Bull. Chem. Soc. Ethiop. **1996**, 10(2), 165-169.
Printed in Ethiopia

ISSN 1011-3294

SHORT COMMUNICATION

DETERMINATION OF L-ASCORBIC ACID IN KENYAN FRESH AND PROCESSED FRUITS AND VEGETABLES BY DIFFERENTIAL PULSE ANODIC STRIPPING VOLTAMMETRY

Nanyili M.N. Wekesa, Sumesh C. Chhabra* and Henry M. Thairu

Chemistry Department, Kenyatta University, P.O. Box 43844, Nairobi, Kenya

(Received December 31, 1996)

ABSTRACT. Concentrations of L-ascorbic acid (L-AA) in ten different types of fresh fruits, thirteen processed fruits, four commercial soft drinks and thirteen different types of vegetables were determined by differential pulse anodic stripping voltammetry. The concentration levels of ascorbic acid ranges from 15.4 - 371.0 mg/100 g in fresh fruits, 5.0 - 414.0 mg/100g in processed fruits, 3.0 - 23 mg/100 mL in soft drinks and 14.8 - 334.4 mg/100 g in fresh vegetables.

INTRODUCTION

L-ascorbic acid, which is a chemical term given for the more widely referred to as vitamin C, occurs naturally in various concentration levels in a broad range of fruits and vegetables. Official recommendations for vitamin C intake in a balance human diet, as given in numerous nutrient composition tables, vary within the range of several milligrams up to 30 - 60 mg/day [1].

Many analytical techniques of varying degrees of sophistication are available for the determination of L-ascorbic acid in different types of samples. These include titration [2], fluorometry [3], AOAC and liquid chromatography, LC [4].

LC is now proposed as the method of choice for the determination of total vitamin C since both L-AA and dehydroascorbic acid, DHA, can be assessed in one experimental run [4]. Techniques which neglect DHA usually give underestimations of vitamin C activity in fruits and vegetables.

Electroanalytical methods (mainly polarography and voltammetry) have also been applied to the determination of L-AA [5-12]. Voltammetry at the carbon paste electrode has been found useful in the determination of vitamin C in fruits, vegetables, products thereof as well as in pharmaceutical quality control of vitamin C-containing drugs [7]. Differential pulse voltammetry at the glassy carbon electrode has been applied for L-AA determination in multivitamin drugs, where vitamin C is selectively determined in the presence of other vitamins with little or no interference [11].

In the present study, the concentration of L-AA in different fresh fruits, processed fruits, commercial soft drinks, and vegetables obtained from markets in Nairobi, Kenya, were determined by differential pulse anodic stripping voltammetry (DPASV).

EXPERIMENTAL

Instrumentation. The differential pulse anodic stripping polarograms were recorded on a Princeton Applied Research model 264A polarographic analyzer/stripping voltammete r equipped with a personal computer (PC) model Phoenix 80386 Bios Plus version 1.1030 via analog digital converter box. A three electrode system consisting of a hanging mercury drop electrode as the working electrode, a platinum wire counter electrode and a saturated calomel reference electrode (SCE) were used. All experiments were done at room temperature. Solutions were purged with pure nitrogen for 4 min before analysis. pH were measured with JENWAY 3020 pH meter.

Reagents. The stock solution of L-ascorbic acid (0.1 g/100 mL) was prepared by dissolving the reagent grade chemical in acetate buffer which had been previously degassed with nitrogen for 30 min. Dilute solutions of L-AA were prepared from the stock, just prior to analysis. The acetate buffer (pH 4.7) was prepared from sodium acetate and acetic acid. All chemicals and reagents were of analytical grade (BDH) .

Sampling. Collection of samples was done through random sampling, every morning the samples were bought from the markets in Nairobi, Kenya. Fifteen samples were analyzed for every variety of sample collected. Five replicate determinations were performed on each sample and the mean L-AA content for each sample was determined.

Extraction procedure. About 10-15 g of the vegetable or fruit (fresh or stewed) were cut into small pieces and macerated with 3% acetic acid in a food-mixer (1 g sample : 5 mL acetic acid). The extracts were centrifuged at 10,000 rpm for 15 min to give a clear solution. Small suspensions were removed by filtering through a Whatman filter paper. The samples were then put in sample bottles and kept in a deep freezer until the time of analysis.

