Impact of Tremendous Consumption of Tea Drink on Blood Lead

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Abstract: Heavy metals especially lead, are considered to be one of the important sources of pollution of foods and drinks. Tea is a very common drink and could be a source of some heavy metals particularly lead. Objectives:1- To determine lead traces in the samples of packed tea; collected from the local market of Egypt; one of EMR countries; by using two techniques, a) the differential pulse anodic stripping voltammetry (DPASV) at a hanging mercury drop electrode and b) the atomic absorption spectrometry (AAS). 2- To evaluate level of plasma lead in heavy and chronic consumers of tea drink. Materials: Reasonable amounts of different tea (black and green) packets, were collected from the local market to determine its lead content. Subjects: 103 randomly chosen Sohag residents; in different work places; who tremendously used to consume tea and other beverages; being guards, carpenters, constructors and iron workers in constructions. All were informed about the research aim and their verbal consents were approved; they subjected to: a) full history reporting for their habits of tea drinking, b) medical examination and c) determination of lead in their plasma by using Atomic Absorption Spectrophotometry. On staistical analysis, plotting the current signals against the lead ion concentration added to the sample gave straight line. From this linear relationship, each concentration, the standard deviation and correlation coefficient values were obtained. SPSS program, version 10 was used to elucidate the statistical correlations. Results: lead element level ranged from 0.027 to 0.603 µg g^{-1}; in tea packets samples by using (DPASV) and from 0.028 to 0.607 µg g^{-1} by using (AAS), but was within the tolerated amount set by FAO/WHO. The concentrations in chronic consumers plasma were above maximum permissible figures; 18.4 % had about 40-150 µg/dl and they were symptomatizing.

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1. Introduction

Many beverages are agricultural products and its pollution by irrigation water, atmosphere, soil, sterilization methods and storage conditions; may play an important role in contamination of plants by heavy metals that may lead to health hazards in some cases. Trace elements, especially heavy metals, are considered to be one of the main sources of pollution [(1)]. Tea and coffee are considered to be one of the most popular beverages in the world. Its consumption continues to increase due to its physiological effects as well as its pleasant taste and aroma. Tea and coffee are considered the most commonly consumed beverages in Eastern Mediterranean Region [(2)]. Therefore, the chemical components in these beverages have received great interest because they may affect consumer's health.

The recent development in analytical atomic spectrometry allows the determination of divalent metals like lead in tea, coffee, anise, hibiscus (karkade) ….etc. However, stripping voltametry is accepted now as a simple, selective, sensitive and low cost technique[(3)].

Heavy metals composition of foods is of interest because of either their essential or toxic nature. For example, iron, zinc, copper, chromium, cobalt and manganese are essential, while lead, cadmium, nickel and mercury are toxic at certain levels [(1-4)]. The compositions of various metals in different food types of various countries have been the subject of many studies [(5-8)].

Lead has no known biological role in the body. Most lead poisoning Symptoms are thought to occur by interfering with an essential enzyme; Delta-aminolevulinic acid dehydratase, or ALAD (is a zinc-binding protein which is important in the biosynthesis of heme, the cofactor found in hemoglobin) [(6, 7)]. It inhibits several enzymes critical to the synthesis of heme, causing a decrease in blood hemoglobin and interferes with a hormonal form of vitamin D, which affects multiple processes in the body; including cell maturation and skeletal growth. Lead can also cause hypertension, reproductive toxicity and developmental effects. Lead exposure can lead to renal effect such as fanconi-like syndromes, chronic nephropathy and gout [(8, 9)]. Excessive lead exposure continues to be a pervasive and serious threat to the health and well being of man especially children [(10)].

Exposure to lead is prevalent in Egypt especially in urban areas mainly due to leaded gasoline, water pipes, food contamination, etc. This adds an extra hazard to the occupational exposure [11] .Central nervous system appears to be the primary target organ for lead effect[12] .

Children show a greater sensitivity to lead's effects than adults do . The incomplete development of blood brain barrier in very young children (up to 3 years of age) increases the risk of lead's entry into developing system, which can result in prolonged neurobehavioral disorders. Children absorb and retain more lead in proportion to their weight than adults. Young children also show a greater prevalence of iron deficiency, a condition that can increase gastrointestinal absorption of lead [13].

