

Ascorbic Acid Analysis in Selected Indigenous Gambian Foods by Use of Titrimetric Analysis in Aqueous Media

Aliou M. Kandeh¹, Matarr Gaye¹, Osaro Iyekowa^{1,2}, Oladele Oyelakin^{1,*},
Mandalena Mendy¹, Chukwudozie Cyril Ntomchukwu^{1,3}, Adjivon Anthony¹

¹Chemistry Unit, Division of Physical & Natural Sciences, School of Arts & Sciences, University of The Gambia, The Gambia

²Department of Chemistry, Faculty of Science, University of Benin, Nigeria

³College of Medicine, American International University, West-Africa, The Gambia

Abstract Data on Gambian foods is few and far between; this research looks at vitamin C content of selected Gambian foods. Ten different Local Gambian Foods were analysed for their vitamin C content in aqueous solutions using titrimetric method and results obtained suggested that the amount of vitamin C in these samples is sufficient for human daily requirement. Results of the analysis further showed that five of the samples analysed ranged from 27.47 to 60.23mg/100g, while the other five samples ranged from 117.72 to 703.88mg/100g. *Detarium senegalenses* has the highest amount of vitamin C content.

Keywords Vitamin C, Ascorbic Acid, Indigenous, Detarium Senegalenses, Gambia, Titrimetric method

1. Introduction

Ascorbic acid or vitamin C is it is commonly known belongs to a class of water soluble organic compounds that is required by the body for its numerous biological functions. The functions of vitamin C in the body are numerous and invaluable. These relate to its ability to donate an electron as it is well-known for its antioxidant role in aqueous media [1]. In addition to its antioxidant effects, vitamin C is reported to be useful in cancer treatment. Vitamin C also helps in the treatment of cancer and the reduction of developing cervical cancer and prostate cancer in the human body [2].

Vitamin C is almost present in all foods of plant origin. The best sources of vitamin C are fruits and vegetables. Some foods particularly rich in vitamin C includes: tomato, cabbage, garlic, ginger, pepper, cherry, apple, lime *etc* [3]. In Africa, some foods exist which are rich in vitamin C and are not known to the wider world. This work will make this known, in special relation to The Gambia, a rather small lesser known country in West-Africa. Further to this, the afore-listed fruits and vegetables are usually more costly compared to indigenous ones. Knowledge of less expensive options would make a difference to locals *vis-à-vis* sources of vitamin C.

Analysis of vitamin C is important in determining the best sources of vitamin C. Several methods exist of doing this;

examples of the methods include, titrimetric methods, hyphenated technique using instruments consisting of flow injection analysis, sensors and biosensors, high performance liquid chromatography, capillary electrophoresis and so on [4]. Some of these methods require technical know-how and are expensive. Others are time consuming, less sensitive and have low detection limits. This work deals with use of titrimetric method. This method is simple and inexpensive.

The simplicity of the chosen method is well-suited to an under-resourced environment. Further to this, this work has as its objective, the determination of ascorbic acid in some indigenous Gambian foods in aqueous solutions. There is little data on indigenous Gambian foods. This study aims to make this data available. This research aims to answer the following research questions: what are the amounts of vitamin C in indigenous Gambian Foods in mg/100g? Are the levels of vitamin C in indigenous Gambian foods sufficient for daily human requirements? This research aims to contribute to scientific knowledge and results obtained will serve as reference for future findings on indigenous Gambian Foods.

2. Materials & Methods

Chemicals and instrumentation

All chemicals used were purchased from Fisher Chemicals. Starch solution, potassium iodide, potassium iodate, hydrochloric acid and ascorbic acid. Digital Analytical Balance that measures up to 0.001g was used for weighing throughout the study.

* Corresponding author:

ooyelakin@utg.edu.gm (Oladele Oyelakin)

Received: Aug. 18, 2020; Accepted: Sep. 10, 2020; Published: Oct. 26, 2020

Published online at <http://journal.sapub.org/fph>

Procedure reaction

The titrimetric analysis method used in this study to determine ascorbic acid is typically called iodometric titration.

