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D.P. LOCATELLI, L. LIMONTA

Influence of food on eggs' hatching of *Plodia interpunctella* (Hbn.) (Lepidoptera Pyralidae)

Abstract - The influence of food on eggs' hatching of *Plodia interpunctella* (Hbn.) was valued; 24 substrates were tested. 100 eggs were placed on a first layer of product about 2-3mm thick and afterwards they were covered with a second layer of equal thickness. 4 replications were carried out for every product. In absence of food, the eggs show the highest average values for hatching (95±0.4). The lowest average values of hatching were observed on finely ground pine seeds (6±0.7) and on finely ground almonds (11.8±1.4), while those higher than 90 are observed for castor sugar, powdered cinnamon, dried yeast and powdered garlic.

Riassunto - *Influenza del substrato alimentare sulla schiusura delle uova di* Plodia interpunctella *(Hbn.) (Lepidoptera Pyralidae)*

E' stata valutata l'influenza del substrato alimentare sulla schiusura delle uova di *Plodia interpunctella* (Hbn.); sono stati saggiati ventiquattro substrati. Cento uova sono state distribuite su un primo strato di prodotto dello spessore di circa 2-3mm e successivamente sono state ricoperte con un secondo strato di uguale spessore. Per ogni prodotto sono state effettuate quattro replicazioni. Le uova in assenza di substrato mostrano i valori medi di schiusura più elevati (95±0.4). I valori medi di schiusura più bassi sono stati osservati su farina di pinoli (6±0.7) e farina di mandorle (11.8±1.4), mentre quelli superiori a 90 si osservano per zucchero semolato, cannella in polvere, lievito di birra in polvere e aglio in polvere.

Key words: *Plodia interpunctella*, foods, eggs' hatching.

INTRODUCTION

Plodia interpunctella (Hbn.) is a typical insect of environments, where food is manufactured and stocked, and that can affect different products. The female produ-

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* Authors have equally contributed to this research.

ces the majority of eggs at 25°C and 75% R.H. (Abdel-Rahman, 1971). The ideal temperatures for oviposition range between 20 and 30°C (Mbata, 1986). The relative humidity doesn't affect significantly fertility at temperatures between 15 and 25°C, while between 30 and 35°C high values of humidity cause an increase of the number of laid eggs (Mbata, 1985). Females lay eggs near or directly on the product, frequently choosing food already infested by larvae of the same species (Anderson and Löfqvist, 1996). This attitude is induced by the presence of attractive substances, similar to sexual pheromones, secreted by mandibular glands of larvae. Unlike pheromones, these substances are little volatile and rather persistent, in order to lead the adults just emerged to pollute the foodstuff again (Philips and Strand, 1994). Notwithstanding this, eggs happen to be laid also on products that don't allow the insects to complete their biological cycle. Mbata (1990) showed that this species lays a variable number of eggs according to the varieties of maize and that broken kernels reduce developmental period of larvae. A number of eggs, 3 or 4 times higher than that recorded on dried, not toasted fruits, is observed on toasted almonds and hazelnuts (Hoppe, 1981). The capability of eggs' hatching increases in relation to relative humidity, in fact at 26°C a percentage of hatching respectively of 77.21 and 95.37% is recorded with relative humidity of 31 and 91% (Abe, 1939).

There are several references about the number of eggs laid by the female and about the period of postembryonic development of *P. interpunctella* in relation to food, while the influence of substrate on eggs' hatching is not yet studied.

MATERIALS AND METHODS

The test was carried out on 24 food products whose composition is listed in Table 1.

Eggs laid from 4 to 24 hours were counted and controlled under a stereo-microscope (40 magnification) in order to eliminate those abnormal, damaged and clustered or with anomalous colourings. To verify the influence of food on hatching, 100 eggs were placed on a first layer of product about 2-3 mm thick and, afterwards, they were covered with a second layer of equal thickness. The plates (Ø 5.5 cm) containing the eggs scattered in the substrate, were placed inside larger dishes (diameter 8.5 cm). The bottom of the largest dish was covered by a veil of glycerine in order to capture emerging larvae.

