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Chapter 10

Occurrence of Aflatoxin M_1 in Raw and Pasteurized Goat Milk in Thailand

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Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/52723

1. Introduction

Aflatoxins are a group of structurally related mycotoxins produced by certain species of the genus *Aspergillus*, particularly *A. flavus*, *A. parasiticus* and *A. nomius*, which can grow on a variety of food and feed commodities [1]. Aflatoxin production is influenced by several factors: for example, temperature and humidity [2]. It has been shown that aflatoxin B_1 (AFB_1) is the most potent hepatocarcinogen of this group of mycotoxins. Aflatoxin M_1 (AFM_1) is a hydroxylated metabolite of AFB_1 produced by the hepatic microsomal cytochrome P450, and is secreted in the milk of mammals that have consumed AFB_1-contaminated foods. AFM_1 is also a hepatocarcinogen and is classified in Group 1 as carcinogenic to humans by the International Agency for Research on Cancer [3]. In terms of food safety and public health concerns, exposure to AFM_1 through milk products is considered to be a serious problem.

According to worldwide regulations for mycotoxins in food and feed compiled by the Food and Agriculture Organization of the United Nations, 60 countries have already established regulatory limits for AFM_1 in raw milk and milk products. The report also indicates that the limits vary from ND (not detectable) to 15 μg/L [4]. The values of 0.05 μg/L and 0.5 μg/L are the two most prevalent regulatory limits for AFM_1 in milk products, enforced in 34 and 22 countries, respectively. The maximum permitted level for AFM_1 established by the European Community is 0.025 μg/kg for infant formulae and follow-on formulae, including infant milk and follow-on milk, while the limit for raw milk and heat-treated milk is 0.05 μg/kg [5]. The U.S. regulatory standard for AFM_1 is 0.5 μg/L [4]. There are still several countries, including Thailand, that have not yet established regulatory limits for AFM_1 in dairy products.

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The law that regulates the quality of milk products in Thailand is the Notification of the Ministry of Public Health No. 265, which regulates only cow milk products. However, the law does not specify the regulatory standards for AFM_1 but states that "…*milk products may be contaminated with aflatoxins at a level that is not harmful to human health*" [6]. The only guideline that regulates the quality of raw goat milk is the Thai Agricultural Standard TAS 6006-2008 of the National Bureau of Agricultural Commodity and Food Standards, Ministry of Agriculture and Cooperatives [7]. Like Notification No. 265 for cow milk products, the TAS 6006-2008 guideline does not specify the recommended limit for AFM_1 in goat milk.

In Thailand, the number of dairy goats is approximately 5% that of dairy cows [8–10]. Goat milk is consumed by only a small percentage of the country's population, particularly Thai people who have an allergy to cow milk. Goat milk has been shown to form finer and softer curds than cow milk following acidification under conditions similar to those in the stomach, thus making it more readily digested [11]. It has been reported that micellar caseins of human and goat milk were 96% hydrolyzed by pepsin and trypsin in *in vitro* studies, while the hydrolytic rate of cow milk was 76–90% [12]. With the knowledge that goat milk is more easily digested, some Thai adults prefer goat milk products. As a result, the number of dairy goats in Thailand has been gradually increasing in recent years. In 2009, the number of dairy goats in Thailand was 20,830; the numbers increased to 22,630 and 33,363 in 2010 and 2011, respectively [8–10].

Thailand is administratively divided into four regions: central, north, northeast and south. The central region was selected for this study, since this region has the highest number of dairy goats and the highest rate of goat milk production, accounting for approximately 60% of the national total [8–10]. There are no internationally published reports regarding the quality and levels of AFM_1 in goat milk produced in Thailand.

The purpose of this study was to investigate whether the concentrations of AFM_1 in raw and pasteurized goat milk produced in Thailand are within the acceptable level for consumption.

2. Materials and methods

2.1. Chemicals

AFM_1 reference standard (from *Aspergillus flavus*) was purchased from Sigma-Aldrich (St. Louis MO, USA). AflaM_1™ immunoaffinity columns were obtained from Vicam (Nixa MO, USA). Solvents (HPLC grade) – acetonitrile, methanol, and water – were purchased from Merck (Darmstadt, Germany).

