DETERMINATION OF SOME ESSENTIAL MINERALS IN CHEESE AND MILK

PEYNİR VE SÜTTE BAZI ESENSİYEL MİNERALLERİN BELİRLENMESİ

Nuray YÜZBAŞI[1], Bedlha DEMİRÖZÜ[2]

1Dış Ticaret Müsteşarlığı İhracat Genel Müdürlüğü İnönü Bulvarı 06510 Emek-Ankara

2Tarım ve Köyişleri Bakanlığı Koruma Kontrol Genel Müdürlüğü Akay Cad. No:3 06100 Bakanlıklar - Ankara

ABSTRACT: In this study, it was aimed to determine the calcium, magnesium, sodium, iron, zinc, and copper contents in milk, pickled white cheese and Kasar cheese samples. The atomic absorption spectrometric method was used to determine of mineral content in samples, and the closed system microwave digestion method was used for digestion of samples.

At the end of the study, it was found that the mean levels of calcium, magnesium, sodium, potassium, iron, zinc and copper contents in milk as 653.00±389 mg/L, 84.00±61.00 mg/L, 320.00±107 mg/L, 876.00±361 mg/L, 0.82±0.23 mg/L, 3.01±2.17 mg/L and 0.09±0.05 mg/L respectively. In pickled white cheese and Kasar cheese products, these values were found as 7067.00±3069 mg/kg and 6026.00±908 mg/kg, 411.00±95.8 mg/kg and 220.00±45.20 mg/kg, 4334.00±3021 mg/kg, and 5802.00±1972 mg/kg, 1742.00±602 mg/kg and 723.00±147 mg/kg, 3.05±1.27 mg/kg and 4.11±1.92 mg/kg, 20.19±5.52 mg/kg and 38.00±5.17 mg/kg, 0.54±0.10 mg/kg and 0.64±0.24 mg/kg, 067.00±3069 mg/kg and 6026.00±908 mg/kg, 411.00±95.8 mg/kg and 220.00±45.20 mg/kg, 4334.00±3021 mg/kg and 5802.00±1972 mg/kg, 1742.00±602 mg/kg and 723.00±147 mg/kg, 3.05±1.27 mg/kg and 4.11±1.92 mg/kg, 20.19±5.52 mg/kg and 38.00±5.17 mg/kg, 0.54±0.10 mg/kg and 0.64±0.24 mg/kg, respectively. Difference in mineral contents of the milk and cheese samples was statistically significant ($p<0.05$).

ÖZET: Bu araştırmada; süt ve peynir örneklerinde kalsiyum, magnezyum, sodyum, potasyum, demir, çinko ve bakır düzeylerinin belirlenmesi amaçlanmıştır. Mineral madde düzeylerinin belirlenmesinde atomik absorbsiyon spektrometrik yöntemden yararlanılmıştır. Örnek çözümlemesinde ise kapalı sistem mikrodalga yaş yakma metodu kullanılmıştır.

Yapılan araştırma sonucunda; analiz edilen süt örneklerde ortalama kalsiyum, magnezyum, demir, bakır, çinko, sodyum ve potasyum düzeyleri sırasıyla 653.000±389 mg/l, 84.00±61.00 mg/l, 320.±107 mg/l, 876.00±361 mg/l, 0.82±0.23 mg/l, 3.01±2.17 mg/l ve 0.09±0.05 mg/l olarak bulunmuştur. Beyaz ve kaşar peyniri örneklerinde ise bu değerler aynı sıra ile 7067.00±3069 mg/kg ve 6026.00±908 mg/kg, 411.00±95.8 mg/kg ve 220.00±45.20 mg/kg, 4334.00±3021 mg/kg ve 5802.00±1972 mg/kg, 1742.00±602 mg/kg ve 723.00±147 mg/(kg, 3.05±1.27 mg/kg ve 4.11±1.92 mg/kg, 20.19±5.52 mg/kg ve 38.00±5.17 mg/kg, 0.54±0.10 mg/kg ve 0.64±0.24 mg/kg olarak bulunmuştur. Yapılan istatistiksel değerlendirmede ürünler arasındaki mineral madde değişiminin önemli olduğu bulunmuştur ($p<0.05$).

