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SUSCEPTIBILITY OF PLASTIC PACKAGES TO INSECT PESTS ATTACKS

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ABSTRACT

Packaging represents the ultimate defence of pasta producers against insect pests: even if the product comes out uncontaminated from the production line, this does not guarantee that it will reach the consumer in the same condition. The ability of some pests to pierce different plastic material is well known: insects are attracted by odors, therefore it is necessary to take in consideration the barrier properties to volatile compounds.

Pasta packages are characterized by numerous pinholes which are mechanically produced to avoid having swollen bags after sealing: these pre-existing holes are often exploited by most pests as a preferential entrance to packages, and they are detected by insects by following the outflow of attractive odors. Packaging, therefore, represents a critical point in the quality preservation of packed pasta. Insect pests are commonly present in the production and storage environments, and their presence is favoured by unappropriate prevention measures. Common pests that affect pasta and starchy products usually belong to the genera: *Tribolium*, *Sitophilus*, *Plodia* and *Rhyzopertha*.

The aim of the study was to evaluate the resistance to piercing of three plastic materials (polypropylene obtained with different processing techniques) by *Tribolium* spp., *Sitophilus* spp. and *Rhyzopertha dominica*, and the relative ability of each pest to enter the packages. Two tests were carried out, the first one was aimed at evaluating the resistance of the plastic materials, the latter evaluated the ability of the species tested to enter pasta bags.

Results confirmed the good resistance of PP to the penetration of insect pests, and highlighted the highest penetration ability of *Sitophilus* spp. The optimization and suitable design of the packaging system, which should consider the reduction of the hole diameter, would allow to reduce the risk of pests penetration.

Key words: Insect pests, Packaging, Pasta, Piercing, Polypropylene.

INTRODUCTION

Packaging represents the ultimate defence of pasta producers against insect pests: even if the product comes out uncontaminated from the production line, this does not guarantee that it will reach the consumer in the same condition. Stored-product insects can enter packaged goods during transportation, storage in warehouses or in retail stores. In any case, consumers who come across contaminated packages, hold the manufacturer responsible for the inconvenient, with severe consequences on the image of the company, even if the responsibility is up to a third part. Insect that attack packaged products can be classified as "penetrators" or "invaders" (Highland, 1984): the former insects, which are able to bore holes through packaging materials, include *Sitophilus* spp., *Rhyzopertha dominica*, *Plodia interpunctella*, *Lasioderma serricone* and *Stegobium paniceum*; on the other hand, invaders are insects that can enter packages only through existing holes: this is the case of *Tribolium* spp., *Cryptolestes ferrugineus* and *Oryzaephilus* spp. (Highland, 1991). This categorization, however, is artificial, as penetrators also enter packages through existing holes, and invaders can, under certain circumstances, penetrate packaging materials: this is the case of *T. confusum*, which will act as penetrator when confined without food (Cline, 1978a; Cline, 1978b; Bowditch, 1997). Moreover, the ability of species to penetrate materials may vary between life stages and depending on the material considered (Cline, 1978a; Cline, 1978b; Bowditch, 1997). It is well known that insects are attracted into packages by odors, and the use of materials with high barrier to aroma compounds is one of the milestones in the prevention of infestations by pests; unfortunately data on aroma permeability of packaging materials are lacking, and the choice of suitable materials can only be helped by O_2, CO_2 and water vapour permeability data, available among the performance characteristics of materials. Pasta packages are characterized by numerous pinholes which are mechanically produced to avoid having swollen bags after sealing: these pre-existing holes are often exploited by most pests as a preferential entrance to packages, and they are detected by insects by following the outflow of attractive odors. Packaging, therefore, represents a critical point in the quality preservation of packed pasta. Insect pests are commonly present in the production and storage environments, and their presence is favoured by inappropriate prevention measures. Common pests that affect pasta and starchy products usually belong to the genera: *Tribolium*, *Sitophilus*, *Plodia* and *Rhyzopertha*.

