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High hair selenium mother to fetus transfer after the Brazil nuts consumption

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ABSTRACT

Lactating mother and her two month old healthy daughter (APGAR 10) gave their scalp hair for a multi-element profile analysis; 25 elements were analyzed with the ICP MS. Mother's hair was divided into 5 cm long segment proximal to the scull (*Young*), and the distal segment further up to the hair tip (*Old*). One centimeter of hair records one month of the metabolic activity of the bioelements in the body. Mother's *Young* hair and daughters hair have 2.70 and 9.74 $\mu g\,g^{-1}$ Se, a distinctly higher Se concentrations than the *Old* hair of 0.87 $\mu g\,g^{-1}$. The adequate hair Se concentrations in Croatia women population vary from 0.08 to 0.63 $\mu g\,g^{-1}$; values below or above that range indicate deficiency or excess, respectively. Dietary recall revealed that during the last trimester of pregnancy and over a period of a week, the mother has consumed 135 g of Brazil nuts (*Bertholletia excelsa*) (BN); BN is an exceptionally rich Se dietary source. The amount of Se in BN varies and one week consumption of 135 g of BN may result in Se daily intake of 367 to 492 $\mu g\,g^{-1}\,day^{-1}$ over a period of seven consecutive days, and what is about or exceeds the Upper Limit of daily selenium intake of 400 $\mu g^{-1}\,g^{-1}$. The excessively high infant hair Se mirrored a natural high mother to fetus transplacental transfer of bio elements in the last trimester of pregnancy. The potential toxicological risks of such a high Se transfer remains to be elucidated.

1. Introduction

Selenium is an essential trace element indispensable for life [1]. The daily selenium requirements are well defined for adult persons, however, infant selenium requirements are the subject of expert consensus based on selenium in milk concentrations [2,3].

This paper is about an unusual observation which caught our attention. Lactating mother and her two months old breastfed baby gave their hair for a mutielement profile analysis. Mother's scalp hair proximal to the skull, *i.e.*, *Young* hair, contained three times more selenium than the distal part of the same hair sample (*Old* hair); also her two months old daughter has even the higher excessive hair Se. Evidently, substantial amounts of dietary selenium may be transferred *via* placenta from mother to fetus hair during pregnancy. This observation initiated our thorough dietary history recall of mother's nutrition with the aim to elucidate this unusual finding along the same thread of hair.

2. Subject (mother and daughter)

On April 12, 2014 a young 30-year old healthy white Caucasian woman (♀SB, 63 kg, 175 cm), Zagreb, Croatia, gave a natural birth to her healthy first baby daughter (♀KBM, birth weight 2670 g, birth length 46 cm, APGAR 10). Two months later, both mother and daughter gave their hair for hair multielement profile analysis; the informed consent was given by the mother. Mother's long hair has been divided into two parts: (A-Proximal, *Young*) some 5 cm up from the protuberantia occipitalis externa on the skull, and (B-Distal, *Old*) involving the rest of the hair up to the hair tips. Thus, Part A represents the younger hair whereas the Part B represents the older hair. Twenty-five elements were analyzed with the ICP-MS in every hair sample (the essential elements are

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Table 1
Hair multielement profile changes in a pregnant/lactating woman and her daughter two months after delivery. High dietary intake of selenium from Brazil Nuts (*B. excelsa*) has occurred in the last trimester of pregnancy. Mean of the 2 replicates ($\mu g\,g^{-1}$).

Before the *Brazil Nuts*		After the *Brazil Nuts were consumed in the third trimester of pregnancy*[a]			
Pregnant Mother (Hair B-Distal)		Lactating Mother (Hair A-Proximal)		Daughter	
☐ Deficiency ■ Excess [(b)]					
B	0.37	B	0.36	B	5.35
Ca	658	Ca	2838	Ca	690
Co	0.004	Co	0.007	Co	0.01
Cr	0.020	Cr	0.04	Cr	0.11
Fe	5.25	Fe	5.82	Fe	15.12
I	0.30	I	0.57	I	3.53
K	74.13	K	90.67	K	3359
Li	0.005	Li	0.01	Li	0.22
Mg	63.63	Mg	166	Mg	70.05
Mn	0.05	Mn	0.06	Mn	0.48
Na	14.74	Na	20.94	Na	881
P	154	P	144	P	186
Se	0.87	Se	2.70	Se	9.74
V	0.003	V	0.005	V	0.01

