Mini Review

Pharmaceutical BIOPROCESSING

Ochratoxin-Induced Toxicoses in Humans and Animals: Chemical, Physical, and Biological Approaches

Abstract

Ochratoxins are fungal secondary metabolites derived from polyketides that can harm the kidneys, suppress the immune system, be teratogenic, or cause cancer.Fungi that produce ochratoxin can contaminate agricultural products during processing, storage, or in the field (preharvest spoilage).Food and feed contamination with ochratoxin poses a serious threat to human and animal health. Reduced ochratoxin levels in agricultural products have been the subject of research into a number of different approaches.There are three primary types of these strategies:decontamination or detoxification of foods contaminated with ochratoxins, inhibition of the gastrointestinal tract's absorption of consumed ochratoxins, and prevention of ochratoxin contamination.This paper provides an overview of promising approaches to lowering human and animal exposure to ochratoxins.

Keywords: Ochratoxin • Detoxification • Adsorption • Spoilage

George Mchussain*

Cereal Research Non-Profit Limited Company, Alsokikoto sor 9, H-6726 Szeged, Hungary

*Author for correspondence:

GeorgeMc@bio.u-szeged.hu

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Introduction

Mycotoxin Ochratoxin A (OTA) is found in various plant products like cereals, coffee beans, nuts, cocoa, pulses, beer, wine, spices, and dried vine fruits. These products are contaminated by OTA. Ochratoxins are pentaketides that cycle: derivatives of dihydroisocoumarin that are connected to an L-phenylalanine moiety.An isolate of *Aspergillus* ochraceus was the first to contain OTA.This mycotoxin has been produced by a number of *Aspergillus* and *Penicillium* species since then. OTA was found to be teratogenic, immunosuppressive, nephrotoxic, and carcinogenic [1]. OTA has been linked to a number of human- and animal-related nephropathies; For instance, this mycotoxin is the cause of Danish porcine nephropathy and other animal renal disorders.Balkan endemic nephropathy, a syndrome characterized by contracted kidneys, tubular degeneration, interstitial fibrosis, and hyalinization of the glomeruli, is frequently linked to OTA in humans.The International Agency for Research on Cancer (IARC) classified OTA as a possible human carcinogen (Group 2B) in 1993, concluding that there was sufficient evidence for the carcinogenicity of OTA in experimental animals but insufficient evidence in humans.Chronic karyomegalic interstitial nephropathy and chronic interstitial nephropathy in Tunisia, urothelial tumors (end-stage renal disease) in Egypt, and testicular cancer [2] have all been linked to OTA.

A Commission Regulation (EC) has established maximum levels of OTA in commodities for a number of agricultural products intended for use as food or feed ingredients [3]. The European Union also has its own set of national laws and regulations. To mitigate the harmful effects of mycotoxins in general and ochratoxins in particular on foods and feeds, a number of approaches have been proposed.

Discussion

Most of the time, the best way to stop mycotoxins from harming animals and people is to stop them from growing and making mycotoxin in the field.Crops must be safeguarded against damage caused by either mechanical processes or insects due to the fact that molds that produce mycotoxin typically can only colonize damaged portions of plants. In addition, to avoid contamination, inoculum sources like weeds and agricultural waste should be minimized.Stress should be reduced for the plants themselves, and good agricultural practices (GAP) like rotating crops and cultivating and harvesting during the appropriate seasons and conditions should be followed [4]. In point of fact, Rousseau and Blateyron also emphasized the fact that proper vineyard management has the potential to reduce the amount of OTA found in wine by about 80%.

Treatment of field crops with fungicides is the traditional method for reducing pre-harvest contamination. Fungicides' chemical nature, application rate, crop type, fungal species, and storage conditions all have an impact on their effect on mold growth and mycotoxin biosynthesis. Dichlorvos, an organophosphate fungicide, was found to prevent A. sulphureus, P. verrucosum, and *A. ochraceus* from producing OTA [5,6]. Iprodione, another fungicide, was found to be able to reduce A. westerdijkiae's production of OTA, and it has been successfully used in agricultural products to prevent the growth of various fungal species, including OTA producers.Numerous laboratories have investigated the effects of fungicide treatments on the OTA content of wines.Black aspergilli, which infest grape berries, were successfully eradicated by combining Euparen, a sulfamide-type fungicide, with Mycodifol, or captan, in earlier research. Lo Curto et al. recently [7] discovered that the use of pesticides like Azoxystrobin (a dinitrophenyl derivative of strobilurin) and Dinocap (a dinitrophenyl derivative of dinitrophenyl) in conjunction with sulfur effectively reduced the amount of OTA in wines.Aspergilli-caused sour rot was found to be uncontrollable with carbendazim and Chorus. However, field trials conducted in France, Spain, Greece, and Italy demonstrated that the application of Switch, a different pesticide, significantly reduced the prevalence of black aspergilli on grapes. Cyprodinil and fludioxonil, which belong to the pyrimidine and pyrrolnitrin classes of fungicides, respectively, are present in the fungicide Switch. Since pyrrolnitrin was previously found to be effective against black aspergilli, the observation that fludioxonil can be used against aspergilli is not surprising. Switch, Scala (which contains the pyrimidine fungicide pyrimethanil), and Mikal (which contains fosetyl-Al and the dicarboximide folpel) were found to be the most effective fungicides for reducing fungal colonization and the OTA content of wines in another study. Mepanipyrim, pyrimethanil, fluazinam, and iprodione are just a few of the other fungicides that have been found to be effective in reducing either OTA levels or fungal growth in grapevine. Belli and others inspected the impact of 26 fungicides on *A. carbonarius* contamination and OTA creation in engineered medium and on grapes, and observed that both disease and OTA creation were decreased while utilizing cyprodinil in addition to fludioxonil, azoxystrobin, and penconazole. However, it should be mentioned that grapes were found to produce more OTA when exposed to certain fungicides. In grapes, for instance, fenhexamid, mancozeb, and copper hydroxide plus copper all increased infection and OTA production. Carbendazim, on the other hand, was found to reduce fungal biota but to stimulate OTA production. Recently, it was discovered that natamycin and fusapyrone, an antifungal compound produced by Fusarium semitectum, were effective in controlling the levels of OTA and aspergilli that produce OTA in vineyards [8,9].

