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ROLE OF ANALYTICAL CHEMISTRY FOR THE DETERMINATION OF ASCORBIC ACID : A REVIEW

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Abstract

Vitamins play an important role in the human health, and thus they are the kind of major nutrients in the body. Chemical products perform numerous physiological functions and can jeopardize health jointly in their absence and surplus. Therefore, it is necessary to establish methods for observation vitamin levels in various molds. In this review paper, the most methods of determination used are high performance liquid chromatography (HPLC), spectrophotometric and potentiometric techniques by listed the value of : slope, linear range, correlation coefficient, detection limit, the max of wavelength and PH and compared with these methods.

Key words : Ascorbic acid, HPLC, Spectrophotometer, vitamins; determination; review.

Introduction

There are 13 vitamins recognized in human nutrition as role plays (Khayat *et al.,* 2017; Glavinic *et al.,* 2017; Eggersdorfer *et al.,* 2012). These vitamins can be broken down into vitamins which are soluble in fat and soluble in water based on their solubility. A former group includes vitamins A, D, E and K, vitamins B and C included in the latter group. Many biological functions in the body were linked to vitamins soluble in fat (Lounder *et al.,* 2017; Ghanbari *et al.,* 2016; Amundson *et al.,* 2016; Riva *et al.,* 2017; Zhao *et al.,* 2014; Clugston *et al.,* 2014; Makarova *et al.,* 2017; Shearer, 2009; Duffy *et al.,* 2017). When the sum of vitamins cannot fulfill the body's needs, supplemental vitamins must be given. Table 1 explains these fat-soluble vitamins ' functions and dietary sources.

Ascorbic acid is one of a water - soluble vitamin (Vitamin C). It happens as a powder or a crystal with an acidic flavor, white or slightly yellow. It is a product that is an antiscorbutic. It gradually darkness when exposed to light. It is relatively stable in air in the dry state, but oxidizes easily in solution. In water, ascorbic acid (vitamin C) can be readily soluble; Sparingly soluble in alcohol and insoluble in chloroform, ether and benzene. L-ascorbic acid (vitamin C) is the scientific name of Ascorbic Acid (vitamin C). The empirical formula is $C_6H_8O_6$, with 176.13gm/mole of molecular weight (Pathy, 2018) and Fig. 1 Displays ascorbic acid chemical structure.

Vitamin C has long been recognized as an important nutrient in several food products (Selimoviæ *et al.,* 2011) and a variety of foods containing vitamin C is available and the public now knows that citrus fruits such as orange and their juices are the best vitamin C sources. A wide range of other foods contain enough vitamin C, including bananas, apple, sweet peppers, broccoli, curly kale, cauliflower, black currants and rose dogs (Jacoba, 1999).

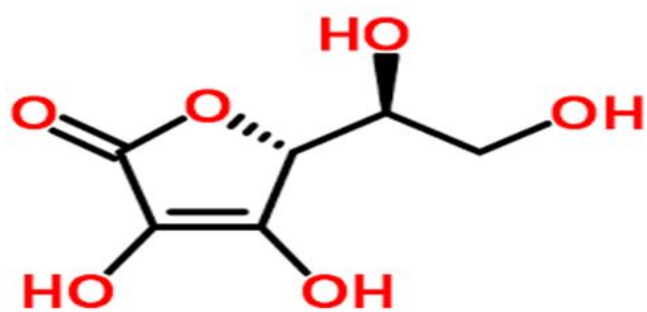

Fig. 1 : Ascorbic Acid Structure Formula (Elgailani *et al.*, 2017).

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Table 1: Fat-soluble vitamins list (WebMD, 2018).

Vitamin Name	Function	Dietary Sources
A	(1) healthy membranes of the mucosa; (2) Skin growth, vision, teeth and bones; (3) Health of Immune System	Source of animal (retinol): liver, eggs margarine, butter, cream, cheese and enhanced milk.
		Sources of plant (beta-carotens): dark green leafy vegetables, dark orange vegetables (pumpkin, sweet potatoes, winter squash, carrots), fruits (cantaloupe, apricots).
K	Needed for proper coagulation of blood	Cabbage family vegetables, green leafy vegetables, milk; also produced by bacteria in the intestinal tract.
E	Protection of walls of the cell	Nuts and sows, egg yolks, liver, whole grain products, wheat germs, green leafy vegetables and unsaturated plant oils.
D	Need to imbibe calcium effectively	Margarine is fortified, enhanced milk, fatty fish, liver and egg yolks; skin can also produce vitamin D when exposed to sunlight.

