

Determination of Zinc in Pharmaceutical Preparations by Atomic Absorption Spectroscopy Using Mixed Solvent System

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Summary: A direct method, based on atomic absorption spectroscopy, is described for the micro-determination of zinc in pharmaceutical preparations. The samples were dissolved in a mixed solvent containing water, hydrochloric acid, ethanol and butane-2-one. The solution was then aspirated into an air-acetylene flame and absorbance of zinc was measured. Effects of organic solvents and hydrochloric acid on zinc absorption have been investigated. Metallic zinc was used as the standard. The method has been found simple, rapid and equally useful for organic and inorganic zinc in pharmaceutical preparations.

Introduction

Zinc is an essential element in nutrition and traces are present in many foods. It is a constituent of several enzyme systems including carbonic anhydrase, alcohol dehydrogenase and alkaline phosphatases and it is present with insulin in pancreas [1]. Deficiency of zinc is associated with impaired growth, parakeratosis and retarded sexual

maturation [2]. Due to its biochemical and pharmaceutical significance zinc is employed as antibacterial and antimicrobial agent alongwith other therapeutic medicines. Zinc-insulin is a drug of choice for diabetes mellitus. Similarly a number of zinc compounds are used as astringents for ophthalmic use and in ointments for skin diseases. Zinc has

to be invariably determined in zinc containing medicines because overdosage of this element may cause nousea, vomiting, chills, fever, salivation and headache [3].

By atomic absorption spectroscopy zinc has been determined in various matrices including water [4], soils [5], fertilizer [6], human milk [7], fish [8], biological materials [9], alcoholic beverages [10] and metallurgical products [11]. In most of the cases the analysis becomes tedious and cumbersome by involving prior decomposition of the sample, extraction of the metal into an organic solvent and then back extraction to aqueous medium [12]. The steps may give rise to the loss of metal and yield inaccurate results. Aspiration of pure organic extract has its own disadvantages as organic solvents tend to make the flame smoky, opaque and very reducing. To avoid such problems use of a mixed aqueous-organic solvent is the most suitable choice that makes it possible to work with either inorganic or organic zinc compounds. Such a mixed solvent would have four components: an organic solvent to dissolve organo-zinc compounds; water to accommodate inorganic metal; hydrochloric acid to keep the metal in solution and ethanol to blend the other components and control the flame conditions.

In this work zinc content of various drugs has been determined by merely dissolving the sample in the mixed solvent and aspirating the solution into flame. This approach has been shown to work well for organo-tin [13] and organo-antimony [14] compounds.

Experimental

Equipment

Varian 1275-AA atomic absorption spectrophotometer equipped with a standard hollow cathode lamp was used. Zinc absorption was measured in an air-acetylene flame at 213.9 nm.

Reagents

All the reagents of AnalaR grade and doubly distilled water were used throughout this work. All the organic solvents were used as such.

Zinc Standard Solution

Standard solutions, containing $100 \mu\text{g ml}^{-1}$ zinc was prepared by dissolving 0.1g AnalaR grade zinc metal in minimum quantity of dilute hydrochloric acid and diluting to 1000 ml with water. Calibration solutions were prepared by further dilution of $100 \mu\text{g ml}^{-1}$ solution.

Calibration

In a set of ten 100 ml volumetric flasks, transfer the aliquots of zinc standard solution containing 10-100 μg of zinc. Add 5 ml of butan-2-one to each flask followed by 5 ml of hydrochloric acid. Then add 30 ml of ethanol to each flask, Mix well and make up the volume with water. Prepare a compensatory blank without adding any zinc solution. Nebulize each solution into a medium air-acetylene flame and measure the absorbance at 213.9 nm. against compensatory blank. Prepare a calibration graph by plotting absorbance values against concentration of calibration solutions.

Drug Samples

Dissolve powdered drug sample equivalent to 10-100 μg zinc in 5 ml hydrochloric acid. Keep it with occasional shaking for ten minutes. Then add 5 ml of butan-2-one and 30 ml ethanol. Mix the contents gently and make up the volume to 100 ml with water.

For liquid preparations, pipette out a known volume of sample containing 10-100 μg zinc into a 100 ml flask. Treat it with butan-2-one, hydrochloric acid and ethanol (as in calibration) and make-up the volume with water. Nebulize the samples into flame under same conditions as used for calibration.

