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Presence of Aflatoxin M_1 in Cube Cheeses Produced in Sivas Region

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ABSTRACT

In this study, the presence and residue levels of aflatoxin M_1 (AFM_1) were investigated in traditionally produced cube cheeses in Sivas and its region. For this purpose, 90 pieces of cube cheese were used as a material. Cheese samples were collected periodically in November and December 2016 from central sales location and surrounding villages. ELISA technique was applied in aflatoxin analyses. According to the analysis results, AFM_1 was detected in total of the cube cheeses. The lowest level of AFM_1 was found to be 2.16 ng/kg, the highest was 53.94 ng/kg and the mean was 6.36±0.87 ng/kg. AFM_1 level vas determined one cheese sample above to the limit set by European Union.

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Introduction

Aflatoxins; mainly *A. flavus* and *A. paraciticus*, including some types of Aspergillus, Penicillium and Rhizopus are produced as secondary metabolites. The clinical picture of aflatoxins in humans and animals is defined as an 'aflatoxicosis' (Sweeney and Dobson, 1998; Ünlütürk, 1998).

According to their color under ultraviolet (UV); aflatoxin B_1 (AFB_1), B_2, G_1, G_2 and M_1, M_2 consists of six main compounds of Aflatoxins. AFM_1 and M_2, AFB_1 and B_2 known as milk toxins are milk-excreted derivatives. The most toxic of aflatoxins is AFB_1. Carcinogenic effect of aflatoxin M_1 is 10 times lower than AFB_1 (Kaya, 2001; Agag, 2004).

Aflatoxins are compounds that have a toxic effect on human and all animal species. In addition to carcinogenic, mutagenic, teratogenic, hepatotoxic and immunosuppressive properties of aflatoxins, they have been reported to be effective in the development of kidney damage and various of organ tumours (Gerbers and Caselman, 1995; Kaya, 2001).

AFB_1 is defined as 'Class 1 carcinogen' and AFM_1 is defined as 'Class 2B probable in human carcinogens' by International Agency for Research on Cancer (IARC) (Rothschild, 1992; IARC, 1993). AFM_1 was included in the Class 1 list in the classification made in 2002 (IARC, 2002).

Aflatoxins are highly resistant to heat treatment. It has been reported that aflatoxin M_1 maintains its stability in pasteurization and processing of milk into various products, but is completely disintegrated at 300°C and higher (Galvano et al., 1996).

Due to the negative effects on human and animal health, legal regulation has been introduced for aflatoxins in many countries. The Commission of the European Union (EU) (EC, 2010) reported the maximum AFM_1 level in milk and dairy products as 50 ng/kg. Turkish Food Codex Regulation on Contaminants (TGK, 2011) was determined the maximum limit of aflatoxin M_1 in raw milk, heat-treated milk and milk-based products as 0.050 µg / kg. This level is reported as 0.025 µg/kg for infant formulas and continuation formulas (including infant milk and continuation milk).

Aflatoxin residue in milk is shaped by the livestock consumption of feeds contaminated with AFB_1 and AFB_2. AFB_1 and AFB_2, taken with feeds, are metabolized in the liver in dairy animals and transformed into AFM_1 and

AFM_2 and pass into the milk from the mammary glands. The passing rate of AFB_1 to milk was reported as 0.18% in dairy cattle and 0.1% in sheep (Yentür and Er, 2011).

The problem of aflatoxin in dairy products occurs due to the presence of toxins in milk or milk powder and additives used in production or the development of toxican-specific Aspergillus species in these products after milking (Kırdar, 2006). The type and composition of food, water activity, ambient temperature, relative humidity, gases in the environment, especially atmospheric oxygen and carbon dioxide level, storage time, storage conditions and harvest type have an effect on mold development and toxin formation (Ünlütürk, 1998; Bulca and Bircan, 2013). It has been reported that the distribution of toxin in milk is not homogeneous, AFM_1 changes to clot and whey in varying proportions, and the amount in the clot is higher due to its binding to casein (Bakırcı, 1995; Battacone et al., 2005).

Cube cheese is a local type of cheese which produced in many regions of our country. It is usually produced in closed family economy or in small enterprises by traditional methods. It is known as dish cheese, test cheese or pot cheese in some regions. The production, storage and marketing conditions of cube cheese are individual. The knowledge and skills of the manufacturer is effective on quality. Therefore, it is very difficult to provide a standard product composition (Kamber, 2005b; Üçüncü, 2013).

AFM_1 levels were determined in studies in different types of cheese in Turkey and other countries are given in Table 2 and Table 3. In the literature review there was no research on the presence of AFM_1 in Sivas cube cheeses.