Table 2 : Water-soluble vitamins list (WebMD, 2018).

Vitamin Name	Function	Dietary Sources
B-complex, B1 thiamine, B2 riboflavin, B3 niacin, B5 pantothenic acid, B6 pyridoxine, B8 biotin, B9 folic acid, and B12 cyanocobalamine.	In processes metabolism for energy production and important roles	In food: fish, meat, green leafy vegetables, legumes, whole grain, seeds, seafood, milk, dairy products, eggs, etc.
Vitamins C	The most important vitamins are essential to many biological processes, like iron absorption, immune reaction, etc.	Fruit & vegetables, especially : kiwifruit, mangoes, papaya, strawberries, lettuce, potatoes, tomatoes, pepers, cantaloupe, etc.

Table 3: HPLC Method for Determination Of Vitamin C.

No.	Determination Methods	Sample Matrix	Analytes	Ref.
1	HPLC	Fruit & Vegetable	Benincasa's Hispida (BH) fruit extract contains ascorbic acid, with three separate solvents, (1) 3% metaphosphoric acid, (2) 3% citric acid and (3) distilled water.	(Fatariah *et al.,* 2015)
2	RP-HPLC	Honey	B2 vitamin, riboflavin; nicotinic acid, vitamin B3; vitamin B5,pantothenic acid; folic acid, vitamin B9, and ascorbic acid vitamin C.	(Ciulua *et al.,* 2011)
3	HPLC	Baking	Ascorbic acid in the bread.	(Topcu *et al.,* 2017)
4	RP-HPLC	Health drinks	Ascorbic acid	(Kumar *et al.,* 2011)
5	RP-HPLC	Oral powder for veterinary consumption	Vitamin $B_{1,}$ thiamine; Vitamin B_2, riboflavin; sodium phosphate; Vitamin B3, niacin amide; Vitamin B_6, pyridoxine; and Vitamin C, ascorbic acid.	(Haþimoðlu *et al.,* 2018)
6		Rapid and Reliable HPLC	pharmaceutical samples	vitamin C (Mitic *et al.,* 2011)
7	HPLC	Soft drinks, fruit juices, and cordials	vitamin C	(Pathy, 2015)
8	HPLC	Human plasma	Ascorbic acid and dehydroascorbic acid	(Kim *et al.,* 2016)
9	UPLC	Several fruits and vegetables	Ascorbic acid	(Cotruþ *et al.,* 2016)
10		Spectrophotometry	Portuguese wild edible mushroom b-carotene and lycopene	Phenols, ascorbic acid, (Barros *et al.,* 2007)

Table 4: Spectrophotometric Method for Determination of Vitamin C.

No.	Determination Methods	Results	Ref.
1	Different Spectrophotometric	Linear Range (µg/mL) =2-45 and 1-22 Slope(m)=0.018 and 0.036 Correlation Coefficient= 0.9993and 0.9992 Molar Absorptivity(L.mole^{-1}.cm^{-1})=2844 and 5280 LOD(µg/L)=0.24 and 0.09	(Saeed *et al.,* 2017)
2	Spectrophotometric Analysis	Linear Range (µg/mL) = up to 10 Correlation Coefficient=0.9929 LOD(µg/L)= 0.017 %RSD= 2.4	(Kapur *et al.,* 2012)
3	Ultraviolet Spectroscopy	Sensitivity(mg/100mL)=0.1110 Analytical Sensitivity(mg/100mL)=0.3315 Correlation Coefficient=0.8890 LOD(mg/100mL)= 1.0941	(Santos *et al.,* 2016)
4	Simple Spectrophotometric	Linear Range (µg/mL) =40-200 λ max(nm)=390 and 530 Correlation Coefficient= less than 0. % RSD= < 2 % Recovery=100.09±0.28 and 99.98±0.88	(Hussien *et al.,* 2017)
5	Direct Spectrophotometric	Slope=14241.79 Correlation Coefficient= 0.9998 Molar Absorptivity(L.mole^{-1}.cm^{-1})=1.42×10^4 LOD (µg/L)=0.257 % RSD=0.81	(Selimoviæ *et al.,* 2011)
6	Spectrophotometric and titrimetric	λ max(nm)=280 Linear Range (mg/mL) = 0.67± 0.02 to 18.00± 3.12 and 14.84± 0.70 to 35.72± 3.42 Correlation Coefficient= 0.9986	(Al-Majidi *et al.,* 2016)
7	Spectrophotometric	Slope= 0.0842 and 0.0603 Correlation Coefficient= 0.999904and 0.999957 Molar Absorptivity(L.mole^{-1}.cm^{-1})= 1.48×10^4 and 1.06×10^4 LOD(µg/L)= 0.19 and 0.15	(Salkiæ *et al.,* 2015)
8	UV spectroscopy	Linear equation :Y=0.0067×+0.0549 Correlation Coefficient= 0.9881	(Desai *et al.,* 2019)
9	Spectrophotometric	λ max(nm)=521 LOD(ppm)= 0.01 LQD(ppm)=0.017 Correlation Coefficient= 0.995 % RSD= 2.4	(Mussa *et al.,* 2014)

