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Quantitative Determination of Some Amino acids and Nutritional Components of Selected Tropical Fruits

Madu, A. N., Bello, S. E.
Industrial Chemistry Department, Crawford University Faith City Igbesa Ogun State Nigeria

ABSTRACT

A quantitative estimation of some amino acids and nutritional values of five selected commonly consumed tropical fruits (watermelon, carrot, mango, tomato and red bell pepper) from the local market of Igbesa, Ogun State have been carried out and results show that for the quantitative composition of protein, mango has the highest protein content of 1.96 g, followed by red bell pepper with 0.90 g, carrot and watermelon having 0.72 g and 0.56 g respectively, tomato has the lowest protein concentration value of 0.52 g. Results obtained for vitamin C shows that, red bell pepper has the highest carbohydrate content of 31.50 mg, followed by mango with 27.00 mg while tomato and water melon had values of 12.80 mg and 8.50 mg respectively, carrot was the least with a concentration of 6.10 mg. Results obtained for carbohydrate ranged from 7.53 g to 17.00 g, with tomato having the highest value of 17.00 g, followed by watermelon with a value of 13.46 g, red bell pepper and mango with concentration values of 11.92 g and 8.59 g respectively, the least being carrot, 7.53 g. Results for citrulline ranged from 1452.00 mg to 121.00 mg, with watermelon having the highest value of 1452.00 mg, followed by tomato with a concentration of 386.00 mg, red bell pepper, tomato 237.00 mg and 158.00 mg respectively, with carrot as least having a citrulline concentration of 121.00 mg. Results for Lycopene ranged from 4324.00 µg to 1.00 µg, tomato has the highest lycopene value of 4324.00 µg, watermelon has a lycopene value of 4245.00 µg, followed by red bell pepper having a value of 23.00 µg, carrot with a value of 3.00 µg and mango having a negligible value of 1.00 µg. Results for arginine shows that, water melon has the highest value of 54.50 mg, followed by carrot 47.10 mg, red bell pepper 40.60 mg and tomato 16.80 mg, mango has the least arginine concentration of 12.30 mg. Results for lysine shows that, watermelon had a value of 63.80 mg, carrot 43.20 mg, red bell pepper 36.30 mg, mango 27.50 mg and the least being tomato 20.40 mg.

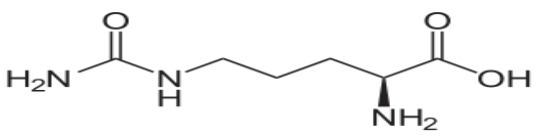
Keywords : Citrulline, Lycine, Lycopene, Arginine, Ascorbic Acid.

I. INTRODUCTION

The tropics is an area of the earth centralized on the equator and bound by the Tropic of Cancer in the North and by the Tropic of Capricorn in the south that is from 23.4 º North Latitude to 23.4º South latitude this include countries such as Mexico, Brazil, Ecuador, Bahamas, Jamaica, France, Zambia, Kenya, Malawi, Nigeria, Mali, Niger, Ghana, Thailand, Malaysia, Togo, Indonesia, etc. Tropical fruits originate from plants located in the tropics and they don't tolerate frost (Michael, 2008). Examples of such fruits include watermelon, pawpaw, mango, tomato, pineapple, apple, guava, cherry, banana, orange, mulberry, cherry, bayberry, sweet pepper, etc. Other fruits grow in more tepid climates. Although, this distinction may vary as some tropical fruits are also grown in warmer areas outside the tropics (Arnold and David, 2006). Many temperate fruits can also be cultivated in the tropics, especially in cooler

