A Note on High Moisture Content Foreign Material Effects on Aflatoxin in Peanuts During Storage

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ABSTRACT

Samples containing four types of high moisture content foreign material were placed in warehouses to determine how this material may contribute to aflatoxin formation in peanuts during storage. The high moisture material included gherkins, maypops, briarballs, and citrons. Results showed aflatoxin levels exceeding 700 ppb in some shelled peanut samples. Frequency tests showed 9% of all grade samples from farmers stock lots contained high moisture foreign material. When averaged across an entire warehouse, the high moisture foreign material could raise the average aflatoxin level in storage by 30 ppb.

Key Words: Aflatoxin, storage, *Aspergillus flavus*, moisture.

Peanuts (*Arachis hypogaea* L.) entering storage may contain foreign material—such as sticks, dirt, rocks, and weeds—collected during the harvesting process. While the current peanut marketing agreement requires that kernel moisture be less than 10.5% (wet basis) at marketing, no regulations govern the amount of moisture in foreign material. Certain types of foreign material common in peanuts—such as citrons (*Citrullus lanatus v. citroides* [Bailey Mansf.]), maypops (*Passiflora incarnata* L.), gherkins (*Cucumis anguria* L.), and briarballs or carolina horsenettle (*Solanum carolinense* L.)—are approximately 80% water. Foreign materials of these types may rewet surrounding kernels and provide moisture for growth of *Aspergillus flavus* Link on peanuts with subsequent production of aflatoxin. Although previous studies document temperature and moisture levels necessary for aflatoxin production (Diener and Davis, 1966, 1967; Jackson and Press, 1967; Welty and Cooper, 1968; Smith *et al.*, 1989), no literature documents the role of high moisture foreign material in the development of aflatoxin. Thus, the peanut industry requested the effects of high moisture foreign material on aflatoxin in warehouses be investigated.

Materials and Methods

Gherkins, maypops, briarballs, and citrons were collected and stored with peanuts in warehouses during 1992 and 1993. Sample preparation included placing about 50 g of each foreign material in the center of about 1 kg of pods in a small mesh bag. This sample was then placed in the center of about 16 kg of pods in a large mesh bag that was placed in a conventional warehouse. A sample with no foreign material served as a control. The large bag provided a buffer between the small mesh bag containing the foreign material and the peanuts in the warehouses. The mesh bags ensured unrestricted air movement through the samples. Samples were replicated three times in 1992 in one warehouse for a total of 15 samples and four times in 1993 for a total of 20 samples in one warehouse.

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On 6 Oct. 1992, three samples per foreign material type were placed in a 7200 t mechanically ventilated warehouse in Colquitt, GA under approximately 1.5 m of peanuts and removed on 1 Dec. On 22 Sept. 1993, four samples per foreign material type were placed in a 3600 t naturally ventilated warehouse in Smithville, GA under approximately 6 m of peanuts and removed on 12 Jan. 1994. Prestorage aflatoxin levels measured using the Vicam fluorometer (Vicam Corp, Watertown, MA 02172) (Trucksess *et al.*, 1991) on 100 g of kernels shelled from a random subsample of about 120 g of pods divided from each sample indicated initial levels were 0 ppb (parts per billion). After storage, aflatoxin levels were again measured using about 100 g of kernels from each small mesh bag to determine the amount of aflatoxin formed in storage. Initial moisture of the foreign material was 80-90% while final moisture was 12-14%. Initial and final kernel moistures were about 9 and 6%, respectively.

Results and Discussion

In 1992, only samples with gherkins had aflatoxin levels significantly ($P<.05$) greater than the control (Table 1). Placing samples in storage late in the year when temperatures were cooler may explain why most samples in this test did not contain much aflatoxin. The average ambient temperature during the first 20 d of storage in 1992 was about 16.5 C. Although the foreign material provided a moisture source, low temperatures did not create an environment conducive to aflatoxin production.

For the 1993 tests, peanut samples with gherkins, maypops, and citrons had significant ($P<.05$) amounts of aflatoxin, with some samples exceeding 700 ppb. Average ambient temperatures during the first 30 d of storage exceeded 20 C, which is in the range for growth of *A. flavus* and aflatoxin formation.

Neither test showed significant amounts of aflatoxin in samples containing briarballs. They are typically <2.5 cm in diameter, whereas the other foreign material types may exceed 10 cm in diameter. The amount of moisture released from briarballs is small due to a thick, waxy coating; and they are more likely to be undamaged, causing moisture to escape slowly. Harvesting and handling typically damages and/or fragments other foreign material allowing rapid moisture transfer to the peanuts.

Table 1. Effect of high moisture foreign material on aflatoxin in peanuts during storage. Aflatoxin was measured on 100-g samples of kernels removed from 1-kg pod samples .

Year	FM type	Avg aflatoxin[a]		Std. dev.
		ppb		
1992	Citrons	3	ab	1.0
	Maypops	9	ab	9.0
	Gherkins	83	a	119.0
	Briarballs	2	ab	1.3
	Control	1	b	0.2
1993	Citrons	760	a	427.0
	Maypops	530	a	918.0
	Gherkins	166	a	214.0
	Briarballs	1	b	0.6
	Control	7	b	14.0

[a]Averages followed by the same letter are not significantly different at P=0.05 using the least significant difference procedure.

The frequency of occurrence of high moisture foreign material was measured in 39,170 lots from 39 peanut buying points in 1993. These determinations revealed that 9% of all lots marketed contained a gherkin, maypop, briarball, or citron in the 2-kg grade sample. Thus, in storage conditions similar to those experienced in 1993, 9% of all lots could contribute to aflatoxin contamination in storage. In a worse case scenario, if 9% of all lots contain high moisture foreign material in a 2-kg sample and that 2 kg is contaminated to a level of 350 ppb, then the average effect of high moisture foreign material on aflatoxin in a warehouse would be about 30 ppb (0.09 x 350 ppb=31.5 ppb). This assumes that the 2-kg sample represents the entire lot, thus any 2-kg sample in the lot will be contaminated to a level of 350 ppb. The level of 350 ppb was derived from the results showing 700 ppb aflatoxin levels in a 1-kg sample with one piece of high moisture foreign material. Thus, a 2-kg sample with one piece of foreign material should have half the aflatoxin level. When examining the test samples, it was noted that only those peanuts in the immediate vicinity of the high moisture foreign material had fungal growth whereas the remaining peanuts in the sample appeared unaffected by the high moisture material. This occurred because only those peanuts in contact with the high moisture foreign material absorbed water from that material. Thus, doubling the sample size while keeping the amount of high moisture foreign material constant should cut the level of contamination in that sample in half.

The results reported in this study alerted the peanut industry to the large number of lots containing high moisture foreign material and the contribution of this material to aflatoxin in storage. As a result, the Peanut Administrative Committee now requires the Federal-State Inspection Service to notify buyers of marketed lots containing gherkins, maypops, briarballs, and citrons. Buyers can then clean lots or shell them immediately. The Inspection Service now incorporates the identification of gherkins, maypops, briarballs, and citrons in their inspection process and supplies all inspectors with color photographs to aid inspectors in identifying this foreign material.

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