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Production of non-alcoholic beverage from roselle calyce (*Hibiscus sabdariffa* L.): Effects of date fruit extract incorporation on quality parameters and consumer acceptability

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Abstract

This study assesses the effects of incorporating date fruit extract on some quality parameters and consumer acceptability of non-alcoholic beverage produced from roselle calyce (*Hibiscus sabdariffa* L.). Non-alcoholic beverages were formulated from blends of extracts of roselle calyce and date fruit pulp in a ratio of 90:10, 80:20, 70:30, 60:40 and 50:50, while sample with 100% roselle calyce extract which served as a control was sweetened with 13% sucrose. Physico-chemical properties, proximate and mineral composition, microbiological quality and sensory attributes were evaluated. Results of physico-chemical analysis indicted a beverage with a high acid content with pH ranged from 2.40-3.40. Total solids and total soluble solids contents of the beverage recorded high values ranging from 9.40-19.20% and 0.9-2.20^0 Brix. The sugar contents and specific gravity of the beverage increased as date fruit extract increases. The beverage was high in vitamin C with sample 40% and 50% providing sufficient amount of vitamin C. Proximate composition indicated moisture content ranging from 78.25 - 88.63%. There was no significant difference ($p > 0.05$) in the fat contents of the beverage while a corresponding increased in fibre and carbohydrate was observed as the proportion of date fruit extract increases in the beverage. Mineral contents of the drinks indicated high potassium and low sodium content while magnesium, calcium, iron and zinc contents of the beverages increased as the proportion of date fruit extract increases. Results of microbiological quality showed absence of coliforms bacteria. The total viable count and fungal count were within the acceptable limits of 10^3 (cfu/ml) for microbiological standard for fruit flavoured products. Sensory attributes showed that the beverages were rated above average in terms of appearance. Samples with 40% and 50% date fruit competed favourably with the control, and were more acceptable as compared to those with lower proportion of date fruit extracts.

Key words: Beverage, Date fruit, Roselle Calyce, Proximate Composition, Physicochemical Properties

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Introduction

Beverage consumption has become an important part of human life style around the world and it is determined more by socials rather than nutritional factors. Beverages are liquids other than water which are usually taken for the purpose of quenching thirst. Some are however consumed as a substitute in filling nutritional deficit as well as for their stimulating effects (Ukwo and Umoh 2017). The essential component of any beverage is the water it contains; other components such as sweeteners, stimulants, colourings, flavoring ingredients may perform useful functions, but are not essentially to the proper physiological function of the body (Ihekoronye and Ngoddy, 1985). Various beverages are consumed worldwide ranging from exotic beverage to indigenous or locally produced beverage which may be alcoholic or non-alcoholic.

Advances in scientific researches in recent years have resulted in changes in the global beverage market. For instance,

researches have shown the possible presence of carcinogenic substances such as Benzene in some carbonated beverage due to the reaction of Sodium benzoate (chemical preservative) with Ascorbic acid. There are also possible allergic effects of sulphite; benzoates and other chemicals to the consumers (Ashrust and Hargitt, 2009). These have resulted in changes in consumption pattern from highly processed exotic beverages to more minimally processed products from natural ingredients with a reduced effect of chemical preservatives with all the attendant negative health consequences. Also the simplicity in the production process, availability of raw materials locally and the new economy revamping programmes of self-sufficiency and strengthening of local currency through reduction in import have resulted in increased production of many traditional foods and beverages at cottage levels in Nigeria (Ukwo and Umoh, 2017).

Reselle (*Hibiscus sabdariffa* L) is a vegetable plant of West African origin. The plant is widely grown in the tropics and its cultivation in Nigeria is highly concentrated in Northern part of the country (Oboh and Elusiyan, 2004). The utilization of the plant however goes beyond its area of cultivation. The parts of the plant that are highly valuable to human are the leaves and the calyces (flower). The calyces are used for food production such as non-alcoholic beverage, industrial wine, jam, marmalade and tea. Walid (2008) also noted that the calyces of this plant have been optimized for the production of colouring reagent for food products and beverages.

