

Hazard type	Specification		Risk level
Health hazard from control measures	Pesticide residues	Effect of exposure to low levels in basic food stuffs	Authorities determine MRLs, below which hazards are estimated to be small
	Toxic fumigants	Accidental poisoning	Low, if safety procedures are followed

For insects the following key actions were identified: Allergy is a result of previous exposure to low levels of allergens. Thorough studies must be conducted to elucidate the relationship between insect contamination in food and subsequent allergic reactions in humans.

It is imperative that pest densities are maintained low, and the methods and technology necessary to prevent pest development are available. However, transfer of knowledge to the primary producers should be improved to ensure production of stored products without insect contamination.

It is evident that the risks stemming from insect infestation in stored products are low, due to general low pest densities found in European stores. However, as discussed at the symposium, new developments in the EU policies concerning pesticide registration for this sector, and the development of resistance to insecticides in insect populations are changing this situation. Thus, health hazards from insects in stored products may increase.

Table Mites

Hazard type	Specification		Risk level
Direct health hazards	Allergenicity	Inhalant allergy following occupational exposure	High for relevant occupations
		Inhalant and ingestive allergy for general public	High
Indirect health hazards	Pathogen transmission	Transfer of pathogens (E. coli O157, prions?)	Unknown (low?)

In the light of the severe consequences that mite allergies may have on human health (asthma, anaphylaxis) it is important that (key actions identified)

the frequency and level of mite contamination in stored products is monitored, edical studies are carried to elucidate the level of allergenic reaction to different degrees of exposure to mites in food, a "no effect" level for mites in foodstuffs is established, the risk of mites as vectors of high risk pathogens is reviewed.

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02 - Pest Control and Constraints in Flour mills

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Abstract

Food factories and especially flour mills are object of severe infestations of pest insects. Mediterranean flour moth *Ephestia kuehniella* and confused flour beetle *Tribolium confusum* belong to the prevailing pests causing expensive precautions and control measures to avoid complaints of customers. The occurrence of pest insects is not in

accordance with food laws and the expectations of buyers of food. Therefore, the biology and behaviour of these pests, the weaknesses of the construction of the premises as breeding place for the pests, the logistic of the flow of product through the machines and the factory have to be understood in the light of pest management. Despite early warning systems and monitoring, inspection of the incoming raw products for possible infestation and many precautions still infestation regularly and often occurs. The choice of possible control procedures is fairly limited. The few remaining contact insecticides lack thorough penetration into infested cracks and crevices let alone the aspect of resistance of pests toward these chemicals. The loss of methyl bromide as quick acting fumigant for thorough pest control of all stages of pests in 2005 opened a chance for sulfuryl fluoride (SF) as alternative fumigant and application of heat in certain circumstances. Also intensive sanitation and partial use of biological antagonists gained its place in the integrated pest management system. The promising use of SF as one to one replacement of methyl bromide found its limitations in the higher cost of the treatment since slightly higher amounts of gas have to be used to be effective possible together with increasing the temperature within the mill to ensure high percentage of mortality. Recently, the maximum residue value for fluorine in treated commodities was reduced in Europe down to 2 mg/kg. This concerns the treatments of large flour mill buildings with in house flour bins that can hardly all be emptied for the fumigation or sufficiently sealed towards the rest of the mill structure. The impact of the high value of the global warming potential (GWP) of SF in comparison with carbon dioxide (higher than factor 1000) is still under consideration.

Heating of all infested parts and machinery and hiding places of pest insects in walls, ceilings and floors sounds easier than it may be in practice. The laws of physics apply and require partially huge amounts of energy to elevate the temperature of concrete, insulating material or other infested parts of the construction to lethal values.

Flour mills and also some other food processing factories offer attractive conditions for surviving for a group of animals like insects, mites, rodents and birds. This group belongs to typical stored product pests. They accompany man since he started after daily hunting and looking for food to store harvested products for a while to become independent from this daily effort some thousand years ago (Reichmuth 2009). These animals are adjusted to live on fairly dry food and get their necessary water supply either outside the premises (rodents and birds) or by chemically cracking the starch into water and carbon dioxide. Together with shelter against uncomfortable weather, elevated temperature due to the electrical machineries and the milling process and plenty of hiding places behind machinery, flour mills are target of pest infestation. Simply, these factories are paradise for certain pests. The preparation of food on the other side does not allow any living or even dead animals that may end up partially in the packages. Therefore, pest management is a very severe issue and requires plenty of dedication in this branch of industry.

