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Research Article

Determination of some macro and micro elements in breast milk in Tokat, Turkey and comparison with the values of other countries

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ABSTRACT

In this study, the concentrations of trace metals iron (Fe), copper (Cu) and zinc (Zn) and major nutrients calcium (Ca), magnesium (Mg), sodium (Na) and potassium (K) in breast milk taken from 32 different volunteer mothers in Tokat, Turkey, were determined the samples were subjected to microwave-assisted acid digestion after by atomic absorption spectrometry analysis. Average values of concentrations (mg/L) of investigated metal; iron, copper, zinc, calcium, sodium, magnesium, and potassium were found to be 0.92, 0.173, 1.34, 167.8, 165.06, 36.42, 511.68, respectively, in studied breast milk samples. Also, these values were compared with values obtained from related articles, from 14 different countries. Among these results, the highest value for Fe belongs to Namibia, for Cu and Zn to Austria when the trace element values obtained from breast milk samples collected in this study were compared with literature data, Fe has the third high value, while Cu and Zn were found to be eleventh. Moreover, the results of the main nutrients obtained from the samples collected in this study were compared with the literature data of two other countries. According to this comparison, the values obtained in our study for Mg and K are the highest values. However, this comparison shows that the Na value is second and the Ca value is the smallest.The determined values of the metals examined in our study are among the recommended tolerable levels of these elements.

TR

Türkiye Tokat'ta, anne sütündeki bazı makro ve mikro elementlerin tayini ve diğer ülkelerin değerleri ile kıyaslanması

Anahtar Kelimeler:
Atomik absorpsiyon spektrometri,
anne sütü,
ana besin elementleri,
eser elementler

ÖZET

Bu çalışmada Türkiye, Tokat'taki 32 farklı gönüllü annenin anne sütünde; eser elementlerden demir (Fe), bakır (Cu), çinko (Zn) ve ana besin maddelerinden kalsiyum (Ca), magnezyum (Mg), sodyum (Na) ve potasyum (K) elementlerinin konsantrasyonları, örneklerin mikrodalga destekli asit parçalama işlemini takiben atomik absorpsiyon spektrometrisi ile tayin edildi. Anne sütü örneklerinde incelenen metaller olan demir, bakır, çinko, kalsiyum, sodyum, magnezyum ve potasyum konsantrasyon (mg/L) değerlerinin ortalamaları sırasıyla 0.92, 0.173, 1.34, 167.8, 165.06, 36.42, 511.68 olduğu tespit edildi. Ayrıca bu değerler, literatürde yer alan çalışmalar yoluyla, 14 farklı ülkedeki anne sütü numunelerinden elde edilen diğer sonuçlarla karşılaştırılmıştır. Bu sonuçlar arasında Fe için en yüksek değer Namibya'ya ait iken, Cu ve Zn için ise Avusturya'ya aittir. Bu çalışmada toplanan anne sütü numunelerinden elde edilen eser element değerleri, literatür verileri ile kıyaslandığında Fe üçüncü en yüksek değere sahip, Cu ve Zn ise en yüksek on birinci değere sahiptir. Ayrıca bu çalışmada toplanan numunelerden elde edilen başlıca besinlere ait sonuçlar, diğer 2 farklı ülkenin literatür verileri ile karşılaştırılmıştır. Bu karşılaştırmaya göre, Mg ve K için çalışmamızda elde edilen değerler en yüksek değerlerdir. Fakat, yine bu karşılaştırma da Na değerinin ikinci olduğu ve Ca değerinin ise en küçük olduğu görülmüştür.Çalışmamızda incelenen metallerin belirlenen değerleri, bu öğelerin tavsiye edilen tolere edilebilir seviyeleri arasındadır.

1. Introduction

Human milk or breast milk is a vital nutrient for an infant during the first months of life. It contains fat, protein and carbohydrate, which can be defined as metabolic fuels. It also includes fatty acids, amino acids, minerals, vitamins, and trace elements known as raw materials which are essential for development and growth of healthy tissue. The personal breastfeeding of infants up to six months and continued breastfeeding with appropriate supplementary nutrition till two years of age are recommended by the World Health Organization (WHO) [1]. Human milk is a multiplex liquid, which is concentrated in nutrients and non-nutritional bioactive components. Trace elements are important for proper development of the human organism. They play roles in different biological functions, especially in enzymes as a cofactor. Because of human milk trace element content, its is essential in nutrition and particularly in infant nourishment [2].

