

ОРИГИНАЛЬНАЯ СТАТЬЯ

HAIR ESSENTIAL TRACE ELEMENTS IN BANGLADESH WOMEN: INFLUENCE OF VEGETARIANISM

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ABSTRACT. Accumulation of essential trace elements was studied in hair of women residing in People's Republic of Bangladesh. Hair samples were taken from vegetarian and non-vegetarian rural women 18-60 y.o. living in Mymensingh district of Bangladesh. Hair essential trace elements (Co, Cr, Cu, Fe, I, Mn, Se, Zn) analysis by ICP-MS was provided and results were compared to Russian women reference ranges. The study has shown that investigated Bangladesh women population has extremely elevated hair Fe and Mn and low I and Cu in comparison to Russians. Also, vegetarianism has no influence on hair essential trace elements level in Bangladesh women, as opposed to Russian.

KEYWORDS: vegetarianism, hair, women, cobalt, chromium, copper, iron, iodine, manganese, selenium, zinc, Bangladesh.

INTRODUCTION

Essential trace elements are very important for healthy human diet. Also the stability of the chemical composition is important for the support and regulation of vital functions. Variations in the content of trace elements as micronutrients may be due to dysregulation of the body's interaction with the environment (Agadzhanjan, Skalny, 2001). The reasons for such disturbances can be both external (environmental, climatic, nutritional) and internal factors. Each person are not able to know and especially to influence many of these factors, except the most simple and clear one – nutrition.

The pursuit of a healthy lifestyle leads many people to vegetarianism. But it often may lead to some functional disorders of organs and body systems. It is known that vegetarianism can cause some essential trace elements' deficiency in humans (Srikumar et al., 1992; Wojciak et al., 2004). But in some countries vegetarianism is a lifestyle based on the traditions that have arisen due to the specialties of the territory of the people's living. The territory is not the only reason, but one of the most important. One of such country is People's Republic of Bangladesh where vegetarianism is typical for majority of population during centuries.

Along with such diagnostic biosubstrates as urine, blood good informative to assess the level of

chemicals in the human body have hair. Hair as a biological tissue is unique in the sense that it serves as an accumulator for trace elements, and in addition, it is formed in a relatively short period of time and remains isolated from metabolic events in the human body. Thus, hair analysis has better chances of being used as a diagnostic tool (Avtsyn et al., 1991; Sharma et al., 2004).

In our previous work we presented data on toxic trace elements hair content in population of Mymensingh district of People's Republic of Bangladesh. Residents of this district (both men and women) are under increased risk of arsenic accumulation, and much risk of mercury and beryllium loading, whereas level of lead and cadmium load in their hair is relatively low (Skalnaya et al., 2015). Also, we found decreased Se level in hair of these people (Skalnaya O., Skalnaya A., 2015).

SUBJECTS AND METHODS

Current study was provided under the three-year program of humanitarian and educational assistance to district Mymensingh (Fig. 1) in the north of the Republic of Bangladesh organized by the Taipei Rotary Club's in early April, 2014.

Hair for tests (length is 2–4 cm) were cut from some (3–5) places of occipital part of the head; the mass of one sample was approximately 50–100 mg.

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The samples were purified and fat from them was removed (using acetone), then they were left to dry in a special oven. Cleaned hair, each in its box, were added 5 ml of concentrate nitric acid, after it was wet-ashing under the influence of microwave decomposition (SpeedWave four, Berghof, FRG).

Obtained solution was added double-distilled water to bring volume to 15 ml. For quantification of the content of chemical elements we used the device for mass-spectral analysis with inductively coupled argon plasma – ICP-MS (NexION 300D, Perkin Elmer, USA). To assess the degree of deviation from the norm of chemical elements' content in hair we

used indicators of biologically acceptable levels of chemical elements in hair (BAL) accepted in Russia (Center for Biotic Medicine, Moscow).

