

Effect of Wheat Infestation by Different Stages of the Lesser Grain Borer on Final Counts of Insect Fragments in Milled Flour

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INTRODUCTION

- The Food and Drug Administration (FDA) has established a Defect Action Level (DAL) of 75 insect fragments per 50 g of flour as the regulatory standard for quality control.
- The relationship between infestation level of wheat and the number of insect fragments produced in the flour is complex and may be influenced by several factors, such as insect species and stage and whether they are alive or dead, the type of wheat, the type of sieve used, and the milling process.
- The current method used by the FDA to quantify insect fragments is labor intensive and expensive because it involves extracting, and counting microscopically the number of insect fragments produced.
- The specific objectives of this study were (1) to determine the relative number of fragments produced by larval, pupal, and adult stages of the lesser grain borer; (2) to characterize the relationship between different levels of internal wheat infestation and the number of insect fragments produced in flour; (3) to develop models to predict the maximum level of wheat infestation than can be accepted to produce flour with fragments below the FDA DAL; and (4) to compare the sensitivity of three near-infrared instruments for detection of insect fragments.

METHODS

- Batches of 100 g of wheat were infested with ten levels of infestation by larvae, pupae, or newly emerged adults of lesser grain borer (Fig. 1) to determine the number of fragments that result from each life stage when the wheat is milled.
- Individual wheat samples (100 g) were conditioned to 15% moisture content and milled on an experimental mill at the USDA-ARS-GMPRC-Wheat Quality Laboratory.
- The Standard Flotation Method was used to determine the number of fragments in the milled flour samples.
- Three different NIR-instruments: Cognis-QTA, Perten DA 7000, and Foss 6500 (Fig. 2) were used to collect spectral data.
- Calibration models were developed with partial least square (PLS) for each NIR-instrument and for each stage infesting the grain by scanning 5 flour samples of each insect-stage infestation level (N = 150), and then models that combined data from the three insect stages were developed.



Fig. 1



Fig. 2

RESULTS

Effects of Grain Insect Infestation on Fragments Counts Produced in Flour

- Fragment counts in flour prepared with wheat samples containing different numbers of kernels infested with larvae were much lower than those present in flour samples from wheat infested with pupae and adults (Table 1).

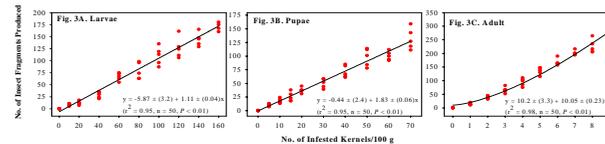
Table 1. Mean number of insect fragments recovered in flour from wheat samples (100 g) infested with three stages and different infestation levels of the lesser grain borer, *Rhyzopertha dominica*.

% Infestation	Larvae		Pupae		Newly Emerged Adults*		
	No. of Infested Kernels/100 g	Fragment Counts*	% Infestation	Fragment Counts*	% Infestation	Fragment Counts*	
0	0	0 ± 0	0	0 ± 0	0	0 ± 0	
0.25	10	8.6 ± 1.1	0.125	5	10.6 ± 1.0	0.025	1
0.50	20	12.0 ± 1.8	0.250	10	17.6 ± 2.0	0.050	2
1.00	40	28.9 ± 2.8	0.375	15	25.4 ± 3.9	0.075	3
1.50	60	66.8 ± 3.6	0.500	20	37.6 ± 2.2	0.100	4
2.00	80	78.8 ± 7.7	0.750	30	50.2 ± 3.8	0.125	5
2.50	100	110.0 ± 8.5	1.000	40	71.8 ± 7.3	0.150	6
3.00	120	126.2 ± 9.7	1.250	50	97.8 ± 7.3	0.175	7
3.50	140	144.2 ± 6.2	1.500	60	100.6 ± 3.7	0.200	8
4.00	160	178.0 ± 8.3	1.750	70	131.6 ± 8.7	0.225	9

* Inside wheat kernels
* Mean ± SEM

- The mean number of insect fragments produced by an individual infested kernel with one larva, one pupa, or one adult was: 1.0 ± 0.06 , 1.8 ± 0.05 , and 24.6 ± 1.8 , respectively.

- The number of insect fragments produced in flour increased as the levels of internal wheat infestation with larvae, pupae, and adults increased (Fig. 3).



Detection of Insect Fragments by NIRS

Fragments from Larvae

- NIR spectra generated with the three instruments correlated well with actual number of insect fragments present in the flour samples (Fig. 4A). The r^2 values ranged from 0.88 to 0.92.

- Over 92% of flour samples containing 30 or less fragments were correctly classified as having less than 60 fragments by the three NIR-models.

Fragments from Pupae

- NIR spectra generated with the three instruments correlated well with the actual number of fragments present in the flour samples (Fig. 4B). The r^2 values ranged from 0.88 to 0.90.

- Over 93% of flour samples containing 30 or less insect fragments were correctly classified as having less than 60 fragments.

Fragments from Adults

- NIR spectra generated with the three instruments tested correlated well with actual number of insect fragments present in the flour samples (Fig. 4C). The r^2 values ranged from 0.53 to 0.88.

- 50% (Foss), 78% (QTA), and 80% (Perten) of flour samples containing 30 or less fragments were correctly classified as having less than 60 fragments by the models.

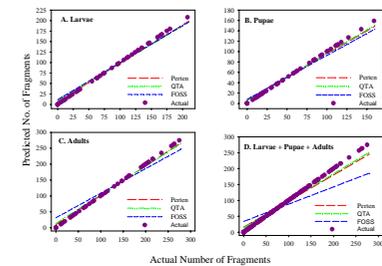


Fig. 4

Fragments from Larvae + Pupae + Adults

- NIR spectra obtained from flour samples containing fragments from larvae, pupae, and adults (combined models), correlated well with actual number of fragments (Fig. 4D). However, r^2 values ranged from 0.53 to 0.88.
- With those models, 45% (Foss), 66% (Perten), and 82% (QTA) of flour samples containing 30 or less fragments were correctly classified as having less than 60 fragments.

SUMMARY

- The number of insect fragments produced in flour was directly proportional to the internal level of infestation with larvae, pupae, or newly emerged adults.
- Wheat samples containing a single kernel infested with one adult contributed 24.4× and 13.7× as many fragments as wheat kernels infested with one larva or pupa, respectively.
- More than 92% of flour samples containing 30 or less fragments were correctly classified as having less than 60 fragments by the NIR-models generated from flour infested with larvae or pupae.
- 82% of flour samples were correctly classified as having 60 or less fragments by the combined NIR-model developed with the QTA instrument.