EVALUATION OF THE PROXIMATE, MINERAL AND VITAMIN CONTENT OF JUICES PRODUCED FROM IMPORTED AND LOCAL LESSER KNOWN FRUITS IN NIGERIA

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Abstract
Background: Lesser known fruits are often poorly consumed compared to the imported variety and we do not have data base of their nutritive contents. Materials and methods: The brix, pH, titratable acidity, proximate, vitamin, mineral content and antioxidant activity a of juice from ten local lesser known and imported fruits: Solanum melongena L (Eggplant), Annona muricata (Soursop), Citrus reticulata (Clementine), Ribes uva-crispa L (Gooseberry), Cucumis melo (Golden melon), Vitis vinifera (White grape), Actinidia chinensis (Kiwi), Litchi chinensis (Lychee), Prunus persica (Peach), Prunus domestica (Plum) and Punica granatum (Pomegranate) were evaluated. Results: The pH varied from 2.55-5.85; S. melongena L had the lowest brix and carbohydrate but highest protein contents (3.88±0.18%, 4.91 ±0.83% and 4.61± 0.13%) respectively. The ash content ranges from 0.52±0.14% in V. vinifera to 1.46 ±0.12% in S. melongena L. Lipids levels were very low (0.29±0.05% - 1.31±0.13%). All juice samples had low fibre and high moisture contents. Vitamins concentrations varied Ascorbic acid (9.18±0.52-32.06±1.28 mg/100ml), vitamin E (0.11±0.03-1.95±0.21 mg/100ml), vitamin A (0.45±0.13-7.01±0.28 mg/100ml), β-carotene (7.34±1.20-152.96±10.55 µg/g), riboflavin (0.06±0.02-0.54±0.08 mg/100ml) and thiamine (0.27±0.04-2.22±0.17 mg/100ml). All the fruit juices contained Ca, Cu, Fe, Mg, K and Zn except C. reticulata which was lacking in Cu and Zn. C. melo had the lowest while P. granatum had the highest antioxidant Conclusion: Generally, all the samples had poor reducing power ability, iron chelating ability and DPPH radical scavenging ability. All fruits showed excellent total antioxidant activity and A. muricata had the highest value. S. melongena had low brix and high fibre content.

Keywords: Fruits, Proximate analysis, Vitamins, Minerals, Antioxidant

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1. INTRODUCTION

Fruits and vegetables are important component of human nutrition because of their outstanding nutritional benefits, especially as some could be eaten fresh. Fruit juices are good source of essential vitamins, minerals, amino acids, dietary fibres and bioactive phytochemicals (Bhardwaj *et al.*, 2014). Fruits vary in their nutritional composition and due to their perishable nature culminating in loss of nutrients and ultimate spoilage. Fruits can be squeezed into juice not just for immediate consumption but also for preservation. A fruit juice is said to be 100% if it contains no added sugar or additives and a properly extracted juice will contain almost all the essential nutrients the raw fruit will provide. Most fruits are seasonal but with food preservation techniques, their juice can be made available in the market all year round.

However, daily intake of fruit juice has been linked to reduced risk of the following: cardiovascular diseases (Chong *et al.*, 2010), neurodegenerative disease, ageing, hyperlipidemia, insulin resistance, cancer (Wu *et al.*, 2009; Kyle *et al.*, 2009), gastrointestinal (GIT) disorders, allergies, skin related diseases (Bae *et al.*, 2009), oxidative stress and inflammation (Wilson *et al.*, 2008). Intake of fruits and vegetables rich in antioxidants has been linked to the balance of the free radicals/antioxidants status, which helps to modulate the oxidative stress in the body, reduce the risks of cancers and cardiovascular diseases (Kaur and Kapoor, 2001).

Free radicals are chemical entities which are capable of independent existence and have one or more unpaired electron in their valence

orbital. Due to the presence of unpaired electrons, they are unstable. They are generated either endogenously from metabolic activity *in-vivo* or exogenously. Endogenously, they can be produced by enzymatic or non-enzymatic process. Enzymatic reactions generating free radicals include those involved in the respiratory chains, foreign body or pathogen phagocytosis of immune response, synthesis of prostaglandin and cytochrome system (Halliwell, 2007; Valko *et al.*, 2007; Pacher *et al.*, 2007). Exogenous sources of free radical include air and water pollution, cigarette smoke, alcohol, exhaust fumes, smoke from burning refuse, certain drugs, industrial solvents, exposure to ionizing radiation just to mention a few. These reactive free radicals include hydroxyl ($OH^{\cdot}$), superoxide ($O_2^{\cdot}$), nitric oxide ($NO^{\cdot}$), peroxy, peroxynitrite and high temperature cooking fumes (Valko *et al.*, 2007; Droge, 2002; Willcox *et al.*, 2004). Oxidative stress is a term used to describe the imbalance of free radical and the activity of the antioxidant defense system. Severe oxidative stress has been implicated in several neurodegenerative diseases such as cancer, atherosclerosis, iron overload, rheumatoid arthritis, Parkinson's disease, motor neurone diseases, diabetes, malaria, HIV and AIDS (Halliwell, 2001; Ceriello, 2008; Singh *et al.*, 2004). The human body has its own mechanism for coping with oxidative stress which by producing antioxidants to neutralize the effect of reactive oxygen species. Antioxidants can either be produced *in situ* or supplied through diet (Lien *et al.* 2008).

