Is Aflatoxin Lurking in our Foods?

Raising Awareness about the Presence of Aflatoxin in Foods, its Health Risks, and Practices to Lessen Exposure to these Carcinogens

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Tag Words: Aflatoxins, Aflatoxicosis, Food Microbiology, Food Contamination, Food Poisoning, Spoilage, Fungi, Mold, Outbreak, Carcinogen, Peanuts

Summary: It may be of some surprise to learn that common foods such as peanuts and peanut butter, ground nuts and tree nuts (pecans, pistachio nuts, and walnuts), corn, rice, figs and dried foods, spices and crude vegetable oils, and cocoa beans can be contaminated with aflatoxin, one of the most potent carcinogens known. Discussed are the conditions that promote and limit aflatoxin in agricultural products and ways to minimize consumption of aflatoxin-contaminated foods. Consumers need to be alerted to the potential hazards of aflatoxin-susceptible food commodities, particularly those stored over time in warm, humid environments.

Video Link: http://youtu.be/xZHeffN5h60

Aflatoxins Can Easily Contaminate Commodities

Aflatoxins are increasingly becoming a major concern in the safety of consuming common household commodities such as ground nuts, cereal, spices, and peanut butter. As secondary metabolites predominantly produced by the species of fungi *Aspergillus Flavus and Aspergillus Parasiticus*, they are suspected of being carcinogenic, mutagenic, immunosuppressive agents usually produced in favorable humid conditions. The stability of aflatoxins presents a challenge in the processing of foods, as aflatoxins can withstand a variety of decontamination procedures applied to food post harvest. It is thus critical that individuals become educated about the risks of remnant aflatoxins in their foods as well as possible decontamination methods they can perform and other ways to avoid Aflatoxicosis. Currently, field control methods such as the development of resistant crops, aeration systems to maintain humidity levels, and application of the fungal antagonist AF36 are being used to prevent growth of the fungal species and aflatoxin production. Heat treatment, irradiation, and chemical inactivation are other detoxification methods applied in the processing of food to help eliminate present aflatoxins. However, not all products are subject to this level of control and hence pose a significant risk to the public.

Outbreaks: In May of 2004, an outbreak of jaundice with a high case-fatality rate (CFR) was reported in the districts of Makueni and Kitui in East Province, Kenya. The outbreak resulted in 125 deaths out of a total of 317 cases reported. It was discovered to be caused by widespread aflatoxin contamination of locally grown maize, which occurred during storage of the maize under damp conditions (7). An earlier outbreak, in 1974, caused 106 deaths of indigenous people of Western India, whom relied on maize as their staple food (3). The same source was identified to be the cause of these two associated outbreaks in the 1960s 'Turkey X Disease' which resulted in the killing of 100,000 turkeys near London, England from consuming peanut meal contaminated with aflatoxins. It was during this discovery that the organism producing these toxins was revealed to be the fungus *Aspergillus Flavus*, which led to terming these toxins aflatoxins as an abbreviation (2).

The immense impact of aflatoxins presents the issue of misinformation about the conditions which enable the fungus to thrive and produce them. Relative to these outbreaks and others, it is of concern how the growth of these organisms and the aflatoxins they produce can easily affect crops, as their dispersal is aided by biological properties in addition to a multitude of other factors. Currently, there is not sufficient research to explain all the full range of negative impacts of aflatoxin consumption but several standards for safety have been developed to ensure aflatoxin production and contamination in food products are minimized.

Variations in Aflatoxins: Aflatoxins encompass over eighteen different compounds which structurally resemble each other and include Aflatoxin B_1, B_2, G_1, G_2, M_1, and M_2 (7). Aflatoxins M_1 and M_2 are metabolites of B1 and B2, respectively which are found in milk as a result of consumption of grains infected with the fungi. The toxicity of M_1 and M_2 however is not as prominent as that of the other aflatoxins (B_1, B_2, G_1, and G_2) which are usually found together in the associated contaminated food products, with aflatoxin B_1 (AFB1) being the most toxic. The difference in the chemical composition of these aflatoxins allows them to be identified by fluorescence under UV light, with aflatoxins B1 and B2 fluorescing blue and G_1 and G_2 fluorescing green (4).

