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Mineral and heavy metal by inductively coupled plasma optical emission spectrometer in traditional Turkish yogurts

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Yogurt, a traditional Turkish dairy product is common in all region of Turkey. The different heavy metals were determined in commercial yogurts by inductively coupled plasma optical emission spectrometer (ICP–OES). Concentrations of calcium (Ca), phosphorus (P), sodium (Na), magnesium (Mg), aluminum (Al), zinc (Zn), iron (Fe), copper (Cu), manganese (Mn), boron (B), molybdenum (Mo), cadmium (Cd), cobalt (Co), chromium (Cr), nickel (Ni) and lead (Pb) were measured by ICP–OES; Varian Vista-Pro, Mulgrave, Victoria, Australia. Traditional Ordu yogurts generally have means of 1126.0 mg/kg Ca, 983.1 mg/kg P, 585.3 mg/kg Na, 112.4 mg/kg Mg, 1.73 mg/kg Fe, 0.71 mg/kg Cu, 4.51 mg/kg Zn, 0.0027 mg/kg Co, 0.017 mg/kg Cr, 18.11 mg/kg Al, 0.69 mg/kg B, 0.86 mg/kg Mn, 0.41 mg/kg Mo, 0.05 mg/kg Ni, 0.055 mg/kg Pb and 0.002 mg/kg Cd.

Key words: Yogurt, minerals, heavy metal, inductively coupled plasma optical emission spectrometer (ICP–OES).

INTRODUCTION

Yogurt is a fermented dairy product, resulting from the growth of *Lactobacillus bulgaricus* and *Streptococcus thermophilus* bacteria, often in an unpredictable ratio to each other in warm milk. The two yogurt bacteriareside either naturally in milk or are introduced as pure cultures in a 1:1 ratio. Large numbers of these bacteria remain in the product in a viable state until consumed. Other desirable lactic acid species are also commonly present in yogurt, including *Lactobacillus acidophilus* and *Streptococcus lactis* (Tamime and Robinson, 1999). Yoghurts are gaining popularity due to its acceptability for the consumers as well as their nutritional properties and potentially beneficial effects in human health. There is currently considerable growth in industrialised countries in the economical importance of yoghurts. In the last few years, this tendency has driven the manufacturers to develop and produce a wide variety of these products with different characteristics. Yoghurt can be a good source of essential nutrients as minerals in the human diet. It could contribute significantly to the recommended daily requirements for calcium and magnesium to maintain the physiological processes. Yoghurts are also a good dietary source of phosphorus (besides calcium, considered the most important nutrient for bone health) and its contribution to total phosphorus intake has been reported as 30 to 45% in western countries. Other key nutrients supplied would include zinc (De la Fuente et al., 2003). Milk and milk products are important compounds of the human diet. The mineral content of yogurt is variable due to factors such as differences between species, geographical area, characteristics of the manufacturing practices and possible contamination from

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the equipment during the process. The level of trace elements is important for nutritional properties, in some traditional and innovative dairy products, contribute to the characterization of the quality and adequacy of the Turkish diet. The heavy metals enter the human body though inhalation and ingestion. The intake via ingestion depends upon food habits. The metals, namely Cu and Zn, are essential micro nutrients and have a variety of biochemical functions in all living organisms (Tarakci et al., 2011). While Cu and Zn are essential, they can be toxic when taken in excess; both nutritional and necessity vary from element to element. However, researches on yogurt are very limited on macro and micro mineral contents. The aim of this research was to examine some mineral and trace metals contents of traditional yogurts. The heavy metal content of yogurt varies due to factors such as differences between species, geographical area, characteristics of the manufacturing practices and possible contamination derived from the equipment during the process. The levels of trace elements, important for nutritional and toxicological properties in some traditional and innovative dairy products, contribute to the characterization of the quality and adequacy of the Turkish diet. The heavy metals enter the human body though inhalation and ingestion. The intake via ingestion depends upon food habits.

MATERIALS AND METHODS

The samples of 15 yogurts were purchased in local markets in Ordu. The yogurt samples were transported to the laboratory and kept at approximately 4°C until they were analyzed. Ash content in yogurt was determined using a gravimetric method after thermal treatment (550°C for 24 h) in a muffle furnace. For determination of mineral contents, 5 g of yogurt samples were ashed in a porcelain crucible, solubilized with 10 ml of 6 N HCl, quantitatively transferred into 50 ml volumetric flasks, and diluted to volume with double-deionized water and filtered after 5 to 6 h with blue-band filter paper and again regulated to 50 ml (AOAC, 2000).

Concentrations of calcium (Ca), phosphorus (P), sodium (Na), magnesium (Mg), aluminum (Al), zinc (Zn), iron (Fe), copper (Cu), manganese (Mn), boron (B), molybdenum (Mo), cadmium (Cd), cobalt (Co), chromium (Cr), nickel (Ni) and lead (Pb) were measured by inductively coupled plasma optical emission spectrometer (ICP–OES; Varian Vista-Pro, Mulgrave, Victoria, Australia). All the analysis was performed in duplicate and the results reported are the mean values. In this study, the statistical calculations were performed, and the obtained values are presented as mean ± standard deviation (SSPS, 2000).

RESULTS AND DISCUSSION

Some macro and micro mineral levels were determined as mg/kg and values of 15 yogurt samples are presented in Tables 1 and 2. The Ca content was found to between 1023.0 to 1179.1 mg/kg. The lowest P content was found as 927.2 mg/kg. The Na contents was found to be similar and ranged from 532.1 to 698.9 mg/kg. The lowest Mg content was found as 98.3 mg/kg and Mg contents of other samples (98 to 122 mg/kg) were similar. These differences might have been due to different milk used.

