JASEM ISSN 1119-8362

Full-text Available Online at www.bioline.org.br/ja

J. Appl. Sci. Environ. Manage. *March*, 2010
Vol. 14(1) 17 - 21

Manganese Concentrations In Hair and Fingernail of Some Kano Inhabitants

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ABSTRACT: Manganese concentrations in hair and fingernails were determined by Flame Atomic Absorption Spectrometry (AAS).The mean manganese in hair and fingernail were 0.54 ± 0.35mg/g and 0.68 ± 0.30mg/g respectively. A progressive decrease in manganese concentrations in hair and fingernails with age indicated no significant difference in their means suggesting that manganese in hair and fingernails originate from a common source. Comparing the mean manganese concentrations in hair with the fingernails a significant difference is indicated in the two tissues ($p \leq 0.05$). Human hair and fingernails are therefore recording filaments that can reflect metabolic changes of many elements over long periods of time and hence furnish an imprint of post nutritional event as dietary levels of essential micro-elements. @ JASEM

Manganese is an essential trace element in human nutrition (Keen et al.,1999). Its richest dietary sources include whole grains, nuts, leafy vegetables and teas(Pennington and Young,1991;Freeland-Graves,1994;Gibson,1994). Manganese is concentrated in the bran of grains removed during processing. The mean intake of manganese world wide range from 0.52 to 10.8 milligrams daily. Concomitant intake of manganese with foods rich in phytic acid or oxalic acid may depress its absorption (Keen et al.,1989; Keen and Zidenberg-Cherr,1996).

In the body, manganese facilitates enzyme functions and many cell processes (Aras and Ataman, 2006). Elevated levels may reflect occupational exposure (Chatt and Katz, 1988). Increased manganese concentrations were found in hair samples of school children scoring poorly in tests to assess general intelligence, visual motor skills, receptive language, verbal memory, non-verbal problem solving and behavioral problems (Wright, et al., 2006). In archaeological bone, manganese is often correlated with aluminium (Pate and Hutton, 1988).

Hair manganese levels correlate with its levels in other body tissues such as urine, saliva, sweat and human milk (Barret,1985; Hull,2003;Afridi et al.,2006a&b; Kazi et al.,2008).Manganese is the preferred metal co-factor for *glycosyltransferases* important in the synthesis of *glycoproteins* and *glycosaminoglycans* (*mucopolysaccharides*). It is a component of the *metalloenzyme manganese* superoxide dismutase (MnSOD) in the mitochondria and is a constituent of the mitochondrial oxidant defense system (Nielsen, 1999).

Symptoms associated with manganese deficiency include fatigue, lack of physical endurance, slow growth of fingernails and hair, impaired metabolism of bone and cartilage, dermatitis, weight loss, reduced fertility, increased allergic sensitivities and inflammation (Baly et al., 1990; Davis et al., 1990). Deficiency signs include nausea, vomiting, change in hair colour and neurologic sequela (Fred, 1998). Manganese is toxic under certain conditions. Patients with end-stage liver disease accumulate manganese in their basal ganglia. Manganese plays a role in the hepatic encephalopathy in those with liver failure and is eliminated through the bile, and hepatic dysfunction leads to depressed manganese excretion (Krieger et al., 1995). Mine workers exposed to high concentrations of manganese dust develop "*locuramanganica*" or manganese madness. In later stages of this disease, symptoms similar to Parkinson's disease are observed (Nagatomo et al., 1999).The aim of the present study was to determine the concentration of manganese in scalp hair and fingernails from some inhabitants resident in Kano.

MATERIALS AND METHODS

Sampling: The hair samples were collected according to the recommendation of IAEA (1991). Human hair were taken from the scalp part. Pre-cleaned stainless steel scissors and trimmers were used for collection of specimens and clean bags were used for sample storage. The hair samples were washed with acetone and deionized water and air dried according to the procedure recommended by IAEA for human hair (IAEA.1991)

Manganese was determined from various subjects resident in Kano for at least six months. Hair (n=350) and fingernail (n=300) samples were collected from subjects in the age range of 1-55years.