Adverse Health Effects of Exposure to Aflatoxin:

Chronic and Acute Aflatoxicosis: In addition to jaundice, aflatoxins are a concerning hazard which have a wide range of consequences on the human body. In general, the severity of food poisoning resulting from consumption of aflatoxins varies depending on the amount, or dosage, consumed in which either Chronic Aflatoxicosis or Acute Aflatoxicosis may result. Long term exposure of a moderate to low aflatoxin concentration results in chronic aflatoxicosis, in which a decrease in growth rate, immunosuppression, impaired food conversion, bile duct proliferation, and liver damage may occur (4). Acute aflatoxicosis occurs when the individual consumes large doses of the toxin ranging between 6250 and 15600 mg/kg of the food (7). The effects are more detrimental with 25% of acute poisonings resulting in death, usually from liver cirrhosis (5). Acute aflatoxicosis is also associated with fulminant hepatic failure, in which hepatic (liver) functions become severely impaired and severe necrosis of liver cells (hepatocytes) occurs. The liver is usually the primary organ affected by aflatoxin ingestion but the lungs, brain, heart, and kidneys have been found to contain high levels of aflatoxin in patients with a fatal case of acute aflatoxicosis. Moreover, acute aflatoxicosis over time may result in edema (6).

Health Risks Common to All Individuals: Overall, aflatoxin exposure can occur through skin or eye contact and through ingestion or inhalation. Cases reported with contact other than through ingestion usually are only attributed to individuals regularly working in aflatoxin contaminated agricultural fields. The most troubling concern associated with aflatoxins is that they may increase the risk of developing cancer, primarily hepatocellular carcinoma (HCC) as doses of any variation over time cumulatively increase the risk of cancer (5). The specific type of toxin commonly associated with this health risk is the more predominant Aflatoxin B1 (AFB1) which has been discovered to be a highly unstable mutagen as well as a very potent carcinogen in humans that becomes oxidized to multiple metabolites (6). This poses considerable risks to individuals who often consume commodities which tend to contain low levels of aflatoxin (such as peanuts or peanut butter). In fact, in Asia and Africa where peanuts are a core dietary food, research revealed that such long term exposure to aflatoxins has increased liver cancer rates as well as has shown an association with Hepatitis B (9). It is nonetheless evident that long term consumption of affected commodities places the individual at greater susceptibility to liver diseases and at an increased risk for liver cancer.

In addition to cancer, Aflatoxins play multiple roles in immunosuppression as aflatoxins, specifically AFB1, can readily react with T-cells and decrease phagocytic activity of macrophages due to interference with antigen presentation. This accounts for the individuals becoming susceptible to secondary infections by other fungi, viruses, or bacteria (7) Moreover, the results include reduced T-cell number and function, reduced complement activity and induced thymic aplasia, and thus suppression of cell-mediated immune responses. In particular, studies have found a decrease in helper T cells occurred in mice when they were treated with 0.75 mg/kg of AFB1in addition to a decrease in interleukin 2 (IL-2) production (5). These results indicate even ingestion of low aflatoxin levels over a long period of time can elicit health conditions similar to acute aflatoxicosis, including jaundice, cirrhosis, chronic hepatitis, impaired nutrient conversion, and cancer.

Moreover, aflatoxin poisoning is particularly problematic as there are currently no effective treatments to combat the toxicity of aflatoxins, although administration at eight-hour intervals of 200 mg/kg 1-methionine and 50 mg/kg of sodium thiosulfate helps if the concentration of aflatoxins consumecd is not high. Additionally, antioxidants, proteins, and vitamins may also be supplemented to counteract some deficiency or impairment (5).

