AFLATOXIN: OCCURRENCE, PREVENTION AND GAPS IN BOTH FOOD AND FEED SAFETY IN NORTH CAROLINA

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Abstract

Aflatoxin is a naturally occurring toxic metabolite produced by mold infestations affecting as much as one-quarter of global food and feed crop output and has been associated with various diseases, such as aflatoxicosis, in livestock, domestic animals and humans (Dohlman, 2003). Consumption of products contaminated with aflatoxin pose a human and animal health risk. To ensure food and feed safety, many countries have adopted regulations to limit exposure to aflatoxin. The primary purpose for this study was to evaluate industry’s knowledge of aflatoxin in food/feed safety. An online survey was submitted to select industries in NC to determine their knowledge about the occurrence, effects and prevention strategies of aflatoxin. Of those who responded less than 50% knew there is an action level the Food and Drug Administration (FDA) has established for aflatoxin present in food/feed in order to protect human/animal health. The results showed that 56% knew that aflatoxin was a toxin and among those respondents, 73% knew that it affected commodities such as corn and peanuts. Majority of aflatoxin testing, conducted by industry, is only on the incoming ingredient (48%); and conducted primarily by the use of a black light (27%) or commercial test kits (22%). The conclusion of this study is that a majority of the responders are aware of what aflatoxin is and how it affects commodities; however, regulation and preventive testing may not be an integral part of industry standards. Ultimately, continuous education of the occurrence and prevention of aflatoxin would help continue to bridge the gap in food/feed safety in NC.
Aflatoxin: Occurrence, Prevention and Gaps in Both Food and Feed Safety

Background

In 1960, an acute hepatotoxic disease in turkeys termed “Turkey X disease” focused the attention of many scientific laboratories on a common problem affecting animals in many areas of the world (Blount, 1961; Lancaster et al., 1961). The dramatic outbreak of the disease, which initially destroyed more than 100,000 turkeys and was linked to heavy mortality in ducklings and young pheasants, was shown to be associated with peanut meal in the feed (Asplin and Carnaghan, 1961). An investigation of the peanut meal determined that it was highly toxic with aflatoxin, a naturally occurring toxic metabolite produced by mold infestations, which demonstrated the seriousness of the problem facing the animal food industry. This ultimately led to the recognition that aflatoxin is both an economic and a public health problem in many areas of the world (Eaton and Groopman, 1994).

Aflatoxin, a mycotoxin produced by fungi, identified as Aspergillus flavus, that contaminates commodities such as corn and corn products, peanuts and peanut products, milk, and tree nuts which are ingredients used in both food and feed products. The occurrence of aflatoxin contamination is influenced by environmental factors such as geography, agricultural/agronomic practices, and the susceptibility of the commodity to the fungi during harvest, storage, and/or processing periods (Environment, Health and Safety Online, 2012). Water stress, high-temperature stress, and insect damage of the host plant are major determining factors in mold infestation and toxin production (Cornell University Department of Animal Science, 2009). The geographical location of
NC provides aflatoxin with favorable conditions such as high moisture and high temperature.

The Food and Agriculture Organization (FAO) of the United Nations estimates that 25 to 50% of the world’s food crops are affected by mycotoxins, with aflatoxin being the most prominent (Boutrif and Canet, 1998). Many countries try to limit exposure to aflatoxin by regulating and monitoring its presence on commodities intended for use as food and feed. Aflatoxins are considered unavoidable contaminants of food and feed; therefore, to help prevent aflatoxin ingestion, FDA has established action levels for poisonous/deleterious substances to control levels of contaminants in human food and animal feed in the document Guidance for Industry: Action Levels for Poisonous or Deleterious Substances in Human Food and Animal Feed (U.S. Food and Drug Administration, 2000). Action levels are established based on the unavoidability of the poisonous/deleterious substance and represent limits at or above which FDA will take legal action to remove products from the market. The action level for aflatoxin in food and milk is 20 ppb and 0.5 ppb, respectively and up to 300 ppb in animal feed.

