Research Article

Polarographic Procedure for Determination of Zn in Yashad Bhasma

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ABSTRACT

A fast, sensitive and simple DC Polarographic method for the determination of the Zinc in Yashad Bhasma is described. Using DC polarograms of dry digested Bhasma sample, in 0.1 M KNO_3 quantities of Zinc was determined. The wave given by the Yashad Bhasma was found to be diffusion controlled. Its height is proportional to concentration, varies with concentration of KNO_3 solution and nature of the solvent and its temperature coefficient was found to be less than 2 mV per degree. The values of $E_{1/2}$ increase with increase in temperature which suggests that irrereversibility increase with increase in temperature.

Keywords: Yashad Bhasma, Zinc, DC polarography.

INTRODUCTION

Herbs and minerals are the integral parts of traditional systems of medicine in many countries. Herbo-Mineral medicinal preparations called Bhasma are unique to the Ayurvedic and Siddha systems of Indian Traditional Medicine. These preparations have been used since long and are claimed to be the very effective and potent dosage form.

According to Ayurvedic treatises, there are seven dhaatus (metals)-gold, silver, copper, iron, tin, lead and zinc-which are essential elements of the body. Perfect health is attributed to the state of equilibrium of these dhaatus in body tissues. Any imbalance excess or deficiency-disturbs the functioning of the body. Every mineral or metal in its native form is basically a biological product and Ayurveda has a way of converting the minerals into a biological form, which can be easily assimilated into the body.

Different herbs are brought together and made to react with the mineral by rubbing, boiling or burning together. Ayurveda uses mineral ash after restoring its biological qualities called as Bhasma.

Bhasma in Ayurveda has been defined as a substance obtained by calcination. Bhasma is a calcinated preparation in which the gem or metal is converted into ash. Gems or metals are purified to remove impurities and treated by triturating and macerating in herbal extracts. The dough so obtained is calcinated to obtain the ashes. Bhasmas are unique Ayurvedic metallic preparations used for medicinal purposes.

Zinc is the metabolically important trace mineral micronutrients. Zinc is present in blood, brain, nerve tissue and muscles. Imbalance causes problems related to nervous system like depression, anxiety, dullness of intellect, extreme forgetfulness and irritable temperament. Zinc Bhasma (Yashad Bhasma), the powder of zinc was characterized using modern physicochemical techniques. Yashad Bhasma is an alternative, diuretic, hypoglycaemic and astringent[1-2].

The study of Yashad Bhasma using modern techniques such as X-ray photoelectron spectroscopy (XPS), inductively coupled plasma (ICP), elemental analysis with energy dispersive X-ray analysis (EDAX), dynamic light scattering (DLS), and transmission electron microscopy (TEM) has been done. Yashad Bhasma particles are in oxygen deficient state and a clearly identifiable fraction of particles are in the nanometer size range[3].

Zinc is a principal limiting factor in the nutrition of children and adolescents and this probably accounted for growth retardation[4]. Yashad Bhasma can arrest the progress of myopia. Considering the high prevalence of myopia specially in childhood and adolescence it was thought worthwhile to assess the efficacy of the drug on controlled myopic patients[5].

Electrochemical methods have the advantage that they require relatively inexpensive instrumentation, have demonstrated ability for multi element determination and are capable of determining elements accurately at trace and ultra tracelevels[6-9].

A large number of pharmaceuticals can be reduced or oxidized in the available potential range and their waves can be used in their determination. It seems that often the therapeutical activity is paralleled by electrochemical reactivity. Pharmaceutical companies will use, whenever possible, officially approved methods of analysis. In the past, some polarographic analytical procedures were listed in numerous Pharmacopoeias. It should be a goal of electro analytical chemists around the world to have them listed again. The lower costs, faster results, and the possibility for quickly detecting mishandlings by technicians, are powerful arguments. To use polarographic methods for analyses of such simple matrices yields results often much faster, with a better accuracy and without using organic solvents[10]. Numerous

examples of such applications have been reported earlier[11-12].

In this work, we determine the zinc in Yashad Bhasma. In order to attain these objectives, we planned to carry out detailed investigation of Yashad Bhasma using Direct current Polarography.

MATERIALS AND METHODS

Apparatus

The direct current recording polarograph (Model- CL 357) of Elico Ltd. was used for study. Three electrode system was used- a working electrode (D.M.E.), reference electrode (saturated calomel electrode) and counter electrode (platinum electrode) as described by the Meites[16]. A glass capillary of 120 mm long and 0.05 mm in diameter was used.

A digital pH meter (Model- 111 E) was used for measuring the pH of the analytes.

Reagents

All the solutions were prepared from triple distilled water and analytical reagent grade chemicals (MERCK).