In Nigeria, the production of non-alcoholic beverage usually called “zobo” from dried red roselle calyce is very popular. The drink serves as a cheaper alternative to the industrially produced carbonated beverage (soft drink) which is also available in every nook and cranny of the country (Bolade *et al*., 2009). The "zobo" is usually sweetened with sugar and sometimes flavoured with spices such as ginger or garlic, along with natural flavourants such as pineapple juice, lime juice or artificial flavourants such strawberry, vanilla, etc. depending on the producers, (Bolar and Aboaba, 2004). Physio-chemical composition of “zobo” indicated a highly acidic beverage with low sugar content. Malic acid, citric acid, oxalic acid, tartaric acid and acetic acid are the predominant acid. According to Gansch *et al*., (2009) the organic acid contents of the beverage is an important factor in the development of its favour. The beverages also contain higher amount of vitamin C compared to orange and mango. The phytochemical analysis showed that the beverage is rich in anthocyanins, flavonoid and gossypectin (Wong *et al.,* 2002). Its alleged medicinal values include; preservation and cure for hypertension and inflammation of the bladder (Qi *et al.*, 2005).

Date, the fruit of date plant (*phoenix dactylifera* L) can be considered as an ideal food that provide a wide-range of essential nutrients with many potential health benefits. Date fruit is widely consumed in the Middle East and North Africa (MENA) where they contribute significantly to their nutrition and socio-economic activities of the people (FAO, 2012). In Nigeria, the cultivation of date plant started in the 17th century through the trans-sahara trade route from Northern Africa by Muslim pilgrims on pilgrimage to the holy cities of Mecca and Madina (Omamar *et al.*, 2002; Abdul Qadir *et al.,* 2011). Nigeria is not a major date producer in the world however; the plant strives well in the Northern part of the country. Also, despite the invaluable role of date plant to humans, the exploitation and its utilization (production, processing and marketing) of date in Nigeria is beleaguered with lack of awareness of its importance to human nutrition and other value-added product (Abdul Qadir *et al*., 2011).

The important quality criteria of date fruit to consumers are the appearance, including colour, size and shape, the mouth feels or texture, flavor and nutritional value (Wills *et al.,* 1988). Dates are consumed in variety of ways; as fresh (30-40%) or in dried form (60-70%) with little or no processing (Al-Hooti *et al* 1997). Dates are usually taken as such or with Arabian coffee, milk or yoghurt. In the processed form, they are consumed as paste, syrups, pickles jams, jellies as well as used in many bakery or confectionery products together with chocolate, coconut, honey, vinegar and others (Besbes *et al.,* 2009).

The major components of date are carbohydrates (sucrose glucose and fructose) and may constitute about 70% of the pulp proximate composition. Date are also good sources of fibre, important vitamins and minerals of which calcium, iron, fluorine and

selenium are in significant amount (Al-Farsi *et al.*, 2005, Khan *et al.*, 2008). Dates have been shown to provide antioxidant and antimutagenic properties. Recent studies have shown that dates and their extracts have demonstrated the free radical scavenging activity, inhibition of the free radical-mediated macromolecular damages, as well as antimatagenic and immunodulatory activates (Vayalil, 2002, Al-Fari *et al.*, 2005, Allaith, 2008).

Fundamental studies on the potential of non-alcoholic beverage produced from calyces of *Hibiscus sabdariffa* have been carried out. The need to explore other ways of utilizing date and the application of its functional components in the development of various value-added food products cannot be over emphasized. Also with the consumption of alcoholic beverage being on the decrease in Nigeria, due to increasing religious and health campaigns against such products, the demand for non-alcoholic beverage have been on the increase. The consumption rate of non-alcoholic beverages such as carbonated beverages or soft drinks are being threatened by high sucrose content and the use of artificial sweeteners such as aspartame, neotame, acesulfame potassium and others due to with their attendant negative effects on the health of consumers. The beverage market is constantly in demand for new and trendy products such as natural products without chemical preservative. Therefore, the use of natural sweetener such as date extract to improve the tart taste of "zobo" will be quite desirable. The objective of this study is to assess the effects of incorporating date fruit extract on the physico-chemical properties, proximate and mineral composition, microbiological quality and sensory properties of non-alcoholic beverage from roselle calyce extract.

