Colorimetric Determination Of Ascorbic Acid Using PaperTest Strips And ScannerTechnology

Galina Petrushina[1], Ludmila Tsiganok[2], Andriy Vishnikin[3]

1. Chemistry Department, Dnipropetrovsk State Agrarian University, UKRAINE, Dnipropetrovsk, Voroshylov street 25, E-mail: galinka83@gmail.com)
2. Chemistry and Chemical Technology of High-molecular Compounds Department, Chemical Faculty, Oles Gonchar Dnipropetrovsk National University, UKRAINE, Dnipropetrovsk, Gagarina av., 72, E-mail: tsiganok_2010@ukr.net
3. Analytical Chemistry Department , Chemical Faculty, Oles Gonchar Dnipropetrovsk National University, UKRAINE, Dnipropetrovsk, Gagarina av., 72, E-mail: vishnikin@hotmail.com

Abstract* – *Dependence of R, G, B color coordinates measured for paper test strips impregnated with 18-molybdo-2-phosphate heteropoly complex on the concentration of ascorbic acid has been studied. A rapid and simple method for colorimetric determination of ascorbic acid has been developed.

Key words – ascorbic acid, Wells-Dawson 18-molybdo-diphosphate heteropoly complex, heteropoly blue, colorimetric determination, test strips.

I. Introduction

The development of rapid, simple, and inexpensive analytical methods is one of areas of growing interest, especially since quick decisions are needed in environmental, medical, and industrial fields. Colorimetry is one of the most frequently used simple methods. Even if the human eye can very good distingush between tints of the colour, ability of quantification is limited. Using of colorimetry can convert semiquantitative visual test methods into quantitative one improving the accuracy and reproducibility of determination [1]. Intensity of the colours has been often calculated from the absorption or diffuse reflectance spectra. However, there exists more easy way to measure the coloured samples. Colorimetric characteristics of images can be obtained with the application of computer programs. The wide availability of scanners and digital cameras has made it possible to use colorimetric methods requiring no special apparatus for measurements.

II. Experimental

Ammonium salt of 18-molybdo-2-phosphate heteropoly complex (18-MPC) $(NH_4)_6P_2Mo_{18}O_{62}\cdot 14H_2O$ was synthesized by the modified method [2]. 0.01 M solution of 18-MPC was prepared by dissolving 0.7855 g of the salt in a 25 ml flask.

0.01 M solution of ascorbic acid was prepared by dissolving the accurately weighed portion of the substance in freshly boiled distilled water.

Paper test strips and colored test scale were obtained by the method described in [3] and based on preiminary impregnation of heteropoly complex on the paper strips.

III. Results and discussion

The series of coloured test strips was obtained by reaction of standard solutions of ascorbic acid with impregnated on the paper 18-MPC.

Digital scan images of colored paper test strips were obtained with the office scanner and resolved into R, G, and B colors with photo editing program Adobe Photoshop-CS2. The resolution of 600 dpi was used by scanning. To determine the R, G, and B color coordinates, the oval area was isolated by means of the editor on the images of scan paper strips and then the average values of brightness were measured for each of the three channels by performing the command "Histogram".

Increase of the concentration of ascorbic acid in the solution is accompanied with increasimg the intensity of blue color of test strips, and, consequently, the decrease in the brightness of the RGB color channels (Fig. 1). The brightness of each RGB color channel depends on the ascorbic acid concentration exponentially.

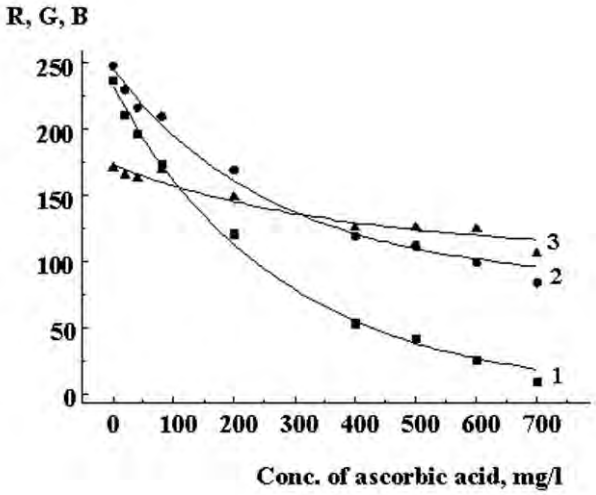

Fig. 1. Dependence of color coordinates R (1), G (2), and B (3) on the concentration of ascorbic acid