These considerations led us to evaluate the nutrient composition of fruits which are available in our environment but are not commonly consume as oranges and mango and the imported fruits whose price is a bit on the high side for the low and middle income group here in Nigeria. Data from this would provide information on nutrient contents, sensitize interest in the lesser known fruits and possibly serve as guide in making purchase for this food items with limited resources available.

2. MATERIALS AND METHODS

Sample Collection

Fresh fruit samples of *S. melongena L* (Eggplant), *A. muricata* (Soursop) and *C. reticulata* (Clementine) were collected from the Botanical garden, University of Ibadan while fruit samples of *R. uva-crispa L* (Gooseberry), *C. melo* (Golden melon), *V. vinifera* (White grape), *A. chinensis* (Kiwi), *L. chinensis* (Lychee), *P. persica* (Peach), *P. domestica* (Plum) and *P. granatum* (Pomegranate) were purchased from a supermarket in Jericho, Ibadan, Nigeria and the fruits were stored at 4^0C and were used within a week of purchase. Authentication of the fruits was carried out at the Herbarium of Botany Department, Faculty of Science, University of Ibadan, Ibadan.

Sample Preparation

Rinsed, sliced fleshy parts (without the seeds) 100g was homogenized with an Ultra-Turrax (T25, IKA- Labortecknik), followed by centrifugation at 10,000 rpm for 10 min at 4^0C and supernatant were stored at 4^0C for further analysis. All assays in this work were done in triplicates

Determination of pH, Titratable Acidity and Brix

Supernatant was used for sugar content measurement by refractometer (Brix) and the pH was measured at room temperature. Titratable acidity was determined by titration with 0.1M NaOH until pH of 8.1 was attained and data was reported as g citric acid /100 g fresh weight.

Proximate Analysis

The proximate analysis of the samples was determined using standard methods (AOAC, 1990). The moisture content was determined by drying in the oven at 100^OC until a constant weight was obtained for at least 24 h. Ash and mineral content was determined by digesting in muffle furnace at 550^OC for 4 h with a slight modification by Tee *et al* (1996). Total dietary fiber was determined by an enzymatic gravimetric method, crude oil content was assayed by extraction with *n*-hexane in a Soxhlet extractor and nitrogen was determined by standard micro kjeldahl method using a

digestion apparatus. The crude protein content was calculated by multiplying nitrogen content by 5.71, correction factor for non-protein nitrogen

Vitamins and β- carotene Content

Riboflavin, thiamine, ascorbic acid, α-tocopherol and β-carotene content of the juice samples were determined using HPLC on C18 reverse phase column (4.6 x 100 x 3.5µm) and mobile phase was methanol, acetonitrile and chloroform (42.5/42.5/15 v/v). Flow rate was maintained at 1.2 ml/min, detection wavelength varied and peaks were monitored on a UV 6000LP diode array detector. HPLC grade reagents vitamins were used for instrument calibration prior to assay of each vitamins in triplicate. ThermoQuest chromatography data acquisition software version 4.1 was used in the collection and processing of results. Same method above was used for carotene content, except fruit juice (5 mL) was clarified using $CaCO_3$ (2 g), diatomaceous earth (1 g), methanol (25 mL), before adding 50mL hexane/acetone mixture 1:1. This was separated using separating funnel, aqueous phase was discarded and upper layer was stored in dark vials and analyzed at 450 nm.

Mineral content

All reagents used were of analytical grade and solutions were made using distilled deionized water. Digestion of juice was with 1:2 nitric acid/perchloric acid mixtures. Adequate analytical precautions were taken with both sample and glassware handling to prevent contaminations and analytical grade reagents were used in making standards for each metal. Flame atomic absorption spectrophotometer (Perkin-Elmer Corporation, 1968) was used to analyze for Ca, Cu, Fe, Mg, K, and Zn contents in Agronomy Department, University of Ibadan. All assays were in triplicate and occasionally spike samples were used to ensure reproducibility of procedure.

