Distribution of Aflatoxin in Pistachios. 4. Distribution in Small Pistachios

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The aflatoxin concentration of small, unsorted pistachio “scalpers” has been measured as a function of nut weight (0.4−0.7 g/nut) for nuts from the 1992−1994 crops for one particular processor. No clear size dependence was noted, but these scalpers were found to have a weight average aflatoxin level around 8 ng/g, 5−7 times that of unsorted, unsized nuts. Results suggest a distinct difference in sorting for such scalpers between processors, the first time such difference has been verified.

Keywords: *Pistachios; smalls; scalpers; nut weight; aflatoxin; early splits*

INTRODUCTION

The distribution of aflatoxin, a deleterious mycotoxin, in processed pistachio nuts has been the subject of a series of recent studies (Schatzki, 1995a,b; Schatzki and Pan, 1996). It was shown that, when dried nuts where sorted on the basis of quality, a set of process streams with differing aflatoxin levels was obtained. These levels were correlated to the preharvest physiological damage the nuts had undergone. Streams which consisted of (water bath) “floaters”, which showed shell discoloration, or which showed evidence of insect damage were found to be high in aflatoxin content. This is in good agreement with previous work (Sommer et al., 1985; Doster and Michaelides, 1994) which found early hull splitting and insect damage in pistachios to be correlated with aflatoxin content. Early splitting causes shell discoloration which can be detected long after harvest (Schatzki and Pan, 1996; Pearson, 1996).

The postharvest sorting results (Schatzki and Pan, 1996) suggested an additional indicator of aflatoxin, nut weight (Table 1). Low weight (small size) might be an indicator of preharvest weakness or damage. However, the strong weight dependence seen in the table is confounded with nut quality as shown by the following. The first three rows describe “scalpers”. Scalping involves separating [by use of a sizing screen with 29/64 in. (1.15 cm) diameter circular holes] low value, small nuts from the process stream as the first sorting step. These nuts were shown to be high in aflatoxin (Schatzki and Pan, 1996). The remaining rows describe finished nuts, which were larger than 1.15 cm and had passed through the full commercial sorting process, including sizing using screens and color sorting by machine and by hand, which removed all, or most, of the low-quality nuts. Accordingly, it was of interest to see whether small size alone could account for high aflatoxin levels and how high a level of aflatoxin might result when only small nuts were considered. The possibility remained that, if the very smallest nuts were eliminated, the remaining scalpers might still contain valuable product. The present study was carried out to address this question.

MATERIALS AND METHODS

The nuts used for this study were obtained from a single California processor (processor B of Schatzki and Pan (1996)) and comprised material from 1992, 1993, and 1994 harvests. The lot was reported to contain both scalpers and sorted small nuts, i.e., nuts corresponding to rows 3 and 4 of Table 1. As received, nuts ranged in size from about 0.4 to 1.1 g/nut (all weights given include shell weight). Sinkers and floaters were included, as were free meats and some shell-only material. By use of a set of screens with progressively smaller circular holes (see Table 2) these nuts were further sorted into seven sublots. Using the size nomenclature given in the footnote to Table 2, it follows that four of these sublots (24, 25, 26, and 29) consisted of scalpers, while sublots 31, 33, and 39 were comprised of nuts which had passed through the entire quality sorting process. Free meats and shell-only material were

Table 1. Nut Source and *Size* vs Aflatoxin Content (Taken from Schatzki and Pan (1996), Table 5)

source	description	average wt/nut, g	aflatoxin concn, ng/g
processor A	floaters, scalpers	0.46[a]	149 ± 79
processor A	sinkers, scalpers	0.60[a]	91 ± 85
processor B	sinkers, scalpers		24
processor B	sinkers, small	1.01[b]	3.1
processor B	sinkers, large	1.18[b]	0.6
processor A	sinkers, large	1.28[a]	0
processor B	sinkers, X large	1.42[b]	0.2
processor A	floaters, X large	1.47[a]	0.9 ± 0.9
processor A	floaters, large	1.48[a]	9.8 ± 9.8
processor A	sinkers, X large	1.55[a]	0

[a] Measured. [b] Computed from nominal nuts/oz.

