Aflatoxin Control Program for Peanuts[1]

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ABSTRACT AND SUMMARY

Under provisions of a USDA Marketing Agreement, an aflatoxin control program for peanuts produced in the United States is administered by the Peanut Administrative Committee composed of peanut growers and shellers. Regulations of this committee contain provisions about the quality of peanuts acquired from farmers, storage of unshelled peanuts, aflatoxin testing, quality and disposition of processed lots, and indemnification of handlers for losses caused by lots which test over 25 parts-per-billion aflatoxin. Effects of the control program on aflatoxin concentrations in peanut products are discussed.

INTRODUCTION

An alfatoxin control program for peanuts produced in the United States is administered by the Peanut Administrative Committee (PAC) under provisions of a USDA Marketing Agreement for Peanuts (1). The 18-member PAC consists of three grower representatives and three sheller representatives from each of the three peanut-production areas (Virginia-Carolina, Southeastern, and Southwestern). PAC generally solicits recommendations from representatives of peanut-product manufacturers. The committee is financially supported by assessment of shellers based upon the volume of peanuts they purchase.

PAC regulates peanut shellers who have signed the Peanut Marketing Agreement, and practically all peanuts produced in the United States are marketed through these shellers. They purchase peanuts from the grower (farmers' stock peanuts), store and process these peanuts into marketable lots of in-shell or shelled raw peanuts, and sell them to manufacturers of peanut products, either directly or through brokers. Through PAC, shellers have accepted a major role in the aflatoxin control program of the peanut industry. They attempt to channel aflatoxin-contaminated peanuts from the farm to nonfood uses; to prevent aflatoxin contamination during storage, handling, processing, and shipment; to remove aflatoxin-contaminated kernels during processing; and to deliver aflatoxin-free peanuts to the manufacturer. In this paper provisions of PAC for the 1975 peanut crop and their relation to the aflatoxin control program are discussed.

PURCHASING FARMERS' STOCK

The aflatoxin-producing *Aspergillus flavus* group of fungi exist throughout the peanut growing areas and may produce aflatoxin in peanuts any time that conditions are favorable for fungal growth. During periods of drought, insects and mites in the soil may favor infection by *A. flavus* and subsequent aflatoxin production before peanuts are dug (2). Extended periods of hot, rainy weather while peanuts are in the windrow, improper drying after harvest, and inadequate protection from rain during temporary storage and transportation are conducive to *A. flavus* growth.

PAC regulations require that all farmers' stock peanuts purchased by shellers be graded by the Federal-State Inspection Service. The 1800-g grade samples taken for this purpose consist of peanut pods, peanut kernels which have been shelled during harvesting and handling operations prior to sampling (commonly called loose shelled kernels), and foreign material. Kernels shelled from a 500-g sample of the pods are examined for external mold or discoloration (damage), and then the cotyledons are split apart for internal examination. These kernels and all loose shelled kernels (LSK) from the sample are examined visually for *A. flavus* infection (3). All suspect kernels are examined under 20X or 40X magnification with a stereomicroscope to determine whether or not fungal growth is present and whether the color and certain morphological traits are characteristic of the *A. flavus* group of fungi.

Lots found to contain kernels suspected to have visible *A. flavus* growth are placed in segregation-3 storage. Lots in which none of these kernels are found but with more than 2% damaged kernels or more than 1% concealed damage caused by rancidity, mold, or decay are placed in segregation-2 storage. Segregation-1 storage receives all other farmers' stock peanuts.

The segregation-3 peanuts are crushed for oil, which is aflatoxin free after refining, and the meal is used for nonfood purposes (4). Segregation-2 peanuts are crushed for oil and the meal is used in animal feed if chemical assay for aflatoxin does not indicate otherwise. (PAC may allow use of segregation-2 peanuts for edible purposes if there is a shortage of segregation-1 peanuts, but this allowance has never been made.) Peanuts from segregation-1 storage are shelled and used for food purposes provided they are found acceptable by chemical assay for aflatoxin. These restrictions do not apply to peanuts used for seed.

