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ScienceDirect

Procedia Food Science 5 (2015) 207 – 210

Procedia
Food Science

International 58th Meat Industry Conference "Meat Safety and Quality: Where it goes?"

Mycotoxins as one of the foodborne risks most susceptible to climatic change

Ksenija Nesic[a,]*, Dragan Milicevic[b], Vladimir Nesic[c], Snezana Ivanovic[a]

[a]*Institute of Veterinary Medicine of Serbia, Autoput 3, Belgrade 11070, Serbia*
[b]*Institute of Meat Hygiene and Technology, Kacanskog 13, 11040 Belgrade, Serbia*
[c]*Faculty of Veterinary Medicine, University of Belgrade, Bulevar Oslobodjenja 18, Belgrade 11000, Serbia*

Abstract

The impact of climate change on agriculture and food safety is certain.This may affect mycotoxin concentrations as fungi with higher temperature optima for growth and mycotoxin production will dominate in regions with currently cooler climates, or become less prevalent as the temperatures become too high in areas where the temperature is already hot. In Serbia, recent drought and then flooding confirmed that mycotoxins are one of the foodborne hazards most susceptible to climate change. This paper ams to discuss the weather influence on the mycotoxicology situation and to point out the possibility of prediction and prevention of such future problems.

Peer-review under responsibility of scientific committee of The 58th International Meat Industry Conference (MeatCon2015)

Keywords: climate change; food safety; mycotoxins

1. Mycotoxins

Mycotoxins are secondary metabolites of different types of fungus, belonging primarily to *Aspergillus*, *Penicillium* and *Fusarium* genera. Under favourable environmental conditions, when temperature and moisture are

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* Corresponding author. Tel.: +381-11-660-4020; fax: +381-11-660-4020.
E-mail address: ksenija_n@yahoo.com

Peer-review under responsibility of scientific committee of The 58th International Meat Industry Conference (MeatCon2015)
doi:10.1016/j.profoo.2015.09.058

suitable, fungi proliferate and may produce secondary metabolites. They have globally significant implications on human and animal health, economy and international trade[3]. Animal feed and human food can be adversely affected. Fungi are a normal part of the microflora of standing crops and stored feeds, but the production of mycotoxins depends upon the fungi present, agronomic practices, the composition of the commodity and the conditions of harvesting, handling and storage[2]. The amount of toxin produced will depend on physical factors (moisture, relative humidity, temperature and mechanical damage), chemical factors (carbon dioxide, oxygen, composition of substrate, pesticide and fungicides), and biological factors (plant variety, stress, insects, spore load).

The accumulation of mycotoxins both before and after harvest largely reflects climatic conditions. *Fusarium* toxins are produced in cereal grains during high moisture conditions around harvest[14], whereas pre-harvest aflatoxin contamination of crops is associated with high temperatures, insect damage and prolonged drought conditions. Moreover, because *Aspergillus* can tolerate lower water activity than *Fusarium*, it is more likely to contaminate commodities both pre- and post-harvest, whereas *Fusarium* is more likely to be found as a contaminant pre-harvest[2]. These examples demonstrate that although it may be convenient to describe fungi as either pre- or post-harvest organisms, the actual colonisation and proliferation of fungi is not clear cut but depends on the environmental and ecological circumstances and the resulting toxins will differ accordingly.

Stored grain is not static as well. It is in a dynamic state and may become infested with fungi and insects. These interrelationships are affected by climatic factors such as temperature and humidity, by geographical location, by the type of storage container and by grain handling and transport. Moisture depends mostly on water content at harvest, the amount of drying, aerating, and turning of the grain before or during storage as well as the respiration of insects and microorganisms in the stored grain. If grain is dry when placed in storage, moisture content can only rise due to leaks or condensation. Grain may go into storage at a uniform temperature, but over a period the grain mass will cool at a different rate in the centre than at the periphery. As a result of temperature differentials moisture migrates through the storage bin, resulting in condensation and the provision of ideal conditions for mould growth or the development of ‘hot spots’ in localized areas. Microbial and insect growth in stored grain also results in moisture condensation and the potential development of ‘hot spots’. The minimum critical levels for the growth of fungi are 70–150 g/kg moisture (depending on commodity) and 80–85% relative humidity. Temperatures at which toxin production can take place vary from 0°C to 35°C, depending on fungal species. Most mycotoxins are very stable chemically and once formed, they will continue to contaminate that commodity and feeds manufactured from it[3]. Two most important factors which affect the life cycle of all microorganisms including mycotoxigenic moulds are water availability and temperature[9].

2. Climate change and mycotoxins

IPCC[6] states that more climate changes are ahead which will affect mycotoxins in food. Concentrations of methane, carbon dioxide, nitrous oxide and chlorofluorocarbons in the atmosphere are increasing, resulting in environmental warming, greater precipitation, or drought. Climate changes or extreme climatic events are already part of our everyday life and can be seen more and more frequently. Changing temperature and rainfall may threaten food security[7,11,12,19] and will have a negative impact especially in developing countries.

The EU green paper on climate change suggests that effects in Europe will be regional and either detrimental or advantageous, depending on region. This could increase the risk of migration of pathogens which might occur as a result of shifts in response to warmer, drought-like climatic conditions. Effects on plant physiology, including stomatal patterns on leaf surfaces, will influence transpiration and photosynthetic capacity and affect invasion by pests and pathogens. There is evidence that increased CO_2 and temperature may modify the phyllosphere mycoflora of cereals during ripening. This may have an effect on the colonization by mycotoxigenic fungal genera which contaminate food and raw materials[10].

Climatic changes resulted in specific extreme conditions in Serbia in 2011/12 and 2013/14 production years. According to the report of the Republic Hydrometeorological Service of Serbia[17], production year 2012 was characterized by pronounced climatic changes. Prolonged periods of extremely high air temperatures during June, July and August 2012, as well as precipitation deficit, resulted in severe and extreme droughts in many regions of Serbia. The hottest and driest period in the major part of the territory coincided with the most important generation phases of spring crops, thus causing substantial damage and losses in agricultural crop production manifested by