ChemSearch Journal 10(2): 100 – 103, December, 2019
Publication of Chemical Society of Nigeria, Kano Chapter

Received: 25/10/2019 Accepted: 02/12/2019
http://www.ajol.info/index.php/csj

Determination and Comparison of Ascorbic Acid Contents in Selected Fruits and Vegetables obtained from Ilorin Metropolis

***Odeyemi, O. T., Amira, E. O. and Hassan, I. R.**
Department of Science Laboratory Technology, Kwara State Polytechnic, Ilorin, Nigeria
***Correspondence Email:** lolaoyeus@yahoo.com

ABSTRACT

The ascorbic acid contents of eight different fruits and four vegetable types were determined by iodometric titration method using standardized sodium thiosulphate against ascorbic acid in the fruit and vegetable extracts. A blank titration was first carried out on the thiosulphate only followed by titration with the extracts. From the blank titre, the total amount of water-soluble iodine produced in the reaction was calculated while the amount of water-soluble iodine that reacted with the sample was obtained from the test titre. The quantity of ascorbic acid in milligrams, present in each fruit and vegetable sample was obtained by calculations. The results showed that the amount of ascorbic acid in the selected fruits was in the order of Orange > Tangerine > Water melon > Pineapple > Grape > Apple > Lemon > Lime and the vegetables, in the order of Pumpkin > Bitter leaf > Water leaf > Amaranth leaf.

Keywords: Ascorbic acid, Fruits, Iodometry, Vegetables, Water-soluble Iodine.

INTRODUCTION

Ascorbic acid or L-Ascorbic acid was first isolated as a pure substance by Albert Azent-Gyorgi and Charles Kingin in 1928 (Oguntibeju, 2008). It is also known as Vitamin C. Vitamins generally are a class of compounds that are essentially required as nutrients by the human body for the normal biochemical and physiological activities (Iqbal, Khan, and Khattak, 2004; Padayatty and Levine, 2001). Contrary to animals, the human body cannot synthesize ascorbic acid because of the absence of the active enzyme, L-gulonolactone oxidase from the liver neither can the body store it because of its quick elimination via stress, fever, viral illnesses, the use of antibiotics and pain relieving drugs and on exposure to heavy metals (Pacier and Martirosyan, 2015). From literature, it was reported that ascorbic acid is used up in two hours and it is absent in the blood within three to four hours of ingestion (Iqbal *et al*., 2004). As a result, the constant ingestion of supplement containing vitamin C is necessary.

Vitamin C is unstable and susceptible to food processing procedures because of its high solubility in water and the ease with which it is oxidised chemically or enzymatically (Oguntibeju, 2008). However, substantial loses do not occur with the usual household method of cooking but are huge in large scale preparation of food. In controlled modern commercial methods of quick heating, dehydration, blanching, bottling and canning, food ascorbic acid is protected with little destruction by inactivating oxidases (Moser, 1991).

Ascorbic acid is very necessary in the metabolism of tyrosine, folic acid and tryptophan; for the growth of tissues and healing of wounds (Yu, Kurata, Kin and Arakawa, 1999); for absorption of iron in the gut; to form collagen in bones, cartilages and muscles (Kadler, Baldock and Boot-Handford, 2007); for reduction of inflammatory and allergic conditions (Walingo, 2005); to prevent the body from harmful effects of free radicals (Weber, Bendich, and Schalch, 1996); and to lower blood cholesterol as well as to regulate the nervous system (Iqbal *et al*., 2004). Its deficiencies however include scurvy (a disease which is accompanied by disintegration of bones, capillaries and teeth), anaemia, sore joints and bones, poor wound healing, dry rough skin and gingivitis – gum disease and bleeding (Said and Mohammed, 2006).

