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## Full Length Research Paper

# Determination of nitrate and nitrite content of Turkish cheeses

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The levels of nitrate and nitrite were determined in 185 samples of Turkish cheese having high consumption rate. All cheese samples contained nitrate and its level in Turkish white cheese produced from cow's and sheep's milk were found between 0.92 - 22.40 (mean 8.96±4.93) mg/kg and 0.47 - 23.68 (mean 12.35±6.28) mg/kg, respectively. Nitrate level in fresh kasar cheese and mature kasar cheese samples were 0.68 - 17.19 (mean 8.97±5.03) mg/kg and 1.76 - 13.31 (mean 9.45±4.03) mg/kg, respectively. Nitrite was detected 88.11% of cheese samples and mean nitrite values were found between 0.88- 1.64 mg/kg. The highest levels of nitrate and nitrite were determined in the Turkish white cheese samples produced from sheep's milk. The nitrate content of the examined samples of Turkish cheese could be attributed to both external sources such as contamination by nitrate fertilizers, forage, and agricultural drinking water and addition of nitrate to the cheese milk. It is suggested that stricter control of nitrate in cheese is necessary, and that it should not be used to mask poor hygienic conditions during manufacturing. Hygienic condition must be kept at excellent level in related industries.

**Key words:** Nitrate, nitrite, Turkish white cheese, Kasar cheese.

## INTRODUCTION

Nitrate and nitrite occur widely in human and animal foodstuffs; these groups of chemicals are added to foods such as meat and certain types of cheese intentionally for their preservative effect. The content of nitrate is very high not only in processed food but also in natural ones. The National Academy of Sciences estimated that vegetables provide 87% of nitrate in a normal diet. Fresh and cured meat products, dairy products provide the

remainder (Kyriakidis et al., 1997). The occurrence of nitrates in food may be considered hazardous because nitrates can be reduced to nitrites before ingestion, in saliva and in the gastrointestinal track (Kyriakidis et al., 1997; Anonymous, 1981). Nitrites may react in the stomach with secondary or tertiary amines and amides present in foods such as cheese or meat to form N-nitroso compounds which are potentially carcinogens (Kyriakidis et al., 1997; Anonymous, 1981).

Generally, potassium or sodium nitrate are added to cheese milk to prevent the growth of gas-producing bacteria, causing blowing of the cheese, i.e. coliforms, at the beginning of the maturation period and *Clostridia butyricum* and *Clostridium tyrobutyricum*, which cause

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late blowing (Koréneková et al., 2000; Walstra et al., 1999; Goodhead et al., 1976).

It has to be considered that the naturally derived nitrate occurs in the range of 1-8 mg/kg in cheese made without the addition of nitrate while values between 1 and 41 mg/kg were found in cheese to which nitrate has been added (Renner, 1999). The nitrate may naturally present in milk and the level of it depends on the quality of feeding materials (i.e. water, feeds) of cows. In many areas, water used in agriculture has relatively high concentrations of nitrates owing to pollution by fertilizers and different domestic effluents (Kyriakidis et al., 1997).

Codex standard for cheese (2003) considers as safe and permits the use of sodium nitrate singly or in combination with potassium nitrate in different varieties of cheese, in amounts up to 50 mg/kg, expresses as  $\text{NaNO}_3$ . An acceptable daily intake (ADI) for nitrate of 3.7 mg nitrate/kg body weight was established by EU Scientific Committee for Food in 1995. Nitrite has higher acute toxicity than nitrate and a lower ADI of 0.06 mg nitrite/kg body weight (EU Scientific Committee for Food, 1995). The low concentration of nitrate and nitrite in cheese do not cause health hazard for the consumer.

Turkish white cheese (TWC) and kasar cheese are the most popular cheese varieties manufactured and consumed in Turkey. They are produced from cow's milk, sheep's milk or combination of them. They constitute 60-80% and 20-30 % of cheese production in Turkey, respectively (Anonymous, 2001). These types of cheese are produced both in industrial scale and in primitive small dairy farms. During the cheese production in small dairy farms, the production techniques which are not applied correctly and the failure in controlling hygienic condition cause defects in cheese. For this reason, these small farms may use nitrate to prevent cheese losses depending on microorganisms.

The objective of this study was to investigate the nitrate and nitrite contents in TWC and kasar cheese mostly consumed by Turkish people and to evaluate their compliance with Turkish cheese regulations.

## MATERIALS AND METHODS

### Materials

A total of 65 samples of fresh Turkish white cheese (TWC) (produced from cow's milk), 45 samples of mature TWC (produced from sheep's milk), 45 samples of fresh kasar cheese, 30 samples of mature kasar cheese were obtained randomly from Ankara markets in Turkey were analyzed from April 2004 to June 2004.

### Methods

Nitrates and nitrites were determined according to the International

Dairy Federation standard method (IDF, 1984). The method involves dissolution of the cheese in warm water, precipitation of the fat and proteins, and filtration. Nitrate was reduced to nitrite in a portion of the filtrate by means of metallic cadmium in a glass column. A red color was developed in portions of both reduced solution and unreduced filtrate by the addition of sulfanilamide and *N*-1-naphthyl-ethylenediamide. Measurement of the color intensity was made by spectrophotometer at a wavelength of 538 nm and compared with standard nitrite solutions. Calculation of the nitrate content was made from the difference between these two analytical results. Analyses were run in duplicate. All reagents were of analytical grade quality. Deionized water was used throughout the procedure. The method was continuously tested by standard addition of nitrates and nitrites in each type of cheese studied. Recoveries were found to be between the 98 and 102%.