INTRODUCTION

Milk and cheese are important food products which contains nearly all parts of nutriment components that are necessary for healthy and balanced nutrition in all periods of human life. These products are also supply essential minerals and trace elements that are necessary for body, and the bioavailabilities of minerals are higher. So, these properties increases their importance in diet. In Turkey, white cheese and Kasar cheese are popular foods and they are generally consumed for breakfast. Besides this, they are consumed in other meal as an ingredient in some foods. Milk is generally used in milky dessert as well as a drink.

Calcium, magnesium, iron, copper, zinc, sodium and potassium are essential minerals in nutrition, and their intake to body are via the food. Human requirements for essential minerals vary from a few micrograms per day up to about 1 g/day.

If intakes are low for some period of time, deficiency sing will develop. Conversely, excessively high intakes can result in toxicity (MILLER 1996). Consequently, it should be determined the mineral contents of food products that have an important place in nutrition, and calculated the portion in daily consumption. For these reasons, the objectives of the present study were to determine and compare the mineral contents in raw cow's milk, pickled white cheese and Kasar cheese and to investigate if there was differences in the concentrations of mineral in the cheese of two species and milk.

MATERIAL AND METHODS

In this study, raw cow milk, pickled white cheese and Kasar cheese samples were used as research materials. Cheese samples were collected in the monthly period by the supermarkets, in Ankara, while milk samples were provided randomly from individual dairy plants in different regions in Turkey.

The digestion processes were carried out using a model Mars 5 microwave unit (CEM) and its accessories (ELLEN and VAN LOON 1990, ANONYMOUS 1998). A solution of nitric acid and 35% hydrogen peroxide (Merck) was used for digestion. The digested samples were diluted with ultra distilled water (Easy Pure UV, Brandstead) to 25 ml and then transferred to polypropylene containers, and were stored at +8 °C until the end of the analyses.

The flame absorption spectrometry method was used for determination of the calcium, magnesium, iron, copper and zinc, while the flame emission spectrometry method was used for determination of the sodium and potassium (ANONYMOUS 1989a, 1996, 1998). The determination was performed with Varian SpectraAA-880 model Flame Atomic Absorption Spectrometry and its automatic sampler SPS-5 (Sample Preparation System). In the measurements, air-acetylene flame and titrisol standards (Merck) were used. Measurements were taken with slit widths of 0.5 nm, 0.5 nm, 0.2 nm, 0.5 nm, 1.0 nm, 0.1 nm, and 0.1 nm, at the wavelengths of 422.7 nm, 285.2 nm, 248.3 nm, 324.7 nm, 213.9 nm, 589.0 nm, and 766.5 nm, respectively. In the measurement of calcium, magnesium, iron, copper and zinc, the hollow cathode lamps were used. The one direction variance analysis was applied in order to identify any differences or similarities between products. The results were obtained using the pocked program of the Minitap-12. The first type error tolerance of a=5 percent was used in tests. In addition, the Tukey Double Comparison Test was applied in order to identify any differences or similarities between products.

RESULTS AND DISCUSSION

The mineral contents of the raw milk, pickled white cheese and Kasar cheese samples are given in Table 1. In general, the mineral content of milk may vary from cow to cow and is influenced by numerous

Table 1. The Mineral Contents of Milk and Cheese Samples (mg/kg-wet weight)