2.2. Milk sample collection and sample preparation

Raw goat milk samples were collected from private farms, while pasteurized goat milk samples were purchased from supermarkets in the central region of Thailand. In Thailand, commercial pasteurized milk is produced by heat treatment, either at 63 °C for 30 min or at 72 °C for at least 15 s [6]. All milk samples were collected over three years: January–February of

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the years 2009–2011. Both types of milk samples were frozen at –20 °C until analysis (within one month from the collection date for raw milk, or 2 months from the manufacturing date for pasteurized milk). A total of 90 milk samples were collected and analyzed in this study.

2.3. Extraction and determination of aflatoxin M_1

The extraction procedure was performed using the manufacturer's recommendations, as previously described by Ruangwises et al. [13]. Briefly, 50 ml of raw milk or pasteurized milk sample was pipetted into a 50-ml plastic centrifuge tube. Milk samples were defatted by centrifugation at 3,500 *g* for 20 min at 4°C. Fat was separated; the resulting skimmed milk was then transferred into a 50-ml plastic syringe with a Luer tip which was attached to an immunoaffinity column. The skimmed milk was allowed to flow into the column by gravity at a flow rate of approximately 1 ml/min. After the skimmed milk had run through, 20 ml of HPLC water was used to wash the column. AFM_1 was eluted from the column with 1.25 ml of acetonitrile:methanol (3:2) and 1.25 ml of HPLC water. The eluate (a total volume of 2.5 ml) was filtered through a nylon syringe filter for HPLC with pore size 0.45 μm (Whatman, UK). AFM_1 in the final solution was determined using HPLC. Each milk sample was extracted and analyzed for AFM_1 in duplicate.

2.4. Instrument

A complete liquid chromatographic system (ProStar; Varian, Palo Alto CA, USA) consisted of a HPLC pump (model 240), an auto injector (model 410), a column oven (model 510), and a fluorescence detector (model 363). The HPLC conditions for analysis of AFM_1 were as follows: column, Spherisorb ODS-2 (Waters, Milford MA, USA); column temperature, 40 °C; mobile phase, water:methanol:acetonitrile (57:23:20); flow rate, 1 ml/min; and detector, fluorescence spectrophotometer (excitation 360 nm; emission 440 nm).

2.5. Determination of limit of quantification

The Q2B procedure of the U.S. Food and Drug Administration [14] was used for determination of the limit of quantification (LOQ) for AFM_1. Milk samples (50 ml) were fortified with standard AFM_1 at four concentrations of 0.025, 0.050, 0.125 and 0.250 μg/L, while blank samples were not fortified with standard AFM_1. Concentrations of AFM_1 in AFM_1-fortified milk samples and blank samples were quantified as described above in Section 2.3 using $AflaM_1^{TM}$ immunoaffinity columns. All samples were analyzed for AFM_1 in duplicate.

Individual linear regression lines were obtained from least-square regression analyses of the residual peak areas versus the four concentrations of fortified AFM_1 (0.025, 0.050, 0.125 and 0.250 μg/ml). The residual peak areas were peak areas of AFM_1-fortified samples minus the peak area of blank sample. A total of 12 regression lines (six regression lines each for intraday and interday analyses) were obtained by least-square linear regression. The LOQ of the method was calculated using the equation $LOQ = 10\ \sigma/S$, where σ is the standard deviation of *y*-intercepts and S is the average slope of the 12 linear regression analyses [14].

2.6. Statistical analysis

A randomized block experiment was used to evaluate the differences in AFM_1 concentrations in the two types of milk samples and among the three collection years. Duncan's multiple comparison test was applied to obtain significance levels between the raw milk and pasteurized milk, and among each year of individual milk products ($P < 0.05$). SPSS Statistics version 17.0 for Windows was used for statistical analysis.