The aim of this study is to investigate the presence of AFM_1 in the cube cheeses produced in Sivas as well as its regions and the evaluation of obtained data according to standards.

Material and Method

Material

The materials of this study were 90 cube cheese produced in Sivas and its region. Cheese samples were collected at regular intervals in November and December 2016 in various sales locations (home, market, public market, wholesale market) and the surrounding villages. Sterile stomacher bags were used for sampling. Samples were taken at least 200 g in aseptic conditions brought to the laboratory with cold chain application and analysed on the same day. Cheese samples were kept in the refrigerator during this process.

Method

The level of AFM_1 was determined by ELISA (Enzyme-Linked Immunosorbent Assay) in cheese products. HELICA Aflatoxin M_1 test kit (CAT. NO. 961AFLM01M-96) was used in the analyses.

Preparation of cheese samples

It was weighed 1 g of a homogenized cheese sample into a centrifuge tube and added 5 ml of absolute methanol over 5 min. then mixed. The mixture was centrifuged at 5000 g for 5 min. After centrifugation, 0.5 ml of the supernatant was transferred to empty tubes and the methanol phase in the tube was evaporated under vacuum via vacuum oven (NÜVE EV018). The total of 0.5 ml of non-AFM_1-free skimmed milk in the kit was added to the remaining viscous liquid and vortexed. After the process to collapse the contents of the tube allowed to stand for 5 min. The resultant extract was ready for use.

Test procedure

From the standard solutions in the kit (0.5, 10, 25, 50, 100 ng/kg) and from each of the cheese samples, 200 µl was transferred to the microplate wells. The microplate was covered with ELISA film layer and left for 2 hours at room temperature and darkness. After this time, the wells were washed 3 times with the wash solution. After washing, 100 µl of enzyme conjugate was added to each well, at room temperature and in the dark for 15 min. and allowed to stand. Then the wells were washed 3 times with the wash solution. After washing, 100 µl of substrate is added to each well and 20 min. and allowed to stand under the same conditions. At the end of this period 100 µl stop solution was added to each well. The results were read at 450 nm via ELISA reader. Calibration curve was generated in the calculation of the absorbance values obtained and AFM_1 levels were calculated as ng/kg versus the absorbance of the samples.

Statistical Analysis

The descriptive statistics of the AFM_1 values detected in the cube cheese samples and the relationships between the values were analysed in the SPSS 22.00 package program (SPSS, 2014).

Results

Aflatoxin M_1 levels and percentage distribution of cube cheese samples produced in Sivas and region are given in Table 1.

According to the results of the analysis; AFM_1 were found in all 90 samples. The value of AFM_1 was determined as 2.16-53.94 ng/kg and the mean was determined as 6.36 ± 0.87 ng/kg. The level of AFM_1, were found to be less than 5 ng/kg in 67.8% (61 samples) of the samples. It was found to be as 53.94 ng/kg in one sample (1.1%) (Table1).

Table1. AFM_1 values and percentage distribution in cube cheese

AFM_1 (ng/kg)	n	%	Minimum	Maximum	Mean±SE
1-5	61	67.8%	2.16	4.98	3.65±0.10
5-25	26	28.9%	5.10	20.89	7.98±0.71
25-50	2	2.2%	43.25	45.64	44.44±1.19
50-100	1	1.1%	53.94	53.94	53.94
100>	-	-	-	-	-
Total	90	100.0%	2.16	53.94	6.36±0.87

SE: Standard error

Table 2. The level of AFM_1 in cheeses from different countries researches (ng/kg)

Country	n	n_1 (%)	n_2 (%)	AFM_1 levels (min-max)	References
Southern Spain	35	16(44.7)		20-200	Barrios et al. (1996)
Brazil	75	56(74.7)	20(26.7)	20-692	Prado et al. (2000)
Libya	20	15(75)		110-520	Elgerbi et al. (2004)
Italy	265	44(16.6)		50-250	Montagna et al. (2008)
Brazil	88	40(46.4)	2		Prado et al. (2008)
Iranian	210	93(80.1)	(24.2)	52.1-785.4	Fallah et al. (2009)
Kuwait	40	32(80)	13		Dashti et al. (2009)
Egypt	150	50	-	51.6-182	Amer and İbrahim (2010)
Iranian	50	30(60)	3(6)	40.9-374	Tavakoli et al. (2012)
Lebanon	111	(67.56)			Elkak et al. (2012)
Brazil	90	18(60)	8(26.7)		Trombete et al. (2014)
Iranian	80	69(86.3)	11(13.8)	14.3-572.1	Rahimi (2014)
Costa Rica	70	49	13		Chavarría et al. (2015)
Iranian	10	6(60)		5.8-21.2	Sohrabi and Gharahkoli (2016)
Iranian	40	(65,5)	4		Bahrami et al. (2016)
Baghdad	40	15(53.85)	10		Al Mossawei et al. (2016)
Egypt	30	13	2	12.5-74.23	Tahoun et al. (2017)
Iranian	100	52(52)	8(8)	50.2-424.4	Sharifzadeh et al. (2017)

n: Sample number; n1: Positive sample; n2: Example exceeding the limit; *Limit value: 50 ng/L: EC (2010)

