A Study of the Nutritional Composition of Freshly Squeezed and Processed Orange Juices

Baturh Yarkwan* and Olutola Oketunde
Biochemistry Unit, Dept. of Biological Sciences, University of Agriculture, PMB 2373, Makurdi, Benue state, Nigeria

Abstract
Large quantities of oranges, *Citrus sinensis* are lost at postharvest due to an array of factors. Processing is considered a means of minimizing losses. However, the question of loss in nutrients remains a major challenging factor deterring the acceptability of processed juices. To compare the nutritional composition of processed and freshly squeezed orange juices, four samples were used including two varieties of oranges (valencia and Ibadan sweet) and two brands of processed orange juice (fumman and chi-exotic) were collected. Proximate composition, vitamin C and mineral content were determined, using standard methods. The result shows that freshly orange juice has more vitamin C than processed orange juice (Ibadan sweet = 10 mg/100g, Valencia = 8 mg/100g, chi-exotic = 2.56 mg/100g, fumman = 2.30 mg/100g). The samples showed high moisture content (89.10%) and valencia had the lowest (86.00%). Ibadan sweet had the highest ash content (45 mg/100g) while valencia, fumman and chi-exotic had 40 mg/100g, 35 mg/100g and 32 mg/100g respectively. Valencia had the highest protein content (385 mg/100g), Ibadan sweet, fumman and chi-exotic had 350 mg/100g, 328 mg/100g and 241 mg/100g respectively. Both varieties of freshly squeezed contained the same amount of fibre (20 mg/100g) while fumman and chi-exotic had 12 mg/100g and 8 mg/100g respectively. Valencia had the highest amount of carbohydrate (13.555%), Ibadan sweet, fumman and chi exotic had 13.085%,11.425% and 10.619% respectively. Fumman had the highest calcium content (0.050 ppm), chi-exotic had the highest sodium and iron content (0.3176 ppm and 0.1287 ppm) while valencia had the highest potassium content (0.210 ppm).
Key words: *Citrus sinensis,* nutrients, proximate parameters, processing.

1. Introduction

Oranges, *Citrus sinensis* has three genera and about eighteen defined species (Etebu *et al*., 2014). It is cultivated on a very large scale in Nigeria and other tropical and subtropical countries of the world (Etebu *et al*., 2014). Global production figures, according to FAO Statistics (2006), stands at about 108 million tons. *Citrus sinensis* are considered one of the most important fruit crops in the tropical and sub tropical regions of the world. They contribute to the diets of several persons globally and are highly cherished due to their nutritional value (Ubani and Okonkwo, 2011).

Natural foods especially citrus fruits play a major role in human nutrition as they are excellent sources of antioxidants such as ascorbic acid, carotenoids; tocophenol and phenolic compounds (Lawal 2007; Morand *et al*., 2012). It also contains a variety of other nutrients such as proteins, carbohydrate and some minerals. Ascorbic acid (vitamin C) is the most abundant nutrient in orange fruits, it is essential for the synthesis of collagen and a lack of vitamin C leads to scurvy which causes loss of teeth. Vitamin C has a wide range of other beneficial effects on good health (Zvaigzne *et al*., 2009)

By definition, according to the united state code of federal regulations, Orange juice is referred to an unfermented juice obtained from mature oranges of the species *Citrus sinensis*. It has been scientifically established that orange juice by virtue of its richness in vitamin and other antioxidant such as hesperidins, flavonone etc and minerals have many proven health benefits (Morand *et al*., 2012)

In order to ensure proper long term preservation, storage, decreased transportation cost, inhibit microbial growth and off season availability of juice, orange fruits are been subjected to processing usually on industrial scale. The processing technique adopted by industries such as freezing, pasteurization and concentration have been proven to have effect on the nutritional composition of the juice product obtained as most of the natural nutrient are either lost or degraded during processing (Goyle and Ojha, 1998), the taste, aroma and colour of the juice are also lost (Zvaigzne *et al*., 2009). Although effective majors to replenish these lost nutrient by fortification of juice with extras vitamins or supplement nutrients such as vitamin C and less commonly vitamins A, E and Beta-carotene are been employed. There are concerns about the stability of these added vitamins and nutrients (Nelson and Tressler 1980).

On the other hand freshly squeezed orange juice is next to consuming orange itself and there is no need for fortification because no loss in nutrient occurs unlike the processed.