Vitamin C is present in fruits, leafy vegetables including cabbage and spinach, and in animal liver and kidney (Tee, Mohd, Mohd and Kahtijah, 1997). Other sources include meat, fish and eggs but these sources are insignificant as they contain small amounts of ascorbic acid (Iqbal *et al*., 2004; Tee *et al*., 1997). Previous and current researches suggest about 90 – 500 mg per day for optimum health benefit which is the amount necessary to prevent clinical deficiency and scurvy, maintain tissue saturation and plasma vitamin C levels without excessive loss in the urine (Pacier and Martirosyan, 2015). An overdose of ascorbic acid in about 2 g daily causes gastrointestinal distress and diarrhoea (Deruelle and Baron, 2008; Fukushima and Yamazaki, 2010). Therefore, there is the need to know the amount of ascorbic acid present in each fruit and vegetables ingested in order to meet up with the regulated standard for a healthy living.

An accurate method for the analysis of vitamin C in fruit and vegetable samples is iodometry, used in its titration form as iodometric titration which is a volumetric method (Kumar, Kumar, Raghu Patel and Manjappa, 2013). Generally, an iodide ion – a weak reducing agent is generated to reduce strong oxidising agents and the disappearance of elementary iodine indicates the end point. In this research experiment, the titrating agent which, Sodium thiosulphate was the oxidant while ascorbic acid (from the fruit and vegetable samples) in acidic medium was the reductant. The ionic equations for the reactions are:

$$IO_3^- + 6H^+ + 8I^- \rightarrow 3I_3^- + H_2O \quad (1)$$

$$I_3^- + C_6H_8O_6 \rightarrow C_6H_6O_6 + 2H^+ + 3I^- \quad (2)$$

$$I_3^- + 2S_2O_3^{2-} \rightarrow S_4O_6^{2-} + 3I^- \quad (3)$$

Equation 1 shows the generation of water-soluble iodine (I_3^-); equation 2 shows the reaction of part of the I_3^- with the ascorbic acid in the sample extracts while equation 3 shows the back-titration of the remaining I_3^- against $S_2O_3^{2-}$.

MATERIALS AND METHOD

Materials

The chemicals include potassium iodate salt (99.9 % purity) from Kermel Chemical Reagent Co., China, solid potassium iodide (99 % purity) from Loba Chemie Pvt. Ltd., Mumbai, India, soluble starch and sodium thiosulphate solution (99 % purity) from Kermel, which were used unmodified. The fruit samples were orange, pineapple, tangerine, apple, grape, lemon, lime and watermelon while the vegetable samples were pumpkin, amaranth leaf, bitter leaf and water leaf. All the fruit and vegetable samples were obtained from their parent plants in Ilorin metropolis, Kwara State.

Method

The fruits and vegetables were collected fresh from source at different places in Ilorin environs, Kwara State, Nigeria. The fruits were peeled and squeezed, and juices were made by blending where relevant and sieved. A blank titration was carried out using 25 cm^3 of 0.01-M KIO_3, 2 g KI and 10cm^3 of 0.5-M H_2SO_4 mixed and titrated against 0.1-M $Na_2S_2O_3$. Using 2 cm^3 of 1-% starch solution as indicator, the average titre value was recorded. A 100 cm^3 aliquot of each extract was transferred into a clean dry 250 cm^3 Erlenmeyer flask which had been previously weighed and this was then reweighed. With the addition of 25 cm^3 of 0.01-M KIO_3, 2 g KI and 10cm^3 of 0.5-M H_2SO_4 to the sample, the solution was titrated against the thiosulphate solution and the titre values were recorded.

From equation 1, mole ratio of $S_2O_3^{2-}$: I_3^- is 2:1 therefore, the total number of moles of I_3^- generated in the reaction was ½n$S_2O_3^{2-}$, represented as p.

From equation 2, no of moles of I_3^- that reacted with $C_6H_8O_6$ was obtained as p-q. Since mole ratio of I_3^- : $C_6H_8O_6$ is 1: 1 then, no of moles of $C_6H_8O_6$ present in the sample was p - q.
Knowing that;

$$\text{no of moles} = \frac{reacting\ mass}{molar\ mass} \quad (4)$$

Then the reacting mass of $C_6H_8O_6$ = molar mass of $C_6H_8O_6$ X no of moles
= molar mass of $C_6H_8O_6$ X (p - q) moles

From equation 3, no of moles of I_3^- back titrated against $S_2O_3^{2-}$ was calculated with the titre value as in equation 1 and represented as q.

