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Integrated Pest Management in Italian pasta factories

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Abstract

Pasta factories can be infested by insects, leading to negative economic and commercial consequences. Considering the importance of Italy as a producer and exporter, alimentary paste has been the subject of much research. Pasta factories use semolina, a raw material obtained from hard wheat which comes directly from the mill. Because of the structure of the building, the possible use of infested cereals and large quantity of dust always present, semolina is the main source of reproduction and diffusion of pests. As a result, the same pests [*Ephestia kuehniella* Z., *Plodia interpunctella* (Hb.), *Lasioderma serricorne* (F.), *Oryzaephilus* spp., *Rhyzopertha dominica* (F.), *Sitophilus* spp., *Stegobium paniceum* (L.), *Tribolium* spp.] present in warehouses, silos and in mills are carried into pasta factories where they can multiply. In some Italian pasta factories recently, new technics and Integrated Pest Management (IPM) have been suggested for the prevention and control of pests. The results obtained led to extending these methods to improve healthy sanitation practices and reduce chemical treatments. Despite these provisions, the problem of pest attacks by *Lasioderma*, *Plodia*, *Rhyzopertha*, *Sitophilus* and *Stegobium* in pasta factories, from packaging to the consumer, remains unsolved because of specific aspects of used packaging and the negligence of warehouses and stores in addition to the long average shelf-life of the product. Warehouse managers and shopkeepers must be involved in the processing cycle by encouraging frequent visits on the part of inspectors and the distribution of booklets concerning relevant problems and their possible solutions. In the meantime, potential new packaging methods that are less susceptible to pest attacks must be studied. Only by controlling the entire processing chain will it be possible to reduce the risk of infestation.

Key words: IPM, pasta factories, Italy.

Introduction

Many sources indicate that pasta originated in China and that the explorer Marco Polo was the first to report its existence. In Italy, the widespread use of handmade and industrial pastas undoubtedly began in Naples in the early 18th century, when production of pasta changed from manual to mechanical. The use and mix of best quality durum wheat, *Triticum durum* Desf., combined with unrelenting technological research have in time decreed the global success of pasta and Italian pasta manufacturers. Production and consumption have received a boost from the technological advancement of machines designed to increase productivity and reduce costs.

Italy is at the top of the world league table for the production and consumption of pasta. According to data gathered by the Unione Industriale Pastai Italiani (UNIPI, 2005), global

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pasta production reached 3,374 million Euro in 2004. In terms of quantity, 3,121,598 tons were produced, 3,023,589 tons of which consisted of dried pasta and 98,000 tons of industrial fresh pasta. As for domestic consumption (1,591,548 tons), annual *pro capita* consumption was 28 kg, consisting mostly of dried pasta (26 kg), whereas the consumption of fresh pasta (2 kg) gradually increased. Exports (1,530,050 tons) accounted for 49 % of production and there have been signs of slight growth. In 2004, 63 % of exports were destined for the 15 member EU countries where Germany is the principal market. As far as nonEU markets are concerned, there were good performances in Japan, Russia and the new markets of China and India.

From 2000 to 2004, expenditure on pasta rose from 23 % to 24 %; in the same period the volume of pasta sold through modern distribution channels climbed from 74 % to 78 %. Italian industry continues to maintain its position as world leader thanks to its structure, which breaks down into 152 industrial plants; 121 of these plants are specialized in the production of dried pasta, 18 in the production of fresh industrial pasta and 13 in the production of both. The productive capacity of the sector is estimated to be about 4,600,000 tons/year, with a degree of plant exploitation of approximately 68 %.

The packaging of dried pasta for family consumption involves to two large packaging categories: solid board boxes and plastic bags (with a structured base and flowpack). For pasta products destined for hotel use, restaurants and catering, large volume paper or plastic bags are used. In contrast, fresh pasta is packaged in protective plastic (tubs or bags), with the exception of fresh pasta with a very short shelflife, which is packaged using plastic that provides no barriers, such as tubs wrapped in flexible plastic film. Every type of pasta is shipped in corrugated cardboard boxes transported on pallets.

In the dried pasta sector, production is divided into the following percentages: dried semolina pasta, 90 %; dried egg pasta, 6 %; dried stuffed pasta, 4 %.

Pasta destined for the Italian or overseas consumer is essentially delivered in sealed packages according to three different quantities (250 gr, 500 gr and 1000 gr) and in two packaging typologies: cardboard boxes and flexible plastic wrappers. Depending on the various pasta families and different markets, the product is destined for domestic or overseas use and delivered in specific quantities; packaging typologies may vary somewhat.

With reference to the three principal categories of dried pasta, the choice of packaging differs. When destined for families, 50 % of dried semolina pasta is packaged in plastic flowpacks, 5 % in plastic bags with a structured base and 45 % in cardboard boxes. Sixty percent of products destined for hotels, restaurants and catering are packaged in plastic bags (average volume, 10 kg) and 40 % in paper bags containing the same volume. The mix remains essentially the same. Three packaging typologies are used for dried egg pasta: flowpack plus cardboard tub (85 %); cardboard box (10 %); plastic bag (mainly for small pasta used in broth) 5 %. Regarding dried stuffed pasta, whose demand is decreasing, packaging consists of flexible polylaminate bags with a structured base. In the majority of cases, boxes are made from white/grey retrofood cardboard weighing 320-330 gr/m^2. Plastic bags and flowpack packaging are made of double film: OPP on the outside and cast PP on the inside.