Table 3. AFM_1 levels determined in different types of cheese researches in Turkey (ng / kg)

Province	n	n_1(%)	n_2(%)	n_3(%)	AFM_1 levels (min-max)	References
Van	50	n.d.				Kıvanç (1990)
İstanbul	75	36(45.2)		1	60-510	Dağoğlu et al. (1995)
Konya	240	n.d.				Gürbüz et al. (1999)
Ankara	150	n.d.				Kardeş (2000)
Bursa	57	(89.7)	7(12.28)	1	40-810	Oruç and Sonal (2001)
Marmara	110	101(91.8)	6		10-2000	Seyrek (2001)
İstanbul	186	121(65)	35(19)		40-4890	Ayçiçek et al. (2002)
İstanbul	15	15(100)	(13,3)		16-713	Özmenteşe (2002)
Bursa	125	86(68.8)	19(22.09)	9(10.46)	10-740	Günşen and Büyükyörük (2003)
Ankara	25	14(56)	1		10-400	Çetin (2004)
Ankara	400	327(81.7)	110(27.5)			Sarımehmetoğlu et al. (2004)
Erzurum	63	28(44.4)			7-202	Gürses et al. (2004)
Erzurum	50	47(94)	3(6)			Başkaya (2004)
Ankara	196	177	19			Ayçiçek et al. (2005)
Diff. province	600	30(5)	6(1)		100-800	Yaroğlu et al. (2005)
Van	110	83	68		100-7260	Tekinşen and Tekinşen (2005)
Kars	60	10			51-115	Kamber (2005a)
Konya	150	123	47		52-860	Özturan (2005)
Amasya	50	50(100)	1(2)			Alkan and Gönülalan (2006)
Aydın	25	25(100)	1(4)		40-250	Kök (2006)
Ankara	38	11(28.21)			78.2-188.4	Gürbay et al. (2006)
Sarıkamış	60	48	12			Kireççi et al. (2007)
Diff. province	132	109(82.6)	36(27.3)		50-690	Tekinşen and Eken (2008)
Diff. province	105	17	7(28)		51-400	Yapar et al. (2008)
Şanlıurfa	64	4(6,25)			51.1-99.6	Ardıç et al. (2008)
Erzurum	193	159(82.4)	60		52-860	Ardıç et al. (2009)
Diyarbakır	90	42(46.67)	13(14.4)			Erkan et al. (2009)
İstanbul	80	41(51.3)			52-2520	Hampikyan et al. (2010)
Maraş	46	32(69.6)			60-1200	Turgay et al. (2010)
Erzurum	304	216(71.1)	63(20.7)	30(9.9)	51-860	Atasever et al. (2010)
Erzincan	64	31	11			Gücükoğlu et al. (2010)
Samsun	50	25(50)			19.6-41.9	Aksoy et al. (2010)
Şanlıurfa	50	14(28)	5(10)		20-2000	Filazi et al. (2010)
Kayseri	60	38(63)	3		12-378	Ertaş et al. (2011)
Ege region	200	66	8		0.24-837.5	Eroğlu (2011)
İzmit	185	123(66.5)	32	10	12.3-760.4	Dinçoğlu et al (2012)
Burdur	45	40(88.9)	7(15.6)	3(6.7)	55-600	Kocasarı et al. (2012)
Diff. province	100	10				Dinçel et al. (2012)
Karadeniz reg	147	144(97.96)		16(11.1)	15-3774	Gül and Dervişoğlu (2014)
Kıbrıs	128	(21.7)			0.00-16.6	Öztürk et al. (2014)
Şanlıurfa	50				103.2	Temamoğulları and Kanıcı (2014)
Diff. province	166	70		5	50-2100	Bakırdere et al. (2014)
Ankara	27	25(92.6)			7.3-84.4	Sarıca et al. (2015)
Diff. province	60	25(41.7)			16-136	Koluaçık et al. (2015)
Diff. province	100	52	19		10.6-702	Özgören and Seçkin (2016)

n: Sample number; n_1: Positive sample; n_2: >250 ng/kg; n_3: >500 ng/kg; n.d.: Not detected

Discussion and Conclusion

In this study, the presence and residual level of AFM_1 was investigated in locally produced cube cheeses in Sivas and the region. For this purpose, 90 cube cheese samples collected from the city center and surrounding villages were used as material. Aflatoxin analysis was performed by ELISA method.