The persistent problem of post harvest losses of the fruits at farm, home, and in the market has remain a problem to all stakeholders (Ubani and Okonkwo, 2011). Thus, the need to process the fruits into less perishable forms cannot be over emphasized. Therefore, the aim of this study was to compare the nutrient content of freshly squeezed orange juice and that of processed orange juices.

2. Materials and Methods

2.1 Sample Collection

Four samples were used for analysis in this experiment, two brands of processed orange juice: fumman orange juice and chi-exotic orange juice were obtained from north bank market, Makurdi metropolis. Two varieties of fresh orange, valencia and Ibadan sweet orange used in making freshly squeezed juice were obtained fresh from orange tree within makurdi metropolis. Valencia orange has a thick and rough peel and a high amount of seeds while the Ibadan sweet orange has a thin and smooth peel with few amount seeds.

2.2 Juice preparation

Fresh oranges were carefully peeled and juice was obtained using a juicer (model no; NJ-465, Naka Japan) and then filtered to remove pulps and seeds. According to the manufacturer's label , fumman orange juice was made from orange concentrate while chi-exotic juice was made from orange concentrate and orange pulp.

The analysis was carried out in duplicates and the following parameters were considered: moisture content, protein, ash content, fibre, vitamin C, and some minerals including potassium, calcium, sodium and iron.

2.3 Proximate Analysis

Moisture content, ash content, crude fibre, crude protein and fat content were all determined using the methods as described by AOAC (2010).

Carbohydrates

Total carbohydrate was calculated by difference using the formula;

$$\%C = 100 - (\%P + \%F + \%A + \%W + \%Fi)$$

Where; %C = percentage carbohydrates
%P = percentage of protein
%F = percentage of fat
%A = percentage of Ash
%W = percentage water
%Fi = Percentage of fibre

Vitamin C was determined using methods as described by AOAC (2010).

2.4 Mineral Analysis

One gram of the respective ash sample was weighed using an electronic analytical balance into a digestion tube and 20 ml of acid mixture (650 ml conc. Nitric acid, HNO_3) 80 ml perchloric acid (PCA) and 20 ml conc. Sulphuric acid (H_2SO_4) was added. The flasks were then heated under khjeldal digestion unit until a clear digest was obtained.

The digest was diluted with distilled water to 100 ml. Standard solution were prepared for each of the parameter; calcium, sodium, iron and potassium following standard protocols.

Wavelengths of maximum absorbance were determined for each standard using UNICO UV 2100 spectrophotometer. Absorbances of the various standards were obtained and the maximum absorbance was selected with its corresponding wavelength. The selected wavelengths were used to measure the absorbance of the concentration of the samples.

Calculations: $\text{Conc. of sample} = \frac{\text{Ab. of sample}}{\text{Ab. of std}} \times \text{conc. of std.}$

Ab sample = absorbance of sample
Ab std = absorbance of standard
Conc. of Std. = concentration of standard (IITA, 2000).

3.0 Results and Discussion

Figures 1 – 6 show the proximate composition of the different samples investigated.

Samples contained quite a high amount of carbohydrates. Valencia had the highest carbohydrate content (13.555%), while Ibadan sweet, fumman and chi-exotic had 13.085%, 11.425% and 10.619% respectively. These values are higher than the 9.35% reported by USDA nutrient database (2014). For the freshly prepared orange juices samples, this could be due to the differences in varieties. These are thought to have developed distinct sugar synthetic biochemical capabilities. The synthetic ones employ the use of concentrates, whose mixture proportion is determined by the respective company's formula. This is thought to constitute a major cause of the differences. Considering the physiological role of carbohydrates in the body, and sucrose, the main sugar in oranges fruits, it is good to note the significant contribution oranges make to the caloric content of a diet, especially when consumed in the fresh state.

