ALFATOXINS IN MAIZE FEED AND THE DAIRY PRODUCTION CHAIN

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In the last decennia, aflatoxin contamination of maize grown in Europe is of increasing importance, amongst others, due to climate change effects. Contamination of maize with this mycotoxin may result into high economic impacts on the feed and food production system, and into potential effects on human health. Understanding the formation and fate of aflatoxins in the maize production chain is necessary to adapt sampling, control, and monitoring such to reduce contamination in Europe. To this end, we have conducted an extensive literature search in the formation and fate of aflatoxins throughout the entire maize feed and dairy production chain.

Aflatoxins are genotoxic and carcinogenic mycotoxins, produced by fungi, in particular by the genus Aspergillus. The group of aflatoxins include the alflatoxins B1, B2, G1 and G2. Out of these four, aflatoxin B1 (AFB1) generally occurs in the highest concentration in maize, and the other three are often found in low concentrations in conjunction with high AFB1 concentrations. Several species of the Aspergillus genus can produce aflatoxins, in particular A. flavus and A. parasiticus. There is general consensus that A. flavus produces aflatoxins B1 and B2, whereas A. parasiticus produces all four aflatoxins B1, B2, G1 and G2. A. flavus is most frequently associated with aflatoxin contamination in maize.

AFB1 can be metabolized to aflatoxin M1 (AFM1) by dairy cows, which is also considered to be genotoxic and carcinogenic. Elevated concentrations of AFB1 in maize feed might result in elevated levels of AFM1 in milk and milk products. In Europe, regulations are in place setting limits to the presence of AFB1 and AFM1 in foodstuffs and feed materials (Regulation EC/1881/2006 and Directive 2002/32/EC).

Contamination of maize with AFB1 originates from the field, where Aspergillus flavus may infect the maize plants during crop cultivation, given conducive environmental conditions. Beside effects of local weather, like water temperature and relative humidity, agronomic conditions like crop variety are also relevant. A. flavus infection and AFB1 contamination of maize in the field is very local; distribution of contamination in the field is thus heterogenous. Conditions during harvest, processing and storage also influence AFB1 contamination of maize lots after harvest. Usually, the overall concentration of aflatoxins in maize lots is low. However, aflatoxin concentrations in individual kernels vary a lot, with extreme high concentrations in some kernels. In addition AFB1 contamination varies widely between individual maize lots. In literature, the largest range of contamination between lots was reported to be 6-1600 µg/kg among 100 samples of maize kernels at three different locations in Brazil. The wide range in AFB1 concentrations between kernels, and between maize lots, may cause serious health effects incidentally.

Maize is a commonly used feed material for dairy cows. Feed manufacturers produce feed by mixing and grinding maize and other feed materials. In recent decades, the maize consumption of dairy cows has increased due to the prices of raw materials and the enlargement of amounts of concentrated feeds in the diets. In the period 2010-2013, the use of maize in feed for cows in the Netherlands has increased from approximately 1 to 18%. These developments have possibly increased the exposure of dairy cows to AFB1 via maize consumption in the Netherlands.

During and after administration of AFB1 to cows, the concentration of AFM1 in milk changes. During AFB1 administration in feed, the concentration of AFM1 in milk increases rapidly, and can already be detected in 10

hours after AFB1 ingestion. A steady state of AFM1 excretion in the milk is reached at 24 h from initial AFB1 ingestion. Then, AFM1 declines to a zero concentration within 3-5 days after the diet of the cow was changed to an AFB1-free diet. In dairy cows, the amount of AFM1 excreted into milk can be in the range of about 0 to 6% of the AFB1 intake, depending of the milk yield and stage of lactation of the cow. Several studies found a higher carryover in cows with a higher milk yield and in early/mid-lactating cows. The carryover percentages varied, possibly due to differences between the metabolisms of the cows and/or the milk yield. A higher carry-over value can imply exceedance of the EC limit for AFM1 concentrations in milk and dairy products.

Thus, AFB1 in the maize feed and dairy production chain is become of increasing importance due to incidentally high contaminations in the maize, increased use of maize in the cow's feed, and increased carryover of the toxin into the milk. Control of aflatoxin contamination should be done throughout the entire chain: by agronomic practices in the field (e.g. selection of crop variety, cropping system, use of insecticides, time of harvesting), monitoring of aflatoxin formation during maize growth and harvest, drying of maize kernels after harvesting (time, temperature), monitoring storage and distribution conditions (water activity, temperature), and monitoring aflatoxin concentrations before feed processing and after milking.

Acknowledgement

The authors acknowledge the Ministry of Economic Affairs (EZ) for financial support of this study.