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**Research Article**

# Effect of Feeding Habits of Cows on Trace Element Contents of Some Dairy Products

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## Abstract

Concentrations of selenium, copper, nickel, zinc, cadmium and lead contents of several typical Turkish dairy products were determined using Inductively Coupled Plasma -Optical Emission Spectrometry (ICP-OES). The order of the elements in the dairy products was determined to be Zn > Se >Ni >Pb > Cu > Cd. Additionally, the concentration ranges in these samples were found to be 0.003-79.7, 4.32-59.8, 0.1-31.53, 0.58-30.9, 0.22-9.89 and 0.008-1.89 μg 100g –1, respectively.

In determination of the selenium content in selected dairy product, the highest values were found in the milk and white cheese, but lower values are observed in yogurt. In addition, the results show two kinds of dairy products (milk and white cheese) have as foods with high levels of nutritionally important trace elements such as Se and Zn. The results identify composition of these dairy products were within safety baseline levels for human consumption. Results obtained from this study also provided important information on safety and quality standards of local milk and milk products; cheese and yoghurts.

**Keywords:** Milk, Yogurt, Selenium, Copper, Zinc, ICP-OES, Turkey, Trace element

## 1. Introduction

Dairy products are important for human diet and in particular provide the well- known trace elements. The level of trace element in dairy products depends on different factors such as environmental conditions, type of pastures and genetic characteristics of organisms. Furthermore, technological treatments, geographical localization and the quality of raw material are important for levels of trace elements in dairy products (Moreno-Rojas et al. 1994). Fermented milks originated in the near-east and spread through central and Eastern Europe (El-Mardi 1988). Moreover, the earliest example of fermented milk was warm, raw milk from cows, sheep, goats, camels or horses of the nomads roaming the area. More than 1000 varieties of cheese are produced around the world. Some of them which are produced in Turkey are Tulum, Kaşar and Çökelek. Cheese making is a complicated process, involving many process steps and several biochemical transformations. The cheese must be left to ripen to acquire desirable flavour and consistency. To achieve this, it is kept for a variable time under favourable conditions. The storage conditions vary widely with the type of cheese involved, but temperature and humidity are usually such that most foods would spoil (El Zubeir et al. 2005).

Cheeses are considered to be a good source of several minerals and there is no doubt that their presence and abundance in different cheese types is strongly dependent on the country or region of milk origin and last but not least, on the manufacturing procedures, processing and post-processing of cheese products. From the last two mentioned, the addition of salts and other optional ingredients together with the method of coagulation, thermal treatment of the curd, and the resulting acidity significantly influences the characteristic properties of cheese, its taste and flavour as well as the mineral content (Suhaj and Korenˇovska 2008).

Cheese is more durable than milk and often also less perishable than sour milk. The intentional and incidental disposal of sewage sludge and industrial wastes to the pasture-land causes increase of trace element concentrations in soil and plants. It leads to contamination of the food chain, because grasses or other plants absorb trace elements from the soil. These elements which are not biodegradable transform to animal and human body by food chain (Demirezen and Aksoy 2004, Demirezen and Aksoy 2006, Stoepper 1984).

The aim of this study is assessment of Cd, Pb, Zn, Cu, Se and Ni concentrations in certain milk and dairy products consuming in Turkey.

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## 2. Material and Methods

### 2.1 Sampling

In total, 133 different samples of seven varieties of dairy products (these are; yogurt, milk, tulum cheese, kaşar cheese, white cheese, çökelek cheese and çömlek cheese which represent about 80-90 % of all the types of traditional cheese and yogurt consumed in Kayseri, Turkey (Table 1). 133 samples were analyzed individually, for example 38 white cheese and 39 milk samples collected from different stations analyzed independently with five replicates per sample. Samples collected from the different shops and the producer in Kayseri. The collected samples were packed in polyethylene bags. Samples divided into two different groups; first group consist of samples that produced by milk of cows or sheep which are fed by natural pastures. Second group consist of samples that produced by milk of cows or sheep which are fed by artificial grain. Sampling procedure was performed according to the FIL/IDF recommendation (FIL/IDF 1990, Gambelli et al. 1999).