mountains or hill areas. Tropical fruits are important sources of carbohydrate, vitamins, minerals and fibers; and consisting of powerful flavonoids, minerals, antioxidants, vitamins, phytochemicals and other micro- and macro- nutrients. Tropical fruits possess variable health benefits and this guarantees an optimum health on the long run. (Schmidt and Leitzmann, 2014). The health benefits of watermelon include prevention of kidney disorders, heat stroke, premature ageing, high blood pressure, strokes, blood clots, atherosclerosis, heart disease, cancer, diabetes impotence and macular degeneration. Watermelons can be a good supplement for diabetics, despite its sweet taste, since ninety-nine percent of its total weight is composed of water and roughage (Helen, 2017). Also, arginine, vitamins and minerals such as potassium and magnesium help in the high performance of insulin in the body, thus reducing blood sugar level. Watermelon contains roughage, vitamin C, Lypocene, Beta-carotene and potassium which helps to reduce bad cholesterol and keep the heart safe. Watermelon contains beta-carotene, vitamin C, lutein, and zeaxanthin which ensure the optimum health of the eyes. Bell red pepper health benefits include improved eye health, reduced risk of anemia, ageing, cancer, heart disease and some chronic diseases when eaten regularly. Bell pepper having low calories is high in carotenoids especially beta-carotene, which lavish the body with antioxidant and anti-inflammatory benefits, research has shown that carotene reduces 'bad' cholesterol, controls diabetes, relieves from pain and reduces inflammation (Chassy, et.al, 2006). Red bell pepper contains capsaicin, a health benefiting alkaloid compound in small levels. Early research carried out on mammals suggested capsaicin as an anti-bacterial, analgesic, anti-carcinogenic, and anti-diabetic properties, this research also showed that capsaicin has the ability to reduce triglycerides and LDL cholesterol levels in obese individuals. Red bell pepper contain plenty of vitamin C and E, which boosts up the body's immune system and maintains the youthful look of the skin and hair looking; vitamin B6, which boosts the nervous system and helps renew cells (Starkenmann and Niclass, 2011). The enzymes contained in red bell peppers like lutein which prevents the growth of cataracts and macular degeneration of the eyes in the future; in fact, it protects the human retina from oxidative damage, (Shubhra, 2013). Tomatoes have a large amount of fiber, which can regulate bowel movements, reduce effect of constipation and diarrhea, stimulate peristaltic motion in the digestive muscles and give out gastric and digestive juices, thereby improving overall digestive health and preventing diseases such as colorectal cancer. Daily consumption of tomatoes reduces the occurrence of high blood pressure and reduces the tension in blood vessels and arteries, owing to a considerable level of potassium in tomatoes. Mango has the ability to improve brain function; it maintains neuronal integrity and protects cognitive function. Mango has the ability to reduce the amount of free radicals generated in the body. In the same way, mango can protect the integrity of red and white blood cells, enhancing oxygen delivery, immunity, and overall health (Pardo-Andreu, et.al, 2005). Mango can even protect against radiation damage, also the tartaric acid, malic acid, and a trace of citric acid found in the fruit help to maintain the alkali reserve of the body. Carrots can also protect against cataracts and macular-degeneration, a common cause of age-related vision loss. Carrot is one of the highest natural sources of carotenoid phytochemicals and antioxidant beta carotene, both of which fight cancer by stopping DNA damage, levels of inflammation and cell mutation. Carrot helps to prevent against Alzheimer's disease, improving memory and defending against other types of cognitive decline. Tropical fruits can be used as natural fibers for mattresses, insulation or floor tiles e.g. Coconut (Austin, 2004). Tropical fruits can be used in floral arrangements or decoration purposes e.g. Milkweed, lotus, unicorn plant, and annual honesty fruits. Some tropical fruits provide wax that can be made into candles e.g. bayberries. Some fruits are useful in repelling insects (Gerwulf, 2004) e.g. Osage-orange which is used to repel cockroaches. The

