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A NOVEL AND SIMPLE APPROCH TO SPECTROPHOTOMETRIC DETERMINATION OF PHOSPHATE IN SOFT-DRINKS

Snehlata Soni
Department of Engineering Chemistry, SVCE Indore. M.P. India

ABSTRACT

A simple spectrophotometric method is developed for the determination of phosphate in soft drinks samples like Pepsi cola, coke, and thums up. The method is based on the formation of phosphomolybdate with added molybdate followed by its reduction with stannous chloride in aqueous sulfuric acid medium. The system obeys Lambert-Beer's law at 635 nm in the concentration range 0.3-12.24 ppm. Molar absorptive, correlation coefficient values were found to be 6.1x103 mol-1 cm,-1 0.999 mg cm-2 respectively. The results obtained were reproducible with acceptable standard deviation 3.7% and relative error 3.4%. For a comparison of the method phosphate present in various samples were also determined separately. The results of the developed method compare well with those of the official method.

Keywords- *Phosphate, soft-drinks, stannous chloride, phoshomolybdate and spectrophotometry*

I. INTRODUCTION

Phosphorus is the eleventh most abundant element on the surface of the earth and is most commonly found as phosphate. It plays an important role in biochemical processes and is a key factor in element in all known forms of life. Inorganic phosphorus in the form of the phosphate PO_4^{3-} plays a major role in biological molecules such as DNA and RNA where it forms part of their structural framework. Living cells also use phosphate to transport cellular energy via adenosine triphosphate (ATP). Nearly every cellular process that uses energy obtains it in the form of ATP. ATP is also important for phosphorylation, a key regulatory event in cells. Phospholipids are the main structural components of all cellular membranes.

Calcium phosphate salts assist in stiffening bones. Unbalanced calcium to phosphate ratio, however, leads to the loss of calcium from the body as inorganic salts. These salts are either excreted through the digestive system or accumulated in organs as stones (e.g. kidney stones). One source that can cause phosphate overdose is the phosphate in beverages such as colas, since phosphoric acid is a common additive, used primarily in colas, as a so- called flavor enhancer. Studies have shown that severe tooth damage and osteoporosis are two symptoms directly linked to the effects of the Phosphoric acid content of beverages. Its ability to remove calcium from bones and teeth poses major risks. Therefore the food and nutrition board set an upper level of oral phosphorus intake for generally healthy individuals.

Men and women 19 through 70 year: 4.0 grams (4000 milligrams) of phosphorus/day.
Men and women over 70 years: 3.0grams (3000 milligrams) of phosphorus/day.

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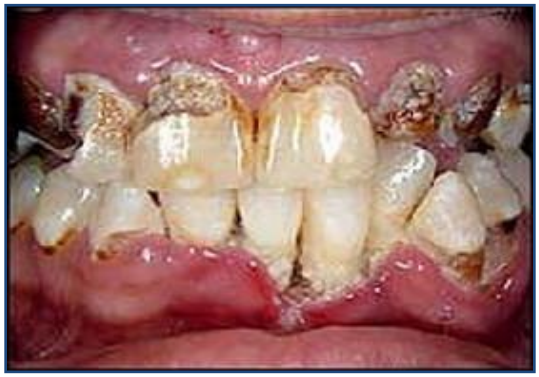

Severe tooth damage due to phosphorus

Background

The analytical chemistry of phosphorus is very important in many fields, for example, medical and clinical science, agriculture, metallurgy and environmental science [3]. Moreover, in recent years large quantities of phosphate have been used in beverages [4], detergents [5], fertilizers [6] and also in sugar industries [4, 7, 8, 9]. As a consequence, various phosphate determination procedures have been reported which include for example, titrometry [10], complexogravimetry, colorimetry, atomic absorption spectroscopy, flow injection analysis, HPLC and spectrophotometry methods. Among such methods spectrophotometry involving molybdovanadate and ammonium molybdate are most commonly used. In ammonium molybdate spectrophotometric method, different reluctant have been employed such as tin (II) chloride, ascorbic acid and 1-amino-2- naphthol-4-sulfonic acid, Some of these methods also involve complicated and expensive equipments and need extraction procedure and such techniques are usually not available in common laboratories. Considering the importance of phosphate and its determination in soft drinks an attempt is made here to analyze the simple spectrophotometric method which is based on the formation of phosphomolybdate with added molybdate followed by its reduction with stannous chloride in aqueous acidic medium.