3. Results and discussion

Table 1 shows the results of analysis and a regression line obtained from least-square analysis of Sample A, of which the slope and *y*-intercept were used for the calculation of LOQ. Twelve regression lines (six lines each for intraday and interday analyses) were performed in this study; slopes and *y*-intercepts of all 12 analyses are presented in Table 2. The calculation for LOQ was based on the equation LOQ = 10 σ/S, where σ and S are the standard deviation of *y*-intercepts and the average slope of the 12 regression lines, respectively. In this study, the standard deviation of *y*-intercepts was 173.69 mV × L/μg and the average slope was 180,518 mV. The calculated LOQ was (10 * 173.69)/180,518 = 0.01 μg/L. The accuracy of the method, expressed as % recovery, ranged from 88.8% to 94.1%, with an average value of 90.8%. The precision of the method, expressed as %RSD (percent relative standard deviation), ranged from 1.1% to 7.5%. Table 3 summarizes the accuracy and precision of determination of AFM_1 in goat milk samples fortified with AFM_1 at four concentrations, with intraday and interday analyses. HPLC chromatograms of standard AFM_1 (10 μg/L), a goat milk sample contaminated with AFM_1 (0.05 μg/L), and an uncontaminated goat milk sample are presented in Figure 1. The retention time for AFM_1 under the conditions in this study was approximately 6.8 min.

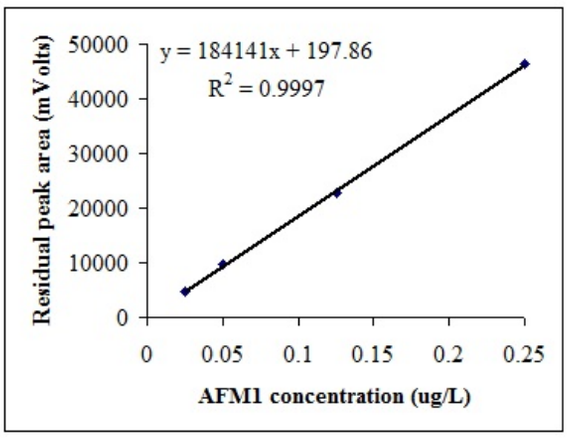
Table 4 shows the incidence and concentrations of AFM_1 in raw and pasteurized goat milk samples. The incidence of AFM_1 in raw goat milk collected in 2009, 2010 and 2011 was 46.7% (7/15), 66.7% (10/15) and 60.0% (9/15), respectively, while the incidence in pasteurized milk was 53.3% (8/15), 46.7% (7/15) and 53.3% (8/15), respectively. The total incidence of positive samples with respect to 90 samples analyzed in this study was 54.4% (49/90). Of the 49 positive samples, only 7 samples (14.3%) were contaminated with AFM_1 above the EU standard of 0.05 μg/L. The three-year average concentrations of AFM_1 found in the raw and pasteurized milk samples were 0.043 and 0.040 μg/L, respectively. The maximum concentration found in this study was 0.086 μg/L, which was far below the U.S. regulatory limit of 0.5 μg/L. In this study, statistical analysis showed that there were no significant differences in AFM_1 concentrations among the raw and pasteurized milk samples and across the two types of milk samples collected over a three-year period.

When compared to cow milk, goat milk has a lower percentage of positive samples and lower AFM_1 concentrations. Ghanem and Orfi [15] reported that the average concentration of AFM_1 in raw goat milk (0.019 μg/L, n = 11), collected from markets in Syria between April 2005 and April 2006, was less than that in raw cow milk (0.143 μg/L, n = 74); the percentage

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of positive samples of goat milk (7 samples, 63.6%) was also less than that of cow milk (70 samples, 94.6%). Hussain et al. [16] found that 6 (20%) of 30 raw goat milk samples were contaminated with AFM_1 at an average concentration of 0.002 μg/L, while 15 (37.5%) of 40 raw cow milk samples were contaminated with an average AFM_1 level of 0.014 μg/L. Rahimi et al. [17] reported that the incidence of AFM_1 in raw goat and cow milk samples collected from Ahvaz in Khuzestan province, Iran, between November 2007 and December 2008, was 31.7% (19/60) and 78.7% (59/75), respectively. Concentrations of AFM_1 in raw milk samples of both species were 0.0301 and 0.0601 μg/L, respectively.