## RESULTS AND DISCUSSION

In this study, nitrate was evaluated in all cheese samples. Nitrate contents of samples are presented in Table 1. According to Turkish Food Codex (2002), in cheese, there can be only naturally existing nitrates and nitrites. Maximum permitted residual value for nitrate is 10 mg/kg for cheese. But the maximum permitted value for nitrite in cheese has not been given.

Nitrate content was found between 0.47 - 23.68 mg/kg in all types of cheese sample. The variation could be due to the age of the cheese as nitrates decrease during ripening and storage (Zerfiridis and Manolkidis, 1981). Nitrate level in 23.08% of TWC (produced from cow's milk), 51.11% of TWC (produced from sheep's milk), 22.22% of fresh kasar cheese and 20.00% of mature kasar cheese samples were found higher than the maximum acceptable levels of the Turkish Food Codex (2002). The high recorded values of nitrates could be attributed to not fully ripened cheese and undue addition of nitrates to the cheese milk. The white cheese produced from sheep's milk exceeded the maximum permitted nitrate level far more than the cow's milk white cheese. Generally, sheep's milk white cheeses are produced from raw milk in small dairy farms. The production techniques which are not applied correctly and the failure in controlling hygienic condition cause defects in cheese. For this reason, these small farms may use nitrate to prevent cheese losses depending on microorganisms.

Nitrite contents of cheese samples are given in Table 2. As can be seen in the table, mean nitrite values varied between 0.88 and 1.64 mg/kg. Nitrite was not detected in 11.11% of TWC (produced from sheep's milk) and 13.33% of mature kasar cheese samples. But, nitrite was detected in all TWC (produced from cow's milk) and fresh kasar cheese samples. Cheeses with nitrates were either

**Table 1.** Nitrate content of Turkish cheese samples.

Sample	Number of samples							Nitrate (mg/kg)			
	Total	Not detected	< 1 mg/kg	1-5 mg/kg	6-10 mg/kg	11-20 mg/kg	>20 mg/kg	Mean value	SD	Minimum	Maximum
TWC (cow's milk)	65	-	1	24	25	10	5	8.96	±4.93	0.92	22.40
TWC (sheep's milk)	45	-	1	9	12	16	7	12.35	±6.28	0.47	23.68
Fresh Kasar cheese	45	-	2	14	19	10	0	8.97	±5.03	0.68	17.19
Mature Kasar cheese	30	-	-	9	15	6	0	9.45	±4.03	1.76	13.31

TWC: Turkish White Cheese; SD: Standard deviation.

**Table 2.** Nitrite content of Turkish cheese samples.

Sample	Number of samples						Nitrite (mg/kg)			
	Total	Not detected	< 0.5 mg/kg	0.5-1 mg/kg	1.1-2 mg/kg	>2 mg/kg	Mean value	S.D.	Minimum	Maximum
TWC (cow's milk)	65	10	14	20	14	7	1.31	±0.63	N.D.	3.06
TWC (sheep's milk)	45	5	8	14	10	8	1.64	±0.77	N.D.	2.76
Fresh Kasar cheese	45	3	12	18	7	5	0.88	±0.44	N.D.	2.55
Mature Kasar cheese	30	4	1	14	11	-	1.05	±0.58	N.D.	1.53

TWC: Turkish White Cheese; S.D.: Standard deviation; N.D.: Not detected.

negative or contained small amount of nitrites, irrespective of the nitrate content of the cheese. This can be attributed to the unstable nature of nitrites (Anonymous, 1981; Zerfiridis and Manolkidis, 1981).

In a previous study, nitrate and nitrite contents were established between 9.09 - 19.49 mg/kg and 0.140 - 0.646 mg/kg, respectively, in kasar cheese samples (Özsınan, 1995). These results were in agreement with ours. Gündüz and Dağlıoğlu (1989) determined nitrate between 1.4 - 78.4 mg/kg in 36% of TWC samples which were collected from Trakya (Thrace) region in Turkey.

In an MAFF (Ministry of Agriculture, Fisheries and Food) (1987) survey, the mean nitrate content of 15 Edam cheese samples were found between 3.1-20 mg/kg. It is also established that English-type cheeses were relatively low in nitrate (mean 2.8 mg/kg). This survey also showed that nitrite content of English cheese sampled to be less than 0.4 mg/kg. In the same research, it is identified that nitrate and nitrite levels in dairy products are generally low except where it is directly

added and the nitrate almost certainly derives from the natural nitrate content of the milk in English-type cheese (MAFF, 1987). Levels of nitrate and nitrite in different types of cheese have been documented in other studies (Zerfiridis and Manolkidis, 1981; Glória et al., 1997; Garcia et al., 1983). Kyriakidis et al. (1997) found maximum nitrate and nitrite levels between 5.20 - 13.10 mg/kg and 0.70 - 1.70 mg/kg, respectively, in Greece cheese.

In conclusion, the mean nitrate values of three of the four cheese samples were lower than the maximum limit according to the Turkish Food Codex (2002). However, nitrate levels in 29.19% of all cheese samples were shown higher value than legal limit. The nitrate content of 70.81% of all cheese samples were found lower than legal limit and it may be derived from the natural nitrate content of the milk related with animal diet. Nevertheless, the high recorded values of nitrates in cheese could be attributed to addition of the nitrates to the cheese milk. In view of the fact that there is a possibility of the production

of carcinogenic nitrosamines from nitrates and nitrites acting as precursors and it is necessary to control their quantity as well as to minimize their use in the cheese industries. Therefore, stricter control of the use of nitrate in cheese is necessary, and it should not be used to disguise poor hygienic conditions during manufacture.

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