### 2.2. Analytical Methods

0.5 mg of samples was weighed and digested with 10 ml of $HNO_3$ in a microwave digestion system (digestion conditions are; Max power: 1200 W, Power (%): 100, Ramp. (min): 30:00, Pressure (psi):175, Temperature (°C): 210 $^0$C and Hold time (min):10:00). Determinations of the elements in all samples were carried out by Varian ICP-OES. The samples were analyzed in triplicate and SPSS statistical program was used to calculate standard deviations and means.

## 3. Results and Discussion

The mean values of cadmium, copper, lead, zinc, selenium and nickel concentrations in certain dairy products studying are given in Table 2 a-b. According to Table 2, the concentrations of trace elements in these products have vary change levels such as, Cd (0.008-2.38 mg 100 $g^{-1}$), Cu (0.05-10.75 mg 100 $g^{-1}$) and Pb ( 0.58-33.4 mg 100 $g^{-1}$). The order of the levels of the trace elements obtained from the seven different dairy products was Zn > Se >Ni >Pb > Cu > Cd. The present results show a good agreement with the data obtained by other researcher (Park 2000, Hejtmankova et al. 2002, Franco et al. 2003, Garcia et al. 2006).

The yield and the composition of the cheese are determined by the properties of the milk, especially composition, and by the manufacturing practice. The highest average trace element concentrations were obtained from in the milk, tulum and white cheese while the lowest values are observed in yogurt. Furthermore, the white cheese and tulum cheese exhibited higher levels of Cd than the other products. This may be due to high cadmium content of soil and water because it is found in manure and pesticides. Another important source of cadmium emission is the use of artificial phosphate fertilizers. Plants absorb cadmium from the ground and water, and in plant-consuming animals it can end up in the food chains (Demirezen and Aksoy 2004, Demirezen and Aksoy 2006). Since grass is the only source of feed for local goats, it is not surprising to find high concentrations of these elements in milk, which was obtained from villages near main roads. There is over whelming evidence that several media including road dust and plants sampled in the vicinity of roads carrying heavy traffic are contaminated by some elements (Coni et al. 1999). Overall, as Kayseri was an agricultural region, substantial amounts of artificial fertilizers are used (Demirezen and Aksoy 2006).

In contrast, milk contains the highest levels of Pb while yogurt contains the highest Ni. Mean Ni concentrations ranged from 0.08 to 34.6 mg 100 $g^{-1.}$ This value was 16 times higher in yogurt than in çökelek cheese and 3 times greater than in milk. The estimated daily intake of nickel in study area is below the WHO / FAO draft guideline of 35-700 $mgd^{-1}$ (WHO 1993, Dri 2002). The

**Table 1:** Specific characteristics of certain dairy products collected from Turkey and number of brands in the analytical samples

| Products | Description | Number of brands in the analytical samples |
|---|---|---|
| Yogurt | Fermented cow or sheep milk, not ripened | 25 |
| Milk | Cow or sheep milk, high fat, not ripened | 39 |
| Tulum cheese | Soft, cow milk, 3-4 months ripened | 12 |
| Kaşar cheese | Hard, yellow cheese, sheep's milk | 7 |
| White cheese | Soft, cow milk, 3-4 months ripened, high fat | 38 |
| Çömlek | Soft, low fat milk, shortly ripened | 9 |
| Çökelek | Soft, low fat milk, shortly ripened | 3 |

**Table 2 a:** Minimum, mean and maximum concentrations (mg 100g $^{-1}$) of Se, Cu, Pb, Ni, Zn And Cd in certain dairy product (**produced by cow or sheep that are fed by pasture**) collected from Turkey and its standard errors (*represents to number of samples)

