

• **Indian regulatory control for aflatoxins:** The Food Safety and Standards Regulations 2011 of Food Safety and Standards Authority of India (FSSAI) have set the maximum limit for aflatoxin present in spices as 30 ppb.

What are the management strategies for avoiding aflatoxin contamination?

Natural contamination of spices is greatly influenced by the environmental factors such as storage structure, temperature, pH, moisture etc. Aflatoxin-producing fungi can grow on a wide range of substrates including spices and spice products. The means to control aflatoxin production is best achieved by adopting measures designed to prevent the contamination of crops in the field as well as during storage. This can be well taken care of by proper stage of harvesting, drying and ideal packaging which helps in reducing the level of contamination. Early detection and removal of infected material during harvest and storage also helps in reducing aflatoxin contamination.

• **Harvesting:** Emphasis should be given for timely harvest. Only fully ripened/ mature fruits should be resorted to for harvesting. In case of nutmeg, split open fruits, nut and the mace should be separated and washed with clean water before keeping for drying. The well drained nut and mace should be put in the drying unit on the same day of harvest.

• **Drying:** The risk of fungal growth on the harvested produce can be reduced to a great extend by drying the produce to final moisture content of 10% or lower, as early as possible. In general drying of spices is achieved by open sun/ solar/ electrical/ fire wood based driers. The optimum temperature for drying black pepper, ginger, turmeric, chilly and mace etc. is around 50-55°C while in the case of drying nutmeg, temperature should be maintained around 40- 45°C and care should be taken to avoid shell breakage and oozing out of oil.

• **Storage:** Since spices are hygroscopic in nature, the risk of mould growth is more under warm and humid atmosphere. On exposure to high moisture conditions, they acquire foul odour and becomes brittle, crumbles and results in loss of preferred quality. So they should be protected from relative humidity of more than 75%. The favourable temperature for storing and transportation of spices is between 5-25°C. At temperatures above 25°C, the essential oils may be lost.



• **Packaging material:** Packaging has an important effect on improving the shelf life of the product. The packaging requires optimization of physical, chemical and environmental factors. The retail distribution of ground spices in consumer packages is becoming increasingly popular in the country as the consumer is assured of the quality product under hygienic conditions.

Aluminium foil laminate offers maximum protection against loss of volatile oil and ingress of moisture. Packaging materials like PET, 2 layered metallized polyester covers (12 μ metallized polyester + 40 μ LDPE), 3 layered metallized polyester covers (12 μ polyester + 12 μ metallized polyester + 80 μ LDPE) are suitable for packaging whole spices without aflatoxin contamination for a period up to 3 years.

• **Modified atmosphere:** A reduction in the concentration of oxygen and/or an increase in carbon dioxide concentration of the storage atmosphere surrounding spice produce reduce the rate of respiration and inhibits the microbial growth. Spice samples kept at 100% vacuum and 100% N₂ are totally effective atmospheres for storage without aflatoxin contamination.

