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ATOM-ABSORPTION DETERMINATION OF MICROELEMENT COMPOSITION OF THE HUMAN HAIR FROM DIFFERENT AREAS OF CHERNIVTSI REGION

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Abstract. *An atom-absorption microelement analysis of the human hair taken from people living in different areas of Chernivtsi region (Ukraine) has been performed. The microcontent of zinc, iron, manganese and copper was determined in relation to the examinees' residence place, sex and age. A comparative analysis of the hair microcomposition proved that concentration of copper and iron in the men's hair of all age groups was higher than in the corresponding women's hair while concentration of manganese and zinc in the men's hair was lower. An average content of Zn, Fe, Mn and Cu in men's hair remains within the corresponding normal ranges. Exceeding concentrations were determined for the men from Novodnistrovsk (Zn), Novoselytsya district (Fe and Cu) and Chernivtsi (Mn). An average content of Fe and Cu in the women's hair remains within the normal ranges. Exceeding concentrations of Zn were reported for the samples from Putyla district while in some samples from Novodnistrovsk this parameter was lower than the mean value. Concentration of Mn exceeded limits for all the women hair samples from Chernivtsi. Significant exceeding in the concentration of Zn and deficiency of Cu has been found in the samples from the first age group (17-25 years). Samples of the fourth age group (50-83 years) have shown deficiency of Zn and some excess of Mn and Fe.*

Key words: *microelement composition, hair, pollution, environment*

Introduction

Human's hair can be used as an indicator of the environment ecological safety and can provide integral information related to the microelemental balance of the human organism [1, 2].
Hair is one of the metabolically active tissues and can be used as an informative object for various investigations. The unique structure and composition of hair depends on the regional, sexual, racial and group parameters of each given person and can also be influenced by different external factors (temperature, humidity, acidity of drinking water, etc.) [3].
Once a substance takes part in the human metabolism, it leaves traces in hair, remaining in the hair during its lifetime. This feature can be used for a retrospective analysis of an examinee's life conditions and health status [4].
The analysis of hair should be performed using modern precise analytical equipment and can be useful for a wide variety of ecological, hygienic and clinical investigations. Hair analysis can be useful for historical retrospective investigations, which can disclose information related to the past and present microelements contents in the human body and environment.
Biological, medical, chemical-ecological and criminalistic investigation of the hair is a comparatively new field of research.
The macro- and microelement analysis of hair can provide accurate information about metabolic conditions of the examinee. The mineral composition of hair is mainly caused by external factors. A balance between processes of

mineralization (accumulation of some mineral compounds in hair), demineralization and transmineralization (transfer of the mineral compounds within the human's body) is governed by nourishment conditions, physical activity and environment pollution.
Therefore, human hair can be used as an indicator of the long-term internal and external influence of the environment pollution on the human organism.

Experiment

37 hair samples have been collected from various examinees from Chernivtsi region (districts of Putila and Novoselytsya, cities of Novodnistrovsk and Chernivtsi). All the samples were classified by age and sex of the examinees. The first group included children of both sexes from 4 to 16 years, the second – men and women from 17 to 29 years, the third – men and women of 30-49 years and fourth – men and women of 50-83 years. All the samples were 2-3 cm long, taken from non-dyed hair and then stored at room temperature without any additional conservation.
Preliminary preparation of the samples was carried out according to [5]. The hair was rinsed with distilled water to remove surface pollutants, dried at room temperature during 24 hours and weighed. Then a 0.3 g sample was placed in the crucible and burnt to ash in the muffle burner at 550 ^{0}C during 5 hours. Then the incinerated sample was boiled with nitric acid until transparence of the mixture and evaporated to almost dry condition. The evaporation residue then was placed in a volumetric flask of 25 ml with 1M nitric of acid solution.
An atom-absorption spectrophotometer KAS-120-M1 has been used to perform measurements of the mineral compounds contents. All the samples were injected in the atomizator as solutions. The concentration of copper has been measured at a wavelength of 324.8 nm; Fe – at 248.3; Mn – 279.5 and Zn – at 213.9 [6].

Results and discussion

The results of atom-absorption analysis on metals contents in the hair samples are shown in Figures 1-4. All the figures show averaged contents of elements.
As seen in Fig. 1, some significant exceeding of Zn content (up to 1.5 times) has been registered for the samples from the district of Putyla. The content of Zn in the women hair from Chernivtsi and district of Novoselytsya is higher than in the men hair but it remains under the threshold limit.
As seen in Fig. 2, the content of Fe in the men hair is slightly higher than in the women but both parameters stay under the threshold limit value. Concentration of Fe is almost similar for the samples from all residence places.
The content of Mn in the women hair was much higher than in the men hair (see Fig. 3). The content of Mn in the samples from Novodnistrovsk was the lowest. An average content of Cu in the men hair samples from Chernivtsi and Novoselytsya district were higher comparing to the corresponding women hair samples but they all remained within a range of normal contents of Cu (see Fig. 4).
As seen from the above-mentioned results, concentrations of Fe and Cu remained within corresponding normal ranges with small deviations from the mean values. The concentrations of Zn in men hair were more stable than those in women hair and also stayed within their normal range except samples from the district of Putyla. An average concentration of Mn in the women hair exceeded normal values for the samples from Chernivtsi and the districts of Novoselytsya and Putyla.

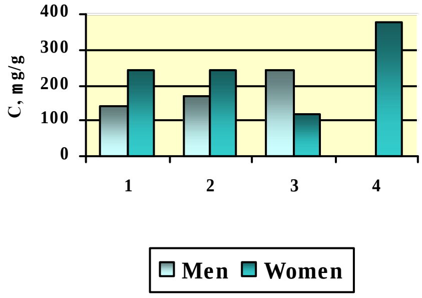

Fig. 1. Content of Zn in the hair of men and women for various residence places: 1 – Chernivtsi; 2 – District of Novoselytsya; 3 – Novodnistrovsk; 4 – District of Putyla. An average normal content of Zn in the hair ranged from 100 to 250 μg/g.