Preparation of sample for determination by DPASV. 1 or 5 mL of the extracts were diluted to 25 mL with 0.1 M acetate buffer (pH 4.7) and used for DPASV of L-AA. The amount of L-AA present in the sample was determined by the standard addition method.

Instrumental control settings. Differential pulse anodic stripping polarograms were recorded in 0.1 M acetate buffer as the supporting electrolyte, with an initial potential of -0.2 V and a scan rate of 5 mV/s in the anodic direction. The modulation amplitude was 25 mV and the deposition time was 60 s.

RESULTS AND DISCUSSION

Table 1 presents the L-AA content determined in fresh and processed fruits, commercial soft drinks, and vegetables. The vitamin C contents in the fresh fruits are mostly within the values previously reported by different authors [13 -16]. The contents of vitamin C in mangoes and lemons, obtained from polarographic and voltammetric data [5,12], are within 37-54 mg/100 g sample.

Differential pulse anodic stripping voltammetry is a very convenient method for the determination of L-AA in citrus fruits which contain all their vitamin C in this form. The stability

Table 1. L-ascorbic acid (L-AA) content in fresh fruits, processed fruits, commercial soft driks, and vegetables.

Fruit	L-AA mg/100 g	Processed fruits	L-AA mg/100 mL	Soft drinks	L-AA mg/100 mL	Vegetables	L-AA mg/100 g
Tangerines	23.6±2.4	Black-currant	32.8±0.7	Sprite	10.6±1.0	Spinach	44.6±1.0
Papayas	37.0±1.4	Tree-Top	27.0±1.0	Sonic Fanta	23.0±0.7	White cabbage	37.8±1.0
Pineaplles	15.4±1.4	Quencher Whole Orange	16.0±0.6	Fanta	5.0±0.4	Tomatoes	21.0±1.4
White Passions	31.7±1.4	Hey-Ho	4.0±0.2	Coca-Cola	3.0±0.0	Carrots	14.8±0.7
Red Passions	371.0±2.5	Ribena	414.0±1.4			Kale	218.4±1.0
White guavas	124.0±2.3	Lecol Pure Lemon*	63.0±0.6			Pepper	114.9±1.5
Red guavas	371.0±2.5	Rubicon Exotic Mango*	13.4±0.5			Gynandra	225.0±1.0
Oranges	56.6±1.4	Real-annanas	27.0±0.6			Cowpea leaves	334.4±3.0
Mangoes	90.5±0.8	Real-orange	60.4±1.0			Pumpkin leaves	131.0±2.0
Lemons	47.6±2.0	Rubicon Exotic Passions*	7.8±0.4			Onions	26.0±0.7
		Kengold	11.8±0.4			English potatoes	19.6±1.0
		Zesta Passion	5.0±0.0			Solanum	210.0±1.7
		Zesta Mango	10.6±0.8			Dania	324.4±1.4

* Imported.

of vitamin C is mainly due to the presence of high concentration of polybasic or polyhydroxy acids, such as citric and malic acids, which, by their ability to chelate metal ions, prevent the oxidation of L-AA [17].

Among the fresh fruits the highest mean levels were determined in red guavas (371.0

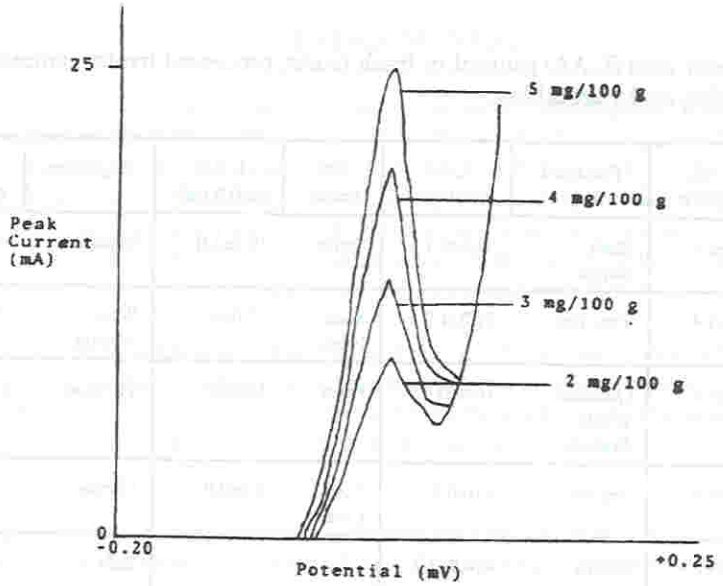

Figure 1. Polarograms of L-AA in cowpea leaf samples.

mg/100g) while the lowest levels were determined in pineapples (15.4 mg/100). Ribena (414.0 mg/100 mL) had the highest mean level among the processed fruits while Zesta passion (5.0 mg/100 mL) had the lowest. Among the soft drinks analyzed Sonic Fanta (23.0 mg/100 mL) had the highest mean level and Coca-Cola (3.0 mg/100 mL) had the lowest.

