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Evaluation of the Peanut Administrative Committee Testing Program for Aflatoxin in Shelled Peanuts[1]

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ABSTRACT

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 (PAC) composed of peanut growers and shellers. The PAC requires aflatoxin tests on all commercial lots of shelled peanuts.

The present PAC testing program initiated in 1975 was evaluated for Crop A which averaged 9.5 parts-per-billion (ppb) aflatoxin and for Crop B which averaged 5.2 ppb aflatoxin. For Crop A and Crop B, respectively, 7.3% and 2.0% of the lots were rejected. The accepted lots contained an average of 7.5 ppb for Crop A and 4.7 ppb for Crop B. A correct decision (accept a lot with ≤ 25 ppb aflatoxin and reject a lot with > 25 ppb aflatoxin) was made 95% of the time for Crop A and 98% of the time for Crop B.

Key Words: Aflatoxin, Peanuts, Sampling, Evaluation.

Under provisions of a U. S. Department of Agriculture Marketing Agreement, an aflatoxin control program for peanuts produced in the United States is administered by the Peanut Administrative Committee (PAC) composed of peanut growers and shellers (4, 2). PAC generally solicits recommendations about the aflatoxin control program from representatives of peanut-product manufacturers. Practically all of the peanuts marketed in the United States are handled by shellers who are regulated by PAC.

As part of the aflatoxin control program, PAC requires aflatoxin tests on all commercial lots of shelled peanuts. Sampling, subsampling and analytical procedures approved by PAC must be followed in these tests. All samples for the official PAC aflatoxin testing program are taken by Federal-State Inspectors. At least 66-Kg (144 pounds) of peanuts are taken from each lot by probing every fourth bag of the lot or by automatic instream samplers which randomly sample the peanuts prior to bagging or packaging for shipment. Although commercial lots of shelled peanuts may weigh from about 16,000 Kg (36,000 pounds) to over 45,000 Kg (100,000 pounds), the same size sample is taken from all lots. The 66-Kg (144 pound) sample taken from each lot is subdivided into three 22-Kg (48 pound) samples for the aflatoxin testing program.

The current PAC testing program diagrammed in Figure 1 was initiated in 1975. One 22-Kg (48-pound) sample of kernels is comminuted in a subsampling mill (3) and a 1100-g subsample is solvent-extracted for aflatoxin analysis. Two analyses, identified as 1A and 1B are made on the extract. If the average of analyses 1A and 1B is 16 parts-per-billion (ppb) or less, the lot is accepted; if the average is more than 75 ppb the lot is rejected. Otherwise, a second 22-Kg (48-pound) sample is processed and two more analyses are made (2A and 2B). If the average of analyses 1A, 1B, 2A and 2B is 22 ppb or less, the lot is accepted; if the average is greater than 38 ppb, the lot is rejected. Otherwise a third 22-Kg (48-pound)

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. The PAC aflatoxin testing program for shelled peanuts which was initiated in 1975.

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sample is processed and two more analyses are made (3A and 3B). If the average of 1A, 1B, 2A, 2B, 3A and 3B is 25 ppb or less, the lot is accepted; if the average is greater than 25 ppb, the lot is rejected. The Best Foods (BF) method (1) as modified by USDA (5) is used for analysis of the 1100-g subsamples.

The objective of this paper is to discuss the current PAC aflatoxin testing program and to predict the number of shelled-peanut lots accepted or rejected according to aflatoxin concentration.

Materials and Methods

The total number of lots accepted in a crop year L_a is given by the following equation:

$$L_a = \sum_{\mu=o}^{\infty} TL \cdot f(\mu) \cdot P(\mu) \qquad (1)$$

where TL is the total number of lots tested in a crop year, $f(\mu)$ is the percent of lots at a given aflatoxin concentration μ, and $P(\mu)$ is the probability of accepting a lot with aflatoxin contamination μ.

Exact counts for TL for a given crop are available from PAC records, and $P(\mu)$ can be computed using the Monte Carlo technique described in a previous publication (8). The distribution of aflatoxin test results for a given crop $f(\mu)$ is also available from PAC records, but due to testing errors, the distribution of lots according to aflatoxin concentration is not the same as the distribution of test results from these lots. Previous studies (7, 6) show that more test results will be lower than the true lot concentration than will be above it. This skewness in the distribution of test results about the true lot concentration is mostly due to sampling error and is more pronounced when small samples are taken from the lot than when large samples are used.