According to the analysis findings, AFM_1 was detected in all of the cube cheese samples. AFM_1 values were determined as minimum 2.16, maximum 53.94 and average 6.36±0.87 ng/kg. AFM_1 level was lower than 5 ng/kg in 61 samples (67.8%). The levels of AFM_1 were determined between 5.10-20.89 ng/kg in 26 samples (28.9%), and between 43.25-45.64 ng/kg in 2 samples (2.2%). Toxin level was determined as 53.94 ng/kg in 1 sample (1.1%) (Table1).

In studies conducted in various countries, the levels of AFM_1 were determined in different types of cheeses between 0.6-6920 ng/kg. In this study, the level of AFM_1 determined in cube cheeses was similar to the findings of some researchers (Sohrabi and Gharahkoli, 2016; Tahoun et al., 2017), but was found lower than many other research results (Table 2).

In studies conducted in different years in our country, AFM_1 level in various types of cheeses was determined between 0.24-8375 ng/kg. The level of AFM_1 which determined in cube cheeses was found lower than the results of these researchers. The study data do not match the findings of the research (Kıvanç, 1990; Gürbüz et al., 1999; Kardeş, 2000), which reported that AFM_1 residue was not found in the cheese samples they examined (Table 3).

There are factors affecting aflatoxin level in cheese which are the hygienic quality of cheese milk, level of contamination, cheese type, number of samples, production technique, degree of fermentation, clot cutting size and analysis methods (Battacone et al., 2005; Bulca and Bircan, 2013; Üçüncü, 2013). The difference in between study results may be due to these factors. In addition, the fact that the studies were carried out in different years and in different regions probably contributed to the different results.

When the research findings are examined only one sample of the analyzed cube cheeses did not comply with the EU reported limit value (50 ng/kg) in terms of AFM_1 residue (EC,2010). The evaluation could not be made since there is no limit value regarding the AFM_1 level in cheese in the Turkish Food Codex (TGK, 2011).

As a result of it will be benefit in terms of food safety and public health since the detection of AFM_1 in all of the samples will be a potential risk for the consumer, by preventing mold contamination in ready-made food and feedstuffs, applying the standard method in making local cheeses, re-determining the limit value of AFM_1 for cheese with the regulation to be made in the Turkish Food Codex notification and regular inspections.

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References

Agag BI. 2004. Mycotoxins in Foods and Feeds. Ass. Univ. Bull. Environ. Res., 71(1): 173-205.

Aksoy A, Yavuz O, Güvenç D, Das YK, Terzi G, Çelik S. 2010. Determination of aflatoxin levels in raw milk, cheese and dehulled hazelnut samples consumed in Samsun province, Turkey. Kafkas Univ. Vet. Fak. Derg., 16: 13-16.

Alkan Y, Gönülalan Z. 2006. An investigation on aflatoxin M_1 levels content and acidity values in white cheeses retailed in Amasya province. J. Health Sci., 15(2): 91-98.

Al Mossawei MT, Al Zubaidi LA, Hamza IS, Abduljaleel SY. 2016. Detection of AFM_1 in milk and some dairy products in Iraq using different techniques. Advances in Life Science and Technology, 41: 74-81.

Amer A, Ekbal Ibrahim MA. 2010. Determination of aflatoxin M_1 in raw milk and traditional cheeses retailed in Egyptian markets. J. Toxicol. Env. Health Sci., 2(4): 50-53.

Ardıç M, Atasever M, Adiguzel G, Atasever M, Karakaya M, Unsal C, Durmaz H. 2008. A survey on the presence of aflatoxin M_1 in Urfa cheese. J. Food Safety, 10: 13-17.

Ardıç M, Karakaya Y, Atasever M, Adıgüzel G. 2009. Aflatoxin M_1 levels of Turkish white brined cheese. Food Control, 20, 196-199. https://doi.org/10.1016/j.foodcont.2008.04.003

Atasever MA, Adıgüzel G, Atasever M, Özturan K. 2010. Determination of aflatoxin M_1 levels in some cheese types consumed in Erzurum, Turkey. Kafkas Univ. Vet. Fak. Derg., 16(Suppl-A): 87-91. DOI:10.9775/kvfd.2009.1639

Ayçiçek H, Yarsan E, Sarımehmetoğlu B, Çakmak O. 2002. Aflatoxin in white cheese and butter consumed in Istanbul, Turkey. Vet Human Toxicol, 44(5): 295-296. https://doi.org/10.1016/j.foodcont.2015.10.039