organic compound citrulline is an α-amino acid whose name derives from citrullus, the Latin word for watermelon, from which it was first isolated in 1914 by Koga and Odake, (Fragkos et al., 2011). It was finally identified by Wada in 1930 having the formula $H_2NC(O)NH(CH_2)_3CH(NH_2)CO_2H$ and remains a key intermediate in the urea cycle; the pathway by which mammals excrete ammonia by converting it into urea. Citrulline is a non-essential amino acid, (Kaore, et al., 2013) and can be found in fruits and is available as a dietary supplement. High intake of citrulline will have positive impact on health and exercise performance (Figueroa, et al., 2017). Citrulline can also help widen blood vessels and play a role in muscle building (Breuillard, et al., 2015). Citrulline produces several important effects in the body. One major way it works is by increasing vasodilation. Vasodilation refers to the widening of arteries or veins. It's associated with lower blood pressure and increased blood flow (Chopra, et al., 2011). After citrulline is consumed, some is converted to another amino acid called arginine. Arginine is converted into a molecule called nitric oxide, which causes vasodilation of blood vessels by relaxing the smooth muscle cells that constrict them. Interestingly, consuming citrulline may increase arginine in the body more than consuming arginine itself, (Figueroa, et.al. 2017). This is because of differences in how the body processes and absorbs arginine and citrulline. Although citrulline isn't an amino acid used directly to build proteins, it has been shown to increase protein synthesis by stimulating an important signaling pathway involved in muscle building. Citrulline can be found in various fruits such as water melon, mango, tomato, etc. Citrulline may also improve erections in men with erectile dysfunction, probably through its ability to increase blood flow (Cormio, et al., 2017).



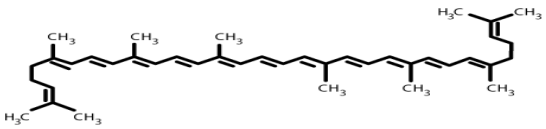


Figure 1. Structure of a Citrulline and Lycopene molecule

Both arginine and citrulline play vital roles in the body's production and metabolism of nitric oxide, which helps in keeping the blood vessels healthy by regulating blood flow and platelets function. Supplementation with arginine and citrulline may help improve heart health by offering protection against the buildup of plaque along artery walls, according to a study published in 2014 in Biochemical and Biophysical Research Communications. It may also help those new to working out stick with it by improving tolerance to exercise. Arginine boosts nitric oxide which relaxes blood vessels and then helps treat “angina pectoris” and other cardiovascular disorders. It also play a major role in the blood circulation problems associated with sickle cell anaemia and has been credited with boosting muscular growth, stimulating the immune system, improving wound healing, curing impotence and more. The best known representative of this category is beta-carotene (vitamin A) which can be found in fruits that are yellow or orange in color (e.g., papayas, carrots), (Brady, et al., 2005). Carotenoids have also been shown to enhance immune system function, (Bendich, 1989) provide protection from sunburn, (Mathews-Roth, 1990) and inhibit the development of certain types of cancers (Nishino, 1998). Carrots are the main source of alpha-carotene (needed to balance beta carotene), tomatoes are the main source of lycopene, and oranges are the main source of cryptoxanthin. Unless a wide variety of carotenoid-containing foods are always eaten, getting adequate amounts of the full range of carotenoid compounds is unlikely. The human body needs significant amounts of alpha-carotene, beta-carotene, lutein, lycopene, cryptoxanthin, and zeaxanthin to stay healthy, but a poor diet can dramatically lower the amounts of these

vital compounds in the body. Lycopene is a natural antioxidant that works effectively to slow the growth of cancerous cells, cooked tomatoes produce even more lycopene. This is the carotenoid that gives tomatoes their red color, is particularly effective at quenching the destructive free radical singlet oxygen (Mascio,et al., 1989). Lycopene is abundant in guavas, watermelon, tomatoes, papaya, sweet red peppers as well as pink and red grapefruit. Lycopene is a powerful antioxidant which is widely recognized as protective against prostate cancer as well as a significant agent in the enhancement of male fertility. Watermelon seeds are good sources of trace metals like zinc, copper, iron, manganese, calcium and even sodium. Interestingly studies show that the iron and zinc in watermelon is surprisingly bioavailable (85-90%) despite the presence of oxalates and phytates contained in the seeds. The water-soluble vitamin group contains vitamin C (ascorbic acid), B_1 (thiamine), B_2 (riboflavin), B_3 (nicotinamide), B_5 (pantothenic acid), B_6 (pyridoxine), B_9 (folic acid), and B_{12} (cyanocobalamin). They have different chemical structures because they represent acid, pyrimidine, and imidazole derivatives as well as acid amides. They are responsible for the proper functioning of the nervous and respiratory systems, synthesis of nucleic and fatty acids, and creation of red blood cells. Lack or deficiency of vitamins in consumed food can lead to deficiency states and diseases (Maton, et al., 1993). Water-soluble vitamins which are (heterogeneous group) soluble in water and so they cannot be stored in the body. 11 types of vitamins are included in this class e.g., thiamine, riboflavin, pyridoxine, cyanoccobalamine, niacin, pantothenic acid, biotin, folic acid and ascorbic acid.