Pest problems

Pasta factories, as any other food industry, can be infested by insects, leading to negative economic and commercial consequences (Süss and Locatelli, 1996; Riudavets et al., 2002; Trematerra, 2002, 2004; Barros et al., 2003; Stejskal et al., 2004). Considering the importance of Italy as a producer and exporter, alimentary paste has been the subject of much research (Frilli, 1965; Dal Monte, 1985; Süss and Locatelli, 1996, 1997; Trematerra, 2002, 2004).

Pasta factories use semolina, a raw material obtained from hard wheat (*Triticum durum*

Desf.), which comes directly from the mill. Because of the structure of the building, the possible use of infested cereals and the large quantity of dust always present, semolina is the main source of reproduction and diffusion of pests. Consequently, the same pests [*Ephestia kuehniella* Z., *Plodia interpunctella* (Hb.), *Cryptolestes* spp., *Gnathocerus cornutus* (F.), *Lasioderma serricorne* (F.), *Oryzaephilus* spp., *Rhyzopertha dominica* (F.), *Sitophilus* spp., *Stegobium paniceum* (L.), *Tribolium* spp.] present in warehouses, silos and mills are carried into the pasta factories where they can multiply.

Sometimes the pasta factory and mill may constitute an industrial unity where the above-mentioned species can also fly and penetrate into the processing and packaging departments if the simplest prevention standards reported in the HACCP procedures are lacking. Moreover, during the summer period some of these pests are able to multiply outside the industrial facilities, hidden under semolina encrustations or on rejected products (Figures 1 to 7).

The first critical step in a pasta factory is to examine the quality of raw material; however, it is difficult to detect an infestation that is in progress. In fact, random samples of semolina on large bags and trucks cannot be considered reliable sources, especially in the case of eggs and larvae. The presence of *Cryptolestes* and *Tribolium* adults on the surface of semolina can be easily verified by inspection only when the raw materials come from heavily infested mills. Once the flour is purchased, insects and their fragments are stored and become part of the first steps in the processing cycle which is similar in the pasta factory and modern mills.

It has been observed that kneading machines and die plates, in particular, represent an unsurmountable obstacle to living insects and eggs. The kneading, subsequent pressure and stretching of the mass and high temperature do not permit insect survival. However, only insect fragments remain, testifying to the bad quality of raw material or the infestations present in the factory. From the desiccation process onwards, alimentary pasta can suffer from insect attacks that are easily detected by consumers. Even when using the most modern desiccation equipment, alimentary pasta wastes often fall on the floor, especially at the end of belt carriers.

However, in the pasta factory, high temperature and humidity favour the development of *Blatta orientalis* L., *Thermobia domestica* (Packard), and *Musca domestica* (L.); if moulds are particularly conspicuous, saprophagous and mycetophagous insects, such as *Typhaea stercorea* (L.) and mites (*Glycyphagus* spp. and *Tyrophagus* spp.), can also be observed.

Neglected places such as belt carriers, hoppers and electrical devices allow the growth of insects, which lay eggs on ensiled alimentary pasta. Short pasta, in particular, stored for longer periods before packaging can become heavily infested. Wood silos, which are common in Italy, provide many crevices in which insects can nest. Insects can reach these places by flying or crawling on the floor, pipes and on machinery.

The first barrier to pest infestation is the use of closed doors and windows. The risk of packaging infested alimentary pasta can occur even if insects are not yet present. Packaging departments must be kept clean and placed under surveillance to prevent infestations.

Infestations (mainly larvae of *P. interpunctella* and adults of *R. dominica*, *Sitophilus* and *Tribolium*) can occur during the storage process in industries, warehouses, general stores and retail shops already colonized by insects deriving from other products. The shelf-life of pasta is particularly long (in general 2 years, but also up to 3 years); in this period, insects can easily penetrate into the packaging and reproduce many generations (Locatelli and Süss, 2002). They often enter through the micro-holes that have been made to remove air during packaging. The product can be attacked by *P. interpunctella* (larvae), *R. dominica* and *Sitophilus* spp. (adults) [mainly *S. oryzae* (L.)], *L. serricorne* and *S. paniceum* (adults) when it is placed on the shelf near infested rice and other foodstuffs (Süss and Trematerra, 2003). In this respect, in a survey conducted over a period of several years, it was observed that complaints and returns by

customers were due to attacks generally occurring after the product left the factory. Inspections carried out in all of Italy, in several shops where infested alimentary pastas were bought (general stores, small and big department stores), showed that usually the stores were neglected and the shelves dusty with infestations in progress (*unpubl. data*).

Figures 1-7. Died pasta (Figure 1); short pasta and spaghetti (Figures 2-3); funnel traps (Figure 4); insect marks (Figure 5); *S. oryzae* adult (Figure 6); shop (Figure 7).

