JHER Vol. 20, September 2014, pp. 10-18

Chemical Composition and Sensory Evaluation of Sorrel (*Hibiscus sabdariffa*) Cordial Juice

Onyeke, N.G.
Department of Home Science, Nutrition and Dietetics
University of Nigeria, Nsukka

and
Emeka Okafor, E.N.
Department of Fashion Design and Clothing Technology
Federal Polytechnic, Oko.

Abstract

The study investigated the chemical properties of sorrel cordial juice. Cordial juice produced from sorrel calyces were analysed for nutrient, antinutrient and sensory properties. Cleaned calyces were used to produce sorrel cordial juice using standard procedures. Black currant cordial juice used by consumers served as control was used to compare and investigate the chemical properties of the product (sorrel cordial juice). Sorrel cordial juice had significantly ($P<0.05$) higher crude protein, ash, calcium, iron, phosphorous, zinc, copper, ascorbate and β-carotene than the control. It contained significant ($P<0.05$) traces of cyanide, phytate and tannin than the control. Sorrel cordial juice was preferred to the control. These results suggested that diversifying the utilization of this indigenous nutritious plant through the development of new product would provide new value-added product into the family menu.

Key Words: Sorrel Calyx, *Hibiscus sabdariffa*, Chemical Composition, Sensory Properties

Introduction

Hibiscus has more than 300 species, which are distributed in tropical regions around the world (Yadon, 2005). Most hibiscus species are used as ornamental plant and are believed to have some medicinal properties. One of the species is *Hibiscus sabdariffa,* commonly named as "red sorrel" or "roselle", "India sorrel", and "Florida cranberry".

Onyeke (2013) reported that Murdock, an African Archaeologist was the first to report on the origin of sorrel at Niger waterside, centre for the cultivation of indigenous plants in about 4000 B.C. Uganda assessment and reports show that the original habitat of sorrel was West Africa and the plant was carried to India during the Muslim invasion in the 8th century A.D, later to West Indies, Jamaica, Florida, California, Philippines and finally, it spread to other parts of the world (Onyeke, 2013).

Sorrel plant (*Hibiscus sabdariffa*) is an acid testing harb, erect, bushy branched annual plant of *malvaccas* family (James 2003). It grows in a warm and humid tropical and subtropical region. There are two major species of sorrel – Var altissima Wester and Var sabdariffa. Var altissima Wester is a tall vigorous unbranched plant, about 5m in height. It is not edible but the stem is used for the production of fibre (Onyeke, 2013). The second type, Var sabdariffa, is of two varieties. The varieties are differentiated by their calyces as follows: the red-calyx and the yellow-calyx varieties. The plants are grown for their edible calyces, seeds and leaves. The plant is widely grown in the northern part of Nigeria with promising nutritional potential (Onyeke, 2001). It is one of the unde-exploited food crops of Nigeria.

Sorrel plant appears to have potential exploitation by the food processing industry (Yadong, Chin, Malekian & Berh, 2005). Limited research has been carried out on the development of products from calyx of the sorrel plant (Nnam and Onyeke, 2010). Already, there is a population drink produced from sorrel calyx in Nigeria which is used for entertainment during ceremonies. The drink has been concentrated to produce bottled carbonated juice (karkadeh juice) in Sudan (James, 2003). Unsuccessful previous attempts to produce carbonated sorrel drink were made by some individual in the carbonated drink industry. The main reason for failure were the occurrence of fermentation precipitation and fading of the red colour intensity of the bottle (Onyeke, 2013)

In Africa, many researchers have noted the food potentials of the sorrel plant (Nnam and Onyeke, 2003). The calyx could be processed to produce jam, juice, ices, herbal tea and wine (Yadong, chin, Malekian & Berh, 2005). Sorrel calyx has some medicinal uses such as the treatment of bilious attacks, decreasing the viscosity of the blood reducing blood pressure and as diuretic for stimulating intestinal peristalsis (Rich, 2004). There is need to document the nutrients and antinutrients composition of the product made from sorrel calyx. Sorrel leave are locally called zobo leaves or 'Yakwa' leave in Hausa or 'Isapa' or 'Aukon' in Yoruba. Sorrel plant could help to promote the use of the product made from sorrel calyx especially in areas where the food crop is not popular. Sorrel cordial juice could help to diversify dietary component and possibly increase nutrient intake.

Objectives of the study

The major objective of this study was to investigate the chemical properties of product developed from sorrel calyx and compare it with existing product.