STORAGE OF FARMERS' STOCK PEANUTS

A. flavus growth during storage may be a major contributor to aflatoxin contamination in peanuts (5). Possible causes of *A. flavus* growth are moisture condensation on roofs and sidewalls, leaking roofs, improper application of insecticide sprays or leaking hoses and application equipment, conveyance of water from flooded elevator dump pits into warehouses, and storage of peanuts on concrete floors that are damp or have no vapor barriers. A major problem is condensation of moisture that evaporates from peanuts as they dry from an average of about 9% moisture to about 7% moisture during storage. This water vapor must be properly removed from the storage structure to prevent wetting some of the peanuts with condensation. PAC regulations require ventilated storage buildings and make provisions to reduce other causes of wetting. Except for seed, all peanuts must contain less than 10% moisture (wet basis) when placed in storage.

SHELLING AND GRADE REQUIREMENTS

Peanut kernels contaminated with aflatoxin before harvesting are often in damaged pods and consequently are more easily shelled by harvesting and handling operations than kernels in sound pods. Small, shriveled kernels also occur more frequently in these damaged pods. Shelled kernels (LSK) and kernels in damaged pods are more susceptible than kernels in sound pods to mold damage during storage. Consequently, in aflatoxin-contaminated farmers' stock peanuts, LSK generally contain higher concentrations of aflatoxin than do unshelled kernels, and the small kernels within each type probably contain higher concentrations than do the larger kernels (5).

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TABLE I

PAC Aflatoxin Testing Program for Shelled Peanuts

Step 1	Step 2	Step 3	Step 4	Step 5
Comminute first 48-lb sample in subsampling mill	Extract 1100-g subsample	Make duplicate analyses of extract (1A & 1B)	Let X = average of 1A and 1B	Accept if X ≤ 16 PPB Reject if X ≥ 75 PPB Go to Step 6 if: 16 PPB < X < 75 PPB
Step 6	Step 7	Step 8	Step 9	Step 10
Comminute second 48-lb sample in subsampling mill	Extract 1100-g subsample	Make duplicate analyses of extract (2A & 2B)	Let Y = average of 1A, 1B, 2A, and 2B	Accept if Y ≤ 22 PPB Reject if Y ≥ 38 PPB Go to Step 11 if: 22 PPB < Y < 38 PPB
Step 11	Step 12	Step 13	Step 14	Step 15
Comminute third 48-lb sample in subsampling mill	Extract 1100-g subsample	Make duplicate analyses of extract (3A & 3B)	Let Z = average of 1A, 1B, 2A, 2B, 3A and 3B	Accept if Z ≤ 25 PPB Reject if Z > 25 PPB

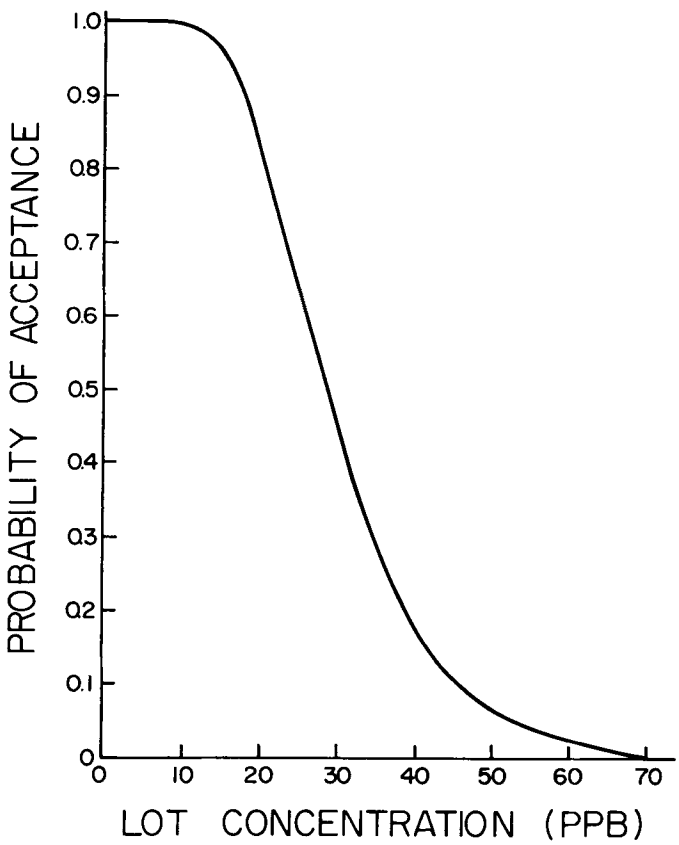

FIG. 1. Probability of accepting aflatoxin-contaminated lots of shelled peanuts with the PAC aflatoxin testing program.

