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ScienceDirect
Journal of Stored Products Research 43 (2007) 118–122
Journal of STORED PRODUCTS RESEARCH
www.elsevier.com/locate/jspr

Studies on insect infestation in chocolates

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Accepted 22 February 2006

Abstract

The ability of stored-product pests including the cigarette beetle, Lasioderma serricorne, the sawtoothed grain beetle, Oryzaephilus surinamensis, the rust-red flour beetle, Tribolium castaneum, and the almond moth, Ephestia cautella, to infest chocolates under packaged and unpackaged conditions was investigated in the laboratory at 25±1 °C and 65±5% r.h. Four types of chocolates were investigated: milk, nut, dried fruit and nut, and wafer chocolates. Adults (beetles only, 20 per replicate) or eggs (30 per replicate) were released on unpackaged and packaged chocolates and infestation levels (number of living adults and larvae) were determined 45 days later. When adult beetles were released on unpackaged chocolates, the degree of infestation varied depending on the species and the type of chocolate. The highest infestation observed in unpackaged chocolate was that of O. surinamensis in wafer chocolate (mean 138.4). When eggs were released on unpackaged chocolates, the most numerous species was E. cautella in dried fruit and nut chocolate (mean population = 180.8). With packaged chocolates exposed to adults or eggs, insect infestation was nil or negligible (mean population <6.0). Although infestation levels were low, infestations were found in 50% of treatments over all. Damage to the packaging material along the folds or edges was observed in infested chocolates. The study has shown that milk, nut, dried fruit and nut, and wafer chocolates can support insect infestation and therefore, insect-proof packing of the chocolates and storage under hygienic conditions are important to avoid customers' complaints.

Keywords: Chocolates; Insect infestation; Ephestia cautella; Oryzaephilus surinamensis; Lasioderma serricorne; Tribolium castaneum

1. Introduction

Chocolate products in many forms and flavours are relished by people of all ages for their sweetness and richness in nutrition. The global confectionery market including chocolate products has been estimated to exceed $73.2 billion per annum and the annual global consumption of chocolate confectionery has been estimated as 6.5 million tonnes (CAOBISCO, 2004). Chocolate is prepared from a mixture of one or more of the following ingredients: cocoa bean/ nib/ press cake, cocoa dust, sugars, cocoa butter, milk solids and flavouring agents. Depending on its composition, chocolate is known as plain chocolate, milk chocolate, white chocolate, blended chocolate, bitter chocolate or composite chocolate. Cocoa, the basic ingredient in these chocolates varies from 20% to 60%. The type of packaging material used for chocolates varies; generally, aluminium foil, composite films, paper or plastic trays are used. The packaged chocolates are known to keep their quality up to 5 months when stored at 10–18 °C and 60–70% r.h. The actual storage period, however, may extend for a longer duration in the distribution network/ retail market.

Insect infestation in chocolates may occur at any stage from production to consumption. Insect infestations in and around chocolate manufacturing facilities have been reported in some countries (Bowditch and Madden, 1997; Wohlgemuth, 1992). It is recommended that chocolate products are stored in hygienic conditions in well-ventilated locations at 18–20 °C and <50% r.h. (ICCO, 2000). In the retail market, however, hygiene varies and accordingly the products are prone to infestation. When insects are found in the chocolates, consumers often direct their complaints to the manufacturer and the image of the company is affected (Highland, 1984). Customers'

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doi:10.1016/j.jspr.2006.02.001

Table 1
Details of the types of chocolates used for the experiments

Chocolate type	Unit weight (g)	Moisture content (%)	Packaging material used	
			Inner	Outer
Milk chocolate	42	1.1	12 μm foil/25 μm polyethylene	Printed paper
Nut chocolate	35	2.8	25 μm biaxially oriented polypropylene	Printed carton
Dried fruit and nut chocolate	80	3.2	12 μm foil/25 μm polyethylene	Printed paper
Wafer chocolate	15	2.4	Nil	12.5 μm polyethylene terephthalate/metallisation/ 17.5 μm biaxially oriented polypropylene

complaints about insect infestation in chocolates in the retail market in both developed and developing countries have been reported (Scheurer and Dubau, 1999).