Materials and Methods

Source of Materials: Dried roselle calyces (*Hibiscus sabdariffa* L.) and dried date fruit (*Phoenix dactylifera* L.) were purchased from Garki international model market Abuja and was transported to Food Processing Laboratory, University of Uyo, Nigeria. The materials were sorted and only those in good conditions were used for the experiment.

Preparation of Non-Alcoholic Beverage from Roselle Calyce: The non-alcoholic beverage otherwise called "zobo" was produced by extraction method. Dried red roselle calyce (300g) were rinsed properly and boiled in 4 liters of potable water for 30 minutes at 80^0C to extract the juice. After the juice was extracted, filtration was done to remove fibrous materials and the calyces to get a clear juice. The beverage was cooled, packaged in sterile plastic containers and refrigerated (Omeire *et al*., 2015).

Preparation of date fruit extract: The dried date fruits were deseeded manually. The dry fruit pulps (850g) were washed and socked in potable water for eight (8) hours. The soaked fruit pulp were wet milled using electric blender with water used in soaking them. Additional water was added to the slurry to final volume of 1200ml and filtered to obtain the date fruit extract (Omeire *et al.*, 2015).

Preparation and formulation of non-alcoholic beverage from roselle calyce and date fruit extract: Samples of non-alcoholic beverage were formulated by blending the roselle calyce extract with date fruit extract to have a homogenous mixture. The ratio of the roselle calyce extract to date fruit extract used for this study was 100:00, 90:10, 80: 20, 70:30, 60:40, 50:50. The 100% roselle calyce extract which served as the control sample was sweetened with 13% sucrose (Bolade *et al.*, 2009). The different blends were pasteurized and separately using water bath for 30 min. at 68^0C, cooled, packaged and stored in a refrigerator for various determinations.

Methods of Analysis

Determination of Physicochemical Properties: The prepared beverage samples were analyzed for the pH by using pH meter that was standardized using a buffer to ensure sensitivity and accuracy of the meter. The total titratable acidity was carried out by the method as described by AOAC (2005) and the result expressed in percentage malic acid. The total solids (%) total soluble solids (^{0}Brix), total sugar (%) and were determined as outlined by AOAC (2005). Vitamin C (mg/100g) content of the beverage was determined using standard method of AOAC (2005).

Determination Proximate Composition of the Beverage: The proximate composition which include, moisture content, protein, ash, crude fat, fibre and carbohydrate were carried out

according to the standard procedures as outlined by AOAC (2005).

Determination of Mineral Composition of the Beverage: Standard methods of analysis as described by AOAC (2005) were used to determine the mineral elements contain in the beverage. The mineral element, determined were calcium, magnesium, sodium, potassium, iron, and zinc using atomic absorption spectrophotometer. Determinations were carried out by ashing 1ml of the sample at 550°C in a muffle furnace for 2 hours. The ash content were then dissolved in 10% HCl and made up with distilled water to 100ml in a standard flask before reading.

Microbiological Analysis: The total viable counts (TVC) were determined by weighing 2.8g of nutrient agar into 100ml of distilled water and sterilized in an autoclave at 121°C for 15 minute at 15psi. The total fungal count (TFC) was determined using 6.3g of potato dextrose agar into 100ml of distilled water while 5.3g of molten Mac-konkey agar in 100ml distilled water both were sterilized at 121^{0}C for 15 minutes, 15 psi for the determination of fungi and total coliform count (TCC) respectively. Beverage samples were serially diluted with distilled water and 1ml was inoculated on the different media at room temperature. The petri dishes were incubated at 37^{0}C for 23-48hours for the TVC, and TCC while 4-5 day for mould and yeast colonies to develop. Counting were done using colony counter and result expressed in colony forming unit per milliliters (log_{10}cfu/ml) (Nester *et al*., 1998).

