MARKET SAMPLES AS A SOURCE OF CHRONIC AFLATOXIN EXPOSURE IN KENYA

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SUMMARY

Surveillance of food and feed quality in Kenya has not reached effective level due to the expensive procedures of mycotoxin analysis and poor structures in quality control. Most foodstuffs and feeds sold in local markets do not go through any quality control measures. The outbreaks of aflatoxicoses every year since the major outbreak that occurred in 2004 (CDC, 2004; Muture and Ogana, 2005, Azziz-Baumgartner *et al*., 2005) suggests that the population is exposed to aflatoxins in their diet. Chronic exposure could be a more serious problem than the outbreaks of aflatoxicosis that attract attention at the time they occur. This paper analyses the extent to which market food and feed samples expose the residents of urban Nairobi Province to aflatoxins. Using TLC method of aflatoxins analysis, maize for food and feed samples collected randomly as part of routine surveillance between the years 2006-2009 were tested. Only 17% of the total maize sampled and 5% of feed were fit for human and animal consumption respectively. Maize Grain Grade 11 and maize milled products were significantly highly contaminated compared with Maize Grain Grade 1 throughout the period of sampling. There was no significant difference in level of contamination among the feeds tested.

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Introduction

Safety of food and feed has been a major concern of nations in the last years as more knowledge is gathered on occurrence of natural toxins in foodstuffs and edible plant species. Both microbiological and chemical hazards are of concern. Among chemical hazards, the contamination of food and feed by mycotoxins (toxic metabolites of fungi), fishery products by phycotoxins (toxins produced by algae) and edible plant species by their plant toxins have been recently characterized by the World Health Organization (WHO) as significant sources of food-borne illnesses (WHO, 2002a). Of these three categories of natural toxins, most attention has been directed to mycotoxins until now. Among the more than 300 mycotoxins known aflatoxins are the most studied. These are produced mostly by *Aspergillus flavus* and *Aspergillus parasitic* which are common and widespread molds in nature growing on varied substrates such as soil, agricultural products, decaying vegetation, hay. These fungi invade and deteriorate all types of organic substrates whenever and wherever the conditions are favourable for their growth. Favourable conditions include high moisture content and high temperature which is typical of the tropics. At least 13 different types of aflatoxins are produced in nature with aflatoxins B1 considered as the most toxic and so is of particular public health importance because of their effects on human health. Food and Agriculture Organization estimates that mycotoxins contaminate 25% of agricultural crops worldwide (Smith *et al*., 1994) and is of great concern in rural communities of developing countries where food quality control is not effected before consumption or even supply to the markets (Bhat *et al*., 1997).

Aflatoxins have both carcinogenic and hepatotoxic actions, depending on the duration and level of exposure. The human gastrointestinal tract rapidly absorbs aflatoxins after consumption of contaminated food, and the circulatory system transports the aflatoxins to the liver (Fung and Clark 2004). From 1 to 3% of ingested aflatoxins irreversibly bind to proteins and DNA bases to form adducts such as aflatoxin B1–lysine in albumin (Skipper and Tannenbaum 1990) causing liver toxicity (Tandon *et al*., 1978). Ingestion of higher doses of aflatoxin can result in acute aflatoxicosis, which manifests as hepatotoxicity or, in severe cases, fulminant liver failure and death (Fung and Clark 2004, Etzel 2002). Such deaths have been recorded in Kenya yearly since the major outbreak of July 2004 that resulted into 317 cases of aflatoxins poisoning and 125 deaths (Azziz-Baumgartner *et al*., 2005; Muture and Ogana , 2005; Muthomi *et al*., 2009; Nyikal *et al*., 2004). Even before the 2004 outbreak, several cases had been observed and documented (Ngindu, *et al*., 1982). However, though interventions by government authorities have followed after each outbreak leading to confiscation and replacement of contaminated produce, chronic exposure to aflatoxins could be the case in Kenya. Studies of aflatoxin poisoning in human have shown that low-level chronic intake may be more devastating than one-time high-level intake leading to hepatocellular carcinoma (Peers and Linsell, 1973, 1997; Wogan, 1975;, McGlashan,1982). This article presents an assessment of aflatoxin contamination of market samples of maize and maize products intended for food and feed in Nairobi Province, between the period 2006-2009.