Table 2. Nut Size and Stain Appearance Versus Aflatoxin Content (All Samples Contain 500 Nuts)

		aflatoxin, ng/g		
sub-lot[a]	wt/nut, g	sample results	average	fraction of contamination
24S	0.39 ± 0.11	9*0, 1.8	0.18 ± 0.18	0.10
24U	0.42 ± 0.10	7*0, 0.29	0.04 ± 0.04	0.12
25S	0.46 ± 0.07	11*0, 1.8, 5.9, 6.0, 108	8.1 ± 7.1	0.27
25U	0.51 ± 0.09	15*0, 1.5, 3.0, 3.9, 94	5.4 ± 4.9	0.21
26S	0.53 ± 0.08	20*0	0	0.00
26U	0.59 ± 0.11	17*0, 0.1, 54, 96	7.5 ± 5.4	0.15
29S	0.58 ± 0.12	16*0, 0.1, 0.4, 2.8, 385	19 ± 19	0.20
29U	0.66 ± 0.12	19*0, 187	9.4 ± 9.4	0.05
31M	0.72 ± 0.13	19*0, 6.8	0.34 ± 0.34	0.05
33M	0.82 ± 0.12	20*0	0	0.00
39M	1.07 ± 0.30	20*0	0	0.00

[a] The sublot number indicates the hole size the nuts fell through (in 1/64 in.); they did not fall through the lower number indicated (thus 31M passed 31/64 in., but not 29/64 in.). The letters indicate the result of image eye sorting: U, unstained; S, stained; M, unsorted (mixed).

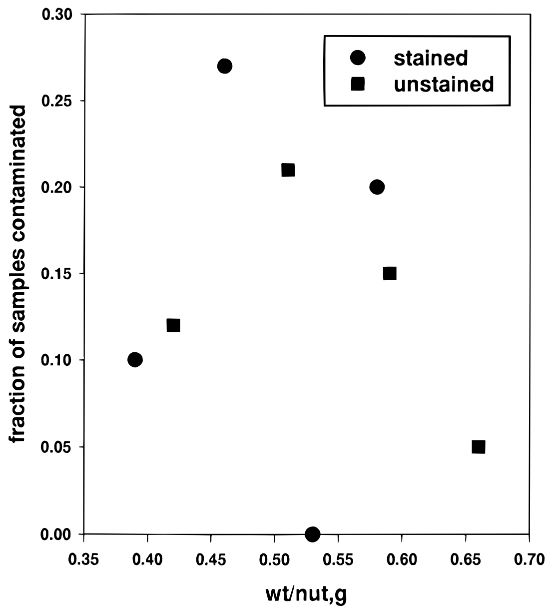

Figure 1. Fraction of 500-nut samples which were contaminated, detection limit 0.1 ng/g, as a function of nut weight.

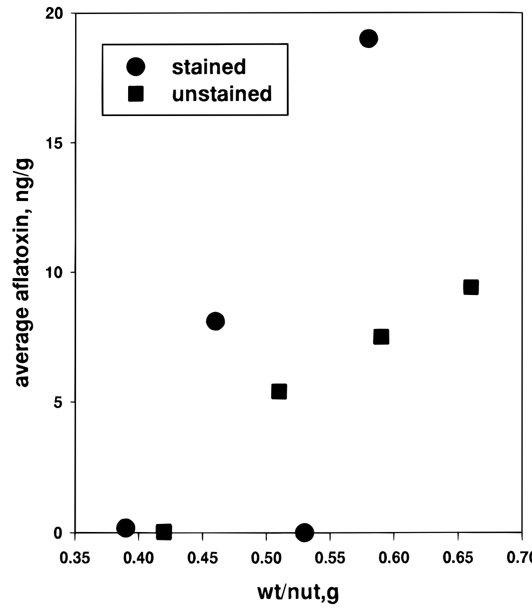

Figure 2. Average sample aflatoxin content, 500-nut samples, as a function of nut weight.