AFM_1 added (μg/L)	**Peak area[1] (mV)**	**Residual peak area[2] (mV)**
0	6,410	-
0.025	11,126.5	4,716.5
0.050	16,144.5	9,734.5
0.125	29,251	22,841
0.250	52,773	46,363



slope = 184,141; *y*-intercept = 197.86

[1] Average value of two determinations

[2] Residual peak area = peak area of AFM_1-fortified sample – peak area of blank sample

Table 1. Linear regression analysis of AFM_1-fortified sample A for the determination of LOQ

Sample	Slope (mV × L/μg)	*y*-intercept (mV)
Intraday (*n* = 6)		
A	184,141	197.86
B	180,733	293.38
C	183,706	141.26
D	179,857	549.02
E	180,039	207.84
F	181,224	109.74
Interday (*n* = 6)		
G	181,454	127.39
H	175,861	432.76
I	185,285	223.45
J	179,462	442.02
K	175,904	339.74
L	178,545	639.60
Overall (n = 12)		
Mean	**180,518 (S)**	**308.67**
SD	**2,955.5**	**173.69 (σ)**

Table 2. Slopes and *y*-intercepts of 12 regression lines used for determination of LOQ for AFM_1

AFM_1 added (μg/L)	Intraday (*n* = 6)			Interday (*n* = 6)		
	Found[a] (μg/L)	%RSD[b]	Recovery (%)	Found[a] (μg/L)	%RSD[b]	Recovery (%)
0.025	0.023 ± 0.001	4.3	92.1	0.024 ± 0.002	7.5	94.1
0.050	0.046 ± 0.001	2.2	91.9	0.046 ± 0.002	3.5	91.4
0.125	0.112 ± 0.003	2.7	89.3	0.111 ± 0.004	3.9	88.8
0.250	0.225 ± 0.002	1.1	89.8	0.222 ± 0.005	2.1	89.0

[a] Values are mean ± SD

[b] % RSD = percent relative standard deviation.

Table 3. Accuracy and precision of determination of AFM_1 in goat milk

Year	Samples analyzed	Positive[1] (%)	AFM_1 concentration (ng/ml)[2]		AFM_1 incidence[3]	
			Mean	Range	0.010–0.050 µg/L	> 0.05 µg/L
Raw milk						
2009	15	7 (46.7)	0.042 ± 0.012	0.022–0.061	6 (85.7)	1 (12.5)
2010	15	10 (66.7)	0.049 ± 0.018	0.025–0.086	8 (80.0)	2 (20.0)
2011	15	9 (60.0)	0.036 ± 0.015	0.018–0.066	8 (88.9)	1 (11.1)
Total	45	26 (57.8)	0.043 ± 0.017	0.018–0.086	22 (84.6)	4 (15.4)
Pasteurized milk						
2009	15	8 (53.3)	0.039 ± 0.017	0.015–0.075	7 (87.5)	1 (12.5)
2010	15	7 (46.7)	0.045 ± 0.015	0.022–0.061	6 (85.7)	1 (14.3)
2011	15	8 (53.3)	0.035 ± 0.019	0.014–0.073	7 (87.5)	1 (12.5)
Total	45	23 (51.1)	0.040 ± 0.016	0.014–0.073	20 (87.0)	3 (13.0)
Overall	**90**	**49 (54.4)**	**0.041 ± 0.016**	**0.014–0.086**	**42 (85.7)**	**7 (14.3)**

[1]Numbers in parentheses are percentages for each year

[2]Means and ranges of AFM_1 concentrations in the positive samples

[3]AFM_1 incidence of the positive samples

Numbers in parentheses are percentages with respect to the positive samples

Table 4. Incidence and concentrations of AFM_1 in raw and pasteurized goat milk samples collected within the central region of Thailand

High incidence and concentrations of AFM_1 in cow milk have also been found in Thailand. Ruangwises and Ruangwises [18] reported that all of 240 raw cow milk samples collected from 80 milk tanks at a milk collecting center in the central region of Thailand were found to be contaminated with AFM_1 at an average concentration of 0.070 µg/L. For pasteurized milk samples, our previous studies showed that AFM_1 was found in 349 (83.1%) of 420 pasteurized milk samples, collected from 40 provinces in all four regions of Thailand from May 2006 to January 2008, with AFM_1 concentrations ranging between 0.012 and 0.114 µg/L [13,19].