Antioxidant assay

The 2, 2-diphenyl-1-picrylhydrazyl (DPPH) scavenging ability of the fruit extracts was measured a method described by Gyamfi *et al.*, 1999 using degree of discoloration of DPPH. Ferric reducing power assay of the samples was done as described by Oyiazu (1986) and Yen and Chen (1995). Total antioxidant capacity assay based on the reduction of Molybdate (VI) to green Phosphate Molybdate (V) complex is measured at 695nm (Prieto *et al.*, 1999). The ferrous chelating ability of the fruit extracts was assayed by using ferrozine and absorbance taken at 562nm as described by Dinis *et al.*, 1994. Total phenolics content was measured Singleton *et al.*, (1999) using Folin-Ciocalteu reagent and total flavonoid content was assayed using aluminum chloride colorimetric method (Jagadish *et al.*, 2009).

Antinutrient assay

Tannin, saponin, phytate and oxalate contents of the juice was done using standard laboratory procedures (Trease and Evans, 1996)

3. RESULT AND DISCUSSION

Diets rich in fruits and vegetables have been known to protect against age related diseases and cancers (Zafra-Stone *et al.*, 2007; Willet, 2001) and consumption of fruits is truly encouraged as these nutrients present therein are eaten fresh, thus minimizing losses. Total solid contents of fruits consist of all the components except water and volatiles such as organic acids (mainly malic acid and citric acid), minerals, lipids, reducing sugars and pigments. Table 1 below shows the pH, sugar content and the tritatable acidity of the eleven fruit samples. Most juice had low sugar content, *A. muricata* (18.88±0.18%) had the highest while *S. melogena L* had the lowest (3.88±0.18%) brix. *P. granatum* had the lowest pH (2.55±0.07) while *C. melo* had the highest pH (5.85±0.07), thus all the fruits were acidic. Titratable acidity was very low in all the samples varying from 0.21% and 1.51%. Interestingly, *C. melo* with the highest pH had the lowest titratable acidity. Sugar content of fruits varies with specie, stage maturity, growing region, farming practice and usually it can be measured using refractometer. Sugars are converted into products such as ethanol by microbial activities in wineries and breweries. The refractive index of any aqueous sugar is directly proportional its concentration and it is

measured in ^{0}Brix (1 ^{0}Brix means there is 1% (w/v) of sugar in the solution). Low brix (%) were recorded in samples studied which makes them ideal for diabetic patients with *S. melongena L* having the least and *A. muricata* with the highest (18.88±0.18%) of the samples.

On Table 2 is data obtained for proximate contents of the samples. Generally, the fruits had low lipid, fiber and protein contents. Moisture content of the juices studied were very high with *A. muricata* (77.15±0.67%) having the least value. Moisture content in decreasing order was *C. melo>R.uva-crispa L>A.chinensis>P. domestica>L. chinensis>P. persica>S. melongena L>P. granatum>C. reticulata>V. vinifera>A. muricata*. The protein content of the samples ranges from 1.12±0.13% (*R. uva-crispa L)* to 4.61±0.13% (*S. melongena L*). There is no significant difference ($p<0.01$) in the protein content of *R. uva-crispa L(*1.12±0.13%*) and A. chinenesis (*1.14±0.11%); likewise *P. domestica (*1.80±0.08%*) and A. muricata (*1.82±0.13%*).* The ash content in all the samples was very low. *S. melongena L (*1.46±0.12%*)* and *P. granatum (*1.38±0.11%*)* are the juice samples having the highest ash contents as shown in table 2 above. The low ash content indicates low inorganic components of the fruit which are mainly minerals. Minerals in minute quantity are beneficial to the body. They serve as co factors of enzymes catalyzing important biochemical reactions in the body, thus, contributing to the general well-being of the body. The lipid as well as ash contents were very low in all the study samples. The mean lipid content of the samples was 0.67%. The lowest (0.29±0.05%) and highest (1.31±0.13%) lipid level were found in *R. uva-crispa L and P. granatum* respectively. Dietary fibre increases the bulk volume of digested food in the GIT thereby increasing its surface area for water reabsorption in the colon and enhancing easy passage of waste. The latter reduce the incidence of constipation and high fibre foods can hinder mineral absorption because of charged polysaccharides such as pectin and phytates. Low fibre content in our study can be attributed to the extraction process used in obtaining the juice from respective fruit and it varied from 0.70±0.13% in *R. uva-crispa L* to 1.13±12% in *A. chinenesis* and *P. persica.*

The moisture contents were relatively high, *C. melo* has the highest and *A. muricata* had the least moisture of 77.15±0.67% as reported in table 2. The high moisture content is testament to their level of perishability and hence, shirt shelf life. The samples all had low levels of carbohydrate as seen in table 2 above and this corroborates the data on Brix. The low carbohydrate content of these fruit juices makes them good choice for diabetics as they will contribute little or no sugar to system.

