Ochratoxin A Occurrence in Food

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Abstract. The aim of the present study was to investigate the occurrence of Ochratoxin A (OA) in food based on the results of the investigation about the Assessment of dietary intake of Ochratoxin A by the population of EU Member States.

Ochratoxin A (OTA) can occur in a large variety of commodities (cereals, beans, groundnuts, spices, dried fruits, coffee, beer, wine) and, because of a carry-over effect, in milk, pig blood, liver, and kidney, and poultry meat from animals fed with contaminated feed. Because of the persistence of OTA in the food chain, exposure to the compound is a potential human health hazard. This has prompted adoption of regulatory limits in several countries which, in turn, implies the development of suitable validated and official analytical methods and rapid screening tests for cost-effective food control on a large scale.

Liquid chromatography with fluorescence detection (LC–FLD), coupled with immunoaffinity column (IAC) clean-up, is the most widely employed analytical technique. LC coupled with electrospray-ionization mass spectrometry (MS) has detection limits comparable with those of LC–FLD and the selectivity of IAC can be achieved by tandem (MS–MS) or sequential (MSn) detection. Synthetic counterparts to natural antibodies in the form of molecularly imprinted polymers seem a promising alternative to IAC for sample preparation. New analytical approaches to rapid, low-cost screening methods, for example those based on biosensors and dip-stick-like kits, are a direction in which innovation can be expected.

Keywords: Ochratoxin A, Mycotoxins, tolerable daily intake

INTRODUCTION

Some molds produce mycotoxins: low-molecular weight fungal secondary metabolites that are capable of initiating a toxic response in vertebrates (Pitt, 2000, Adams, 2002; Davis, 2001). Mycotoxins are considered secondary metabolites because they are not essential for maintaining mold cells or fungal growth, but are derived from primary metabolic process chemicals such as polypeptides, amino acids, phenols, or terpenoids. Mycotoxins are believed to provide competitive advantages for fungi such as assisting parasitic fungi with invading host tissue, or helping to eliminate other competing organisms in the same environment (Adams, 2002). Nearly all mycotoxins are cytotoxic, disrupting various cellular structures such as membranes, and interfering with vital processes such as protein, RNA and DNA synthesis (Mold-Help, 2001).

Until recently, human health effect studies for mycotoxin exposure have generally prevailed on the topic of ingestion. Consumption of mycotoxins has shown immunosuppression, mutagenicity, and cancer as well as adverse effects on various organs and systems of the body including kidney and liver, gastrointestinal, nervous, urogenital, and vascular (FAO/IAEA, 1997). Additional symptoms of mycotoxins exposure can include dermatitis, cold and flu symptoms, sore throat, headache, fatigue, and diarrhea. Only a very
limited number of studies have been conducted on the role of mycotoxins in indoor air and human health, therefore the role of mycotoxins remains controversial (Miller, et al, 2001).

Molds are multicellular microorganisms and a typical mold possesses hyphae, conidiophore – consisting of stalk, vesicle, sterigmata, and conidia (spores) (Fig. 1). Often the identification of mold species is done by examining the morphological shape and size of the spores under a light microscope (Bennett, 2003). The cell wall consists of polymer of hexose chitin and N-acetyl glucosamine (NAG). Mold spores or hyphae are allergenic to humans and frequent exposure may occur in damp buildings with high humidity with poor air circulations.

Fig. 1 Schematic drawing of (A) Aspergillus species and (B) Penicillium species. Panels (C) and (D) are the light microscopic photograph of Aspergillus niger (C) and Penicillium citrinum (D) (magnification 400×) (See Color Plates)

Ochratoxin is primarily produced by species of Penicillium and Aspergillus. Ochratoxin is damaging to the kidneys and liver and is also a suspected carcinogen. There is also evidence that it impairs the immune system.

Opinions of the Scientific Committee for Food (SCF) of the European Union have recently discussed a nephrotoxicity, immunotoxicity, carcinogenicity and teratogenicity of the mycotoxin ochratoxin A (OTA) (Bennett, 2003). Maximum limits for the OTA intake of humans (tolerable daily intake) range from 1.2 to 14 ng/kg bodyweight and day, dependent on the toxicologic endpoint of risk assessment.

Aspergillus ochraceus and several other species including Penicillium spp. produce seven structurally related secondary metabolites called ochratoxin (Fig. 2) (Ortega, 2005).

Fig. 2 Chemical structures of Ochratoxin A

Ochratoxin is found in a large variety of foods including wheat, corn, soybeans, oats, barley, coffee beans, meats and cheese. Barley is thought to be the predominant source (Ray,
B. and Bhunia, A. K. 2007). The toxin is analyzed by using high performance liquid chromatography (HPLC) technique and mass spectrometry.

Ochratoxin is hepatotoxic and nephrotoxic and a potent teratogen and carcinogen. Nephropathy and renal pathology are predominant consequences of ochratoxin poisoning. It inhibits cellular function by inhibiting the synthesis of phenylalanine–tRNA complex, and ATP production. It also stimulates lipid peroxidation. The LD50 value in rats is 20–22 mg kg−1. The IARC considers ochratoxin as category 2B carcinogen (Cousin et al., 2005).

**Estimated dietary intake from susceptible food commodities**

With the aim to evaluate the contribution to the OA dietary intake by European population from each food matrix, the estimated dietary intakes from each commodity were also calculated, and presented in Tab. 1 and Fig. 3. The sum of contributions from processed foods derived from the same raw matrix was also calculated.

The best estimates of dietary intakes were calculated only for those commodities, for which both consumption and occurrence data were provided. In order to provide a more exhaustive overview of all data available for each commodity, OA occurrence values related to food commodities for which consumption data were not available are also reported in the Tables.

The OA dietary intake from cereals has been calculated by summing up the dietary intakes from each subgroup of cereals. The best estimates of OA dietary intake were not calculated for green coffee, but only for the total consumed coffee products (i.e. roasted, instant and decaffeinated). All participant countries have provided best estimate of dietary intakes on the basis of the available occurrence and consumption data.
Seven out of 12 participants provided best estimate of dietary intake from beer and ten out of 12 participants evaluated dietary intake from wine.

Four out of 12 countries provided estimates on dietary intake for dried fruits and three countries provided estimates of dietary intakes from meat.

Six countries provided occurrence and consumption data necessary for the intake calculation from other food commodities.

**CONCLUSIONS**

Good agricultural practices (GAP) and good manufacturing practices (GMP) to control molds in preharvest and postharvest crops should be employed. Those include soil testing, crop rotation, irrigation, antifungal treatments, appropriate harvesting conditions, drying, and storage.

Traditionally mold control was achieved by controlling the temperature, pH and moister levels of the stored grains, cereals and fruits.

In modern day HACCP is employed to reduce mold and mycotoxins in products. Implementation of HACCP is aided by improved analytical techniques for sensitive detection of mycotoxins and stringent regulatory standards to exclude products for human consumption that contain mycotoxin levels over the allowable limits.

In addition, development of transgenic plants that are able to increase the insect and mold resistance may aid in reduced levels of mycotoxins in products.

**REFERENCES**