| Products | | Cu | Zn | Ni | Cd | Pb | Se |
|---|---|---|---|---|---|---|---|
| Tulum cheese (*12) | Min. | 0.98 ±0,1 | 2.9 ± 1.2 | 0,18 ± 0,1 | 0.08 ±0.01 | 0.9 ± 0.1 | 4.32 ± 1 |
| | Mean | 1.48 ± 0.2 | 68.4 ± 21 | 1.87 ± 0.2 | 0.12 ± 0.09 | 4.8 ± 2 | 11.8 ± 4 |
| | Max. | 9.89 ± 2 | 79.7 ± 15 | 4.41 ± 1 | 1.56 ± 1 | 29.4 ± 9 | 59.8 ± 14 |
| White cheese (*38) | Min. | 1.2 ± 1 | 0.4 ± 0.1 | 1.01 ± 1 | 0.14 ± 0.04 | 1.8 ± 1 | 23.17 ± 11 |
| | Mean | 1.2 ± 0.4 | 1.4 ± 0.4 | 1.50 ± 0.1 | 0.18 ± 0.08 | 2.5 ±1 | 29.73 ± 14 |
| | Max. | 6.4 ± 2 | 3.69 ± 2 | 8.84 ± 2 | 2.2 ± 1 | 30.9 ± 9 | 34.4 ± 19 |
| Çökelek cheese (*3) | Min. | 0.1 ± 0.07 | 0.003 ± 0.001 | 0.1± 0.01 | 0.008 ± 0.002 | 1.5 ± 0.1 | 12.6 ± 8 |
| | Mean | 0.5 ± 0.01 | 2.1 ± 1 | 1.13 ± 1 | 0.06 ± 0.01 | 1.67 ± 1 | 21.7 ± 10 |
| | Max. | 1.12 ± 1 | 10.2 ± 5 | 1.96 ± 0.1 | 1.89 ± 1 | 3.4 ± 2 | 32.9 ± 14 |
| Çömlek cheese (*9) | Min. | 0.3 ± 0.02 | 0.3 ± 0.03 | 0.2± 0.06 | 0.8 ± 0.02 | 1.5 ± 0.01 | 14.6 ± 2.1 |
| | Mean | 0.5 ± 0.09 | 25.1 ± 1 | 11.3 ± 0.4 | 1.06 ± 0.04 | 14.67 ± 0.4 | 24.7 ± 1.6 |
| | Max. | 7.12 ± 1 | 50.2 ± 5.1 | 21.9 ± 0.4 | 1.29 ± 0.1 | 23.4 ± 2.1 | 32.9 ± 1.4 |
| Kaşar cheese (*7) | Min. | 0.98 ± 0.1 | 0.8 ± 0.4 | 0.7 ± 0.1 | 0.10 ± 0.02 | 0.64 ± 0.1 | 7.4 ± 1 |
| | Mean | 2.6 ± 1 | 3.01 ± 2 | 1.58 ± 0.9 | 0.22 ± 0.1 | 0.98 ± 0.4 | 10.7 ± 2 |
| | Max. | 4.98 ± 1 | 5.78 ± 2 | 1.96 ± 1 | 0.87 ± 0.4 | 1.5 ± 1 | 15.7 ± 8 |
| Milk (*39) | Min. | 0.23 ± 0.4 | 14.2 ± 6 | 0.55 ± 0.1 | 0.07 ± 0.01 | 0.58 ± 0.2 | 28.68 ± 10 |
| | Mean | 2.68 ± 2 | 22.5 ± 11 | 2.75 ± 1.1 | 0.18 ± 0.1 | 1.39 ± 0.9 | 30.8 ± 13 |
| | Max. | 7.3 ± 4 | 27.16 ± 5 | 31.53 ± 6 | 0.27 ± 0.1 | 1.91 ± 0.8 | 32.73 ± 5 |
| Yogurt (*25) | Min. | 0.22 ± 0.1 | 0.32 ± 0.1 | 11.8 ± 6 | 1.62 ± 0.7 | 3.21 ± 1 | 17.83 ± 11 |
| | Mean | 0.06 ± 0.01 | 0.35 ± 0.2 | 4.92 ± 1 | 1.72 ± 0.5 | 3.25 ± 1.1 | 20.1 ± 14 |
| | Max. | 1.21 ± 0.5 | 0.38 ± 0.1 | 15.12 ± 9 | 1.84 ± 0.4 | 3.29 ± 1.5 | 22.38 ± 8 |