Specifically, the study:

1. determined the nutrients and antinutrients composition of the product made from sorrel calyx;
2. Assessed the acceptability of the products from sorrel calyx; and
3. Compared the product produced with black currant cordial juice.

Materials and Methods

***Preparation of Materials*:** Dry red sorrel calyces used for the study were harvested from the Faculty of Agriculture farm, University of Nigeria, Nsukka. Processing method one hundred and eighty grammes (180g) of sorrel calyces were cleaned manually. The washed calyces were soaked in cold water, extracted, sweetened and reboiled used for the production of cordial juice. The sample was stored until analysed.

Development of product from sorrel calyces

Step 1: Sorrel calyces (180g) were picked, washed and dried in an air oven at 55 ^{o}C for 5 mins.

Step 2: The cleaned dried red sorrel calyces were soaked in cold water (750ml) for 1hr at room temperature (28 ± 2^{o}C).

Step 3: The soaked sorrel calyces were boiled with water for 10mins. Juice was extracted with double layer Muslim cloth by decanting from the cooking pot.

Step 4: Granulated sugar (650g) was added to the juice and boiled at 90°C for 10mins.

Step 5: The juice was bottled hot in pre-sterilized bottles and corked with locally made corking machine.

Step 6: The sorrel cordial juice and black currant cordial juice (control) were stored for evaluation for chemical and sensory properties.

Chemical Analysis

***Proximate analysis*: ** The Association of official Analytical Chemists (2000) methods was used to determine the proximate analyses. The analyses were performed in triplicates.

Step 1: Protein was determined using microKjeldahl method. The crude protein was calculated by multiplying the total nitrogen by the conversion factor of 6.25 (N x 6.25).

Step 2: Lipid (fat) was determined by extracting petroleum ether (Bpt 40°C – 60°C) using Tector Sohxlet extractor for 3hr.

Step 3: The total ash was estimated by weighing 2g of each sample into crucible and placed in muffle furnace at 550°C for 3hr until ash was obtained.

Step 4: Crude fibre was determined by boiling in sulfuric acid for 30 mins in an automatic fibre technology. The sample was washed with hot water and reboiled with potassium hydroxide for 30 mins and ashed at 550°C for 1hr in muffle furnace.

Step 5: Moisture was determined using an air oven overnight at 105°C to a constant weight. A factor (F) was calculated.

Step 6: Carbohydrate was computed by difference. The sum of percentage of crude protein, ash, fat, fibre and moisture were subtracted from 100%.

Mineral Analyses:

The ashes from the samples were used to determine mineral contents.

Step 1: The samples were dissolved in distilled water and filtered through no 5 whatman filter papers to get filtrates.

Step 2: the filtrates were used to determine calcium, iron, zinc, copper and phousphoms as described by Onwuka (2005), using an Atomic Absorption spectrophotometer (flame system, Buck scientific Inc., model 2004), using the standard lamps and solutions.

Ascorbic acid was determined using AOAC (2000) method.

Step 1: About 2g of the samples were dissolved with distilled water.

Step 2: 2ml of trichloro-acetic acid was added and colour was developed with 2, 6 – dichloroindophenol.

Step 3: The colour developed was read with spectrophotometer.

β – Carotene (pro-vitamin A): was determined using the method adopted from International Vitamin A Consultative Group.

Step 1: Samples were washed with volatile organic solvent (chloroform).

Step 2: The absorbance of the filtrate was measured with UV – spectrophotometer at 328nm.

Antinutrients:

Tannin was determined by AOAC (2000) method.

Step 1: About 0.5g of each sample was extracted with 10ml of de-ionized water.
Step 2: The filtrate was developed with 3ml of 0.1m ferric chloride in 0.1N hydrochloric acid, followed by 3ml of 0.008m potassium ferrocynate.
Step 3: Absorbance was read at 520nm in spectrophotometer within 10 mins of preparation.

Phytate was determined by:
Step 1: About 0.5g of each sample was extracted with 100ml of 2.4% HCl and shaken for 1hr. Step 2: Colour was developed with 1ml modified reagent (0.03% $FeCl_3$. $6H_20$ and 0.3% sulphosalicyclic acid) and read at 500nm in a spectrophotometer.

Cyanide was determined by the rapid enzymatic assay using linamarase extracted from cassava context under laboratory condition based on the method of Ikediobi, Onyia and Eluwah (1980). The absorbance of the characteristic deep orange colour produced on incubation of the released cyanide with alkaline picrate was read at 490nm.

Sensory evaluation

Preparation of samples: Sorrel cordial juice which was prepared and stored and the control (black currant cordial juice) bought from the market were all subjected to sensory evaluation.