RESULTS AND DISCUSSION

All the fruit and vegetable samples analysed were observed to contain ascorbic acid though in varying quantities. It was observed in Table 1 that orange contained the highest quantity of ascorbic acid while Lime contained the least quantity of all the fruits analyzed. Equally, the amaranth leaf had the least quantity while Pumpkin leaf contained the most quantity of ascorbic acid among all the vegetables analyzed.

From the column of their average titres, it could be inferred that the lower the titre, the greater the quantity of ascorbic acid. This is to say that the quantity of ascorbic acid present in a sample of fruit or vegetable is the inverse proportion of the titre value. This may be attributed to the fact that in the orange sample, after all the ascorbic acid had reacted with the water-soluble iodine, the remaining water-soluble iodine left to react with the Sodium thiosulphate was so little that little volume of the titrant was consumed. However, in the lime sample, after all the ascorbic acid had reacted with the water-soluble iodine, the remaining water-soluble iodine left to react with the Sodium thiosulphate was so much that much volume of the titrant was consumed. This is also applicable to the other fruits and vegetables.

Table 1: Results of the ascorbic acid contents of the selected fruit and vegetable juices in mg / 100 cm^3

Sample	Average Titre (cm^3)	Amount of ascorbic acid present (mg)	% ascorbic Acid
Orange	9.60	90.64	0.09
Tangerine	10.30	84.48	0.08
Watermelon	12.45	65.65	0.07
Pineapple	12.90	61.60	0.06
Grape	13.30	58.08	0.06
Apple	14.70	45.76	0.05
Lemon	15.10	42.24	0.04
Lime	19.50	35.20	0.03
Pumpkin	10.10	84.92	0.08
Water leaf	13.00	59.40	0.06
Bitter leaf	11.35	73.93	0.07
Amaranth leaf	13.10	58.52	0.06

* The average blank titre was found to be 19.90 cm^3 and the weight of 100 cm^3 of each sample was 100 g.

A graphical comparison of the amount of ascorbic acid in each sample is presented in Figure 1. It was observed that in equal volume of extract, the ascorbic acid contents of only three samples viz apple, lemon and lime were below an average of 100 mg. Therefore, since many of the fruits and vegetables contained substantial amount of ascorbic acid that can be essential for optimum growth, they are good sources of vitamin C (Tee, Mohd, Mohd and Kahtijah, 1997). The order of decrease for the fruits is orange > tangerine > watermelon > pineapple > grape > apple > lemon > lime and for the vegetables, pumpkin > bitter leaf > water leaf > amaranth leaf.

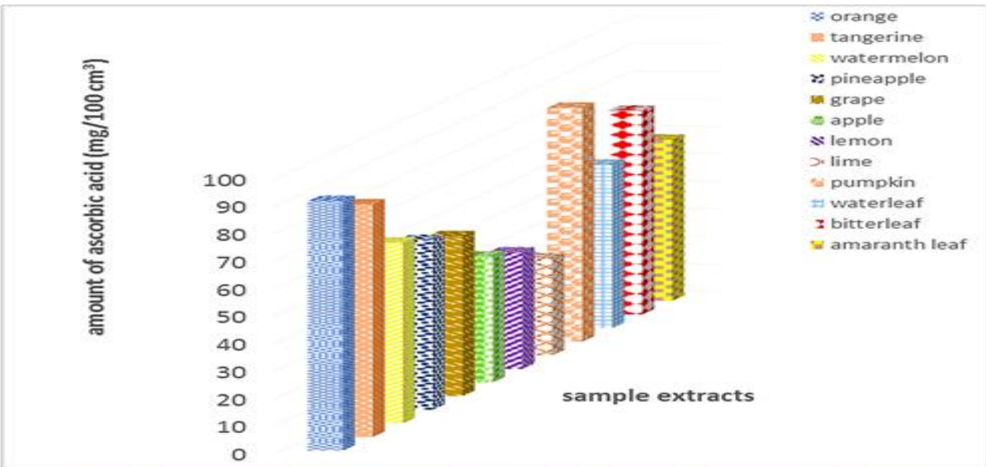

Figure 1: Comparison of the ascorbic acid contents of selected fruits and vegetables

Knowing well according to Fukushima and Yamazaki, 2010 and Pacier and Martirosyan, 2015, that the required daily intake of 90-500 mg is suggested for optimum nutrition, then it can be inferred from the table of results that only the Orange fruit falls within the minimum limit per 100 cm^3 of sample. However, for all the fruits and vegetables, more than 100 cm^3 are required to make up to the minimum daily requirement.