Nail samples were collected in polyethylene containers and were washed in 1% solution of TRITONX-100 in de-ionized water in an ultra sonic bath and on drying were stored in small plastic tubes (Iyengar,1984). Hair samples were collected from each subject as close to the scalp as possible (Kucera et al.,1996).Cleaning of hair and nail samples prior to determining the manganese content was done using distilled water, organic solvents and a mixture of organic solvent and a nonionic detergent. The hair samples were washed using three different washing methods. Distilled water was initially employed (Chittleborough, 1980) followed by a 50% solution of ethanol and

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acetone (Kucera et al.,1996) and finally a 1% solution of nonionic detergent (Extran MA01 or Teepol),distilled water and acetone (Schrauzer et al.,1988; Nowak,1998; Martin et al., 2005) after which they were kept in an alcohol –ether mixture for 45mins and dried at 60ºC for 72hr.

0.5g of each sample was digested in $10cm^3$ concentrated HNO_3 and the resulting solution was evaporated to dryness and redissolved in 0.1M nitric acid (Nnorom et al., 2005). Manganese concentrations were determined by Flame Atomic Absorption on a Model 210 VGP Spectrophotometer attached to IBM computer. The result of the absorbance of each sample was the average of ten sequential readings. Background light absorption and scattering were compensated for either by deuterium hollow cathode lamp. Distilled water was digested as blank using the same procedure previously described (Ayodele and Abubakar, 1998; Ayodele and Abubakar, 2001)

Statistical Analysis: All statistical computations were on the PC 486 66MHZ microcomputer using the integrated statistical package for windows from Umstat Ltd.(London) or dedicated micro instructions for the Excel spread sheets from Microsoft. The approach enabled the advantages of the various computational and graphical facilities of both types of software's to be used with the ability to read different file formats. The analyses of variance (ANOVA) were carried out according to described procedures (O'Mahony, 1986).

RESULTS AND DISCUSSION

The frequency distribution pattern for the age of hair and fingernail donors is as shown in Fig.1.The distribution is multimodal with a mean age of 27.51 ± 16.5 years. The frequency distribution pattern for manganese in hair is as shown in Fig.2. The distribution is multimodal and is skewed towards high frequency of low concentration with a mean and standard deviation of 0.54 ± 0.35mg/g while the frequency distribution pattern for manganese in fingernails (Fig. 3) is multimodal and is skewed towards high frequency of low concentration with a mean and standard deviation of 0.68 ± 0.30mg/g. Pearson parametric correlation showed a significant correlation between the manganese content in hair and fingernails ($p<0.05$)Table 1. The analysis of variance (ANOVA) revealed that the mean manganese concentration of manganese in hair is not significantly different from that in the fingernails at $p>0.05$ (Table 2). The levels obtained in this study are in agreement with mean manganese in hair and fingernails reported by other authors worldwide (Table3).