Sensory Evaluation: Sensory analyses were carried out with 20-semi-trained panelist using the acceptance preference test. The beverage samples were assessed for taste, colour, aroma, consistency, month feel and general acceptability using 9 point hedonic scale ranging from 9 (like extremely) to 1 (dislike extremely) as described by Ihekoronye and Ngoddy (1985).

Statistical Analysis: The data obtained from the analysis were subjected statistical analysis using SPSS version 16. The analysis of variance (ANOVA) was performed to determine significant differences between mean ($P<0.05$) while the mean were separated using Ducan multiple range test (DMRT). All the determinations were done at triplicate.

Results and Discussion

The Physico-chemical Properties of the Non-alcoholic Beverage: The physico-chemical properties of non alcoholic beverage produced from blends of roselle calyce and date fruit extracts are presented in Table 1.

Table 1: Physico-chemical Properties of the Formulated Beverages

Parameter	Blending ratio (roselle calyce: date fruit extract)					
	100:00	**90:10**	**80:20**	**70:30**	**60:40**	**50:50**
pH	2.40^c	2.60^c	2.80^b	3.00^a	3.20^a	3.40^a
T.TA (% malic acid)x10^{-2}	1.48^a	1.00^a	0.42^b	0.36^b	0.33^b	0.34^b
Total solid (%)	9.40^c	10.20^c	11.80^c	13.40^b	15.60^b	19.20^a
Total soluble solid (° Brix)	0.90^e	1.10^e	1.80^d	1.80^c	1.80^b	2.20^a
Specific gravity	0.94^a	0.92^a	0.91^a	0.87^a	0.85^b	0.83^b
Total sugar (%)	9.80^a	3.00^d	5.00^c	8.00^b	10.00^a	10.40^a
Vitamin C (mg/100g)	22.42^f	38.32^e	40.24^d	44.20^c	46.40^b	49.25^a

* The mean values in the same row with different superscript are significantly different ($p < 0.05$)

The pH of the samples were acidic and the acidity decreased slightly as the proportion of date fruit extract increased across the formulations. The pH values ranged from 2.40-3.40. The total titratable acid also showed corresponding decreased as the proportion of the date fruit extract increase in the blends. The control sample with 100% of roselle calyces extract had 1.48x10^{-2}% malic acid while sample with 50% roselle calyce and 50% date extract recorded 0.34x10^{-2}% of malic acid. Values for the total solid and total soluble solids increased as the concentration of date fruit extract increased in the formulated non-alcoholic beverages. The specific gravity significantly ($p <0.05$) decreased from 0.94 to 0.83 with increase in the proportion of date fruit extract in the formulations. Percentage total sugar increased in the beverage as the concentration of date extract increased but there was no significant difference ($p > 0.05$) between the control and the blends that

