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10. Mycotoxins in Crops - A Threat to Human and Domestic Animal Health

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ABSTRACT:

In food and feed, filamentous fungi produce mycotoxins as secondary metabolites in response to a variety of factors that influence fungal growth and mycotoxin production in varying degrees. This study aims to examine the various factors that influence the production of mycotoxins and the methods for controlling them. Fungal growth and mycotoxin production can be exacerbated by conditions such as high temperature and humidity. Contamination can also be affected by pH, fungus strain, and substrate, to name a few. Prior to planting, an integrated approach is needed to control mycotoxin contamination, so that good practises can help minimise contamination at every step of the food chain and deliver safe products. Due to its tropical, warm, and humid climate, the Philippines is particularly vulnerable to the introduction of mycotoxigenic fungi. Currently, seven Aspergillus species, four Fusarium species, and one Penicillium species have been identified as mycotoxins in various agricultural crop commodities in the United States. Fifty-five mycotoxin groups (aflatoxin, fumonisin, ochrataxin, zearalenone, and nivalenol) have been found in the raw form and in the by-products of major crops grown in this country. Although mycotoxins and mycotoxinsogenic fungi have been studied extensively since 1972, little has been known about other mycotoxins until the last two decades of the 21st century.

KEYWORDS: Mycotoxins, Fungi, WHO.

Introduction:

Toxic compounds that are produced by certain types of moulds are known as mycotoxins (fungi). Numerous foodstuffs, including cereals, dried fruits, nuts, and spices, harbour mycotoxins-producing moulds. Before or after harvesting, during storage, and on/in the food itself, mould can grow. This is often the case in warm and humid conditions. Stable mycotoxins can withstand food processing. Mycotoxins are fungi-produced chemicals that are harmful to humans and domesticated animals alike. Food safety is jeopardised if these chemicals end up in the world's staple foods and feeds. Fig. 1 For even small amounts (in the parts per million or billion range), mycotoxins can be lethal or severely illening (ppb).

Only a small percentage of the thousands of mycotoxins on the planet are capable of causing plant and animal diseases. Mycotoxins in nature can disable the host's defence responses or protect the fungus from other microorganisms, depending on their function.

Fig. 1:

Mycotoxins may contaminate foods and feeds worldwide, posing a significant threat to the health of humans and domestic animals. Here, corn is infested with a fungus that produces the mycotoxins deoxynivalenol and zearalenone

In some cases, the effects of food-borne mycotoxins are immediate, resulting in symptoms of severe illness that begin to appear within minutes of eating contaminated food. Long-term health effects, including cancer and immune deficiency, have been linked to other mycotoxins found in food. More than a dozen mycotoxins have received the most attention because of their harmful effects on human health and the fact that they can be found in food.

Mycotoxigenic fungi are perhaps the most important pathogens of global significance in the context of food security and safety. Toxic mycotoxins metabolites can be found in both damaged and seemingly healthy products or commodities caused by this group of fungi, which are capable of reducing the quality and quantity of marketable produce. Because mycotoxins must be detected using expensive analytical facilities or kits, this is a serious problem. The presence of environmental and storage conditions that favour the growth and development of mycotoxigenic fungi is a major concern worldwide, including the Asia Pacific region (e.g. Japan, Korea, Taiwan, the Philippines, Malaysia, Thailand, Indonesia, etc.). When it comes to rice, for example, Asia is the primary source of production and consumption, and it is highly susceptible to mycotoxigenic fungi and mycotoxins during storage.

Control Of Mycotoxins:

The government of each country should begin and administer mycotoxins control through ministries and organisations such as the Food and Drug Administration, the National Environment Committee Board, and the Consumer Protection Committee Board. A special administrative committee and the legislative body in charge of overseeing the national food safety policy and the maximum tolerance limits for mycotoxins can devise the control strategy. This means that mycotoxins will be well-known to farmers, middlemen and food and feed factories; they will also be encouraged to prevent and control mycotoxins as much as possible in the products they produce and sell.