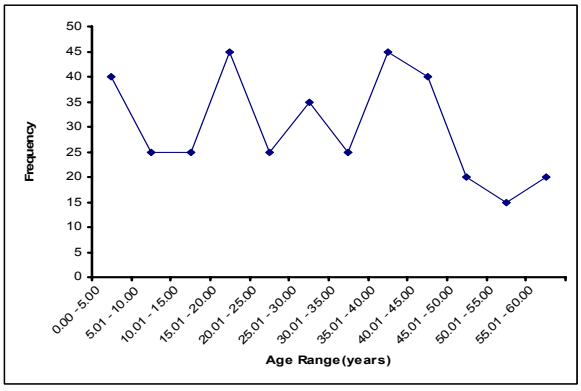

Fig 1: Frequency Distribution Pattern for Age (years) of Donors in Hair

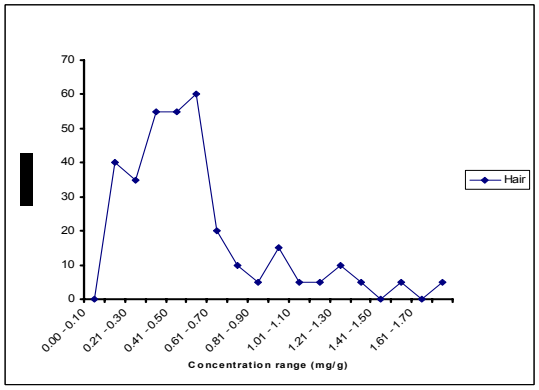

Fig. 2: Frequency Distribution Pattern for Manganese

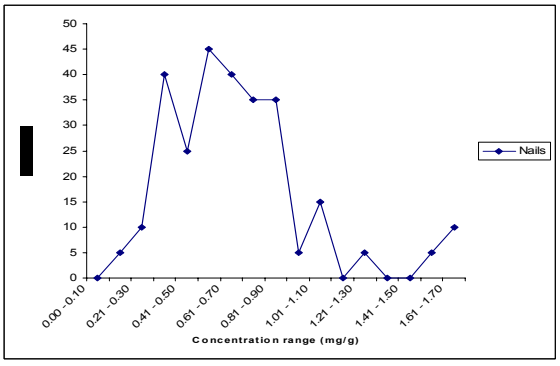

Fig. 3: Frequency Distribution Pattern for Manganese in Fingernails

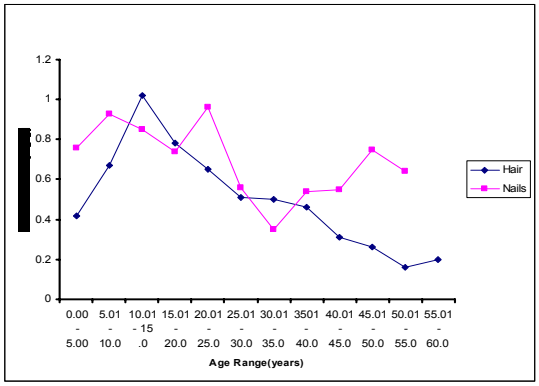

Fig. 4.: Manganese Concentration (mg/g) in hair and Fingernails with respect to age

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Table 1: Parametric Correlation Coefficients for Manganese in Hair and Fingernails

	Hair	Fingernails
Hair Pearson correlation	1	.91
Sig. (2-tailed)	.	.501
N	350	300
Fingernails Pearson Correlation	.091	1
Sig. (2-tailed)	.507	.
N	300	300

Table 2:Analysis of variance for Manganese in Hair and Fingernails

Source of variation	SS	Df	MS	F	P-valve	F crit
Between Groups	0.574568	1	0.57456818	6.38530834	0.0136633	3.9290115
Within Group	9.872764	108	0.09141448			
Total	10.44733					

Table3: : Results of manganeseConcentrations in Hair and Nails from different Countries

Country	Mean	Unit	References
	0.5-1.5	µg/g	Iyengar and Iyengarl(1994)
Poland	0.601±0.59	mg/kg	Chojnacka et al(2005)
India	8.81-43.19	µg/g	Mehra and Juneja (2005)
Poland	70.9-951.6	µg/kg	Grybos et al(2005)
Brazil	0.105-2.5	µg/g	Saiki et al (1998)
Czech	0.62-1.97(hair)	mg/kg.	Katz and Chatt (1988)
Peru	1.01-6.40	mg/kg	Bergfield (2007)
Czech	0.729-1.757(nail)	mg/kg	Kucera et al (2001)
Poland	0.26-0.75 (hair)	mg/kg	Mickeley et al(1998)
Poland	2.41	"	Nowak (1998)
Sweden	0.560	"	Rodushkin &Axelssom (2000)
	1200(200-4000)	µg/kg	Iyengar andWoittiez(1988)
Brazil	5	mg/kg	Mickeley et al(1998)
Nigeria	0.62-4.74	µg/g	Oluwole et al (1994)
Nigeria	0.54±0.35 (hair)	mg/g	This study
Nigeria	0.68±0.30 (nail)	mg/g	This study

Manganese concentration in hair and fingernails with respect to age is as shown in Fig.3 Manganese levels in both hair and fingernails decreased with age, but the decrease is pronounced in hair, indicating that manganese may be playing some physiological functions (Hull, 2003).

Scalp hair and fingernails can record the level and changes of elements in the body over a long period of time(.Saiki et al.,1998; Khuder et al.,2008) Changes in the elemental composition of hair therefore depend on alterations of external and internal media of the human body, and it is considered that hair and fingernails of healthy individuals contain each element within a well defined range of concentration and may be considered as a potential indicator of both external and internal long term exposure to pollutants. The idea of hair and fingernail analysis is inviting, since it is painlessly removed, normally discarded, easily stored and transported to the laboratory for analysis. Analysis is simple and painless, mineral concentrations are not subjected to rapid fluctuations due to diet or other variables and therefore reflect a long – term nutritional status. Samples are stable at room temperature, analytical methods are easy because mineral concentrations in hair are relatively high (Borel and Anderson, 1984; Ayodele and Bayero, 2008; Ayodele and Bayero, 2009).

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