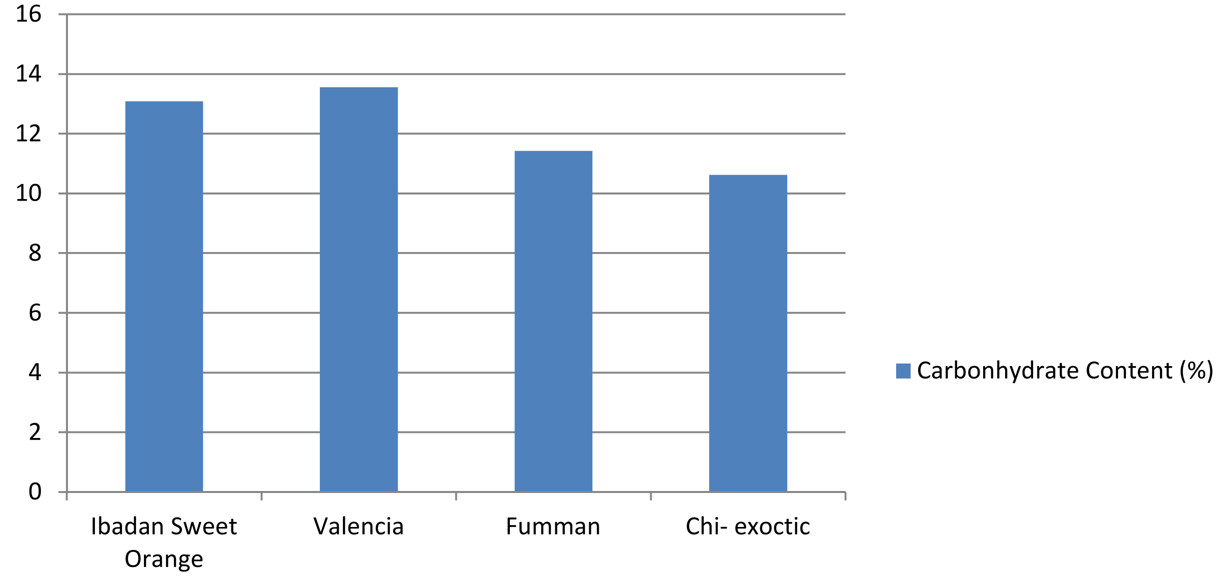

Fig. 1: % Carbonhydrate Content in four orange juices

The crude protein of both freshly squeezed orange juice and processed varied, especially between the fresh juices and the processed ones. Valencia orange juice had the highest amount of crude protein (385 mg/100g) while Ibadan sweet orange had a value of 350 mg/100g. fumman and chi-exotic orange juice had crude protein of 328 mg/100g and 241 mg/100g respectively (fig. 2). These values are far less than the 940 mg reported by USDA Nutrient Database (2014). Nzeagwu and Onimawo (2010) reported 1.007%/100ml of crude protein from freshly prepared juice of *Eugenia uniflora*L (Pitanga cherry) juice. This shows that orange juice is rich in crude protein. These results observed for the freshly squeezed juices were quite higher than those obtained Peter *et al, (*2009). The crude protein value for fumman corresponded with that reported on the package.

