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Research Article

DETERMINATION OF THE LEVELS OF 19 DIFFERENT ELEMENTS IN BREAST MILK BY ICP-MS IN KARABÜK PROVINCE: WHICH IS AN INDUSTRIAL CITY

Namık BİLİCİ[1], Yılmaz ALTUNER[2], H.Kubra KOC TOPCUOGLU[2], Mustafa CENGİZ[5], Adnan AYHANCI[5], Kübra DEMİR[3], Öznur Hayat ÖKTEM[3], and Ilknur Kulcanay SAHIN[5], ,

[1] Karabük University Faculty of Medicine Department of Medical Pharmacology. Balıklarkayasi area Karabük
[2] Karabük University Faculty of Health Sciences, BalıklarKayası Region, Karabük
[3] Ministry of Health, Yıldızeli ŞeyhHalil Village, Yıdız Family Health Center. Sivas
[4] Ministry of Health, KBU Training and Research Hospital, Karabük.
[5] University of Osmangazi, Eskisehir

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ABSTRACT

Breast milk is an excellent nutritional source for the baby in terms of its nutritional items. However, it is also very sensitive to the mother's nutrition and the environmental conditions she is exposed to. Metals are important agents that pollute the breast milk through exposure and nutrition. Metals excreted through milk may be transmitted to babies through breastfeeding. It is also possible to transmit them to the embryo or fetus by trans-placental route during pregnancy. In this study, the presence of 19 elements in the mother's milk was researched in Karabük. Within this context, lithium (Li), beryllium (Be), aluminum (Al), vanadium (V), chromium (Cr), cobalt (Co), copper (Cu), gallium (Ga), strontium (Sr), silver (Ag), indium (In), tellurium (Te), cesium (Cs), barium (Ba), thallium (Tl) and bismuth (Bi) were screened using ICP-MS. It has been observed that the amounts of these elements are in a tendency of decreasing significantly, during the time period of 15-30th days and 30-120th days, in which they are present in the breast milk ($p < 0.05$). This fact has been assessed to be extremely important in terms of public health.

INTRODUCTION

Breast milk is the most sensitive basic element of the immune system with its immunological factors in addition to being an ideal nutrient for the baby in terms of protein, carbohydrate, fat and minerals. Breastmilk, which is the most valuable nutrient for the baby's life, is more or less affected by all kinds of pollution types such as the nutrition of the mother, the environmental conditions she lives in, and the nutrients that she consumes. Various studies have been made on the fact that many substances, such as metals contaminating the food, phytohormones, maturing agents, drug residues, pesticides, nanoparticles contaminate the breastmilk, which is an important public health problem that should be addressed(9,14,33,36,42).

While metals such as Fe, Zn, Mg, Mn and Se play a useful role in various biochemical reactions for the human body, heavy metals such as Pb, Hg, Cd, Li, Be, Al, V, Cr, Co, Cu, Ga, As, Se, Rb, Sr, Ag, In, Te, Cs, Ba, Tl and Bi easily constitute toxic effects on vegetable and animal source foods by being included in the food chain (31-33). These heavy metals have been explained by studies in which they can cause cancer in human tissues and organs, not only through food, but also due to mutagenic and teratogenic intensities they have for occupational reasons(6,7,15,19,21,25,39,40).

Despite the fact that iron and steel mining is highly effective in the industrialization of countries, uncontrolled releases of the substances (carbon-derived gases, wastes of the liquids that they were treated and semi-solid wastes in the form of solid and slag), especially to the environment, have negative effects on human health. Depending on the level of affinity and accumulation of the released wastes in an uncontrolled way, for example, As for skin, Cd for gonads, lead for bones and central nervous system, Ni for the nose-sinusoidal region create quite harmful results. In addition, it has been shown in the screenings and in experiments on the animals that, there is the possibility of serious health diseases such as the idiopathic abortions, hepato-renal insufficiencies, immune system problems,

**Corresponding author:* Namık BİLİCİ
Karabük University Faculty of Medicine Department of Medical Pharmacology. Balıklarkayasi area Karabük

proliferative degenerations in lung, breast, uterus and testes, various lymphomas, myeloid leukemia, neurodegenerative problems, mutations, congenital malformations, teratogenesis, due to the furan and dioxin compounds which are formed in the iron-steel production and primary processing stages (4,24,41,46,47).

The effects of the exposure of heavy metals to the breastmilk has been studied with different metals or metal groups, and the measures and levels of exposure limits for countries' health and food authorities, based on the quality, intensity, exposure level, route and duration of the industrial pollutants, have been identified under the light of a considerable number of studies (18,19,23).