Individual Susceptibility: In addition to the dose, the severity of symptoms experienced is also dependent on the host's age, health condition, and area of location. Generally, healthy adult humans tend to have a higher tolerance of aflatoxin and thus are likely to recover from acute aflatoxicosis while children are likely to die from the illness (5). However, pregnant women are more susceptible to toxic effects as studies have shown doses of 4mg/kg of Aflatoxin B1 to cause developmental anomalies or tetratogenesis (8). Similarly, immunocompromised humans with HIV or Hepatitis B are at greater risks for the harmful effects of aflatoxin. It has been found that in patients with Hepatitis B, aflatoxin is approximately 30 times more potent (5). Children are more prone to the developmental complications caused by exposure to aflatoxins, of which included stunted growth and developmental delays (10). Furthermore, in children aflatoxins can interfere with nutrient conversion by contributing cause to other conditions which interfere with nutrient conversion such as including Reye's syndrome and the protein-energy malnutrition known as Kwashiorkor. Accordingly, malnutrition or being underweight significantly increases the individual's susceptibility to the harmful impacts as the additional risks of nutrient deficiency will harm an already malnourished individual further. Thus, populations in developing countries, particularly those in tropical countries which depend on affected crops as a staple, are more likely to be affected and experience the health problems associated with aflatoxin exposure (5). Such countries are currently adopting the proper methods of storage and decontamination.

Prevalence of Aflatoxin-Producing Species in the Environment

Growth Requirements of *A. flavus*: The fungus, *A. flavus*, is a plant pathogen which primarily inhabits the soil wherein it functions mostly as a saprotroph, retrieving energy through breaking down or decomposing matter into its lipid, starch, and protein constituents. It produces resistant structures, or sclerotia, during winters which can germinate to produce spores that can be dispersed through the air or throughout the soil. The stability of the thick wall of the spores allows them to withstand harsh conditions and those which land in favorable environments start to proliferate and produce aflatoxin as the fungus grows (12). This life cycle allows the organism to survive at varying conditions and thus development of pre harvest decontamination techniques which successfully work to eliminate it from crops is a challenge.

Generally, growth of *A. flavus* favors hot, moist conditions, with an optimal growth temperature of 37°C (98.6°F). However, growth can also occur at the minimum temperature of 12°C (54°F) and the maximum of 48°C (118°F). The fungus grows slowly at 12-15°C and almost no growth occurs at all at 5-8°C (11). Accordingly, humidity plays the most significant role in enabling the organism to thrive. The humidity level required for growth, however, can vary with many crops such as corn it is 14%, while it is 13-13.2% for starchy cereals (11).

Factors Affecting Contamination of Crops by *A. flavus*: The environment of *A. flavus* is not limited to crops and food, it can also be found generally in freshwater as well as seawater and even air. Thus it has been found in home and outdoor air and hospital air (11). The ability of the fungal spores to be airborne enables the organism to spread easily to commodities and effectively if there is wind. Relatively, rodents and insects present a huge problem to contamination of crops as they can aid in spreading the fungus when they land from crop to crop. Additionally, insect pests may also damage crops, such as corn for example, causing them to be more susceptible to infection by *A. flavus* (11). Thus to ensure the spread of Aflatoxins and fungal spores is limited, extra precautions must be taken to eliminate pests. *A. flavus* can infect commodities during pre-harvest, post-harvest, transit, and storage. *A. flavus* infection causes ear rot in corn and yellow mold in peanuts either before or after harvest. A significant part of why aflatoxins can easily spread and contaminate commodities is due to the favorable conditions during harvest which allow the growth and proliferation of organisms that produce them. Such organisms include *A. flavus*, *A. parasiticus*, and rarely *A. nomius*, while *A. flavus* is usually the predominant microorganism of concern. Climate remains a prominent factor in affecting growth of such organisms, which accounts for their growth being an issue mainly in tropical regions, while these organisms can be found in all countries at varying environments (11).

Identifiable Characteristics of Growth: *A. flavus* colonies can be distinguished by powdery masses of yellow-green spores with a reddish-gold color underneath (on the lower surface). Indication of growth is also characterized by the thread-like branching and mycelium (from hyphal growth). Thick mats of mycelia are often produced by conidia. These growth characteristics also apply to other aflatoxin producing Aspergillus species such as *A. parasiticus,* except that *A. parasiticus* produces darker green conidia and more pronounced ornamentation. *A. parasiticus* can be separated from *A. flavus* by the darker green conidial head and by the more pronounced ornamentation of the conidium. Additionally, *A. parasiticus* differs from *A. flavus* in addition to aflatoxins B_1 and B_2, *A. parasiticus* also produces G_1 and G_2. Both species produce sclerotia (14).