Results and Discussion

Effect of Hydrochloric Acid

As hydrochloric acid has been used as one of the constituents in the mixed solvent to dissolve zinc compounds and to keep the inorganic zinc in solution, its effect on zinc absorption is explored. Different volumes of 6M hydrochloric acid (1-10

Table-1: Zinc Found in Drug Samples by the proposed Method.

Drug Sample	No. of Determination	Zinc (%) reported	Zinc (%) found
Hazeline (Eye Drops) Welcome Pakistan Ltd. Karachi.	5	0.0202	0.0182
Mendoza (Eye Drops) Chas. A. Mendoza Karachi Pakistan.	5	0.1863	0.1900
Cicatrín (Powder) Wellcome Pakistan Ltd., Karachi.	7	0.0168	0.0080
Protamine, Zinc-Insulin (Suspensions). Eli Lilly Itaqlia Sesto Fiorentino-Firenze (Italy).	7	0.08-0.1 mg/cc.	0.0855 mg/cc
Stresstabs (Tablets 600 mg) Leaderle Labs. Cyanamide Pakistan Ltd. Karachi.	7	1.6136	1.6175

ml) has been added into aqueous standards containing equal quantity of zinc. As shown in Fig. 1, initially the acid enhanced the absorption mildly but later on it remained unaffected. The slight enhancement in zinc absorption may be attributed to the

dissociation of molecular species by the addition of adequate quantities of hydrochloric acid.

Effect of Acetone and Butan-2-one

Acetone may be used as one of the constituents of the proposed solvent mixture to help in dissolving organo-zinc compounds, hence the effect of acetone on zinc absorption has been checked by adding its different volumes in aqueous zinc solutions containing equal quantity of the metal. As shown in Fig. 2 acetone showed a pronounced effect on zinc absorption. It increased the absorption steadily when added 10-50%. This increase was mainly due to the improvement in up-take rate and favourable flame conditions.

In present work however a relatively better solvent for organo-metallic compounds, butan-2-one, has been used. This solvent became immiscible when its volume exceeded than 25% in water. Ef-