Element	Product Name	Sample Count	Mean±SD	Medium	Range
Calcium	Milk	30	653.00±389	508.00	219.00-1832.00
	W. cheese	30	7067.00±3069	6852.00	2250.00-12180.00
	K. cheese	30	6026.00±908	5745.00	4500.00-8445.00
Magnesium	Milk	30	84.00±61.00	65.50	28.00-333.00
	W. cheese	30	411.00±95.80	431.50	178.00-625.00
	K. cheese	30	220.00±45.20	210.00	150.00-300.00
Sodium	Milk	30	320.00±107	310.00	156.00-661.00
	W. cheese	30	4334.00±3021	3434.00	1915.00-14880.00
	K. cheese	30	5802.00±1972	5212.00	2925.00-11640.00
Potassium	Milk	30	876.00±361	788.50	364.00-1748.00
	W. cheese	30	1742.00±602	1924.00	705.00-2858.00
	K. cheese	30	723.00±147	735.00	480.00-1080.00
Iron	Milk	30	0.82±0.23	0.77	0.57-1.70
	W. cheese	30	3.05±1.27	2.50	1.30-6.20
	K. cheese	30	4.11±1.92	3.71	0.96-11.11
Zinc	Milk	30	3.01±2.17	2.10	1.06-10.33
	W. cheese	30	20.19±5.52	20.75	9.50-32.00
	K. cheese	30	38.00±5.17	37.10	26.47-47.57
Copper	Milk	30	0.09±0.05	0.07	0.03-0.21
	W. cheese	30	0.54±0.10	0.55	0.30-0.75
	K. cheese	30	0.64±0.24	0.61	0.32-1.57

W.: White K.: Kasar

factors involving its secretion from the mammary gland such as the lactation period, season, and type of feeding. The mineral content of cheese is also highly variable and depends on numerous factors such as source of milk used in the production, cheese making process, contamination from equipment and air.

As it is known, calcium plays a major regulatory role in numerous biochemical and chemical physiological processes, and it must be ingested with daily diet. Milk and milk products, especially cheese, plays an important part of the calcium intake to body.

As shown in the Table 1, the mean calcium contents of raw milk, pickled white cheese and Kasar cheese samples were found as 653.00±389 mg/kg, 7067.00± 3069 mg/kg, and 6026.00±908 mg/kg, respectively. The statistical evaluation shows that the variation in the among of the sample groups are significant ($p<0.05$), and these differences were verified by the Tukey test.

It was determined that the calcium content of cheese samples is higher than milk samples. This is an expected situation. In the production of cheese, the calcium chloride was added to cheese milk (approximately 150 ppm calcium), and the big part of calcium was passed to the curd. In addition, dry matter of cheese is higher than the milk (dry matter of milk, pickled white cheese and Kasar cheese are 12%, 35%, and 60%, respectively). All of these are important in this increase. When a comparison is made between white cheese and Kasar cheese samples, first of all, the calcium content of Kasar cheese should be higher than that of the white cheese, because of higher dry matter contents (approximately 1.7 times). But the results of the study have shown that the calcium content of white cheese is higher (Table 1). The mean values that are calculated on the basis of dry weight are also shown this (Table 2). In white and Kasar cheese production, the same process steps were applied to obtain the curd. In Kasar cheese production, after this step, the treatment of scalding and kneading was applied to curd. As it is known, minerals are extracted from cheese by boiling with diluting acid solution, and can be analyzed by benefiting from this characteristic. This method is called acid extraction (SKURİKHİN, 1993). In Kasar cheese production, while scalding operation is applying in acid medium (5.0-5.4 pH and 78-80 oC), some of total calcium is extracted from curd and deposit in the scalding water, then calcium content of Kasar cheese decreases.

Table 2. The Mean Mineral Levels of Milk and Cheese Samples in Dry Matter Basis (mg/kg-dry weight)

Element	Milk	White Cheese	Kasar Cheese
Calcium	5442	20191	10043
Magnesium	700	1174	367
Sodium	2667	12383	9670
Potassium	7300	4977	1205
Iron	6.83	8.71	6.85
Zinc	25.10	57.70	63.33
Copper	0.75	1.54	1.10

FOX (1982) reported that the calcium content in milk varies with an interval of 1100-1300 mg/L and an average of about 1200 mg/L. RENNER (1989) showed that the average calcium content of milk was in the range 900-1400 mg/L. Some of the values that were found in this research are nearly the same with values above, while the mean and median values are lower than them (Table 1). On the other hand, 90% of research samples are lower than 1000 mg/L.