Mineral contents of the fruit juice samples are shown on Table 3 above. Potassium level of the samples was relatively high when compared with other electrolytes analyzed. Like Copper, Zinc was absent in *C. reticulata.* Calcium, Copper, Iron, Magnesium, Potassium and Zinc were present in all the fruit juices in varying quantities except in *C. reticulata* which did not have copper. Essential minerals are important for growth, bone formation, nerve impulse transmission and deficiency could lead to disease (Reddy and Love, 1999). Copper deficiency has been associated with cardiovascular, nervous and bone disorders also and it is worth noting that the concentration of Cu in this study tallies with levels obtained for orange, apple, grape fruit and black currant juice (Krejpcio *et al*., 2005). *A. chinenesis* (32.92±1.83 mg/100ml) had highest Cu value and it was evidently absent in *C. reticulata.* There is no significant difference in the copper content of *S. melongena L, R. uva-crispa L, P. domestica, P. persica* and *A. muricata* at $p<0.01$. Iron content ranges from 0.39±0.04 mg/100ml in *V. vinifera* to 0.08±0.01 in *C. reticulata.* The concentration of Iron in our study is lower than 1.84 and 0.455 mg/100g respectively reported for carrot and tomato juice (Motegaonkar & Salunke, 2012). Iron is important in the diet, especially of infants, expectant / nursing mothers, convulsing patients and the elderly for the prevention of anemia (Oluyemi *et al*., 2006). Interestingly, there was a good linear correlation between iron and copper (R^2 =0.91,

ρ<0.01) of the fruit juices in our study. Insufficiency in Mg in man has been linked to severe diarrhea, migraines, hypertension, cardiomyopathy, atherosclerosis and stroke (Appel *et al.*, 1997) and from our study 47.26 and 19 mls of *C. reticulata* and *A. chnensis* juice respectively would provide 320 mg/day RDA of Mg. Potassium content of 305.00±9.90 mg/100ml of *A. chinenesis* was the highest compared to the lowest, 152.50±6.36 mg /100ml in *P. domestica*. There was a good linear correlation between potassium and magnesium (R^2=0.92, ρ<0.01). Potassium, which has been reported to help in maintaining water and electrolyte balance in the body, was very high in all the juices studied; while *P. domestica* (152.5 mg/100ml) was high, orange juice had 7 mg/100g (FSANZ NUTTAB, 2010). The average zinc level of all the fruit juices is 0.15mg/100ml, *L. chinenesis* had the least value and *P. granatum* was the highest. Often Zn deficiency leads to poor growth, impaired immunity and increased morbidity form infectious diseases (Melaku *et al.*, 2005) and it is commonly associated with diets high in phytic acid

Tables 4 and 5 are data obtained for *in-vitro* antioxidant assay. Only *P. granatum* (61.71±0.25%), *L. chinenesis* (59.77±2.45%) and *A. chinenesis* (43.76±2.50%) showed moderate inhibition of DPPH radical activity. *C. melo* had the lowest (5.18±0.14%) while *P. granatum* demonstrated the highest DPPH radical scavenging activity of the samples examined (Table 5). Our data for DPPH radical scavenging activity of *P. granatum* is comparable to the result obtained by Mutahar *et al* (2012) from methanol extracts of *P. granatum* peels. The reducing power of the samples ranges from 0.78±0.10 mg/100ml in *P. granatum* to 0.21±0.01 mg/100ml in *C. melo*. There is no significant difference in the reducing power of *P.granatum* and *L. Chinenesis*. All the fruit juices showed excellent total antioxidant activity *in vitro*. *C. melo* had the lowest total antioxidant activity (124.00±7.07 mg/100ml) while *A. muricata* had the highest total antioxidant activity (295.00±4.14 mg/ 100ml). At p<0.01, there was no significant difference in the total antioxidant activity of *C. reticulata, V. vinifera, P. persica* and *P. domestica;* and also between *S. melongena L* and *P. granatum***.** The ability of the fruit extracts to chelate iron was low across all the samples. The increasing order of the Fe^{2+} chelating is as follows: *P. domestica*<*C. melo*< *P. persica*< *A. chinenesis*< *V. vinifera* <*C. reticulata*< *A. muricata*< *R. uva-crispa L*< *S. melongena L*< *L. chinenesis*< *P. granatum*. There was no significant difference in the Fe^{2+} chelating ability of *A. muricata* (2.98±0.32mg/100ml), L. *chinenesis* (3.22±0.46mg/100ml), *C. reticulata* (2.96±0.11mg/100ml), *R. uva-crispa* L (3.00±0.32 mg/100ml) and *S. melongena L*(3.16±0.32mg/100ml). Free radicals have been implicated in the etiology of several human disesase such as cardiovascular diseases, cancer, atherosclerosis, iron overload, rheumatoid arthritis, Parkinson's disease, motor neuron diseases, diabetes, malaria, HIV and AIDS (Halliwell, 2001; Ceriello, 2008; Singh *et al.*, 2004). Epidemiological studies have shown that there is a negative correlation between the consumption of fruits and vegetables and the morbidity and mortality of cardio- and cerebro-vascular diseases and certain types of cancers (Johnsen *et al.*, 2003). In this study, several assays were used to determine the antioxidant activity of the various fruit extracts. All the fruit samples were poor inhibitor of DPPH radical except *L. chinenesis* (59.77±2.45%), *P. granatum* (61.71±0.25%) and *A. chinensis* (43.76±2.50%) that showed moderate inhibition of DPPH. At p<0.01, there was no significant difference in the DPPH activity of *L. chinenesis* (59.77±2.45%) and *P. granatum* (61.71±0.25%). The DPPH radical scavenging activity of *P. granatum* is comparable to the one obtained by Mutahar *et al* (2012) using methanolic extracts of *P. granatum* peels at 25 ppm (59.2%).