What kind of constraints limits pest control in Flour mills?

Legal Constraints (Food Law, PP Law, Biocidal Law): Flour mills are legally situated on the edge between regulations derived from the Plant Protection Law (PPL), the Biocidal Law (BL), the Food Law, the Hygiene Law and many others (Kroos 2009). Concerning pest control, the PPL and the BL are of paramount importance. The miller or pest controller has to follow stiff rules when trying to keep pests out or control them after infestation. Health and safety aspects for the workers and bystanders and side effects towards the environment have directly or indirectly reduced the number of chemical products dramatically. Hansen (these proceedings) reports on this issue. The development of a new suitable compound is with more than 100 million € extremely expensive and has to meet various requirements by various laws and authorities involved in the process. On the other side, this effort is in the interest of the European consumer (Reinhard, these proceedings).

In the case of destruction of the plant products by frass - as with pests like weevils, beetles or moths -, still plant protection regulations determine the choice of chemicals to be applicable. In food storages on the other hand, always regulations of the BL must be applied. Interestingly, the definition of food varies from law to law. EU Directive 178/2002 considers all produce from the primary production (for instance grain prior to harvest) already as food if the purpose of production is the later use as food (food grain). On the contrary, the PPL considers agricultural raw products not as food. Only if these products have been processed not by simple steps like pressing or milling but more complicated techniques like baking or mixing with other products, the end products – especially when packed as consumer package - are no more objects of the PPL but the BL. Flour in flour mills as well as the infested flour mills themselves are therefore in Germany regulated under the PPL. Some other European countries rank this differently. If cockroaches, flies, and rats are the target pests for control, that are supposed to act as vectors for microbial diseases, generally the BL or even the law against infectious diseases apply and those chemical products that are registered accordingly must be used only. In most European countries these three laws require different kinds of data packages before a registration for use of a chemical will be authorised. So, for the applicants, companies that want to earn money with selling of registered chemicals for pest control, the legal and financial situation is a severe constraint to develop effective, safe and economically feasible compounds. Bearing in mind the cost of a disinfestation it can be calculated how long it may take to gain the investment back.

Economic Constraints (price of flour, price of sanitation, plant protection products): The margin between the price for the grain to be milled and the price of the flour as end product determines the availability of investment including that for measures for pest management. As Schaub (these proceedings) points out, the price of pest management (PM) is part of the price of the final food product. The consumer must be aware that a high quality food product requires more and more investment also on the side of PM. This has to include also the aspect of sustainable use of chemical products for pest control that will consequently reduce the number of suitable chemicals and possibly lead to increased usage of appropriate physical and biological measures as well as better prevention of pest infestation. The consumer determines in the end what kind of PM will be used.

Technical Constraints (logistics, grain import, flour export): Still in the financial area, also aspects of storage, import and export of goods determine the feasibility of running a flour mill including application of PM. Grain is imported from all over the world and contains to an extend living pests. Due to climatic change, it can be expected that more tropical pests will be imported. In the future, following the concept of increased prevention, the grain trade has to be observed more carefully to avoid importation of pests. On the other side, due to global markets it may increasingly happen that flour is imported. In this context, costs for PM may contribute to the competitiveness of European flour comparing with prices in Asia or elsewhere. Transport prices may on the other hand increase and help to keep European flour competitive.

Scientific (biological, physical, chemical): The appropriate use especially of alternative measures for PM like physical or biological control is based on sound knowledge of the pest and the physical background of a building. This complexity can normally only be handled by professional biologists and engineers. The tendency is obvious, to spare money at this educational end and try to avoid high costs for academic personnel. The alternative approaches suffer to an extent from being inappropriately applied and are therefore considered to be ineffective. So, it is very important that professional academics are involved into the development and application of PM.