The true lot distribution according to aflatoxin concentration can be determined by use of the system of equations given below:

$$\begin{aligned}
y_o &= a_o^o x_o + a_1^o x_i + a_2^o x_2 + \cdots + a_j^o x_j \\
y_1 &= a_o^1 x_o + a_1^1 x_1 + a_2^1 x_2 + \cdots + a_j^1 x_j \\
y_2 &= a_o^2 x_o + a_1^2 x_1 + a_2^2 x_2 + \cdots + a_j^2 x_j \qquad (2) \\
&\vdots \\
y_i &= a_o^i x_o + a_1^i x_1 + a_2^2 x_2 + \cdots + a_j^i x_j
\end{aligned}$$

where y_i is the number of test results indicating i in ppb, x_j is the number of lots with concentration j, and a_j^i is the probability of obtaining a test result i from a lot with concentration j. From the above system of equations, the true distribution of lot concentration $x_o, \cdots, x_j$ can be computed given the distribution of test results $y_o, \cdots, y_i$ and the probability coefficients a_j^i. These techniques were used to obtain estimates of the lot distribution for the 1973 and 1974 crops, and the values of $f(\mu)$ used in this study were determined from those distributions.

Since the lot distributions based on the 1973 and 1974 crops are only used to determine the disposition of lots if the current PAC aflatoxin testing program had been applied to crops with similar distributions, the 1973 and 1974 lot distributions will hereafter be referred to as Crop A and Crop B, respectively.

Results and Discussion

The computed probabilities $P(\mu)$ of accepting lots with indicated aflatoxin concentrations when the PAC testing program is used are plotted in Figure 2. The testing program would accept all lots with less than 10 ppb aflatoxin and would reject all lots with more than 70 ppb.

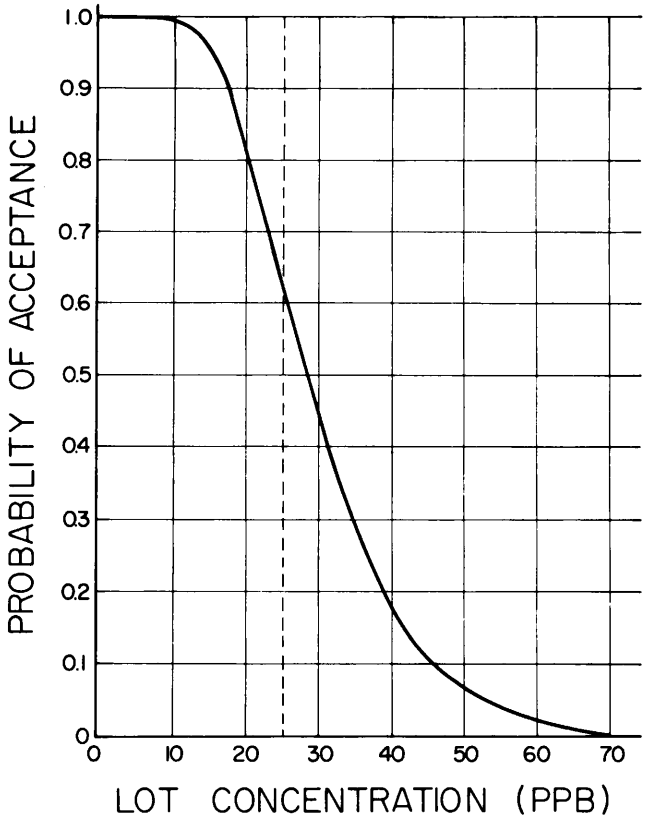

Fig. 2. Computed probabilities for accepting lots containing indicated concentrations of aflatoxin with the PAC testing program initiated in 1975.

The distributions according to aflatoxin concentration of the lots from Crop A and Crop B are shown in Table 1. The number of these lots accepted or rejected by the 1975 PAC testing program (computed with Equation 1) are also given. For either crop, very few lots below 15 ppb were rejected: while very few lots above 45 ppb were accepted.