Characteristics of Infected Crops: While it is sometimes easy to overlook infected crops as signs of *A. flavus* are often unseen, there are many characteristics of infection that can be distinguished on crops (which may indicate aflatoxin). Such would include ear rot on corn and yellow mold appearing on peanuts (which can happen before or after harvest). Infection is not limited to fully developed plants as *A. flavus* can also sporulate on injured seeds and invade seem embryos in grains. This can potentially result in infected seeds being planted in the crop field. In addition, infection can also discolor embryos as well as damaged seedlings and killed seedlings. It is nonetheless critical to check for such characteristics as a first precautionary measure (14).

Limiting the Growth of *A. flavus* in Agricultural Production

Methods of Pre-Harvest Crop Control: Currently, a number of field control methods are being employed to restrict growth of *A. flavus* and aflatoxin production, which differ among the different crops that are susceptible, relative to their cultivation requirements. Such control measures include altering conditions to not suit the favorable ones under which *A. flavus* thrives. For example, for grains and legumes, aeration systems are the most commonly used management practices, as they remove excess heat and moisture which can otherwise support growth of *A flavus*. This additionally controls temperature, in which a decreased temperature can also inhibit insect and pest activity to prevent the growth and spread of the fungus (14).

A form of biological control, which is usually applied on corn and cotton fields, that is currently being employed is the use of the strain AF36, which is a fungal antagonist that is non-carcinogenic and incapable of producing aflatoxin. This method of control is convenient in crops where moisture levels are necessary, as AF36 seeds grow in the presence of high moisture to outcompete *A. flavus*. As with many other fungi, dispersal of these seeds throughout the field are aided by wind and insects (15). Moreover, to prevent infection of susceptible crops, implementation of GMO's and development of genetic resistance in crops helps reduce the occurrence of aflatoxin on the commodity. Such would include the use of the Bt Toxin, in corn (16).

Elimination of Aflatoxin during Processing: One major procedure is extrusion, which degrades aflatoxins at various percentages, with the highest being 59% decontaminated in peanut meal at feed moisture of 35 g/100 g (17). However, in assuring that commodities do not become contaminated with aflatoxins with levels kept to a minimum, multiple decontamination methods are usually employed during the processing of crops.

Such include a combination of physical cleaning and separation procedures. This involves removal of infected crops, in which mold is growing on them and which show damage (such as a damaged kernel, seed, or nut). This standard procedure works to reduce 40-80% of present aflatoxins levels. The crops are then usually subject to dry and wet milling to divide the rest of the aflatoxin residues into smaller fractions, so that ammoniation can be applied. Ammoniation usually decreases prevalence and toxicity of aflatoxins by 99%. Other materials, such as anticaking agents which covalently bind to aflatoxins and diminish their uptake, may then be applied. The selected combination of methods usually differs among industries relative to costs and time requirements associated (18).

Effect of Growth Rate on Aflatoxin Production:

In assessing the time parameters which confine the safety of commodities during storage, it is important to consider during which stages of growth that aflatoxin production maximally occurs, the effect of storage temperature on the growth rate of *A. flavus*, and the effect of moisture on the growth rate. Generally, after extended periods of time, given the product is stored under favorable conditions, the fungus will proliferate and cause discoloration, moldiness, or shriveling of the food, which potentially indicates large amounts of aflatoxin produced. Accordingly, in conditions which limit growth significantly, such as freezing, the organism may not produce aflatoxin over time and thus the commodity remains safe for consumption even after extended periods of time.