Ayçicek H, Aksoy A, Saygi S. 2005. Determination of aflatoxin levels in some dairy and food products which consumed in Ankara, Turkey. Food Control, 16: 263-266. https://doi.org/10.1016/j.foodcont.2004.03.004

Bahrami R, Shahbazi Y, Nikousefat Z. 2016. Aflatoxin M_1 in milk and traditional dairy products from west part of Iran: Occurrence and seasonal variation with an emphasis on risk assessment of human exposure. Food Control, 62: 250-256. https://doi.org/10.1016/j.foodcont.2015.10.039

Bakırcı İ. 1995. Sütlerde aflatoksin M_1 oluşumu ve ürünlere geçişi üzerinde bir araştırma. Doktora Tezi, Yüzüncü Yıl Üniversitesi Fen Bilimleri Enstitüsü, Van.

Bakırdere S, Yaroğlu T, Tırık N, Demiröz M, Karaca A. 2014. Determination of trace aflatoxin M_1 levels in milk and milk products consumed in Turkey by using enzyme-linked immunosorbent assay. Food Agr. Immunol., 25: 61-69. https://doi.org/10.1080/09540105.2012.733354

Barrios MJ, Gualda MJ, Medina LM, Jorjano R. 1996. Occurrence of aflatoxin M_1 cheeses from the South Spain. J. Food Prot., 59, 898-900.https://doi.org/10.4315/0362-028X-59.8.898

Başkaya R. 2004. Civil peynirinde ELİSA yöntemiyle aflatoksin M_1 seviyesinin saptanması. Yüksek Lisans Tezi. Atatürk Üniversitesi Sağlık Bilimleri Enstitüsü, Erzurum.

Battacone G, Nudda A, Palomba M, Pascale M, Nicolussi P, Pulina G. 2005. Transfer of aflatoxin B_1 from feed to milk and from milk to curd and whey in dairy sheep fed artificially contaminated concentrates. J. Dairy Sci., 88(9): 3063-3069. https://doi.org/10.3168/jds.S0022-0302(05)72987-8

Bulca S, Bircan C. 2013. Peynirlerde aflatoksin M_1 varlığı ve aflatoksin M_1 konsantrasyonu üzerine etki eden faktörler. Adnan Menderes Üniv. Vet. Fak. Derg., 10(1): 31-38.

Chavarría G, Granados-Chinchilla F, Alfaro-Cascante M, Molina A. 2015. Detection of aflatoxin M_1 in milk, cheese and sour cream samples from Costa Rica using enzyme-assisted extraction and HPLC. J. Food Addit. Contam.: Part B, 8(2): 128-135. https://doi.org/10.1080/19393210.2015.1015176

Çetin T. 2004. Ankara piyasasında satışa sunulan kaşar peynirlerinde olası AFM_1 varlığının HPLC metodu ile belirlenmesi. Yüksek Lisans Tezi. Ankara Üniversitesi Fen Bilimleri Enstitüsü, Ankara.

Dağoğlu G, Keleş O, Yıldırım M. 1995. Peynirlerde aflatoksin düzeylerinin ELİSA testi ile araştırılması. İstanbul Üniv. Vet. Fak. Derg., 21(2): 313-317.

Dashti B, Al-Hamli S, Alomirah H, Al-Zenki S, Abbas AB, Sawaya W. 2009. Levels of aflatoxin M_1 in milk, cheese consumed in Kuwait and occurrence of total aflatoxin in local and imported animal feed. Food Control, 20, 686-690. https://doi.org/10.1016/j.foodcont.2009.01.001

Dinçel A, Demli F, Durlu-Özkaya F, Alatan F, Uzun R, Subaşı SA. 2012. Çeşitli peynir örneklerinde aflatoksin M_1 varlığının HPLC ile analizi. Türk Hijyen ve Deneysel Biyoloji Dergisi, 69(2): 89-96. DOI: 10.5505/TurkHijyen.2012.78942

Dinçoğlu AH, Gönülalan Z, Kök F. 2012. İzmit bölgesinde satışa sunulan peynirlerdeki aflatoksin M_1 düzeylerinin ELİSA yöntemiyle tespiti. Journal of New World Science Academy,Vol. 7, s. 1.

Elgerbi AM, Aidoo KE, Candlish AAG, Tester RF. 2004. Occurrence of aflatoxin M_1 in randomly selected North African milk and cheese samples. Food. Addit. Contam., 21(6): 592-597. https://doi.org/10.1080/02652030410001687690

Elkak A, Atat OE, Habib J, Abbas M. 2012. Occurence of aflatoxin M_1 in cheese processed and marketed in Lebanon. Food Control, 25(1): 140-143. https://doi.org/10.1016/j.foodcont.2011.10.033

Erkan ME, Vural A, Güral HŞ. 2009. Diyarbakır örgü peynirinde aflatoksin M_1 ile Verotoksin 1 ve 2 varlığının araştırılması. Dicle Üniv. Vet. Fak. Derg., 1(1): 19-25.

