Development of Six Species of Stored-Product Insects on Multi-Grain Blend Supplement[1,2]

Michael A. Mullen and Henry A. Highland

Stored-Product Insects Research and Development Laboratory, USDA-ARS
Savannah, GA 31403

J. Entomol. Sci. 25(1): 21-24 (January 1990)

ABSTRACT A multi-grain blend intended as a flour supplement to fill the void between brown and white bread and provide an economical source of protein and fiber was tested to determine the potential for infestation by six species of stored product insects. The blend was compared to a standard rearing medium and bleached white flour and was found to be a suitable medium for the red flour beetle, *Tribolium castaneum* (Herbst), the cigarette beetle, *Lasioderma serricorne* (F.), and the lesser grain borer, *Rhyzopertha dominica* (F.). The warehouse beetle, *Trogoderma variable* Ballion, and the almond moth, *Cadra cautella* (Walker), were able to reproduce at reduced rates and only the Indianmeal moth, *Plodia interpunctella* (Hübner), performed poorly on the multi-grain blend. With the exception of the almond moth, development times for the other species on the multi-grain blend were similar to that of the rearing medium. Because of the potential for infestation, proper packaging and storage will be needed to protect this product.

KEY WORDS Insect Resistant Packaging, Insect Survival, Stored-Product Insects.

With increased health consciousness and more sophisticated dietary awareness, the baking industry is developing high fiber, nutritious, and tasty breads to satisfy consumers. One product, a multi-grain blend, has been developed by Pizza Technologies of Raleigh, NC to fill a void between brown bread and white bread. This blend is an economical source of protein and fiber and has been proposed for use by the military, in school lunch programs, and in other markets. Because large quantities of this product may be stored for up to six months in non-refrigerated storage, high quality must be maintained under a variety of conditions. Similar products, containing high-protein soy blend, can become heavily infested by many common stored product insects in a short time (Highland 1974).

Materials and Methods

As the initial step in determining suitable protective packaging for this product, we assessed the ability of six cosmopolitan species of stored product insects to develop on this multi-grain blend. The insects were from stock laboratory cultures and included the cigarette beetle, *Lasioderma serricorne* (F.), the warehouse

[1] Accepted for publication 11 July 1989.

[2] This paper reflects the results of research only. Mention of a proprietary product does not constitute an endorsement by the USDA.

http://prime-pdf-watermark.prime-prod.pubfactory.com/ | 2025-01-25

beetle, *Trogoderma variable* Ballion, the red flour beetle, *Tribolium castaneum* (Herbst), the lesser grain borer, *Rhyzopertha dominica* (F.), the almond moth, *Cadra cautella* (Walker), and the Indianmeal moth, *Plodia interpunctella* (Hübner). The cigarette beetle and the lesser grain borer are considered good package penetrators (Highland 1983). The remaining species, although not generally considered as penetrators, are invaders and are capable of entering packages through small openings (Highland 1983).

Tests were conducted at the Stored-Product Insects Research and Development Laboratory Savannah, GA, with multi-grain blend samples provided by the manufacturer. The blend contains a mixture of wheat bran, whole wheat, wheat gluten, rye flour, corn flour, oatmeal, soy flour, barley flakes, and rice flour. Nutritionally, it contains 13.5-15% protein, 10-12% moisture, and 43% fiber.

All tests were conducted in 0.95 l glass jars containing 250 g of multi-grain blend, bleached white flour, or the standard rearing medium used to maintain laboratory cultures. The media for each species have been described elsewhere (Singh and Moore 1985).

Five pairs of adults were placed in each jar for 5 days. The adults were removed and the jars were held at 27±2°F and 60±5% RH with 12:12 L:D photoperiod cycle until progeny matured and emerged. F_1 adults were removed daily, counted, and the time to first and last emergence was noted. Each species was replicated five times for the multi-grain blend and three times each for the rearing medium and flour. The rearing medium and flour were included as potentially the most and least suitable, respectively, growth medium for each species.

The moisture content of the multi-grain blend and the flour were determined with a Motomco® Model 919 moisture meter and a Burrows® Digital Moisture Computer Model 700, respectively. The moisture content of the moth rearing medium was determined by oven-drying freshly made medium at 66° C until no further weight loss occurred.

Differences between species were separated by using ANOVA ($P<0.05$) and Duncan's Multiple Range Test (SAS 1982).