Yashad Bhasm was obtained from Rajasthan Drugs Pharmaceuticals Ltd. Standard stock solutions of Zn was prepared from their Zinc Acetate salt. 0.1 M KNO_3 has been used as supporting electrolyte. Triton X-100 (0.001%) was used to suppress polarographic maxima.

Sampling and digestion

Yashad Bhasma is digested by dry ash method[13].

Procedure

The working procedure for direct current polarography (d.c.p) was as follows:

Total 10mL of experimental solution was placed in a polarographic cell and deoxygenated with ultra pure nitrogen which had been passed through acidified vanadous chloride solution for ten minutes. The cell was placed in the thermostat and the capillary was inserted in solution. The current were measured at various applied voltages. Half wave potential $E_{1/2}$ (volts *vs* S.C.E.) and peak current(s) (μA) were recorded.

The potential was applied to the working electrode with scan rate of 150 mV/min and 100 nA/div sensitivity of current measurement.

For the reduction study 0.05 M stock solution of Yashad Bhasm were prepared by dissolving digested solution of Yashad Bhasm in triple distilled water. The AR grade potassium nitrate was taken as supporting electrolyte.

Electrochemical Study of Yashad Bhasm in Bulk Forms at Dropping Mercury Electrode

For determination of concentration of Zn^{+2} ions in Yashad Bhasma standard addition method of polarographic analysis is used[14].

RESULTS AND DISCUSSION

A well-defined two-electron reversible reduction and diffusion controlled wave of Zn^{2+} was observed in 0.1 M KNO_3. The value of $E_{1/2}$ reversible for Zn^{2+} was -1.0545 V vs. SCE. To ascertain the presence of the metal ions in the sample, a known quantity of stock standard solution of zinc metal ion was added to the sample solution and polarograms were recorded.

The diffusion currents were found to increase with increase of metal concentration, without any change in its $E_{1/2}$ values confirming the presence of Zn^{+2} ions in sample solution.(Fig 1)

The nature of the Current-Voltage curve of Yashad Bhasma was also reversible and diffusion-controlled. The slope values of the plots of $\log(i/i_d-i)$ vs. E (mV) are found in the range 31±2 mV suggesting the reversible nature of electrode reaction. (Fig. 2.A & 2.B)

Linearity of calibration curves was obtained in all cases with the value of correlation factor (r) near to one. Linear relationship between concentration and diffusion current (I_d) has been proved statistically by applying straight line equation to all calibration curves[15]. The results obtained from the study of Zn metal in Yashad Bhasma presented in table 1.

Effect of temperature

A gradual change in diffusion current and half wave potential was observed when the solution temperature was increased from 20°C to 40°C (Table 2 & Fig.3). When we increased the temperature of solution the half wave potential of system becomes more positive and diffusion current increases gradually. In this system the temperature coefficient is less than 2 mV per degree so that the system is reversible[16].

Table 1: Trace Analysis of Zn in Yashad Bhasm

A (M)	B (M)	Mean	S.D.	R.S.D.	% Error
1.25×10^{-3}	1.23×10^{-3} 1.20×10^{-3} 1.17×10^{-3}	$1.20X10^{-3}$	2.79×10^{-5}	2.326	0.0436

Where: A - Concentration of Zn^{+2} ions in standard stock solution; B - Concentration of Zn^{+2} ions in sample solution; S.D. - Standard Deviation; R.S.D. - Relative Standard Deviation; % Error- Percentage Error.