II. METHODOLOGY

Reagents: All chemical reagents used were of analytical grade and the water used was distilled water.

I:-Preparation of molybdate solution:-Weighed amount of ammonium molybdate, 2.5 grams was dissolved in about 50 mL of water. In a separate vessel add 13.6mL of concentrated sulfuric acid to about 35mL of water and allow the solution to cool. Mix up the two solutions and make up the volume to 100Ml.

II:-Reducing solution:-0.05garms of stannous chloride was dissolved in 50mL water and then transferred to 100mL volumetric flask. The beaker was washed 3-4 times with water and washings were also transferred into the flask and the solution was diluted to the mark with water.

III:-Standard solution of phosphate:-0.020grams of potassium hydrogen phosphate was dissolved in 100mL of aqueous solution. The concentration of phosphate in the standard solution is 0.14mg/l.

Apparatus: Systronics Model 160, with a1.0cm optical path quartz cell was used for spectrophotometric measurement.

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Simple spectrophotometer (systronics)

Procedure: I) A series of 10mL volumetric flasks were arranged. To each flask 0.5mLof ammonium molybdate,0.2mLof reducing solution, X mL of standard solution corresponding to 0.3 to 12.24ppm(X=0.2,0.4,0.6,0.8,1.0,1.2,1.4,1.6,1.8,1.9and 2.0mL) and Y mL of distil water where X+Y=9.3 were added. Then each solution was let at room temperature for about 20 min. The absorbance of the solution was measured at 635 nm against water.

II) Sample preparation: Commercially available soft drinks used as sample are Pepsicola, Coke, Thumsup, Limca, Mirinda. Samples are diluted 10 times .Mix 1mL of this dilute sample with o.5mL ammonium molbdate, 0.2mL reducing solution and 8.3mL water. The absorbance of the test solution were measured at 635nmagain.

III. RESULTS AND DISCUSSION

The developed method is based on the Formation of phosphomolybdate due to the reaction between molybdate and phosphate followed by its reduction with stannous chloride in aqueous sulfuric acid medium. Under optimized experimental condition, with fixed concentration of molybdate and reducing agent, the color intensity was found to be proportional to the amount of phosphate present in potassium hydrogen phosphate.

A graph is plotted between absorbance vs. various standard solutions. Calibration curve was obtained. From this curve the amount of phosphate in the test solutions was determined. The results obtained are shown in Table 1 and Table 2.

TABLE 1

Sr.no	*Ammonium molybdate mL)*	*Reducing solution(mL)*	*Standard phosphate solution (mL)*	*Distil water(mL)*	*Absorbance*
1	*0.5*	*0.2*	*0.2*	*9.1*	*0.15*
2	*0.5*	*0.2*	*0.4*	*8.9*	*0.20*
3	*0.5*	*0.2*	*0.6*	*8.7*	*0.25*
4	*0.5*	*0.2*	*0.8*	*8.5*	*0.38*
5	*0.5*	*0.2*	*1.0*	*8.3*	*0.46*
6	*0.5*	*0.2*	*1.2*	*8.1*	*0.47*
7	*0.5*	*0.2*	*1.4*	*7.9*	*0.53*
8	*0.5*	*0.2*	*1.6*	*7.7*	*0.63*
9	*0.5*	*0.2*	*1.8*	*7.5*	*0.64*
10	*0.5*	*0.2*	*1.9*	*7.3*	*0.65*
11	*0.5*	*0.2*	*2.0*	*7.1*	*0.75*