Materials and Methods

Random environmental sampling of maize and maize products for food and feed was done as a surveillance procedure between the period 2006-2009 from retail shops within Nairobi Province. Five retail packs of food and feed were picked at random from the same batch from retail shops for analysis. In cases where this number of packs was not available, as many packs as possible were picked randomly to make up 1 kg. Pre-packed samples were retained in their packaging and packed in plastic bag after purchase and sealed after putting the sample code on the outside of the bag. Sterile paper bags were used for incremental samples that were unpacked (Food Science Agency Scotland, 2006). A total of 1643 samples consisting of maize grains, maize flour, milled maize cereal products, dairy cattle feed and oil seed cake were collected. Incremental samples were mixed thoroughly and subsamples of 300g used for analysis. The AOAC method was adopted for analysis. The test portion was extracted with chloroform, filtered and a portion of the aliquot taken, concentrated on a rotary evaporator and the same purified (cleaned) by column chromatography on silica gel. The elute was evaporated and an aliquot of this subjected to thin layer chromatography for the separation of the aflatoxins and identified under U.V light by comparison with known quantities of standards spotted alongside the sample and quantified using a densitometer.

Chi-square tests of association were used to compare levels of Aflatoxins with different types of feeds and foods.

Results

Aflatoxin levels in maize and maize products

Aflatoxin levels in market maize indicate widespread contamination in both maize grain and its products, Table 1. Of the 144 food samples collected 120 (83%) had levels greater than the regulatory limit of 10ppb (FAO/WHO), Fig 1. Aflatoxin levels ranged from 0.11ppb to values as high as 4593.93 ppb.

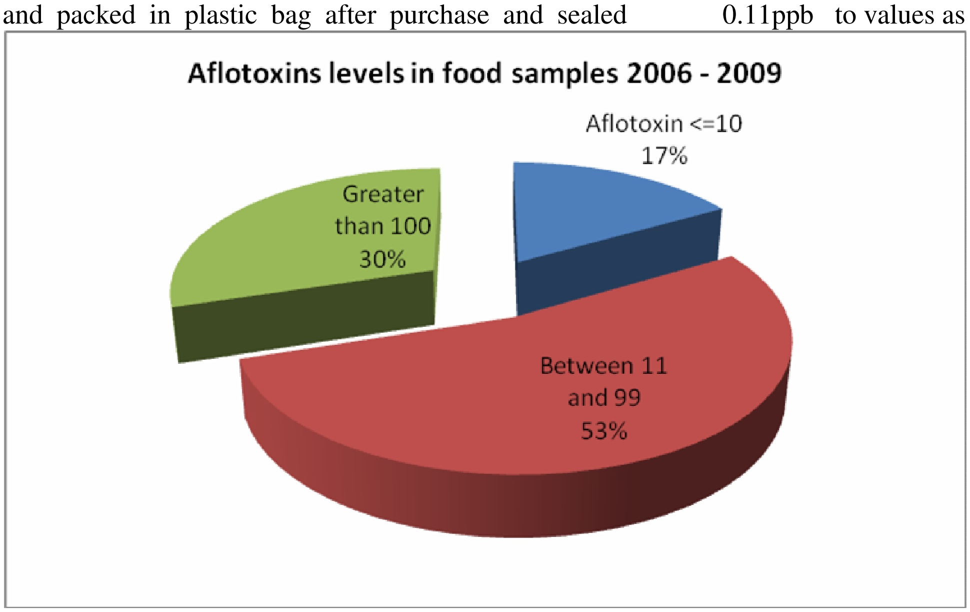

Figure 1: Total aflatoxins level in food between the period 2006-2009

Maize grain grade 1 formed 50% of the food samples with aflatoxins below the regulatory limit while maize grain grade 11 scored only 4%. Most of maize grain grade 11 and milled cereal products had aflatoxins levels greater than 100ppb. This difference was highly significant at 5% significance level (Fisher's exact = 0.009, Fig 2.

