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Research Article

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ATOMIC ABSORPTION SPECTROPHOTOMETRIC DETERMINATION OF HEAVY METALS LEAD AND CHROMIUM LEVELS IN HUMAN HAIR OF PEOPLE LIVING IN KATPADI AND YELAGIRI HILLS OF VELLORE DISTRICT

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ABSTRACT
Lead and Chromium levels in human hair were determined by atomic absorption spectrotometery. Comparison of metal contents on human hair was made between people living in plains and hills areas of Vellore district, Tamilnadu, India as a function of color of hair and geographical location.
KEYWORDS: Lead; Chromium; Hair; Nitric acid

INTRODUCTION

Hair has the advantage of long term memory. Hair is a permanent record, like tree ring. A three-inch strand of human hair will give six month history of what is going on in the body since head hair grows at a rate of about a half an inch a month. Scalp hair is the metabolic end product that has a recognized ability to reflect the body metal burden. The quantification of trace elements in hair has been used for assessment of long – term environmental and occupational exposure to trace metal as well as metabolic status.

Toxic elements may be 200-300 times more highly concentrated in hair than blood or urine. Therefore hair is the tissue of choice for detection of recent exposure of elements such as arsenic, aluminium, cadmium, lead, antimony and mercury. Human hair is a reliable and convenient biological indicator of environmental pollution[1-3]. The analysis of human hair is used to study environmental and occupational exposure as well as to assess nutritional and bodily status of several metals – essential (Ca, Cr, Cu, K, Mg, Mn, Na and Zn) and toxic (Ag, Al, Ni and Pb)[4-6]. Hair, unlike blood or organs can be collected easily and painlessly is easy to transport and store[7].

The elemental composition of hair reflects long term exposure to these metals, since hair is an indicator of past changes in metabolism and environmental exposure; hair content depends also on age, sex, anatomic location, hair color, ethnic and geographic origin, dietary habits and exposure[8]. There are also several problems related with hair analysis, including differentiation between endogenous and exogenous deposition or with metabolic status of a given subject. The aim of the present work was to investigate the atomic absorption spectrophotometric determination of heavy metals Lead and Chromium levels in human hair of the population group living in Katpadi and Yelagiri hills of Vellore District. The dependence of hair metal content on age, sex, hair color and different location was examined.

MATERIALS AND METHODS

Materials and reagents

Single elements standard solutions of Pb and Cr, Con HNO_3 (analytical purity), $HClO_4$, Redistilled water, Acetone (analytical purity) Atomic absorption spectrometer Varian spectra-240 (mulgrave, Victoria, Australia)

Sample collection

Hair samples were collected from male and female subjects working in roadways workshop, leather factory, college, exposed to Pb and Cr in their work environment in Katpadi and Yelagiri hills of Vellore District. The age of subjects range from 21-30 to 51-60 years. The sample of hair was cut from the scalp region and the hair length varied between 3 and 5 cm 0.5-2.0g of hair samples were collected in polythene bags which were thoroughly closed and labelled. A questionnaire were got filled up for obtaining the personal and medical history of subjects as per the recommendations of world health organization.

Sample washing

The washing procedure was carried out as per the recommendation of international atomic energy agency (IAEA). Hair samples were first washed three times with deionized water, then with acetone, and finally, they were again washed with deionized water. The samples were then oven dried at 110ºC.

Digestion procedure

About 0.25g of dried sample was taken in a 50ml beaker and digested with 10ml of 6:1 mixture of concentrated HNO_3 and $HClO_4$ and kept overnight at room temperature. The contents in the beaker were heated on a plate at 160º-180º C to obtain white crystalline residue. It was then diluted with 0.1N HNO_3 and made up 100ml. The blank was prepared the same way but without the hair sample.

Analytical procedure

All reagents used were of ultra high purity (certified >99.99%) procured from E-Merck. Working solutions were prepared by serial dilution of 1000ppm standard solution. Quantitative analysis was carried out on a flame atomic absorption spectrophotometer varian-240, with automatic background compensation and under optimum analytical conditions shown in table 1. The samples were analysed for lead and chromium. Three samples of each specimen were treated and run separately on to the spectrophotometer to pool mean metal concentrations.