Some diseases and syndromes can be seen when trace elements are present in the organism in inappropriate concentrations. Nutritional anemia depends mostly on iron (Fe) deficiency which causes the most widespread malnutrition syndrome. This syndrome has negative effects on development, health, and performance. Dietary iron comprises heme iron (animal sources) and non-heme iron (vegetable and cereal sources). Heme iron bound to hemoglobin and myoglobin is responsible for delivering oxygen to the tissues [3]. Also, copper (Cu) and zinc (Zn) regulate vital enzyme functions [4].

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Major nutritional elements, which are calcium (Ca), magnesium (Mg), potassium (K), and sodium (Na) in human milk, are necessary for infant development and growth [5]. Adequate nutritional element supply is required for healthy tissue development in early years of life for a rapid growth of infants. These macro- and micro-nutritional elements are construction ingredients for protein, blood, muscle, etc. [6].

Recently, determination of trace element combination in milk has attracted more attention [7]. Usually, methods for quantitative determination of trace elements in breastmilk are electro thermal atomic absorption spectrometry (ET-AAS) [8], flame atomic absorption spectrometry (FAAS) [9] and inductively coupled plasma - atomic emission spectrometry (ICP-AES) [10].

Breast milk content is variable with the phase of lactation, breastfeeding pattern, season, parity and it also differs among individuals and nations. Maternal nutrition is a clear nominee for investigation, but the situation is not simple. Supplementation and comparisons of cross-cultural studies have shown that the total concentrations of lactose, fat, and protein, are relatively insensible to current dietary intake and nutritional condition, whereas the fatty acid profile and the concentrations of several micronutrients, especially water-soluble vitamins, are responsive to maternal diet. Trace elements and minerals in breastmilk can be affected by mother's diet, environmental pollutions, climate conditions, habits, customs, and ignorance [11].

The composition of human milk has difference according to its origin of place, economic status, and ethnic groups [12]. However, some distinct regional differences are evident, particularly in the concentrations of certain protein components, minerals, vitamins, and trace elements [13]. The exact reason is mysterious, but some evidence points out to the maternal diet and the geographical and cultural conditions.

For the first four-six months of a baby's life, breastfeeding will normally provide all the required nutrients. After this period some nutrients may become not adequate, including not only dietary other but also essential trace elements such as zinc, iron, and minerals. Actual suggestions are that spoon feeding is unnecessary before four months, but a mixed diet should be offered after six months [14].

This study is aimed to determine levels of Ca, Mg, Na, K, which are the major nutritional elements and, Fe, Cu, Zn, which are the essential trace elements, in breast milk in Tokat, Turkey. Also experimental results of this study were compared with literature values of 14 different countries, for getting ideas about our status among other countries.

2. Experimental

2.1. Reagents

All reagents were of analytical grade unless otherwise stated. HNO_3 and H_2O_2 are purchased from Merck. A stock standard solution of investigated elements 1000 mg/L was prepared before use. For all dilutions, double deionized water was used. Deionized water was produced with Milli-Q system, Millipore. All glassware was soaked in 10% HNO_3 for 30 min. and rinsed with deionized water before use.

2.2. Sample collection

The samples of human milk were collected from 32 healthy volunteer women which were at 2 months postpartum. The study was carried on, in Tokat, Turkey (40°19'28.7"N 36°32'53.7"E). Sample collection was done roughly before rnoon (10 a.m.) and before evening (15 p.m.). The mothers donated completely milk using a manual breast pump, from both breasts into sterile containers. Total collected milk is directly transferred in a sterile container in cold chain and stored -22 °C until analysis time.

2.3. Equipment

Elemental analysis was done by Perkin-Elmer Analyst 700 AAS with deuterium background. Milestone Ethos D microwave closed system was used for digestion of human milk samples.

2.3. Procedure of analysis

Two mL of unfrozen sample was put into the Teflon vessel of the microwave device and 1 mL concentrated HNO_3 and 0.5 mL H_2O_2 (33% w:w) were added for digestion operation. Also, the microwave device was used for heating, which can provide energy until 1000 Watt. The following microwave heating program was applied: 250 Watt / 2 min.; 0 Watt / 2 min.; 250 Watt / 6 min.; 400 Watt / 5 min.; 500 Watt / 8 min. and 10 min. ventilation. Then the digested solution was transferred to a tube and added deionized water until the total volume reached 10 mL.