***Selection of panel*:** Twenty-six trained panelists were drawn from the Departments of Home Science, Nutrition and Dietetics and Food Science and Technology, University of Nigeria, Nsukka, for the evaluation. They were exparts in the field of Home Science and also familiarity with the product.

***Instrument for Data Collection*:** The parameters tested include colour, flavor, texture and overall acceptability. A nine-point hedonic scale was selected for sensory evaluation of the product and control, (9 = like extremely, 8 = like very much, 7 = like moderately, 6 = like slightly, 5 = neither like nor dislike, 4 = dislike slightly, 3 = dislike moderately, 2 = dislike very much being the middly score and 1 = dislike extremely). The appropriate codes were tallied with the codes in the instrument. Food attitude and rating form (FARF) was selected for assessing general acceptability of the product developed and the control. The panelists rinsed their mouths with a glass of water after tasting each product.

***Data collection Techniques*:** Twenty-six copies of the questionnaire were administered to the respondents with the help of food laboratory assistants. The judges were instructed on the use of the scoring sheets and the importance of their independent judgement. They were served with small plates and cups to place the products and a glass of water was given to each of the judges to rinse their mouth after each testing to avoid a carry over effect from the proceeding samples. The products were coded to tally with the codes in the instrument. The evaluation forms for each product were collected separately at the end of each testing. All the copies of the questionnaire were retrieved.

Data analysis Techniques: Data collected were analysed using means and standard deviation.

Results

The following findings were made:

Table 1: Proximate composition of sorrel cordial juice and black currant cordial juice (%)

Nutrients	Sorrel cordial juice	Black currant cordial juice
Crude Protein	4.4 ± 0.1	1.2 ± 0.15
Crude fat	0.46 ± 0.11	0.76 ± 0.05
Ash	0.36 ± 0.05	0.23 ± 0.05
Carbohydrate	1.15 ± 1.06	7.23 ± 0.15
Crude fibre	Trace	Trace
Moisture	93.6 ± 0.91	90.6 ± 0.2

Values in the same row are significantly different (p<0.05).

Table 1 shows the proximate composition of sorrel cordial juice and black currant cordial juice. There were differences in proximate values between sorrel cordial juice and black currant cordial juice. Sorrel cordial juice had higher crude protein (4.4%) and ash (0.36%) than black currant cordial juice. On the other hand, black currant cordial juice had higher (0.36%) crude fat (0.76%) and carbohydrate (7.23%) than sorrel cordial juice (0.46% and 1.15% respectively). There were traces of crude fibre in both samples. Black currant cordial juice had higher moisture (93.6%) while Black cordial juice had 90.6%.

Table 2: Micronutrients composition of sorrel cordial juice and black currant cordial juice (mg and µg)

Nutrients	Sorrel cordial juice	Black currant cordial juice
Calcium (mg)	2.6 ± 0.1	1.26 ± 0.15
Iron (mg)	15.6 ± 0.25	6.5 ± 0.3
Phosphorus (mg)	48.4 ± 0.15	36.36 ± 0.05
Sodium (mg)	3.56 ± 0.05	18.46 ± 0.41
Zinc (mg)	1.46 ± 0.15	0.7 ± 0.11
Copper (µg)	56.66 ± 1.15	8.3 ± 0.11
Ascorbic acid (mg)	136.1 ± 1.15	126.7 ± 0.15
B-Carotene (µg)	10.0 ± 0.01	8.7 ± 0.2

Values in the same row are significantly different (p<0.05)

Table 2 shows the mineral, ascorbate and β-carotene compositions of sorrel cordial juice and black currant cordial juice. There were varied differences in the micronutrients levels of sorrel cordial juice and black currant cordial juice. Sorrel cordial juice had higher Ca (2.60mg), Fe (15.60mg), P (48.40mg), Zn (1.46mg), Cu (56.66µg), ascorbic acid (36.10mg) and β-carotene (10.00µg) than black currant cordial juice. Black currant cordial juice, however, had only higher ($p<0.05$) Na (18.47mg) than sorrel cordial juice (3.56mg).

Table 3: Antinutrient composition of sorrel cordial juice and black currant cordial juice (mg/100g)

Antinutrients and food toxicant	Sorrel cordial juice	Black currant cordial juice
Tannins	Trace	0.9
Cyanide	Trace	Trace
Phytate	Trace	Trace

Values in the same row are significantly different (p<0.05)

The antinutrient and composition of sorrel cordial juice and black currant cordial juice are shown in Table 3. Tannins value for black currant cordial juice was 0.90mg and trace value for sorrel cordial juice. The samples had traces of cyanide and phytate.