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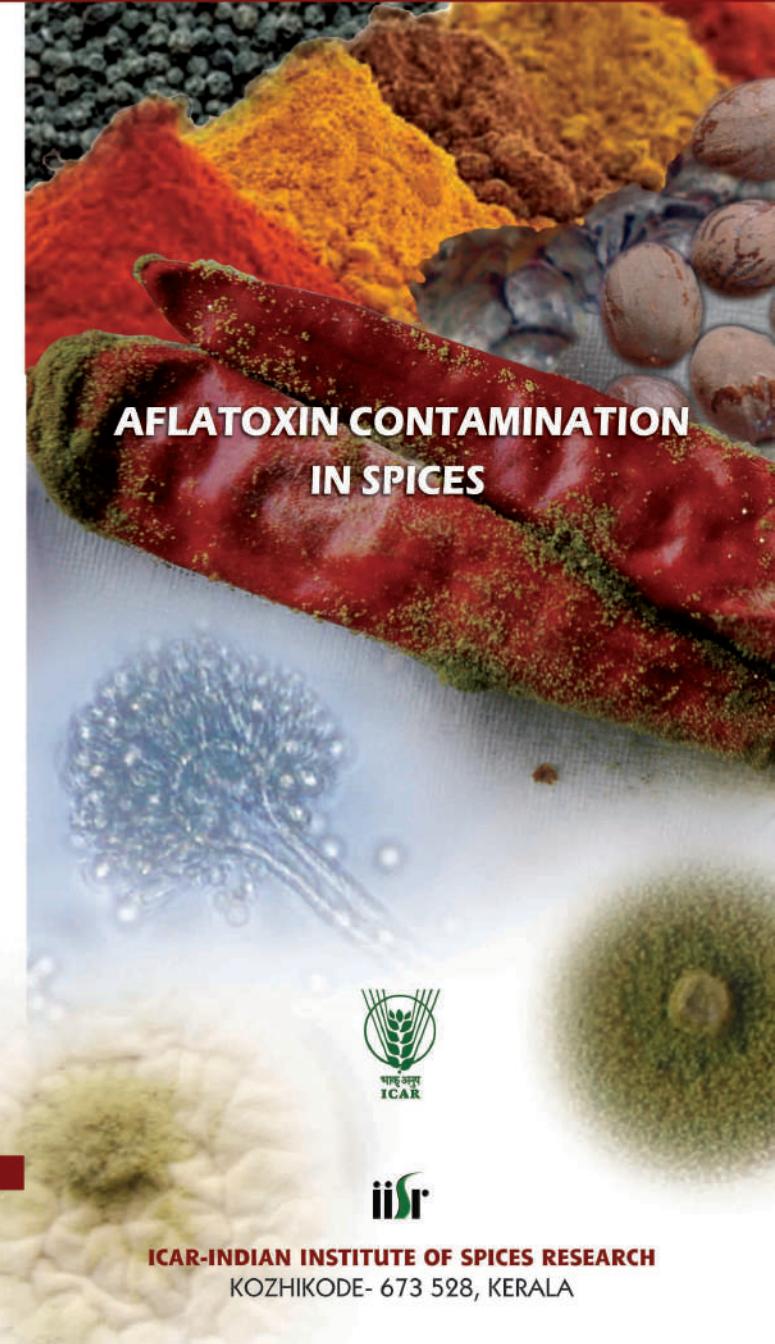
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What are Aflatoxins /Mycotoxins?

- Aflatoxins are naturally occurring mycotoxins produced by a group of fungi known as *Aspergillus*. The major aflatoxigenic species of *Aspergillus* are *A. flavus* and *A. parasiticus* and the toxins produced by them called as aflatoxins are among the most carcinogenic substances known.
- Aflatoxins consist of about 20 similar compounds belonging to a group called difuranocoumarins, but only four aflatoxins namely B_1 , B_2 , G_1 & G_2 are naturally found in foods.
- Aflatoxin B_1 is the most toxic and when lactating cattle ingest aflatoxins through the contaminated feed, toxic metabolites can be formed in the body and may be present in milk. These metabolites, aflatoxin M_1 and M_2 , are potentially important contaminants in dairy products.
- Aflatoxin B_1 & B_2 are produced by *Aspergillus flavus* and *A. parasiticus* whereas aflatoxin G_1 and G_2 are produced only by *A. parasiticus*.
- The B-group aflatoxins exhibit blue fluorescence while the G-group exhibits yellow-green fluorescence under ultraviolet (UV) light, thus making the use of fluorescence important in identifying and differentiating between the B and G groups.
- Aflatoxin M_1 and M_2 are hydroxylated products of B_1 and B_2 , respectively and once formed aflatoxins M_1 and M_2 remain stable.

Why so much concern over aflatoxin?

- Aflatoxin B_1 is one of the strongest orally ingestible natural compounds which is converted into a highly carcinogenic compound as a result of oxygenase in the liver and its acute poisoning is referred to as aflatoxicosis.
- Aflatoxins are of concern to human because of the wide range of toxic effects they pose. They are toxic at very low levels (ppb) and can cause damage to the immune system and vital organs such as the liver (hepatotoxic) and kidneys (nephrotoxic) when ingested above the toxic levels.
- In the case of chronic toxicity after long-term ingestion, conditions such as liver cancer, deformities, stomach cancer as well as sporadic metastases in the lung and kidneys may occur.

Are aflatoxins stable in foods?

- Aflatoxins are quite stable compounds and survive relatively high temperatures with little degradation. Their heat stability is influenced by other factors, such as moisture level and pH, but heating or cooking processes cannot be relied upon to destroy aflatoxins. For example, roasting green coffee at 180°C for 10 minutes gave only 50% reduction in aflatoxin B_1 level.