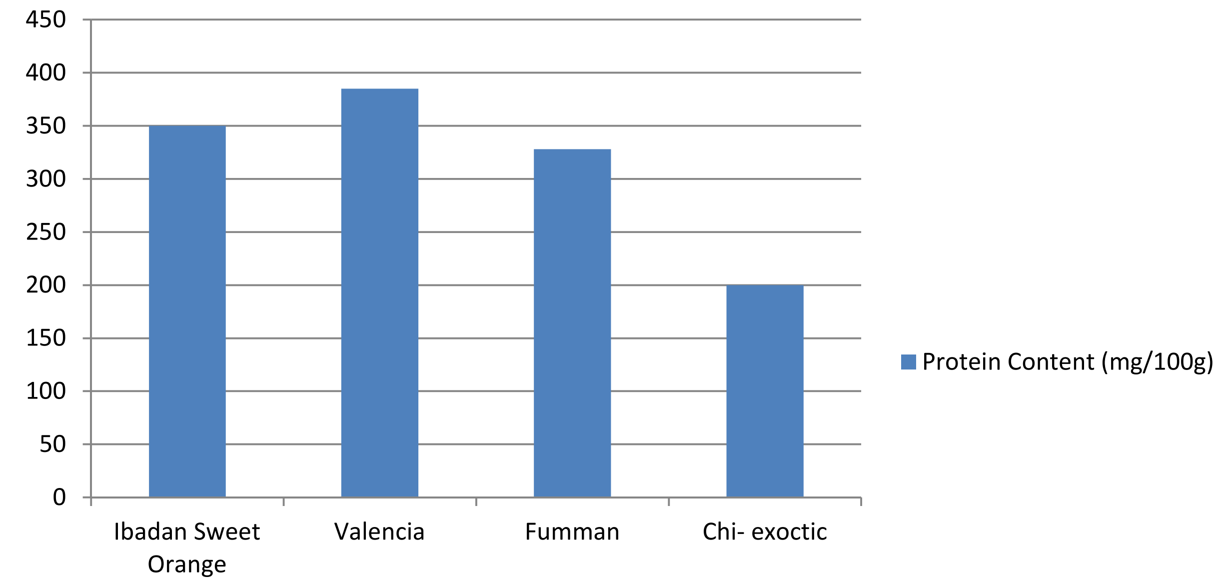

Fig.2: Protein Content (mg/100g) of four orange juices

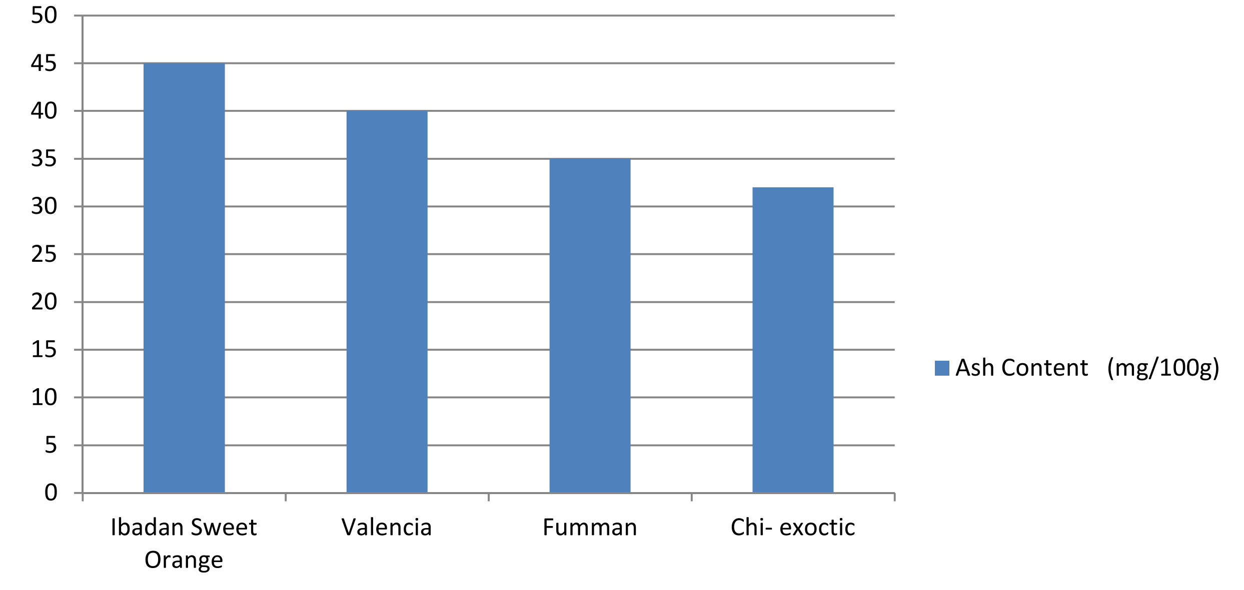

Fig. 3: Ash Content (mg/100 g) in four orange juices

The ash content ranged from 32 mg/100g in the processed chi-exotic brand to 45 mg/100g in the freshly squeezed Ibadan sweet orange juice, with a mean value of 38 mg/100g. Although the freshly squeezed juice had higher value of ash than the processed ones, there was no significant difference ($p<0.05$) between them. The ash content of freshly squeezed juices were lower than those reported by Onibon *et al.* (2007) but were in agreement with those reported by Peter *et al.* (2004).

The result of the fibre content (fig. 4) shows that both varieties of freshly squeezed juice contained the same amount of fibre (20 mg/100g). Fumman and chi-exotic orange juice contained 12 mg/100g and 8 mg/100g respectively. USDA Nutrient Database (2014) reported no dietary fibre component of 2.4 g/100g. This large difference could be attributed to differences in varieties, among other factors. Nzeagwu and Onimawo (2010) reported 0.553%/100ml of fibre in *Eugenia uniforaL.*

The experimental procedure showed a result wherein fats were not detected. This however, contradicts the report of USDA Nutrient Database (2014) which reported as much as 120 mg/100ml of fat. This also agrees with the nutritional information label placed on Fumman package.

