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Research Article

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Determination of heavy metals (cadmium, lead, copper) in herbal syrups by polarography

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ABSTRACT

People have taken the advantage of using herbs as an effective method for medical treatment since long times ago that can be attributed for their cheap prices and the belief of their being safer than equivalent chemical medicines. Industrial development and the ever-increasing exposure of environmental threatening materials especially heavy metals have merged the necessity for iterative examination of herbal products safety. In this study, highly sensitive and selective method of Differential Pulse Stripping Voltammetry was employed to measure copper, lead and cadmium in seven herbal syrups available in Tehran city drug stores. The mean concentrations of lead, cooper and cadmium were measured to be 5.95µg/L, 6.269 µg/L, 66.926ng/L in the studied samples, respectively. The results indicate that the extent of copper, lead and cadmium amounts were below the standards of WHO for all the samples.

Keywords: Polarography, Herbal Syrups, Cadmium, Lead, Copper.

INTRODUCTION

Heavy metals are serious environmental pollutants that menace the environment and because of their not being biodegradable, remain in food chain and ecological system and consequently threat human health [1,2].Obviously, plants are commonly consumed in daily food basket. Further, the everyday increase in public's interest in taking herbal medicine and treatments instead of those of chemicals with destructive side effects they bring along has concerned the safety of herbal products [3,4]. Researchers have demonstrated that plants are polluted with copper, cadmium and lead toxic metallic elements that are stable in environment so that can be disintegrated difficultly[5,6]. Copper, as an essential micronutrient for metabolic mechanisms, regulates different biological processes such as oxidation-reduction, energy production, iron metabolism and formation of connective tissue [7,8]. The high amount of copper in human body may yield some digestive problems such as nausea and vomiting. This element bonds with mature lymphocytes and regulates the immune functions of the body so that its low amount may result in occurrence of some disorders for immune systems [9]. Lead, as one of the most toxic heavy metals enters body through various ways such as imbibition, respiration, eating lead-contaminated foods and dermal attraction while its concentration in body does not have any known effects [10].This toxic metal does have many side effects on different organs of the body such as immune, cardiovascular, renal, digestive and reproductive organs [11]. Finally, cadmium is a heavy metal that deals with people working in occupational environments and engaged in these related activities. Cadmium exposure has various side effects on the body that is due to its long biological half-life. Cadmium is mainly

transferred to plants from soil in a very speedy process. Moreover, this toxic metal has carcinogenic effects on liver, pancreas and stomach [12].

There are some different methods to measure the amounts of heavy metals such as: Atomic Absorption Spectrometry (AAS), Inductively Coupled Plasma Mass Spectrometry (ICP-MS), Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES)[13-15]. The main disadvantages of the mentioned methods are their not being fast, frugal, and easy. Also, they need sample preparation steps which sometimes result in the target elements lost, especially in trace concentrations. Electrochemical analysis, voltammetry, is a precise, inexpensive, and sensitive method that can be applied to simultaneously determine without extensive sample preparation steps[16-18]. Differential Pulse Stripping Voltammetry (DPSV), in addition to its high sensitivity, is a relatively economical and with considerably low detection limits technique for measuring trace amounts of heavy metals, simultaneously[19-22].

Here in this research, DPSV method has been applied for the simultaneous determination of lead, cadmium, and copper concentrations in herbal syrups.

EXPERIMENTL SECTION

Sample collection: Seven herbal syrups were obtained in the drug stores of the city of Tehran at June 2014 that are prepared from Sena, Ginsin, Ivy, Viola flower, Dill,*Zataria Multiflora*, Jalap.

Apparatus: Analysis was conducted by 797 VA computerize device from Metrohm. A three-electrode system with an Ag/AgCl electrode as the reference electrode, a hanging mercury drop electrode (HMDE) as the working electrode and a platinum electrode as the auxiliary electrode. The device outfitted in the following conditions: stirrer speed 2000 rpm, mode Dp, purge time 300 s, equilibration time 10 s, pulse amplitude 0.05 V, start potential -1.15 V, end potential 0.05 V, voltage step 0.006 V, voltage step time 0.3 s, sweep rate 0.020 V/s.

Reagents and solutions: All the chemical substances and solutions were of analytical grade and prepared with Merck (Germany). The used standard solution contains 0.02 ml cadmium 1mg/l, 0.02 ml lead 1 mg/l and 0.025 mL copper 1 mg/l [22]. Buffer solution was prepared by dissolving 7.49 mL ammonium 25%, 11.8 mL acetic acid and then adding ultrapure water up to 100 ml and adjusting the solution pH to 4.6. The buffer was then kept in refrigerator.