Data on the infestability of different types of chocolates under packaged and unpackaged conditions by insect pests are lacking. Experiments, therefore, were conducted to study the infestability of different types of chocolates under packaged and unpackaged conditions by four common stored-product insect pests viz., the rust-red flour beetle, Tribolium castaneum (Herbst), the sawtoothed grain beetle, Oryzaephilus surinamensis (L.), the cigarette beetle, Lasioderma serricorne (L.), and the almond moth, Ephestia cautella (Walker), over a storage period of 45 days.

2. Materials and methods

2.1. Chocolates

Milk chocolate (ingredients: milk solids, cocoa butter, cocoa solids, sugar, emulsifiers etc.), nut chocolate (ingredients: almonds + other ingredients as in milk chocolate), dried fruit and nut chocolate (ingredients: raisins, cashew nuts, apricot kernels + other ingredients as in milk chocolates) and wafer chocolate (ingredients: wheat flour, hydrogenated vegetable oil, edible starches + other ingredients as in milk chocolates) of the same brand were obtained from the local market. The type of packaging material used on the chocolates and their unit weight varied. The chocolates were not checked for damage or defects in the packaging materials prior to use in the experiment. The moisture content of the chocolates as determined by the toluene distillation method ranged from 1.1% to 3.2% (Table 1).

2.2. Insects

Tribolium castaneum and L. serricorne cultures were maintained on whole wheat flour + 5% yeast, O. surinamensis on broken wheat + rolled oats + yeast at a 5:5:1 ratio and E. cautella on broken wheat + 5% yeast + 5% glycerol in the laboratory at 25 ± 1 °C and 65 ± 5% r.h. From these cultures, unsexed 1–2 week old adults of T. castaneum and O. surinamensis and 2–3 day old adults of L. serricorne were taken for infestation studies. For the collection of eggs of T. castaneum, L. serricorne and O. surinamensis, wheat flour was passed through an 85-mesh standard sieve (pore size 180 μm). Into the sieved flour (200 g) c. 250 adults were released for oviposition for 48 h. At the end of 48 h, the adults were removed from the flour using standard 25- or 44- mesh sieves (pore sizes 600 and 335 μm, respectively). The flour was subsequently sieved through an 85-mesh sieve to separate the eggs, which were then placed on the chocolates. To collect E. cautella eggs, newly emerged adults were released into a metal cage having a mesh bottom, which allows eggs to pass through. Eggs, 0–2 days old, were collected in a tray under the cage and then placed on the chocolates. Viability of eggs of individual species was checked as described in Rajendran et al. (2004). Eggs (four replicates per species) were placed individually in the wells of ELISA plates that were cut into half so as to have only 48 wells and egg hatch was observed under a binocular microscope, daily, until there were no more emergences. Viability (% hatched) of eggs was: T. castaneum (91.0 ± 5.9), L. serricorne (79.2 ± 12.3), O. surinamensis (86.8 ± 7.8), and E. cautella (76.1 ± 14.5).

2.3. Infestation studies

The studies were carried out on chocolates (70–84 g per replicate) under packaged conditions as well as without any packaging materials. Chocolates were placed in bottles (size 13 cm × 9 cm) for 45 days at 25 ± 1 °C and 65 ± 5% r.h. There were 2 sets of experiments. In the first set, adults (20 per replicate) were released on to chocolates with and without packaging material. In the second set, 1–2 day old eggs (30 per replicate) of the individual species were placed on both unpackaged and packaged chocolates. There were 5 replicates for each type of chocolate. After the addition of insects, the bottles containing chocolates and reference diets were covered with pieces of cloth, tied with rubber bands and held at 25 ± 1 °C for 45 days. At the end of 45 days, insect populations (live larvae and adults) in chocolates were recorded. In packaged chocolates, whenever infestation was found, the packaging materials of the