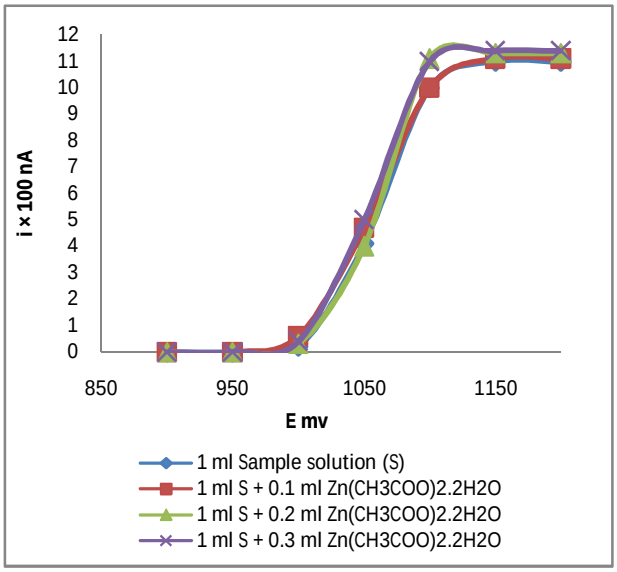

Figure 1: Effect of Concentration

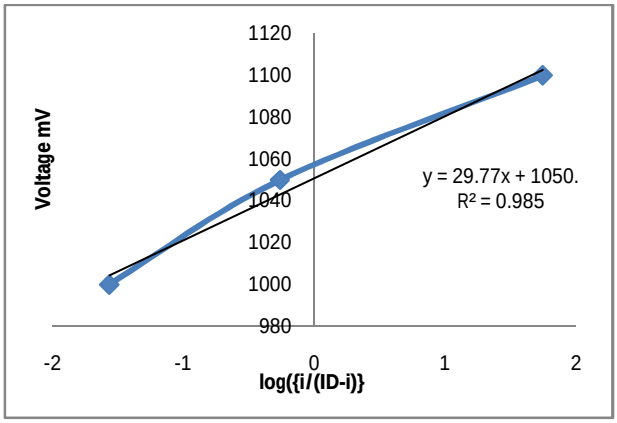

Figure 2.A

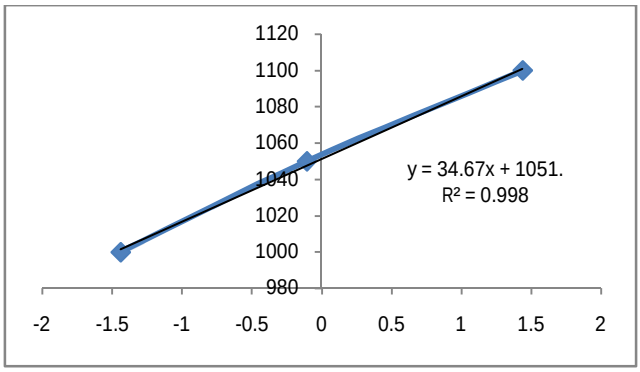

Figure 2.B: Linearity graph for Yashad Bhasm

Table 2: Effect of temperature

Temperature (K)	Bhasma Concentration (M)	E ½(V)	I_d(µA)
293	1.25×10^{-3}	-1.054	11.0
298	1.25×10^{-3}	-1.047	12.2
303	1.25×10^{-3}	-1.041	13.1
308	1.25×10^{-3}	-1.035	13.7
313	1.25×10^{-3}	-1.025	14.6

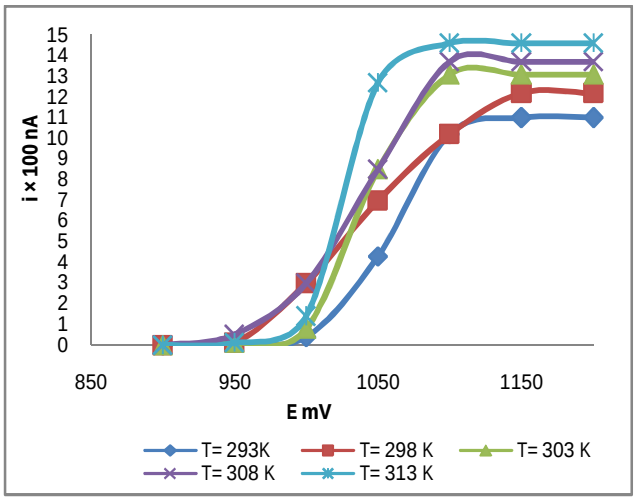

Figure 3: Effect of temperature

Effect of sporting electrolyte concentration

Electrochemical behaviour of Yashad Bhasma has been studied as a function of sporting electrolyte concentration in KNO_3 solution (Table 3 & Fig. 4). The diffusion currents decrease with the increase in concentration of the KNO_3 solution. Since the diffusion current (I_d) depends on the diffusion coefficient of the electroactive species, which in turn depends on the viscosity of the solution, increasing the viscosity causes I_d to decrease[17]. Further, the half wave potential of the Yashad Bhasma shifts to the more negative direction on increasing the concentration of the KNO_3 solution[18].

Table 3: Effect of sporting electrolyte concentration

KNO_3 conc. (M)	Bhasma Concentration (M)	E ½(V)	I_d(µA)
0.1	1.25×10^{-3}	-1.054	11.0
0.2	1.25×10^{-3}	-1.062	10.8
0.3	1.25×10^{-3}	-1.075	10.6