Several experiments have been conducted in a study determining such factors which can parallel growth of *A. flavus* on a commodity (and thus aflatoxin production over time). Studies on polished rice found that the highest amount of aflatoxins are produced during a temperature of 20°C with a favorable water activity (Aw) of 0.90 to 0.92 after 21 days of incubation (13). Other studies have speculated that aflatoxin productions (particularly of AFB1) might be linked to colony area, but concluded that the production of aflatoxins may follow a mixed growth trend. In a study examining the varying concentrations of aflatoxin production in maize at differing water activity, in relation to the biomass and area of the colonies, they found the highest aflotoxin production sometimes occurring during early stages of growth, while sometimes it increased directly with time, and ultimately decreased when a peak was reached. Developing growth models depicting the relationship between aflatoxin production and time of has thus been a challenge due to the conditions with which *A. flavus* can grow and produce the toxins (19).

These studies indicated while maximum growth conditions for *A. flavus* are defined, they do not have a direct relationship with the rate of production of aflatoxins. Thus it is challenging to determine the rate at which the aflatoxin concentration in a commodity increases over time, even if the commodity is stored under ideal conditions for growth. In general, high concentration of aflatoxin can be expected to be produced with high moisture content and warm temperatures on peanut, nutmeg, grains, legumes (19).

Public Awareness and Precautions to Limit Aflatoxin Contamination of Foods

Current Regulations Imposed on Many Commodities:

The FDA has developed standards for various commodities, implicated in the Food Code, to address health issues that may arise in result of improper storage or handling. Controlling the growth of *L. monocytogenes*, for example requires date labeling as well as time and temperature controls. According to the FDA, in addition to being maintained at 5°C or below, the products associated with *L. monocytogenes* also have a limit of 14 calendar days from packaging to consumption (excluding freezing time). In this case, this "Sell By" date is imperative to follow as it serves to prevent the concentration of the pathogen from increasing in the commodity and posing a risk to human health. Regulations such as this, particularly date labeling for certain products, can be applied to foods associated with aflatoxin contamination so that consumers are prevented from ingesting high aflatxoin levels which have accumulated over time (2). Maintenance conditions of aflatoxin-associated products at stores should also be considered and added to the Food Code.

In order to fully comprehend the risks associated with purchasing food products that are susceptible to aflatoxin contamination, individuals must become educated about the limitations imposed during food processing and the commodity brands to which they apply. The FDA mandates that no greater than 20 ppb of aflatoxin levels may be detected in foods for them to be safe for human consumption (25). This is with the general assumption that this much aflatoxin not consumed frequently over a life time will not incur hazardous impacts on human health. However, such stringent testing occurs more often in big name brand stores such as Jif or Peter Pan for peanut butter. As a result, there have been reports of unacceptable levels of aflatoxin found in peanut butter in discount stores, online stores, etc. These high levels may be due to the product being older or started out with higher levels due to it being of poorer quality and that accumulated aflatoxin concentration due to the growth of *A. flavus* over time.

Studies have indicated prolonged periods of storage under conditions favorable to fungal growth have indeed caused the concentration of aflatoxins to rise in products. One such study conducted by ICRISAT (International Crops Research Institute for the Semi-Arid-Tropics) examined aflatoxin levels post-harvest in maize stored under a high temperature and 65% relative humidity in Mali (as pertains to many other tropical regions). It was found that after two months of storage, the levels of aflatoxin rapidly grew with levels almost tripling after one month and becoming four times the original in the village Kolokani. Another study, conducted on maize in Guatemala found that the concentration of aflatoxin 20 days past harvest was 130 µg/kg of total maize, while after an additional 60 days, the concentration significantly increased to 1680 µg aflatoxin per kg. This increase is attributed to the lack of drying of the maize before storage (27).

The same results were found for studies conducted on cottonseed, of which include two modules, TX-1 and MS-1, were prepared in Odem, Texas and Starkville, MI, respectively. The cottonseed in the MS-1 module was assessed in field and the aflatoxin level was found to increase from 0 ppb to 23 ppb after storage of the cotton seed for four weeks. The cottonseed in the TX-1 module was kept under temperature below 38°C (and the optimum growth for *A.flavus* is 37°C) which gradually decreased over time. It was found that aflatoxin was maximally produced in the cotton seed between 25°C and 30°C. Furthermore the levels began to decrease by the third week as the temperature decreased further (32). Nonetheless, comparing results for these two studies, aflatoxin levels appear to be greatly maximized under temperatures nearing the growth optimum over weeks. Such statistics bring to perspective the dangers of keeping products such as corn, peanuts, and peanut butter stored for prolonged periods of time on hot and humid days.