However, other systems including cardiovascular, renal hepatic, and hematological systems are also affected. Lead exposure, in contrast to long old beliefs , is a problem that affects all socioeconomic groups. [12] Parents should thus be informed regarding sources of lead exposure and informed about the basic nutritional information protecting their children [13] .

Aims of the work:-

1- To measure lead traces in the samples of tea samples collected from the local market of Sohag by using two techniques, the differential pulse anodic stripping voltammetry (DPASV) at a hanging mercury drop electrode. The second technique was the atomic absorption spectrometry (AAS); for lead, the graphite furnace atomic absorption spectrometry was used.
2- To evaluate levels of plasma lead intoxication in a sample of heavy and chronic consumers of tea beverages by self-reliance reporting and their medical and laboratory investigations versus a control group .

Materials:

Reasonable amounts of different tea samples commonly consumed in Sohag, Upper Egypt i.e. black and green were collected from the market. Table (1) shows the trade name and the production countries of each sample.

Subjects:

One hundred and three residents; both rural and urban, were randomly chosen from Sohag work places; having tremendous consumption of tea, e.g.: Construction's guards, carpenters, masonry constructors and blacksmith or forgers in civil constructions. They were informed about the research aims and their verbal consents were approved before participation in the research. They subjected to full history reporting about the habits of herbal drinking at home, work and their entertainment places (qahwa and ghorza), prolonged and heavy consumption of tea, using the boiling maneuver for a long time in its preparation. They subjected to thorough medical examination and determination of lead in their plasma by using AAS. Similarly; 96 men reported no or mildly tea, consumers of the light, non-boiling manouver (koshry method) for tea preparation worked as a control group and subjected also to examination and plasma lead determination.

Statistical handling:

Plotting the current signals against the lead ion concentration added to the sample gave straight line. From this linear relationship, each of the concentrations, the standard deviation and correlation coefficient values were obtained. SPSS program, version 10 was used to elucidate the statistical correlations.

3. **Results**:

In order to set the optimal condition of lead cations, preliminary measurements were made to obtain the highest peak signal for the metal ions Pb(II) in solution samples. It was noticed that Briton-Robinson buffer solution (pH~2.1) gives promising results for the determination of Pb ions. The effect of deposition potential of the metal ion was studied and it was observed that the highest and best shape peaks for Pb^{2+} was at deposition potential -0.55 V vs. /AgCl. The effect of deposition time on the oxidation peak signals of this metal ions was examined

Table (1) shows the trade name, codes and country of origin of tea (Ceylon- India- Kenya and Indonesia.

Table (1): Trade names and product origin of the selected tea samples

Code	Trade name	Country of origin
T_1	Lipton tea	Ceylon- India- Kenya
T_2	El arosa tea	Kenya
T_3	El temsah tea	India – Kenya
T_4	Rose tea	Kenya
T_5	El gawhara tea	Kenya-Ceylon
T_6	Keda tea	Kenya
T_7	Crown tea	Kenya
T_{8*}	Lipton tea	Indonesia

The samples from T_1 to T_7 are black tea and the sample T_8 is green tea.

The results obtained by using AAS of the lead element ranged from 0.028 to 0.607 µg g^{-1}. All the element contents in the tea samples were within the tolerated amounts set by FAO/WHO.

I-Determination of lead in tea samples:

a- DPAS voltammetric determination of Pb(II):

Figures (1-a, b) represent the differential pulse anodic stripping (DPAS) voltammograms of Pb(II) ions for samples T_2 (El arosa tea) and T_3 (El temsah tea) at different deposition times, in order to obtain the optimum deposition time for the determination of lead ions. The linear relation was obtained between deposition time and the current signals of the tea samples as shown in Figures (2-a, b).

The plots of peak current (i_p) against Pb (II) concentration in tea samples under study, using the standard addition method are shown in Figures (3-a, b). From the interception of this line with the concentration axis at zero current signals, give the concentration of lead ions in the voltammetric cell for each sample after correction of the back ground current of blank experiments.