The need to understand the nutritional values of some tropical fruits in terms of their protein carbohydrate, ascorbic acid and some amino acids like L-lysine, arginine and other importance body requirements like Lycopene and Citrulline informed this research. The comparative analysis of these nutrients will guide consumers especially in the local setting where scientific knowledge of nutritional values is lacking. On the other hand, nutritionists and dieticians may be guided by the outcome of the research to place preference on a choice of food combination to another.

II. MATERIALS AND METHOD

The fruit samples (Water melon, Bell red pepper, tomato, mango, carrot) were collected from the local market in Igbesa and the fruits were obtained fresh in the early hours of the morning. Fruit samples (water melon, bell red pepper, tomato, mango, carrot) were washed with lean water and air dried. The fruits samples were cut into smaller sizes and placed in the juice extractor, thawed, filtered twice and centrifuged at 600rpm and the supernatant stored for analysis. The ascorbic acid content was determined using the 2, 4-Dinitrophenylhydrazine (DNPH) Method in which an extract of the substance to be analyzed was prepared with 0.5% oxalic acid. The ascorbic acid is oxidized to dehydro-5-ascorbic acid which is coupled with 2,4-dihydrophenylhydrazine to form osazone. Treatment with osazone so formed with 85% H_2SO_4 and causes a rearrangement to yield a red coloured complex measured spectrophotometrically at 520 nm. Thiourea is added to the diphenyl hydrazine reagent by interfering substances. The carbohydrate content of the various fruit samples prepared for study was determined using the Anthrone Method. In the method, carbohydrates are dehydrated with concentrated H_2SO_4 to form furfural, which condenses with Anthrone reagent to form a blue-green coloured complex which is measured spectrophotometrically at 620 nm or by using red filter paper. The Hartree-Lowry method was used for analysis of protein in which under alkaline conditions, a complex is formed between the divalent copper ion and peptide bonds and then reduced to a monovalent ion while the absorbance was monitored at 650 nm. Lycopene and citrulline were determined spectrophotometrically by extraction with hexane, ethanol and acetone and measured at 503nm. The acetone and hexane were HPLC grade from Fisher. The ethanol used was 200-

proof absolute ethanol obtained from Spectrum Chemicals (Gardena, CA). Hexane, ethanol and acetone were mixed in the ratio 2:1:1 and stored in a stoppered bottle to prevent evaporation. The determination of arginine was based on Sakaguchi reaction. The absorbance was measured at 500 nm with an UV-1700 spectrophotometer (Shimadzu Corporation, Japan). All reagents and solutions were cooled on ice before determination. The samples were prepared as for other analysis, filtered and kept for analysis using HPLC. The chromatographic system was a KNAUER HPLC instrument (Knauer, Berlin, Germany) consisting of a K-1000 Knauer controller Quaternary pump, a Spark Triathlon autosampler and a fluorescence detector (Shimadzu, RF-551) operating with the Chromgate 3.7 software. Separations were achieved using a spherimage 250mm×4 mm, reversed-phase ODS column (Knauer; Berlin, Germany). For OPA/MPA derivatives the eluent system consisted of two components: eluent (A) was methanol–sodium phosphate (pH 6.5, 12.5 mM) (10:90, v/v), while eluent (B) was methanol– tetrahydrofuran (97:3, v/v). The separation (gradient) conditions were as follows: 15–20% B in 5 min, 20–32% B in 12 min, 32–60% B in 10 min, 60%–90% B in 3 min and 90–15% B in 2 min. Detection was by fluorescence (Fl) (Shimadzu; RF – 551) detector. The optimum excitation (λex)/emission (λem) wavelengths were as λex/λem = 330/450 nm.