Furthermore, ascorbate is essential for neuronal maturation and function as well as for the brain's defense against oxidized stress. The evidence presented in the articles therefore support this, and researchers have paid great attention to determination of ascorbic acid (Noroozifar *et al.,* 2012). For instance: a spectrophotometer, HPLC, colorimetric, voltammetry as shown in table 3, 4 and 5. Several analytical methods for the determination of ascorbic acid have been used.

Conclusion

From table 3, 4, 5 that have been seen the HPLC have high selectivity and sensitivity, HPLC which can be regarded as a confirmatory technique has become the principal technique of analyzes for the detection of vitamins, compared to other instruments. Spectrometry may be used in different samples to detect vitamins. (Elzanfaly *et al.,* 2010; Pieszko *et al.,* 2010; Mohamed *et al.,* 2011), the method is simple, delicate and precise. And electrochemical sensors for detection of vitamins have been developed using receptors manufactured using various printing methods. (Pisoschi *et al.,* 2011; Baghizadeh *et al.,* 2015; Revin *et al.,* 2012; Ba′s *et al.,* 2011; Nie *et al.,* 2013; Jamali *et al.,* 2014; Bobreshova

Table 5: Determination of Ascorbic acid by Potentiometric Technique.

Type of Electrode	Slope	Range of Concentration	Detection Limit	R^2	PH	Ref.
Modified multiwallcarbon nanotube paste electrode	-	5.6×10^{-5} to1.2 × 10^{-2} mole/L	1.2×10^{-6}mole/L	0.999	2.0	(Noroozifar *et al.,* 2012)
Solid-state potentiometric electrodes	104–112 (mV)	0.005–5.0 mM	0.002mM	-	5.0	(Veltsistas *et al.,* 2004)
Film–holes modifiedglassy carbon electrodes	-	5 to 45 mM	1.656 mM and 0.123 µM	0.998	5.0	(Olana *et al.,* 2015)
L-Ascorbic Acid by Adsorption Potentiometry with Carbon Paste Electrode	95mV/decade	$7.0\times10^{-7}\times4.0\times10^{-5}$ mol/L	1×10^{-7}mol/L	-	-	(Hu *et al.,* 1995)
PVC Matrix Membrane Sensor	57.0±0.5mV/ decade	6×10^{6} -1×10^{2} M 4×0^{6}M	4×0^{-6}M	-	- 3.0-10	(Mostafa, 2007)

et al., 2010; Verma *et al.,* 2013; Nie *et al.,* 2014).

Because of its advantages, HPLC is the most common analytical method. For different matrices, like foods and biological samples, HPLC techniques can fulfill the qualitative and quantitative specifications of analyzing vitamins. UV and FLD detectors are affected by overlap the peaks when treating complex samples whereas matrix effect and high costs of using LC-MS are significant. Biosensors ' main advantages include their minimal costs, technological simplicity, and their potential for field analysis, however their relatively short lifetime restricts the development of technology. Spectrometry can be promoted cheaply and easily, but its sensitivity is sometimes not quite adequate. In short, this technology will surely be widely used with the development of HPLC and MS equipment. Also other techniques were be used such as potentiometric methods.

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