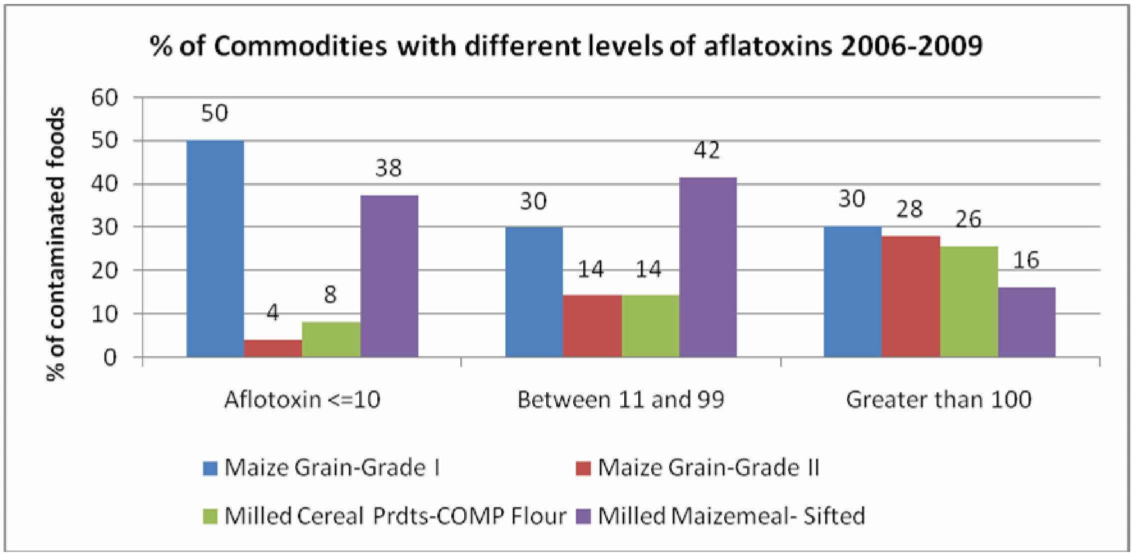

Figure 2: Variation in contamination level with maize product type

Each year the number of samples with levels greater than 10ppb was high (87% in the year 2006, 87% in the year 2007, 70% in the year 2008 and 92% in the year 2009). This was the case for both the maize grains and its milled product, Fig 3.

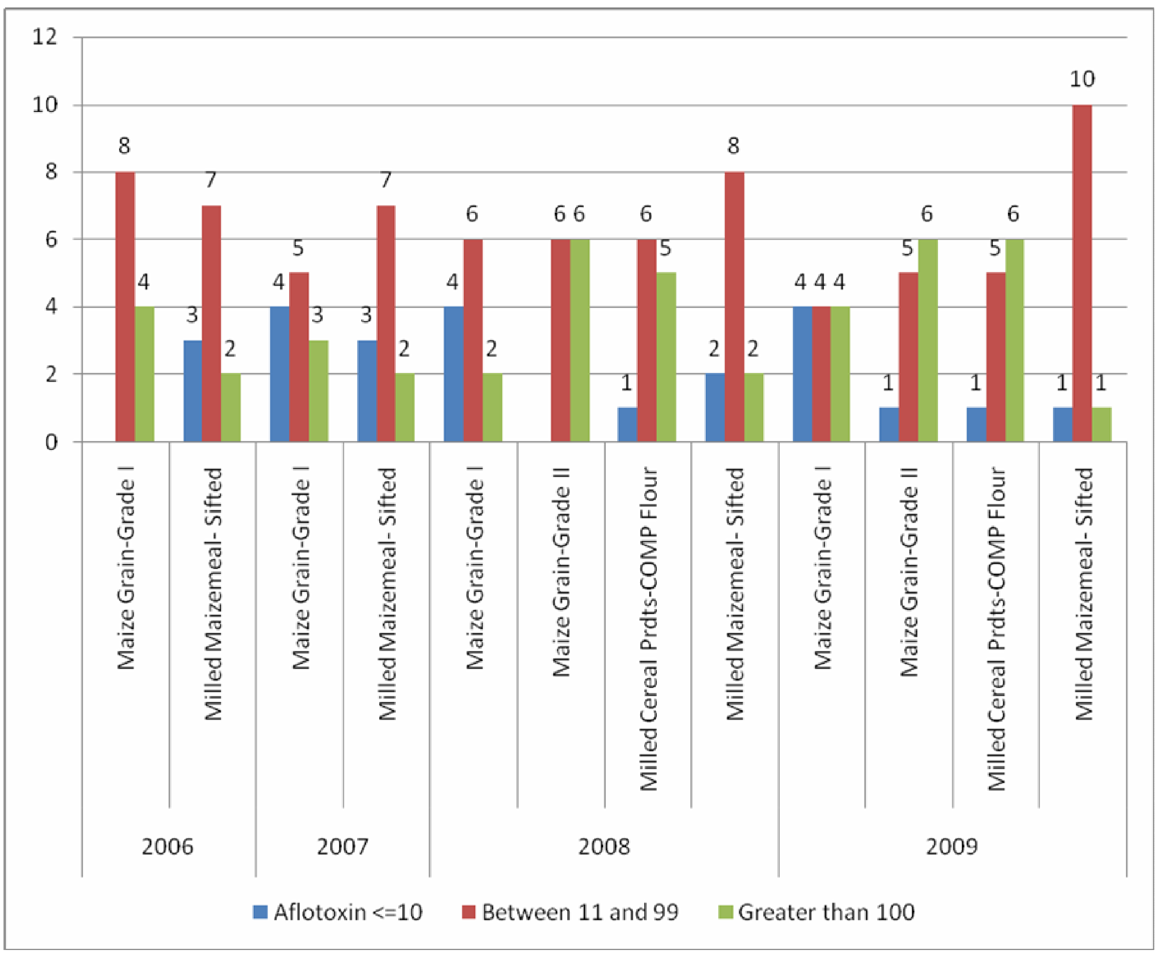

Figure 3: Variation in contamination level with maize product type between 2006-2009