CONCLUSION

The ascorbic acid contents of eight fruits and four vegetable leaves obtained from Ilorin Metropolis were quantitatively analysed by iodometric titration. The amount of the ascorbic acid in the samples were also compared to observe the least and most among them. It does not matter the type of fruit or vegetable an individual enjoys eating, the quantity of ascorbic acid consumed is of much paramount importance. It is therefore necessary that an individual take into consideration the quantity of ascorbic acid needed for optimum nutrition before consumption.

ACKNOWLEDGEMENT

We appreciate the Department of Science Laboratory Technology, Kwara State Polytechnic, Ilorin for the conducive environment and research facilities to successfully carry out this work.

REFERENCES

Deruelle, F., & Baron, B. (2008). Vitamin C: Is supplementation necessary for Optimal Health? *The Journal of Alternative and Complementary Medicine*, *14*(10), 1291–1298.

Fukushima, R., & Yamazaki, E. (2010). Vitamin C requirement in Surgical Patients. *Current Opinion in Clinical Nutrition and Metabolic Care*, *13*(6), 669–676.

Iqbal, K., Khan, A., & Khattak, M. A. K. (2004). Biological Significance of Ascorbic acid (Vitamin C) in Human Health - A Review. *Pakistan Journal of Nutrition*, *3*(1), 5–13.

Kadler, K. E., Baldock, C., & Boot-Handford, R. P. (2007). Collagens at a glance. *Journal of Cell Science*, *120*, 1955–1958.

Kumar, G. V, Kumar, A. K., Raghu Patel, G. R., & Manjappa, S. (2013). Determination of vitamin C in some fruits and vegetables in Davanagere city, (Karanataka) - India. *International Journal of Pharmacy and Life Sciences*, *4*(3), 2489–2491.

Moser, U. B. (1991). *Handbook of Vitamins* (2nd ed.). New York: Machlin, Marcel Dekker.

Oguntibeju, O. O. (2008). The Biochemical, Physiological and Therapeutic roles of Ascorbic acid. *African Journal of Biotechnology*, *7*(25), 4700–4705.

Pacier, C., & Martirosyan, M. D. (2015). Vitamin C: Optimal dosages, Supplementation and Use in disease prevention. *Function Foods in Health and Disease*, *5*(3), 89–107.

Padayatty, S. J., & Levine, M. (2001). New Insights into the Physiology and Pharmacology of Vitamin C. *CMAJ*, *164*(3), 353–355.

Said, H. M., & Mohammed, Z. M. (2006). Intestinal absorption of water-soluble vitamins: an update. *Current Opinion in Gastroenterology*, *22*(2), 140–146.

Tee, E. S., Mohd, I. N., Mohd, N. A., & Kahtijah, I. (1997). *Nutrient Composition of Malaysian foods*. (M. F. C. D. Programme, Ed.) (4th ed.). Kuala Lumpur: Institute for Medical Research.

Walingo, K. M. (2005). Role of Vitamin C (Ascorbic acid) on Human Health- A Review. *African Journal of Food Agriculture and Nutritional Development*, *5*(1), 1–12.

Weber, P., Bendich, A., & Schalch, W. (1996). Ascorbic Acid and Human Health - a review. *International Journal of Vitamin and Nutrition Research*, *66*(1), 19–30.

Yu, R. T., Kurata, M., Kin, K., & Arakawa, N. (1999). The Behaviour of L-Ascorbic Acid in the Healing process of Dorsal Wounds in Guinea Pigs. *Journal of Nutritional Science and Vitaminology*, *27*, 207–211.