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Aflatoxin M1 contamination in raw milk from major milk-producing areas of China during four seasons of 2016

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ABSTRACT

This survey was performed to determine the frequency with which raw milk from the major milk-producing areas of China was contaminated with aflatoxin M1 (AFM1) in 2016. In total, 5650 raw milk samples produced during the four seasons of 2016 were collected from the major milk-producing areas of China, including Hebei, Heilongjiang, Henan, Inner Mongolia, Shandong, and Xingjiang provinces. Contamination of AFM1 was detected in 267 of the 5650 raw milk samples in totally, with the incidence of 4.7%. Only 1.1% of raw milk samples exceeded the European Union legal limit (50 ng/L), and none of samples exceeded the Chinese and United States legal limit (500 ng/L). The incidence of AFM1 contamination in raw milk samples was much higher during winter (10.2%) than in spring, summer, or autumn (3.0%, 2.1%, and 4.4%, respectively) in China. Thus, it is particularly important to monitor AFM1 contamination in raw milk during the winter season. This comprehensive study will facilitate future risk analysis and the management of AFM1 contamination in raw milk in China.

1. Introduction

Aflatoxins occur naturally in the feed and food industry and constitute a major global public health concern because they are poisonous, carcinogenic, and teratogenic, among other deleterious effects (Zinedine & Mañes, 2009). In particular, the contamination of milk products with aflatoxins is a serious health hazard for consumers (N. Ruangwises & Ruangwises, 2010). A particularly toxic aflatoxin contaminant in milk products is aflatoxin M1 (AFM1), which is classified as a Group 1 toxin (IARC, 2012). It is the principal metabolite of aflatoxin B1, which is produced by *Aspergillus*. AFM1 usually enters milk products by being excreted into the raw milk by dairy cows that have ingested aflatoxin B1 contaminated feedstuffs (Prandini et al., 2009). Since AFM1 is heat stable (it is only degraded at temperatures of at least 250 °C) (Ellis, Smith, Simpson, Oldham, & Scott, 1991), the AFM1 in contaminated raw milk cannot be removed by pasteurization, ultra-high temperature heat processing, or other methods (Iqbal, Paterson, Bhatti, & Asi, 2010).

AFM1 contamination in raw milk is a substantial public health concern worldwide (Tajkarimi et al., 2008) as many countries have reported high incidences of AFM1 contamination in raw milk (Elzupir & Elhussein, 2010; Ertas, Gonulalan, Yildirim, & Karadal, 2011; Iqbal & Asi, 2013; Kang'ethe & Lang'a, 2009; Manetta et al., 2009; Nuryono et al., 2009; Oluwafemi, Badmos, Kareem, Ademuyiwa, & Kolapo, 2014; Sani, Nikpooyan, & Moshiri, 2010). To reduce these high levels of AFM1 contamination, the regulatory authorities in most countries have established the legal limits of AFM1 in milk and milk products. These legal limits range from 50 ng/L in many countries such as the European Union (EU) to 500 ng/L in countries such as the United States (US). In China, 500 ng/L is also the legal limit of AFM1 levels in milk and milk products.

In September 2010, Zheng et al. (2013) measured the AFM1 levels in 360 raw milk samples that were collected from five provinces of China. They found that 78.1% of the raw milk samples were positive for AFM1. However, these samples contained between 5 and 123 ng/L AFM1, which is far below the legal limit in

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China. Notably, around the same time (August 2010), Han et al. (2013) assessed 200 raw milk samples from ten provinces of China. However, they detected a much lower incidence of positivity for AFM1 contamination (32.5%). All samples were well below the Chinese legal limit (5.2–59.6 ng/L). The inconsistency between Zheng et al. (2013) and Han et al. (2013) in terms of the frequency of positive samples suggests that, to best determine the general situation of raw milk contamination with AFM1 in China, a study that measures the frequency of AFM1 contamination in a large number of raw milk samples from the major milk-producing areas of China is warranted.

To address this, 5650 raw milk samples that were produced during all four seasons of 2016 were collected in the major milk-producing areas of China (Fig. 1). The results of this comprehensive survey will facilitate future risk analysis and therefore the management of AFM1 contamination of raw milk in China.

2. Material and methods

2.1. Sampling

In total, 5650 raw milk samples were collected from the major milk-producing areas of China, including Hebei, Heilongjiang, Henan, Inner Mongolia, Shandong, and Xingjiang provinces. The samples were from four seasons of 2016. The winter, spring, summer, and autumn samples were produced in February, April, August, and October, respectively (Fig. 2).