Aflatoxins levels in animal feeds

All samples tested positive for aflatoxins. Only 5% of the total 72 samples collected were below the regulatory limit of 10ppb, Fig. 4. Aflatoxins ranged from 5.13 to 1123ppb, with the largest proportion being between 11-99ppb. There was no significant difference in the level of contamination among the dairy meal, cotton based oil-seed cake or sunflower based oil-seed cake, Fig. 5.

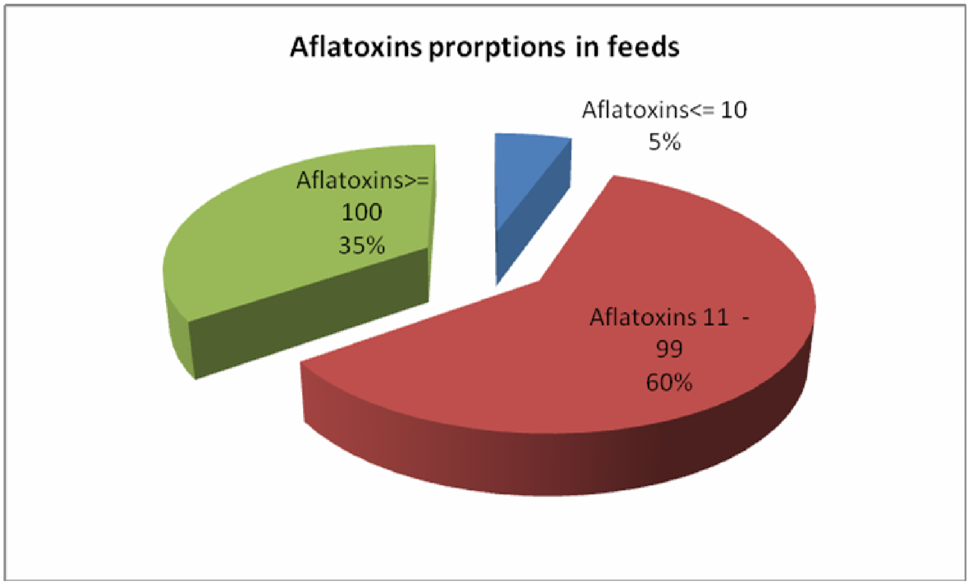

Figure 4: Total aflatoxins level in feed between the period 2006-2009

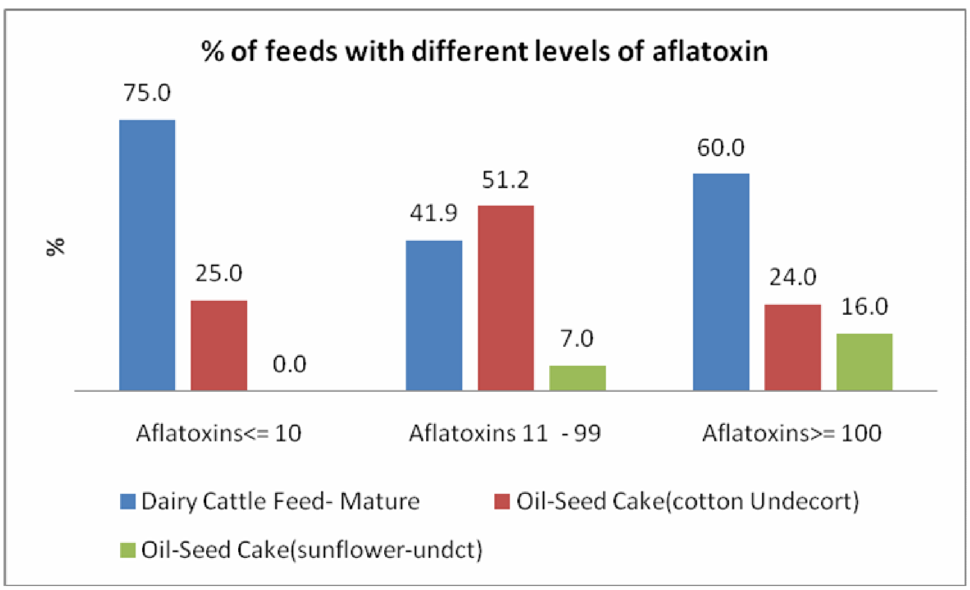

Fig 5: Aflatoxins in various feed types

The number of feed samples with levels greater than 10ppb was more than 87% each year, Fig 6.