It was found using the Origin 5.0 that dependence of the brightness of RGB color channels on the ascorbic acid concentration can be described by an exponential function of 1st order:

$$Y = Y_0 + A \times \exp\left(\frac{-C}{t}\right) \qquad (1)$$

where Y – RGB color coordinate (brightness) that varies in the range from 0 to 255, C – concentration of substance in solution, mg/l, A, Y_0, t – parameters of the regression equation that describe the position and shape of the curve. Curves are satisfactorily linearized in the following coordinates:

$$\ln\left(\frac{A}{Y - Y_0}\right) = \frac{1}{t} \times C \qquad (2)$$

Parameters of the equation calculated by using Origin 5.0 software are shown in Table 1. Corresponding experimental data are presented in Table 2.For all the color coordinates relationship good lined with the proposed coordinates using equation (2). The R', G', B' were calculated according to the formula:

$$Y' = \ln\left(\frac{A}{Y - Y_0}\right) \times t \qquad (3)$$

Calibration graphs for the determination of an ascorbic acid are presenten on Fig. 2. Equations of calibration graphs are presrnted on Table (3)

TABLE 1

PARAMETERS OF THE EQUATION (1) FOR THE CHANNELS R, G AND B

Color channels	Parameters of the equation (1)		
	Y_0	A	t
R	0	231±4	278±12
G	84	161±4	271±19
B	106	66±4	378±55

TABLE 2

COLORIMETRIC DATA FOR THE TEST STRIPS OBTAINED BY THE CONSTRUCTION OF THE CALIBRATION GRAPH FOR THE DETERMINATION OF ASCORBIC ACID

Ascorbic acid concen-tration, mg/l	Color coordinates			Linearized color coordinates calculated by eq. (3)		
	R	G	B	R´	G´	B´
0	236	248	171	-6	-115	12
20	211	230	166	26	-84	42
40	196	216	163	46	-57	60
80	173	210	170	80	-43	18
200	121	169	148	181	62	173
400	53	119	126	409	304	462
500	42	112	126	474	367	463
600	25	99	125	621	530	482

TABLE 3

PARAMETERS OF THE ASCORBIC ACID DETERMINATION CALIBRATION GRAPHS

Colors coordinates	Equations of calibration graphs	R^2
R	$Y = -2+(1{,}00\pm0{,}03)\cdot C_{AA}$	0,996
G	$Y = -116+(1{,}03\pm0{,}04)\cdot C_{AA}$	0,998
B	$Y = 0{,}8+(1{,}0\pm0{,}1)\cdot C_{AA}$	0,978

A method of colorimetric determination of an ascorbic acid hase been developed. Limit of detection of the proposed methods is at the level of 10 mg/l. The procedure was tested in the analysis of real objects.

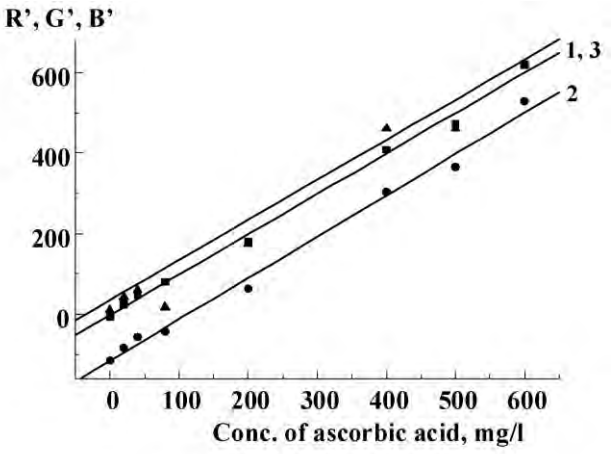

Fig. 2. Dependence basic color coordinates R' (1), G' (2), B' (3) on the concentration of ascorbic acid

Conclusion

In this paper study of dependence colors coordinates R, G, B of test strips on the concentration of ascorbic acid is described. Rapid and simple colorimetric method for the determination of ascorbic acid is developed.

References

[1] Yu.A. Zolotov, V.M. Ivanov and V.G. Amielin, Khimicheskie test-metody analiza [The chemical test methods of analysis]. Moskow: Editorial URSS Publ., 2002.

[2] G. Brauer, Ed., Rukovodstvo po nieorganichieskomu sintezu: v 6 tomakh. T.6" [Inorganic synthesis manual: in 6 volumes. V. 6]. Moskow: Mir Publ., 1986.

[3] G.O. Petrushyna and L.P. Tsyganok, "Sposib ekspresnoho test-vyznachennia askorbinovoi kysloty" [Method of express test determination of an ascorbic acid] UA Patent 55028, December 10, 2010.

[4] S.G. Dmitrienko, V.V. Apiari, O.A. Sviridova at al., "Ispolzovanie rieaktsyi diazotirovania i azosochetania s uchastiem penopoliuretana dlia opriedielienia nitrit-ionov s pomoshchiu spiektroskopii diffuznogo otrazhenia i tsvietomietrichieskikh skaner-tekhnologiy" [Using diazotation and azocoupling reactions involving polyurethane foam for the nitrite determination by the reflection spectroscopy and colorimetric scaner technology], Viestnik Moskovskogo univiersitieta, seria 2. Khimia – Herald of the Moskow university, ser. 2. Chemistry, vol. 45, no. 2, pp. 131-138, 2004.