Sensory properties

Table 4: Sensory properties of sorrel cordial juice and black currant cordial juice

Attributes	Sorrel cordial juice	Black currant juice
Flavour	8.08 ± 0.95	6.44 ± 1.63
Texture	7.76 ± 0.97	6.88 ± 1.27
Colour	8.00 ± 0.82	6.60 ± 1.7
General acceptability	8.04 ± 0.91	6.24 ± 1.59

Values in the same row are significantly different (p<0.05)

Table 4 shows the sensory evaluation scores for sorrel cordial and black currant cordial juices. There were differences between sorrel cordial and black currant cordial juices. Sorrel cordial juice had higher ($p<0.05$) values for flavour (8.08), texture (7.76), colour (8.00) and general acceptability (8.04) than black currant cordial juice (6.44, 6.88, 6.84 and 6.24, respectively). The sorrel cordial juice was well accepted by the panelists than the control.

Discussion

The higher protein content of sorrel cordial juice than that of the black currant cordial juice was significant (Table 1). This is especially in the developing countries like Nigeria where protein malnutrition is prevalent (Grewal, 2000). It is known that the most common form of malnutrition in Africa is protein-energy malnutrition (PEM). The need for cheaper alternative sources of protein cannot be overemphasized. Sorrel cordial juice is a cheap source of protein and could be promoted and consumed to alleviate protein malnutrition (Nnam & Onyeke 2010). The lower crude fat content of sorrel cordial juice has important health implication. It is more ideal food than black currant cordial juice. Consumption of high fat is associated with overweight. This predisposes one to obesity and cardiovascular diseases. The higher ash content of sorrel cordial juice suggests that it may contain more minerals. Iron, iodine and zinc are problematic nutrients in developing countries. Iron deficiency anaemia precipitates learning disabilities, an increase risk of infection, diminished work capacity and could to lead to the death of women during pregnancy and child birth (Hunt, 2005). Sorrel cordial juice with its high ash content may contribute significantly to reduction of some of the micronutrient deficiencies in Nigeria. These deficiencies result from diets that are rich in energy and poor in proteins, minerals and vitamins. High levels of iron, β-carotene (pro-vitamin A) and the moderately high level of zinc in sorrel cordial juice is of nutritional importance. A 100g serving of sorrel cordial jelly (15.60mg Fe/100g) per day will provide all the iron that is needed by an adult. Zinc is among the important minerals deficient in the developing countries. Sorrel cordial juice contains relatively high amount of zinc. Zinc deficiency negatively influences growth of children and increases the risk of diarrhea, malaria, respiratory infections and child mortality (Black, 2003). β-carotene is important because it is a precursor of vitamin A. Currently, it is estimated that at least 40 million preschool children consume insufficient amounts of vitamin A; 13 million have some eye damage and annually 250,000 to 500,000 preschool children become partially or totally blind as a result of vitamin A deficiency. Some 37 countries, predominantly in Southeast Asia and Africa, are affected. In vitamin A–deficient populations, improving vitamin A status reduces the prevalence of anemia in most of the cases (Mwanri, 2000). Some vitamins such as ascorbic acid and provitamin A (β-carotene) while providing nutrients also serve as antioxidants which have disease-preventing and health promoting potentials, as phytochemicals. Ingestion of ascorbic acid has been known to enhance iron absorption and counteract the inhibitory effect of tannins on bioavailability (Nnam & Onyeke, 2010). Sorrel cordial juice has appreciable amounts of calcium and phosphorus. Consumption of sorrel cordial juice might be good source of minerals very important for strong bones and teeth. The trace amounts of antinutrients in sorrel cordial juice are beneficial (Table 3). This is because antinutrients bind important nutrients and make them unavailable for utilization in the body. Tannins interact with proteins and enzymes to increase the excretion of proteins and essential amino acids (Henry & Massey, 2001). Phytate reduces the bioavailability of minerals and causes growth inhibition. The low levels of phytate in sorrel cordial juice would increase bioavailability of iron and protein. This would reduce anaemia and protein malnutrition in communities that grow and consume sorrel product.

Sorrel cordial juice had higher ($p<0.05$) flavor (8.08), texture (7.76) and colour (8.00) than black currant juice, 6.44, 8.88 and 6.84, respectively (Table 5). Yodang *et al*. (2005) reported that many parts of sorrel are acceptable and useful in various food productions. This observation agreed with that of Nnam & Onyeke, (2010) who reported that in Switzerland, sorrel calyces are used for jams, jellies, sauces and wines.