The aim of the study was to evaluate the resistance to piercing of three plastic materials (polypropylene obtained with different processing techniques) by *Tribolium* spp., *Sitophilus* spp. and *Rhyzopertha dominica*, and the relative ability of each pest to enter the packages. Two tests were carried out, the first one was aimed at evaluating the resistance of the plastic materials, the latter evaluated the ability of the species tested to enter pasta bags.

MATERIALS AND METHODS

The research evaluated the ability of the tested insects to enter pasta packages by piercing or using the pre-existing pinholes. Three polypropylene films were used, all

supplied by Rotocalco Mediterranea s.r.l.: bioriented PP laminated with co-extruded PP (thickness 25 mm + 30 mm) (A), acrylic-coated PP (thickness 25 mm) (B), and bioriented PP laminated with cast PP (thickness 25 mm + 30 mm) (C).

Two trials were carried out: the former aimed at evaluating the resistance of packaging materials to perforation, the latter aimed at evaluating the susceptibility of pasta pouches to pest invasion. For both tests, insects were previously left unfeeded for 36 h.

Test 1. Five insects for each of the species tested were confined without food in cylinders (height 5,3 cm, diameter 3 cm), which were sealed with the test material. Three replicates for each film were performed. Each cylinder was placed inclined by 45° into a container being completely covered with pasta. In order to validate the effectiveness of the method, the same trial was performed using Kraft paper instead of PP, as the former offers limited resistance to insect attacks.

Test 2. The ability of pests to penetrate pasta pouches during shelf-life was assessed. This test simulated the real packaging and storage conditions, and consisted in packing pasta in 250 g pouches realized with pinholes having the same diameter as those present in commercial packages. Each pouch was placed into plastic boxes (27 × 6 cm) where 10 insects for each tested species were introduced, simulating a large infestation. Observations for insect penetration were performed at 7-minute intervals in the first 45 minutes; afterwards the frequency of examinations was one every 20 minutes. The trial, carried out in triplicate, ended when the first insect managed to enter the packages.

Both tests were performed at a controlled temperature of 27 ± 2°C and at 70% relative humidity.

RESULTS AND DISCUSSION

In the first test, carried out for 27 days, all materials showed numerous superficial abrasions by microscopic observations, as to testify the piercing trials made by insects. However, pests were not able to pierce the materials. Cline (1978b), in a study on the resistance of flexible packaging materials to insect attacks, classified PP as the most resistant, followed by polyester, aluminium, PVC, paper, polyethylene and cellophane. The result observed has to be attributed only to the resistance opposed by the materials to the insects attacks, as the test carried out with Kraft paper, maintaining the same conditions as the tests performed with the tested materials, allowed to validate the effectiveness of the technique used. In the latter test, Kraft paper was pierced by *R. dominica* after 24 hours, by *Sithophilus* spp. after 60 hours and by *Tribolium* spp. after 5 days.

The results relative to the second test are reported in Table 1, which reports the time required for each insect species to penetrate the pouches. *Sithophilus* spp. detected the food source most promptly, as 80% of the insects penetrated the pouches within 45 minutes. For what concerns *Tribolium* spp., this species showed a typical behaviour, which consisted in the association of insects in the effort of piercing the material.

Table 1. Time required (minutes) for the penetration of insect in pouches made with different plastic materials.

	Sitophilus spp.	*Tribolium spp.*	*Rhyzopertha dominica*
A	10	100	120
B	13	100	120
C	18	100	140

Results confirmed the good resistance of polypropylene to the penetration of insect pests, not depending of the association with other materials in a laminated structure. The tests especially highlighted differences in the piercing ability of insects, with the highest penetration ability of *Sitophilus* spp. The optimization and suitable design of the packaging system, which should consider the reduction of the hole diameter, would allow to reduce the risk of pests penetration.

Insect-proof packaging can help reduce the employment of insecticides in order to reduce the risk of food losses due to insect contamination. The experimental trials performed in the present research represent useful tools for testing the resistance to insects and choosing the best materials intended for the packaging of pasta, cereals and other products subject to insects attacks, such as bakery products, powdered milk, tea etc.

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