[a]Time line (1 cm hair = 1 month) indicates that high dietary selenium was onsumed five month before hair was sampled at two months after the delivery.
[b]Adequate hair reference ranges ($\mu g\,g^{-1}$): // Ca ♀ 290–4400, Mg ♀ 40–450 [29]; // I ♀ 0.15–2.06, Se ♀ 0.08–0.63 [8,30]; // P ♂♀ 120–200 [14]; // K ♀ 20–500, Na ♀ 60–1400 [31] // CBM reference values for women: B (0.00–5.00), Co (0.006–0.200), Cr (0.15–1.00), Fe (10.0–50.0), Li (0.005–1.00), Mn (0.25–1.80), V (0.00–0.10) [4].

underlined—Al, As, B, Be, Ca, Cd, Co, Cr, Cu, Fe, Hg, I, K, Li, Mg, Mn, Na, Ni, P, Pb, Se, Si, Sn, V, Zn), at the Center for Biotic Medicine, Moscow, Russia. CBM is an ISO Europe certified commercial laboratory for analyzing bioelements (major and trace and ultratrace elements) in different biological matrices, as described in full detail earlier [4]. In brief, hair analysis was performed following the International Atomic Energy Agency recommendations [5] and other validated analytical methods and procedures [6]. Approximately 0.5–1.0 g of the hair was cut off from the occipital head region above the protuberantia occipitalis externa and stored in numbered envelopes and kept refrigerated at 4 °C before they were randomly assigned for analysis. The individual hair samples were cut prior to chemical analysis to be less han 1 cm long, stirred 10 min in an ethylether/acetone (3:1, w/w), rinsed three times with the redistilled H_2O, dried at 85 °C for one hour to constant weight, immersed one hour in 5% EDTA, rinsed again in the redistilled H_2O, dried at 85 °C for twelve hours, wet digested in HNO_3/H_2O_2 in a plastic tube, and sonicated. The samples were analyzed for their element contents by the inductively coupled plasma mass spectrometry (ICP MS) (Elan 9000, PerkinElmer, USA). All chemicals were proanalysis grade (Khimmed Sintez, Moscow, Russia). We used certified GBW0910b Human Hair Reference Material (Shanghai Institute for Nuclear Research, Academia Sinica, Shanghai 201849, China) (CV [SD/Mean] 0.077) [7].

Our adequate hair selenium reference values for women are 0.08–0.63 $\mu g\,g^{-1}$ [8]. Values below or above this range are considered to indicate selenium deficiency or excess, respectively; our detection limit for Se is 0.026 $\mu g\,g^{-1}$.

Selenium belongs to the pleiad of 124 elements sharing the same mass number (number of isotopes/elements): 4 Zn, 7 Ga, 13 Ge, 16 As, 22 Se, 18 Br, 17 Kr, 11 Rb, 10 Sr, 6 Y, and 1 Zr [9].

3. Results and discussion

The highlights of the hair multielement profile analysis are shown in Table 1. Immediately, our attention was directed to the fact that selenium concentrations were quite different in Part A and Part B of the same thread of mother's hair and exceptionally high in the hair of her daughter. Indeed, the Se concentrations of 0.870 $\mu g\,g^{-1}$ in the mother's hair Part B—Distal, *Old,* were close to the expected adequate selenium status of the body [10]; however, the Se concentrations in Part A—Proximal, *Young* of the mother's hair were 2.70 $\mu g\,g^{-1}$ and 9.74 $\mu g\,g^{-1}$ in her daughter's hair, respectively. Adequate hair selenium concentrations of Croatian women population range from 0.08–0.63 $\mu g\,g^{-1}$, Median 0.266 $\mu g\,g^{-1}$ [8]; these hair selenium values are in good agreement with the reported values by the other authors [11–13]. Since Ms. ♀SB denied using any selenium containing supplements, ointment and/or shampoos, this observation initiated an extensive dietary recall task of what she was eating in the apparently last trimester of her pregnancy. Indeed, approximately 5 cm long hair sample would cover a period of about five months, *i.e.*, in this particular case three months of pregnancy and two months of lactation. She regularly consumed just the usual mixed Mid European diet. Ultimately, we discovered that somewhere around her third trimester of pregnancy Ms. SB consumed a single pack of Brazil nuts (*Bertholletia excelsa*) weighing about 135 g. Brazil nuts (BN) happen to be notorious for their exceptionally high selenium content of 2.550 $\mu g\,g^{-1}$ Se! This is a 3643% of a daily value recommended for this element [3,14]. The amount of Se in BN varies and one week consumption of 135 g of BN may result in Se daily intake of 367–492 $\mu g\,g^{-1}\,d^{-1}$ over a period of seven consecutive days, and what is about, or exceeds, the Upper Limit of daily selenium intake of 400 $\mu g^{-1}\,g^{-1}$ [15]. Recently, the