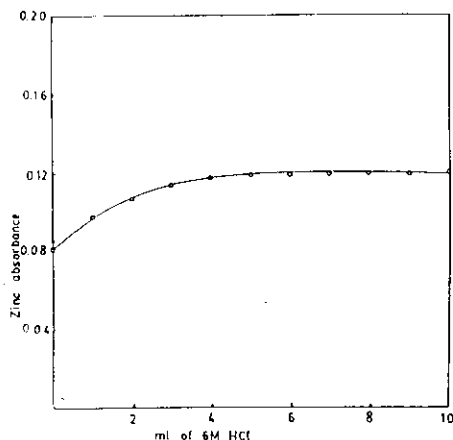


Fig.1: Effect of hydrochloric acid

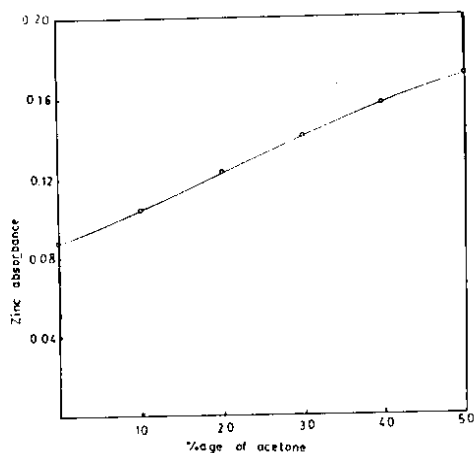


Fig.2: Effect of acetone

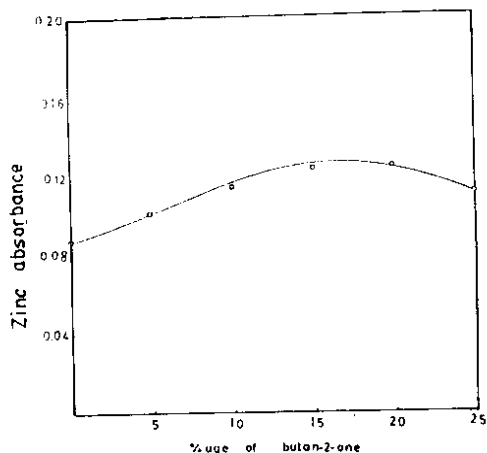


Fig.3: Effect of butan-2-one

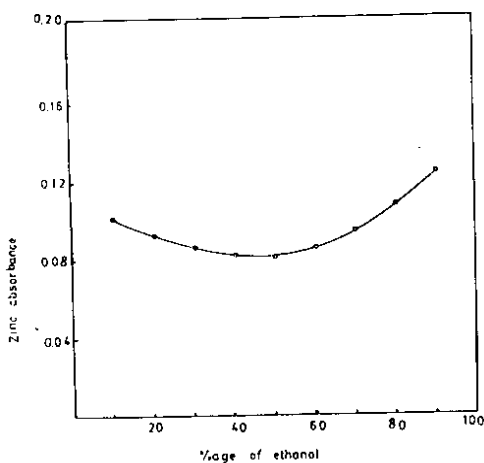


Fig.4: Effect of ethanol

fect of different volumes of butan-2-one on zinc absorption is shown in Fig. 3. Similar to acetone, butan-2-one also increased the absorption in start but higher concentrations of this solvent depressed the absorption in a medium air-acetylene flame. The decrease in absorption may be due to the fact that excessive addition of butan-2-one has changed the thermal conditions of the flame which affected adversely to the atomization of zinc.

Effect of Ethanol

Ethanol was a major constituent of the proposed solvent mixture. Its function was to blend the rest of the solvent components and to control the flame conditions. Effect of ethanol concentration in the range 10-90% on zinc absorption is shown in Fig. 4. There is a slight decrease in absorption in start and then by increasing the ethanol concentration more than 50%, the absorption was enhanced significantly. This change in ethanol behaviour is probably due to the change in up-take rate. Up-take rate is always inversely proportional to the viscosity of the solution. It has been observed that viscosity reached to its maximum value when ethanol is present with water in 1:1 ratio. So at this ratio the up-take rate is minimum. Therefore as shown in Fig. 4, minimum zinc absorption has been found when 50% ethanol was present in the solution.

Zinc in Drug Samples

Zinc content in a number of drug samples has been determined by the proposed method and the results obtained are compared with the reported values in Table-1. Except only one drug, the results obtained for rest of the samples are reasonably in agreement with those reported by their manufacturers.

In case of "Cicatrín", which is an antibiotic powder containing zinc as zinc-bactiracin, the results obtained are significantly lower than the value reported on the drug. This difference in results may be attributed firstly to the heterogeneity of the sample and secondly to its low solubility in the proposed solvent mixture.

By the proposed method zinc content in pharmaceutical preparations can be easily determined by simply dissolving the sample into a mixed solvent

and aspirating the solution into an air-acetylene flame. Metallic zinc can be used for standards. The method is simple, rapid and equally useful for organic and inorganic zinc determinations.

References

1. Mortindale The Extrat Pharmacopia, A. Wade (editor) 27th Ed., Pharmaceutical Press, London 1977 Page 220.
2. J.H. Block, E.B. Roche, T.O. Soine and C.O. Wilson "Inorganic and Pharmaceutical Chemistry" Philadelphia, Page 233, 1974.
3. Merck Index, 10th Ed. Merck & Co. Inc. Rahway, N.J., U.S.A. Page 9930 (1983).
4. H.M. Kingston, I. Barnes, T.J. Brady, T.C. Rains and M.A. Champ, *Anal.Chem.*, **50**, 2064 (1978).
5. C.J. Ritter, S.C. Bergman, C.R. Cothorn and E.E. Zamierowski, *At.Abs. Newsletter*, **17**, 70 (1978).
6. H.E. Hammar and N.R. Page, *At.Abs. Newsletter*, **6**, 33 (1967).
7. L.Nassi, G. Poggini, C. Vecchi and P. Galvan, *Boll.de Soc.Italiana di Bio. Sperimentale*, **48**, 86 (1972) *Anal.Abstracts*, **23**, 4714 (1972).
8. P.E. Paus, *At.Abs. Newsletter*, **11**, 129 (1972).
9. N.E. Vieira and J.W. Hansen, *Clin.Chem.*, **27**, 73 (1981).
10. R.Boriello and G.Sciaudone, *At. Spectrosc.* **1**, 131 (1980).
11. E.Lundberg and W. Frech, *Anal.Chim.Acta*, **108**, 75(1979).
12. D.Clark, R.M. Dagnall and T.S.West, *Anal. Chim.Acta*, **63**, 11(1973).
13. I.L. Marr and J.Anwar, *Analyst*, **107**, 260 (1982).
14. I.L. Marr, J.Anwar and B. Bruce Sithole *Analyst*, **107**, 1212 (1982).