The average aflatoxin concentration in accepted and rejected lots and the number of lots accepted or rejected with 25 ppb aflatoxin or less and with more than 25 ppb aflatoxin are given in Table 2. More lots were rejected from Crop A (9 ppb average aflatoxin concentration) than from Crop B (5 ppb average aflatoxin concentration). The right decision (accept a lot with $\leq$ 25 ppb and reject a lot with $>$ 25 ppb aflatoxin) was made 95% of the time for Crop A and 98% of the time for Crop B. The manufacturer's risk that an accepted lot contained $>$ 25 ppb aflatoxin was 3% for Crop A and 1% for Crop B. The sheller's risk that a rejected lot contained $<$ 25 ppb aflatoxin was 29% for Crop A and 46% for Crop B. The average aflatoxin concentrations in accepted and rejected lots were, respectively, 7.5 ppb and 33.6 ppb for Crop A and 4.7 ppb and 28.0 ppb for Crop B. The aflatoxin concentration in the accepted lots was 80% of the aflatoxin

Table 1. Number of lots with indicated aflatoxin concentrations accepted or rejected by the current PAC testing program for two different lot distributions (Crop-A and Crop-B).

Lot Concentration (PPB)	CROP-A Number of Lots			CROP-B Number of Lots		
	Tested	Accepted	Rejected	Tested	Accepted	Rejected
0	2311	2311	0	4467	4467	0
1	1903	1903	0	2884	2884	0
2	1652	1652	0	2193	2193	0
3	1458	1458	0	1751	1751	0
4	1297	1297	0	1431	1431	0
5	1160	1160	0	1187	1187	0
6	1041	1041	0	993	993	0
7	937	937	0	836	836	0
8	844	844	0	708	708	0
9	761	761	0	601	601	0
10	688	688	0	512	512	0
11	622	621	1	437	436	1
12-13	1072	1064	8	695	690	5
14-15	879	859	20	512	500	12
16-17	722	685	37	379	360	19
18-20	852	747	105	395	347	48
21-25	971	704	267	372	271	101
26-30	600	315	285	180	96	84
31-35	374	130	244	89	31	58
36-40	233	49	184	44	9	35
41-45	145	16	129	22	2	20
46-50	91	4	87	11	1	10
51-60	92	2	90	8	0	8
61-70	36	0	36	2	0	2
>70	23	0	23	1	0	1
Totals	20764	19248	1516	20710	20306	404

Table 2. The number of lots accepted or rejected and the aflatoxin concentration in different portions of Crop A and Crop B.

	LOTS FROM CROP A			LOTS FROM CROP B		
	≤25 PPB	>25 PPB	TOTAL	≤25 PPB	>25 PPB	TOTAL
No. Accepted	18,732*	516	19,248	20,167*	139	20,306
Avg. Aflatoxin Conc.	6.8 PPB	30.6 PPB	7.5 PPB	4.5 PPB	29.7 PPB	4.7 PPB
No. Rejected	438	1,078*	1,516	186	218*	404
Avg. Aflatoxin Conc.	20.1 PPB	38.7 PPB	33.6 PPB	20.5 PPB	34.4 PPB	28.0 PPB
Total	19,170	1,594	20,764	20,353	357	20,710
Avg. Aflatoxin Conc.	7.1 PPB	36.1 PPB	9.4 PPB	4.6 PPB	32.6 PPB	5.2 PPB

*Correct decisions were made for these lots.

%Correct decisions for Crop A = (18,732 + 1,078)(100)/20,764 = 95%

%Correct decisions for Crop B = (20,167 + 218)(100)/20,710 = 98%

Manufacturer's Risk

% of accepted lots from Crop A with > 25 PPB = (516)(100)/19,248 = 3%

% of accepted lots from Crop B with > 25 PPB = (139)(100)/20,306 = 1%

Sheller's Risk

% of rejected lots from Crop A with ≤ 25 PPB = (483)(100)/1516 = 29%

% of rejected lots from Crop B with ≤ 25 PPB = (186)(100)/404 = 46%

concentration in the total crop for Crop A and 90% of the aflatoxin concentration in the total crop for Crop B.

Lot distributions for Crop A and Crop B were used in this paper to demonstrate the magnitude of the sheller's and manufacturer's risks that might be expected with the present PAC testing program when it is used to test crops with two significantly different average concentrations of aflatoxin. Lot distributions according to aflatoxin concentration and corresponding risks to the sheller and manufacturer may vary from year to year and from one production location to another within a given crop year.

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