The data of total number of 77 vegetarian and non-vegetarian rural women (18–60 y.o.) from Mymensingh district are presented. Analysis of essential trace elements in the hair of these women was performed in order to identify differences of their contents depending on the type of diet. The obtained data are expressed as a median and quartile range. Also comparison was done with reference values, established for Russian Federation (Skalny, Kiselev eds., 2012).

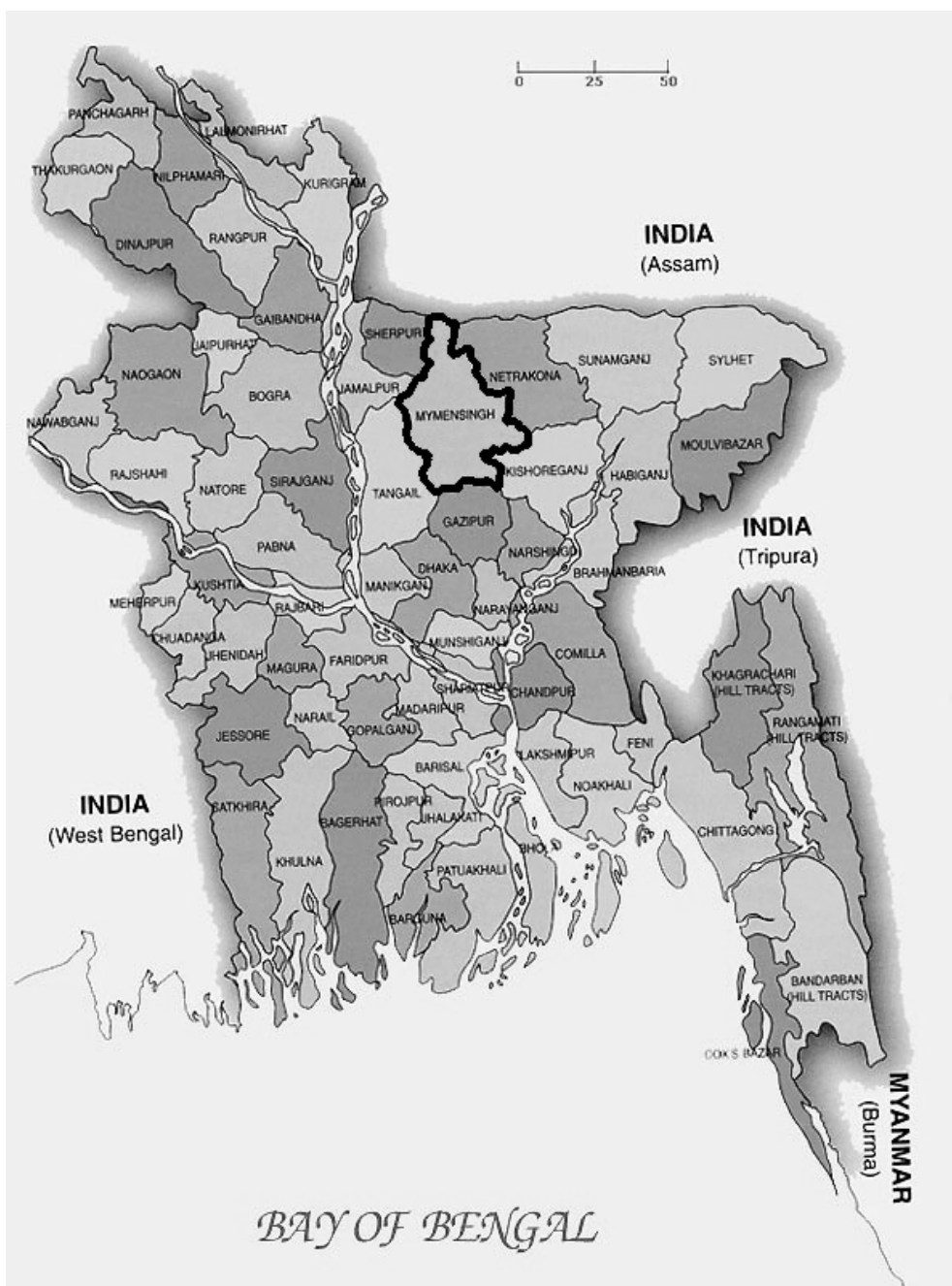


Fig. 1. The studied Mymensingh district is circled by black line on the map of Bangladesh