Table 5 shows the incidence and concentrations of AFM_1 in raw and pasteurized goat milk from various countries. For raw goat milk, Assem et al. [20] found that all of the three raw milk samples collected from markets in Lebanon between March–July 2010 contained AFM_1 less than the LOQ of 0.005 ng/ml. Ozdemir [21] found that the mean concentration of AFM_1 in 93 positive samples out of 110 raw milk samples collected from the city of Kilis, Turkey, from March–April 2006 was 0.019 µg/L. For pasteurized milk, Oliveira and Ferraz [22] determined the concentrations of AFM_1 in 12 pasteurized goat milk samples collected from the state of Sao Paulo, Brazil, and found that 7 samples (58.3%) were contaminated with an average concentration of 0.034 µg/L.

The levels of AFM_1 in goat milk are influenced by both feeding practices and the types of feedstuffs. Virdis et al. [23] determined the concentrations of AFM_1 in goat milk collected from two groups of farms with different feeding practices – extensive and intensive farms – in Sardinia, Italy, between the years 2003 and 2004. In extensive farms, goats were principally fed on grass and naturally growing bushes which were often present in marginal areas, supplemented with low levels of concentrates consisting of broad bean (*Vicia faba*) and garden pea (*Pisum sativum*). In intensive farms, goats were mainly fed silo maize, maize grains, and alfalfa (*Medicago sativa*). The incidence of AFM_1 in goat milk samples from extensive and intensive farms was 11.2% (9/80) and 71.4% (20/28), respectively. Concentrations of AFM_1 found in positive samples from both farms were 0.009 and 0.0177 ng/ml, respectively.