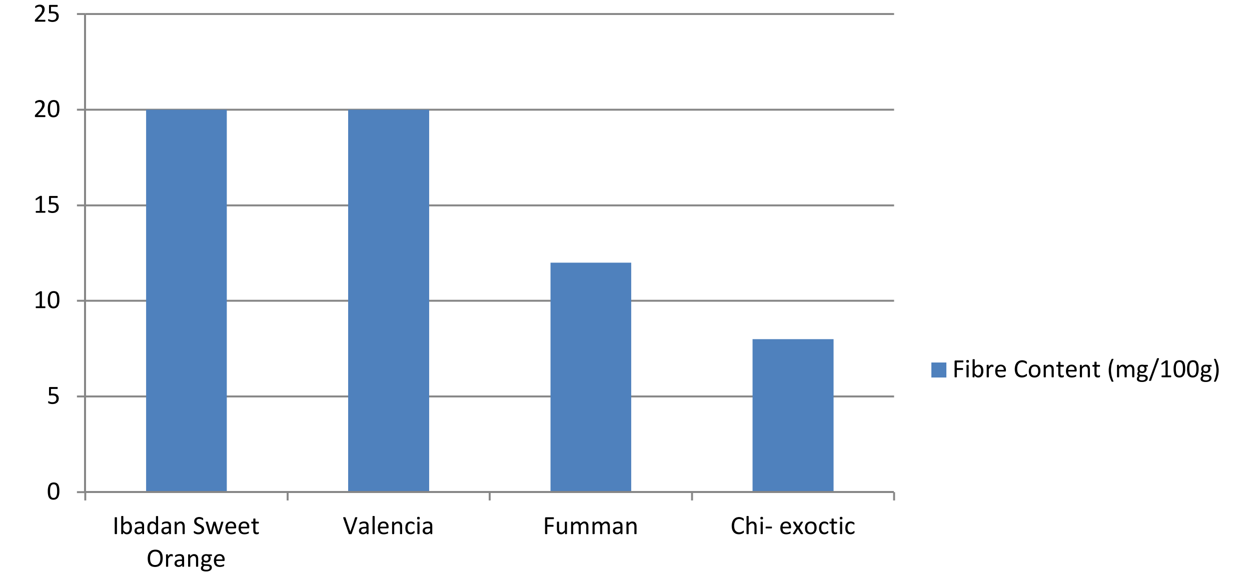

Fig.4: Fibre Content (mg/100 g) in four samples of orange juices

Ibadan sweet orange had the highest vitamin C (ascorbic acid) content of 10 mg/100g while Valencia orange juice had of 8.0 mg/100g, fumman orange juice contained 2.30mg/100g and chi-exotic orange juice contained 2.56 mg/100g (fig.5). This agrees with the result obtained by Zvaigzne *et al.* (2009). However, it is far lower than the 53.2 mg/100g reported by USDA Nutrient Database (2014). From this result, freshly squeezed juice contains more vitamin C than processed juice. Ascorbic acid is highly oxidizable in the presence of atmospheric oxygen. Thus, this could have affected the total content of the vitamin in the juices. Moreover, in the processed samples, this relatively low vitamin content could be due to the high rate of dilution during reconstitution or loss as a result of heat.

This shows that freshly squeezed orange juice can contribute substantially to the 45 mg WHO/FAO (2004) daily recommended dietary allowance of vitamin C. From the result of this study, processed oranges are useful as food supplements to prevent vitamin C deficiency.