RESULTS

The quantitative determination of amino acids and nutritional values of the selected tropical exotic fruits found in local market of Igbesa, Ogun State Nigeria has been examined and the results obtained are as stated below:

Table 1. Results of glucose, protein and ascorbic acid concentrations in fruit samples

SAMPLES	Glucose (g/100 g)	Protein (g/100g)	Ascorbic acid (mg/100g)
Carrot	7.53 g	0.72 g	6.13 mg
Mango	8.59 g	1.96 g	27.04 mg
Water Melon	13.46 g	0.56 g	8.52 mg
Tomato	17.00 g	0.52 g	12.83 mg
Red bell pepper	11.92 g	0.90 g	31.51 mg

Table 2. Results of Citrulline, lycopene, arginine and lysine concentrations in fruit samples

SAMPLES	CITRULLINE (mg/kg)	LYCOPENE (μg/kg)	ARGININE (mg/100 g)	LYSINE (mg/100 g)
Carrot	121.0 mg	3.0 mg	47.1 mg	43.2 mg
Mango	158.0 mg	1.0 mg	12.3 mg	27.5 mg
Water Melon	1452.0 mg	4245.0 mg	54.5 mg	63.8 mg
Tomato	386.0 mg	4324.0 mg	16.8 mg	20.4 mg
Red bell pepper	237.0 mg	23.0 mg	40.6 mg	36.3 mg

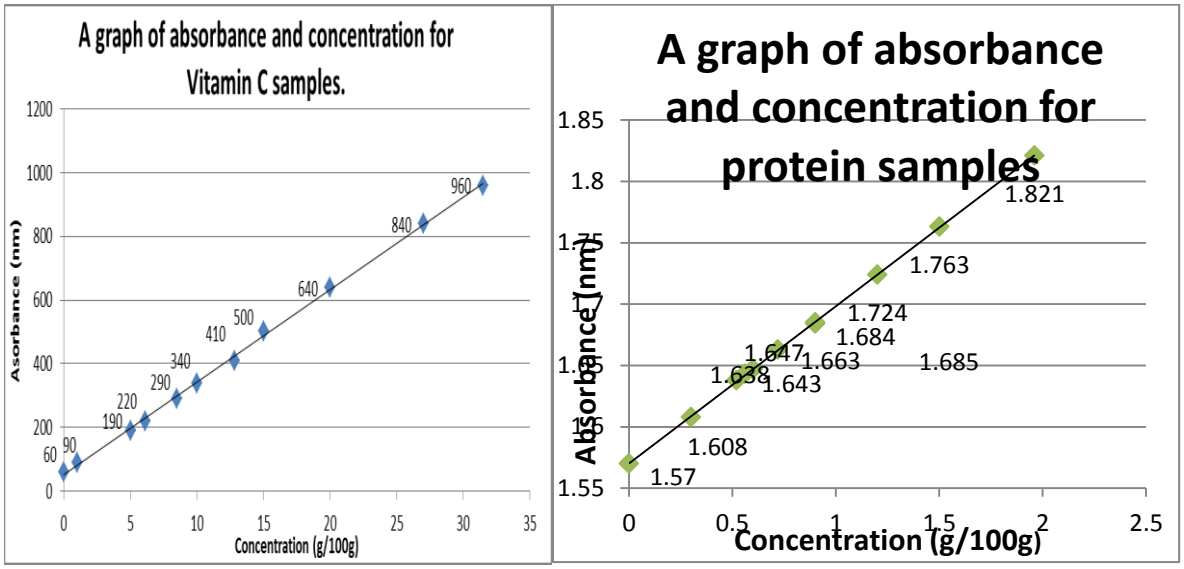


Figure 2. Calibration curves of (a) Vitamin C and (b) Protein.