On Tables 6 is data obtained for vitamins contents of the fruit juices. Ascorbic acid level was high in *C. reticulata* (32.06±1.28 mg/100ml), *L. chinenesis* (22.26±1.63 mg/100ml), *A. muricata* (20.50±2.96

mg/100ml) and *C. melo* had the lowest value. Ascorbic acid, an antioxidant vitamin, present in fruits and vegetables but its content decreases in commercial fruit juice with regards to temperature and time during both processing and storage (Biljana and Marija, 2009). *P. granatum* juice had the highest riboflavin content, while *C. melo* recorded the least and similar trend was observed for thiamine content. Furthermore, there was a good linear correlation between riboflavin and thiamine contents (R^2= 0.92, ρ<0.01).

Table 1: Physicochemical properties of some selected fruit juice

Fruit juices	pH	Brix (%)	Tritatable Acidity(%)
Citrus reticulata	3.70±0.14^{c}	12.75±0.00^{e}	0.67±0.07^{d}
Solanum melongena L	4.40±0.00^{b}	3.88±0.18^{j}	0.52±0.04^{e}
Ribes uva-crispa L	2.80±0.00^{f}	8.00±0.00^{h}	0.32±0.05^{f}
Cucumis melo	5.85±0.07^{a}	7.00±0.00^{i}	0.21±0.10^{f}
Vitis vinifera	3.05±0.07^{e}	17.38±0.18^{b}	0.67±0.05^{d}
Actinidia chinenesis	2.85±0.07^{f}	10.88±0.18^{f}	1.51±0.05^{a}
Litchi chinenesis	3.15±0.07^{de}	15.13±0.18^{d}	0.67±0.05^{d}
Prunus persica	3.55±0.07^{c}	10.13±0.18^{g}	0.74±0.05^{d}
Prunus domestic	2.80±0.14^{f}	10.63±0.18^{f}	1.37±0.05^{b}
Punica granatum	2.55±0.07^{g}	16.13±0.18^{c}	1.17±0.06^{c}
Annona muricata	3.30±0.00^{c}	18.88±0.18^{a}	0.74±0.05^{d}

Values are mean±standard deviation (n=3). Different letter superscripts indicate significant differences at p<0.01

Table 2: Proximate Analysis of some Selected Fruit juices

Fruit juices	Protein content (%)	Ash content (%)	Lipid content (%)	Fibre content (%)	Moisture Content (%)	Carbohydrate content (%)
Citrus reticulata	3.27±0.26^{b}	0.61±0.14^{c}	0.86±0.08^{b}	0.82±0.11^{cd}	83.68±0.93^{b}c	10.78±0.34^{b}
Solanum melongena L	4.61±0.13^{a}	1.46±0.12^{a}	0.65±0.06^{c}	1.49±0.11^{a}	86.90±0.99^{bc}	4.91±0.83^{f}
Ribes uva-crispa L	1.12±0.13^{g}	0.95±0.09^{b}	0.29±0.05^{f}	0.70±0.13^{d}	90.32±0.96^{a}	6.64±0.56^{e}
Cucumis melo	2.00±0.13^{d}	0.81±0.15^{bc}	0.38±0.05^{ef}	1.04±0.15^{bc}	91.35±0.92^{a}	4.44±0.45^{f}
Vitis vinifera	1.24±0.24^{g}	0.52±0.14^{c}	0.35±0.06^{ef}	0.81±0.14^{cd}	78.92±0.11^{d}	18.17±0.47^{a}
Actinidia chinenesis	1.14±0.11^{g}	0.66±0.15^{bc}	0.60±0.06^{cd}	1.13±0.13^{b}	88.27±0.37^{b}	8.18±0.76^{c}
Litchi chinenesis	1.57±0.16^{ef}	0.70±0.16^{bc}	0.53±0.09^{cde}	0.83±0.11^{cd}	87.61±1.02^{b}	8.77±0.50^{c}
Prunus persica	2.59±0.13^{c}	0.66±0.11^{bc}	0.42±0.06^{def}	1.13±0.12^{b}	87.60±0.10^{b}	7.61±0.33^{cd}
Prunus domestica	1.80±0.08^{de}	0.74±0.14^{bc}	0.98±0.16^{b}	1.01±0.12^{bc}	88.24±1.54^{b}	7.24±1.36^{cd}
Punica granatum	1.48±0.23^{efg}	1.38±0.11^{a}	1.31±0.13^{a}	0.92±0.13^{bcd}	84.71±0.41^{bc}	10.49±0.32^{b}
Annona muricata	1.82±0.13^{de}	0.68±0.15^{bc}	0.35±0.06^{ef}	1.03±0.13^{bc}	77.15±0.67^{d}	18.99±0.76^{a}