**Table 2 b:** Minimum, mean and maximum concentrations (mg 100g $^{-1}$) of Se, Cu, Pb, Ni, Zn and Cd in certain dairy product (**produced by cow or sheep that are fed by artificial grain**) collected from Turkey and its standard errors (*represents to number of samples)

| Products | | Cu | Zn | Ni | Cd | Pb | Se |
|---|---|---|---|---|---|---|---|
| Tulum cheese (*12) | Min. | 1.15 ± 0.02 | 3.58 ± 0.07 | 0.2 ± 0.1 | 0.2 ±0.02 | 1.98 ± 1 | 6.15 ± 0.2 |
| | Mean | 3.72 ± 0.4 | 95.16 ± 5 | 2.7 ± 0.5 | 0.52 ± 0.2 | 7.58 ± 1 | 18.48 ± 1 |
| | Max. | 10.75 ± 0.1 | 159.8 ± 0.4 | 5.6 ±2 | 2.36 ± 0.18 | 32.09 ± 0.9 | 63.58 ± 2.4 |
| White cheese (*38) | Min. | 1.31 ± 0.01 | 3.59 ± 1 | 1.13 ± 1 | 0.13 ± 0.08 | 2.12 ± 0.91 | 25.15 ± 1.1 |
| | Mean | 1.9 ± 0.5 | 7.67 ± 2 | 2.9 ± 1 | 0.4 ± 0.1 | 3.24 ± 0.32 | 123.10 ± 2.4 |
| | Max. | 7.4 ± 0.2 | 23.2 ± 10 | 12.44 ± 3 | 2.38 ± 0.16 | 5.35 ± 0.11 | 131.6 ± 5.2 |
| Çökelek cheese (*3) | Min. | 1.6 ± 0.001 | 0.22 ± 0.1 | 0.2 ± 0.01 | 0.24 ± 0.05 | 3.05 ± 0.2 | 13.07 ± 0.8 |
| | Mean | 2.7 ± 0.13 | 6.1 ± 0.29 | 2.04 ± 0.1 | 0.39 ± 0.1 | 3.1 ± 1.1 | 22.86 ± 1.4 |
| | Max. | 7.9 ± 0.21 | 14.87 ± 0.06 | 2.45 ± 0.1 | 2.2 ± 0.15 | 5.49 ± 2.1 | 33.5 ± 1.8 |
| Çömlek cheese (*9) | Min. | 1.6 ± 0.01 | 0.25 ± 0.4 | 0.2 ± 0.07 | 0.24 ± 0.04 | 3.9 ± 1.1 | 7.07 ± 0.2 |
| | Mean | 5.7 ± 1.1 | 22.8 ± 2 | 17.04 ± 1 | 2.39 ± 0.3 | 10.2 ± 0.01 | 25.86 ± 1.4 |
| | Max. | 7.9 ± 2.1 | 24.8 ± 3.1 | 22.5 ± 1.4 | 2.13 ± 0.01 | 15.9 ± 0.1 | 43.5 ± 1.8 |
| Kaşar cheese (*7) | Min. | 1.6 ± 0.4 | 2.9 ± 1.4 | 1.05 ± 0.1 | 0.17 ± 0.01 | 1.4 ± 0.4 | 9.7 ± 1.8 |
| | Mean | 3.5 ± 0.5 | 3.9 ± 0.2 | 2.01 ± 0.12 | 0.25 ± 0.1 | 1.97 ± 0.01 | 11.9 ± 2.1 |
| | Max. | 5.22 ± 1 | 6.98 ± 0.03 | 2.73 ± 1.1 | 0.97 ± 0.2 | 3.13 ± 0.2 | 16.2 ± 1.5 |
| Milk (*39) | Min. | 1.38 ± 0.4 | 0.35 ± 0.2 | 1.6 ± 0.01 | 0.013 ± 0.01 | 1.039 ± 0.1 | 34.13 ± 1.9 |
| | Mean | 3.6 ± 0.04 | 25.8 ± 1.4 | 7.6 ± 0.23 | 1.85 ± 0.9 | 2.26 ± 0.01 | 37.95 ± 2.1 |
| | Max. | 8.4 ± 2.04 | 61.75 ± 1.2 | 10.2 ± 0.4 | 0.34 ± 0.1 | 33.4 ± 0.99 | 93.63 ± 2.5 |
| Yogurt (*25) | Min. | 0.05 ± 0.01 | 12.3 ± 0.09 | 0.08±0.01 | 0.09 ± 0.02 | 0.71 ± 0.1 | 24.64 ± 0.5 |
| | Mean | 0.76 ± 0.2 | 34.8 ± 2.01 | 13.4 ± 0.2 | 0.14 ± 0.01 | 2.14 ± 0.1 | 30.27 ± 1.7 |
| | Max. | 1.83 ± 0.05 | 47.3 ± 0.05 | 34.6 ± 0.1 | 0.22 ± 0.1 | 5.96 ± 0.2 | 36.10 ± 1.5 |

