Concentrations of some chemical elements in human hair from Basrah Province, Iraq.

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Abstract

As a continuation of chemical analysis in human hair carried out in different areas of Basrah Governorate during the years 2009 and 2010 by different researchers, this study was focused upon accumulation of other chemical elements: Barium (Ba), Berylium(Be), Bismoth(B), Boron (B), Carbon (C), Chlorine (Cl), Chromium (Cr), Lithium (Li), Manganese(Mn), Nickel (Ni), Phosphorous (P), Platinum 195 (Pt), Silicon (Si), Silver (Ag), Sulphur (S), and Vanadium (V) in human hair which were analyzed by adopting the instrument ICP/MS at Maxxam Analytical INC, Canada. Hair samples were collected from different volunteers with respect to sex and age of ordinary peoples. Sampling of human hair, treatment and Chemical elements were analyzed according to standard procedures. The results revealed that the C, S, Cl, P, and Si element showed the highest concentrations, other element showed low concentration, being the least for Pt, Ag, Li, and Be,while the rest of studied elements Ba, Mn, Ni, B, Cr, and elements concentration were higher in male than female. The presence of chemical elements in the hair of human being indicates that those elements are presence in the surrounding environmental area.Overall results show that studied chemical elements in human hair for subjects from Southern Iraq follows the trend C>> S>Cl>P>Si>Ba>Mn= Ni> B>Cr>Li>Bi>V>Ag>Be>Pt

Key Wards: Chemical elements, Humain hair, ICP/MS, Basrah Governorate, Pollution.

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Introduction

Accumulation of chemical elements in the body for a certain periods of time could reflect the biomedical and environmental history of the body as well as long term metabolic changes (D'Ilio et al., 2000; Arnold and Sachs, 1994)

Human hair is represented as an interested tissue for elemental determination. Different techniques were employed for this purpose, Atomic Absorption Spectroscopy, Atomic Fluorescence Spectrometry, ICP/AES, Spectrofluorometric, DPASV, … etc. (Abdulraheem et al., 2012).

Heavy metals are a class of non-biodegradable pollutants in the environment that can enter into human bodies through different routes, such as food consumption and then can be accumulated in the body. Certain heavy metals are toxic or non-essential such as Cd, Hg, and Pb and eventually posing a serious health risk to human and ecosystem health. It is important to monitor the existence of such heavy metal and assess their levels (Liang et al., 2017). For certain essential chemical elements , their excess or deficiency can cause serious problems in the physiology of the human body (Dombovari et al., 1999). Katz and Chatt (1988) indicated that decreased levels of essential elements Cu, Fe, and Zn in human hair caused physiological disorder

A number of studies have been conducted for the determination of chemical elements in human hair samples around the world, some are maintained here.Hair analysis for the presence of heavy metals have been used to check for the levels of toxic elements eg. As, Cu, Cd, Pb as a way for monitoring environmental sources of pollutants (Abdulrahman et al., 2012).A certain essential heavy metals were determined in hair of subjects residing near Traffic Areas in the Rajasthan state of India , this study raveled that population at risk to metals in environment due to increasing traffic and vehicular pollution (Mahra, et al., 2010). The contents of different elements including the toxic metals B, Cd, Pb, and Sr in a hair of adult subjects exposed to a wide spectrum of pollutants were studied for citizens from Gadanisk, Poland (Szynkowsta et al., 2009). Human hair from workers in working estate in Omdurman, Sudan were studied by performing XRF of Cd ^{109} radioactivesource for the determination of toxic elementsCa, Mn, Fe, Cu, Zn, Hg, Pb, and Sr. (Abdelbaji et al., 2017).Hair samples from population in Arabia Saudi were assessed as a bio indicator of heavy metals As, Cd, and Pb contamination (Ahmed et al., 2016).Subjects residing near heavy traffic area are at risk to deficiency of iron and cobalt also as evidnces form as few subjects were suffering from anemia. This deficiency might be due to interaction of metals like Cr, Mn and others with the biological binding sites of Fe and Co in hair.

Certain researchers have used hair analysis to check levels of hazardous elements as a way of monitoring environmental sources of pollution. Various techniques have been employed in the detection of trace elements present in human hair. Among which are, atomic fluorescence spectrometry (Samanta,et al., 2004), atomic absorption spectrometry (Markiewicz, et al., 2002) inductively coupled plasma atomic emission spectrometry (ICP-AES) (Sreenivasa,et al.,2002), and spectrofluorometric (Ashraf et al., 1994).

Determination of chemical elements in human tissues and fluids were used to obtain information's on nutritional status for diagnoses of diseases and to obtain information's on environmental exposureet(Kazi et al., 2008). Hair can provide more permanent recordfor trace and toxic elements associated with normal and abnormal metabolism as well as toxic elements assimilated from the environment. In addition, hair is easily collected, conversantly stored, and

easily treated. Therefore, the analysis of human hair has become an important way to understand any quantitative change in certain elements inside the body (Afridi et al., 2008).