PAC requires removal of all LSK from farmers' stock peanuts prior to shelling. Whole LSK that ride screens with designated slot sizes (16/64 x 3/4-in. for runner type, 15/64 x 3/4-in. for Spanish and Valencia type, 15/64 x 1-in. for Virginia type) may be included with other peanuts prepared for human consumption. All other LSK must be designated for crushing, but they may be used for wildlife feed or rodent bait if they do not test more than 25 parts-per-billion aflatoxin.

Shelled peanuts sold for human consumption must meet requirements about kernel size, damaged kernels, moisture content, and foreign material. For compliance with these requirements, each lot must be sampled and graded by the Federal-State Inspection Service. The lots must be "positive-lot identified" by means of lot-numbered Federal-State Inspection Service tags sewn in the closure of bags or by means of official seals on bulk containers. Edible peanuts must not contain more than a total of 1.5% unshelled peanuts and damaged kernels or a total of 3.0% unshelled peanuts, damaged kernels, and kernels with minor defects. Moisture content of the peanuts must not exceed 10% (wet basis) in the Virginia-Carolina peanut-production area and 9% in the other areas. Foreign material must not exceed 0.1% for some grades and 0.2% for other grades. All kernels which fail to ride screens with designated slot sizes are called "fall-through." Fall-through must not exceed 3% of the lot except 4% is allowed for U.S. No. 2 Virginia grade peanuts and only 2% is allowed for certain grades of Spanish peanuts with splits.

AFLATOXIN INDEMNIFICATION PROGRAM

The PAC indemnifies shellers for most of the losses related to aflatoxin contamination in lots of edible peanuts which meet grade requirements. PAC regulations prohibit the sheller from negotiating the sale of peanuts on the basis of aflatoxin content. The buyer (manufacturer) is guaranteed that the peanuts will test "negative" (not more than 25 parts-per-billion) by the official PAC aflatoxin-testing program, but the sheller is not allowed to make any other specification in regard to aflatoxin. Manufacturers who complete tests within 36 hr after the lot is sampled may accept lots of peanuts on the basis of their own aflatoxin analyses, but only those lots which test positive in PAC approved laboratories may be returned to the sheller because of aflatoxin contamination.

PAC AFLATOXIN TESTING PROGRAM

All shelled peanuts sold for human consumption must be positive-lot-identified and sampled by the Federal-State Inspection Service for aflatoxin tests. The aflatoxin testing program is outlined in Table I. One 48-lb sample is comminuted in a subsampling mill (6) and a 1100-g subsample is sent to a PAC approved laboratory. (Except for two independent laboratories, PAC approved laboratories are operated by federal or state government.) The entire 1100-g subsample is extracted in 3000 ml methanol-water (55:45) and 1000 ml hexane or technical-grade petroleum ether. Duplicate 50-ml portions of the methanol-water extract are analyzed for aflatoxin by Method II of AOAC (7). The two independent determinations of aflatoxin concentration by thin layer chromatography (TLC) are averaged. If the average is 16 parts-per-billion (ppb) or less, an "aflatoxin-negative" certificate is issued and the lot is accepted. If the average is more than 75 ppb, the average concentration is shown on the certificate, and the lot is rejected. Otherwise, a second 48-lb sample is analyzed by the same procedure, and the aflatoxin determinations from the first and second 48-lb samples are averaged. If the average of the four determinations is 22 ppb or less, an aflatoxin-negative certificate

TABLE II

Distribution According to Aflatoxin Concentration of Shelled-Peanut Lots Produced for Edible Purposes

	Aflatoxin concentrations (PPB)										
	5	10	15	20	25	30	35	40	45	50	55
% of total lots above indicated PPB in 1973	53.00	32.00	20.00	12.40	7.70	4.80	3.00	1.90	1.20	0.70	0.46
% of accepted lots above indicated PPB in 1973	49.20	27.00	13.80	6.40	2.70	1.10	0.38	0.12	0.04	0.01	0.00
% of total lots above indicated PPB in 1974	32.80	15.20	7.30	3.50	1.70	0.85	0.42	0.21	0.10	0.05	0.03
% of accepted lots above indicated PPB in 1974	31.50	13.50	5.50	2.50	0.69	0.27	0.08	0.02	0.00	0.00	0.00

is issued. If the average is 38 ppb or more, the average concentration is shown on the certificate, and the lot is rejected. Otherwise, a third 48-lb sample is analyzed, and when the six determinations average 25 ppb or less, a negative certificate is issued. Otherwise, the average concentration is shown on the certificate and the lot is rejected. The results of all aflatoxin analyses are made available to the buyer of the peanuts.