Toxic mycotoxins must be regulated in products or commodities traded internationally, as well. For goods that are to be exported or imported, countries should set quality control limits for the goods themselves. We'd like to raise awareness among exporting countries about the dangers of mycotoxins. Flavatoxins have already been established as a maximum tolerance limit for animal feeds by the European Economic Community (EEC), for example, in complete feeds, poultry, and dairy supplements not exceeding 20 parts per billion (ppb); in mixed feeds and complete feeds, cattle, sheep, and goats not exceeding 50 ppb (ppb).

FAO, WHO, and UNEP in the United Nations system are providing essential information on various aspects of mycotoxin control and prevention to all nations. A sampling and analysis procedure, surveillance systems, food control inspections, the use of contaminated products in animal feed, and protocols for detoxification and product quality control are all examples of international trade guidelines.

The promotion of current information on mycotoxins should include conferences, symposiums, trainings, and workshops. Developed countries could then transfer low-cost technology for assessing, preventing, and controlling environmental mycotoxins.

WHO Response:

It is the responsibility of WHO and the FAO to assess the risks to humans posed by mycotoxins in food, and to recommend appropriate measures of protection. Governments and the Codex Alimentarius Commission (the intergovernmental standards-setting body for food) use the risk assessments of mycotoxins in food done by the Joint FAO/WHO Expert Committee on Food Additives (JECFA) to establish maximum levels in food or provide other risk management advice to control or avoid contamination. It is the goal of Codex standards to ensure that people around the world can have confidence in the food they buy, no matter where it was grown or produced, regardless of where it was grown or produced.

Review of Literature:

The presence of mycotoxins in the food supply chain persists despite decades of research and the adoption of sound agricultural and manufacturing practises. In terms of both domestic and international trade, mycotoxins have a significant impact on human health, animal welfare and productivity, as well as on both domestic and international food production (Pitt and Miller 2017; Wu and Mitchell 2016).

Over the course of eight years, Streit et al. (2013) collected 17,300 feed samples from around the world and found that 72% of them contained mycotoxins. The contamination of feeds with mycotoxin can reach up to 79% or even higher, according to a study by Kovalsky et al. (2016), which included samples from 52 different countries.

As a starting point for further global research into mycotoxin contamination rates, the authors noted that their findings were significantly higher than the FAO's 25 % estimate.

When meat animals consume contaminated feed and accumulate the lipid-soluble toxin ochratoxin A, humans who consume the meat are at risk of exposure (Matthews et al. 2017). Balkan endemic neuropathy, a kidney disease with a high mortality rate in Eastern Europeans living near Danube tributaries, has been linked to ochratoxin A. (Pfohl-Leszkowicz and Manderville 2007). Trichothecenes, a toxic or biologically active metabolite produced by Fusarium species, can cause severe symptoms in humans, such as allergic reactions, vomiting, and diarrhoea, when present in high concentrations.

A decrease in body weight gain and immune system dysfunction in animals are also linked to trichothecene use (Wu et al. 2014). Zearalenone causes uterotrophic (anti-reproductive) effects in animals like pigs, despite the fact that its toxicity to humans is unknown (Agriopoulou et al. 2020).

In some animals, fumonisins may cause neurotoxicity. It has been found that Fusarium verticillioides can cause human esophageal cancer (Bennett and Klich 2003).

Objectives:

- the fungi that produce mycotoxins, the crops in which mycotoxins are most frequently found, and the major groups of mycotoxins
- Toxic mycotoxins are currently responsible for a number of major human and domestic animal diseases (known as mycotoxicoses),
- In agricultural systems, consider ways to reduce mycotoxin contamination
- Toxic contamination can be detected using a variety of current technologies.
- The global impact of mycotoxins, with a focus on developing countries, should be discussed.

Research Methodology:

The enforcement of mycotoxin regulations, other monitoring programmes, and research studies necessitate sensitive, specific, accurate, and precise analytical methods. For food and feed production, rapid screening tests are a valuable tool. Both quantitative and qualitative methods can be used to identify mycotoxins in food.