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TABLE 2

S.NO	Soft drink	Ammonium molybdate (mL)	Reducing solution(mL)	Sample (mL)	Distil water (mL)	Absorbance
1	Pepsicola	0.5	0.2	1	8.3	0.75
2	Coke	0.5	0.2	1	8.3	0.74
3	Thumsup	0.5	0.2	1	8.3	0.71
4	Limca	0.5	0.2	1	8.3	0.60
5	Mirinda	0.5	0.2	1	8.3	0.20

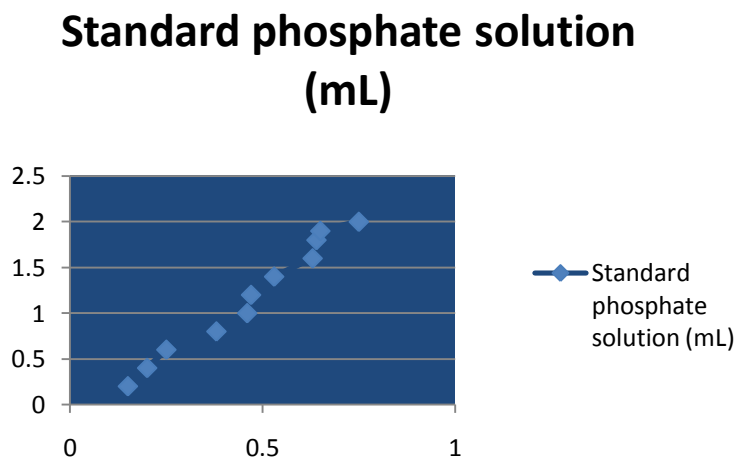

Figure 1. Calibration graph for the determination phosphate under optimized experimental condition

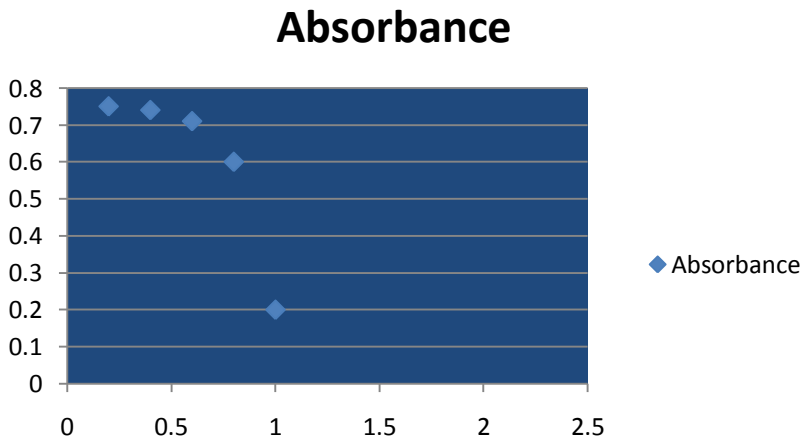

Figure 2 Absorbance of soft drink sample in calibration with figure 1

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The beers law is obeyed as linear plot is obtained. The amounts of phosphate in the sample of soft drinks reported are;

Sample1-pepsicola: 2.8mg/l
Sample2-coke: 2.52mg/l
Sample3-thums up: 2.4mg/l
Samle4-limca: 2.24mg/l
Sample5-mirinda: 0.56mg/l

IV. CONCLUSIONS

The proposed method is working on simple and straight forward principles of the reduction of phosphomolybdate by stannous chloride leading to molybdenum blue which was monitored at, max 635 nm The method found to be having the following advantages over the reported methods. (i) It is more sensitive when compared to the reported method. (ii) The preparation of reducing agent in this method is very simple when compared to that in the official method. (iii) It neither involves extraction nor sophisticated instruments like HPLC, flow injection spectrophotometer and atomic spectroscopy, nor requires strict control of pH or temperature or heat treatment.

As the method is observed to be working satisfactorily for the determination of phosphate in various samples giving the results which are not only comparable with the results of phosphate determined separately from an official method and also reproducible as revealed by the values of statistical parameters like standard deviation, 3.7% and relative error, 3.4%. Therefore, the method could be employed for the determination of phosphate as an independent or a complimentary one to the official method.

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