Several methods are currently being used to test for the presence of aflatoxin such as analytical laboratories, commercial test kits and black light tests (Iowa State University, 2009). Analytical laboratories are highly accurate and quantitative and use one of several procedures such as thin-layer chromatography, gas chromatography, or mass spectroscopy to determine aflatoxin levels. Commercial test kits using immunoassay or ELISA techniques, which are based on the detection of specific proteins found in aflatoxins using antibodies, are available for on-site tests for aflatoxin. The black light (also called ultraviolet light) test is a visual inspection for the presence of
A greenish gold fluorescence under light at a wavelength of 365 nm (nanometers). Because aflatoxin does not occur uniformly through a commodity and is usually localized in a small area, the best approach is to make a composite sample consisting of subsamples from every part of a load, bin, or unit of corn. The North Carolina Department of Agriculture and Consumer Services (NCDA&CS) requires testing for aflatoxin in corn products prior to use in products for human consumption as described in the North Carolina Administrative Code (NCAC) (02 NCAC 09J. 0101). However, food products that are deemed adulterated by industry or by regulation may be allowable as a feed product and therefore diverted into feed products. These products may then be consumed by pets and livestock.

Exposure to aflatoxin is difficult to avoid since fungal growth in commodities is not easy to prevent. Aflatoxin has been associated with various diseases, such as aflatoxicosis a hepatic disease, in livestock, domestic animals, and humans. Susceptibility to aflatoxin varies depending on age, sex, and nutrition of both humans/animals. In developed countries, food/feed products contaminated with specific levels of aflatoxin are not permitted; however, concern still remains for the possible adverse affects from long-term exposure to low levels of aflatoxins in the food supply. In July 2011, there were two Class II recalls due to elevated levels of aflatoxin in peanut butter (U.S. Food and Drug Administration, 2011). In 2001 and 2009, FDA cited a company for shipping peanuts contaminated with aflatoxin (U.S. Food and Drug Administration, 2001; U.S. Food and Drug Administration, 2009).

In animals, aflatoxins can cause liver damage, decreased milk and egg production, gastrointestinal dysfunction, reduced reproductivity, reduced feed utilization
and efficiency. According to the FDA Recall List, there were pet food recalls due to aflatoxin in 2005, 2010, and most recently there were five recalls in December of 2011 (U.S. Food and Drug Administration, 2011). In 2005, over 100 canine deaths and at least one feline fatality were linked to pet food contaminated by the potentially deadly toxin aflatoxin, according to Cornell University veterinarians (Cornell University, 2006).

Aflatoxin is a particular problem in underdeveloped countries which can cause concern for imported products. According to FDA, melon seeds from the Sudan have been on “Detention Without Physical Examination” since 1982 due to violative levels of aflatoxin. Shipments continue to be offered for entry, and refused, due to the presence of aflatoxin (U.S. Food and Drug Administration, 2011). As the ethnic population in the United States continues to grow, so does the popularity of imported products such as ethnic foods and cuisines. According to the International Dairy Deli Bakery Association (IDDBA), the ethnic food segment continues to grow due to a combination of factors such as an increase in immigrants, international travel, and increased interest in cooking and cooking shows that inspire cooking of traditional and non-traditional recipes (IDDBA, 2012).

Aflatoxins are considered unavoidable contaminants of food and feed. For that reason, action levels were established at which FDA will take legal action to remove products from the market. However, aflatoxin contamination of food and feed poses both human and animal health concerns. The geographical location of NC provides aflatoxin with favorable growing conditions such as high moisture and high temperature. Therefore, it is necessary for those who may use susceptible commodities to understand the occurrence, effect and prevention of aflatoxin in food/feed safety.
Problem Statement

The presence of aflatoxin in significant quantities can cause illness to both humans and animals. Ingredients and finished feed deemed adulterated with aflatoxin by one industry group or by regulation may potentially enter another industry group. By identifying the aflatoxin knowledge of industry, agencies can focus on the most effective way to address the educational gaps between occurrence and prevention of aflatoxin in the food and feed supply chain.

Research Questions

This study examined industries’ knowledge of aflatoxin in common ingredients such as corn and peanuts used in North Carolina food and feed manufacturing.