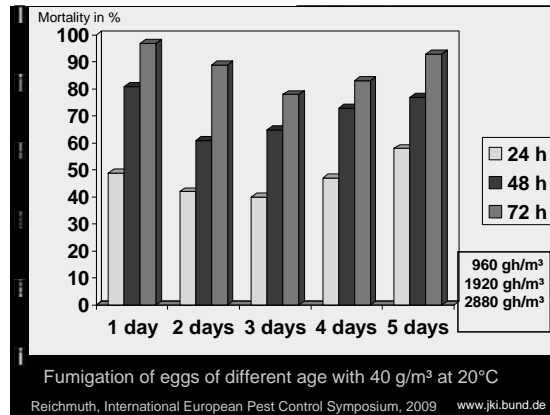
Pest organisms (microbes, insects, moisture): As pointed out, arthropods and some vertebrates form the most prominent group of pests in flour mills. Additionally, also fungi may play an underestimated role (Reichmuth CoE). The mass growth of fungi and even more important the formation of mycotoxins is considered to present a severe risk for the human health. Good storage practice of grain and other products would aim at relative humidities of less than 65% in stores. In some regions of the world this is not feasible in others it is not performed strictly enough. Due to the pronounced stability of the poisonous metabolites of moulds, it happens that toxins like ochratoxin and aflatoxin end up in food. Also insects, mites, rodents and birds play a significant role in this context (Hansen and Hamel, these proceedings, CoE). A thorough knowledge of the various pest organisms that may occur in flour mills or in storage of the raw products is absolutely necessary to overcome the constraint posed by these organisms.

Why are Flour mills so difficult to keep them free of pests? Additionally to the above mentioned aspects, these factories differ very much in size (less than 5000 to more than 200,000 m³), construction (wood, concrete, bricks, metal), function (production of flour, semolina, pasta, baking mixture etc.), various machinery, various materials (wooden furniture, plastic floors, insulation material, packed food etc.). Therefore, pests find various opportunities for shelter, food and hiding palaces.

Where do the pests come from? Logically, pest insects and mites are either imported continuously with infested grain or other raw products, package material (also rodents!) or all of the pests may invade via windows, doors, roofs, machinery or other openings into the buildings. Birds and some insects simply fly in.

Constraints linked to insufficient pest control: As an example for risks of surviving pests after inappropriate application of PM sublethal heat treatment and SF fumigation can be mentioned. Also, the occurrence of phosphine resistance (Reference) falls into this category.

The eggs of insects have been proven to be especially tolerant versus treatment with sulfuryl fluoride (Bell, Reichmuth). In intensive experiments with caged eggs of different age at 20°C it was shown, that fumigation with 40g/m³ over 1, 2, and 3 days, respectively, did not control all tested eggs of different age between 1 and 5 days. 3 days old eggs seemed to possess the greatest tolerance in these experiments with three replicates with about 500 eggs each. From the presented figures it seems obvious that the recommended dosage of 1500 gh/m³ is not sufficient to obtain a sufficiently lethal effect against the eggs of this species. A recommendation to obligatorily increase the temperature when treating against eggs of this species with SF with 1500 gh/m³ seems to offer one way to overcome this constraint or to apply more than one fumigation within a predetermined time period to control the surviving eggs after they have emerged and developed into more susceptible stages (Reichmuth, Binker).



As shown for SF and insect eggs, it is absolutely necessary to include sufficient data into any control program that is prepared for pest control in a given practical situation. If a too low lethal effect is envisaged in the first place, later complaints will most likely arise. Registrants and registration offices are encouraged to list dosages and all the pest organisms that have been investigated to exclude later disputes. The problem of protection against other registrants has to be addressed

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03 - Stored product protection in grain storage with special regard to phosphine fumigation

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Abstract

In Germany stored product protection belongs until now to the legislation field of plant protection. All stored product protection products used for controlling insect- and other pests require a legal approval of the plant protection authority. Roughly, the pesticides for stored product protection in grain storage can be divided into three groups:

- contact insecticides (spraying, fogging, powdering insecticides)
- fumigants
- rodenticides

In the last decade, the decrease of available active ingredients and compounds for stored product protection is quite obvious. Especially in grain storage more and more problems arise due to phase out and disappearance of these products. Several issues like ineffective control of pests or insect resistance against few remaining compounds contribute to the pressure in this context especially for the grain storage industry and difficulties in controlling pests. An update of all products and active ingredients that have an approval in 2009 are presented.

During the last few years considerable changes have taken place in stored product protection throughout Europe. Well-proven active ingredients disappear one by one because they do not meet the new legal requirements set up by the European Union. The situation in stored product protection as it presents itself for grain storage in Germany will be set out below.