removed from each sublot by hand-sorting. Some of the sublots were further divided into two approximately equal piles by use of an image sorter (Pearson, 1996). This latter sorter is similar to an electric eye color sorter, except that it selects nuts not by their average color, but by particular staining patterns on the shell. Each of the sublots so obtained was characterized as to average weight by a random selection of 20 subsamples of 20 nuts each. The aflatoxin content of each sublot was measured for up to 20 samples of 500 nuts each. The analytic method follows that of Schatzki and Pan (1996).

RESULTS AND DISCUSSION

The nut weights in each sublot and the aflatoxin results are shown in Table 2. As noted above, the sublots fell into two groups, the scalpers (24−29) and the finished nuts (31−39), which need to be considered separately. The finished nuts contained 0−0.34 ng/g of aflatoxin, somewhat lower than the 3.1 ng/g listed in Table 1. In light of the low measured aflatoxin level, these sublots were not separated into stained and unstained nuts by use of the Pearson sorter.

In measuring aflatoxin levels of tree nuts the sample variability is notoriously large, because aflatoxin is contained in but a few, highly contaminated, nuts. When a number of samples are taken, aflatoxin is reported commonly in one of two ways. One reports either the fraction, P, of samples which show a positive result or the average level of aflatoxin. The former can be computed from the fraction, p, of nuts in the lot whose aflatoxin level exceeds nc_0, where c_0 is the detection limit (here 0.1 ng/g) and n the sample size (here 500 nuts), with $P = np$ (Schatzki, 1995a). The sample average aflatoxin level, on the other hand, is approximated by $p'c'$, where p' is the fraction of nuts in the lot which have the maximum aflatoxin level possible, c' (generally around 2×10^5−10^6 ng/g) (Schatzki 1995b).

The results are shown in Figures 1 and 2. Because of the relatively small sample size (500 nuts) and the limited number of samples available (≤20), the standard errors are very large. Nevertheless, it is clear that no upsweep is seen in aflatoxin levels at very small nut size, as had been expected from Table 1. In fact, the average aflatoxin level appears to fall when the nut size gets very small (below about 0.5 g/nut). The weight average aflatoxin level of all scalpers studied here comes to 8 ng/g, somewhat lower than the 24 ng/g previously reported for scalpers from processor B, but not inconsistent with the 3.1 ng/g reported for small sorted nuts reported for that processor. On the other hand, the weight average is well above that of all unsorted and unsized pistachios, which amounts to 1.2−1.5 ng/g (Schatzki et al., 1995b, 1996). In brief, there appears to be a small size dependence when total received product is considered, with smaller nuts showing greater aflatoxin content, regardless of quality, with a possible peak around 0.5 g/nut, but the size dependence is not overwhelming. The scalpers in Table 1 from processor A showed a much higher aflatoxin content, which is what motivated this study. It is possible that the scalping process (or possibly the source of product) differed in some way between the two processors, although it is not clear how.

A small increase of aflatoxin with decreasing nut size and a peak in aflatoxin occurring at a very small size is not inconsistent with knowledge of pistachio growth. It is known that early splitting of pistachios tends to occur in small nuts (0.9−1.1 g/nut) but not in very small nuts (Stiefvater, 1996). Early hull splitting of pistachios is the main cause of fungus infection and aflatoxin production (Sommer et al., 1985). It would thus seem that very small nut size is not the result of fungus infection. Instead, very small size appears to reduce the possibility of offering an entrance path for fungi.

Even a level of 8 ng/g is uncomfortably close to the 20 ng/g action level of the FDA and a number of individual lots could be expected to exceed the latter. There is thus some question whether these scalpers, or any sublot thereof, should be used for food product, at least without careful lot by lot testing. On the other hand, the small sorted nuts (sizes 31, 33, and 39) are clearly acceptable on the basis of aflatoxin content.

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