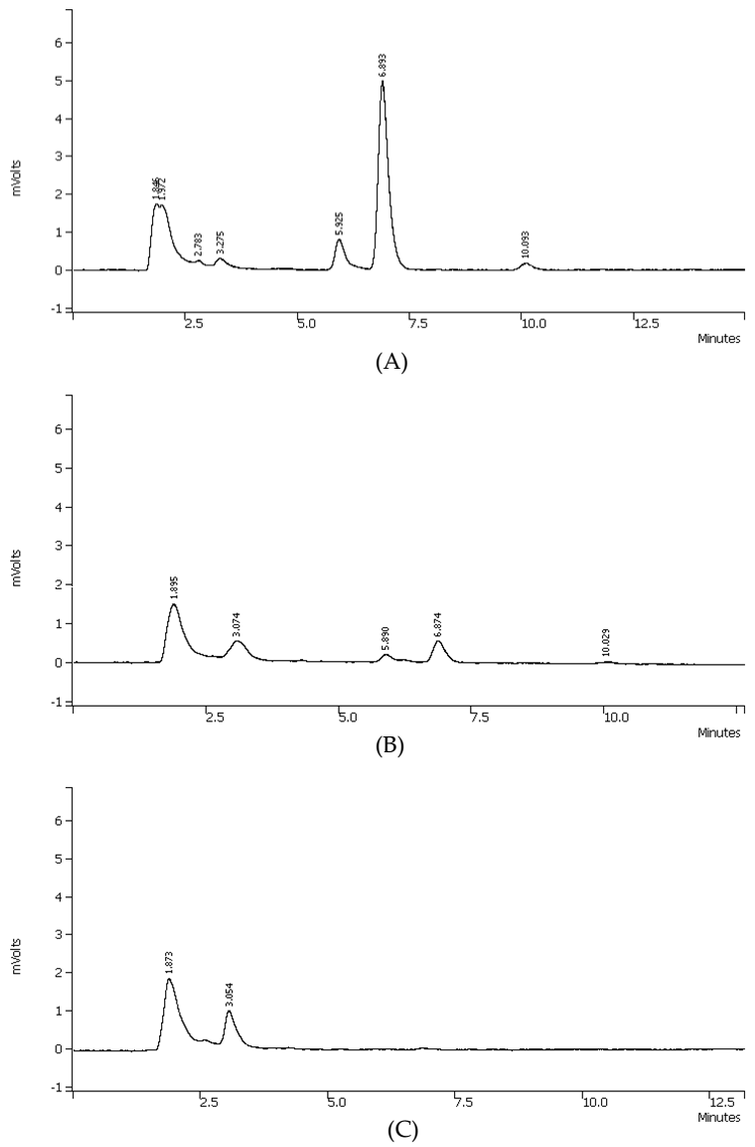


Figure 1. HPLC chromatograms of AFM_1 with a retention time of approximately 6.8 min: (A) standard 10 µg/L AFM_1, (B) goat sample contaminated with 0.05 µg/L AFM_1, and (C) uncontaminated goat milk sample

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Country	Year	Samples analyzed	Positive (%)	Concentration (μg/L)[1]	Reference
Raw milk					
Lebanon	Mar–July 2010	3	0 (0)	< 0.005	Assem et al. (2011)
Iran	Nov 2007 – Dec 2008	60	19 (31.7)	0.0301 ± 0.0183	Rahimi et al. (2010)
Pakistan	Jan–Dec 2007	30	6 (20)	0.002 ± 0.005	Hussain et al. (2010)
Turkey	Mar–Apr 2006	110	93 (84.5)	0.019 (0.005–0.117)[2]	Ozdemir (2007)
Syria	Apr 2005 – Apr 2006	11	7 (63.6)	0.019 ± 0.0138 (0.008–0.054)	Ghanem and Orfi (2009)
Thailand	Jan 2008 – Feb 2011	45	26 (57.8)	0.036 ± 0.015 (0.011–0.064)	Present study
Pasteurized milk					
Brazil	Oct 2004 – May 2005	12	7 (58.3)	0.072 ± 0.048	Oliveira and Ferraz (2007)
Thailand	Jan 2008 – Feb 2011	45	23 (51.1)	0.034 ± 0.014 (0.010–0.058)	Present study

[1] Concentrations of AFM_1 in positive samples

[2] Values in parentheses are ranges

Table 5. Incidence and concentrations of AFM_1 in raw and pasteurized goat milk in various countries

The observation that the incidence and concentrations of AFM_1 in goat milk are relatively lower than those in cow milk can be explained in terms of the feeding procedure and the carry-over rate of AFB_1 in feedstuffs to AFM_1 in the milk. Cows are generally fed with several major AFB_1-contaminated feedstuffs: corn, cotton seed, and concentrated feed. Unlike cows, goats are fed with fresh grass but not corn or cotton seed; the main AFB_1-contaminated feedstuffs fed to goats are concentrate feedstuffs. Motawee et al. [24] explained the different feeding patterns of cows and goats in Egypt. Cows are generally kept in enclosed areas and fed with a large proportion of AFB_1-contaminated feedstuffs, with a short period of time for grazing on pasture; while goats are allowed to graze on pasture in the morning and are brought back into the enclosed areas for concentrate feedstuffs in the evening. Hussain et al. [16] explained that goats in Pakistan are mainly fed by grazing on pasture. AFB_1-contaminated feedstuffs – corn, cotton seed, and concentrate feed – are not used to feed goats. In Thailand, the feeding procedures for cows and goats are similar to those in Egypt and Pakistan [25].

The carry-over rate of AFB_1 in feedstuffs to AFM_1 in milk is relatively lower in goats than in cows. The carry-over rates in cows have been reported to vary from 0.3% to 6.2%, with a mean value of 1.81% (n = 42) [26]. In Thailand, Ruangwises and Mhosatanun [27] determined the carry-over rates during the early lactation period (the first 4 weeks of lactation) in nine cows fed with feedstuffs naturally contaminated with AFB_1. The carry-over rates ranged between 1.96% and 3.12%, with an average value of 2.02%. For goats, Smith et al. [28] reported an average carry-over rate of 0.55% in three goats which were fed with feedstuffs containing 100 ppb AFB_1. Mazzette et al. [29] found an average carry-over rate of 0.26% in three goats within 72 h after receiving a single oral dose of 0.8 mg of AFB_1.