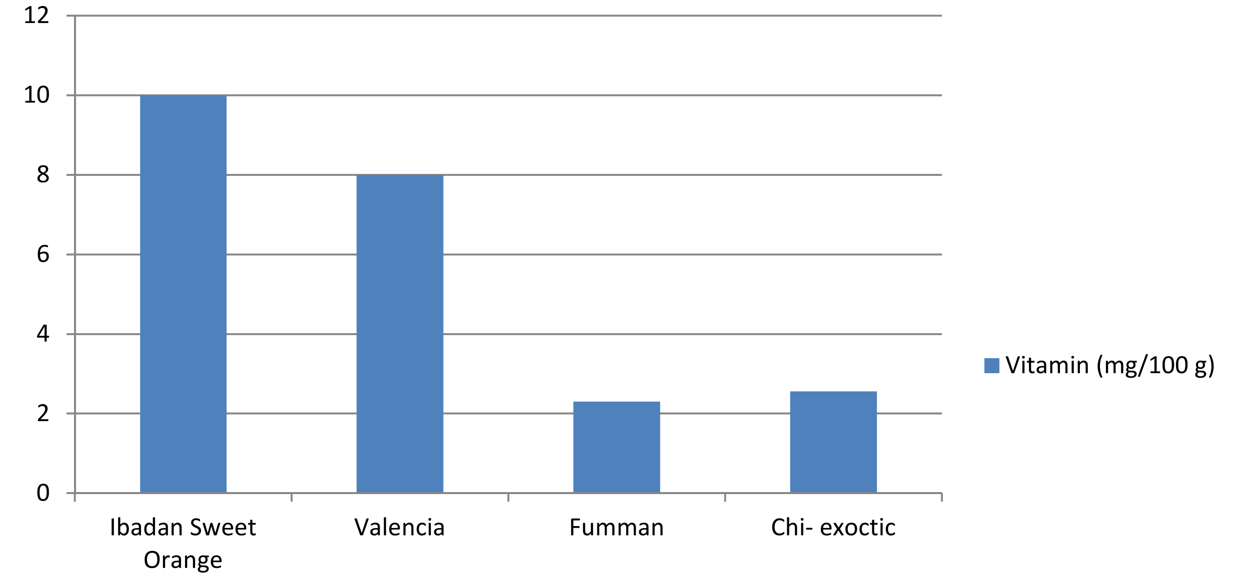

Fig. 5: Vitamin C content (mg/100g) in four samples of orange juices

The moisture content varied from 86.00% in valencia orange variety to 89.10% in chi-exotic orange juice with a mean value of 87.45% (fig. 6). Among the processed orange juices, chi-exotic had the highest moisture content of 89.10% while fumman had a moisture content of 88.20%. Among the freshly squeezed orange juice, Ibadan sweet orange variety had a moisture content of 86.00%. The moisture content of freshly squeezed orange varieties were quite lower than those reported by Onibon *et al.* (2012) (Within the 1^{st} to 7^{th} day of storage). However, they were in agreement with the 86.75% reported by USDA Nutrient Database (2014). Moisture content of fumman orange juice is within the range of values disclosed on the package.

Considering the high moisture content, it is believed that oranges or orange juices can be a good source of water in the body especially during seasons of decreased appetites when water intake is no longer appealing.