Result and Discussion:

Mycotoxins can be found in a wide variety of foods, and the animals that are most susceptible to their effects are summarised here.

Mycotoxin	Contaminated products	Animalsaffected	Clinical effects
Aflatoxins	Com, peanuts, cottonseed,tree nuts, dairy products	Swine, dogs, cats, cattle,sheep, young birds, humans	Liver damage, intestinal bleeding, cancer
Ergotalkaloids	Rye,sorghum, pasture grasses	Cattle, sheep, humans	Hallucinations, gangrene, loss of limbs, hastening of birth
Fumonisins	Corn, silage	Horses, swine, humans	Pulmonary edema, leukoencephalomalacia, esophageal cancer, neural tube defects, liver damage, reduced growth
Ochratoxins	Cereal grains, coffee, grapes	Swine, humans	Kidney and liver damage, cancer
Trichothecenes	Wheat, barley, oats, corn	Swine, dairy cattle, poultry, horses, humans	Feed refusal, diarrhea, vomiting, skin disorders, r educed growth
Zearalenone	Corn, hay	Swine, dairy cattle	Enlargement of uterus, abortion, malformation of testicles and ovaries

Table 1: summarises the major classes of mycotoxins, common food products that may be contaminated with mycotoxins, and animals that are most affected.

More than 300 mycotoxins have been identified so far, with a wide range of fungal origin, structure, function, and biological effect; however, only a few of these have been shown to have a significant impact on human health and agriculture (Table 1). Mycotoxins can range from simple four-carbon compounds to more complex ones because of the different biosynthetic pathways that lead to their synthesis.

Mycotoxin	Producing Fungi	Affected Foodstuff
	Aspergillus flavus	
Aflatoxin B1, B2, G1 and G2	Aspergillus parasiticus	Wheat maize, rice, peanuts, nuts, spices, oilseeds, and cottonseed
	Aspergillus nomius	
Aflatoxin M1	Metabolite of aflatoxin B1	Milk and dairy products
	Aspergillus carbonarius	
	Aspergillus niger	

Mycotoxin	**Producing Fungi**	**Affected Foodstuff**
	Aspergillus ochraceous	
Ochratoxin A		Wheat, barley, oats, cocoa beans, coffee beans, fruits and fruit juicc Ochratoxin A
	Penirithurnvarricusm	
	Pe:Silkennordinan	
	Penirithurncyctopium	
	nenicaiumexpansum	
Patulin	Byssochlarnys Sea	Fruit and fruit juices, cheese, and wheat
	Aspergiliusclavatus Fusarium sporotrichiodesFusariurnlangsethiae	
	Aspergiliusclavatus Fusarium sporotrichiodesFusariurnlangsethiae	
	Aspergiliusclavatus Fusarium sporotrichiodesFusariurnlangsethiae	
Trichothecenes	Fusarium graminearum	Maize, wheat, barley, oats, grains, and animal feed
	Fusarium rutmorum Fusarium tweaks	
	Fusarium graminearum Fusarium cubnorum	
	Fusarium rutmorum Fusarium tweaks	
	Fusarium graminearum Fusarium cubnorum	
Zearalenone	FusarasnequiseaRrsarannverticaliodes&Gan= incarmztum	Maize, wheat barley, rye and animal feed
	FusarasnequiseaRrsarannverticaliodes&Gan= incarmztum	
	FusarasnequiseaRrsarannverticaliodes&Gan= incarmztum	
Fumonism B1, Bz Si	Fusaraanveracalioides	Maize, rice, wheat sorghum, bailey, and oats
	&sari= proliferatum	

Table 2: lists the most common mycotoxins, the fungi that produce them, and the foods they are found in.

