh, M. J. (2009a). Effect of sodium benzoate on the growth and enzyme activity of *Aspergillus niger* and *Penicillium citrunum* on zobo drink during storage at 30±2 °C. *African Journal of Health Technology*, 8 (12): 2843 – 2847.

[27] Nwafor, O. E. and Ikenebomeh, M. J. (2009b). Effect of different packaging materials on microbiological physicochemical and organoleptic quality of *zobo* drink stored at room temperature. *African Journal of Biotechnology,* 8 (12): 2843-2447.

[28] Ogiehor, I. S. and Nwafor, O. E. (2004). Associated microbiological, biochemical and chemical quality changes in *zobo* beverage produced from *Hibiscus sabdariffa* Linn. *Nigerian Animal and Natural Science,* 5: 1-10.

[29] Ogiehor, I. S., Nwafor, O. E. and Owhe-Uregbe, U. B. (2008). Changes in the quality of *zobo* beverages produced from *Hibiscus sabdariffa* Linn and effect of ginger alone or in combination with refrigeration. *Afrcan Journal of Biotechnology.* 7: 1176-1180.

[30] Okeniyi, S. O. and Kolawole, J. A (2007). Qualitative mineral ion content of a Nigerian local refreshing drink-*zobo* (water extract of *Hibiscus sabdariffa* calyx). *Research Journal of Pharmacology,* 1 (1): 23-26.

[31] Omemu, A. M., Edema, M. O., Atayese, A. O., and Obadina, A. O. (2006). A survey of the micoflora of *Hibiscus sabdariffa* (roselle) and the resulting 'zobo' juice. *African Journal of Biotechnology,* 5: 245-259.

[32] Onyeka, E. U. (2008). Food and Nutrition. 2nd Edition, Charismatic Forum Publisher, Owerri, Nigeria, 151.

[33] Onyesom, I., Oriero, D., Okolo, A. C. and Pender, K. E. (2008). Effect of *zobo* on alcohol-induced changes in body weight, blood glucose and lipid levels in experimental rabbits. *Oriental Journal of Chemistry*, 24 (2): 389-396.

[34] Osueke, J. C. and Ehirim, F. N. (2004). Chemical, nutritional and sensory analysis of *zobo* drink *(Var Sabdariffa)* and selected soft drinks. *Journal of Agriculture and Food Science*, 2: 33-37.

[35] Qi, Y., Chin, K. L., Malekian, F., Berhane, M. and Gager, J. (2005). Biological characteristics, nutritional and medicinal value of *Hibiscus sabdariffa*. *Circular paper on Urban Forestry, Natural Resources and Environment,* 604.

[36] Shahnaz, A., Atiq-Ur-Rahman, M., Qadiraddin and Shanim, Q. (2003). Elemental nalysis of Calendula of officinalis plant and its probable therapeutic roles in health. *Pakistan Journal of Scientific and Industrial Research,* 46: 283-287.

[37] Wang, H., Cao, G. and Prior, R. (1997). Oxygen radical absorbing capacity of anthocyanins. *Journal of Agricultural Food Chemistry*, 45: 304-309.