RESULTS AND DISCUSSION

We found the extremely high hair Fe 66.8 (47–99 ppm) and Mn 15.6 (8.5–27.7) content, as compared to reference ranges in Russian women 14.5 (9.8–23.1) and 0.58 (0.31–1.36 ppm respectively) (Table 1). So in 48% and 80.5% of investigated Bangladesh women in comparison to 11.2% and

22.9% to Russian women hair Fe and Mn were elevated (Fig. 2).

Hair I and Se levels were moderately, but significantly decreased (Table 1).

It is interesting to highlight that 93.5% of Bangladesh women vs 30% in Russians have decreased Cu level (Fig. 3).

Table 1. Content of essential trace elements in hair of vegetarian and non-vegetarian women from Bangladesh and Russia (mcg/g of hair)

Element	Median (25–75 centiles)			
	Bangladesh		Russia	
	Vegetarians	Conventional food	Vegetarians	Conventional food
Co	0,04 (0,03–0,05)*	0,04 (0,03–0,06)	0,02 (0,01–0,04)	0,02 (0,01–0,05)
Cr	0,12 (0,08–0,18)*	0,1 (0,07–0,16)	0,07 (0,05–0,13)	0,34 (0,23–0,5)
Cu	7,57 (7,01–8,08)*	7,1 (6,33–8,35)	11,3 (9,15–17,48)	12,2 (10,1–15,3)
Fe	72,9 (48,8–117,01)*	63,43 (43,46–90,15)	10,83 (7,75–17,27)	14,5 (9,8–23,1)
I	0,27 (0,18–0,45)	0,23 (0,15–0,51)	0,32 (0,18–0,58)	1,12 (0,5–2,59)
Mn	18,84 (9,56–33,36)*	12,42 (6,76–18,45)	0,50 (0,29–1,34)	0,58 (0,31–1,36)
Se	0,3 (0,25–0,33)	0,27 (0,23–0,31)	0,28 (0,21–0,38)	0,39 (0,21–0,6)
Zn	171,88 (149,9–80,23)*	161,03 (149,18–74,16)	197,51 (162,58–51,04)	177 (146–212)

Note: * – statistically significant differences between groups of vegetarians from Bangladesh and Russia ($p < 0,05$).

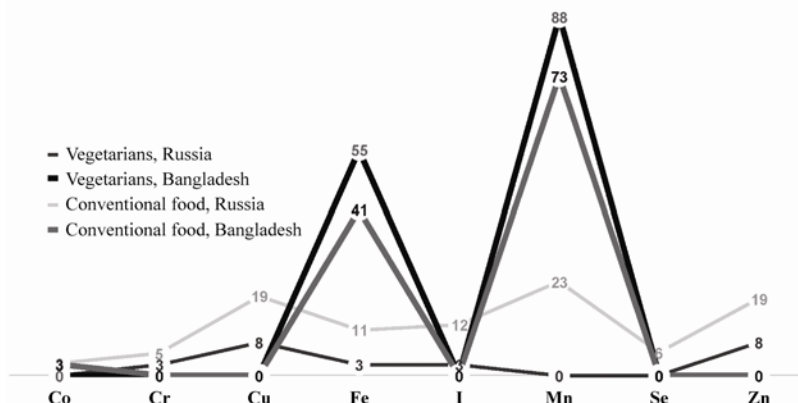


Fig. 2. Increased hair content of trace elements in vegetarian and non-vegetarian women from Bangladesh and Russia (%)

