

КРАТКОЕ СООБЩЕНИЕ

ON DECODING THE SYNTAX
OF THE HUMAN HAIR BIOELEMENT METABOLISM

B. Momčilović

Institute for Research and Development of the Sustainable Eco Systems, Srebrnjak 59, 10000, Zagreb, CROATIA

ABSTRACT. Human hair (HH) is a suitable long term biological indicator for assessing the nutritional status of bioelements (BioE). Every BioE has its individual biological assay sigmoid curve, and every such ogive has a distinct, central linear segment of a range of concentrations wherein the rate of BioE incorporation into the HH is in the dynamic equilibrium with the HH growth and its saturation capacity. This is adequate reference range of BioE indicating a satisfactory nutritional status or harmless environmental exposure. Concentrations below that linear range are considered deficient and those above it as excessive. New adequate/acceptable Min-Max reference range values for the HH BioE are ($\mu\text{g/g}$): Ca ♂ 290–1200, ♀ 440–4400; Zn ♂♀ 130–200; P ♂♀ 120–200; Na ♂ 84–1450, ♀ 55.6–1307; Mg ♂ 20–850, ♀ 40–450; Cu ♂ 8.50–18.95, ♀ 9.11–18.04; Al ♂ 3–39–27.74, ♀ 1.93–20.02; B ♂ 0.578–4.776, ♀ 0.434–2.570; Li ♂ 0.015–0.100, ♀ 0.014, 0.086; Sr ♂ 0.418–2.950, ♀ 0.846–7.260; I ♂ 0.15–1.97, ♀ 0.15–2.06; Se ♂ 0.013–0.98, ♀ 0.08–0.93; Ag ♂ 0.015–0.215, ♀ 0.024–0.695. The metabolic syntax of BioE is discussed. New hypothesis on the metabolic etiology of depression is proposed.

KEYWORDS: bioelements, interrelation, metabolism, biological indicator, human hair.

Human hair (HH) is a complex protein fiber polymer that contains both essential and non-essential major-, trace-, and ultra-trace elements (bioelements, BioE). The unidirectional and irreversible HH growth renders it as a preferable long-term biological indicator tissue for non-invasive assessment of the BioE nutritional status and environmental exposure. The major obstacle for wider use of the multiple BioE profile analysis in medical practice and public health is the wide individual variability of the within and between the individual HH analytical data. This variability in the analytical data generated from our currently prevailing assumption of a constant and linear rate of BioE deposition in the HH, whereas incorporation of BioE into the HH is governed by the Weber- Fechner Power Law. Therefore, we have studied the HH BioE frequency distribution with the help of the median derivatives bioassay sigmoids. Indeed, every BioE has its own individual biological assay sigmoid curve, and every such ogive has a distinct central linear segment of a range of concentrations wherein the rate of BioE incorporation into the HH is in the dynamic equilibrium with the HH growth and its saturation capacity. This is the adequate reference range of BioE for subjects having an adequate nutritional status or those with harmless environmental exposure; concentrations below that linear range indicate deficiency, and

those above it indicate overexposure.

New adequate reference range values for the HH BioE are proposed; they are in the decreasing order of abundance: Ca > Zn > P > Na > K > Mg > Cu > Al > B > Li > Sr > I > Se > Ag. Namely: Ca ♂ 290–1200, ♀ 440–4400; Zn ♂♀ 130–200; P ♂♀ 120–200; Na ♂ 84–1450, ♀ 55.6–1307; Mg ♂ 20–850, ♀ 40–450; Cu ♂ 8.50–18.95, ♀ 9.11–18.04; Al ♂ 3–39–27.74, ♀ 1.93–20.02; B ♂ 0.578–4.776, ♀ 0.434–2.570; Li ♂ 0.015–0.100, ♀ 0.014, 0.086; Sr ♂ 0.418–2.950, ♀ 0.846–7.260; I ♂ 0.15–1.97, ♀ 0.15–2.06; Se ♂ 0.013–0.98, ♀ 0.08–0.93; Ag ♂ 0.015–0.215, ♀ 0.024–0.695. Apparently, we may speak about the "calcified tissue" of HH, since about a half of all the studied HH BioE is Ca, whereas P was the most invariant regardless of sex, analytical method, geographical location or race over the period of 20 years (meta analysis). Adequate ranges of HH osteotrophic BioE Ca, Mg, and Sr were distinctly higher in women than men (♀ > ♂), whereas other BioE showed a variable and much less sex related dependence. The observed difference in the osteotrophic BioE affinity between the men and women indicate the existence of a specific sex-dependent multi-site and cooperative binding allosteric ligand. Major essential BioE of Na and K are metabolically "shadowed" by their respective, but much less abundant "sputnik", BioE of La and Rb.