This study showed that 49 samples (54.4%) of the 90 goat milk samples collected within the central region of Thailand in January–February of the years 2009–2011 were contaminated with AFM_1 equal to or more than the LOQ of 0.01 μg/L. Concentrations of AFM_1 were not significantly different among the raw and pasteurized milk samples and across the two types of milk samples collected over three years. Of the 49 positive samples, 7 samples (14.3%) had AFM_1 greater than the EU regulatory limit of 0.05 μg/L. All 90 goat milk samples contained AFM_1 below the U.S. regulatory limit of 0.5 μg/L. This study presents the first internationally published report on the contamination of AFM_1 in raw and pasteurized goat milk produced in Thailand. The present study and our three previous reports on the occurrence of AFM_1 in cow milk products [13,18,19] suggest that regulatory standards be adopted for AFM_1 to ensure the quality of raw milk and milk products in Thailand.

Acknowledgments

This study was financially supported in part by The 40th Anniversary of Khon Kaen University Fund. The authors thank Mrs. Chailai Kuwattananukul and Sunan Rangseekansong for their technical assistance, and Mr. Christopher Salisbury, Chiang Mai University, Thailand, for reviewing the manuscript.

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References

[1] JECFA (Joint FAO/WHO Expert Committee on Food Additives). (2001). Safety Evaluation of Certain Mycotoxins in Food: Aflatoxin M_1. WHO Food Additives Series. (47), Geneva, Switzerland: World Health Organization.

[2] Jay, J. M., & Loessner, Golden. D. A. (2005). Modern Food Microbiology (7th edition). New York: Springer Science and Business Media.

[3] IARC (International Agency for Research on Cancer). (2002). IARC Monographs on the Evaluation of Carcinogenic Risks to Humans,. 82, Some Traditional Herbal Medicines, Some Mycotoxins, Naphthalene and Styrene. Lyon, France: World Health Organization (WHO), IARC Press.

[4] FAO (Food and Agriculture Organization of the United Nations). (2004). Worldwide Regulations for Mycotoxins in Food and Feed in 2003. *Food and Nutrition Paper*, 81. Rome: FAO.

[5] European Commission. Commission Regulation (EC) No. (2006). Setting Maximum Levels for Certain Contaminants in Foodstuffs. *Official Journal of the European Union*, 364-5, L 364/24.

[6] Ministry of Public Health. (2003). Notification of the Ministry of Public Health. B.E. 2545): Cow's Milk., *The Royal Thai Government Gazette* [265], , 120 Special Issue 4D (January 2003) (in Thai).

[7] Ministry of Agriculture and Cooperatives. (2008). Thai Agricultural Standard (TAS) 606-2008 Raw Goat Milk. The Royal Thai Government Gazette, 139(139D), August 2008) (in Thai).

[8] DLD (Department of Livestock Development). (2009). Livestock Infrastructure Information in Thailand:. Bangkok: Department of Livestock Development, Ministry of Agriculture and Cooperatives; 2009 (in Thai).

[9] DLD. (2010). Livestock Infrastructure Information in Thailand:. Bangkok: Department of Livestock Development, Ministry of Agriculture and Cooperatives; 2010 (in Thai).

[10] DLD. (2011). Livestock Infrastructure Information in Thailand:. Bangkok: Department of Livestock Development, Ministry of Agriculture and Cooperatives; 2011 (in Thai).

[11] Park, Y. W. (2007). Rheological Characteristics of Goat and Sheep Milk. *Small Ruminant Research*, 68, 73-87.

[12] Jasinska, B. (1995). The Comparison of Pepsin and Trypsin Action on Goat, Cow, Mare and Human Caseins. *Roczniki Akademii Medycznej w Białymstoku*, 40, 486-493.

[13] Ruangwises, N., Saipan, P., & Ruangwises, S. (2011). Estimated Daily Intake of Aflatoxin M_1 in Thailand. In: Guevara-González RG (ed.). Aflatoxins- Biochemistry and

Molecular Biology. Rijeka: InTech; Available from:, http://www.intechopen.com/articles/show/title/estimated-daily-intake-of-aflatoxin-m1 -in-thailand.

