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Mycotoxin prevalence in stored animal feeds and ingredients in Rwanda

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Abstract

Aflatoxins and fumonisins are fungi metabolites produced when climate conditions are favorable. They contaminate feed ingredients when storage conditions are unfavorable. Aflatoxins and fumonisins have a negative impact on animal health and productivity. Humans are indirectly exposed to mycotoxins when they consume contaminated animal source foods from livestock fed contaminated feeds. A total of 3328 feed samples were collected in all 30 district of Rwanda between March and October 2017. Four categories of participants participated in the study (dairy farmers, poultry farmers, feed processors/grain millers, and feed vendors). Feed samples were highly contaminated with aflatoxins but not fumonisins. Average aflatoxin levels were highest in dairy feeds (108.3 μg/kg) followed by poultry feed (103.81 μg/kg). Average aflatoxin levels were lowest in samples from feed vendors (88.64 μg/kg) compared to samples from feed processors (94.95 μg/kg). This study documents high levels of aflatoxin contamination in feed samples, and recommends year-round surveillance of feed ingredients and mixed feeds for mycotoxin presence. Additionally, more awareness through communication and education needs to be raised among stakeholders in the evolving feed value chain in Rwanda to mitigate the consequences of mycotoxin contamination on public health and animal produtivity.

Keywords: aflatoxins, fumonisins, ELISA, value chain

Introduction

Mycotoxins (e.g., aflatoxins and fumonisins) are secondary metabolites produced by fungi. Aflatoxins are produced by *Aspergillus flavus* and *A. parasiticus* while fumonisins are produced by *Fusarium verticillioides* and *F. proliferatum* in favorable conditions. They contaminate crops especially maize, peanuts and cottonseed throughout sub-Saharan Africa (Binder, Tan, Chin, Handl, & Richard, 2007; Perrone & Gallo, 2017; Richard, 2007). Aflatoxins and fumonisins have a negative impact on human and animal health. Human exposure to these mycotoxins is the result of ingestion of contaminated foods (e.g., maize flour, peanut butter), or indirectly from consumption of animal source foods (e.g., dairy products, eggs) derived from animals previously exposed to aflatoxins in feeds. Aflatoxins are classified as carcinogenic susbtances (IARC, 2002). Fumonisins are associated with neural tube defects, disrupt sphingolipid metabolism and folate transport (Marasas et al., 2004). Fumonisins are also associated with different animal diseases such as Equine Leukoencephalomalacia (ELEM) in horses and Porcine Pulmonary Edema (PPE) in pigs. They are reported to be nephrotoxic, hepatotoxic and hepatocarcinogenic in a number of livestock and poultry species (Wan Norhas et al., 2009). Mycotoxin feed contamination has attracted worldwide concern due to losses in animal productivity and feed safety (Bryden, 2012; Placinta, D'Mello, & Macdonald, 1999). Different factors contribute to high risk of feed contamination in Africa. Environmental conditions with high relative humidities and temperatures favor fungal growth. Socio-economic status and food production system result in high contamination of feeds (Wagacha & Muthomi, 2008). Feed contamination will not only lead to reduction in animal productivity but will also contribute to milk contamination due to aflatoxin M1 which is the result of aflatoxin B1 metabolism and excreted in milk. A number of studies have reported feed contamination in different African countries (Kang'Ethe & Lang'A, 2009; Mohammed, Munissi, & Nyandoro, 2016; Nyangi et al., 2016). Thus, mycotoxins are a significant risk to animal productivity and food safety in East Africa (Atherstone, Grace, Lindahl, Kang'ethe, & Nelson, 2016). The main objective of this study was to assess the prevalence of aflatoxins and fumonisins in stored animal feeds and ingredients in Rwanda.

Materials and Methods

a. Sample collection

A countrywide survey in all 30 districts of Rwanda was carried out between March and October 2017 targetting four categories of participants: dairy farmers, poultry farmers, feed vendors and feed processors/grain millers. Samples were collected in six rounds by taking approximately 2 kg of feed from each participant who agreed to participate in the study.

b. Sample analysis

All collected feed samples were analyzed using competitive Enzyme-Linked Immunosorbent Assay (ELISA) technique (Catalog #941AFL01M-96 and Catalog #951FUMO01C-96 for Total Aflatoxin Assay and Fumonison ELISA Assay, respectively, Helica Biosystems, Santa Ana, CA, USA).

Results

Table 1. Aflatoxin and fumonisin levels in feed samples collected at different points in the feed value chain.

	Aflatoxins (µg/kg)			Fumonisins (mg/kg)		
	Mean	**SD**	**Median**	**Mean**	**SD**	**Median**
Dairy farmers	109	145	44	1.5	1.8	0.7
Poultry farmers	104	136	48	1.2	1.5	0.6
Feed Vendors	89	129	31	1.5	1.7	0.8
Feed Processors/ Grain Millers	95	103	71	1.0	1.3	0.5

Discussion

Rwanda, a tropical country, offers favorable conditions for mycotoxigenic fungi growth. At all points in the feed value chain high aflatoxin contamination and less fumonisin contamination was documented in samples collected. In this study, the averaged fumonisin contamination was well below the guidance level by the U.S. Food and Drug Administration (USFDA) of 5 mg/kg in maize and maize by-products intended for equids and rabbits.

However, more than 85% of dairy feed samples exceeded the aflatoxin standard of 5 µg/kg for aflatoxin B1 established by Rwanda Standards Board (RSB) standard for feed ingredients. It confirms the concern over aflatoxin contamination in a few feed samples collected from different vendors in Kigali (Rwanda) during a previous study (Nishimwe, Wanjuki, Karangwa, Darnell, & Harvey, 2017). Lack of knowledge and awareness about aflatoxin contamination in grain and feed samples remains a concern. Aflatoxin and fumonisin contamination in animal feeds were also reported in different East African countries (Kang'Ethe & Lang'A, 2009; Mohammed et al., 2016; Nyangi et al., 2016;

Senerwa, 2016). Year-round surveillance and creation of mycotoxin awareness through communication and education along the feed value chain are needed for mitigating mycotoxin contamination in feed value chain of Rwanda.

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Development of sensitive polyclonal antibodies against dominant stored wheat grain fungus for its immunological detection

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Abstract

Fungal infestation causes deterioration of stored food grains. Most fungal species produce secondary metabolites like aflatoxins which are highly toxic to animals and humans. *Aspergillus flavus* has been found to be the predominant contaminant in stored wheat grains collected from the godowns of Food Corporation of India, West Bengal. The present study focuses on the development of sensitive polyclonal antibodies (PAbs) for molecular immunological detection of dominant toxigenic fungus. Pure *A. flavus* isolate was cultured on