Method of analysis: 1 µl of each herbal syrup as well as 25 mL of deionized water and 1 mL of the buffer solution were placed in the polarographic vessel for the measurements. The determination procedure was carried out based on method VA-46 of the apparatus software. The replication option was adjusted on 3 to remove a peak in case the difference between the peaks with the two other peaks was notable. Calculations were made by the method of standard addition and all the above-said stages were performed 3 times for each sample.

RESULT AND DISCUSSION

Frightening expose of environmental pollutants by especially through industrial activities have made rapid and precise measuring of the contaminants released, especially heavy metals, of great importance. Although this need has been full field by means of accurate with low detection limit technique such as DPSV as a suitable method to measure very low concentrations and without requiring metal enrichments before analytical measurements performance. Other considering advantages of the technique is that the obtained electrical signals (response) that occur as a result of the metals oxidation and reduction interactions are directly proportional to the concentration of metal in the sample.

The differential pulse polarograms of cadmium, lead, copper in Ginsin syrup are presented in Figure 1 as an example. Mean concentrations of Pb, Cd and Cu in the studied herbal syrups are presented in Table 1.The studied heavy metals were all observed in all of the studied samples except that of in that of Ivy syrup in which the concentration of cadmium may have be lower than the applied device detection limit to be spot (that is 0.1 µg/l) or the syrup may have been cadmium free. The highest concentration of Cd was observed for the syrup from Viola flower that obtained to be 86.23±13.71ng/L, while highest concentrations of Pb and Cu were observed in the syrups from Ivy and Jalap with the concentrations of 9.33±0.06 µg /L and 7.59±0.31 µg /L, respectively. The result

indicated that copper, lead and cadmium were below WHO standards (Cd 0.3 ppm, Cu 20 ppm and Pb 10 ppm in herbal medicine in all the samples[23].

Table 1. Mean concentrations of Pb, Cd and Cu in the studied herbal syrups
**Not detectable*

Sample	Herbal drug	Cd (ng/L) ± SD	Pb (µg /L) ± SD	Cu (µg/L) ± SD
1	Sena	51.31±2.04	3.94±4.07	6.74±5.77
2	Ginsin	68.85±2.84	5.79±0.19	5.25±0.39
3	Ivy	Nd*	9.33±0.06	6.38±0.18
4	Viola flower	86.23±13.71	5.73±0.62	6.22±1.31
5	Dill	59.76±16.51	6.40±2.01	5.65±2.13
6	*Zataria Multiflora*	68.44±3.38	6.253±0.03	6.00±0.84
7	Jalap	66.94±4.71	4.18±0.93	7.59±0.31

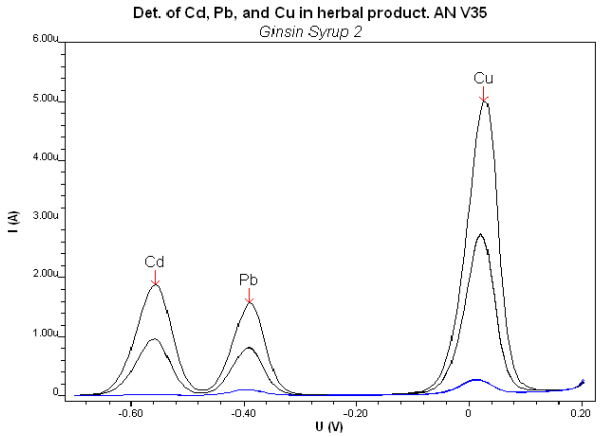

Figure 1.The differential pulse polarogram of cadmium, lead, copper in Ginsin syrup

CONCLUSION

With the increasing consumption of herbal medicine worldwide along with considerable amount of hazardous material (like heavy metals) release to the environment, rapid and precise determination of heavy metals concentrations in herbal products has become of great importance. In this research DPSV was employed to simultaneously determine cadmium, lead and copper in herbal syrups available in Tehran city drug stores. The concentrations of metals in syrups ranged from 51.31-86.23ng/L for Cd, 3.94-9.33 µg/L for Pb and 5.25-7.59µg/L for Cu. The target metals concentrations were obtained to be lower than WHO limitations.

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