The calcium contents obtained from white cheese samples (2250-12180 mg/kg) were nearly the same as those in the other research (1620-10760 mg/kg) (ALPERDEN 1975, DEMİRCİ 1987, 1988, BÜYÜKKILIÇ et al. 1994, HAZIR 1995, GUVER 1992). In addition, the higher standard deviation of mean values shown those calcium contents varied from sample to sample in white cheese. The calcium content of Örgü cheese which was produced with nearly same processes with the Kasar cheese, was found to be between 3614.5 and 6529.7 mg/kg (OZDEMİR et al. 1998). When the above values are compared with those obtained from the Kasar cheese (4500-8445 mg/kg), the results are similar.

Magnesium is important in nucleic acid and protein metabolism, communication between neurons and muscles, and especially muscle system, and it has been reported that magnesium regulated the operation of heart muscles together with calcium (FOX 1982, METİN 1996). Milk and milk products are not the principal sources in magnesium intake. But they have got certain role in the intake (ANONYMOUS 1989b).

When the magnesium values given in Table 1 (the mean values of milk, white cheese and Kasar cheese are 700 mg/L, 1174 mg/kg, and 339 mg/kg, respectively) was evaluated; it was shown that each group has different values. The statistical evaluation also showed that the differences of the sample groups were significant ($p<0.05$), and these differences were verified by the Tukey test.

When the magnesium values were evaluated, it was seen that white cheese was higher group than others. The values given Table 2, which are calculated on the basis of dry weight, also showed that Kasar cheese was the lower group.

In the literature, it was reported that the magnesium contents in milk and Örgü cheese changed in the interval 50-240 mg/L and 318.3-551.8 mg/kg, respectively (RENNER 1989, ÖZDEMİR et al. 1998). When the magnesium contents found in this study (28.00-333.00 mg/L for milk, 150.00-300.00 mg/kg for Kasar cheese) was compared with these values, it was shown that all values were nearly the same.

Sodium is necessary in the regulation of osmotic pressure of body liquids and acid-base balancing. The food products, which contain sodium chloride, are the main sources in sodium intake. Since white cheese and Kasar cheese contain sodium chloride, they are significant food in sodium intake, but milk is not. The values found in this study (4334±3021 mg/kg for white cheese, 5802±1972 mg/kg for Kasar cheese and 320.00±107 mg/L for milk) also show this.

At the end of the statistical evaluation, it was found that the variation in the sample groups are significant ($p<0.05$), and these differences were verified by the Tukey test.

Potassium is an important component of living cells, and it is found in all food products. Especially fresh fruits and vegetable are primary potassium sources (ANONYMOUS 1989b). Nevertheless, milk and milk products provide 75% of body necessities (DEMİRCİ 1996).

As shown in the Table 1, the Kasar cheese has the least potassium content (723±147 mg/kg), while it was higher in white cheese (1742±602 mg/kg). It was found that the potassium levels in milk samples were higher than that of Kasar cheese. The statistical evaluation showed that these variations among groups were significant ($p<0.05$). In Tukey test, it is seen that this difference sources from white cheese.

When the potassium levels given in the Table 2 are evaluated; it is seen that the milk samples are higher potassium content than the contents of white cheese and Kasar cheese samples on dry weight basis. These values were shown that potassium was lost in production steps. In the literature, it was reported that the potassium in milk was soluble form (DEMİRCİ 1996), and great amount of potassium was deposited with whey during the production.

The milk and milk products were not main the iron sources, and the iron content of these products is mainly effected from the composition of cow's feed. On the other hand, contamination may result from milking or processing in factories as a result of contact with iron in equipment (ANONYMOUS 1992).

As it can be seen from Table 1, the iron values of milk, white cheese and Kasar cheese changed in the interval 0.57-1.70 mg/L, 1.30-6.20 mg/kg, and 0.96-11.11 mg/kg, respectively. The milk samples were at the lowest mean value (0.82±0.23 mg/L), while Kasar cheese samples were at the highest mean value (4.11±1.92 mg/kg) among the analyzed sample groups. The statistical evaluation showed, that the differences of the groups are significant ($p<0.05$). Tukey test also showed that the mean values of each group were different.

As shown in the Table 2, if the mean values in dry basis are evaluated, it can be seen that the milk and Kasar cheese values are nearly the same, but white cheese sample values are higher than others. It can be concluded from these values that, some part of iron was lost in the cheese manufacturing. Likewise, YÜZBAŞI (2001) was reported that the iron was lost in the manufacturing steps.