contained 40-50% date fruit extracts. Vitamin C content of the beverage increased with addition of date fruit extract in the beverage with the control having 22.42mg/100g and the blend that contained 50% date fruit extract with 49.25mg/100g. The low pH value and the acidic nature of the beverage are as a result of high acidic nature of the roselle calyce (Table 1). Zobo drink is characterized as a highly acidic fruit beverage rich in organic acids such as oxalic, malic and tartaric acids. (Wong *et al*, 2002, Gansch *et al*., 2009). The acidic content of the beverage decreased with the addition of date fruit extract because date fruit is less acidic compared to the roselle calyce extract. This implies that the beverage should not be taken in an empty stomach. The pH and acidity level of beverage obtained in this study agrees with and (Odebunmi *et al.,* 2002 and Fasoyiro e*t al,* 2005). The acidic nature of beverage can help in the preservation of the beverage. There was a steady increase in the amount of total solid and total soluble solid as the concentration of date extract increased in the beverage. This was a result of increases in sugar, fibre and minerals contained in the date fruit extract. This result agrees with the work of Omeire *et al* (2015). The total solid and soluble solids are indications of the amount of solids present and gradually dissolved within the beverage. They sugar along with the protopectin and soluble pectin in the fruit pulp may be responsible for the increase in the solids content of the beverage. The total solids and soluble solids content of the beverage have been observed to have contributory effects on the overall mouth-feel of the beverage. The total sugar content of the beverage ranged from 9.80-10.40%. The vitamin C content of the beverage indicated significant difference (P< 0.05) between samples with sample with 50% date fruit extract having the highest value. Duke (1985) noted that "zobo" drink contains moderate amount of vitamin C which can help the body immune system. With the addition of date fruit extract the vitamin C content of the beverage was increased. However, pasteurization and other heat treatments might have affected the overall vitamin C content of the beverage. This is because vitamin C is labile and degrades upon exposure to light, oxidation and thermal processes. Additionally, beverage samples that contained 40% and 50% of date fruit extract were found to provide sufficient amounts of vitamin C to meet the 45mg recommended daily allowances (RDAs) of adults.

Proximate Composition of the Formulated Beverage: The results of proximate composition of the formulated non-alcoholic beverage are presented in Table 2.

Table 2: Proximate Composition of the Formulated Beverage (%)

Parameter	Blending ratio (roselle calyce: date fruit extract)					
	100:00	**90:10**	**80:20**	**70:30**	**60:40**	**50:50**
Moisture content	88.63^{a}	86.10^{a}	84.23^{ab}	81.06^{b}	80.63^{b}	79.25^{bc}
Crude fat	0.16^{a}	0.18^{a}	0.19^{a}	0.22^{a}	0.25^{a}	0.23^{a}
Crude protein	0.04^{b}	0.16^{ab}	0.20^{ab}	0.25^{ab}	0.27^{a}	0.29^{a}
Ash	0.63^{b}	0.71^{ab}	0.80^{a}	0.89^{a}	0.92^{a}	0.95^{a}
Fibre	0.12^{c}	1.82^{b}	2.22^{b}	2.50^{ab}	2.78^{a}	3.30^{a}
Carbohydrate	10.41^{b}	11.03^{b}	12.36^{b}	15.08^{ac}	15.78^{a}	15.98^{a}

* The mean values in the same row with different superscript are significantly different ($p < 0.05$)

The moisture content ranged from 78.25-88.63% with the control having the highest moisture content. There was no significant difference ($p < 0.05$) in the crude fat content of the beverage. There were slight increases in the percentage of crude protein and ash contents of the beverage as the concentration of date extract in the blends increased. Similarly the percentage fibre and carbohydrate contents of the beverage increased with increase level of date extract in the blends increased. Values ranged from 0.12-3.30% and 10.41-16.98% for fibre and carbohydrate respectively. The proximate composition of the beverage indicated moisture content in the ranged of 78.28-88.63%. The moisture content of the control sample was within the finding of Fosoyiro *et al* (2005). The moisture contents of the formulated beverage indicated significant difference ($p < 0.05$). The high moisture content of the beverage is quite desirably

because of the primary function of the beverage which is to quench thirst. There was an improvement in the nutritional composition of beverage with date fruit extracts incorporation. As the concentration of date fruit extract increased in the blends there were correspondent increase in crude protein, carbohydrate, fat and ash contents. Beverage sample with 50% date fruit extract was better in carbohydrate and fibre content. Al- Farsi *et al* (2005) noted that date fruit apart from being rich with carbohydrate (sucrose, glucose and fructose), is also a good source of fibre due to the present of pectin, cellulose, hemicelluloses and lignin present in the fruit. The non-alcoholic beverage prepared from the combination of date fruit will provide sugars which will produce a readily source of energy to human body. The sugars present are easily absorbed during digestion which can lead to a rapid elevation of blood sugar (Liu *et al.*, 2000). The fibre content of this beverage can further contribute to the nutritional significance such as induces satiety, laxative effect due to increase stool weight as well as therapeutic benefits (Marlett *et al.*, 2002).