Eroğlu A. 2011. Ege bölgesinde tüketilen bazı geleneksel peynirlerdeki aflatoksin M_1 düzeyinin belirlenmesi. Yüksek Lisans Tezi. Fen Bilimleri Enstitüsü, Manisa.

Ertaş N, Gonulalan Z, Yıldırım Y, Karadal F. 2011. A survey of concentration of aflatoxin M_1 in dairy products marketed in Turkey. Food Control, 22, 1956-1959. https://doi.org/10.1016/j.foodcont.2011.05.009

European Commission (EC). 2010. Regulation (EC) No. 165/2010, setting maximum levels for certain contaminants in foodstuffs as regards aflatoxins. Official Journal of European Communities, L50, 8-12.

Fallah AA, Jafari T, Fallah A, Rahnama M. 2009. Determination of aflatoxin M_1 levels in Iranian white and cream cheese. Food Chem. Toxicol., 47(89): 1872-1875. https://doi.org/10.1016/j.fct.2009.04.042

Filazi A, İnce S, Temamoğulları F. 2010. Survey of the occurrence of aflatoxin M_1 in cheeses produced by dairy ewe's milk in Urfa city, Turkey. Ankara Univ. Vet. Fak. Derg., 57, 197-199.

Galvano F, Galofaro V, Galvano G. 1996. Occurrence and stability of aflatoxin M_1 in milk and milk products: A worldwide review. J. Food Protect, 59(10): 1079-1090. https://doi.org/10.4315/0362-028X-59.10.1079

Gerbers AE, Caselman W. 1995. Human hepatocellular carsinom and aflatoxins. J Hepatol, 19, 312-315.

Gül, O, Dervişoğlu M. 2014. Occurrence of aflatoxin M_1 in vacuum packed kashar cheeses in Turkey. Int. J. Food Prop., 17, 273-282. https://doi.org/10.1080/10942912.2011.631247

Gücükoğlu A, Çadırcı Ö, Özpınar N. 2010. UHT süt ve peynir örneklerinde aflatoksin M_1 varlığının belirlenmesi. Etlik Vet. Mikrobiyol. Derg., 21, 45-50.

Günşen U, Büyükyörük İ. 2003. Piyasadan temin edilen taze kaşar peynirlerinin bakteriyolojik kaliteleri ile aflatoksin M_1 düzeylerinin belirlenmesi. Turk J. Vet. Anim. Sci., 27, 821-825.

Gürbay A, Engin AB, Çağlayan A, Sahin G. 2006. Aflatoxin M_1 levels in commonly consumed cheese and yogurt samples in Ankara, Turkey. Ecol. Food Nutr., 45, 6. https://doi.org/10.1080/03670240600985274

Gürbüz Ü, Nizamlıoğlu M, Nizamlıoğlu F, Dinç İ, Doğruer Y. 1999. Bazı et ve süt ürünleri ile baharatlarda aflatoksin aranması. Veterinarium, 10(1): 34-41.

Gürses M, Erdoğan A, Çetin B. 2004. Occurrence of aflatoxin M_1 in some cheese types sold in Erzurum, Turkey. Turk J. Vet. Anim. Sci., 28(83): 527-530.

Hampikyan H, Bingöl EB, Çetin Ö, Çolak H. 2010. Determination of aflatoxin M_1 levels in Turkish white, kashar and tulum cheeses. J. Food Agric. Environ. 8(1): 13-15.

IARC. 1993. IARC monographs on the evaluation of carcinogenic risks to humans, some naturally occurring substances: Food items and constituents, heterocyclic aromatic amines and mycotoxins. No. 56, Lyon, France.

IARC. 2002. Some traditional herbal medicines, some mycotoxins, naphthalene and styrene. IARC monographs on the evaluation of carcinogenic risks to humans. No. 82, Lyon, France.

Kamber U. 2005a. Aflatoxin M_1 contamination of some commercial Turkish cheeses from markets in Kars, Turkey. Fresenius Environ. Bull., 14(11).

Kamber U. 2005b. Geleneksel Anadolu Peynirleri. Miki Basımevi, Ankara.

Kardeş E. 2000. Türk silahlı kuvvetlerine bağlı birliklere alınan peynirlerde aflatoksin B_1 ve M_1 varlığının ve seviyelerinin saptanması. Yüksek Lisans Tezi. Ankara Üniversitesi Sağlık Bilimleri Enstitüsü, Ankara.