The aim of this study is to determine the contents of chemical elements in the human hair of residential subjects in Basrah Province /Southern Iraq, and to compare the present results with other nearby and worldwide studies.

Materials and Methods

Collection of hair samples

Hair samplesca 1-2 gm, each from 17 volunteers individual persons randomly chosen were taken from the nape of the neck, scalp hair and put into separate plastic envelopes together with the statement of questionnaire representing the physical status and the habitat,(health, gender, and age , for each individual) and taking to the laboratory for treatment. In the lab preliminary treatment was proceeded in which each hair sample was cut into about 0.5 cm longpieces and mixed, washed with distilled water, then with deionized water ,then with acetone (Afridi et al., 2006), and finally dried in oven at about 80 ^{O}C and stored separately in polyethylene bags.

Mineral acids digestion

Samplesof scalp hair(about 250 mg) of each individuals were directly placed in Teflonflasks. Three milliliters of a freshly prepared mixture of concentrated HNO_3: $HClO_4$ (1:1 v/v) was added to each flask and digestedon hot plate for 15 min, then cooled and evaporated until near dryness and finally diluted up to 25 ml in a volumetric flask and kept prior to elemental analysis.Dogan and Dincer Kaya (2010) determined Zn and Pbin hair samples by atomic absorption spectrometry after digestion with tetra methylammonium hydroxide.

Elemental Analysis byMaxxamInc

Maxxam Inc. offers a heavy and other trace metals analysis in different samples by utilizing the ICP/MS technique with microwave digestion sample preparation techniques. The traditional method for determining heavy metals in test articles is the classic colorimetric method. ICP/MS enables the analysis of up to 70 elementsin a single sample at low part per thousand – part per billion detection limit.

Results

Mean concentrations of chemical elements in human hair samples as a function of age and health status from male and female volunteers from Basrah Province, Iraq are listedin Tables 1 and 2 respectively, together with the standard reference levels set by Ertenetal., (1978).

Table 1.Mean concentrations of chemical elements (µg/g) in human hair samples from male with respect to age and health status in BasrahGovernorate, Iraq.

Age years→	2	22	31	46	58	60	62	Standard Erten et al., 1978.
Health status→	good	Good	Good	Good	Good	Diabetic	Heart disorder	
Metals↓								
Ba	1.1973	1.603	4.293	0.875	1.168	0.821	1.4764	5.4337
Be	0.0064	0.0102	0.021	0.0046	0.0046	0.0259	0.0118	0.0149
Bi	0.14	0.54	1.24	0.18	0.15	0.14	0.11	0.32
B	1.934	2.567	2.419	2.860	1.307	3.622	0.979	50.7323
C	445645	436191	492415	416138	384092	539158	425490	401411.4
Cl	14067	6900	6342	10278	13182	19694	19042	3278.23
Cr	0.930	0.954	1.1787	0.77	0.66	0.69	0.62	2.5258
Li	0.093	0.0592	0.1252	0.0533	0.0415	0.0872	0.0393	0.0325
Mn	2.069	1.239	2.4395	0.8622	0.5892	0.1267	0.647	2.452
Ni	0.67	1.9457	3.1449	0.3412	0.8226	0.388	23.455	2.336
P	2055.6	209.8	221.0	183.01	166.01	171.1	154.6	181.96
Pt	0.0016	0.0005	0.0026	0.0001	0.005	0.0057	0.0005	0.0027
Si	35.76	40.01	29.98	32.75	9.82	4.5	223.88	97.59
Ag	0.0212	0.0543	0.4577	0.1201	0.1014	0.1065	0.3675	0.3715
S	37171	33776	40521	33012	35012	35005	36006	42307.94
V	0.295	0.3502	0.9465	0.1403	0.0896	0.1534	0.1491	0.0418

Age years→	4 **	9	20	33	35	36	45	55	60	80	Standard Erten et al., 197

											8.
Health status→	Good	Asthma	Good	asthma	Rheumatoid	good	good	diabetic	Diabetic	Good	
Metals↓											
Ba	2.0082	1.5488	4.8754	4.6251	11.8688	3.6341	7.3489	1133.016	1.8783	613.3507	5.4337
Be	0.0076	0.0206	0.0094	0.0156	0.0255	0.0068	0.0061	0.019	0.0092	0.0051	0.0149
Bi	0.55	0.43	0.29	15.53	3.61	0.22	8.61	0.39	0.17	0.34	0.32
B	2.9971	2.4811	1.3083	3.0435	1.1827	1.8657	3.894	3.1463	0.8007	0.9792	50.732
C	464068	5286767	410221	410736	540005	384092	392823	488322	467671	448957	401411
Cl	9351.244	36172.39	3830.8686	2372.6955	9299.6268	4113.326	3933.0409	9773.3721	3825.19914	8573.0012	3278.2327
Cr	0.6275	0.8	1.4	1.0183	1.01	0.68	0.9	0.75	0.69	1.4	2.5258
Li	0.0387	0.1935	0.0485	0.1064	0.0667	0.0658	.0585	0.0664	0.0571	0.1024	0.0325
Mn	1.0725	2.1247	2.3385	3.2368	1.5152	1.2067	14.8532	13.5664	1.1843	4.3349	2.452
Ni	0.3478	1.7815	3.7832	4.4521	12.033	23.4558	5.5902	6.0533	0.8538	0.9029	2.336
P	168.64	166.98	178.24	160.12	269.3	139.2	220.07	211.8	171.13	149.17	181.96
Pt	0.0003	0.0008	0.0004	0.0001	0.0029	0.0017	0.0007	0.0025	0.0014	0.0041	0.0027
Si	9.2	61.8	24.8	46.43	49.42	83.06	48.02	28.28	45.95	11.8	97.59
Ag	0.1215	0.2913	0.0651	0.1066	0.2773	0.063	0.1064	0.0746	0.0521	0.0714	0.3715
S	35005	43308.3	33174	40822	38609	31021	33341	40859	32785	40771	42307
V	0.2282	0.3821	2.4093	0.438	1.012	0.4172	1.7052	1.0463	0.3155	0.5083	0.0418