Mineral Composition of the Formulated Beverage: Mineral composition of the non-alcoholic beverage produced from different blends of roselle calyce and date fruit extracts are presented in Table 3.

Table 3: Mineral Composition of the Beverage (mg/100g)

Parameter	Blending ration (roselle calyce: date fruit extract)						
	100:00	**90:10**	**80:20**	**70:30**	**60:40**	**50:50**	**RDA**
Potassium	103.5^{d}	121.4^{c}	138.4^{b}	142.0^{b}	158.4^{a}	163.2^{a}	2g
Sodium	8.8^{a}	9.0^{a}	10.2^{a}	10.4^{a}	10.7^{a}	10.9^{a}	500mg
Magnesium	98.5^{b}	105.2^{b}	118.8^{ab}	121.2^{a}	128.6^{a}	130.5^{a}	240mg
Calcium	15.89^{a}	16.20^{a}	16.82^{a}	16.94^{a}	16.98^{a}	17.01^{a}	1g
Iron	10.5^{b}	10.8^{b}	11.01^{b}	14.0^{a}	14.3^{a}	14.8^{a}	27mg
Zinc	0.81^{b}	8.22^{a}	10.71^{a}	11.20^{a}	11.56^{a}	11.72^{a}	10mg

* The mean values in the same row with different superscript are significantly different ($p < 0.05$)

Values for potassium were significantly different ($p < 0.05$) while there was no significant difference ($P > 0.05$) in the sodium content of the beverage. There was a correspondent increased in magnesium content of the non-alcoholic beverage as the concentration of the date extract increased in the formulated beverages. Values for calcium ranged from 15.89-17.01mg/100g which indicated no significant difference ($P > 0.05$) in the formulated beverage. The amount of iron and zinc in the beverage ranged from 10.5 to 14.8mg/100g and 0.81 to 11.72mg/100g, respectively. Potassium was the most abundant mineral (163.2mg/100g) followed by magnesium (130.5mg/100g) in the formulated beverage. Potassium is important not only as a cation in the intra-cellular fluids but also essential in the nervous systems, maintenance of correct rhythm of heart beat and clothing of blood (Shahidi, 2004). Minerals especially potassium increased with increasing level of date fruit extract addition. The date fruit has been known to contain significant levels of potassium and other minerals. The high potassium and low sodium contents of the formulated beverages are desirable for people suffering from hypertension.

Magnesium and calcium present in the beverage could help the consumer to absorb other minerals into their body. Calcium is important in the ossification of bones and for normal impulse transmission. Iron is an important element with several vital functions in the body; as a carrier of oxygen in the tissue (heamoglobin) and storage of oxygen in the muscle tissue (myoglobin) Babalola, (2001) stated similar importance of micronutrients in body functions. Date fruit has been used as a practical supplement for iron deficiency without any side effects such as nausea, headache, and anorexia that may occur with iron tablet supplements (Al-Farsi *et al.*, 2005). But Al-Hooti *et al*, 1997 noted that the chemical composition especially mineral content of the date fruit can vary depending on the cultivar, soil conditions, agro-economic practices, ripening stage, as well as harvest and post harvest treatments. Assuming, high bioavailability of the minerals that is present in the beverages. About 100g of the beverage could provide a significant amount of

magnesium and potassium to meet the RDAs of adults.

Microbiological Analysis: Results of microbiological analysis of the formulated non-alcoholic beverage are shown in table 4.

