Aflatoxins in dairy feed and milk

By Lishia Daya Khilosia, Michael Francis Dutton, Suretha de Kock, and Mulunda Mwanza

Mycotoxins are naturally occurring toxins produced by filamentous fungi in many crops after harvest, during storage and later when processed into food, animal feed and feed concentrates (Smith & Henderson, 1991). These toxins are invisible, odourless and very stable compounds resisting degradation by most physical and chemical food technology practices. It has been found that at least 14 mycotoxins are carcinogenic with aflatoxins being the most potent (Stark, 1980).

A commonly occurring mycotoxin is aflatoxin B_1 (AFB_1) which has been found as a frequent contaminant in most feeds and foods. The International Agency for Research on Cancer has classified AFB_1 as a group 1 human carcinogen (IARC, 2002) with the liver being the main target organ for aflatoxin toxicity and carcinogenicity (Abdel-Wahhab *et al.,* 2007). There is some preliminary evidence suggesting that there may be an interaction between chronic mycotoxin exposure and malnutrition, immune suppression, impaired growth and development, as well as diseases such as malaria and HIV/AIDS (Gong *et al*., 2003; 2004).

If feed contaminated with AFB_1 is consumed by ruminants such as the dairy cow, this toxin may be converted to aflatoxin M_1 (AFM_1) under the influence of cytochrome P_{450} oxidase system found in rumen microflora and the animal's own cells (Yoshikawa *et al*., 1982). The quality of the meat and milk produced by the animal consuming the contaminated feed is thus compromised, owing to the presence of carcinogenic toxins. The consumption of aflatoxin-contaminated foods whilst breastfeeding may also result in the formation of aflatoxins and their metabolites in breast milk (Polychronaki *et al*., 2006; Galvano *et al.,* 1996). As milk is a primary food source for infants and continues to be an important component of a growing child's diet, it is of paramount importance that this toxin be limited or eliminated. The most effective way of controlling levels of AFM_1 in milk seems to be through regular surveillance studies of commercial milk as well as regular analysis of dairy feed. The South African permitted level of AFB_1 in dairy feed is 5µg/kg (SA Fertilisers, 2009) and the permitted AFM_1 level is 0.05µg/L in bovine milk (SA Foodstuffs, 2004).

A study with a multifold (biotracer) approach was done to address these surveillance issues. Firstly, AFM_1 contamination levels in commercially-available milk in South Africa were determined to check quality and to see whether seasonal variation had an influence on the concentrations. Secondly, the milk produced by a small South African dairy was analysed, together with the feed fed to the cows on all the selected farms supplying the dairy. The feed and farm-gate milk analyses were also conducted during two seasons. The final aspect of this study was to assist the dairy and farmers involved, with regards to recommendations regarding quality control issues which could reduce levels of AFB_1 in feed and subsequently reduce AFM_1 contamination levels in milk produced by the lactating animal. A full biotracer investigation could follow this study, but practical difficulties in sampling of batches and compounding present challenges.

Preliminary results indicate that approximately 78% of the feed ingredients sampled were found to be contaminated with AFB_1. It was further found that over half the farm-gate milk analysed was above the

South African legislated levels. The contamination of commercially available milk by AFM_1 is evident in South Africa. On average, AFM_1 contamination levels among fourteen selected brands were noticeably higher during the winter sampling period and this may be attributed to the increased use of compound feed in winter as opposed to pasture feeding in summer. ■

Lishia Daya Khilosia (B. Tech Food Technology, University of Johannesburg) conducted the research for her M. Tech in Food Technology at the FEHRG laboratory, with her supervisors being: Professor M. F. Dutton (Food Environment and Health Research Group, University of Johannesburg), Dr. S. de Kock (Department of Food Technology, University of Johannesburg) and Mr. M. Mwanza (Food Environment & Health Research Group, University of Johannesburg).

References

Abdel-Wahhab, M.A., Abdel-Galil, M.M., Hassan, A.M., Hassan, N.H., Nada, S.A., Saeed, A. & El-Sayed, M.M. (2007). *Zizyphus spina-christi extract protects against AFB_1 initiated hepatic carcinogenicity.* Africa Journal Traditional CAM 4 pp. 248–256.

Galvano, F., Galofaro, V. and Galvano, G. (1996) *Occurrence and stability of AFM_1 in milk and milk products.* Journal Food Protection 59 pp. 1079–1090.

Gong, Y., Egal, S., Hounsa, A., Turner, P.C., Hall, A.J., Cardwell, K.F. and Wild, C.P. (2003). *Determinants of aflatoxin exposure in young children from Benin and Togo, West Africa: the critical role of weaning.* International Journal of Epidemiology 32 pp. 556–662.

Gong, Y., Hounsa, A., Egal, S., Turner, P.C., Sutcliffe, A.E., Hall, A.J., Cardwell, K. and Wild, C.P. (2004). *Post-weaning exposure to aflatoxin results in impaired child growth: a longitudinal study in Benin, West Africa.* Environmental Health Perspectives 112 pp 1334–1338.

International Agency for Research on Cancer (IARC) (2002) *Aflatoxins. Traditional herbal medicines, some mycotoxins, naphthalene and styrene.* IARC monograph on the evaluation of carcinogenic risks to humans 82 IARC, Lyon pp. 171–300.

Polychronaki, N.C., Turner, P.C., Mykkänen, H., Gong,Y., Amra,H., Abdel-Wahhab, M. and El-Nezami, H., (2006). *Determinants of AFM_1 in breast milk in a selected group of Egyptian mothers.* Food Additive Contaminants 23 pp. 700–708.

Smith, J.E. & Henderson, R.S. (1991). *Mycotoxins and animal foods*: Boca Raton, Florida: CRC Press.

South African Foodstuffs, Cosmetics and Disinfectant Act 1972 (Act No. 54 of 1972) (October 2004) *Regulations Governing Tolerance for Fungus Produced Toxins in Foodstuffs* Amendment No. 26849, R1145, pp. 1.

South African Fertilisers, Farm Feeds, Agricultural Remedies and Stock Remedies Act 1947 (2009). *Regulations relating to Farm Feeds* Amendment R227 No. 31958, pp. 27.

Stark, A.A., (1980). *Mutagenicity and carcinogenicity of mycotoxins : DNA binding as a possible mode of action.* Annual Review Microbiology 34 pp. 235–262.

Yoshikawa,H., Uchimaru, R., Kamataki, T. Kato, R. and Ueno, Y., (1982). *Metabolism and activation of AFB_1 by reconstituted cytochrome P_{450} system of rat liver.* Cancer Research 42 pp. 1120–1124.