The concentrations of Pb(II) in tea samples under consideration, using DPASV; with optimal deposition times for the metal ion in each sample are shown in table (2). It was found that the mean levels of Pb(II) are ranging from 0.027 to 0.603 µg g^{-1}.

Lead concentration exists in the range from 0.028 to 0.607 µg g^{-1} where, the lowest concentration (0.028 µg g^{-1}) is found in T_1 (Lipton tea) and the highest concentration (0.607 µg g^{-1}) was found in T_3 (El temsah tea beverage); it didn't differ so much from that determined by DPAS

II-Determination of Lead in the plasma of the consumers by AAS:

Fig (4) shows the blood Pb level in 19 symptomatizing Pb-intoxicated, tremendously, heavy consumers of tea; who were found to drink more than 10 times a day of about 200 ml each time of strongly boiled preparation of tea packets; about 0.5-6 minutes reboiling, for a long period of their ages; 10 $\pm$ 1.1 years**.** The others; (the remaining 84 of the heavy consumers group and the 96 lightly consumers control group) were not symptomatizing and they didn't exhibit raised Pb levels in their sera above the maximum permissible figure in Egypt of 20 µg\dl blood. The formers consumed tea heavily for a period of 6 $\pm$ 0.83 years; although raised levels above that of the control group were noticed [mean levels were 6.4 $\pm$ 3.7 versus 1.9 $\pm$ 0.4 µg/dl of blood, $p < 0.001$; by independent T test]

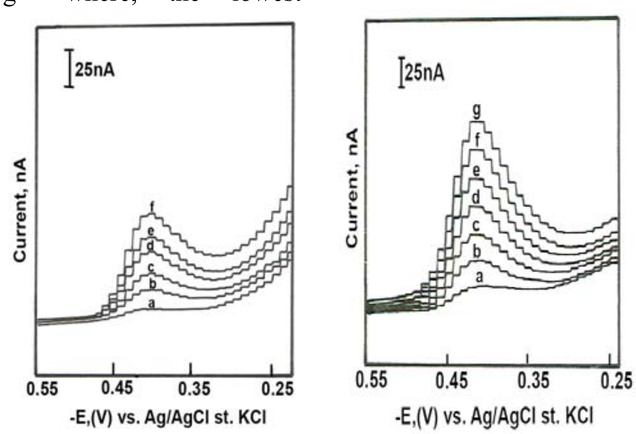

Fig. (1a, 1b): DPAS Voltammograms of Pb(II) in T_2 sample in presence of 0.028M Briton-Robinson buffer solution, pH ~2.1 at deposition potential – 0.55V and different deposition times:a) zero sec. b) 15 sec. c) 30 sec. d) 45 sec. e) 60 sec. f) 75 sec. And for T_3 sample in deposition times: a) zero sec. b) 10 sec. c) 20 sec. d) 30 sec. e) 40 sec. f) 50 sec. g) 60 sec.