Standardization

A standard solution of 1.0×10^{-2} M KIO_3 was prepared by dissolving 2.140g of KIO_3 in 1000mL of distilled water. 0.260g of ascorbic acid in 100mL was used to confirm the concentration of the standardized KIO_3 . A 5% standard solution of starch was prepared by dissolving 0.500g of

starch powder in 100mL distilled water. Standardization was repeated for each sample being analyzed.

Samples and Sample Selection

Different samples of indigenous Gambian foods were purchased from Brikama and Serrekunda Markets; some were collected from the Brikama Forest. A total of ten different samples were analysed using titrimetric method. For each sample, different parts of the plant was used. The used parts were, (according to the listed code in table 1): 0.1 fruit; 0.2 fruit (white part in photo); 0.3 leaves; 0.4 leaves; 0.5 leaves; 0.6 fruit; 0.7 fruit; 0.8 leaves, 0.9 fruit; 1.0 leaves.

Table 1. Table showing samples analyzed

Code	LOCAL NAME (W,M, F)	ENGLISH NAME	SCIENTIFIC NAME	IMAGE
0.1	<i>Daharr, Timbingo, Dabe</i>	Tamarind	<i>Tamarindus indica</i>	
0.2	<i>Bui, Sito, Bohee</i>	Baobab	<i>Adansonia digitata</i>	
0.3	<i>Mborr-Mborr</i>	Tea Bush	<i>Lippia chevalieri</i>	
0.4	<i>Barah, Kinkiliba (M,F)</i>	Tea of kinkiliba:	<i>Combertum micranthum</i>	
0.5	<i>Wonjo</i>	Sorrel	<i>Rumex acetosa</i>	

0.6	<i>Ditakh, Tallo, Talle</i>	Sweet Detar	<i>Detarium senegalensis</i>	
0.7	<i>Kabba, Lamude</i>	Senegal Saba	<i>Saba senegalensis</i>	
0.8	<i>Jambakatgo, Rat, Doge</i>	French khat	<i>Combretum glutinosum</i>	
0.9	<i>Nette, Neto</i>	African Locust Beans	<i>Parkia biglobosa</i>	
1.0	<i>Lenge, Bume</i>			

W = Wollof, M = Mandinka, F = Fula.

Sample Analysis

The samples analyzed were divided into two; liquids and solids. For each of the food samples, the following procedure was followed:

KIO₃ was standardized by using ascorbic acid. 100g of the solid sample was weighed and dissolved in 500mL distilled water. The liquid samples were prepared according to the way they are consumed. 100mL of the mixture was collected and introduced into a 250mL conical flask. 0.560g of KI, 5.600mL of 1M HCl and 4 drops of 0.5% starch solution were added to the 250mL conical flask containing the sample, respectively. The aliquot was shaken gently and titrated against the standardized KIO₃. For each food sample, five different titrations were carried out and the average of the closest three titres was taken.

Ascorbic acid content was calculated using stoichiometric relations in units of mg/100g of sample using these two equations.

1. $\text{KIO}_3 (aq) + 6 \text{H}^+ (aq) + 5 \text{I}^- (aq) \rightarrow 3 \text{I}_2 (aq) + 3 \text{H}_2\text{O} (l) + \text{K}^+ (aq)$
2. $\text{C}_6\text{H}_8\text{O}_6 (aq) + \text{I}_2 (aq) \rightarrow \text{C}_6\text{H}_6\text{O}_6 (aq) + 2 \text{I}^- (aq) + 2 \text{H}^+ (aq)$

3. Results and Discussion

The table below shows the average titre values for each sample and the amount of vitamin C in mg/100g for each sample.

