# Chapter 3
# Food Safety and Climate Change: Case of Mycotoxins

**Abdellah Zinedine**
*Chouaib Doukkali University, Morocco*

**Samira El Akhdari**
*Ministry of National Education, Morocco*

## ABSTRACT

*Mycotoxins are chemical compounds produced mainly by mounds of genera Aspergillus, Penicillium, and Fusarium on various grains and agricultural commodities at different stages in the field, before harvest, post-harvest, during processing, packaging, distribution, and storage. The production of mycotoxins depends on several environmental factors such as temperature and moisture. This chapter gives an overview about the major mycotoxins (e.g., aflatoxins, ochratoxin A, and Fusarium toxins), masked mycotoxins, and emerging mycotoxins. The toxicity of these mycotoxins and their negative economic impact was also discussed together with the effect of climate change on their production. A section on mycotoxins regulations by international agencies and organisms (WHO, FAO, EU, etc.) was discussed. Finally, the different strategies to reduce or eliminate the toxic effects of mycotoxins in contaminated foods and feeds by using chemical, physical, and biological/biotechnological methods or innovative approaches were explained.*

## INTRODUCTION

Fungi are considered ubiquitous microorganisms found in nature, their spores are able to travel across countries and continents on our planet (De Ruyck *et al*, 2015). They are known to produce active chemical compounds called mycotoxins, which are secondary metabolites that exert adverse negative effects both on human and animal health and may contaminate agricultural food products of vegetal and animal origin (Tantaoui-Elaraki *et al*., *in press*).

DOI: 10.4018/978-1-7998-5354-1.ch003

Strains of the genera *Aspergillus*, *Penicillium*, *Fusarium* and *Alternaria* are the most mycotoxins producing fungi. Mycotoxins synthesis by toxigenic species depend widely on internal parameters of fungal strains (physiological, genetic and biochemical, etc.) but also on external factors (climatic factors) such as humidity and temperature.

The genus *Aspergillus* was described by Pier Antonio Micheli in 1729. It was reported that *Aspergillus* species that produce mycotoxins are more common in the warmer, subtropical and tropical areas than in the temperate areas of the world (Wilson *et al*., 2002). *Aspergilli* species are soil fungi or saprophytes, and several are able to produce active compounds especially aflatoxins, ochratoxins, citrinin, penicillic acid, sterigmatocystin, cyclopiazonic acid, gliotoxin, citreoviridin and other important metabolites. All these compounds are produced by a high number of fungal mycotoxin species producers belonging to the genus *Aspergillus* including *A. flavus, A. niger, A. nomius, A. ochraceus, A. parasiticus, A. candidus, A. clavatus, A. restrictus, A. tamarii, A. terreus, A. versicolor*, etc. (Frisvad & Samson, 1991).

Mycotoxins are known as low molecular weight (below 700 Da) chemical substances and are produced on various grains and agricultural commodities at different stages in the field, before harvest, post-harvest, during processing, packaging, distribution and storage (Creppy *et al*., 2002). Modified mycotoxins called also "masked mycotoxins" can be produced by fungi or generated as part of the defense mechanism of the infected plant. They can be produced during the processing of contaminated food processing (e.g. cooking), then can be converted to the original mycotoxin by the metabolism of animals and humans (Berthiller *et al*., 2013). The conversions of these modified mycotoxins to their free form possibly increased the bioavailability of the parent mycotoxin and induce potential risk to human health (Paris *et al*., 2014). Some species belonging to the *Fusarium* genus are responsible for the production of another group of bioactive compounds called *emerging* or *minor* mycotoxins. This group includes enniatins (A, A1, B and B1), fusaproliferin, beauvericin, and moniliformin (Jestoi, 2008).

Some mycotoxins are known of their acute toxic properties on humans (ergot alkaloids) and animals (aflatoxins, OTA, *Fusarium* toxins), but the majority of them are of chronic toxicological effects (Zinedine & Mañes, 2009).

Several mycotoxins are correlated with toxicological effects including hepatotoxicity, teratogenicity, carcinogenicity, neurotoxicity, immunosuppressive effects as well as reproductive and developmental toxicity in humans and animals. Among these substances, aflatoxins, ochratoxin A, fumonisins, zearalenone, trichothecens, T-2, HT-2 toxins are of a great concern because of their negative impact on human and animal health (Bennett & Klich, 2003). Mycotoxins are also known with their negative economic impacts. Indeed, according to FAO, one third of all foodstuffs produced for world's population are lost from field to consumer, reaching nearly 1.3 billion metric tons each year; and that 25% of the crops in the world are damaged by mould or fungal growth (FAO, 2012).

The mycotoxin problem in public health is longstanding and all humans and animals are at risk for mycotoxin exposure. People are mainly exposed via the ingestion of contaminated foods; however, alternate routes include dermal absorption and inhalation of toxinogenic molds containing mycotoxins. The major regulated mycotoxins and the most associated producing fungi are summarized in Table 1.

The climate change is likely to alter the degree of human exposure to pollutants and the response of human populations to these exposures. The contamination of food and feed by mycotoxins, and the production of these compounds by fungi can be very sensitive to environmental factors such as temperature and humidity. Paterson and Lima (2010) showed that indirect effects of climate change may also be important; for example, changes in the distribution and activity of insect vectors may increase the exposure and vulnerability of plants to mycotoxins. It was reported that climate change could have a