Of the 5650 samples, 1040 samples were collected from Hebei province (311 from spring, 100 from summer, 335 from autumn, 294 from winter), 1184 samples were collected from Heilongjiang province (237 from spring, 329 from summer, 487 from autumn, 131 from winter), 826 samples were collected from Henan province (141 from spring, 183 from summer, 243 from autumn, 259 from winter), 1105 samples were collected from Inner Mongolia province (371 from spring, 174 from summer, 343 from autumn, 217 from winter), 1080 samples were collected from Shandong province (452 from spring, 226 from summer, 230 from autumn, 172 from winter), 415 samples were collected from Xingjiang province (89 from spring, 162 from summer, 95 from autumn, 69 from winter). All samples were directly collected from the milk holding tanks at milk stations in these provinces.

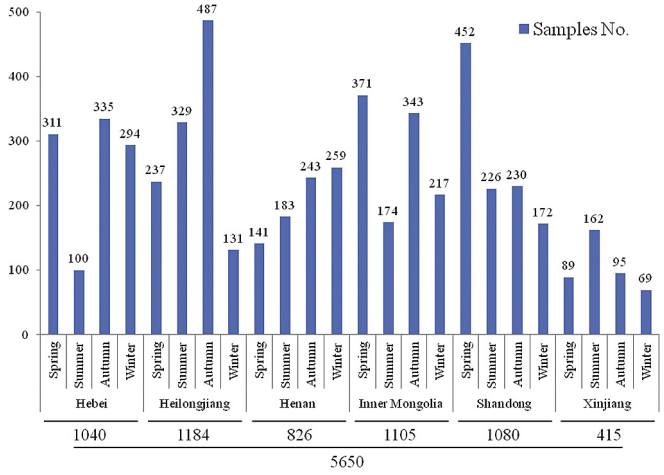

Fig. 2. Number of raw milk samples collected in the major milk-producing areas of China during the four seasons of 2016.

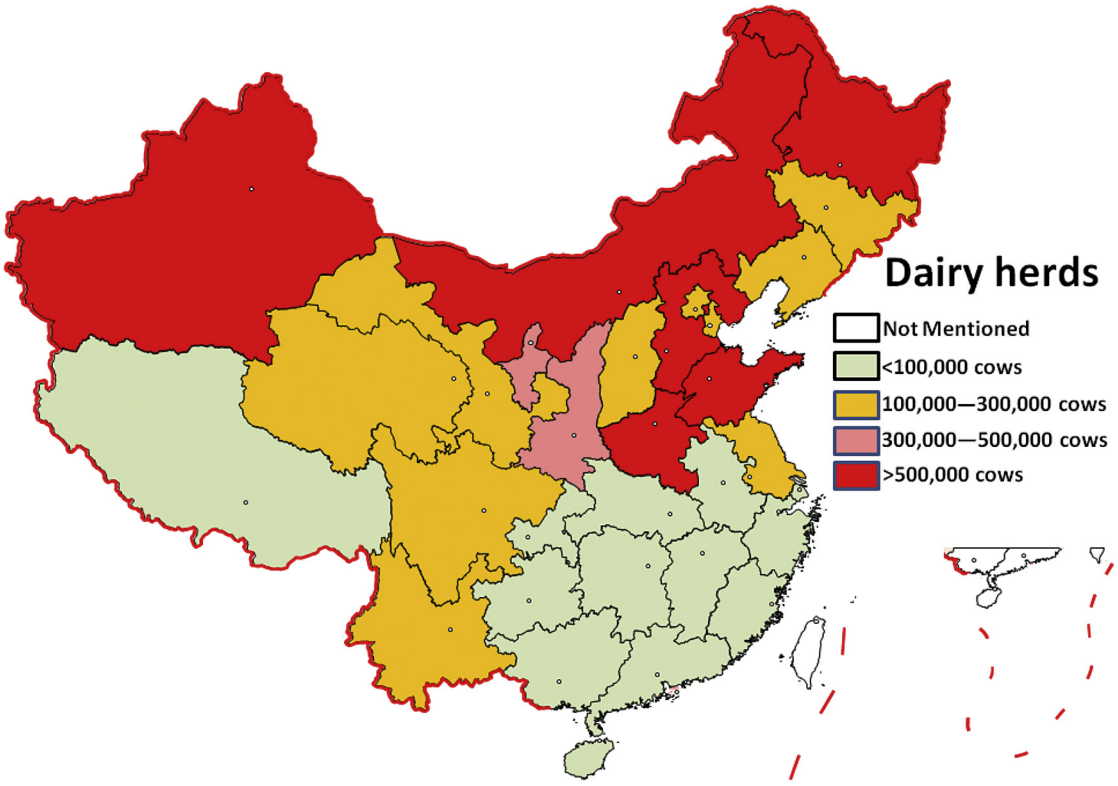

Fig. 1. Dairy herd sizes in Chinese provinces in 2015 (derived from the Ministry of Agriculture of China). The milk stations of major milk-producing areas of China including Hebei, Heilongjiang, Henan, Inner Mongolia, Shandong, Xingjiang provinces (Red Label), the dairy herds were more than 500,000 cows in these provinces. Thus, to obtain a more representative picture of aflatoxin M1 contamination in raw milk in China, it is best to focus on these major milk-producing areas. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)