Values are mean±standard deviation (n=3). Different superscripts indicate significant differences at p<0.01. Significant difference was analyzed using ANOVA.

Table 3: Mineral content of the selected Fruit juice

Fruit juices	Calcium content (mg/100ml)	Copper (mg/100ml)	Iron (mg/100ml)	Magnesium (mg/100ml)	Potassium (mg/100ml)	Zinc (mg/100ml)
Citrus reticulata	21.26±1.34^{b}	-	0.08±0.01^{f}	6.77±0.88^{ef}	128±3.54^{f}	-
Solanum melongena L	8.66±0.59^{def}	0.06±0.01^{c}	0.19±0.01^{de}	11.75±0.55^{bc}	217.50±3.54^{bc}	0.14±0.01^{bc}
Ribes uva-crispa L	24.20±1.13^{b}	0.06±0.01^{c}	0.30±0.02^{bc}	9.96±0.13^{d}	188.50±13.44^{d}	0.15±0.04^{bc}
Cucumis melo	9.02±0.93^{de}	0.04±0.00^{d}	0.20±0.02^{de}	11.41±1.15^{bc}	255.00±16.97^{bc}	0.15±0.05^{bc}
Vitis vinifera	10.88±0.52^{d}	0.12±0.01^{b}	0.39±0.04^{a}	7.97±0.93^{de}	183.00±11.31^{d}	0.10±0.04^{d}
Actinidia chinenesis	32.92±1.83^{a}	0.13±0.00^{b}	0.35±0.05^{ab}	16.84±0.43^{a}	305.00±9.90^{a}	0.17±0.04^{b}
Litchi chinenesis	5.29±0.59^{f}	0.13±0.02^{b}	0.37±0.08^{a}	11.01±0.22^{bc}	167.00±5.66^{de}	0.07±0.01^{de}
Prunus persica	6.68±0.85^{f}	0.06±0.02^{c}	0.23±0.03^{cd}	9.36±0.50^{d}	187.00±4.24^{d}	0.16±0.01^{bc}
Prunus domestica	6.10±0.63^{ef}	0.06±0.00^{c}	0.15±0.04^{ef}	7.19±0.49^{de}	152.50±6.36^{de}	0.09±0.01^{de}
Punica granatum	9.69±0.63^{de}	0.15±0.02^{a}	0.35±0.06^{ab}	12.76±0.52^{b}	224.00±16.97^{bc}	0.32±0.04^{a}
Annona muricata	15.53±1.31^{c}	0.06±0.01^{c}	0.25±0.03^{cd}	16.41±1.82^{a}	275.50±16.26^{b}	0.17±0.01^{b}

Values are mean±standard deviation (n=3). Different superscripts indicate significant differences at p<0.01. Significant difference was analyzed using ANOVA.