Results and Discussion

The multi-grain blend was a favorable medium for most insects tested (Table 1). Only the Indianmeal moth did not do well on this medium with a mean of 10 adults emerging compared to a mean of 352 adults emerging from the laborataory medium. However, there was an abundance of first instar larvae on the multi-grain blend that failed to survive. The larvae survived for several weeks but apparently fed little and died before or shortly after reaching the second instar. These results are similar to those reported for the Mediterranean flour moth, *Anagasta kuehniella* (Zeller), on whey-soy drink mix (Cline 1982). Adults that emerged from the multi-grain blend appeared smaller than normal, indicating a possible dietary deficiency. The limiting dietary factor may have been the low moisture. The moisture level of the blend tested was 11%, which was well below that of the moth rearing medium at 18% and the flour at 13%. Flour was the poorest growth medium, producing only one adult. As the case with the multi-grain blend, larvae failed to develop beyond the first instar.

http://prime-pdf-watermark.prime-prod.pubfactory.com/ | 2025-01-25

Table 1. Days to produce adult progeny and total progeny production by six species of stored-product insects feeding on multi-grain blend (MGB), rearing medium (MED) or bleached white flour.*

Species	Diet	Development period (Days) ($\bar{x} \pm SE$)	Number of adult progeny per jar ($\bar{x} \pm SE$)
Almond moth	MGB	67 ± 3a	175 ± 10b
	MED	27 ± 3b	671 ± 40a
	Flour	—— †	—— †
Indianmeal moth	MGB	48 ± 3a	10 ± 2b
	MED	49 ± 2a	252 ± 23a
	Flour	33 ± 0a	1 b
Red flour beetle	MGB	40 ± 3a	308 ± 46a
	MED	36 ± 2a	322 ± 40a
	Flour	40 ± 2a	228 ± 21b
Cigarette beetle	MGB	41 ± 3a	313 ± 67b
	MED	38 ± 3a	520 ± 72a
	Flour	45 ± 3a	390 ± 34b
Lesser Grain Borer	MGB	56 ± 2a	180 ± 35a
	MED	55 ± 2a	262 ± 106a
	Flour	57 ± 2a	79 ± 112b
Warehouse Beetle	MGB	59 ± 2a	48 ± 20b
	MED	59 ± 2a	113 ± 13a
	Flour	81 ± 2b	31 ± 7b

* Means for each species in each column followed by the same letter are not significantly different at the $P < 0.05$ level using ANOVA and Duncan's Multiple range test for mean separation (SAS 1982).
† Almond moths failed to develop, although first instars were noted.

More almond moths than Indianmeal moths developed on the multi-grain blend. However, the standard rearing medium yielded almost four times the number of adults as did the multi-grain blend, and the development times were longer on the multi-grain blend than on the rearing medium. Slower development rates and smaller adults possibly were due to the relatively low moisture content of the multi-grain blend. No almond moths developed on the flour although large numbers of first instar larvae were noted.

Red flour beetles developed as well on multi-grain blend and the flour as on the standard rearing medium. Mean development time for the red flour beetle was similar on the multi-grain blend and on the rearing medium, and the time from first to last emergence was 19 and 15 days for insects reared on the multi-grain blend and the rearing medium, respectively. Fewer adult red flour beetles emerged from the flour than from the multi-grain blend or rearing medium.

http://prime-pdf-watermark.prime-prod.pubfactory.com/ | 2025-01-25

The cigarette beetle developed in greater numbers on rearing medium than on the multi-grain blend; however, development time was not significantly different.

Mean development time for the lesser grain borer was 55-57 days for the three growth media. The time to first adult emergence was the same, but the time to last emergence differed. The adults emerged from the multi-grain blend for 43 days while emergence on the rearing medium and flour was 24 and 27 days, respectively. Population growth was similar on the rearing medium, and multi-grain blend and lowest on flour.

Progeny production of the warehouse beetle was the poorest of all beetle species on the multi-grain blend with approximately one-half the number of adults emerging as from the laboratory medium. The mean development time on multi-grain blend was equal to that on the rearing medium, and only the time from first to last emergence was longer.

The results show that the insects tested will successfully develop and reproduce on the multi-grain blend. This indicates a potential for serious insect infestations, especially if the blend is to be stored for extended periods without refrigeration. As subsequent generations adapt to the diet, infestation problems would probably increase.

The multi-grain blend is sold by the manufacturer in heat-sealed polyethylene bags, composite cans and multi-wall paper bags. Storage at 3.3 to 4.4°C is recommended to prevent spoilage and insect infestation. The only approved insect resistant multi-wall bags are those treated with synergized pyrethrins. These bags are no longer available and care must be exercised to prevent insect infestation. Polyethylene bags and untreated multi-wall bags offer only moderate protection against insect infestation. As demonstrated in this study, the multi-grain blend is a suitable growth medium for several serious stored product insect pests. Because storage and handling conditions may vary in the U.S. and abroad, care must be exercised to properly package the product to prevent infestation.

References Cited

Cline, L. Daniel. 1982. Development of seven species of stored-product insects on whey-soy drink mix. J. Ga. Entomol. Soc. 17(3): 308-15.

Highland, Henry A. 1974. Insect infestation of protein fortified cereal blends. Cereal Sci. Today. 19(6): 235-37.

Highland, Henry A. 1983. Insect infestation of packages. pp. 309-20. *In* Baur, F. J. [eds]. Insect Management for Food Storage and Processing. Am. Assoc. Cereal Chem.

SAS Institute. 1982. SAS user's guide: statistics. SAS Institute Inc., Cary, NC 950 pp.

Singh, Pritam and Moore, R. F. [eds]. 1985. Handbook of Insect Rearing, Vol. I and II. Elsevier Sci. Pub., New York.

http://prime-pdf-watermark.prime-prod.pubfactory.com/ | 2025-01-25