Conclusion

This study showed that the sorrel cordial juice developed compared favourably with already existing similar food product (black currant cordial juice). The two products were evaluated for nutrients, antinutrients and sensory properties. The sorrel cordial juice contained higher levels of some of the micronutrients than the control, especially Fe, Na, Zn, Cu, P, ascorbic acid and β-carotene. It established diversified food uses of this indigenous local plant. The product was nutritious and acceptable. This offers new food uses for sorrel an indigenous available food plant that could be commercially produced in large scale.

Recommendations

1. Advertisement to promote sorrel product must be intensified in Nigeria and other countries in West Africa where sorrel grows.
2. Use of the products, needs to be encouraged as an alternative to imported juice. This would increase consumption that was limited in many families due to high costs.
3. There is need for biological studies on these new products possibly using rats to determine the bioavailability of the nutrients (proteins, minerals and vitamins)

References

Association Official Analytical Chemists. (2000). *Official Methods of Analysis.* Washington D.C.pp35-56

Black, R. (2003). Micronutrient deficiency – an underlying cause of morbility and mortality. *Bulletin of World Health Organisation*, 81 (2), 79.

Grewal, R.B. (2000). Utilization and processing of soybean to prepare traditional foods of India. Production, processing and utilization in Nigeria. The third international soybean processing and utilization conference (ISPUC-III): 2000 of the innovative era for soybean, Tsukuba. Ibarak. Japan. 325-326.

Henry, C.J.K. & Massey, D. (2001). Micro nutrients changes during food processing and storage. Crop Post-harvest Programme. Issue Paper 5.

Hunt, (2005). The potential impact of reducing global malnutrition on poverty reduction and economic development. *Asia Pacific Journal of Clinical Nutrition*, 14, 10-38

Ikediobi, C.O., Onyia, G.O.C. & Eluwah, C.E. (1980). A rapid and inexpensive enzymatic assay for total cyanide in cassava (*Manihot esculenta crantz*) and cassava products. *Journal of Agriculture, Biology and Chemistry*, 44, 2803-2809.

James, M.S. (2003). Roselle – *Hibscus sabdariffa L.* Institute of Food and Agricultural Science. University of Gainesville, Florida; 659.

Mwanri, L., Worsley, A., Ryan, P. & Masika, J. (2000). Supplemental vitamin A.improves aneamia and growth in anaemic school children in Tanzania *Journal of Nutrition,* 130, 2691-2696.

Nnam, N.M. & Onyeke, N.G. (2003). Chemical composition of two varieties of soorel (*Hibiscus sabdariffa*) calyces and the drinks made from them. Dept. of Home Science, Nutrition and Dietetics, University of Nigeria. Nsukka. Nigeria. Netherlands: *Plant Foods for Human Nutrition.* Kluwer Acadm Publishers. 58, 1-7.

Nnam, N.M.and Onyeke, N.G. (2010). Development of recipes and products from sorrel (*Hibiscus sabdariffa*) calyces, leaves and seeds and evaluation of their nutritionals phytochemicals and sensory properties, (4th Eds.). Nigeria Universities Research and Development Fair (NURESDEF). 8.

Onyeke, N. G. (2001). Chemical evaluation of the calyx, seed and leaf of sorrel plant *(Hibiscus sabdariffa*) and its drink. M. Sc. Dissertation. Department of Home Science, Nutrition and Dietetics, University of Nigeria. Nsukka. Nigeria.

Onyeke, N.G. (2013). Development of products from sorrel. (*Habiscus sabdariffa*) and evaluation of their nutrients, phytochemicals, antinutrients, toxicants, physico-chemical, sensory and storage properties. Ph.D Thesis. Department of Home Science, Nutrition and Dietetics, University of Nigeria, Nsukka. Nigeria.

Onwuka, G.I. (2005). Food *Analysis and Instrumentation,* Naphthalie print, HG Ltd, Lagos, Nigeria, pp. 319

Rich, M. (2004). *Hibiscus sabdariffa*. Plants for future edible, medicinal and useful plants for a healthier world. England and Wales: Charitable Company Ltd.

Yadong, Q. Chin, K. L., Malekian, F. & Berh, M. (2005). Biological characteristics, Nutritional and Medicinal value of Roselle, *(Hibiscus sabdariffa)*. Agriculture Research and Extension Centre. Department of Agriculture, Southern University Agriculture Centre. Circular UFNR, 604.