Kaya S. 2001. Mikotoksinler. Veteriner Hekimliğinde Toksikoloji. 2. Baskı, s. 537-571, Kaya, S., Pirinçci, İ., Bilgili, A. (Ed.): Medisan Yayınevi, Ankara.

Kırdar SS. 2006. Süt ve süt ürünlerinde mikotoksinler. 9. Gıda Kongresi Bildiri Kitabı, 24-26 Mayıs, s. 307-310, Bolu.

Kıvanç M. 1990. Mold growth and presence of aflatoxin in some Turkish cheeses. J. Food Safety, 10(4): 287-294. https://doi.org/10.1111/j.1745-4565.1990.tb00030.x

Kireçci E, Savaşçı M, Ayyıldız A. 2007. Sarıkamış'ta tüketilen süt ve peynir ürünlerinde aflatoksin M_1 varlığının belirlenmesi. İnfeksiyon Dergisi, 21(2): 93-96.

Kocasarı F, Tasci F, Mor F. 2012. Survey of aflatoxin M_1 in milk and dairy products consumed in Burdur, Turkey. Int. J. Dairy Technol., 65, 1-7. https://doi.org/10.1111/j.1471-0307.2012.00841.x

Koluaçık A, Sivri GT, Kaptan B. 2015. Aflatoxin M_1 determination in traditional küp cheese samples of Turkey using immunoaffinity column and high-performance liquid chromatography. Turk J. Agricul., 3(12): 916-919. DOI: https://doi.org/10.24925/turjaf.v3i12.916-919.504

Kök Z. 2006. Aydın ili ve çevresinde üretilen süt ve süt ürünlerinde aflatoksin varlığının araştırılması, Yüksek Lisans Tezi. Adnan Menderes Üniversitesi Sağlık Bilimleri Enstitüsü, Aydın.

Montagna MT, Napoli C, De-Giglio O, Latta R, Barbuti G. 2008. Occurrence of aflatoxin M_1 in dairy products in Southern Italy. Int. J. Molecul. Sci, 9, 2614-2621. https://doi.org/10.3390/ijms9122614

Oruc HH, Sonal S. 2001. Determination of aflatoxin M_1 levels in cheese and milk consumed in Bursa, Turkey. Vet. Human Toxicol., 43(5): 292-293.

Özgören E, Seçkin AK. 2016. Aflatoxin M_1 contaminations in mouldy cheese. Mljekarstvo, 66(2): 154-159. https://doi.org/10.15567/mljekarstvo.2016.0208

Özmenteşe N. 2002. İstanbul piyasasından sağlanan süt ve süt ürünlerinin aflatoksin B_1 ve M_1 içerikleri yönünden yüksek basınçlı sıvı kromatografisi yöntemi ile araştırılması. Doktora Tezi. Marmara Üniversitesi Sağlık Bilimleri Enstitüsü, İstanbul.

Özturan K. 2005. Süt ve süt ürünlerinde ELISA yöntemiyle aflatoksin M_1 aranması. Yüksek Lisans Tezi. Selçuk Üniversitesi Sağlık Bilimleri Enstitüsü, Konya.

Öztürk B, Çelik F, Çelik Y, Kabaran S, Ziver T. 2014. To determine the occurrence of aflatoxin M_1 (AFM_1) in samples of Cyprus traditional cheese (Halloumi): A crossectional study. Kafkas Üniv. Vet. Fak. Derg., 20(5): 773-778. DOI: 10.9775/kvfd.2014.11108

Prado G, Oliveira MS, Pereira ML. 2000. Aflatoxin M_1 in samples of Minas cheese commercialized in the city of Belo Horizonte-Minas Gerais, Brazil. Ciência Technol Alime, 20, 398-400. https://doi.org/10.1590/S0101-20612000000300020

Prado G, Oliveira MS, Lima AS, Moreira APA. 2008. Occurrence of aflatoxin M_1 in parmesan cheese consumed in Minas Gerais, Brazil. Ciência Technol Alime, 32, 6. https://doi.org/10.1590/S1413-70542008000600033

Rahimi E. 2014. Survey of the occurrence of aflatoxin M_1 in dairy products marketed in Iran. Toxicol. Ind. Health, 30(8): 750-754.

Rothschild LJ. 1992. IARC classes AFB_1 as class 1 human carcinogen. Food Chem., 34, 62-66.

Sarıca DY, Has O, Taşdelen S, Ezer Ü. 2015. Occurrence of aflatoxin M_1 in milk, white cheese and yoghurt from Ankara, Turkey markets. Biol. Chem. Res., 36-49.