The Zn, Cu and Co contents of yogurt samples were similar to each other, 4.01 to 4.84, 0.55 to 1.02 and 0.0015 to 0.0039 mg/kg, respectively. De la Fuente et al. (2003) reported higher Ca, Mg and P contents of plain yoghurt samples than our findings, but Na, Fe, Cu and Mn contents were lower than our values. Cichoscki et al. (2002) studied Prato cheese and they found higher Ca, P and Mg content than in the present study, but lower Na content. Prieto et al. (2002) studied Leon raw cow's milk cheese and they found similar Ca, P, Mg and Zn contents with the present study. Sanchez-Segarra et al. (2000), De la Fuente et al. (2003) and Guler (2007) studied the mineral content of plain yoghurt. Their results for Ca, Mg and P content were higher, but those for Na, Fe, Cu, Zn and Mn contents were lower than in the present study. Gambelli et al. (1999) studied minerals and trace elements in some Italian dairy products. They found Fe, Zn and Co content lower than in the present study, whereas Cr was higher (Table 1).

The highest Mo content was found in purslane sample with average 0.041 mg/kg. The lowest and the highest contents of Al, Fe, Cr, B, Mn, Ni, Pb and Cd of yogurt samples were 15.61 to 20.83, 1.34 to 2.59, 0.013 to 0.021, 0.44 to 0.75, 0.74 to 1.05, 0.036 to 0.059, 0.045 to 0.061 and 0.0023 to 0.003 mg/kg, respectively. Differences might have been due to various sources of raw materials used in the manufacture and milk, herbs used in these products. Rodriguez et al. (1999) reported as 0.0184 ppm, being the maximum content of Cd and 0.04 for Pb in raw milk, while in this study the highest contents were 0.008 ppm for Cd and 0.15 ppm for Pb. There is overwhelming evidence that several media including road dust and plants sampled in the vicinity of roads carrying heavy traffic are contaminated by some elements (Guler, 2007).

The S content in yogurt samples was found from 66.07 to 83.49 ppm, similar to each other and when compared to other sample, S contents were significantly greater. It has been observed that qualitative and quantitative changes occurred in vitamin, protein, carbohydrate and bacterial contents in yoghurt. The bacterial cell mass constitutes about 1% of the dry matter in yoghurt, which is a rich source of essential amino acids. Since the percent protein in yoghurt is increased, the elevated S content in yoghurts may be attributed to the increased S-containing proteins from bacterial cell mass or additional S-containing proteins in the products synthesized by the bacterial culture during the fermentation process. Previous reports indicated that fermented dairy products are more nutritious than the original milk from which they are made (Deeth and Tamime, 1981), implying that certain nutrients such as S-containing proteins may be synthesized by the bacteria during the fermentation process of products (Guler, 2007).

Table 1. Some chemical macro minerals of yogurt samples (n=15).

Content (mg/kg)	Minimum	Maximum	Means	Sx
Ca	1023.0	1179.1	1126.0	13.46
P	927.2	1109.3	983.1	8.63
Na	532.1	698.9	585.3	9.08
Mg	98.3	122.6	112.4	4.21
S	66.07	83.49	72.53	3.75
Fe	1.34	2.59	1.73	0.86
Cu	0.55	1.02	0,71	0.29
Zn	4.01	4.84	4.51	0.53

Table 2. Some chemical micro minerals of yogurt samples (n=15).

Content (mg/kg)	Minimum	Maximum	Means	Sx
Co	0.0015	0.0039	0.0027	0.00
Cr	0.013	0.021	0.017	0.00
Al	15.61	20.83	18.11	1.08
B	0.44	0.75	0.69	0.31
Mn	0.74	1.05	0.86	0.12
Mo	0.036	0.045	0.041	0.01
Ni	0.036	0.059	0.050	0.00
Pb	0.045	0.061	0.055	0.00
Cd	0.0023	0.003	0.002	0.00

Maximum limit (0.02 ppm) of toxic lead element in milk was stated in the Turkish Food and Codex (1997). This may be due to being very low from detection limit (0.001 ppm) of the apparatus of amounts present in milk and its products. Rodriguez et al. (1999) reported 0.0184 ppm as the maximum content of Cd and 0.04 for Pb in raw milk, while in this study the average contents were 0.63 ppm for Cd and 0.06 ppm for Pb. 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 animal sit can end up in the food chains. Since grass is the only source of feed for local goats, it is not surprising to find high concentrations of these elements in raw goats' milk, which was obtained from villages near main roads.

Dairy products are important sources of animal protein, vitamins, minerals and essential fatty acids for infants and adults. A large number of fermented milk products are consumed worldwide, which differ in the process of manufacture and nature of the starter organism used. These dairy products could contribute significantly tothe recommended daily requirements for calcium and magnesium to maintain the physiological processes. Mineral availability in dairy products is affected by the nature of the complex. The levels of essential minerals and trace elements that occur in cow's milk depend on a number of factors, such as genetic characteristics, stage of lactation, environmental conditions and types of pasture. The levels at which they are present in dairy products also depend on the technological treatment and production of the dairy products (Tarakci and Kucukoner, 2008) (Table 1).

Conclusion

The results of the present study indicated differences among the mineral matter contents of Turkish traditional yogurt samples. There were significant differences in Ca, P, Na, Mg, Cu, Fe, Zn, Co, Cr, B, Mo, Mn, Al, Ni, Pb and Cd content of the cacik samples. This milk product is important sources of macro and micro minerals for humans in Turkey. In order to evaluate the convenience of including foods in diets, metal levels of cheese samples can be useful as nutritional guidance's. Also the values in the present work for the levels of the traces metal ions in the yogurt samples from Turkey could help in the yogurt composition tables for Turkish people.

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