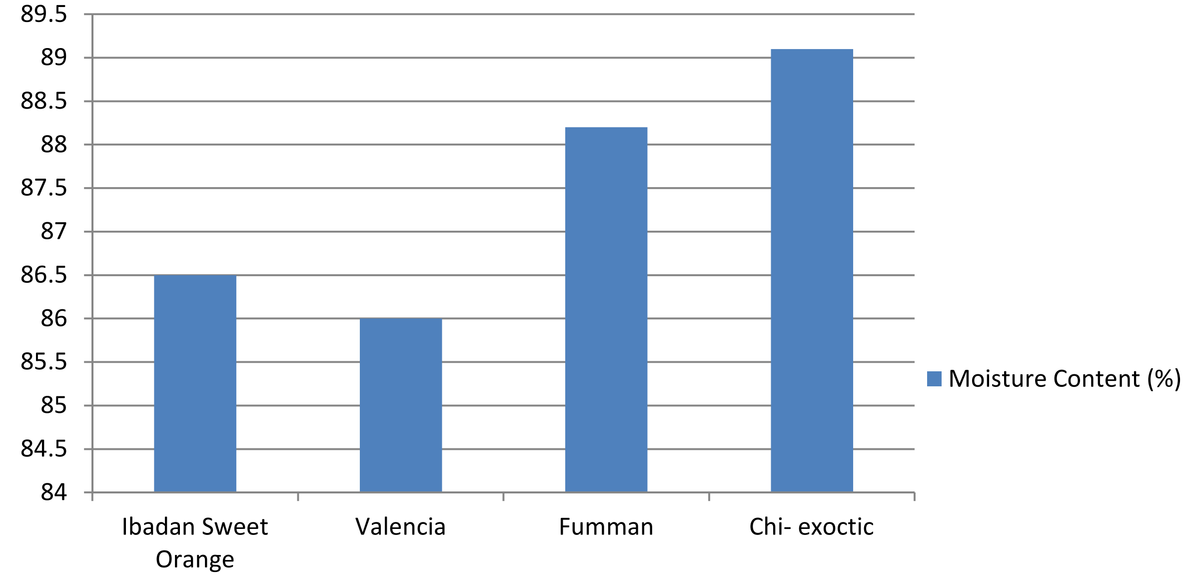

Fig. 6: Moisture Content (%) in four orange juices

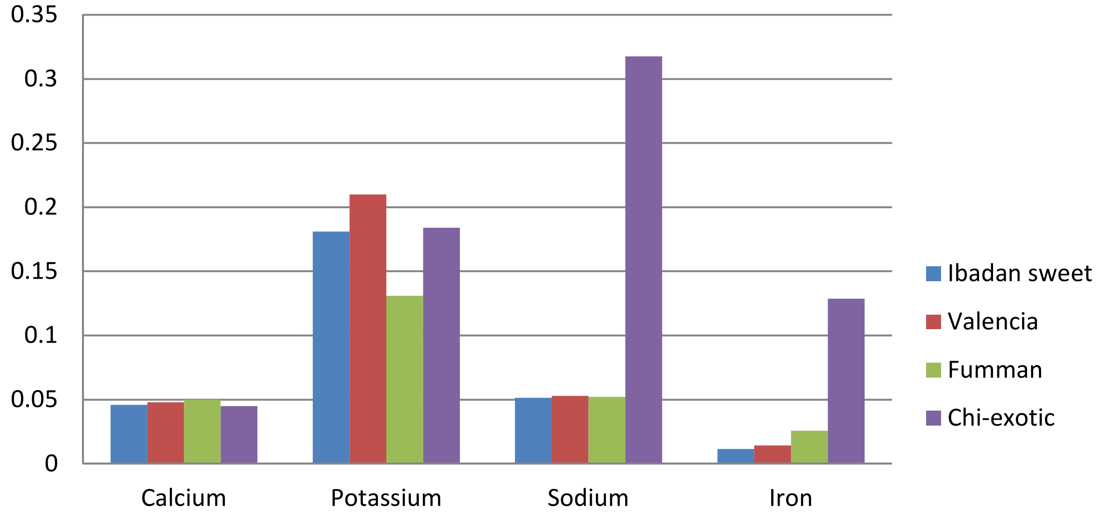

Fig. 7: Mineral composition (ppm) of different oranges juices

The result of the mineral concentration of the samples is shown in fig.7 above. It reveals that fumman oranges juice has the highest amount of calcium (0.050 ppm) followed by Valencia (0.048 ppm), Ibadan sweet orange juice (0.046 ppm) and chi-exotic oranges (0.045 ppm). Chi-exotic had the highest amount of sodium (0.3176 ppm), Valencia (0.053 ppm), fumman (0.0523 ppm) and Ibadan sweet (0.0515 ppm). Potassium was found to be higher in Valencia (0.210 ppm) than in chi- exotic (0.184 ppm), Ibadan sweet orange (0.181 ppm) and Fumman (0.131 ppm). USDA Nutrient Database (2014) reported the values for calcium, iron and potassium to be 40 mg, 0.1 mg and 181 mg respectively.

Iron was found to be highest in Chi-exotic (0.1287 ppm), while Fumman, Valencia and Ibadan sweet had 0.0257 ppm, 0.0142 ppm and 0.0115 ppm respectively in descending order of magnitude. Prolong consumption of some of these minerals such as iron and sodium could lead to toxicity in man.

The adequate intakes (AI) of these minerals are 1500 mg/day, 1000 mg/day and 4700 mg/day in both men and women for sodium, calcium and potassium respectively. Iron has a RDA value of 8 mg/day and 18 mg/day for average men and women respectively. Thus, in reference to the AI and RDA, orange is not a good source of these minerals and so cannot be relied upon to provide them. However, these can be easily sourced from other diets in enough quantities.

