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Ability of Selected Stored-product Insects to Infest Polyurethane Foams Containing Canary Corn (Maize) Dextrin*

JAMES E. THRONE[1] AND R. LEO CUNNINGHAM[2]

[1]*Agricultural Research Service, U.S. Department of Agriculture, Stored-Product Insects Research and Development Laboratory, 3401 Edwin St, Savannah, GA 31405, U.S.A. and* [2]*Agricultural Research Service, U.S. Department of Agriculture, National Center for Agricultural Utilization Research, Food Physical Chemistry Research, Peoria, IL 61604, U.S.A.*

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Abstract—Polyurethane foams prepared with or without a canary corn (maize) dextrin filler were exposed to five common pests of stored products [*Cryptolestes ferrugineus* (Stephens), *Plodia interpunctella* (Hübner), *Rhyzopertha dominica* (F.), *Sitophilus zeamais* Motschulsky, *Tribolium castaneum* (Herbst)] to determine whether the dextrin affected the susceptibility of the foams to infestation by these stored-product insects. Grain diets were included as controls. No adult progeny were produced on either of the types of foam. The addition of dextrin to polyurethane foams did not make the foams susceptible to infestation by these stored-product insects.

Key words—canary corn (maize) dextrin, insect infestation, pest potential, polyurethane foam, stored-product insects.

INTRODUCTION

Polyurethane foams containing canary corn (maize) dextrin (partially hydrolyzed cornstarch) have been shown to be a suitable alternative to standard polyurethane foams that are used primarily in the construction industry for insulation (Cunningham *et al.*, 1992). The addition of dextrin to polyurethane foams may reduce cost and does provide additional markets for agricultural products. However, corn dextrin is a potential food source for stored-product insects that may feed on many different grain products (Cotton and Wilbur, 1974). These insects are ubiquitous (Linsley, 1944), and one would expect that polyurethane foams used in the construction of buildings might be exposed to infestation by stored-product insects. Therefore, the present study was initiated to determine the ability of some common stored-product insect pests to infest polyurethane foam containing dextrin.

MATERIALS AND METHODS

Cubes (2.54 cm) of polyurethane foam either made without canary corn dextrin (Amaizo 1752S dextrin, American Maize-Products Co., Hammond, IN, U.S.A) or containing 7.4% by weight

*The mention of firm names or trade products does not imply that they are endorsed or recommended by the U.S. Department of Agriculture over other firms or similar products not mentioned.

excluding blowing agent, of the dextrin were used in the study. Initial weight of the foam cubes ranged from 0.39 to 0.42 g.

The insects tested were *Cryptolestes ferrugineus* (Stephens) (Coleoptera: Cucujidae), *Plodia interpunctella* (Hübner) (Lepidoptera: Pyralidae), *Rhyzopertha dominica* (F.) (Coleoptera: Bostrichidae), *Sitophilus zeamais* Motschulsky (Coleoptera: Curculionidae), and *Tribolium castaneum* (Herbst) (Coleoptera: Tenebrionidae). The *P. interpunctella*, *R. dominica* and *T. castaneum* were from cultures that have been maintained in the laboratory for many years. The *S. zeamais* were third-laboratory generation and the *C. ferrugineus* were second-laboratory generation, and were from cultures that were started with adults obtained in or around bins of corn on farms in Bamberg and Barnwell Counties, SC, U.S.A. Rearing medium was cracked corn for *C. ferrugineus*; a mixture of 4 parts by volume of white cornmeal, 4 parts whole wheat flour, 2 parts dog food pellets, 1 part yeast, 1 part honey, 1 part glycerine, 1 part rolled oats, and 0.5 part wheat germ for *P. interpunctella*; a mixture of 99 parts by weight soft red winter wheat and 1 part yeast for *R. dominica*; whole corn for *S. zeamais*; and 10 parts by volume white flour, 10 parts white cornmeal, and 1.5 parts yeast for *T. castaneum*. Rearing conditions were 30 ± 1°C and 60–65% relative humidity for *C. ferrugineus*; 25 ± 1°C and 60–65% relative humidity for *S. zeamais*; and 27 ± 1°C and 60 ± 5% relative humidity for *P. interpunctella*, *R. dominica* and *T. castaneum*. These insects were chosen for the study because of differences in their feeding habits. *R. dominica* and *S. zeamais* are primary pests that may damage sound grain (Anonymous, 1986). The other three species primarily attack only damaged kernels.

