MYCOLOGY ANSWERS

WHAT ARE MYCOTOXINS AND HOW HARMFUL ARE THEY?

Many foodstuffs, even those that have been preserved, deteriorate and go mouldy when stored in unsuitable conditions or if they are kept too long. Sometimes the visible 'fur' of fungal growth (mycelium) and spores is easily recognised and most of us will throw such contaminated material straight in the bin. In other circumstances however, such growth may not be detected so clearly and may be overlooked. Fungi growing on foodstuffs not only impair the quality but may also produce toxic compounds (mycotoxins), presenting a serious health risk for both man and animals.

Fungi growing in their natural environment, in culture or on our leftovers, will quickly take from their surroundings nutrients that they can use easily, extracting energy and converting them into fungal biomass (primary metabolism). When growth is well established or when supplies of key nutrients are depleted some biochemical compounds, known as intermediates, may accumulate in the fungus. In order to keep the biochemical machinery working, and also not to poison itself, parts of the mycelium may then switch to other pathways (secondary metabolism). Rather than producing fungal building materials this gives rise to other compounds (secondary metabolites). Some such metabolites are very useful to man (e.g. antibiotics) but others can be extremely harmful (mycotoxins).

Suitable foodstuffs are quickly colonised by a wide range of spoilage fungi many of which produce mycotoxins, including species of *Fusarium, Penicillium, Alternaria*, and *Aspergillus*. These compounds (alkaloids, cyclopeptides, coumarins) have toxic or carcinogenic (cancer causing) properties when eaten. Apart from the widespread occurrence of these species a worrying aspect is the extremely small quantities in which mycotoxins have effect. Tiny amounts, trace quantities (less than 1 μg/kg) are acutely toxic and can cause fatalities in livestock, fed with contaminated feed, in a very short time. Even smaller amounts, although not necessarily fatal, may cause the development of cancers and other physiological problems. They are also very persistent in foodstuffs and are often heat stable, remaining toxic after sterilisation or cooking.

Many basic foodstuffs such as beans, bread, dried pasta, some dried fruits, milk, peanuts, maize, other stored grains and cereals are particularly susceptible to fungal contamination. In storage conditions where moisture levels are relatively high, and if the temperature is conducive (particularly difficult to control in warm climates) then a range of toxic compounds may be found. Some of the most famous are the aflatoxins produced by *Aspergillus flavus*, a mould which often grows on stored grain and animals feed. Aflatoxins are difurano-coumarin compounds which occur in a number of forms, the most common of which are aflatoxin B_1 and G_1 (Fig. 1). These are the toxins which gave rise to the outbreak of Turkey X disease in the early 1960s and killed over 100,000 turkeys in Great Britain, as well as other livestock fed with contaminated grain. The main causes of death were liver and kidney failure.

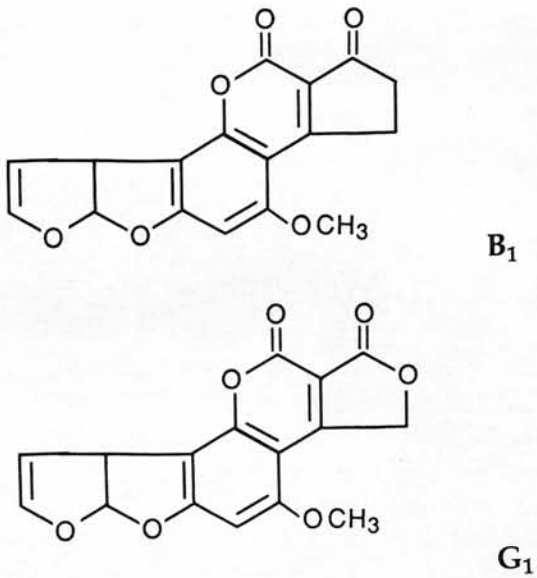

Fig 1 Chemical structure of two common aflatoxins

Growth of *Fusarium graminearum* on damp grain, during storage, produces vomitoxin (trichothecene) which leads to sickness in pigs. The species also produces zearalenone (F_2 toxin) which can cause infertility and stillbirths in pigs by an action which seems to mimic the female hormone oestrogen. More recently the toxin patulin, pro-

duced by *Penicillium patulum* and other species, has been in the news as a contaminant of fruit juice. This fungus grows readily on apples, as storage rot, and therefore contamination of apple juice can be hard to avoid. Constant vigilance on the part of the producers is needed to monitor for toxic compounds.

There will almost always be an uneven distribution of any contamination in stored materials. A very little fungal growth can give rise to worrying levels of toxins throughout a batch of foodstuff. In some cases specialist techniques are required to extract and identify toxic compounds and constant screening is essential. Aflatoxins can be detected by virtue of their fluorescence in ultraviolet light. Susceptible materials are well monitored in developed countries where this problem is well recognised.

The best way to avoid mycotoxin contamination is to prevent fungal growth. Storage conditions for produce can now be controlled in terms of humidity, temperature and oxygen levels. Many foods are preserved or processed and carefully packaged immediately after production so that contamination is avoided. Forced drying, freezing and the use of preservatives are also helpful. Most important however, is constant vigilance in screening and monitoring. Fortunately modern methods of detection usually raise the alarm before harm is done and help to minimise the potential problems for the consumers.

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