In the literature, it was reported that the iron levels of different type cheese samples were changed in the interval 1.20-6.55 mg/kg (ANONYMOUS 1992, MİTCHELL 1981). When these values are compared with our study results in Table 1 (0.96-11.11 mg/kg), it can be seen that the values are nearly the same.

Zinc is essential for growth and development of all life forms and is found as a normal constituent of cow milk. Dairy products are considered to be a good source of this element, as they contribute readily assimilable zinc to the diet (ANONYMOUS 1992).

As can be seen from Table 1, the zinc content was found to be between 1.06 and 10.33 mg/L in milk, 9.50 and 32.00 mg/kgin white cheese, and 26.47 and 47.57 mg/kg in Kasar cheese samples. The statistical evaluation shows that the variation among sample groups were significant ($p<0.05$). Besides this, the values given Table 2 (25.10 mg/kg for milk, 57.70 mg/kg for white cheese, and 58.50 mg/kg for Kasar cheese) are evaluated, it was seen that the both of cheese sample values are nearly the same.

In a study, it was realized to determine the zinc level of milk, mean zinc level was found as 3.95 mg/kg and it was reported that the zinc levels of milk were fluctuated throughout the year (BRİEN 1999). The mean zinc value (4.11±1.92 mg/kg) was founded in this research nearly the same above value.

It was reported in the literature that the zinc levels of hard type and soft type cheese are changed in the interval 28-45 mg/kg, and 3-20 mg/kg, respectively (ANONYMOUS 1992). When these values are compared with our study, it can be seen that Kasar cheese values (26.47-47.57 mg/kg) are higher than hard cheese value, while white cheese's values (9.50-32.00 mg/kg) are not higher than soft cheese values.

Cow milk is considered to be a poor source of copper (ANONYMOUS 1992). The researches realized with this subject were also shown this. Likewise, The founded values in our study were shown this (Table 1). In the statistical evaluation, it was found that the differences of sample groups are significant ($p <0.05$) With the Tukey test, it was found that the mean value of each group is different form each other.

Numerous studies have been carried out to determine the copper content in milk and milk products. The mean copper contents were found as 0.23 mg/L and 1.45 mg/kg in marketed milk and cheddar cheese (MİTCHELL 1981), and 0.095 mg/L in cow milk (HERNANDEZ et al. 1992). It was founded in the interval 0.70-1.06 mg/kg for Edam cheese in Finland, 0.45-1.06 mg/kg for semi-hard cheese in Spain, 0.22-0.55 mg/kg in Czechoslovakia, and 0.24-0.39 mg/kg for Gouda cheese in Japan (ANONYMOUS 1992). When the above values are compared with those obtained from the milk and cheese samples the results (0,03-0,21 mg/L, 0.30-0.75 mg/kg and 0.32-1.57 mg/kg) obtained from milk, white cheese and Kasar cheese samples were analogous to that other country.

REFERENCES

ALPERDEN, I. 1975. Erzurum Piyasasında Mevcut Peynir ve Tereyağların Besin Unsurları (Kimyasal Bileşimleri ve Vitamin A miktarları) Üzerinde Araştırmalar. TÜBİTAK Marmara Bilimsel ve Endüstriyel Araştırma Enstitüsü Yayın No:18,40-65.

ANONYMOUS 1989a, Analytical Methods, Flame Atomic Absorbsion Spectrometry, Varian, Australia Pyt Ltd.

ANONYMOUS 1989b, Recommended Dietary Allowances, 10th ed., National Academy Press, Washington D.C., p. 284.

ANONYMOUS 1992. Trace elements in milk and milk products. Bulletin of The International Dairy Federation, No 278/1992

ANONYMOUS 1996, Magnesium and calcium. Determination by atomic absorption spectrometry after wet digestion in a microwave oven. Nordic Committee on Food Analysis. No 153.

ANONYMOUS. 1998. Determination by atomic absorbtion spectrophotometry after wet digestion in a microwave oven. NMKL Method (Nordic Committee on Food Analysis), No:161, p. 8.