Table 4: Microbiological counts of the Non-alcoholic Beverage (log_{10}cfu/ml)

Parameter	Blending ratio (roselle calyce: date fruit extract)					
	100:00	**90:10**	**80:20**	**70:30**	**60:40**	**50:50**
TVC	0.30	0.32	0.34	0.35	0.37	0.38
TFC	**	**	**	0.11	0.12	0.30
TCC	**	**	**	**	**	**

*Means are values from triplicate determinations. ** Not detected
TVC - Total viable count, TFC - Total fungal count, TCC - Total coliform count

Microbial analysis indicated no coliform and fungal growth after production. Few colonies detected in the total viable count were within the acceptable limit of microbial standard on fruit flavoured products (ICMSF, 1996). The safety and stability of the non-alcoholic beverage in regard to microbial load could be attributed to high acidity of the roselle calyce extract, the thermal processing, technique that was applied and good hygienic practices that was observed during production.

Sensory Evaluation of the Formulated Beverage: The result of sensory analysis carried out on the formulated beverage is presented in Table 5.

Table 5: Mean Sensory Scores of the Formulated Beverage

Parameter	Blending ration (roselle calyce: date fruit extract)					
	100:00	**90:10**	**80:20**	**70:30**	**60:40**	**50:50**
Appearance	7.85^{a}	7.58^{b}	7.39^{c}	6.72^{d}	6.62^{e}	6.45^{e}
Taste	8.20^{a}	4.40^{c}	4.50^{c}	5.68^{b}	6.65^{b}	7.25^{a}
Aroma	6.82^{a}	6.72^{a}	6.80^{a}	6.62^{a}	6.78^{a}	6.80^{a}
Consistency	7.52^{a}	7.50^{a}	7.48^{a}	7.40^{ab}	7.35^{b}	7.00^{bc}
Mouth feel	7.07^{a}	4.10^{c}	4.21^{c}	4.38^{c}	6.28^{b}	6.86^{a}
General Acceptability	8.26^{a}	4.00^{f}	4.92^{e}	5.46^{d}	6.58^{c}	6.74^{b}

* The mean values in the same row with different superscript are significantly different ($p < 0.05$)

There was a significant difference in the appearance of the beverage. Values indicated that appearance was less preferred with a correspondent increase in the proportion of date extract in the beverage. There was no significant difference ($p < 0.05$) in the aroma of the beverage. The control recorded the highest value for all parameters determined, followed by the blend with 50% date fruit extract incorporation. The non-alcoholic beverage produced from roselle calyle and date fruit extracts were rated high. The appearance of the samples with date fruit extract were rated above average compared to control sample indicating that addition of date fruit extract did not have negative effect on the appearance of the beverage. The combination of date and roselle calyce resulted in a beverage with high pigment content. This helps to improve product's appearance and taste because of their high contents of active phenolic acids (Makki *et al.*, 1998). The present of organics and olfactory oils in the roselle calyce and date fruit extracts which are regarded as taste enhancer help in sensory characteristics and general acceptability of the non-alcoholic beverage. Also there was no significant difference ($P < 0.05$) in taste between the control and the sample with 50% date fruit extract. There was no significance difference ($p > 0.05$) in the aroma of the beverage produced. The control had the highest score in terms of all the attributes analysed and was closely followed by the sample that composed of 50:50% roselle calyce date fruit extracts. Generally samples with 50% and 40% date fruit extract were more acceptable in taste, consistency, appearance and mouth feel compared to those with lesser proportions of date fruit extract.

Conclusion

The results of this study revealed that homemade non-alcoholic beverage can be produced from blends roselle calcyce and date fruit extracts. The quality of the non-alcoholic beverage was within the acceptable range specified by regulatory agencies. Carbohydrate, crude fibre, improves significantly as the proportion of date fruit increases. The most abundant mineral in the formulated non-alcoholic beverage were potassium followed by magnesium and calcium. There was a progressive increase in these minerals as proportion of date fruit extract increased in the beverage. Non-alcoholic beverage with the ratio of 40:60 and 50:50 roselle calyce – date fruit extracts compared favourable with conventional zobo drink produced using sucrose and other artificial sweeteners in terms of sensory attributes and acceptability.

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