1. What is the level of aflatoxin knowledge in industry of the cause and effect of aflatoxin in food/feed safety?

2. What is this industry doing to help prevent aflatoxin contamination of food/feed?

Methodology

A twenty question online survey was submitted to NC food and feed industry including farmers, to collect information concerning industries’ knowledge of aflatoxin and prevention strategies. The survey was sent to approximately 200 NC firms selected from the North Carolina Department of Agriculture and Consumer Services, Food and Drug Protection Division, Food and Feed firms database based on industry code which identifies the firm type. Firm types such as bakeries, flour mills, dairy farms, peanut
processors, cereal/breakfast food manufacturers, and animal feed manufacturers were selected based on their potential use of commodities that are susceptible to aflatoxin contamination in food/feed manufacturing. The survey identified the establishment size and primary purpose of the firm as human food manufacturer, animal feed manufacturer or crop farmer. Next, questions about the identity, occurrence, regulation and effects of aflatoxin on human and animal health were used to help gather information on the firm's knowledge of aflatoxin. Finally, the survey explored the firms' policy on testing for aflatoxin in susceptible commodities.

**Results**

The survey was designed to capture information pertaining to each firm's establishment size and purpose, knowledge of aflatoxin occurrence, policy on aflatoxin testing and the firm's opinion of aflatoxin testing. Of the responses, 48% identified their primary purpose as animal feed manufacturers, 32% human food manufacturers, and 10% and less as farmers for human/animal consumption and other types of firms that handle commodities.

The results showed that 56% of those who responded knew that aflatoxin was a toxin and among those respondents, 73% knew that it affected commodities such as corn and peanuts. Approximately 50% knew FDA has established an action level for aflatoxin present in food/feed in order to protect human/animal health. The survey identified each firm's policy on testing for aflatoxin in susceptible commodities as well as finished product. Of those who responded, 48% only tested aflatoxin on incoming ingredients only and no more than 21% conducted aflatoxin testing on the finished
product. The results showed that the primary means of testing for aflatoxin was a form of the immunoassay technique (22%) and the use of a ultraviolet lamp or black light (27%). A black light is often used as an initial screen to detect aflatoxin contamination; however, this is strictly a presumptive test and does not confirm the presence of aflatoxin; only a chemical analysis can verify the presence of aflatoxin (Woloshuk and Wise, 2011). The U.S. Department of Agriculture Grain Inspection, Packers and Stockyards Administration (GIPSA) under Directive 9181.2 have implemented a program to verify the performance of rapid commercial tests for mycotoxins in grains (U.S. Department of Agriculture, 2011). According to the GIPSA Aflatoxin Handbook, there are several approved commercial methods for testing aflatoxin (U.S. Department of Agriculture, 2002).

**Conclusions**

The research findings suggest that gaps do exist in both NC’s food and feed industry concerning the occurrence, effects, regulation and prevention of aflatoxin. This project identified that industry has awareness of aflatoxin; however, aflatoxin testing is conducted on a limited bases throughout the industry. The testing of ingredients and finished products for aflatoxin contamination is an area of great concern. The survey results showed that a popular testing method is the use of a black light, which is strictly a presumptive test and does not confirm the presence of aflatoxin. Only a chemical analysis can verify the presence of aflatoxin. If these ingredients are not monitored then there is the risk of aflatoxin contamination in our food/feed supply which could lead to potential health issues for both animals and humans; issues which may include
emotional distress, loss of consumer confidence, economic loss and even death. Risk, such as aflatoxin contamination, is an everyday possibility in business. Those companies that take a proactive approach to risk management often put themselves in a better position to succeed.

**Recommendations**

As the U.S. strives to build an integrated food/feed safety system, the importance of educational outreach is imperative. One method to lower both the health risks and the economic loss associated with aflatoxin is to increase awareness among food and feed producers of practices which would minimize aflatoxin contamination and to encourage the adoption of process-based guidelines such as good agricultural practices (GAPs) and good manufacturing practices (GMPs) (Dohlman, 2003). A Codex Committee on Food Additives and Contaminants (CCFAC) report recommended that GAPs and GMPs be used to establish formal hazard analysis and critical control point (HACCP) food safety systems to identify, monitor, and control mycotoxin risks all along the food production chain (Codex, 2002). Park et al. (1999) suggest steps to lower mycotoxin contamination that can be taken at the following five stages of food production: preharvest, harvest, postharvest (storage and processing/manufacturing), and animal feeding. For example, at the postharvest processing/manufacturing stage, all susceptible ingredients for aflatoxin should be tested. Incoming ingredient and finished product testing helps ensure that food/feed safety controls are in place. Education and outreach about the identity, occurrence, regulation and effects of aflatoxin on human and animal health are necessary to promote awareness of this common entity.
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