What are the major sources of aflatoxin contamination?

- Aflatoxin-producing fungi of the genus *Aspergillus* are common and widespread in nature. They can colonize and contaminate grains like maize, sorghum, groundnuts and spices and spice products such as chillies, nutmeg, black pepper, ginger, turmeric etc. before harvest or during storage.
- Many crops or produce are susceptible to infection by *Aspergillus* species following prolonged exposure to a high-humidity environment, or damage from stressful conditions such as drought.
- The native habitat of *Aspergillus* species is soil, decaying vegetation, grains etc. that undergo microbial deterioration. They also invade all types of organic substrates, whenever conditions such as high temperature and moisture are favourable for its growth.

Concern over aflatoxin in spices

- Spices are harvested at a very high initial moisture content which varies from 55 to 85% and has to be brought down to less than 10% for safe storage. During storage, dried spices also require protection from ingress of moisture, light, heat and loss of flavour/aroma. Hence proper post harvest handling would ensure retention of basic qualities like oil or oleoresin contents which contribute to flavour/aroma of spices.
- For the export of spices and spice products, the most popular specification is the "ASTA Cleanliness Specifications for Spices, Seeds and Herbs". Besides, the importing countries insist mainly on the specification for pesticide residues, aflatoxin, trace metals and microbial contamination.
- Spices are highly hygroscopic (a tendency to absorb moisture from the atmosphere readily) and absorption of moisture from air, during rainy season results in mould and insect infestation. Almost all spices are prone to contamination by *Aspergillus* species. However, among the spices, chillies, paprika, and nutmeg are often polluted with aflatoxin and ochratoxin-A.

What are ochratoxins?

- Ochratoxins are a small group of chemically related toxic fungal metabolites (mycotoxins) produced by certain moulds of the genera *Aspergillus* and *Penicillium* growing on a wide range of raw food commodities. Some ochratoxins are potent toxins and their presence in food is undesirable.

Rapid Alert System for Food and Feed

- The notification from European Union on Rapid Alert System For Food and Feed (RASFF) relating to the presence of Aflatoxin beyond the permissible limit in nutmeg and mace, exported from India to EU

countries, led to the destruction of the consignment at the destination which necessitated the authorities to take up precautionary measures to avoid quality lapse with respect to export of nutmeg from India.

- Since 1987, different spice samples imported to Europe are continuously tested for aflatoxins and ochratoxin- A and in 2006, a maximum level of aflatoxins B_1 , B_2 , G_1 and G_2 allowable in some spices has been laid down in the EU, and since 1 July 2010 this also applies to ochratoxin A in paprika and chilli powder.

Effects on trade

- Aflatoxin contamination does not affect crop productivity but it makes the produce unfit for consumption as toxins are injurious to health. The marketability of contaminated produce, particularly in international trade is considerably reduced due to stringent standards of permissible limits on aflatoxin contamination set by the importing countries.
- Hence, it is necessary for the exporting countries to develop new techniques for production, processing, storage and transport and ensure that the described standards are strictly carried out in order to reduce contamination levels in food.
- Additionally, measures for sampling and analysis as well as training of staff have to be developed or adopted. Producers, traders and official authorities must take into account these additional factors that ensure acceptable quality assurance. Regulation can have major implications for the producing countries because they are forced to follow the increasing technical demands.

What are the regulations?

- **EU regulations for mycotoxins in spices:** The European Union (EU) has a number of directives and regulations concerning food safety and the European Spice Association (ESA) have fixed minimum quality and sanitary standards agreed by all member countries. Accordingly the maximum level for pepper (white and black), *Capsicum* spp. (dried fruits, whole or ground, including chillies, chilli powder, cayenne and paprika), *Zingiber officinale* (ginger), *Curcuma longa* (turmeric) and *Myristica fragrans* (nutmeg and mace) is 5 ppb Aflatoxin B_1 and 10 ppb total Aflatoxin (B_1 , B_2 , G_1 and G_2).

- **US regulatory control for aflatoxins:** The Federal Drug Administration (FDA) of United States has established specific guidelines on acceptable levels of aflatoxins in human food and animal feed. The action level for human food is 20 ppb total aflatoxins, with the exception of milk which has an action level of 0.5 ppb for aflatoxin M_1 . The action level for most feeds is also 20 ppb.