It is also possible to successfully reduce OTA levels in coffee and grapes by applying insecticides that target ochratoxin-producing fungi's vectors. Due to the contribution of *L. botrana* to berry wounds and fungal spore dissemination, a good correlation has been found between damage caused by the grape-berry moth (*Lobesia botrana*) and OTA content in grape berries in grapevine. According to field tests, fungal infection and OTA accumulation in grapes were reduced when *L. botrana* was successfully controlled using either biological methods or insecticides. In addition, treatment with fungicides and insecticides against *L. botrana* significantly decreased OTA levels in the field. The larvae of the grape moth *Cochylis* sp., which are studied at the Interprofessionnel de la Vigne et du Vin France (ITV France),also serve as carriers for OTA-producing fungi's conidial dispersal. Grape OTA concentrations were found to be strongly correlated with the number of perforations caused by these larvae. As a result, the insecticides Lufox (a carbamate type insecticide containing luferunon and fenoxycarb), Decis (a pyrethroid insecticide containing delthametrin), and Bt (Bacillus thuringiensis) were successfully used by researchers at the Institut Coopératif du Vin

(ICV) to reduce the amount of OTA in wines. Another study found that Bacillus thuringiensis significantly inhibited the growth of OTA-producing fungi on grapes [10].

Conclusion

In espresso, the espresso berry drill (likewise called broca), Hypotenemus hampei, has been demonstrated to be a vector of *A. ochraceus*. The OTA contamination of coffee beans may be reduced by insecticides that control these insects. However, such trials have not been conducted due, in part, to the coffee berry borer's resistance to some pesticides (such as Endosulfan) and their high toxicity. In the field, other methods, such as cultural and manual methods, traps, or biological control with toxin-producing Bacillus thuringiensis strains, entomopathogenic fungi (such as Beauveria bassiana), or the insect parasitoids Cephalonomia stephanoderis or Prorops nasuta, are also used to control the coffee berry borer. Additionally, these methods might lower the amount of OTA in coffee beans. Nonetheless, the bug parasitoid Prorops nasuta, which has been acquainted from Africa with numerous espresso creating nations trying to control the espresso berry drill, has additionally been displayed to convey another OTA delivering mold, *Aspergillus* westerdijkiae. These findings raise the possibility that an ochratoxin-producing fungus is being spread by this insect parasitoid in coffee plantations. Using yeasts as biological controls, promising outcomes were also achieved in grape fields. Cryptococcus laurentii, Aureobasidium pullulans, and a strain of Hanseniaspora uvarum, in particular, produced favorable outcomes. A strain of Aureobasidium pullulans was found to be a good biocontrol agent for *A. carbonarius* in field trials. It reduced both the severity of *Aspergillus* rots and the accumulation of OTA in wine grapes. *In vitro* tests also demonstrated that this isolate could degrade OTA. It has also been discovered that other epiphytic yeasts, such as Candida guilliermondii, Acremonium cephalosporium, Issatchenkia orientalis, Metschnikowia pulcherrima, Issatchenkia terricola, and Candida incommunis, are effective at preventing rots in wine grapes caused by *Aspergillus niger*. The production of OTA was inhibited by antifungal metabolites that were isolated from the culture fluids of *Bacillus pumilus*.

Results

Ochratoxins are among the mycotoxins with the highest economic significance. Fungi that produce ochratoxin can contaminate agricultural products during processing, storage, or in the field (preharvest spoilage). Food and feed contamination with ochratoxin poses a serious threat to human and animal health. The toxicity of OTA necessitates that this toxin not be present in agricultural products intended for use as food or feed in order to safeguard the health of both humans and animals. Significant endeavors have been applied to concentrate on the basic places of OTA presence in the creation chain of a few impacted products, including those of cereals, espresso, and wine, and detoxification techniques have likewise been examined. It has been established that the most efficient strategy for managing contamination with this mycotoxin is pre- and post-harvest OTA prevention. Although OTA accumulation can be minimized, it is not possible to completely prevent its formation everywhere. Additionally, effective methods for purifying contaminated goods are receiving more attention. In order to recondition contaminated agricultural products for use as animal feed, decontamination or detoxification procedures are useful. Although some treatments have been shown to lower levels of particular mycotoxins, no single method has been developed that is equally effective against the many different mycotoxins that may co-occur in various commodities. Concerning, the most encouraging methodologies incorporate the utilization of microorganisms or their chemicals for sterilization purposes. To find more efficient organisms that can be used safely for OTA decontamination, more in-depth research is required.

Acknowledgement

None

Conflict of Interest

None

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