Climate Role:

In terms of fungal activity and colonisation, climate conditions play an important role. Humidity and temperature, in particular, have a significant impact on the fungi's activity and level of colonisation. Doohan et al. claim that these elements affect the growth, survival, dispersal, and frequency of mycotoxigenic fungi, as well as the accumulation of their toxins.

In addition to temperature and humidity, mycotoxins are influenced by the competitiveness of fungi that produce mycotoxins. Temperature and water activity ranges are critical to the growth, germination, and mycotoxin production of each type of fungal organism. As a result, there is no single temperature and water activity range that is associated with fungal growth.

Fungi	**Growth**				**Optimal growth**	
	Temperature	aw	Temperature	aw	Temperature	Aw
Aspergillus flavus/ parasitic us	15-44 °C	0.91-0.99	35 °C	0.95	33 °C	0.99
Aspergillus ochraceous	10-40 °C	0.80-0.98	24-31 °C	0.96-0.98	25-30 °C	0.98
Aspergillus carbonarius	8-40 °C	0.90-0.93	32-35 °C	0.94-0.99	30-35°C	0.98

Table 3: Optimal conditions for the growth and production of mycotoxins by fungi reported in various studies.

There are many stages in the food chain where improper storage could compromise the safety and quality of subsequent products, so it's critical that the conditions of storage be closely monitored and controlled throughout the duration of storage. Aeration systems in storage facilities that monitor temperature and humidity should be installed so that any problems in storage can be discovered at an early stage, allowing for effective interventions to be made.

As part of the regular quality checks that must be performed, the bulk of the product must be sampled and analysed for quality parameters such as temperature, moisture content, microorganism contamination, and any visible signs of damage, pest attack, or mould growth. Pest invasions must also be avoided, as their presence increases moisture levels, damages crops physically, and facilitates fungal spread.

Element	**Measures**
Grain	Check for appropriate physical conditions prior to storage Check that appropriate moisture content is achieved before storage Check for the presence of disease or fungal infections

Element	Measures
Storage facilities	Check soundness and suitability Perform weatherproofing Ensure sanitation of building and equipment Remove previous crop residues Install impermeable moisture barriers on floors
Insect, rodents, and birds prevention	Apply insecticide to building before use Use insect and rodent trapping Seal any holes in the building to prevent the entry of rodents and birds
Maintenance and monitoring	Install devices to measure temperature and moisture Calibrate devices regularly Monitor the presence of pest infestation Monitor any physical damage or signs of disease in crops
Quality assessment	Assess visually the presence of any pest infestation Assess visually the presence of any physical damage or fungal invasion Perform periodic microbiological and chemical assessments
Record keeping	Record data Retain tested samples

Table 4: Safe storage practises to prevent the growth of fungi and the release of mycotoxins

Conclusion:

Pathogens of global significance, mycotoxigenic fungi. They have a negative impact on the quality of agricultural crops and food safety. More than a dozen species of Aspergillus, Fusarium and Penicillium have been found to contaminate major crops in the Philippines. Aflatoxin, fumonisin, ochratoxin, nivalenol, and zearalenone were the five major mycotoxin groups that were found. There are numerous ways to prevent and control dangerous fungi and their harmful mycotoxins. Biological control, as well as physical and chemical treatments, are all options. Recommendation and further experimentation with fungal resistant hybrids of crops are made Prior to harvesting, the field and surrounding environments should be prepared as much as possible. Commodities drying after harvest is

the most cost-effective and efficient method for farmers or layment, but may not be suitable in rainy or wet weather. Villagers cannot benefit from or use thermal or gamma irradiation treatment. An alkalinization and ammoniation treatment is well-known in the industry. It is necessary to alter mycotoxins-detoxifying chemicals in some way. As a result of decades of research, little is known about the best ways to prevent the spread of mycotoxins and fungi in the country. In spite of this, the rise in scholarly output indicates that researchers are becoming increasingly interested in these fungi. In the future, research outputs could help policymakers develop or improve standards and policies.