The Influence of Refrigeration, Washing, and Cooking on Aflatoxin Contamination

Freezing is one of the most effective methods for avoiding aflatoxin contamination as it restricts the growth of *A. flavus* and maintains the shelf life of the product for prolonged periods of time. Accordingly, associated products such as corn must be kept in the coldest section of the fridge (which is on the bottom for vertical fridges for example). More specifically, products must be kept at temperatures below the minimum for the growth of *A. flavus*, which is 12°C or 54°F. It is thus important to follow the FDA's recommended settings for a refrigerator temperature at or below 4° C (40° F) and the freezer temperature of -18° C (0° F) (30). However, this method may be undesirable for foods such as peanut butter, in which refrigeration alters the texture and quality. It is best to keep such products in pantries with low humidity and at low temperatures. This is mostly an issue on summer days, when temperatures are high, and using a dehumidifier or keeping the house air-conditioned would be helpful. To effectively prevent growth and activity of *A. flavus*, the product must be kept sufficiently dry in which the moisture level is brought to less than 10% (29). More specifically, for corn, at 20°C the safe moisture level is less than14% while the percentage is half as much (7%) for groundnuts (29). As a general rule of thumb, foods should be stored in a cool, dry area.

Some cooking methods, such as roasting, work to destabilize aflatoxins. This is particularly because roasting involves subjecting the food to temperatures up to three times the maximum growth temperature of *A flavus* (48°C) for 30 minutes or more. A study found that mycotoxins in general, are destroyed at their high temperature melting points when subjected to roasting. The toxicity of AFB1, in particular, becomes reduced by 70% and that of B2 reduced by 45% (23). Thus, while roasting alone is not a completely sufficient method of eliminating aflatoxins, it can work to reduce the toxic effects of aflatoxins on health. Forms of heat treatment other than roasting are ineffective in decontaminating food from aflatoxins (24). Thus, even though subjecting food to heat at temperatures above the maximum which *A. flavus* can withstand may kill the organism, it does not destabilize possible levels of the aflatoxin present and the food can still cause illness.

Methods that would be expected to reduce contaminants, such as washing, may be ineffective. The small size of aflatoxins allows them to be buried deeply into the food and become difficult to access by running water. For example, washing with water will hardly have an effect on aflatoxins deeply embedded in corn kernels.

Decreasing the Risk of Liver Cancer

While ingesting high concentrations of aflatoxins may be irreversible, the effects of ingesting small doses over time associated with dietary consumption of aflatoxin prone foods can be counteracted. Including apiaceous vegetables such as carrots, cilantro, celery, parsnips, or parsley in the diet counteracts the carcinogenic effects of aflatoxins. These vegetables contain flavonoids and phytochemicals which have been found to inhibit the activity of cytochrome P-450 1A2, an enzyme responsible for the transformation of carcinogenic intermediates to carcinogens and the activation of aflatoxin B_1 following consumption (26).

Additionally, the absorption of aflatoxins can be limited by vegetables containing chlorophyll or chlorophyllin (the derivative of chlorophyll) such as spinach, kale, asparagus, and broccoli. The suspected mechanism of action of these compounds include chlorophyll binding aflatoxins, making them less bioavailable and thereby reducing genomic damage and suppressing tumor formation (31). It is nonetheless extremely valuable, in the case of avoiding cancer from consumption of the common food products, that such vegetables are included in the diet.

Testing for Aflatoxin Presence:

There are several ways food products at home can be tested for the presence of aflatoxin, of which include through the FTRTest Kit, Agrastrip Test Kits, or through Fluorescence. The FTRTest Kit provides results within 10 minutes and requires a simple sample preparation in which the sample of suspected food can be shaken in the presence of the extraction solution provided, and a diluted aliquot of the supernatant is used in the assay. Results can be visually interpreted and this test works on many commodities such as cereals, soya beans, nuts, and derived products (20). Agrastrip Kits work on the same products in addition to figs and dried fruits, spices, and milk. Results for this test are provided within 5 minutes and this test is approved by the USDA (21). Fluorescent tools, such as the Surveyor FL Plus can detect low concentrations of aflatoxin in which a suspected food may test positive if green or blue fluorescent specs are seen visible on it (22).