highest average concentrations of Cu were observed in tulum cheese (Table 2). The average copper concentration was 0.05- 10.75 mg 100 $g^{-1}$ in samples. These values are similar to obtained by Park (Park, 2000). The average daily intake level of copper from dairy products studied was 1.83 $mgd^{-1}$, so this rate within the safety limits (900 -30 000 $mgd^{-1}$) according to WHO [1] (WHO 1993, Dri 2002). Results show that the samples belong to group 1 (Table 2 b) contains higher concentration of trace elements than the samples belong group 2 (Table 2 a). According to Turkish Ministry of Agriculture and Rural Affairs, there are some restriction on the levels of trace elements that are added to feeds, such as it may contain 15-50 mg $kg^{-1}$ Cu, 600 mg $kg^{-1}$ Pb and 0.5 mg $kg^{-1}$ Se (TMARA 2002). High Cu and Ni contents may be due to contamination caused by contact of the milk or yoghurt with metallic utensils during manufacture (Coni et al. 1999). Ni is an important ingredient in steel (Garcia et al. 2006).

The zinc contents of samples were between 0.003- 159.8 mg 100 $g^{-1.}$ The lowest zinc concentrations were found in Çökelek cheese (Table 2). These values are in agreement with reported results by Park (2000). To protect human from harmful effects of heavy metals, the provisional tolerable weekly intake should not exceeds the levels given by WHO / FAO [1] (WHO 1993, Dri 2002). The estimated average daily intake of zinc from dairy products collected from study area was 17.21 $mgd^{-1}$, so this portion exceeds the tolerance limits (WHO, 1989). In contrary, the daily intake of cadmium (0.51 $mgd^{-1}$) and lead (2.49 $mgd^{-1)}$ from samples which are collected from Turkey do not exceed tolerable limits. According to WHO (1982), the provisional tolerable daily intake of cadmium and lead are 60 $mgd^{-1}$ and 210 $mgd^{-1}$, respectively (WHO 1982). Selenium contents in the samples were observed to be 4.32- 131.6 mg 100 $g^{-1}$. These values are lower than those reported earlier (Gambelli et al. 1999, Merdivan et al. 2004). Smrkolj et al. (2005) observed that, there are some differences selenium concentrations in different kind of dairy products such as, they found milk contains from 12 to 0.9 $ngg^{-1}$ wet weight, yoghurt contains from 12.4 to 0.5 $ngg^{-1}$ wet weight and cheese contains from 23.2 to 3.1 $ngg^{-1}$ wet weight selenium. Furthermore, the estimated daily intake of selenium from studied products was within the safety limits (55 $mgd^{-1}$) [1] (WHO 1993, Dri 2002).

High levels of essential elements may be due to the season of production, genetic factors, regional differences and feeding of goats as well as high protein and fat content of milk since the B, Co, Mn, Mo, Se and Zn contents of milk depend largely on the animals' feed, that is, their amounts in the diet (Park 1988, Rincon et al. 1994, Rodriguez et al. 1999, Pedro et al. 2006). A direct correlation has been reported between Se, Fe, Zn, Cu, Mo and Mn and the protein and fat content in milk (Shen et al. 1995, Belewu and Aiyegbusi 2002, Garcia et al. 2006).

Comparing the element concentrations in the studied dairy product with other previous studies; Gambelli et al. (1999), found Zn, Fe and Se in different types of cheese in concentration ranges of 0.35 - 4.50 mg 100 $g^{-1}$ / 0.04-0.24 mg 100 $g^{-1}$/ 1.10-11 mg 100 $g^{-1}$, respectively, so, Zn and Se concentrations are lower than those of present study (Gambelli et al. 1999).

In conclusion, in all respects, the results of the present study indicate that mean intake of trace elements due to consumption of milk and milk products is generally well below the tolerable daily intake is fairly satisfactory in Kayseri, Turkey. This work provides important information on safety and quality standards of milk and milk products collected from Kayseri,Turkey.

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