In Italy, pasta factories are usually subject to one or two yearly treatments of general fumigation (conducted during April or August) using methyl bromide (25-30 g/m^3 for 48-72 hours); however, these treatments are generally not sufficient to prevent the growth of infestations (Süss and Trematerra, 2003).

Opening doors and windows for degassing can favour the arrival of adult *E. cautella*, *E. kuehniella*, *P. interpunctella*, *R. dominica*, *Sitophilus* spp., *Lasioderma* and *Stegobium*. Moreover, treatments with toxic gasses do not always provide successful results. Often the structures are inadequately sealed and gas does not reach the proper concentrations; consequently, results are unsatisfactory in spite of high treatment costs.

Specimens of *Sitophilus* and *Tribolium* may also be present in the raw materials delivered.

Trends in integrated pest management

The Integrated Pest Management (IPM) concept emphasizes the integration of disciplines and control measures including biological enemies, cultural management, sanitation, proper temperature utilization and pesticides into a total management system aimed at preventing pests from reaching damaging levels. Crucial factors for IPM in stored products include understanding factors that regulate systems, monitoring insect populations, maintaining good records and using this information to make sound management decisions.

In recent years, new methods of protecting the production cycle have been introduced for the prevention and control of pests.

Constant monitoring of insects with different techniques and particular attention on behalf of staff prevent heavy infestations. Moreover, a continuous inspection of raw materials has been conducted by sampling semolina, using the filth test, and by controlling companies' supplies with on the spot investigations.

Prevention techniques were suggested, and in some cases also applied, from ensiling semolina to die plates. This was accomplished by monitoring Lepidoptera and Coleoptera with pheromone and food traps, by examining tracks on dust, substituting wooden structures, sealing crevices and by replacing screw conveyers with pneumatic feeding. Some elements in building departments and machinery were changed: gaskets were replaced. Crevices in which debris could accumulate were sealed, walls edges and column floor junctions were modified. Nowadays, however, the plan managers of food industries only rarely consider the problem of maintaining proper hygienic conditions, which represent the first step in reducing pest infestations. However, standard cleaning procedures were modified and staff were trained to clean the least accessible areas that are generally neglected and therefore sure sources of infestation. Big vacuum cleaners were used to eliminate the accumulated dust. In fact, the removal of debris is more efficacious than any localized chemical treatment.

Nonetheless, it was necessary to study how to reduce processing wastes and how to protect belt carriers for unpackaged alimentary paste. An integrated method to protect alimentary paste processing must involve planning engineers, foremen, mechanics and bricklayers.

In this context, the use of pheromones also plays an important role, especially in monitoring timing. To control *E. kuehniella*, funnel traps baited with 2 mg of (*Z*,*E*)-9,12-tetradecadien-1ol acetate (TDA) were used with good results in the packaging department, and to survey *P. interpunctella*, sticky wing traps baited with 0.2 mg of TDA were used in the processing and packaging departments. Different types of pheromone traps (Anobi-trap, Lasiotrap, Serrico-trap) have been used to verify the presence of *L. serricorne* and *S. paniceum*. Placed in different areas of the pasta factory (processing department, packaging department, etc.), mainly near pasta silos, kneading machines and in warehouses, these traps revealed several hot spots of insect infestation. These areas were treated by cleaning, modifying critical points and sometimes by using

localized chemical applications with synergized pyrethrum or pyrethroids. A high number of catches generally occurred in the area of alimentary pasta silos.

The use of pheromones to control *T. castaneum* (Herbst) and *T. confusum* du Val was unsatisfactory. On many occasions, the number of insects collected in the traps (Pantry Patrol trap, PC Beetle trap or Window trap) was inferior to the observed infestation. In this case, proper insect monitoring through periodical inspections of debris, insect marks, as well as living individuals, offers many more significant results. The severity of infestation can be assessed by observing the number and frequency of marks. To trap *Tribolium* specimens, better results have been obtained recently by using food bait traps applied in a study on the spatial distribution of beetle pests (Trematerra and Sciarretta, 2004). In this case, it was also important to clean and carry out some localized treatments.

The articulated use of the above-cited methods improved the situation in pasta factories that adopted this new method of integrated pest control. The results obtained extended to other Italian pasta factories reducing the use of pesticides.

In several pasta factories, ProFume® is replacing methyl bromide in fumigant treatments; other structures are introducing heat treatments as experimental applications in pest control management (Savigliano et al., 2006).

Despite these preventive measures, the problem of pest attacks in pasta factories from packaging to the consumer remains unsolved because of certain aspects of used packaging and the negligence of warehouses and stores in addition to the long average shelf-life of the product. Warehouse managers and shopkeepers must be involved in this processing cycle by encouraging frequent visits on the part of inspectors and the distribution of booklets concerning the problems and their possible solutions. In the meantime, potential new packaging methods that are less susceptible to pest attacks must be studied.

Only by controlling the entire processing cycle, from the purchase of raw material to the distribution of the finished product, will it be possible to reduce the risk of infestation.

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