Community Action: Changing the Date Labeling of Foods Prone to Aflatoxin Contamination

In our YouTube, we inform the viewers of the potential contamination of food with aflatoxin and describe procedures by which to reduce/limit conditions favoring growth of *A. flavus* on commodities and the subsequent production of aflatoxin.

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As part of our community action, we wanted to write to the agency that would have an impact on developing better date labeling regulations of our foods; specifically regarding aflatoxin contamination. We first wrote a letter to the lead author of a recently published paper on the date labeling of foods http://onlinelibrary.wiley.com/doi/10.1111/1541-4337.12086/full

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To: Rosetta Newman
Institute of Food Technologists, Chicago, IL, U.S.A

Dear Rosetta,

I wanted to show my appreciation for your helping to write the comprehensive review paper "Applications and Perceptions of Date Labeling of Food". The misunderstandings of the current, almost meaningless date labeling of food products is likely the leading cause of the unnecessary disposal of edible food. Personally, I sometimes shop at a food warehouse that sells salvaged food - items that other stores may have returned or rejected due to, in most cases, the date label on the products. My children were unnerved by my serving them food that was outdated...

I am writing to you for some advice. I teach "Ethics in Science and Society" at Rutgers University and work with students on various projects. This summer, I have had the pleasure of working with Hager Mohamed on a project on Aflatoxin contamination of food. There is some concern that certain commodities that contain some level of aflatoxin (like peanuts, peanut butter) may produce more aflatoxin as they age especially under warm, humid conditions. As a peanot lover, I frequently will buy peanuts and peanut butter when they are on sale and may not get to eating them for a while. After reading more about aflatoxin, I will not do that anymore.

I now think that the date labeling, which for me was mostly bogus, should take into account potential safety concerns relating to some of the toxins like aflatoxin in addition to some of the bacterial pathogens (L. monocytogenes, nonproteolytic C. botulinum, some B. cereus strains, Yersinia enterocolitica); perhaps to the point of not allowing the sale of foods or sale of food recovered/salvaged items after some determined time. Ideally, there would be some indicator of the toxin to identify foods that were indeed contaminated.

Some containers have lids that pop up when the product contains bacteria, etc and some cellophane packaging may have some indicator on it as well. There are tests for aflatoxin but these are not designed for the consumer or the food store owner.

Do you know of any new emphasis/pending recommendation/regulation on commodities with a high prevalence for aflatoxin contamination labeling? Who would we write to express our concerns? Is the FDA and/or the USDA going to take action (in near future?) and rewrite the book on the date labeling of food?

Looking forward to your response.

Julie M. Fagan, Ph.D.
Associate Professor
Rutgers, The State University of New Jersey
84 Lipman Dr.
New Brunswick, NJ 08903

Her Reply…
---------------------------- Original Message ----------------------------
Subject: RE: date labeling of food
From: "Rosie L. Newsome" <rlnewsome@ift.org>
Date: Mon, July 28, 2014 12:15 pm
To: Dr. Julie Fagan <Redacted>
Cc: "HAGER MOHAMED" <Redacted>

Hello Dr. Fagan;

Thank you for your message, and expression of appreciation for the food date labeling paper. I am pleased that you found the paper of interest.

With regard to your question about whether I know of any activities on "commodities with a high prevalence for aflatoxin contamination labeling," I am not aware any such activities. I thought I would mention an IFT Scientific Status Summary on food mycotoxins, by Patricia Murphy and others (2006), available at: http://www.ift.org/~/media/Knowledge%20Center/Science%20Reports/Scientific%20Status%20Summaries/mycotoxins_0606.pdf, in case you are not aware of it and may find it of interest.