The tests were placed in air conditioned cells at the temperatures of 26±1°C, 70±5% R.H. and photoperiod 16:8.The dishes were daily observed for a period of 8 days, removing the emerged larvae. The larvae present in food and in the glycerine were counted, in order to calculate the percentage of hatching.

The control was observed according to the same method, by placing eggs directly on the smallest dish.

4 replications were carried out for every product and for the control. Data were subjected to Anova and Duncan test (SPSS 8.0 for Windows).

RESULTS

The values concerning eggs' hatching of *Plodia interpunctella* on different kind of food are listed in Table 2.

The control shows the highest average values of hatching (95±0.4) compared to those observed on other substrates. The lowest average values of hatching are observed on finely ground pine seeds (6±0.7) and almonds (11.8±1.4).

Average values of hatching higher than 90 are observed for castor sugar, powdered cinnamon, dried yeast and powdered garlic.

Table 1 – Average composition of food used in the test.

Food	Glucides	Proteins	Lipids	Water	Fibre and ashes
Flour type 00°	75.50	8.50	1.00	14.50	0.50
Durum wheat bran*	72.00	12.10	0.75	14.50	0.65
Corn meal˜	77.80	7.90	1.20	12.80	0.30
Italian plain flour˜	65.02	12.46	1.72	14.00	6.80
Potato flour°	80.68	0.88	0.05	17.76	0.63
Chestnut flour°	79.80	7.70	3.00	4.70	4.80
Icing sugar°	99.50	-	-	0.50	-
Castor sugar*	99.50	-	-	0.50	-
Finely ground peanuts*	18.60	26.00	47.50	5.60	2.30
Finely ground almonds*	16.00	19.00	54.00	7.00	4.00
Finely ground pine seeds˜	4.60	35.80	48.30	8.00	3.30
Cocoa powder°	37.70	21.60	28.90	9.00	2.80
Powdered milk°	59.30	13.30	21.40	2.50	3.50
Powdered garlic*	63.89	10.22	0.26	8.00	17.63
Chopped dried basil ˜	61.00	14.40	4.00	6.40	14.20
Powdered cinnamon°	79.80	3.90	3.20	9.50	3.60
Chopped dried onions˜	59.59	7.28	2.65	7.30	23.18
Chili powder*	54.70	10.67	2.73	8.84	23.06
Dried tomato˜	47.54	11.96	4.32	13.56	22.62
Chopped dried spinach ˜	28.75	23.00	4.60	8.00	35.65
Chopped dried courgettes˜	56.06	11.21	1.53	8.26	22.94
Dried yeast°	41.49	34.62	1.31	2.00	20.58
Baking powder°	18.90	0.10	0.20	1.00	79.80
Fine salt*	-	-	-	2.00	98.00

° food with granulometry inferior to 0,1.mm.
* food with granulometry included between 0.1 and 1 mm.
˜ food with granulometry superior to 1 mm.

Table 2 – Average number of hatched eggs of Plodia interpunctella *(Hbn.) placed in contact with every single food.*

Food	Average number of hatched eggs ± S.E.
Finely ground pine seeds	6.0±0.7a
Finely ground almonds	11.8±1.4b
Chili powder	39.0±2.6c
Chestnut flour	50.8±1.8d
Finely ground peanuts	52.0±2.2d
Corn flour	72.0±2.3e
Chopped dried onion	73.3±1.9ef
Cocoa powder	74.3±2.1efg
Chopped dried tomato	75.3±2.6efg
Potato flour	78.3±2.0fgh
Flour type 00	79.0±2.1fgh
Icing sugar	79.5±2.6ghi
Chopped dried courgettes	79.5±3.0ghi
Italian plain flour	82.0±1.5hij
Powdered milk	85.8±1.8jkl
Baking powder	86.3±1.6jklm
Fine salt	88.0±2.1jklmn
Chopped dried Spinach	88.0±0.7jklmn
Chopped dried basil	89.3±0.6klmno
Durum wheat bran	89.3±1.2klmno
Castor sugar	91.5±2.3lmno
Powdered cinnamon	91.8±1.7lmno
Dried yeast	92.5±2.2mno
Powdered garlic	94.3±1.4no
Control	95.0±0.4o