3. Results and discussion

In the present study human milk samples were investigated with FAAS system. In Fig. 1, the concentration (mg/L) of the studied breast milk samples were compared to the other studies in other countries from literature (Austria, Germany, Italy, Canada, Korea, Taiwan, USA, Kuwait [15]; Sweden [16], Poland [17], Argentina, Namibia [18], Iran [19]). As seen in Fig. 1, when the values from human breast milk in lactating women residing in 14 different countries obtained by using different analytical techniques were compared the concentrations of Fe, Zn, and Cu showed wide variations. These variations can be related to maternal age, parity, nutritional state, socioeconomic level, and geographical & climate conditions [20,21]. We can also see in Fig. 1 Fe concentration in Tokat, Turkey (0.173 mg/L) is the third highest value after Namibia and Iran, in all the other countries. The smallest Fe level belongs to Korea in defined values.

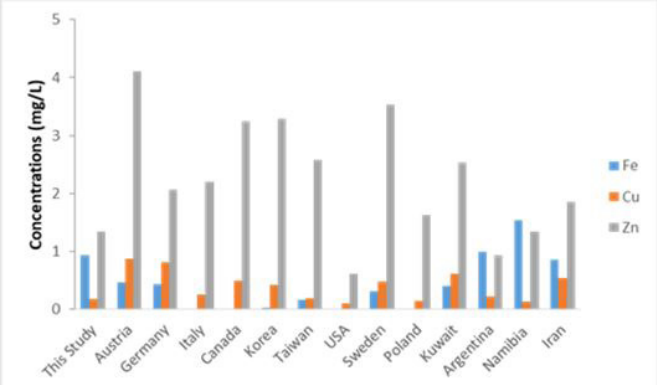

Fig. 1. Concentrations of Iron, Copper, and Zinc.

The highest Cu concentrations are Austria (0.860 mg/L), Germany (0.800 mg/L), Kuwait (0.603 mg/L) and our Cu result has eleventh value (0.173 mg/L), the smallest value belongs to USA (0.100 mg/L). The highest Zn concentrations are in Austria (4.100 mg/L) Sweden (3.524 mg/L), and Korea (3.290 mg/L) and, our Zn result has eleventh value (1.340 mg/L) like Namibia, while the smallest value belongs to USA (0.605 mg/L). We can observe that the values of the elements in this study are smaller, except those of USA.

In Fig. 2, our findings about major nutrients are compared to other countries (USA [22], and Sweden [16]). As we can see, our results for Ca (167.8 mg/L) has smallest value after USA (283 mg/L), and Sweden (196 mg/L); for Mg our result has highest value (36.42 mg/L), USA has second (30.5 mg/L), the least value belongs to Sweden (28 mg/L); for Na our result has second highest value (165.06 mg/L) after Sweden (192 mg/L), the least value belongs to USA (145.5 mg/L); lastly for K our result has highest value (511.68 mg/L), USA has second (433.5 mg/L), the least value belongs to Sweden (307 mg/L).

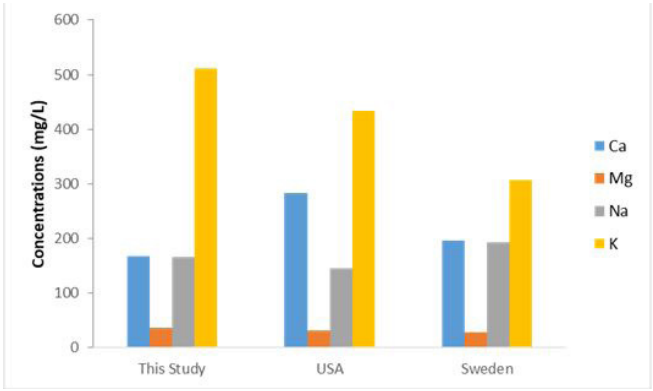

Fig. 2. Concentrations of Calcium, Magnesium, Sodium, Potassium.

4. Conclusions

Concentrations of trace metals like iron (Fe), copper (Cu), zinc (Zn), and major nutrients including calcium (Ca), magnesium (Mg), sodium (Na) and potassium (K) in breast milk from 32 different volunteer mothers in Tokat, Turkey were determined with FAAS microwave digestion method. In the method the required sample volume is small and analysis time is short. Also, FAAS microwave digestion for determining these trace elements in human milk is a reliable and suitable method.

The median of concentration (mg/L) values of investigated metals iron, copper, zinc, calcium, sodium, magnesium, and potassium was 0.92, 0.173, 1.34, 167.8, 165.06, 36.42, and 511.68, respectively, in studied breastmilk samples.

According to experimental results of this study,the values of investigated elements are coherent with literature the values.

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