Kind regards,

Rosetta Newsome, Ph.D., CFS
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Below is our letter that we sent to the FDA as a Citizen Petition:

Letter to the Center for Food Safety and Applied Nutrition:

U.S. Food and Drug Administration
Center for Food Safety and Applied Nutrition
Outreach and Information Center
5100 Paint Branch Parkway HFS-009
College Park, MD 20740-3835

Dear CFSA Team,

We would like to bring to your attention two concerns: one being the level of aflatoxin in foods that may increase upon storage and the 2nd separate, but related issue of the date labeling of foods.

There is concern that certain commodities that contain some level of aflatoxin (like peanuts, peanut butter) may produce more aflatoxin as they age especially under warm, humid conditions. We believe that foods that pose a safety risk should have a “discard by” date that would prevent the foods from being recovered and sold as salvaged foods. It would also alert the consumer to not consume the product (perhaps stored inappropriately) past this date.

The “use by”, “best by”, “sell by” dates are totally confusing to the consumer, rendering them almost meaningless, and result in enormous amounts of edible food being discarded. This is a huge problem that comes with an enormous economic and humanitarian loss. We understand that the date labeling of foods is under the jurisdiction of the food manufacturers and not the FDA. However, most consumers probably think that the FDA has set these dates and that they have some real purpose. Leaving this up for the manufacturers to decide what to do with the date labeling of foods has some level of conflict of interest as they obviously have an economic interest in selling more product. As an objective solution, perhaps the date of manufacture of the product should be displayed and eliminate the subjective "best, use &sell by" dates.

Foods like infant formula, or that may grow/contain *Listeria monocytogenes* or Aspergillus producing aflatoxin post-harvest and manufacture, in addition to being included in the Food Code, should display a "discard by" date on the packaging that would be regulated by the FDA.

We ask you to play a leadership role in the date-labeling of food products to prevent unnecessary waste and to implement within the date labeling, proper safety precautions and timely disposal of foods prone to produce/contain harmful bacteria, toxins and the like.

Sincerely,

Julie M. Fagan, Ph.D.
Associate Professor
Rutgers, The State University of New Jersey
84 Lipman Dr.
New Brunswick, NJ 08903

and

Hager Mohamed
Rutgers University Student, class of 2014, majoring in Microbiology

We hope that the FDA plays more of a leadership role in the date-labeling of food products (now controlled by the manufacturers of food products) to prevent unnecessary waste and to implement within the date labeling, proper safety precautions and timely disposal of foods prone to produce/contain harmful bacteria, toxins and the like.

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Letter to the Editor

eletters@starledger.com
Dear Editor, Please consider the following letter in the submission below, for publication in the Newark Star Ledger. I feel it's necessary that the public is informed about avoiding foodborne poisoning caused by aflatoxins as well as long term health impacts of exposure. Please feel free to contact me with any questions or concerns. Thank you for your time and consideration.

IS THERE AFLATOXIN IN YOUR FOOD?

Many people may unknowingly consume several products containing aflatoxin, which include peanuts, peanut butter, cereals, tree nuts (such as pistachios), corn, and rice. Aflatoxins are highly toxic fungal metabolites and Aflatoxin B1 is a very potent carcinogen responsible for causing liver cancer. Other associated health risks with aflatoxin exposure are jaundice, developmental problems, impaired nutrient conversion, and cirrhosis.

Small amounts of aflatoxin is not considered to be a safety risk. However, if the person's diet is such that they consume alot of raw peanuts for example, they may be consuming much more aflatoxin than is considered safe. Although the FDA has established action levels for aflatoxin present in food and feed, if these commodities are kept under high temp or moisture conditions for long periods of time, then these levels that were acceptable on testing, may now exceed the limit allowed and pose a health risk.

To avoid exposure and consumption to aflatoxins, individuals should keep their food frozen, refrigerated or in a cool area as warm, humid environments result in increased concentrations of aflatoxin. Roasting decreases aflatoxin levels, but washing and general heating do not. Additionally, products, such as peanut butter, should also not be kept for months and discarded if they appear moldy, discolored, or shriveled. There is some literature to suggest that the carcinogenic effects of aflatoxin exposure can be counteracted by the consumption of carrots, celery, parsley, or parsnips.

As the adage goes: when in doubt, throw it out.

Sincerely,

Hager Mohamed

Rutgers University Student, class of 2014, majoring in Microbiology