RESULTS AND DISCUSSION

Human hair is reliable and convenient biological indicator of environmental pollution. The analysis of human hair is used to study environmental and occupational and bodily status of several metals - essential and toxic. Although several limitations were encountered in the application of hair analysis, this has got many other advantages too.

Hurdles with the proper interpretation of results in hair analysis are due to the absence of well defined reference concentration ranges, problems associated with differentiating between endogenous and exogenous deposition, inconsistency of hair concentration anamolies with nutritional status and chemical symptoms[9]. The difficulties in establishing normal or reference ranges are also due to natural variance of hair composition as a possible consequence of age, sex, hair colour and geographic origin, dietary factors, etc[10-11]. The present project was undertaken on the occupants of polluted Palar

river bed (Katpadi) and less polluted hill area (Yelagiri hills) of Vellore District, Tamil Nadu, South India. In the present investigation, an attempt has been made on the atomic absorption spectrophometric determination of heavy metals Lead and Chromium levels in human hair of people living in Katpadi and Yelagiri hills of Vellore District, Tamil Nadu. Hair analyses of the samples collected from 48 individuals living in Katpadi and Yelagiri hills was carried out.

Heavy metals lead & chromium levels in human hair as a function of age

Table 2 presents mean and standard deviation values of the heavy metal Lead and Chromium present in hair samples of male population of different age group varying from 21-30 to 51-60 years. In general an increase of metal content Lead and Chromium was observed from the age group of 21-30 to 31-40 years. A decrease was observed in higher age group i. e. from 41-50 to 51-60 years. Manuvald et al[3] have reported a significant decrease in Lead levels with increasing age. The changing metabolic processes associated with aging may be responsible for different levels of metals.

Heavy metal lead and chromium levels in human hair as a function of sex

Table 3 give details regarding the presence of heavy metals Pb, Cr in male and female populations of Katpadi and Yelagiri hills. Chromium level was found to be higher in female hair than in male hair and Lead level was found to be more in male population than in female population. This trend is in agreement with the studies done by Mortada et al, 2002[14] and it has been observed that both in the polluted and non-polluted areas metal content of human hair in the male population was found to be more than that of female population. The reason for higher Lead level in male hair may be due to outdoor activities including smoking habits, health behaviors like urine excretion of kidney and so on.

Heavy metals lead and chromium levels as a function of hair color

Table-4 give data regarding the presence of metal content Lead and Chromium in different colored hair – black, mixed (Black and White) and White. In general Lead and Chromium contents were higher in Black hair than in White hair. Mixed hair contains higher Lead and Chromium levels than in black hair. White hair was found to contain relatively low concentration of Lead and Chromium. This trend was observed both in polluted and non-polluted area. However, levels of metal content are less in hill area than in the Palar river bed area.

Schreeder and Nason observed some differences in elemental content ratios in White, Brown and Black hair. Sturaro et al[15] have found maximum concentration of metals in Black hair as observed in the present study. The variability of data can be explained due to exogeneous contribution on account of pollution in the environments. Besides the pigment content, small air spaces and caliber of the hair shaft also affect hair colour.

Heavy metals lead & chromium levels as function of polluted and non-polluted areas

The mean concentration of Lead and Chromium along with relevant standard deviation values are reported in Table-5. In general Lead and Chromium levels are higher in human hair of polluted Katpadi area when compared with less polluted Yelagiri hills of Vellore District, Tamil Nadu. Higher Lead and Chromium content in the hair samples of Palar river bed region may be due to Industrial and Tannery pollution. Tanneries use Chromium and Lead salts for leather tanning processes.

The concentration of Lead in human hair was related to either environmental exposure or through intake from food and drinking water. This may be due to geographical location. In the area, where there are tanneries and other chemical industries, the effluent contains higher concentrations of the metals Lead and Chromium. This cause's soil and water pollution. The food grown in these areas may contain higher metal contents. Also the drinking water may contain high metal concentration. This enters human body and gets accumulated in various organs of the body including hair.

The presence of a smoker at house and living close to heavy traffic affect levels of metal concentration in hair. Cigarette smoking is an important source of heavy metal exposure especially Lead. A cigarette generally contains 0.16-17µg of Lead. About 10% of this amount may be inhaled. Wolfsperger et al[16] showed that smoker hair lead levels were higher than non-smoker hair lead levels Schuhmacher et al[17] showed that blood and hair levels decreased during the period of reduced lead free gasoline consumption. Consumption of Lead free petroleum in China resulted in to decrease of blood Lead levels in children.