* Corresponding author:

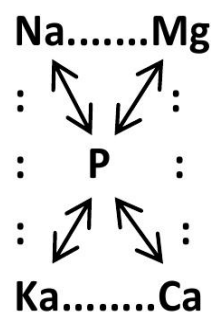
Momčilović Berislav

E-mail: berislav.momcilovic@gmail.com

BioE also tend to group in distinct factors, forming a tentative biological Periodic system.

A sketch is incorporated to show a hypothetic stoichiometry of five major BioE in their dynamic interplay. Here, they are cross-related such that the principal extracellular (Na) and intracellular (K) cations (left column), and the principal osteotrophic and cellular excitability related Mg and Ca cations (right column), are balanced *via* the central Phosphorus pivot. The balanced interplay structure between the intracellular (K) and extracellular (Na), with the organic mineralized bone matrix buffer of Mg and Ca, is equilibrated by the respective energy control production of ATP and protein synthesis control of DNA backbone of phosphorus. No external controller is required. In our study of the biological roots of depression, the most prevalent human mental impairment, HH multi BioE profile showed the excessive accumulation of both Na and K accompanied with the low serum vasopressin. Moreover, the overall metal's body burden was increased in

depression and what would indicate the impaired function of ionic channels *via* the (presumably) oxidative damage of the cellular membrane Na^+, K^+ ATPase function across the human body. This study on the "syntax" of the HH BioE provides for the new insight into the internal wiring of the multiple metabolic pathway, that operate simultaneously and in synchrony within the same confined environment of human cells.



РАСШИФРОВКА ИНФОРМАЦИИ О МЕТАБОЛИЗМЕ БИОЭЛЕМЕНТОВ В ВОЛОСАХ ЧЕЛОВЕКА

Б. Момчилович

Институт изучения и развития устойчивых экосистем, Загреб, Хорватия

РЕЗЮМЕ. Человеческие волосы является удобным биологическим индикатором для оценки алиментарной обеспеченности организма биоэлементами за продолжительный период. Каждый биоэлемент имеет свою индивидуальную сигмоидную кривую биологической активности, и каждая такая кривая имеет центральный линейный сегмент диапазона концентраций, в котором скорость включения биоэлементов в волос находится в динамическом равновесии со скоростью роста волоса и его поглощающей способностью. Это адекватный референтный диапазон содержания биоэлементов, указывающий на удовлетворительный статус питания и отсутствие вредного влияния окружающей среды. Концентрации ниже этого линейного диапазона считаются недостаточными, а выше него – чрезмерными. Новые адекватные/допустимые референтные значения содержания (Min-Max) биоэлементов в волосах человека следующие (мкг/г): Ca ♂ 290–1200, ♀ 440–4400; Zn ♂♀ 130–200; P ♂♀ 120–200; Na ♂ 84–1450, ♀ 55,6–1307; Mg ♂ 20–850, ♀ 40–450; Cu ♂ 8,50–18,95, ♀ 9,11–18,04; Al ♂ 3–39–27,74, ♀ 1,93–20,02; B ♂ 0,578–4,776, ♀ 0,434–2,570; Li ♂ 0,015–0,100, ♀ 0,014, 0,086; Sr ♂ 0,418–2,950, ♀ 0,846–7,260; I ♂ 0,15–1,97, ♀ 0,15–2,06; Se ♂ 0,013–0,98, ♂ 0,08–0,93; Ag ♂ 0,015–0,215, ♀ 0,024–0,695. Обсуждается вопрос о "метаболическом синтаксисе" биоэлементов. Предлагается новая гипотеза метаболической этиологии депрессии.

КЛЮЧЕВЫЕ СЛОВА: биоэлементы, взаимосвязь, обмен веществ, биологический индикатор, человеческие волосы.