# Aflatoxin in Pecans: Problems and Solutions

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## ABSTRACT AND SUMMARY

The aflatoxin contamination potential in pecans has been clearly demonstrated in the literature. No definitive study has been published indicating the extent of aflatoxin contamination in pecans. Good manufacturing practices can be maintained in culture, drying, sizing, storing, and processing which should reduce the possibility of mold growth or aflatoxin production. Sampling of pecans for aflatoxin analysis would be costly due to the great number of pecan sizes and grades as well as to the high cost of pecans. Surveillance costs could be minimized by incorporating chopping with subsampling.

## INTRODUCTION

The potential for aflatoxin contamination of pecans was first reported by Lillard et al. in 1970 (1). Of 120 isolates of *Aspergillus flavus* group organisms, 85 were found to be toxigenic. Steam-sterilized pecan meats were found to be a good substrate for aflatoxin production. In 1971, Doupnik and Bell (2) found that a number of molds isolated from moldy pecan meats were toxic to chicks. Included in these mold isolates were *A. flavus*. A conference was held in 1971, between pecan shellers and USDA and FDA officials to discuss this problem (3). At this conference, data on a survey of pecans were presented indicating substantial aflatoxin contamination in in-shell pecans, and lower aflatoxin levels, below 20 ppb, were found in edible shelled pecans.

Pecan shells offer excellent protection against bacterial and fungal invasion. Very low bacterial and fungal counts were observed by Chipley and Heaton (4) in sound pecans which were aseptically shelled. Substantial cross contamination occurs during commercial shelling and sorting operations. Marcus and Amling (5) found that unshelled pecans soaked for 24 hr in lactose broth with *Escherichia coli*, to simulate field conditions, resulted in no transfer of bacteria to pecan meats. However, after 48 hr pecan shells developed suture cracks which allowed microorganism entrance.

To date, no extensive survey has been published as to the actual severity of the aflatoxin problem in commercially shelled pecans. However, considerable work is underway to determine which cultural, storage, and processing procedures will minimize *A. flavus* invasion of pecans (6), allow detection and measurement of aflatoxin levels in shelled pecans, and remove aflatoxin-containing kernels.

## CULTURAL PRACTICES

Pecans are commercially harvested from both improved variety and seedling pecan trees. These trees may be in well maintained pecan orchards, or completely unmaintained orchards, or single trees. With increasing labor costs, more of the pecan industry is moving toward mechanical harvesting of pecans. It is imperative that an adequate insect control program be implemented to assure that no nut shells are punctured or damaged from a fall from the trees prior to harvest. The orchard floor should be maintained so that sprayer trucks can easily treat the trees and so that ventilation of the grove is maintained to prevent mold growth. During harvest, pecans should be shaken from the trees, windrowed, harvested, cleaned, and dried as quickly as possible. A thorough clearing and mowing of orchard floors, as well as sterilization of grass next to trees can aid in complete pick up of uncontaminated nuts. In a well maintained orchard, trees are generally shaken three times. These harvests are generally spaced 2 to 3 wk apart with the last harvest after the fall frost. Beuchat (6) found that there was no particular method of mechanical harvest which caused increased levels of mold contamination of pecan nutmeats.

## CLEANING, DRYING, AND SIZING

Pecans are generally purchased after they are cleaned and dried. Samples are taken to determine meat yield, variety, color grade, and moisture content. As with other nut crops (7), rapid reduction of moisture after harvest is imperative to control mold growth. Pecans are generally purchased on a 5.0% moisture basis. Yield penalties are imposed for moisture levels above 5.0%, and processors avoid the purchase of pecans above 6.5% since mold growth and discoloration in cold storage is a problem above 6.5%. After cleaning and drying, pecans are placed in tote bins or clean bags and put in cold storage at 32-34 F and 70-75% relative humidity. This temperature is clearly below minimal level for aflatoxin production (8). The relative humidity is sufficient to maintain good shelling conditions and control mold problems (9).

When pecans are sampled for grading, usually a number of small samples, 8-16 oz, are hand shelled and visually inspected. If mold is detected in pecans, the pecans should not be purchased since there is a good possibility that aflatoxin-producing molds may be present. Although subsequent sizing, grading, and sorting can effectively remove discolored kernels, lots containing mold should be completely avoided. Since the grading samples are small, only a portion of moldy pecan lots can be detected by this process. However, if growers are forced to realize that a penalty exists, they have little choice but to improve cultural practices which will aid in preventing the problem.