It has been known that metals such as Hg, Pb, As, Se and Zn threaten the public health by being able to be very easily involved in the food chain, especially the mercury is formed via teeth fillings (inorganic mercury = Hg) and through the consumption of the fish (monomethyl mercury = MMeHg) caught from the seas highly polluted by the mercury. It has been determined that maternal lead accumulation is due to the mechanism of Ca and P that the lead interacts with the bone, and that lead can be found at high rates in baby foods. It has been reported that the risk of contamination of lead via maternal and food products is both higher and longer lasting, while the infant's reference dose of Hg is lower than that of Pb, and that cows' milk that is used as a substitute instead of breastmilk is not a solution for heavy metal pollution. It is also known that when the doses of Al and ethyl Hg used in vaccination that causes neuro-pathological growth retardation is decreased over time, the effects are also decreased. In the light of literature data on the studies carried out in the US, it has been expressed that these two vaccine adjuvants cause serious developmental problems (16,17,27,29,35,549,50).

In elemental exposures, the way of exposure, the duration, the amount, the compound structure, the organ or tissue it is accumulated, and the interaction with other components is of vital importance. For example, the Agency for Toxic Substances and Disease Registry (ATSDR) under the Centers for Disease Control and Prevention (CDC) stated that; for Al, the individual exposure limit is 30-50 mg at the rates of 1.5-2% in dermal, 0.01-0.5% in inhaler; and the bone level in the healthy individual is 5-10 mg/kg and the serum level is 0.005-018 μg/m3 for respiratory tract exposure of 3 μg/L, the difference between rural and industrial areas is 0.4-8.0 μg/L and that the rate of presence in the surface waters is on average 0.1 mg/L. The minimum risk levels for Al (minimal risk levels = MRLs) is limited to 1 mg/kg/day and 15-364 days orally. 365 days and over for MRLs is determined as 0.9 mg/kg/day(3,13,34,37,43).

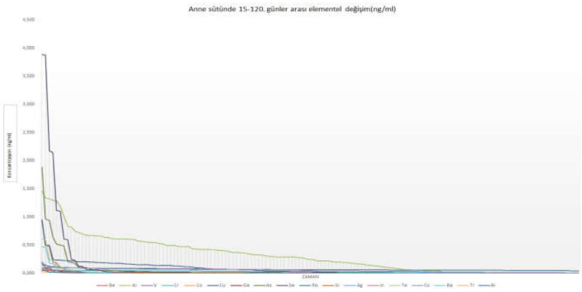
In this study, it was aimed to determine the level of 19 elements in breastmilk in Karabük, which is an industrial city. For this purpose, 150 samples of breast milk were analysed for 19 heavy metals.

MATERIAL AND METHOD

Ethical committee approval was obtained from the KBÜ for the collection of milk to be used in this study, and 5 ml milk samples in 15 ml pp tubes were collected for an average of three months from 150 mothers living in Karabük province. Samples were taken between July and December of 2014, between the 15th and 120th days of lactation. The collected samples were stored at <-40°C and then transferred to the Scientific and Technological Research and Application Center Laboratory of Aksaray University in the cold chain. %65 Nitric acid (Merc 100456), 30% hydrogen peroxide (Merc 108600) and 99.995% pure argon gas were used in the studies on the samples and the HNO3/H2O2 ratio was taken as 1:9 for each of the 0.5 gr sample. The devices used were Cem Mars-5X press microwave for solubilizing the samples, Cetac ASX-520 Auto Sampler automatic sampler and automatic pipet compatible with ICP-MS device.

Findings

In the study conducted, the results of analysis were calculated using ICP-MS on breast milk and the graph (Graph 1) of these results is presented below.



Graph 1 Change in breastmilk between 15^{th} and 120^{th} days

In this study, it was found that the existence of the of Li, Be, Al, V, Cr, Co, Cu, Ga, As, Se, Rb, Sr, Ag, In, Te, Cs, Ba, Tl and Bi elements in the breastmilk, detected by ICP-MS between 15^{th} and 120^{th} days, has a decreasing tendency. This excretion shows a decreasing trend. Since Ga, In, Tl, and Bi values in the breastmilk could not be measured until the 15th day, their states after 15th day were considered to be "zero". Cs, Rb presence was detected until the 120th day. The mean values of the elements analyzed for 15-120 days were found to be; Li:0.02556, Be:0.01892, Al:0.3074, V:0.0077, Cr:0.0263, Co:0.0045, Cu:0.9478, Ga:0.0973 , As:0.0557, Se:0.1159, Rb:0.0657, Sr:0.0061, Ag:0.0044, In:0.0022, Te:0.0161, Cs:0.0514, Ba:0.030, Tl:0.0009, Bi:0.0015 (Graph 1). Findings suggest that as the timeframe after the delivery increases, the amount of the substances in the breastmilk decreases. The difference between lactation milk in the first group (15-30 days) and the milk samples (30-120 days) is significant (Anova; p=0,028 <0,05).

While there is no equivalent study to this study that searched the same 19 elements, there are many data related to this field. ATSDR determined the maximum daily intake values as 1, 0.005, 0.2, 0.005, 0.01, (0.01-0.0008), mg/kg/day for Al, As, Ba, Cr, Co and Cu respectively. These values are tabulated in comparison with the data of the current study (Table1). In addition, in our study,% RDS with the minimum, average, and maximum values of 19 elements were tabulated (Table 2).