Table 2. Values of titre, (average & three closest) values for each sample and its respective ascorbic acid concentration in mg/100g

Sample Code	Three closest titre values for each sample	Average titre value (mL)	Concentration (mg/100g)
0.1	22.28, 22.28, 22.27	22.28±0.01	117.72
0.2	37.33, 37.37, 37.33	37.33±0.01	197.24
0.3	49.37, 49.38, 49.37	49.37±0.01	260.85
0.4	133.21, 133.23, 133.23	133.22±0.01	703.88
0.5	34.09, 39.05, 39.06	39.05±0.01	206.32
0.6	8.91, 8.90, 8.91	8.91±0.01	47.07
0.7	7.22, 7.20, 7.19	7.20±0.01	38.04
0.8	10.20, 10.20, 10.19	10.20±0.01	57.89
0.9	11.40, 11.39, 11.40	11.40±0.01	60.23
1.0	5.19, 5.18, 5.22	5.20±0.02	27.47

Table 3. Comparison with Values of Other Fruits from other sources using the same iodometric method in mg/100units [5]

Fruit	Concentration (mg/100g)
Grape	70.345±1.889
Lime	44.138±1.542
Orange	75.000±5.172
Tangerine	98.851±10.535
Banana	17.356±6.333
Pawpaw	90.041±0.000
Pineapple	14.086±0.000

From table 2, samples with higher average titre values indicate higher concentration of vitamin C. It can be seen that the vitamin C content of the samples range from 27.47mg/100g in sample 1.0 to 703.88mg/100g in sample 04.

4. Conclusions

The US recommended dietary allowance for ascorbic acid is from 100 - 120 mg/per day for adults [6]. Results obtained from the food samples analyzed suggest that a good number of Gambian Local Foods meet this requirement. Considering the fact that these foods are often consumed in their natural state, it is logical to conclude that using them to replace imported foods will largely ameliorate vitamin C requirement in The Gambia.

After critically looking at available literature and the results obtained from the food samples analyzed, the following recommendations are provided for consideration:

1. Consumption of these local Gambian Foods for their vitamin C content should be encouraged.

2. It is recommended that these foods be processed and preserved so as to make them available all year round.

5. Implications for Chemical Education

This study has dealt with indigenous African food. With special reference to chemical education, the following are noteworthy:

1. In teaching about food and nutrition, examples of locally grown plants should be used in schools; the use of examples that relate to foods grown in Europe and America should be minimized or discouraged altogether.
2. All locally grown African foods and which are not known to the wider world should be analysed for their nutritional value.

ACKNOWLEDGEMENTS

Appreciation goes to National Agricultural Research Institute, Brikama, The Gambia for provision of glassware and distilled water.

REFERENCES

- [1] Sharaa, Samira Ben Mussa and Intisar El, Analysis of Vitamin C (ascorbic acid) Contents packed fruit juice by UV-spectrophotometry and Redox Titration Methods, *Journal of Applied Physics* 6, no. 5 2014, 46-52.
- [2] Derg., Ankara Ecz. Fak., An Overview of Ascorbic Acid Biochemistry, *Aesthetics Journal* 38, no. 5 2009, 233-255.
- [3] Ogle, Louis E. Grivetti and Britta M., The value of traditional foods in meeting macro-and micronutrient needs: the wild plant connection, *nutrition research review* 13 (2000), 31-46.
- [4] Zbynek Gazdik and et al, Determination of Vitamin C (Ascorbic Acid) Using High Performance Liquid Chromatography Coupled with Electrochemical Detection, *Open Access Journal Sensors*, 8, 2008, 1-16. DOI: 10.3390/s8117097.
- [5] Jun Yang, Jiaren Liu and John Parry. Vitamin C: Daily Requirements, Dietary, © 2009 Nova Science Publishers, Inc., 2009, 237-259.
- [6] Ikewuchi, C.J. & Ikewuchi, C.C., Iodometric Determination of the Ascorbic Acid (Vitamin C) of some fruits Consumed in a University Community in Nigeria, *Global Journal of Pure and Applied Sciences*, 17, 1, 2011, 47-49.