Table 4: Antioxidant Activity of the Selected Fruit Samples

Fruit juices	DPPH (%)	Reducing power (mg/100ml)	Total Antioxidant (mg/100ml)	Fe^{2+} Chelating (mg/100ml)
Citrus reticulata	8.710.83^{f}	0.73±0.03^{ab}	169.50±7.78^{c}	2.96±0.11^{ab}
Solanum melongena L	8.12±0.17^{f}	0.74±0.01^{abc}	188.50±6.36^{b}	3.16±0.32^{ab}
Ribes uva-crispa L	18.95±1.10^{d}	0.70±0.00^{bcd}	137.5±6.36^{de}	3.00±0.26^{ab}
Cucumis melo	5.18±0.14^{g}	0.21±0.01^{g}	124.00±7.07^{e}	0.90±0.05^{d}
Vitis vinifera	12.24±0.16^{e}	0.67±0.00^{d}	160.00±5.66^{c}	2.73±0.11^{b}
Actinidia chinenesis	43.76±2.50^{b}	0.41±0.02^{e}	153.00±2.83^{cd}	1.63±0.07^{c}
Litchi chinenesis	59.77±2.45^{a}	0.75±0.05^{a}	189.00±11.31^{b}	3.22±0.46^{ab}
Prunus persica	7.98±0.14^{g}	0.26±0.01^{f}	155.50±6.36^{c}	1.02±0.06^{d}
Prunus domestic	36.95±0.33^{c}	0.23±0.00^{fg}	166.00±4.24^{c}	0.87±0.08^{d}
Punica granatum	61.71±0.25^{a}	0.78±0.01^{a}	193.00±8.49^{b}	3.31±0.33^{a}
Annona muricata	39.59±1.91^{c}	0.69±0.02^{cd}	295.00±14.14^{a}	2.98±0.32^{ab}

Values are mean±standard deviation (n=3). Different superscripts indicate significant differences at p<0.01. Significant difference was analyzed using ANOVA.

Table 5: Phenolic, Flavonoid and β-carotene Contents of the Fruit Juices

Fruit juices	Total Phenolic Content (mg/100ml)	Flavonoid Content (mg/ 100ml)	B-Carotene (µg/g)
Citrus reticulate	107.95±1.48	1.11±0.01	56.50±2.83^{b}
Solanum melongena L	88.70±0.57	2.65±0.23	-
Ribes uva-crispa L	116.00±2.97	3.44±0.23	-
Cucumis melo	48.72±1.62	0.35±0.09	7.34±1.20^{e}
Vitis vinifera	123.70±1.41	4.76±0.17	34.98±0.21^{cd}
Actinidia chinenesis	103.35±3.32	3.05±0.78	44.48±2.60^{c}
Litchi chinenesis	182.55±18.17	10.93±0.30	-
Prunus persica	91.94±2.54	2.92±1.30	150.05±1.88^{a}

Prunus domestica	116.43±0.40	9.20±0.11	152.96±10.55[a]
Punica granatum	214.86±8.08	2.28±0.23	-
Annona muricata	235.45±1.63	8.58±1.56	-

Values are mean±standard deviation (n=3).

Table 6: Vitamin content of the selected Fruit juices

Fruit juices	Vitamin C (mg/100ml)	Vitamin E (mg/100ml)	Vitamin A (mg/100ml)	Riboflavin (mg/100ml)	Thiamin (mg/100ml)
Citrus reticulata	32.06±1.28[a]	1.24±0.08[c]	-	0.33±0.13[bc]	1.20±0.04[bc]
Solanum melongena L	13.22±0.58[c]	1.11±0.12[c]	5.02±1.19[c]	0.10±0.01[def]	0.33±0.10[e]
Ribes uva-crispa L	10.19±1.52[de]	-	0.45±0.13[e]	0.09±0.01[ef]	0.65±0.23[de]
Cucumis melo	9.18±0.52[e]	0.11±0.03[f]	-	0.06±0.02[f]	0.27±0.04[e]
Vitis vinifera	21.74±0.27[b]	0.22±0.06[f]	1.11±0.18[e]	0.18±0.02[def]	0.86±0.17[cd]
Actinidia chinensis	12.69±1.70[cd]	0.80±0.08[d]	0.96±0.13[e]	0.20±0.02[de]	0.91±0.06[cd]
Litchi chinenesis	22.26±1.63[b]	0.59±0.07[de]	-	0.22±0.05[cd]	1.37±0.27[b]
Prunus persica	11.44±0.38[cde]	0.47±0.06[e]	2.61±0.66[d]	0.11±0.02[def]	0.52±0.05[de]
Prunus domestica	12.30±0.32[cd]	1.56±0.06[b]	8.80±0.76[a]	0.36±0.06[b]	1.22±0.17[bc]
Punica granatum	13.56±0.40[c]	1.95±0.21[a]	7.01±0.28[b]	0.54±0.08[a]	2.22±0.17[a]
Annona muricata	20.50±2.96	-	-	0.16±0.06[def]	0.66±0.35[de]

Values are mean±standard deviation (n=3). Different superscripts indicate significant differences at p<0.01. Significant difference was analyzed using ANOVA.