Few literature studies report that elemental concentration of human hair as a function of colour. Nowak[18] studied those living in Poland in a non-industrialised region (Silesian Beskid). The author examined the effect of age, sex and hair colour on elemental composition of hair. Nowak divided the reference population into two age groups 0-30 and 30-50 years. In the present project work, four age groups were studied. When comparing the effect of sex, similar trends of elevated concentration of Lead in male hair and Chromium in female hair were observed.

The results were also compared with data reported by other authors. The following similarities were observed.

- Higher level of lead in males; (Sharma et al, 2004)[10]
- Sturero et al have found maximum amount of metals in Black hair[15].
- Manuwald et al have reported a significant decrease of Lead levels with increasing age[13]

CONCLUSION

Hair analysis might soon become a powerful diagnostic tool in monitoring of environmental pollution. However, it is necessary to precisely elaborate standard ranges of hair composition from different groups of people, with consideration of age, sex, hair colour and living habits. The results of the present study might be used in elaboration of reference values for the concentration of elements in hair with the consideration of age, sex and exposure. It is necessary to perform further, wider examination of people living in different geographic regions.

In the present study it was found that the concentration of heavy metal in human hair varied with age, sex, hair colour and different location. The obtained results were compared with findings of other authors – some tendencies were confirmed. Therefore, in order to evaluate global reference values of hair analysis it is necessary to study the effect of age, sex, hair color and exposure on large group from various populations living in different regions. By this way, hair analyzing would be reliable.

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Table 1: Heavy metals Pb and Cr levels in human hair as a function of polluted and less polluted area

S.No.	Details	Pb	Cr
1	Wavelength (nm)	217.0	357.9
2	HC lamp current (mA)	10.0	7.0
3	Slit width (nm)	1.0	0.2
4	Fuel-gas flow rate ml/min	2.0	2.0
5	Detection limit (µg/L)	10.0	6.0

Table 2: Heavy metals Pb and Cr levels in male hair as a function of age

Age (In years)	Katpadi		Yellagiri hills	
	Lead	Chromium	Lead	Chromuim
21 – 30	0.1174±0.1266	0.1473±0.2846	0.0746±0.1508	0.1681±0.2457
31 -40	0.2106±0.1436	1.0152±0.8844	0.1306±0.3460	1.4990±0.6540
41 – 50	0.5996±0.1131	0.708±0.8077	0.0506±0.0141	0.0896±0.0264
51 – 60	0.0786±0.0732	0.5236±1.084	0.1066±0.0321	0.0426±0.2135

Values are expressed as mean ± SD of 3 individual values.
Mean concentration of elements is mg/g

Table 3: Heavy metals Pb and Cr levels in human hair as a function of sex

Age	Katpadi				Yelagiri hills			
	Lead		Chromium		Lead		Chromium	
	Male	Female	Male	Female	Male	Female	Male	Female
21 – 60	0.1296 ± 0.1140	0.1216 ± 0.0850	0.5340 ± 0.7651	0.2073 ± 2.8356	0.0744 ± 0.1357	0.0600 ± 0.9626	0.2483 ± 0.2849	0.3616 ± 0.4799

Values are expressed as mean ± SD of 12 individual values.
Mean concentration of elements is mg/g

Table 4: Heavy metals Pb and Cr levels in human hair as a function of hair colour

Colour	Katpadi		Yelagiri hills	
	Lead	Chromium	Lead	Chromium
Black	0.1172±0.1266	0.1472±0.2846	0.0746±0.1508	0.168±0.2457
White	0.0784±0.0730	0.556±1.084	0.0424±0.0321	0.1368±0.2135

Values are expressed as mean ± SD of 3 individual values.
Mean concentration of elements is mg/g

Table 5: Heavy metals Pb and Cr levels in human hair as a function of polluted and less polluted area

Age	Katpadi		Yelagiri hills	
(In years)	Lead	Chromium	Lead	Chromium
21 – 60	0.1258±0.1065	1.266±2.575	0.0812±0.1794	1.058±0.4560

Values are expressed as mean ± SD of 24 individual values.
Mean concentration of elements is mg/g

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