References:

1. United Nations, Department of Economics and Social Office, Population Division 2017. [(accessed on 4 July 2019)]; Available online: https://www.un.org/development/desa/publications/world-population-prospects-the-2017-revision.html.
2. Pangga I.B., Salvacion A.R., Cumagun C.J.R. Climate Change and Mycotoxins. DeGruyter; Berlin, Germany: 2015. Climate change and plant diseases caused by mycotoxigenic fungi: Implications for food security; pp. 1–28. [Google Scholar]
3. Feuell, A.J., Aflatoxin in groundnuts IX, Problems of detoxification, Trop. Sci., 8,1966, 61.
4. SongpanWangjaisuk, Detoxification of aflatoxin B1 in peanut by ammonium bicarbonate and gamma irradiation, M. Sc. Thesis, 1989.
5. Sommer, N.F. &Fortlage, R.J., lonizing radiation for control of postharvest diseases of fruits and vegetables, Adv. Food. Res., 15, 1969, 147.
6. Pons, W.A. jr., Cucullu, A.F., Lee L.S., Janssen, H.J., & Goldblatt, L.A., Kinetic study of acid catalyzed conyersion of aflatoxins B1 and G1 to B2a and G2a, J. Am. Oil Chem, Soc.58, 1981, 995A-1002A.
7. Brekke, O.L., Sinnhuder, R.O., Peplinski, A.J., Wales, J.H., Putnam, G.B., Lee, D.J. &Ciegler, A., Aflatoxin in corn, Ammonia inactivation and bioassay with rainbow trout, Appl. Environ. Microbiol. 34, 1977, 34-37.
8. Moretti A.T., Logrieco A.F., Susca A. Mycotoxin: An underhand food problem. In: Moretti A., Susca A., editors. Mycotoxigenic Fungi Methods and Protocols. Humana Press; New York, NY, USA: 2017. pp. 3–12. [Google Scholar] Bennett, J. W., M. Klich. 2003. “Mycotoxins.” Clin. Microbiol. Rev. 16(3): 497–516.
9. Agriopoulou, S., E. Stamatelopoulou, T. Varzakas. 2019. “Advances in Occurrence, Importance, and Mycotoxin Control Strategies: Prevention and Detoxification in Foods.” Foods 9: 137. doi:10.3390/foods9020137.
10. Wu, F., J. D. Groopman, J. J. Pestka. 2014. “Public Health Impacts of Foodborne Mycotoxins.” Annu. Rev. Food Sci. Technol. 5(1): 351–372. doi:10.1146/annurev-food-030713-092431.
11. Pfohl-Leszkowicz, A., R. A. Manderville. 2007. “Ochratoxin A: An overview on Toxicity and Carcinogenicity in Animals and Humans. Mol. Nutr. Food Res. doi:10.1002/mnfr.200600137.
12. Streit, E., K. Naehrer, I. Rodrigues, and G. Schatzmayr. 2013. Mycotoxin occurrence in feed and feed raw materials worldwide: Long-term analysis with special focus on Europe and Asia. Journal of the Science of Food and Agriculture 93 (12):2892–9. doi: 10.1002/jsfa.6225.

13. Matthews, K. R., K. E. Kniel, T. J. Montville. 2017. "Food Microbiology: An Introduction." Washington, DC: ASM Press.
14. Kovalsky, P., G. Kos, K. Nährer, C. Schwab, T. Jenkins, G. Schatzmayr, M. Sulyok, and R. Krska. 2016. Co-occurrence of regulated, masked and emerging mycotoxins and secondary metabolites in finished feed and maize – An extensive survey. Toxins 8 (12):363. doi: 10.3390/toxins8120363
15. Pitt, J. I., and J. D. Miller. 2017. A concise history of mycotoxin research. Journal of Agricultural and Food Chemistry 65 (33):7021–33. doi: 10.1021/acs.jafc.6b04494.
16. Zain ME (2011) Impact of mycotoxins on humans and animals. J Saudi Chem Soc 15: 129–144. doi: 10.1016/j.jscs.2010.06.006