4.0 Conclusion and Recommendations

This study hereby corrects the erroneous impression that orange juice is taken to aid digestion and should be preferentially taken after a meal. The report shows rich sources of nutrients found, especially in freshly squeezed orange juices actually qualifies it to be taken as a source of food.

Furthermore, the study showed that there was no significant difference between the nutritional compositions of freshly squeezed orange juice and the processed orange juices except in vitamin C content. Freshly squeezed orange juice contains more vitamin C the processed ones.

It's recommended that freshly squeezed juice should be included in the daily diet of both adults and children, due to its nutritional benefits so outlined above. Manufacturers of processed juices should be encouraged to state the nutritional content of their products on the package so that individuals can be aware of the amount of nutrients obtainable from the products they buy.

Further studies should be carried out on the effects of additives in processed orange juice and the anti-nutrients present in these additives since measures have been taken to reduce to loss of nutrients during processing.

5.0 References

Association of Official Analytical Chemists, (AOAC) (1990). Official methods of analysis, Association of Official Analytical Chemists, Washington D.C (15th ed.)

Association of Official Analytical Chemists, (AOAC) (2010). Official method of analysis, Association of Official Analytical Chemists, Washington D.C (18th ed.)

Etebu, E. and Nwauzoma, A.B. (2014). A review on sweet orange (Citrus sinensis L osbeck): Health, Diseases and Management. *Afr. J. Res. Comm.* 2(2):33-70.

Food and Agriculture Organization of the United Nations (2006). (FAO Statistics)

Goyle, A. and Ojha, P. (1998). Effect of storage on vitamin C, microbial load and sensory attributes of orange juice. *J. Food Sc. Tech.* (35): 346-348.

International Institute of Tropical Agriculture, IITA, (2000). Methods of mineral analysis.www.iita.org.

Lawal, M.A. (2007). Efficiency of sweet orange production among small scale farmers in osun state , Nigeria. *Afr. J. Gen. Agric.* 3(2). 127-132.

Morand, C., Claude, D., Dragan, M., Delphine, L., Jean F.M. and Augustin, S (2011): Herperidins contributes to the vascular protective effect of orange juice, a randomized crossover study in healthy volunteers. *Am. J. Cli. Nut.* (93): 73-80.

Nelson, P. E. and Tressler, D. K. (1980). Fruit and juice vegetable processing technology 3rd ed. Avi publishing Co.

Nzeagwu, O.C., and Onimawo, I.A. (2010). Nutrient composition and sensory properties of juice made from pitanga cherry (*Euglena uniflora* L.) fruits. *Afr. J. Food Agric. Nut. Dev.* 10(4):2379-2393

Onibon, V.O., Abulade, F.O. and Lawal, L. O. (2007). Nutritional and anti-nutritional composition of some Nigerian fruits. *J. Food Tech.* 5(2):120-122.

Pasha, A.R., Butt, M.S., and Mohyuddin, M.M. (1994). Quality evaluation of some commercially manufactured fruit beverages. *Pak. J. Agric. Sc.* 3(3): 19-24

Peter, A.I., John, J.M., and Mohammed, A. (2010). Effect of storage period on some nutritional properties of oranges and tomato *Au. J. Tech.* 13(3):181-185.

Pilar, R., Perez, C., and Russell, R. (2008). Processing and storage effects on orange juice aroma. *J. Agric. Food Chem.* 56(21): 9785-9796.

Ubani, O.N., and Okonkwo, E.U. (2011). A review of shelf life extension studies of Nigerian indigenous fresh fruits and vegetables in the Nigerian stored products research institute. *Afri. J. Plant Sci.* 5(10):537 - 546

USDA Nutrient Database (2014). United States Department of Agriculture, National Nutrient Database for Standard Reference Release 26, Fruits and Fruit Juices

WHO/FAO (2004). World Health Organisation and Food and Agricultural Organization of the United Nations. Vitamins and mineral requirements in human nutrition. Pp 130-139.

Zakpaa, H.D., Mak-Mensah, E.E., and Adubofour, J. (2010). Production and characterization of flour produced from ripe "apam" plantain (Musa sapientum L. var. paradisiacal; French horn) grown in Ghana. *J. Agric. Biotech. Sust. Dev.* 2(6):92-99

Zvaigzne, G. Karklina, D. Seglina and Krasnova, I (2009): Antioxidants in various citrus juices. *Chem. Techn.*. 3(52):56-62.