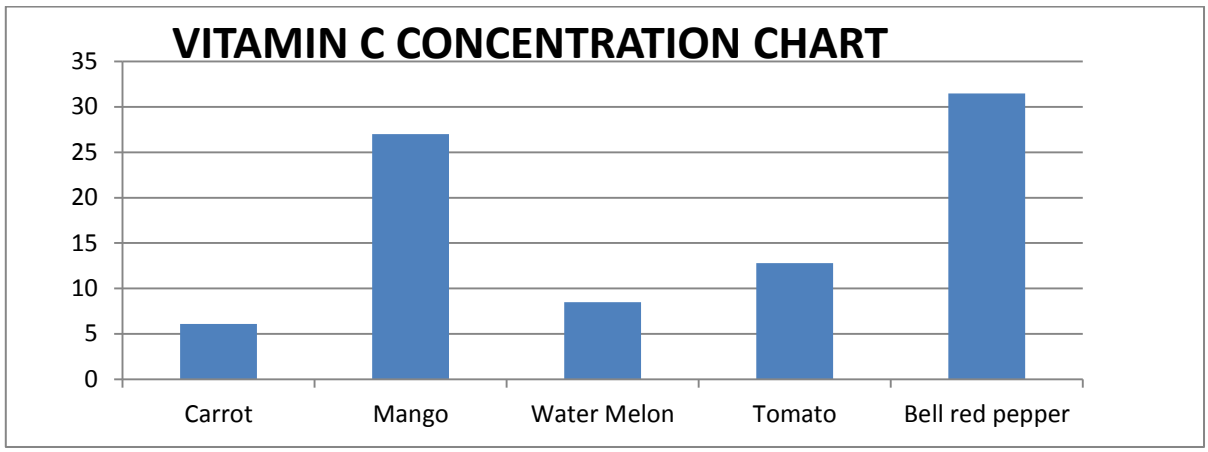


Figure 3. Bar chart showing the Vitamin C concentration of samples

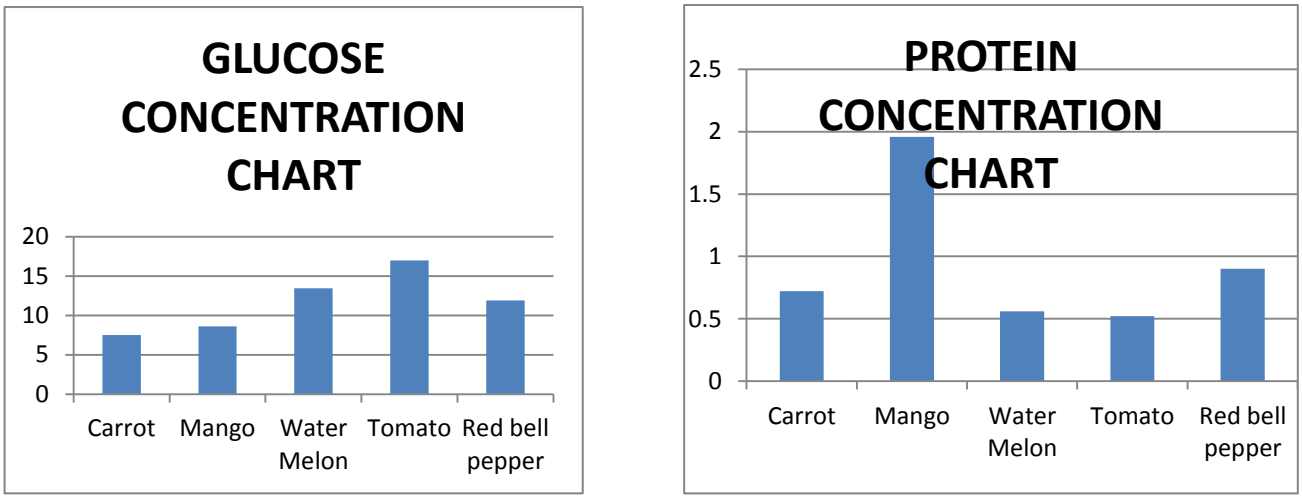


Figure 4. Bar Chart showing the concentrations of (a) Glucose and (b) Protein.