BRIEN, O., MEHRA, R., CONNOLY, J.F. AND HARRINGTON, D. 1999. Seasonal variation in the composition of Irish manufacturing and retail milks. 4 minerals and trace minerals. Irish Journal of Agricultural and Food Research. 38(1);87-99.

BUYUKKILIÇ, N., ERDİNÇ, B., YALÇIN, B., UNVER, G., 1994. Kaliteli Beyaz Peynir Üretiminde Peyniraltı suyuna Geçen Maddelerin Azaltılması İçin Sütlerde Uygun Asitlik Derecelerinin Tespiti Üzerine Araştırmalar. T.K.B. TAGEM Yayın No:008, Ankara.

DEMIRCI, M. 1987.Taze Beyaz Peynirlerimizin Mineral Madde Miktarları ve Enerji Değerleri. Doğa Türk Tarım ve Ormancılık Dergisi, 13;952-958.

DEMIRCI, M. 1988. Ülkemizin Önemli Peynir Çeşitlerinin Mineral Madde Düzeyi ve Kalori Değerleri. Gıda dergisi, 13(1);17-21.

DEMIRCI, M. 1996. Beslenmemizde sütün önemi. Süt Teknolojisi Dergisi. 1(1) :1 Hasad yayıncılık. 22-30 s.

ELLEN, G. AND VAN LOON, J.W. 1990. Determination of cadmium and lead in foods by graphite furnace atomic absorption spectrometry with Zeeman bacground correction: Test with certified refrence materials. Food Additives and Contaminants, 7(2);265-273.

FOX, P.F. 1982. Developments in Dairy Chemistry-3 (Lactose and minor constituents). Chapter 7, Nutritional aspects of Minerals in Bovine and Human Milks. 405 p., USA.

GUVER, R. 1992. Dengeli Beslenmede Süt ve Süt Ürünlerinin Önemi ve Vazgeçilmezliği, SETBİR Haberler, 3(41);2-4.

HAZIR, M. 1995. Beyaz peynir Üretiminde Değişik Isısal İşlemin ve Farklı Kalsiyum Klorür Katımının Peynir Kalitesine Etkisi. Ç.Ü. Fen Bilimleri Enstitüsü. Yüksek lisans tezi. 93 s., Adana.

HERNANDEZ, M.C., AMIGO, L., MARTIN-ALVAREZ, P.J. AND JUAREZ, M. 1992. Differentiation of milks and cheeses according to species based on mineral content. Z. Lebensm Unters Forsch., 194;541-544.

METIN, M. 1996. Sütün Bileşimi ve İşlenmesi. Süt Teknolojisi, 1. Bölüm, E.Ü. Mühendislik Fakültesi Yayınları:33, 623 s., Bornova-İzmir.

MILLER, D.D., 1996, Minerals, in Food Chemistry, Third Ed. (O.R. Fennema ed.), Marcel Dekker, Inc., New York, pp. 617-649.

MITCHELL, G.E. 1981. Trace Metal levels in Quesland dairy products. The Australian Journal of Dairy Technology, 36(2);70-73.

ÖZDEMİR, S., ÇELİK, Ş., OZDEMİR, C. VE SERT, S., 1998, Diyarbakır'ın Karacadağ yöresinde mahalli olarak yapılan örgü peynirinin mikrobiyolojik ve kimyasal özellikleri.Geleneksel Süt Ürünleri, V. Süt ve Süt ürünleri Sempozyumu, Milli prodüktivite yayınları No: 621, s.154-166., Ankara.

RENNER, E. 1989. Micronutrients In Milk And Milk Based Food Products. p.311, USA.

SKURİKHİN, I.M. 1993. Methods of analysis for toxsic elemnts in foods. Part IV. General methods of ashing for determination of toxic elements, Journal of AOAC International, 76(2), p.257-262.

YUZBASI, N. 2001, Kasar Peynirinde Bazı Ağır Metallerin Düzeyi ve Prosesteki Değişimi. A.Ü. Ziraat Fak. Süt Teknolojisi Anabilim Dalı, Doktora Tezi, s. 87, Ankara.