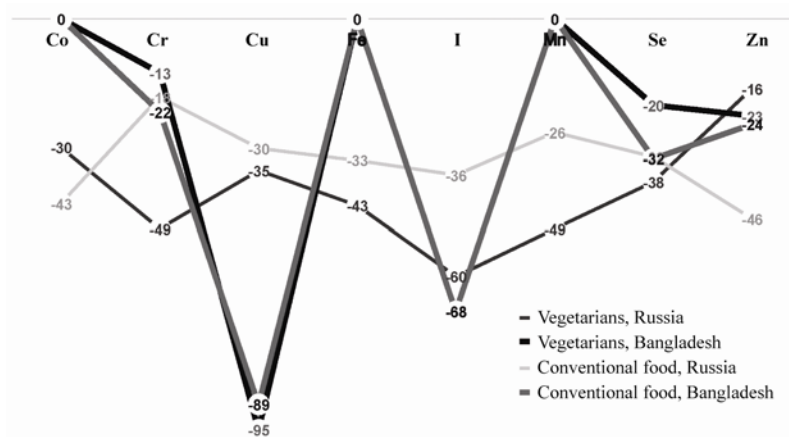


Fig. 3. Decreased hair content of trace elements in vegetarian and non-vegetarian women from Bangladesh and Russia (%)

Probably, low hair Cu 7.43 (6.62–8.09) vs. 12.2 (10.1–15.3 ppm in Russians) can be due to overloading of Fe and Mn (as Cu antagonists) and dietary habits. Low hair Cu reflects the Cu deficiency in human body. Also, Fe and Mn overloading can be responsible to decreased Cr levels 0.11 (0.08–0.18) vs 0.34 (0.23–0.5).

Hair Co was relatively increased, but Zn content was similar to Russian data. We revealed the tendency to decreasing of hair Zn content in non-vegetarians, especially in Russia, what is in accordance with low animal protein consumption.

It is known that copper deficiency causes the iron-deficient anemia, which is widespread in developing countries, firstly among women. Cu is synergist of iodine and participates in thyroxin synthesis (Oberleas et al., 2008). So it is not surprising that both Cu, I and also Se are simultaneously low in hair of Bangladesh women often suffering from goiter.

Elevated Mn concentration in drinking water is typical for Bangladesh and it correlates with increased Mn content in blood and urine of women. Some studies have shown that about half of the water samples that were tested in the rural Bangladesh (in the east of the central plain, south of Dhaka) had manganese concentrations above the World Health Organization's guideline value and showed a strong inverse correlation with arsenic concentrations (Vahter, 2009). Chewing of betel and tea drinking that are typical for Bangladesh population increase Mn intake.

The results of another study reveal that Bangladeshis have the highest intake of Mn compared to any other population that have been studied thus far. These researchers hypothesise that increased tremor, and possibly skin lesions, previously reported for betel quid chewers drinking arsenic contaminated water may be related to elevated exposure to Mn and other chemicals that are present in the betel quid (Al-Rmalli et al., 2011). Also, groundwater is rich in iron - there is no Fe deficiency in food intake in Bangladesh. Anemia is common in this population, however, in contrast to widely held assumptions that half of anemia cases are caused by inadequate iron status, this population exhibited surprising iron sufficiency in an environment where the diet is chronically low in bioavailable iron, as conventionally assessed without reference to water intake.

This and previous studies in the area suggest that the iron sufficiency is most likely due to the chronic consumption of iron-rich groundwater and that a proportion of anemia may be due to an unexpectedly elevated prevalence of thalassemia and Hb E (Ali, West, 2012). In addition to that our obtained data about almost total Cu and I deficiencies can explain the high frequency of anemia in the country too.

Investigation of traditional Indian food demonstrated the high content of essential trace elements (Singh, Garg, 2006). This study notes that Cr, Fe, Mn and Zn are contributed to the extent of 7.5% by various spices, whereas Cu, P and Se are contributed at less than 5% of the total dietary intake. It may be mentioned that most middle and higher income groups use these spices.