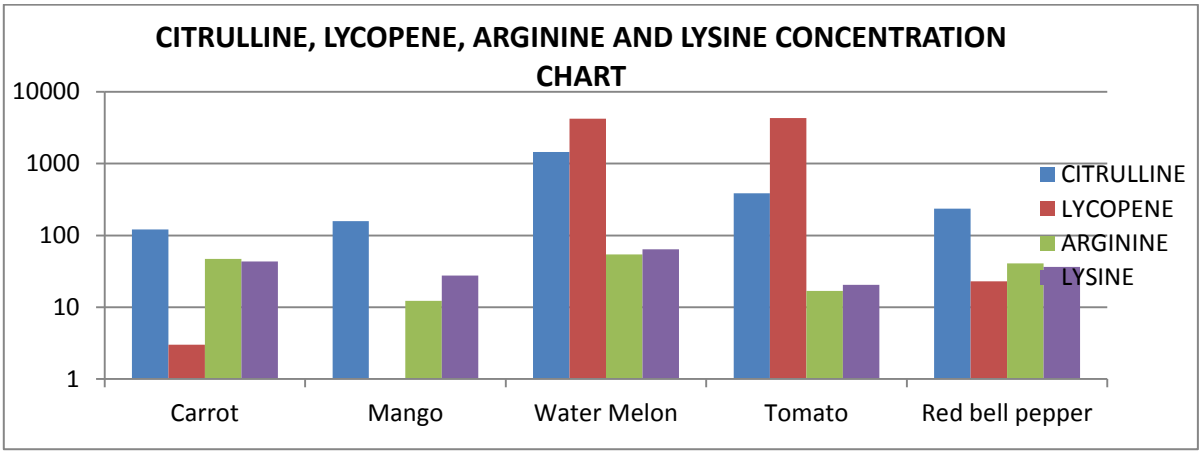


Figure 5. A bar chart showing the Citrulline, Lycopene, Arginine and Lysine concentration.

III. DISCUSSIONS

Results obtained for protein shows that, Mango has the highest protein content of 1.96 g, followed by red bell pepper with 0.90 g, carrot and water melon having 0.72 g and 0.56 g respectively, tomato has the lowest protein concentration value of 0.52 g. Also, results for Vitamin C shows that, red bell pepper has the highest content of 31.5 mg, mango has the second highest value of 27.0 mg followed by tomato and water melon with concentration values of 12.8 mg and 8.5 mg respectively, carrot being the least with a concentration value of 6.1 mg. The carbohydrate (glucose) concentration values had values within the range 7.53 g to 17.00 g, with tomato having the highest value of 17.00 g, closely followed by water melon with a value of 13.46 g, red bell pepper and mango with concentration values of 11.92 g and 8.59 g, the least being carrot, 7.53 g. The citrulline concentration values ranged from 1452 mg to 121 mg, with water melon having the highest citrulline value of 1452 mg, followed by tomato having a concentration value of 386 mg, red bell pepper and tomato 237 mg and 158 mg, with the least being carrot having a citrulline concentration of 121 mg. Results obtained for the quantitative composition of Lycopene for the fruit samples shows that, tomato has the highest lycopene value of 4324 µg, watermelon has a lycopene value of 4245 µg, after which red bell pepper having a value of 23 µg, carrot with a value of 3µg and mango having a negligible value of 1µg.

Results for arginine shows that, water melon has the highest value of 54.5 mg, followed by carrot 47.1 mg, red bell pepper 40.6 mg and tomato 16.8 mg; mango has the least arginine concentration value of 12.3 mg. Accordingly, results obtained for the quantitative composition of Lysine according to Figure 4.6 for the five samples shows that, Water melon 63.8 mg, carrot 43.2 mg, red bell pepper 36.3 mg, mango 27.5 mg and tomato 20.4 mg.

IV. CONCLUSION

This work aimed at quantitatively estimating some of the amino acids and nutritional composition of tomato, bell red pepper, water melon, mango and carrot and to proffer advice to local consumers on the health benefits of each exotic fruit. It was observed that mango appeared to possess nutritional values that are very effective in body building, repairing of tissues and for fighting infection due to its very high protein contents. Red bell pepper are the most advisable fruits to be taken by patients having cough, cold and catarrh owing to their abundance in vitamin C. Tomato and water melon are the most preferred fruits to be taken to prevent stomach or intestinal problems, such as constipation and might also help lower cholesterol and blood sugar due to their high carbohydrate and fiber content. Water melon and tomato can also aid in

male erectile dysfunctions due to the abundance of lycopene and Citrulline. For phytochemical related diseases watermelon, tomato and carrots are the most effective due to their high Citrulline, lycopene, arginine and lysine contents and are believed to lower the risk of heart disease and cancer.

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