Size grading of pecans divides the nuts into specific diameter classifications to facilitate cracking, shelling, and sorting (10). During this sizing operation, lighter low-meat-yield pecans are separated from sound kernels and a higher incidence of moldy pecans is observed in the lighter pecans. However, of 48 samples tested for aflatoxin or *A. flavus* group organisms, there was no correlation between meat yields and toxin or toxigenic organisms present in the kernels (11). From this study, only 2 to 4% of the pecans tested contained *A. flavus* group organisms. All sound pecan lots contained less than actionable levels of aflatoxin.

## SHELLING

After size grading, pecans are resampled to determine yield, moisture level, and color grade to aid in efficient cracking and shelling. At this point, samples should be carefully examined for the presence of mold. If mold is observed, the lot of pecans should be retained and shelled with continuous monitoring for aflatoxin prior to product shipment. Samples of moldy pecans from retained lots can be pretested to determine if the mold present is toxigenic. This procedure would aid in reducing aflatoxin monitoring costs.

Prior to cracking, pecans are preconditioned with mois-

ture to reduce kernel breakage, improve appearance, and improve stability of the stored kernel (10). Moisture can be added by soaking the nuts in cold or hot water or by application of steam. If cold water is used, pecans are stored in wet barrels overnight. Both bacterial and mold counts in cold water conditioning can be controlled by treatment of water with 800-1000 ppm (parts per million) active chlorine. Under no circumstances should inshell pecans be held for more than 24 hr in an elevated moisture condition. Work is currently underway to determine the effect of moisture conditioning on aflatoxin production in mold-containing pecans.

Immediately after cracking, pecan moisture is reduced to less than 4.5% on pecan halves and less than 3.5% on pecan pieces. Moisture level must be continuously monitored on all driers to assure that these maximum moisture levels are not exceeded. Shells are separated from whole pecan halves and pieces by air-classification. During shelling, considerable break-up of kernels occur and the broken pecan kernels are separated from shells by water flotation. Chlorination of flotation water for shell and meat separation at a 200-300 ppm active chlorine level has been found to be an effective method to control and reduce total and toxigenic mold counts. After wet flotation, pecan pieces are then sized and electronically color sorted. Electronic color sorting of pecans separates color grades and separates shell fragments, insects, and discolored kernels from sound kernels. Although no study has been published on electronic sorting of pecans, work with other nut products (12,13) has shown the effectiveness of this process. Following electronic sorting, pecans are hand picked to remove any foreign material or discolored nuts from sound kernels. The final product is packaged and placed in cold storage at 22 F. Shelled pecans should have a final yeast and mold count of less than 500 organisms/g and a toxic mold count of less than 10 toxic mold/g (R.J. Bothast, personal communication).

## AFLATOXIN DETECTION AND MEASUREMENTS

The primary problem with aflatoxin detection is one of sampling. Shelled pecan halves are sold in eight to ten different sizes, and in at least three different color grades. Pecan pieces are sold in nine different sizes and three different color grades. In addition to these over 50 distinctly different products, some processors have additional products separated by different pecan varieties. It would be quite costly to provide automatic devices to sample each of these different products. The current cost of pecans ranges from $2.00 to $3.00 per lb which makes it mandatory to keep sample size to a minimum for economical operations.

In most pecan operations, halves and large pieces are chopped to balance sales of small sized pieces. Product value loss during chopping is ca. $.10 to $.20 per lb due to production of low value pecan meal. If halves and large pieces are statistically sampled from various lots, chopped and subsampled for assay, both sales and aflatoxin surveillance needs can be fulfilled at a minimum cost. Either the chopped pieces or meal generated during chopping could be utilized for analysis. A meal sampling scheme assumes that the pecan piece is uniformly contaminated throughout. Although this is not likely a true situation, the assumption may be more valid for pecans which contain 60-70% fat than for other commodities, i.e., corn and peanuts which are lower in fat, since aflatoxin is fat soluble. Assay for aflatoxin can be conducted using either millicolumn (14) or AOAC procedures (15).

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