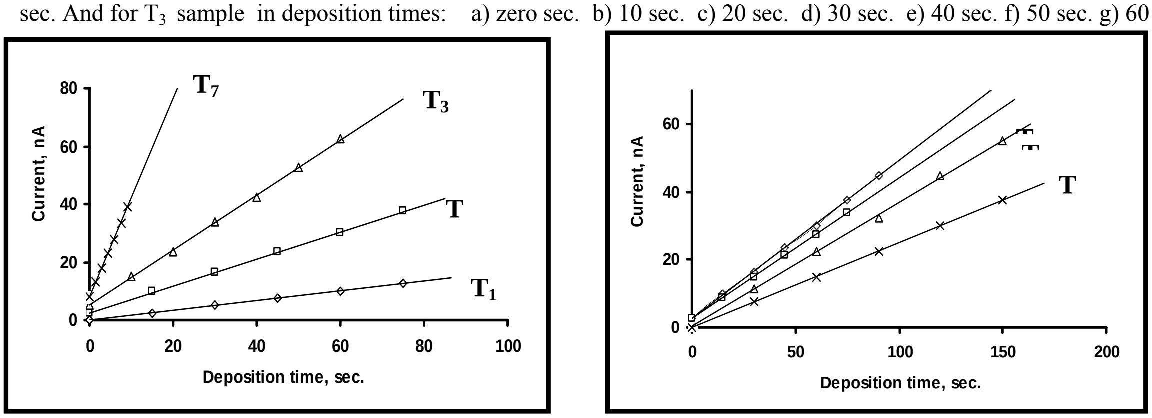

Fig. (2-a, b): The linear relationship between the deposition time and the current signals in tea samples (**T_1- T_8**) in presence of 0.028 M Briton- Robinson buffer solution, pH~2.1 at deposition. potential – 0.55V, using DPASV

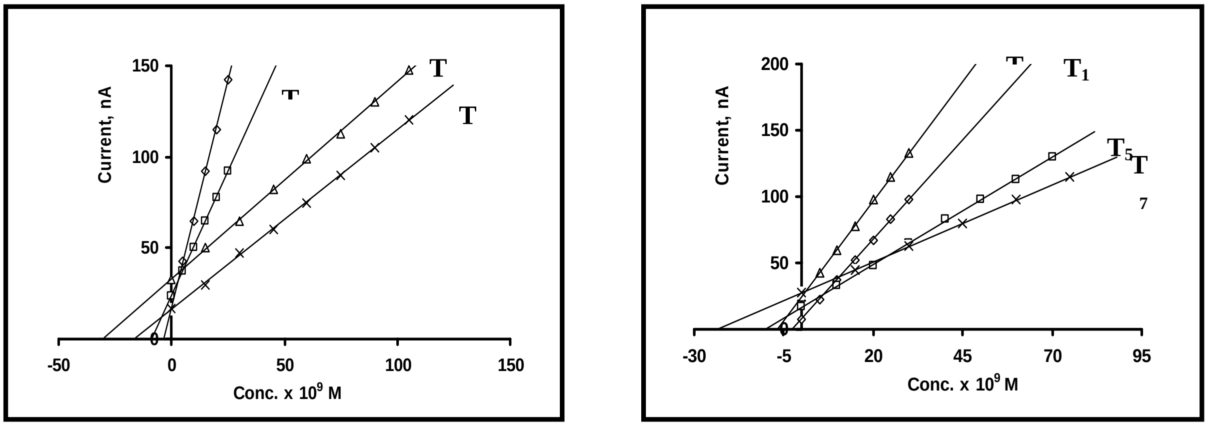

Fig. (3a, 3b): Standard addition plots of Pb (II) in tea samples: 1)T_1 at 45 sec. 2) T_2 at 45 sec. 3) T_3 at 30 sec. 4) T_4 at 30 sec. 5) T_5 at 45 sec. 6) T_6 at 60 sec. 7) T_7 at 30 sec. 8) T_8 at 60 sec. at deposition potential -0.55 V, using (DPASV).

Table (2): Regression Parameters, mean levels and confidence intervales for Lead content in different tea sample

Tea Sample codes	T_d Sec.	Lead content (mean ± SD)^a µg g^{-1}	Regression parameters: Slope	Intercept / (10^{-9} mol dm^{-3})	Correlation Coeffecient	confidence: Higher	Lower
T_1	45	0.027 ± 0.002	3	7.5	1.0000	0.031	0.025
T_2	45	0.149 ± 0.012	2.7	23.75	0.9994	0.164	0.134
T_3	30	0.603 ± 0.043	1.11	32.5	0.9994	0.657	0.551
T_4	30	0.321 ± 0.032	0.98	16.5	0.99954	0.361	0.281
T_5	45	0.0130.188 ±	1.60	17.5	0.9993	0.204	0.172
T_6	60	± 0.0110.115	3.58	25	0.9996	0.129	0.101
T_7	30	± 0.0360.463	1.17	72.5	1.0000	0.508	0.418
T_8	60	± 0.0030.044	4.97	17.5	0.9994	0.048	0.040