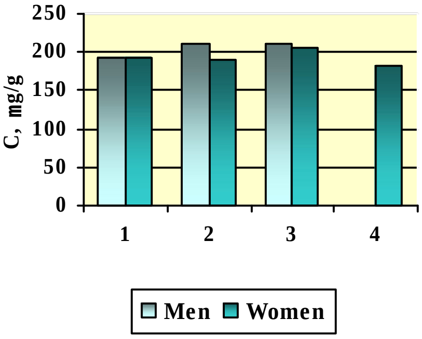

Fig. 2. Content of Fe in the hair of men and women for various residence places: 1 – Chernivtsi; 2 – District of Novoselytsya; 3 – Novodnistrovsk; 4 – District of Putyla. An average normal content of Fe in the hair ranged from 192 to 230 μg/g.

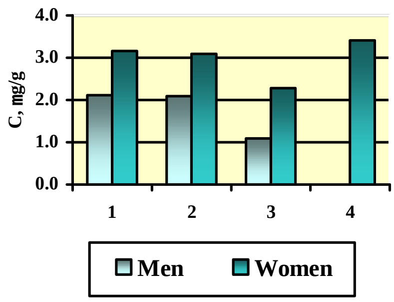

Fig. 3. Content of Mn in the hair of men and women for various residence places: 1 – Chernivtsi; 2 – District of Novoselytsya; 3 – Novodnistrovsk; 4 – District of Putyla. An average normal content of Mn in the hair ranged from 0.1 to 2.0 μg/g.

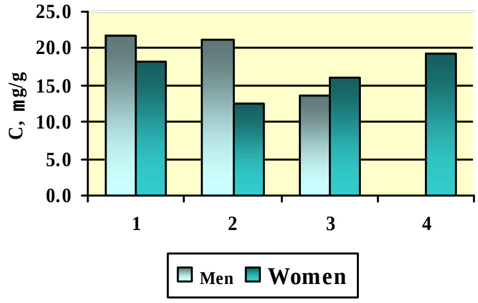

Fig. 4. Content of Cu in the hair of men and women for various residence places: 1 – Chernivtsi; 2 – District of Novoselytsya; 3 – Novodnistrovsk; 4 – District of Putyla. An average normal content of Mn in the hair ranged from 10 to 28 μg/g.

Another series of bar charts represents the distribution of microelements concentrations in age groups.

As seen from Figures 5-8, the concentration of Zn reaches the highest level in the hair of men and women of 17-25 years and this concentration is 1.5 times higher than the corresponding normal level.

It is known [7] that concentrations of Zn and Fe are interconnected since assimilation of Zn is complicated by Cu, Mn and Fe. This result has also been proved by our experiments (see Fig. 5 and 6, especially the results for age group IV).

On the other hand, deficiency of Cu can be seen in the age group II (Fig. 8) and this can be caused by quite a high concentration of Zn (see Fig. 5). Concentration of Mn (Fig. 7) in the first age group is also very high and its value is almost twice higher than the normal limit. Concentrations of Zn, Fe and Cu for this age group are within the normal limits. Concentration of Fe remains within the normal range for all age groups.

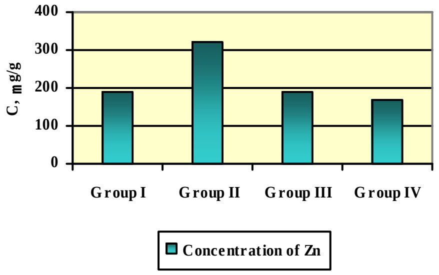

Fig. 5. Concentration of Zn in the hair samples for different age groups

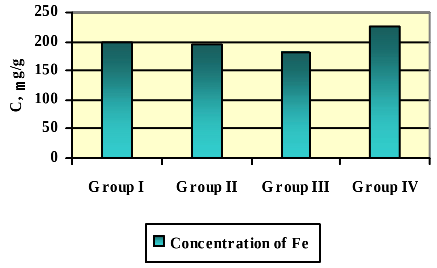

Fig. 6. Concentration of Fe in the hair samples for different age groups

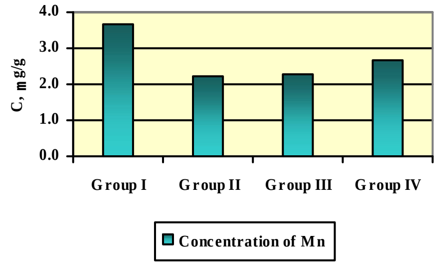

Fig. 7. Concentration of Mn in the hair samples for different age groups

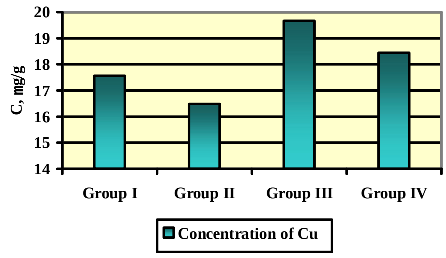

Fig. 8. Concentration of Cu in the hair samples for different age groups

Conclusion

An investigation on the microelements' content and distribution in the human hair from examinees living in different areas of the Chernivtsi region has been performed. Deviations in the microelement composition of the hair samples from different locations can be explained by different biogeochemical conditions in the examinees' residence places, different health conditions of the participants, sexual differences in the metabolic processes and individual differences in the living conditions of each participant.

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