[14] U.S. FDA (United States Food and Drug Administration). (1996). Guidance for Industry- Q2B Validation of Analytical Procedures: Methodology. Rockville, MD: Department of Health and Human Services, Center for Drug Evaluation and Research;, Available from:, http://www.fda.gov/downloads/Drugs/GuidanceComplianceRegulatoryInformation/Guidances/ucm073384.pdf.

[15] Ghanem, I., & Orfi, M. (2009). Aflatoxin M1 in Raw, Pasteurized and Powdered Milk Available in the Syrian Market. *Food Control*, 20, 603-605.

[16] Hussain, I., Anwar, J., Asi, M. R., & Munawar, Kashif. M. (2010). Aflatoxin M_1 Contamination in Milk from Five Dairy Species in Pakistan. *Food Control*, 21, 122-124.

[17] Rahimi, E., Bonyadian, M., Rafei, M., & Kazemeini, H. R. (2010). Occurrence of Aflatoxin M_1 in Raw Milk of Five Dairy Species in Ahvaz, Iran. *Food Chemistry and Toxicology*, 48, 129-131.

[18] Ruangwises, N., & Ruangwises, S. (2010). Aflatoxin M_1 Contamination in Raw Milk within the Central Region of Thailand. *Bulletin of Environmental Contamination and Toxicology*, 85, 195-198.

[19] Ruangwises, S., & Ruangwises, N. (2009). Occurrence of Aflatoxin M_1 in Pasteurized Milk of the School Milk Project in Thailand. *Journal of Food Protection*, 72, 1761-1763.

[20] Assem, E., Mohamad, A., & Oula, E. A. (2011). A Survey on the Occurrence of Aflatoxin M1 in Raw and Processed Milk Samples Marketed in Lebanon. *Food Control*, 22, 1856-1858.

[21] Ozdemir, M. (2007). Determination of Aflatoxin M_1 Levels in Goat Milk Consumed in Kilis Province. *Ankara Universitesi Veteriner Fakultesi Dergisi*, 54, 99-103.

[22] Oliveira, C. A. F., & Ferraz, J. C. O. (2007). Occurrence of Aflatoxin M_1 in Pasteurized, UHT Milk and Milk Powder from Goat Origin. *Food Control*, 18, 375-378.

[23] Virdis, S., Corgiolu, G., Scarano, C., Pilo, A. L., & De Santis, E. P. L. (2008). Occurrence of Aflatoxin M_1 in Tank Bulk Goat Milk and Ripened Goat Cheese. *Food Control*, 19, 44-49.

[24] Motawee, Bauer. J., & Mc Mahon, D. J. (2009). Survey of Aflatoxin M_1 in Cow, Goat, Buffalo and Camel Milks in Ismailia-Egypt. *Bulletin of Environmental Contamination and Toxicology*, 83, 766-769.

[25] DLD. (2010). Transition to Organic Goat Milk Production System. Bangkok: Department of Livestock Development, Ministry of Agriculture and Cooperatives.

[26] Pettersson, H. (2004). Controlling Mycotoxins in Animal Feed. In: Magan N, Olsen M (eds.). Mycotoxins in Food: Detection and Control. Cambridge, England: Woodhead Publishing;, 262-304.

[27] Ruangwises, S., & Mhosatanun, B. (1996). Relation of aflatoxin B_1 in dairy cow feed and aflatoxin M_1 in milk. Final Research Report. Chulalongkorn University (Bangkok); (in Thai).

[28] Smith, Phillips. T. D., Ellis, J. A., Harvey, R. B., Kubena, L. F., Thompson, J., & Newton, G. (1994). Dietary Hydrated Sodium Calcium Aluminosilicate Reduction of Aflatoxin M_1 Residue in Dairy Goat Milk and Effects on Milk Production and Components. *Journal of Animal Science*, 72, 677-682.

[29] Mazzette, A., Decandia, M., Acciaro, M., Fenu, A., Francesconi, A. H. D., & Battacone, G. (2009). Excretion of Aflatoxin M_1 in Milk of Goats Fed Diet Contaminated by Aflatoxin B_1. *Italian Journal of Animal Science*, 8, 631-633.

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