As indicated previously, the manufacturer located in the production area may elect to conduct his own 36-hr aflatoxin analyses. In this case, the Federal-State Inspection Service will provide the manufacturer's laboratory with two 1100-g subsamples from the first 48-lb sample and hold two subsamples in reserve. After analysis of his subsamples, the manufacturer may accept the lot or request the official PAC test outlined above.

Whitaker and Dickens (unpublished data) have estimated the probability of accepting lots with various concentrations of alfatoxin when the official PAC testing program is used. As shown in Figure 1, there is over 99% probability of accepting lots with 10 ppb and very little probability of accepting lots with 70 ppb. Approximately 65% of the lots with 25 ppb are accepted.

APPEAL TESTING FOR AFLATOXIN

Manufacturers may appeal official PAC aflatoxin tests if positive-lot identification has been maintained for the lot. A 144-lb sample is comminuted and duplicate analyses are made on three 1100-g subsamples. If the average of the six determinations is 25 ppb or less, the lot must be accepted. If the average is more than 25 ppb, the manufacturer may reject the lot. The manufacturer pays all costs of appeal testing, and there is no limit on the number of appeals made on a lot.

DISPOSITION OF AFLATOXIN CONTAMINATED LOTS

Lots of shelled peanuts which test positive for aflatoxin may be remilled or blanched in an attempt to remove the aflatoxin. Remilling may include the following procedures: (a) screening to remove small kernels, (b) treatments to remove low-density kernels and foreign material, (c) electronic color sorting to remove discolored kernels, and (d) hand picking to remove discolored kernels. The blanching process consists of removing the skin or testa from the kernels followed by color sorting and hand-picking to remove the discolored kernels and those kernels that retain their skins. After blanching or remilling, the lots are considered to be new lots and are subjected to the PAC aflatoxin testing program outlined above. There is no limit on the number of times a lot may be remilled, and the lot may be blanched following remilling. Eventually, all lots which fail to pass the PAC aflatoxin testing program must be restricted from food or feed except for the oil which is aflatoxin-free after proper refining. Exported peanuts that do not test negative must show aflatoxin concentrations on official documents sent to the purchaser of the peanuts.

EVALUATION OF THE AFLATOXIN CONTROL PROGRAM

The average aflatoxin concentration in all lots of peanuts accepted by the PAC aflatoxin testing program and the risk of accepting lots with high concentrations depends upon the condition of the peanut crop after shelling. Whitaker and Dickens (unpublished data) have estimated the distribution according to aflatoxin concentrations for all lots of edible-grade shelled peanuts produced from both the 1973 and 1974 crops and for those lots accepted from each crop by the PAC testing program. All lots contained an average aflatoxin concentration of 10 ppb for the 1973 crop and 5 ppb for the 1974 crop. As shown in Table II, ca. 7.70% of the lots produced and 2.70% of the lots accepted from the 1973 crop contained over 25 ppb aflatoxin compared to 1.70% and 0.69%, respectively, for the 1974 crop. Only 0.01% of the lots accepted from the 1973 crop and none of the lots accepted from the 1974 crop contained more than 50 ppb aflatoxin.

The manufacturer has the final responsibility for producing wholesome peanut products for the consumer market. The National Peanut Council has published a voluntary code of good practices for purchasing, handling, storage, processing, and testing of shelled peanuts (8). The voluntary code recommends the removal from the processing stream before and/or after blanching of those peanut kernels most likely to contain aflatoxin. These kernels include moldy, discolored, shriveled, and damaged kernels; kernels that resist blanching or splitting; and those that have a dark color after roasting. Destruction by roasting of from 30 to 50% of any aflatoxin remaining in the peanuts also reduces aflatoxin in the finished product (9).

The alfatoxin control program of the PAC, the procedures outlined in the National Peanut Council code of good practices, the destruction of aflatoxin during roasting, and thorough aflatoxin testing of the finished product help provide the consumer with safe peanut products.

ACKNOWLEDGMENT

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