Table 7: Antinutrient Content of the Fruit Juices

Fruit juices	Tannin Content(mg/100ml)	Saponin Content (mg/100ml)	Oxalate Content (mg/100ml)	Phytate Content (mg/100ml)
Citrus reticulate	19.44±0.88[fg]	0.03±0.02[gh]	1.08±0.02[cd]	3.59±1.39[de]
Solanum melongena L	9.06±1.24[i]	0.74±0.18[c]	0.85±0.05[de]	24.85±2.62[a]
Ribes uva-crispa L	21.17±1.00[ef]	0.06±0.03[g]	1.16±0.04[c]	0.74±0.23[i]
Cucumis melo	3.73±1.77[j]	0.03±0.02[gh]	0.05±0.01[g]	0.07±0.02[j]
Vitis vinifera	37.27±1.68[d]	0.11±0.03[f]	1.33±0.08[bc]	1.27±0.27[gh]
Actinidia chinenesis	17.8±1.19[g]	0.07±0.03[g]	1.04±0.04[cd]	12.30±1.90[c]
Litchi chinenesis	45.38±1.12[c]	3.19±1.10[a]	1.84±0.21[b]	1.88±0.41[fg]
Prunus persica	12.38±0.80[h]	0.63±0.30[cd]	0.52±0.59[ef]	2.30±1.16[ef]
Prunus domestica	24.55±1.22[e]	0.15±0.04[ef]	1.12±0.08[c]	1.86±1.22[fg]
Punica granatum	52.30±1.67[b]	1.83±0.54[b]	2.47±0.53[a]	4.75±0.52[d]
Annona muricata	67.06±1.53[a]	0.23±0.08[e]	2.48±0.15[a]	19.28±1.16[b]

Beta carotene, a precursor of vitamin A, was absent in *S. melongena*, *R. uva-crispa*, *L.chinenesis*, *P. granatum* and *A. muricata*. Obtained values for beta carotene ranged from 152.96 – 7.34 µg/100g fruit, with *P. domestica* having the highest value while *C. melo* had the lowest content. Our results are higher than those obtained for orange juice (0.053-0.069 µg/mL); apple juice (0.014-0.023 µg/mL) and in vitamin supplemented drinks (0.13-0.19 µg/mL) (Chiosa *et al*., 2005). Vitamin A was also absent in *C. reticulata*, *L. chinenesis*, *A. muricata* and *C. melo*. On the other hand, vitamin A varied from 0.45±0.13 mg/100ml to 8.80±0.76 mg/100ml and *P. domestica* having the highest content. Retinal vitamin A equivalence of beta carotene of the fruit juice ranged from 0.61-12.75 RAE/g and the international unit equivalence of beta carotene was between 12.23-254.94 IU/g. Beta carotene is a free radical scavenger and it is believed to have anticancer effect (Handelman, 2001). Vitamin E was absent in *A. muricata* and *R. uva-crispa L.* and *P. domestica*. Vitamin E content varied significantly ($\rho<0.01$) from 0.11 to 1.95 mg/100mL. Our data is similar to those obtained for tomato juice 0.66 mg/100mL; Kiwi juice 1.11 mg/100mL and mango juice 2.32 mg/100ml (Mae, 2013).There was a good linear relationship vitamin E and riboflavin ($R^2=0.84$, $\rho<0.01$) on one hand and between vitamin E and thiamine ($R^2=0.71$, $\rho<0.05$) on the other, thus implying positive influence of vitamin E content on thiamine and riboflavin concentration in the juices.

On Table 7 is data obtained for antinutrients content of the fruits studied. Antinutrients are naturally or synthetic compounds that interfere with absorption of nutrients mainly through inhibition and binding (Montagnac et al., 2009). These compound include tannins, saponins, phytic acid, amylase inhibitors, protease inhibitors, oxalic acids, trypsin inhibitors etc. they belong to polyphenolic class of compounds and can have either positive or negative effect depending on the amount ingested. In this study, *A. muricata* showed the highest level of antinutrient (tannin, oxalate and phytate) while *C .melo* showed the low level of the antinutrients. The tannin, oxalate and phytate level of *A. muricata* are 67.06±1.53 mg/100g, 2.48±0.15 mg/100g and 19.28±1.16 mg/100g respectively. Tannins in fruits impart astringent taste that affects palatability, reduce food intake and consequently body growth. Phytate consumption (10-60 mg/g) over a long period of time has been reported to decrease bioavailabilty of minerals in monogastric animals (Thompson, 1993). Oxalate binds calcium, thus, preventing its absorption in the body. Most kidney stones are composed primarily of calcium oxalate and hyperoxaluria has been identified to be a major risk factor in kidney stone formation (Kaufman et al., 2008).

4. CONCLUSION

Conclusively, the total antioxidant assay revealed that all the fruit juices had excellent total antioxidant activity. Consumption of some locally available fruit such as *S. melongena* with low brix, high fibre content should not only be encouraged but probably greater innovation in the use of the fruit should be looked into. Furthermore *A muricata* had the highest total antioxidant activity (295.00±00 mg/100ml, this fruit though locally available in the market, it is about the most expensive fruit and the cultivation should be encouraged.

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