Sarımehmetoglu B, Kuplulu O, Celik TH. 2004. Detection of aflatoxin M_1 in cheese samples by ELISA. Food Control, 15, 45-49. https://doi.org/10.1016/S0956-7135(03)00006-9

Seyrek K. 2001. Türk silahlı kuvvetlerine bağlı birliklerde tüketilen beyaz peynirlerdeki aflatoksin M_1 seviyesinin ELİSA metodu ile saptanması. Veteriner Hekimler Derneği Dergisi, 72, 55-58.

Sharifzadeh A, Dehkordi PG, Foroughi M, Shahrekordi EM, Ramaz S. 2017. Aflatoxin M_1 contamination levels in cheeses sold in Isfahan province, Iran. Osong Public Health Res. Perspec., 8(4): 260-263. doi: 10.24171/j.phrp.2017.8.4.05

Sohrabi N, Gharahkoli H. 2016. A seasonal study for determination of aflatoxin M_1 level in dairy products in Iranshahr, Iran. Curr. Med. Mycol., 2(3): 27-31. doi: 10.18869/acadpub.cmm.2.3.27

SPSS. 2014. IBM SPSS Statistics for Windows, version *22.00*. SPSS Inc., Chicago, IL.

Sweeney M, Dobson ADW. 1998. Mycotoxin production by *Aspergillus*, *Fusarium* and *Penicillium* species. Int. J. Food Microbiol., 43: 141-158.

Tavakoli HR, Riazipour M, Kamkar A, Shaldehi HR, Mozaffari NAS. 2012. Occurrence of aflatoxin M_1 in white cheese samples from Tehran, Iran. Food Control, 23, 293-295. https://doi.org/10.1016/j.foodcont.2011.07.024

Tahoun ABMB, Ahmed MM, Abou Elez RMM, Abdellatif SS. 2017. Aflatoxin M_1 in milk and some dairy products: Level, effect of manufacture and public health concerns. Zagazig Vet. J., 45(2): 188-196, Egypt. DOI: 10.21608 /ZVJZ.2017.7891

Tekinşen KK, Tekinşen OC. 2005. Aflatoxin M_1 in white pickle and Van otlu (herb) cheeses consumed in Southeastern Turkey. Food Control, 16, 565-568. https://doi.org/ 10.1016/j.foodcont.2004.02.006

Tekinşen KK, Eken HS. 2008. Aflatoxin M_1 levels in UHT milk and kashar cheese consumed in Turkey. Food Chem. Toxicol., 46(10): 3287-3289. https://doi.org/10.1016/ j.fct.2008.07.014

Temamoğulları F, Kanıcı A. 2014. Short communication: Aflatoxin M_1 in dairy products sold in Şanlıurfa, Turkey. J. Dairy Sci., 97(1): 162-165. https://doi.org/10.3168/jds.2012-6184

Trombete FM, De-Castro IM, Teixeira AS, Saldanha T, Fraga ME. 2014. Aflatoxin M_1 contamination in grated parmesan cheese marketed in Rio de Janeiro-Brazil. Braz. Arch. Biol. Technol., 57(2): 269-273. https://doi.org/10.1590/S1516-89132013005000015

Turgay Ö, Aksakal DH, Sünnetçi S, Çelik AB. 2010. Kahramanmaraş peynirinde aflatoksin M_1 oranlarının belirlenmesi üzerine bir çalışma. Turk J. Vet. Anim. Sci., 34(6): 497-500.

Türk Gıda Kodeksi Yönetmeliği (TGK). 2011. Gıda Maddelerinde Belirli Bulaşanların Maksimum Seviyelerinin Belirlenmesi Hakkında Tebliğ. Resmi Gazete, 29 Aralık 2011, s. 28157, Başbakanlık Basımevi.

Üçüncü M. 2013. Süt ve Mamulleri Teknolojisi. Meta Basımevi, Bornova-İzmir.

Ünlütürk A. 1998. Gıda Kaynaklı Küf İntoksikasyonları (Mikotoksikozis). Gıda Mikrobiyolojisi, Mengi Tan Basımevi (Çeviri: Ünlütürk, A.,Turantaş, F.): s. 289-307, İzmir.

Yapar K, Elmalı M, Kart A, Yaman H. 2008. Aflatoxin M_1 levels in different type of cheese products pruduced in Turkey. Med. Weter., 64(1): 53-55.

Yaroğlu T, Oruc HH, Tayar M. 2005. Aflatoxin M_1 levels in cheese samples from some provinces of Turkey. Food Control, 16, 883-885. https://doi.org/10.1016/j.foodcont. 2004.08.001

Yentür G, Er B. 2011. Gıdalarda aflatoksin varlığının değerlendirilmesi. Türk Hijyen ve Deneysel Biyoloji Dergisi, 69(1): Ankara.