However, for lower income groups, the daily dietary intake of some of these elements may be considerably low. It can explain small difference in essential trace element status in hair and blood samples, which were investigated by us and other authors (Wojciak et al., 2004).

In addition along with diet, the treatment of hair (use of shampoos, oils, etc.), water quality, and exposure to exogenous contaminants, may affect the concentrations of trace elements in hair, resulting in national or ethnic differences (Srikumar et al., 1992).

In some works there are data that is not similar to ours. We observed the lowest zinc deficiency and the highest excess of iron exactly in Bengal vegetarians, despite the fact that the iron and zinc from vegetarian diets are generally less bioavailable than from non-vegetarian diets because of reduced meat intake as well as the tendency to consume more phytic acid and other plant-based inhibitors of iron and zinc absorption (Hunt, 2003).

CONCLUSIONS

1. Investigated Bangladesh women population has extremely elevated hair Fe and Mn and low I and Cu in comparison to Russians.
2. Vegetarianism has no influence on hair essential trace elements level in Bangladesh women. But vegetarian women from Russia differ from conventional food consumers by increased hair content of Cr, Fe, I, Se and decreased Zn.
3. Hair trace elements content depends on climate, nutritional habits, drinking water composition, environment and probably genetics. Our results may reflect the adaptation to traditional vegetarianism in Bangladesh population.
4. Determination of regional reference ranges can provide more correct interpretation of hair trace element tests from physiological point of view.

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СОДЕРЖАНИЕ ЭССЕНЦИАЛЬНЫХ МИКРОЭЛЕМЕНТОВ В ВОЛОСАХ ЖЕНЩИН ИЗ БАНГЛАДЕШ: ВЛИЯНИЕ ВЕГЕТАРИАНСТВА

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РЕЗЮМЕ. Известно, что вегетарианство может приводить к дефицитам эссенциальных микроэлементов у человека. В предыдущих исследованиях были продемонстрированы данные о повышенном уровне As, Hg, Be и сниженном Se в волосах взрослого населения (мужчин и женщин) округа Мименсингх Народной Республики Бангладеш (Skalnaya et al., 2015). В настоящей работе представлены данные 77 жительниц сельской местности (18–60 лет), придерживающихся (40 человек) и не придерживающихся (37 человек) вегетарианства. Проведен анализ волос на содержание эссенциальных микроэлементов (Co, Cr, Cu, Fe, I, Mn, Se, Zn), с использованием прибора масс-спектрального анализа с индуктивно связанной аргоновой плазмой. Результаты сравнивались с данными по жителям РФ. Обнаружено значительно повышенное содержание железа и марганца в волосах вегетарианок из Бангладеш, чуть менее выраженное повышение аналогичных элементов у женщин, придерживающихся смешанной диеты, но в обеих группах цифры были выше, чем у женщин из России. Дефицит йода был идентичен в обеих группах жительниц Бангладеш, при этом обе русские группы продемонстрировали меньшее снижение его уровня. Содержание селена в волосах было больше снижено в группе смешанной диеты бенгальцев. Дефицит хрома и цинка был не столь значительным, и он сопоставим с данными по российским женщинам. Снижение уровня меди в волосах наблюдалось практически у всех женщин во всех группах, но у жительниц Бангладеш данный дефицит выражен намного больше. При сравнении групп вегетарианок и не вегетарианок из Бангладеш значительных отличий выявлено не было, хотя между группами из России отличия явно присутствуют. Можно предположить, что вегетарианство не оказывает заметного влияния на микроэлементный статус жителей Бангладеш. Возможно, причиной тому является проживание на одной территории с похожими источниками продуктов и адаптация организма к жизни в данных условиях.

КЛЮЧЕВЫЕ СЛОВА: вегетарианство, волосы, женщины, кобальт, хром, медь, йод, никель, марганец, селен, цинк, Бангладеш.