CONCLUSIONS

The highest percentage of hatching was observed for the control, so it seems that hatching is favoured by a direct contact with the environmental humidity while the influence of the content of food humidity is smaller. Also the period of postembryonic development doesn't depend on the water content of food. Savov (1973) in fact, in tests of rearing carried out on nuts and dehydrated fruits, observed that *P. interpunctella* develops more rapidly on dried fruits, characterized by a water content lesser than that one of dehydrated fruits. Abdel-Rahman *et al.* (1968) verified that on different cultivar of maize with equal content of humidity changes the term of larvae development.

Results show that ground products with a fat content higher than 40% (finely ground pine seeds, almonds and peanuts) negatively influence the hatching, probably

because the oils obtained with the product grinding plug chorion aeropyles, so preventing the egg respiration. Similar observations were made by Johnson *et al.* (1992) in a test where eggs were not directly in contact with food, but on some plastic dishes, placed on ground nuts (almonds, pistachios and walnuts), with a granulometry between 0.6 and 1.4 mm. Low values of hatching were recorded because of oil that spread through the plastic barrier. The same Authors observed that ground products characterized by a high content of fats like walnuts, almonds and pistachios can develop oxidative rancidity, that negatively affects eggs' hatching for the presence of aldehydes, ketones, alcohols. Oxidative rancidity of fats can be favoured by preservation at high temperatures, but also by the product grinding (Musco and Cruess, 1954). Values of fats inferior to 30% don't seem to affect negatively the hatching, like for cocoa powder and powdered milk. Hoppe (1981) observed on toasted cocoa beans and products based on cocoa without nuts a slow development and a high mortality of the larvae.

Fine salt and castor sugar don't prevent eggs hatching, while they can cause dehydration of the larvae by osmosis (Mansingh, 1981). Also semimanufactured for baking products containing 52% of sugar obstacle the insect growth (Locatelli and Biglia, 1995).

The baking powder (4.5% in baking products) doesn't inhibit eggs' hatching but affect the insect growth (Locatelli and Biglia, op. cit.).

Composition being equal, the granulometry influences eggs' hatching: in fact average values of hatching inferior to those obtained on castor sugar were obtained on icing sugar. The thin particles of icing sugar, probably obstruct chorion aeropyles making more difficult the respiration. Also in the case of the larvae spiracles are occluded by unpalatable and thin dusts, such as gluten of wheat, yolk of egg in powder, starches and ascorbic acid (Barrer and Jay, 1980).

Flour type 00 permits to obtain high values of hatching, but, as it presents a low content of B group vitamins and of mineral salts, only a scanty number of larvae reaches the adult stage (Thomas *et al.*, 1942).

Also food not suitable for larval development of this species such as baking powder and powdered milk (Locatelli and Biglia, op.cit.), fine salt, icing sugar and castor sugar (Mansingh, 1981) guarantee however the hatching of a high number of eggs, whose larvae potentially can move from these substrates to other product contiguous and suitable for the development as it could happen on shelves of stores and supermarkets, causing crossed infestations.

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PROF. DARIA PATRIZIA LOCATELLI - Istituto di Entomologia agraria. Università degli Studi di Milano, Via Celoria 2, I - 20133 Milano (Italy). E-mail: daria.locatelli@unimi.it.

DR. LIDIA LIMONTA - Istituto di Entomologia agraria. Università degli Studi di Milano, Via Celoria 2, I - 20133 Milano (Italy). E-mail: lidia.limonta@unimi.it.

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