DISCUSSION AND RESULTS

As environmental pollution worsens every day in the world and the measures taken against them are inadequate, contamination of the products that help the nutrition causes the fatal diseases of plants, animals and people and their generations and even their deaths. Among the environmental pollutants, there are gas, liquid and solid wastes especially released to the environment by the iron and steel industry. It has been identified by studies that these can lead to serious health problems such as hepato-renal insufficiencies in human tissues and organs, immune system problems, proliferative degenerations in lung, breast, uterus and testes, various lymphomas, myeloid leukaemia, neurodegenerative problems, mutations, congenital malformations, teratogenesis (4,6,7,15,19,21,24,41,46,47).

Table 1 Comparison of findings with ATSDR data

		% RSD	Karabük(µg/l)		
	Element		Min	Average	Max
1	7Li	0.636	0.005	0.026	0.307
2	9Be	0.280	0.001	0.019	0.928
3	27Al	0.720	0.017	0.307	1.457
4	51V	12.580	0.002	0.008	0.179
5	52Cr	5.448	0.011	0.026	0.068
6	59Co	1.395	0.001	0.005	0.191
7	65Cu	5.307	0.006	0.071	0.948
8	69Ga	3.093	0.001	0.097	0.195
9	75As	5.551	0.001	0.056	1.879
10	82Se	4.016	0.001	0.116	3.882
11	85Rb	8.544	0.054	0.066	0.182
12	88Sr	9.808	0.002	0.006	0.098
13	107Ag	2.010	0.001	0.004	0.202
14	115In	3.523	0.001	0.002	0.097
15	125Te	2.479	0.001	0.016	0.611
16	133Cs	5.786	0.019	0.051	0.144
17	137Ba	2.584	0.001	0.013	0.468
18	205Tl	6.273	0.001	0.0001	0.043
19	209Bi	5.794	0.001	0.002	0.055

Table 2 The minimum, average, and maximumvalues of 19 elements

Element	Findings (µg/l) Avg.	ATSDR Data (mg/Kg)
Al	0307	1
As	0.056	0.003
Ba	0.013	0.2
Cr	0.026	0.005
Co	0.005	0.1
Cu	0.071	0.01
Be	0.019	0.002
Sr	0.006	2
Cs	0.051	-

Protein, carbohydrates, fats and minerals and immunological factors that are in the content of the breast milk are very important in feeding and growing the baby. Various studies have been made on the fact that many substances, such as metals contaminating the food, phytohormones, maturing agents, drug residues, pesticides, nanoparticles contaminate the breastmilk, which is an important public health problem that should be addressed (9,14,33,36,42). The effects of the exposure of heavy metals to the breastmilk has been studied with different metals or metal groups, and the measures and levels of exposure limits for countries' health and food authorities, based on the quality, intensity, exposure level, route and duration of the industrial pollutants, have been identified under the light of a considerable number of studies (18,19,23). In another study, amalgam-derived inorganic mercury quantities were found to be significant on 23 breast milk samples between postpartum 7-30 days. It has been reported that there is a significant relationship between dental amalgam treatment and Hg excretion of the milk. (12,21,22,48).

In addition, in a study conducted in Taiwan for 6 months on the milk of 45 healthy mothers, Al (56 µg / L) and As (1.50 µg / L) levels were found to be considerably high in the colostrum. Both metals have shown a decreasing tendency in milk during the lactation period (10). Similarly, Björklund (2012) compared his research in 2002 and 2009 with that of WHO in the presence of 32 different metals in Sweden. Cu, Co, Se, Cr, Se, As, and V values of the data obtained in this study are well above the data obtained in our study (8,9). In our study, the LOD table is below the minimum values given in the table (Table 2) and the LOQ table is regarded as the minimum values. The% RSD is calculated separately for each element and is found to be at the average of 0.459 for all of the data.

It is known that the elemental existence in the breast milk is influenced by nutritional habits, environmental conditions and other habits. The displacement of Zn and Ca in the bones with Pb is also known, as well as it is known that the babies of the mothers who have a tooth filling have a high amount of zinc and that they are susceptible to autism. Again, the relationship between the concentration of As in the breast milk and that of the infant's urine has been shown (1,2,11,28).

In our study, it was found that the values for 19 elements (Pb, Hg, Cd, Li, Be, Al, V, Cr, Co, Cu, Ga, As, Se, Rb, Sr, Ag, In, Te, Cs, Ba, Tl, Bi) except for As are all lower than the values found in our country and abroad. It is thought that the high amount of As is due to environment, nutrition, drinking water and heavy industry and its side branches. For the As value, WHO predicts 0.1-0.8 and the average is 0.3 ng/mL, while ATSDR indicates this value as 0.003 mg/kg. We showed in our study that the concentrations 19 elements were higher in the early stages of lactation in the breast milk and they had a gradually decreasing trend. The results we found in our study of 19 elements suggest studies to be carried out on the development of new methods in the future on the fact that the heavy metals pass to the mother very effectively and its causes of passing to the mother.

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