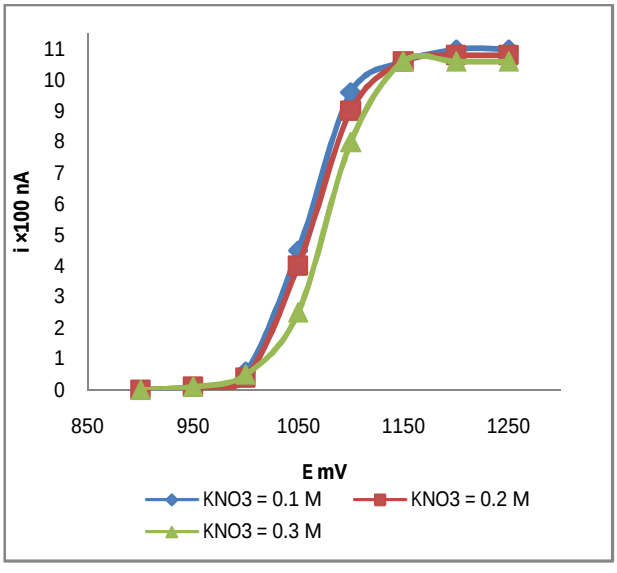

Figure 4: Effect of sporting electrolyte concentration

CONCLUSION

A simple and sensitive method was developed for the qualitative determination of Yashad Bhasma. The described direct current polarography method for the determination of Zn in Yashad Bhasma is specific, sensitive and rapid with a simple approach comprising low cost instrumentation. The results obtained by direct current polarography method are quantitative and in good agreement in terms of precise measurement. The wave given by the Yashad Bhasma was found to be diffusion controlled. Its height is proportional to concentration, varies with concentration of KNO_3 solution and nature of the solvent and its temperature coefficient was found to be less than 2 mV per degree. The values of $E_{1/2}$ increases with increase in temperature which suggests that irrereversibility increases with increase in temperature; this implies that reduction products of drug are stable at lower temperature. In other words the electrode reaction was rendered more irreversible at higher temperature. Provided that proper attention is given to the factors of pH, concentration, temperature etc on the half-wave potential, the wave could be of value for qualitative identification.

REFERENCES

1. Manohar CM, Ayurveda for All, 2002, Pustak Mahal, New Delhi, 2005, 220.
2. Umrani RD, Paknikar KM, Ayurvedic medicine zinc bhasma: physicochemical evaluation, anti-diabetic activity and safety assessment, J Biomed Nanotechnol., 7(1), 2011, 148-149.
3. Bhowmick TK, Suresh AK, Kane SG, Joshi AC, Bellare JR, Physicochemical characterization of an Indian traditional medicine, Jasada Bhasma: detection of nanoparticles containing non-stoichiometric zinc oxide Nanopart Res, 11, 655–664, 2009.
4. Ronaghy HA, Zinc supplementation of malnouristed school boys in Iran: Increased growth and other effects, A.M. J. Clin. Nutr., 27, 1974, 112-121.
5. Puri RN, Thakur V, Nema HV, Role of zinc (Yashad Bhasma) in arrest of myopia, Indian J. Ophthalm., 31(7), 1983, 816-822.
6. Inam RR, Somer GG, A direct method for the determination of selenium and lead in cow's milk by differential pulse stripping voltammetry, J. Food Chem., 69, 2000, 345-350.
7. Inam R, Somer G, Determination of Copper, Zinc and Selenium in Chicken Liver by Differential Pulse Polarography, J. Talanta, 46, 1998, 1347- 1355.
8. Inam R, Somer G, Determination of selenium in garlic by cathodic stripping Voltammetry, J. Food Chem., 66, 1998, 381-385.
9. Somer G, Unal U, New and direct method for the trace element determination in cauliflower by differential pulse polarography, J. Talanta, 62, 2004, 323-328.
10. Zuman P, What Can DC Polarography Offer Today, Acta Chim. Slov., 56, 2009, 18–29.
11. Brˇezina M, Zuman P, Polarography in Medicine, Biochemistry and Pharmacy, Interscience Publ., New York, 1958, 585.
12. Pandey R, Kumar Y, Sharda, Singh M, Electrochemical Study of Zn+2-Theophylline Complex, Int. J. ChemTech Res., I.3(1), 43-50, 2011.
13. Jones JW, Gajan RJ, Boyer KW, Fiorino JA, Dry ash-voltammetric determination of cadmium, cooper, lead, and zinc in foods, J. Assoc. Off. Anal. Chem., 60(4), 1977, 826-32.
14. Meites L, "Standard addition" Method of Polarograhic Analysis, Anal. Chem., 28 (1), 1956, 139–140.
15. Pandey R, Meena O P, Garg A , Kumar Y, Electro analytical Procedure for determination of Heavy Metals in Brassica oleraceae ver. Botrytis, Int. J. ChemTech Res., 3(3), 2011, 1596-1603.
16. Meites L, “Polarographic techniques”, Brooklyn, New York, 1964, 288.
17. Samota S, Garg A, Pandey R, The Polarographic Reduction and Electrode Kinetics of Antidepressant Drug Bupropion Hydrochloride, Portugaliae Electrochimica Acta, 28(2), 2010, 87-94.
18. Meites L, “Polarographic techniques”, Brooklyn, New York, 1964, 291.

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