A foam cube made with dextrin was placed in each of 15 40-dram-styrene tubes (BioQuip Products, Gardena, CA, U.S.A; 49-mm i.d. by 85-mm H). A 35-mm-dia. hole was cut into the lid and base of each tube and covered with 64-μ-mesh nylon screen (Tetko Inc., Briarcliff Manor, NY, U.S.A.). A foam cube made without dextrin was placed in each of an additional 15 tubes. Assorted grain diets were added to each of 15 tubes for control treatments. These diets had a volume of 16.5 ml, which was *ca* the volume of a foam cube. The grain diets were 1991 crop "Pioneer 3320" corn that had previously been sieved over 4.76 and 11.11 mm round-hole sieves for *S. zeamais*; coarsely cracked corn that had previously been sieved over 1.02 and 4.76 mm round-hole sieves for *C. ferrugineus* and *P. interpunctella*; a soft, red winter wheat that was primarily "FL 302" for *R. dominica*; and Con-Agra Hotel and Restaurant Flour (Omaha, NE, U.S.A.) for *T. castaneum*.

The 45 tubes (3 treatments by 5 species by 3 replications) were divided among three plastic boxes (40 × 27.5 × 16-cm H), one replication per box, containing a perforated false floor below which was a saturated sodium chloride (NaCl) solution. This salt solution maintains relative humidity at 75% (Greenspan, 1977). The plastic boxes were placed in an environmental chamber maintained at 30 C and 12:12 L:D, and the diets and foam cubes were allowed to equilibrate to the test conditions for 6 weeks prior to the start of the test.

After the equilibration period, three presumably-mated pairs of each of the species of test insects (except for *R. dominica*, which were unsexed) were placed into tubes, three pairs of one species per tube. Moths (which are short-lived) were 2–3 days old at the start of the test, and beetles (which are long-lived) were 2–3 weeks old. The insects were allowed to feed and reproduce for 12 weeks, sufficient time for at least one generation of insects to develop at these conditions (Howe, 1965), and then the contents of the tubes were examined for insects and insect damage. The observed numbers of adult progeny present at the end of the test were tested with *t*-tests to determine whether the populations had increased significantly beyond the original 6 adults.

RESULTS

C. ferrugineus, *R. dominica* and *S. zeamais* populations increased significantly on the control diets during the study period (Table 1). Although the number of adult *P. interpunctella* and *T. castaneum* in tubes containing control diets was not increased at the end of the study, there was evidence that large populations of both species had developed (Table 1).

No adult progeny were produced in any of the tubes containing foam cubes (Table 1). All species made small punctures in the foam. These punctures were presumably made to try to tunnel into the foam for shelter. There was no evidence, such as the presence of foam in the frass, that the insects were feeding on the foam. *P. interpunctella* laid many eggs in the tubes containing foam

Table 1. Mean (±SD) number of adults present after 12 weeks in tubes containing foam made either with or without canary corn dextrin and on a grain diet

	Foam with dextrin		Foam without dextrin		Grain diet	
Species	Live	Dead	Live	Dead	Live	Dead
Cryptolestes ferrugineus	0 ± 0	6 ± 0	0 ± 0	6 ± 0	12.3 ± 7.2	4.7 ± 1.5*
Plodia interpunctella	0 ± 0	6 ± 0[a]	0 ± 0	6 ± 0[b]	0.0 ± 0.0	6.7 ± 1.2[c]
Rhyzopertha dominica	0 ± 0	6 ± 0	0 ± 0	6 ± 0	136.7 ± 5.9	13.3 ± 5.1[d]*
Sitophilus zeamais	0 ± 0	6 ± 0	0 ± 0	6 ± 0	77.3 ± 15.5	0.7 ± 1.2*
Tribolium castaneum	0 ± 0	6 ± 0	0 ± 0	6 ± 0	0.0 ± 0.0	7.7 ± 12.4[e]

*Number of adults (total of live plus dead) significantly different from 6 (*t*-test, $df = 2$, $\alpha = 0.05$).
[a]140.3 ± 65.0 hatched eggs, 42.3 ± 13.3 unhatched eggs, and several dead larvae were also present.
[b]165.3 ± 55.6 hatched eggs, 56.3 ± 12.0 unhatched eggs, and several dead larvae were also present.
[c]Extensive webbing (which is produced by larvae) and many body parts of adults were present, indicating populations had developed and depleted the available food.
[d]An additional 143.3 ± 63.1 adults had escaped and were present in the salt solution.
[e]An additional 14.0 ± 7.0 adults and large numbers of larvae had escaped and were dead in the salt solution.

and parts of several dead larvae were found in these tubes. *P. interpunctella* will lay their eggs whether or not a food source is available (Mullen and Arbogast, 1977), so the presence of the foam may not have influenced their egg laying. The dead *P. interpunctella* larvae were small and covered with mold, so they presumably died young without feeding. However, one *P. interpunctella* larva, one *R. dominica* adult, and two *C. ferrugineus* adults died in tunnels in the foam.

DISCUSSION

The addition of canary corn dextrin to the polyurethane foam did not affect its susceptibility to infestation by the species tested. Presumably, the dextrin combines with the polyurethane in a manner that makes it unavailable to the insects. Neither the foam made with dextrin nor the foam made without dextrin were susceptible to insect infestation.

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