Table 2. Mean concentrations of chemical elements (µg/g) in human hair samples from female with respect to age and health status in Basrah Province, Iraq.

*4 months old baby female

Discussion

Chemical elements have the ability to incorporate with the keratin structure of hair which taking place by binding through the sulfhydryl groups of protein (Abdulraheem et al., 2012). All types of detergents have the ability to cause leaching of those elements and reduce their concentrations in the hair compare to other tissues such as nails (Buchancova et al., 1993).

Human hair contain various elements other than carbon, hydrogen, nitrogen, oxygen, and sulfur. The mineral content of human hair is generally very low (less than 1%) (Robbins, 2002)

Accumulation of chemical elements in hair might be attributed to two different major sources of exposure: occupational, and food and drinks (WHO, 1995).

Analysis of human hair is a routine task to monitor the levels of exposure of population to toxic pollutants such as chemical elements. Concentrations of chemical elements in human hair were evaluated according to standard reference for elements contents in the hair samples (Rao et al., 2002).

Tables 1 and 2 revealed that all studied chemical elements within this study are exist in a certain concentrations in hair samples from both gender male and female. Concentrations are identical in their trends being very high for carbon, sulfur, chloride, phosphorus and silicon, and low values recorded for platinum, silver, lithium, and berelium, while the rest elements nickel, vanadium, manganese, boron and barium were at a moderate levels.

The greatest abundance for chemical elements recorded within this study in the human hair from Basrah Province were for carbon in the range 384092 – 540005 µg/g compared to standard value of 401411 µg/g , sulfur in the range 31021-43308 µg/g compared to standard value of 42307 µg/g,chloride in the range 2372.6 – 19694.07 µg/g compared to standard value of 3278.23 µg/g , and phosphorous in the range 139.2-2055.6 µg/g compared to standard value of 181.96 µg/g .

Extreme values for concentrations of chemical elements in human hair from BasrahProvince are showing levels greater than standard levels. Vanadium in the range 0.2282 – 2.4093 µg/g for male and 0.0896 – 0.9465 µg/g for female compared to standard value of 0.0418µg/g., Sulfur recorded lower values for both male and female compared to standard level, Silver was within the range of standard values of 0.0001- 0.0041 µg/gfor female and 0.0001-0.0057 µg/g for male compared to standardvalue of 0.0027 µg/g.

Barium in human hair recorded quite high values for female compared to male ones. Values recorded were 613.3507 µg/g for healthy female of 80 year old, and 1133.01 µg/g for diabetic female of 55 years compared to standard value of 5.433 µg/g while the rest were ranged between 0.0064 – 11.8688 µg/g. The concentrations of beryllium were within the standard levels for all subjects under study with no differences between male and female, as well as healthy and illness subjects. Concentration values for bismuth were identical and correlate with boron in which bismuth levels in hair of female were higher than male and extreme values recorded were 15.53

µg/g for female age 33year, 3.61 µg/g for female age 35 year, and 8.61 µg/g for female age 45 years compared to standard value of 0.32 µg/g . These extreme values could be attributed to hair coloring with different sort of dyes in which some hair colors contain heavy metal impurities (Hussein, 2013; Wilson, 2016;Ahmed et al., 2016) .

Overall results show that studied chemical elements in human hair for subjects from Southern Iraq follows the trend C>> S>Cl>P>Si>Ba>Mn= Ni>B>Cr>Li>Bi>V>Ag>Be>Pt

Conclusion

Acertain chemical elements are a part of the constituents of tissues and human organicssuch as hair in a considerable concentrations which could be determined by traditional procedures like atomic absorption spectroscopy (AAS)and recently by inductive coupled plasmaaccompanied by mass spectroscopy (ICP/MS). The presence of certain chemical elements in high concentrations may reflect a state of pollution either through the environment or the food and water. If polluted chemical elements are recorded in human hair in high levels which reflects the existence of highly toxic elements in the whole body of human being hair could play as a good agent for execration of toxic chemical elements. In this study it was found that the concentration of chemical elements in human hair varied with type of the element and age as well as gender.

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