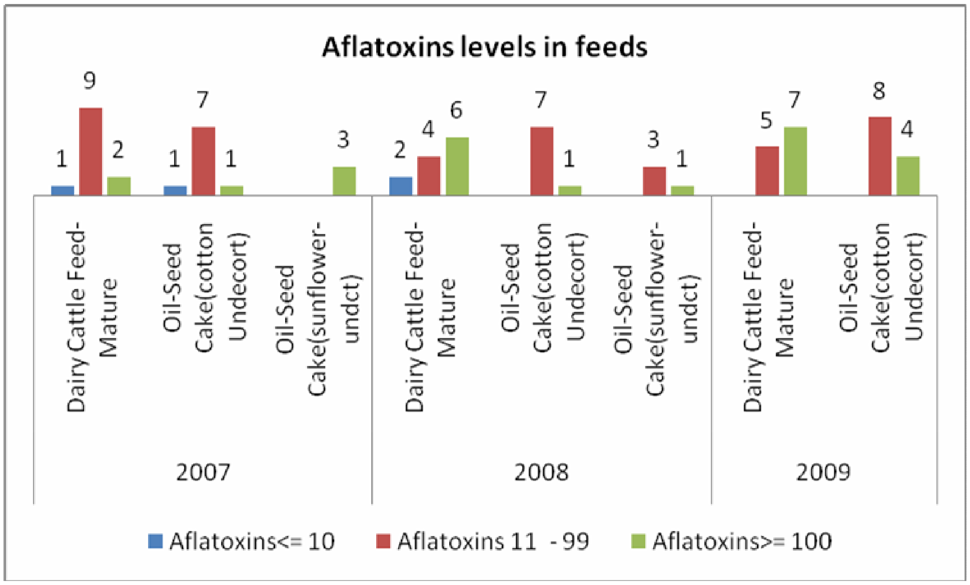

Figure 6: Aflatoxin levels in feed between 2007-2009

Discussion

These results show that market maize represent a significant source of chronic exposure to aflatoxins. The source of contamination of these market samples can be anywhere along the long maize value chain that exists in the maize trade in the country. Farmers mostly sale their maize to middlemen or take the produce to the market where again apart from villages buying, middlemen my purchase and sell to millers or to the cereal board. It was also evident from the results that milled maize products and Grade 11 maize were significantly more contaminated than Grade 1 maize grains showing the importance of the role played by post harvest management practices, including sorting of maize, in controlling contamination. Transportation and storage is a major part of this trade and thus knowledge of proper handling in order not to expose the maize to factors that favor the growth of aflatoxigenic *Aspergillus* and production of toxins is paramount. However this knowledge is largely lacking along the value chain Kengethe and Langa (2009). There are several efforts in Kenya today focusing on reducing aflatoxins contamination in maize either through biocontrol (Ranajit, *et al.*,2011) or through promotion of less vulnerable maize varieties (Jagger, 2011). These efforts should also consider the potential role of market system in sustaining exposure and the importance of sensitization of actors in the maize value chain whose activities determine the safety of the commodity (Lewis *et al.*, 2005; and CDC, 2004)

The use of poor quality raw material for feed is confirmed by the high level of contamination of the samples analysed. One of the main uses of rotten maize is for livestock feed (NRI, 2006) . Kengethe and Langa (2009) reported that most of the feed manufacturers imported raw materials for manufacturing animal feeds which they rarely tested for aflatoxins due to prohibitive costs of analysis and failure by Kenya Bureau of standards to remit results regularly. This further confirms use of uncontrolled quality of raw material for manufacturing feed and lack of knowledge regarding the risks posed by aflatoxins M1 in milk. Aflatoxin M1 (AFM1) is the principal hydroxylated aflatoxins B1 (AFB1) metabolite present in milk of cows fed with AFB1 and excreted within 12 hours of administration of contaminated feeds.

Conclusion

Market source of grains remain a major source of chronic aflatoxins exposure to humans in Kenya. Aflatoxin poisoning likely will continue to be a public health problem until actors along the maize value chain are sensitized and trained on appropriate transportation and storage methods for dry maize and maize products. In addition, enhanced surveillance for human aflatoxin poisoning and testing of commercially sold maize, raw materials for feed manufacture and feed samples for aflatoxin levels will lead to long-term improvements in public health.

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