Microanalytical Quality of Unsweetened Chocolate

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ABSTRACT

A survey was made to determine the sanitary quality of unsweetened chocolate. The analytical data obtained were representative of unsweetened chocolate at the national retail level. The mean and range for each defect, based on a 100-g sample, were as follows: insect fragments, 23.69 (0-95); whole insects, 0.02 (0-4); feather fragments, 0.07 (0-9); and rodent hairs, 0.57 (0-6). Positive samples found for each defect were as follows: insect fragments 99.1%; whole insects 0.7%; feather fragments 4.6%; and rodent hairs 33.2%. The association between the defect pairs is shown in correlation coefficients. It was determined that each defect occurs independently of the others.

Food defect limits were established soon after passage of the 1906 Federal Food and Drug Act. Cacao was first regulated in 1931 through a Notice to the Trade that cited limits of 10% for insect infestation and/or mold contamination in cacao beans. In 1959 the Import Cocoa Bean Survey was conducted to evaluate the applicability of the 1931 defect limits for mold and insect contamination of cacao beans. As a result of this survey, the limits for insect and mold contamination in cacao beans were revised downward to 4% for insect infestation or mold or 6% combined total. For economic reasons, greater quantities of cacao beans were being processed abroad and offered for entry in the ground form. Limits for insect fragments were thus required for the regulation of products such as cocoa and chocolate.

In 1962 and 1965 investigations were initiated to determine the correlation between percentage of insect-infested cacao beans and insect fragment counts in the ground products. Both of these studies showed that whole bean insect infestation levels do not correlate with insect fragment counts in the ground products. In 1973 a retail market sampling and analysis program was conducted to develop data on insect, bird, and mammal contamination levels in unsweetened chocolate as it was offered to the consumer. The sampling and analytical details of that program are presented in this report.

MATERIALS AND METHODS

Samples were collected by Food and Drug Administration inspectors from 20 standard metropolitan statistical areas. These 20 areas were randomly chosen from the 276 areas defined by the bureau of the Census as integrated economic and social units with a recognized urban population nucleus of substantial size (2). The selection of the 20 areas was subject to the restriction that continental United States, Hawaii, and Puerto Rico be represented with statistical adequacy. In each metropolitan area, products in three chain stores and two independent stores were selected for sampling. Five retail units of unsweetened chocolate were collected at each of the sampling locations. Different brands of products were selected wherever possible in a given store; however, if brand duplication was necessary, different production codes were collected. The collection plan was designed to ensure random sampling that would provide adequate lot representation nationally.

Analyses were conducted by an independent laboratory under contract to the Food and Drug Administration. One hundred-gram samples were analyzed for insect fragments, whole or equivalent insects, feather fragments, and rodent hairs according to Method 44.006 of the Association of Official Analytical Chemists (1). Data were obtained on 435 samples.

RESULTS AND DISCUSSION

The defects found as a result of this survey were insect fragments, whole insects, feather fragments, and rodent hairs.

Table 1 presents a frequency distribution for insect fragments. The insect fragment contamination ranged from 0 to 95. Approximately 99% of the samples examined contained insect fragments and showed a broad distribution. The median insect fragment count was 21 and the mean was 23.7. Ninety-five percent of all samples had a count of less than 59. Insect fragments originate from a wide variety of field and storage insects that attack the cacao beans during processing in the country of origin or during handling and storage in the United States. Most insect contaminants are eliminated during shell removal; however, the few remaining are subsequently reduced to fragments during the grinding of the nibs into chocolate liquor.
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Approximately 1% of samples contained whole insects and showed a narrow distribution. The median whole insect count was 0 and the mean was 0.02. Ninety-five percent of the samples had a count of zero. The whole insect contamination represents either a rather infrequently occurring, post-milling, implant contamination or infestation in the distribution or marketing channels.

Table 2 presents a frequency distribution for whole insects. The whole insect contamination varied from 0 to 4. Approximately 1% of the samples contained whole insects and showed a narrow distribution. The median whole insect count was 0 and the mean was 0.02. Ninety-five percent of the samples had a count of zero. The whole insect contamination represents either a rather infrequently occurring, post-milling, implant contamination or infestation in the distribution or marketing channels.

Table 3 presents a frequency distribution for feather fragments. The feather fragment contamination ranged from 0 to 9. Approximately 5% of the samples contained feather fragments and showed a narrow distribution. The median feather fragment count was 0 and the mean was 0.07. Ninety-five percent of the samples had a count of zero. Feather contamination of cacao beans may occur during processing and handling before export from the producing country or during handling and storage in the United States. The presence of feather fragments in the chocolate suggests either whole bean contamination that has not been completely removed during shelling or airborne contamination of the semi-refined product.

Table 4 presents a frequency distribution for rodent hairs. The rodent hair contamination ranged from 0 to 6. Approximately 33% of the samples examined contained rodent hairs and showed a moderate distribution. The median rodent hair count was 0 and the mean was 0.57. Ninety-five percent of the samples had a count of less than 4. Rodent hairs found in chocolate can originate from a number of sources. Cacao beans are subject to contamination by a variety of rodents while being prepared for export in the producing country or during handling and storage in the United States.

Table 5 provides a statistical summary for each defect variable. Scatter diagrams and their associated correlation coefficients were used as a measure of association between defect variables. These diagrams did not reveal any significant association between the various combinations of defect variables; however, some association was shown in the following correlation coefficients: insect fragments vs. whole insects -0.06; insect fragments vs. rodent hairs 0.33; insect fragments vs. feather fragments 0.18; whole insects vs. rodent hairs -0.02; whole insects vs. feather fragments -0.01; and rodent hairs vs. feather fragments 0.09.

The most significant positive associations occurred between insect fragments and rodent hairs and insect fragments and feather fragments. The correlation coefficient between insect fragments and rodent hairs was 0.33 and between insect fragments and feather fragments was 0.18. A perfect direct or inverse correlation is +1.0 and -1.0, respectively. For the 435 samples involved in this study, a correlation coefficient of +0.13 or greater would be expected to occur by chance alone only 1% of the time. Thus, the correlation coefficients of 0.33 and 0.18 give statistical evidence that some association exists between the variables. However, the fact that both values are closer to 0 than to 1 shows that these associations, though real, are weak.

The analytical data presented in this report represent a current data base representative of the sanitary quality of unsweetened chocolate on the retail market.
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REFERENCES