--- a = mean value ± standard deviation for n = 5 at 95 % confidence level.
--- AAS détermination for Pb(II), expressed as an average revealed that: T_1 had 0.028, T_2 had 0.150, T_3 had 0.607, T_4 had 0.323, T_5 had 0.189, T_6 had 0.116, T_7 had 0.463 and T_8 had 0.043 **µg g^{-1}** of Pb(II)

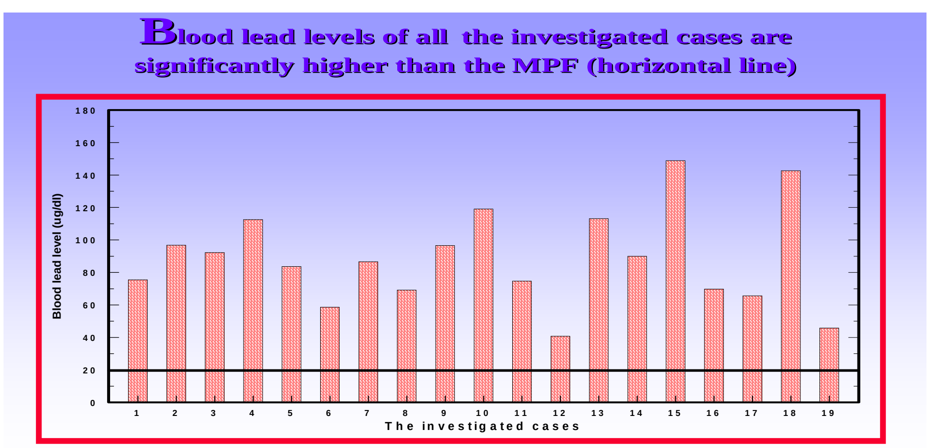

Fig (4): Blood Pb level in the 19 symptomatizing lead-intoxicated, tremendously heavy consumers of strongly-boiled tea, for more than 10 ± 1.1 years

Discussion:

Lead is one of a limited class of elements that can be described as purely toxic.[1] It has a cumulative effect and is found in a variety of products. Lead poisoning or plumbism is an environmental public health problem that dates back at least to the Roman Empire. In modern society, environmental exposure to lead remains pervasive.[2] The most common sources of lead poisoning are, occupational followed by environmental including air, soil, water and food contamination.[3]-[4]

In the index study, there is a good agreement in all cases between the data obtained by stripping voltammetric technique and those evaluated by atomic absorption spectrometry. Both showed the presence of lead in tea beverages consumed in Egypt as many parts of EMR; although the tea samples under study were of different origins, lead element level ranged from 0.027 to 0.603 $\mu g\ g^{-1}$; in tea packets samples by using (DPASV) and from 0.028 to 0.607 $\mu g\ g^{-1}$ by using (AAS). Pb (II) concentration were still below the allowable figures approved by FAO and WHO.[(10)] Heavy consumption of tea; using prolonged boiling may extract the Pb ions in the tea products; cumulating in the blood of the consumers day after day till reach high levels of intoxication and make symptoms of chronic lead poisoning to be apparent in the form of affection of the functions of the primary organ systems that are the liver, kidneys and the nervous system. It is stored in the bones, hairs and teeth; leading to anemia, reticulocytosis, basophilic stippling and increased red cell fragility. [4] A blue line on the bottom of the teeth and anorexia with recurrent gastrointestinal upsets and peripheral neuropathy were reported in all cases encountered in the present study, even a sexual impact in the form of delayed pubertal signs were noticed in the adolescent cases; agreeing with Hernández J et al., 1989, R. Tahvonent, 1989 and Fernández P.L, 2002.

The stripping voltammetric technique gives accurate results, where the trace metal; lead under the optimal conditions can be determined precisely and directly without separation, using standard addition method.

Conclusion:

Tea packets contain traces of lead but not exceeding the Maximum Permissible Figures (MPF). Exceptionally, Lead intoxication may result due to heavy, prolonged consumption of strongly boiled tea.

The stripping voltammetric technique for screening lead traces in food elements is promising.

Recommendations:

Repeated studies using sophisticated investigations for the methods of preparing tea on extracting its contents of metals including lead is highly recommended. Thence, health education for the public to gain benefits of tea drinks and avoid its possible hazards.

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