

Microanalytical Quality of Wheat Flour

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ABSTRACT

A survey was made to determine the sanitary quality of wheat flour. Samples were collected and analyzed by the USDA Federal Grain Inspection Service under the quality check program for contract government purchases. The Association of Official Analytical Chemists' method for light filth in flour was used to extract fragments of insects, feathers and rodent hairs; insect heads, larvae, mites and psocids. Insect fragments were most frequently encountered: 83% of the samples contained insect fragments, with counts ranging from 0 to 721 and a mean of 12.52. Ranges of other counts were rodent hair fragments, 0 to 75; feather barbules, 0 to 3; insect heads, 0 to 2; mites, 0 to 2; insect larvae, 0 to 3; psocids 0 to 1.

The concern of the Food and Drug Administration (FDA) about the quality of wheat flour dates back to a 1944 survey on wheat milling and its relationship to insect and rodent contamination of flour (2). That survey determined that insect fragments in flour are contributed primarily by insects inside the wheat kernel and that rodent hair fragments in flour result from rodent pellets in the wheat used to produce the flour. In a 1950 investigation of insect and rodent contamination of wheat and wheat flour, Harris et al. (3) found that the number of insect fragments in flour is closely related to the number of whole or equivalent insects (insect heads, head capsules, cast skins) inside the wheat kernel. Analytical surveys were conducted in 1953, 1954 and 1955 to determine the levels of insect and rodent hair fragments in retail market and mill samples of flour; however, none of these studies resulted in the establishment of regulatory limits to control insect and animal contamination in wheat flour. In 1975 the FDA initiated a study to develop data on levels of contamination in wheat flour by insects, birds, rodents and other animals. The sampling and analytical details of that program are presented in this report.

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MATERIAL AND METHODS

The samples were collected by agents of the U.S. Department of Agriculture (USDA) under the routine quality check program for contract government purchases. Finished product samples were collected from production lines of 72 flour mills in the United States.

Each sample represented a production lot of 60,000 to 100,000 lb of flour and consisted of composited portions from 10- and 50-lb bags of flour drawn periodically from the production line. The flours represented the major USDA wheat classes (hard red spring, hard red winter, soft red winter, white and mixed), excluding durum and red durum. Of the samples collected, 98% consisted of various blends of all-purpose flour. They were analyzed by the USDA Grain Division according to method 44.045 of the Association of Official Analytical Chemists (4). Data are available on 5,081 samples of flour collected from 1969 to 1979.

TABLE 1. *Frequency distribution of insect fragment counts.*

Insect fragment counts	No. of samples	% of samples
0	862	17.0
1- 10	2,954	58.2
11- 20	554	10.9
21- 30	193	3.8
31- 40	123	2.4
41- 50	79	1.5
51- 60	57	1.1
61- 70	46	0.9
71- 80	38	0.8
81- 90	16	0.3
91-100	15	0.3
101-150	127	2.5
151-200	7	0.1
201-300	3	0.1
301-721	7	0.1

RESULTS AND DISCUSSION

The defects found in 100-g samples of wheat flour were insect and rodent hair fragments, feather barbules, insect heads, mites, larvae and psocids. Frequency distribution for these defects is given in Tables 1-3. Statistical summaries of the defects are given in Table 4.

Fragments from the various life stages of insects inside the wheat kernel remain in flour if they are not completely removed by the usual wheat-cleaning methods. The insects

TABLE 2. Frequency distribution of rodent hair fragment counts.

Rodent hair fragment count	No. of samples	% of samples
0	4,187	82.40
1	738	14.53
2	108	2.13
3	25	0.49
4	9	0.17
5	6	0.12
6	3	0.06
11	1	0.02
14	1	0.02
52	1	0.02
74	1	0.02
75	1	0.02

TABLE 3. Frequency distributions of defects in flour.

Defect count	No. of samples				
	Psocids	Larvae	Mites	Insect heads	Feather barbules
0	5,072	5,064	5,052	5,014	4,952
1	9	16	26	63	116
2		1	3	4	12
3					1

TABLE 4. Statistical summary of defects found in wheat flour.

Defect	Mean	Range	% of samples with defects
Insect fragments	12.52	0-721	83.0
Rodent hairs	0.26	0- 75	17.6
Feather barbules	0.03	0- 3	2.5
Insect heads	0.01	0- 2	1.3
Mites	0.01	0- 2	0.6
Larvae	0.00	0- 3	0.3
Psocids	0.00	0- 1	0.2

which usually contaminate wheat flour are the rice and granary weevils and the lesser grain borer. Other stored grain pests include cadelle beetles, confused and red flour beetles, flat grain beetles, rust red grain beetles, saw-toothed grain beetles, mites and psocids, all of which are surface feeders and are, for the most part, readily removed from the wheat before the milling process (5). Insect fragments were found in 83% of the samples, with counts ranging from 0 to 721 and a mean of 12.52. Insect heads were found in 1.3% of the samples, with counts ranging from 0 to 2 and a mean of 0.01. Mites were found in 0.6% of the samples, with counts ranging from 0 to 2 and a mean of

0.01. Larvae were found in 0.3% of the samples, with counts ranging from 0 to 3 and a mean of 0.00. Psocids were found in 0.2% of the samples, with counts ranging from 0 to 1 and a mean of 0.00.

Rats and mice contaminate wheat with fecal pellets, urine and hair; fecal pellets are the primary source of rodent hair fragments in flour. Rodent pellet contamination may originate in farm machinery, temporary open grain storage, transport vehicles and storage facilities (1). Rodent hair fragments were found in 17.6% of the samples, with counts ranging from 0 to 75 and a mean of 0.26.

Birds contaminate wheat with excreta droppings and feathers; feather fragments are the primary bird-contaminant found in flour. Sources of bird contamination include farm equipment, temporary open storage and storage facilities that are inadequately bird-proofed (1). Feather barbules were found in 2.5% of the samples, with counts ranging from 0 to 3 and a mean of 0.26.

TABLE 5. Frequency distribution of mean insect fragment counts by mills and samples.

Mean insect fragment count	No. of mills	% of mills	No. of samples	% of samples
1.0-10.0	52	72.2	1,398	27.5
10.1-20.0	15	20.8	3,140	61.8
20.1-30.0	4	5.6	402	7.9
30.1-40.0	1	1.4	141	2.8

Table 5 gives the frequency distribution of mean insect fragment counts by mills and samples. Mean insect fragment counts of 20 or less were observed in 93% of the mills, which represented approximately 90% of the samples.

TABLE 6. Mean insect and rodent hair fragment counts by production year.

Year	No. of samples	Mean insect fragment count	Mean rodent hair count
1969	15	3.9	0.3
1970	74	5.9	0.3
1971	130	5.2	0.3
1972	1,472	9.6	0.2
1973	2,092	14.3	0.3
1974	1,147	13.8	0.3
1975	128	16.8	0.3
1976	32	8.1	0.2
1977	176	9.0	0.1
1978	1,312	18.7	0.1
1979	651	13.3	0.1

Table 6 shows the mean insect fragment and rodent hair fragment counts by production year. Mean insect fragment counts ranged from 3.9 in 1969 to 18.7 in 1978 and fluctuated erratically in the years between. Mean rodent hair fragment counts ranged from 0.1 in 1979 to 0.3 in 1969. The decreasing trend shown over the ten-year period may

reflect the stricter regulatory guidelines for rodent pellets in wheat, which became effective in 1977.

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