In the processed fruits, shown Table 1, the most commonly used preservatives are sodium benzoate and carbon dioxide. These preservatives are used to deactivate the enzyme L-AA oxidase, which is a copper-protein containing enzyme and therefore reduces the rate of decomposition.

Among the vegetables, the highest and lowest mean levels were found in cowpea leaves (334.4 mg/100 g) and carrots (14.8 mg/100 g), respectively. The L-AA content in vegetables compare with values published by Souci et al. [13], Sebrell and Harris [14], Belitz and Grosch [15], and Herman et al. [16].

All the vegetables that were analyzed have almost all the vitamin C in the form of L-AA. Figure 1 displays typical polarograms of L-AA in cowpea leaves whose peak potential was at 0.01 V versus SCE reference electrode. The minimum quantification limit for this technique was 0.4 mg/100 mL while the detection limit, defined graphically by 2σ the blank, was 1.0×10^{-7} M.

ACKNOWLEDGMENTS

The authors are grateful to Mr. M.M. Mitambo of Chemistry Department, Kenyatta University, Nairobi, for the assistance rendered in the operation of Differential Pulse Anodic Stripping Voltametry.

REFERENCES

REFERENCES

1. Reuler, J.B.; Broudy, V.C.; Cooney, T.G. *JAMA* **1985**, 253, 805.
2. Freed, M. *Methods of Vitamin Assay*, Interscience: New York; 1966.
3. Deutsch, M.J.; Weeks, C.E. J. *Assoc. Off. Anal. Chem.* **1965**, 48 1248.
4. Wills, R.B.H.; Wimalasiri, P.; Greenfield, H.J. *Assoc. Off. Anal. Chem.* **1983**, 66, 1377.
5. Lau, O.W.; Shiu, K.K.; Chang, S.T. *J. Sci. Food Agric.* **1985**, 36, 733.
6. Patriarch, G.J.; Chateau-Gosselin, M.; Vandenbalck, J.L.; Zuman, P. *Polarographic and Related Techniques in Pharmacy and Pharacology in Electroanalytical Chemistry*, Marcel Dekker: New York; 1979, p 67.
7. Lechien, A.; Valenta, P.; Nurnberg, H.W.; Patriarch, G.J. *Fresenius Z. Anal. Chem.* **1982**, 311, 105.
8. Lindquist, J.; Farroha, S.M. *Analyst* **1975**, 100, 377.
9. Erb, F.; Dequidt, J.; Phillipo, A.; Thomas, P. *Ann. Falsf. Expert Chim.* **1981**, 74, 71.
10. Dequidt, J; Erb, F.; Brice, A.; Hiruox, D. *Ann. Falsf. Expert Chim.* **1981**, 74, 89.
11. Ballantine, J.; Woolfson, A.D. *J. Pharm. Pharmacol.* **1980**, 32, 353.
12. Lindquist, J. *Analyst* **1975**, 100, 339.
13. Souci, S.W.; Fachmann, W.; Kraut, H. *Die Zusammensetzung der Lebensmittel*, Nahrwert-Tabellen II, Wisenschaftliche Verlagsgesellschaft: Stutgart; 1979.
14. Sebreel, W.H.; Harris, R.S. *The Vitamins*, Vol. 1; Academic Press: New York; 1954.
15. Belitz, H.D. Grosch, W. *Food Chemistry*, Springer: Berlin; 1986.
16. Herman, F.M. Donald, F.O.; Charles, G.O.; Glenn, T.G. *Kirk-Othmer Encyclopedia of Chemical Technology*, Vol. 24; 3rd ed., John Wiley: New York; 1984, p 11.
17. Kozar, S.; Bujak, A.; Eder-Trifunovic, J.; Kniewald, G. *Fresenius Z. Anal. Chem.* **1988**, 329, 760.