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ZEOLITE AND MYCOTOXINS : OCHRATOXIN DETOXICATION OF ANIMAL FEED BY KMI ZEOLITE

General statement: Zeolites are crystalline hydrated aluminosilicates with remarkable physical and chemical properties, which include losing and receiving water in a reverse way, adsorbing molecules that act as molecular sieves, and replacing their constituent cations without structural change. They have the ability to **lose** and gain water reversibly, to **adsorb** molecules of appropriate cross-sectional diameter and to **exchange** their constituent cations (NH_4^+, Na^+, K^+, Ca_2^+).In a structural standpoint, clinoptilolite like zeolite is made of windows, cages, and supercages (Fig.1). The windows are how the molecules reach the cages and supercages to be adsorbed or catalyzed. The window size can be modified by the ratio Si/Al and also by the ion exchange.

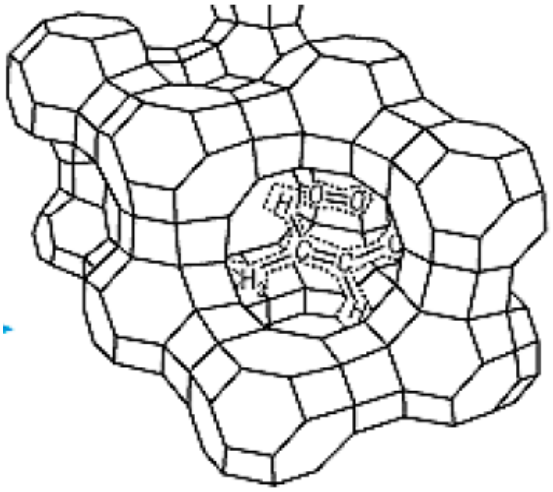

Fig.1 Zeolite structure with windows, cages and super cages

Ochratoxin: origin, toxicity and effects: Ochratoxins are produced by a series of molds of the genera Aspergillus and Penicillium. The largest amounts of ochratoxin are synthesized by *A. ochraceus*. The ochratoxin group consists of metabolites, but only ochratoxin A (OTA) is found as a worldwide contaminant in most grains used in animal feed. OTA is a polyaromatic molecule, more hydrophobic than zearalenone (ZEA) when ionized, and it is a potent nephrotoxin (European Food Safety Authority, 2009; Markov *et al*., 2013). It is considered immunosuppressive, hepatotoxic, genotoxic and nephrotoxic in all mammalian species. OTA has been related with the spontaneous avian and porcine nephropathy, and with the Balkan endemic nephropathy in humans. However, its mechanism of genotoxicity remains controversial (Corcuera *et al.*, 2012; Denli *et al.*, 2008).

Zeolite an effective adsorbent to eliminate ochratoxins: According to Eroglu *et al.* 2017, natural zeolites with a high content of clinoptilolite (over 80%) effectively adsorbed aflatoxin B1, aflatoxin B2 and aflatoxin G2. By contrast, zeolite with a surface modified with ammonium ions, displays very good adsorption features for ochratoxin A, T-2 toxin, zearalenone and aflatoxin B1.

Mechanisms of action of aluminosilicates like-zeolite on ochratoxins: Several studies have demonstrated that modified zeolites (clinoptilolite) significantly decrease the activity of ochratoxins and particularly ochratoxin A. The incorporation of long-chain organic acids on the surface of the zeolite - (organoaluminosilicate) results in increased hydrophobicity of the zeolite surface, which raises the affinity for non-polar molecules and reducing the adsorption of hydrophilic molecules (Dakovic *et al.*, 2005). Organoaluminosilicates are produced by exchange of aluminosilicate cations by organocations (usually alkylammonium quaternary ions). This modification enables the aluminosilicate to sequester low polarity mycotoxins, such as ochratoxins (Hauschild *et al.*, 2007; Tapia-Salazar *et al.*, 2010) with an extreme low rate of desorption through the intestinal tract. As clearly demonstrated by Trailovic *et al.*, 2013 in their *in-vitro* investigation of artificial intestinal fluid of broiler chickens fed with ochratoxin A, the modified zeolite exhibited the highest adsorption of ochratoxin A compared to esterified glucomannans and a mixed of inorganic and organic components plus enzymes. A significant *in-vivo* adsorption efficacy of ochratoxin A in the pectoral muscles and livers of broilers by the three adsorbents was also shown by the authors. The results confirmed two fundamental aspects of the adsorption of ochratoxins by zeolite :1)

increased of the efficacy of adsorption through its modification; 2) the level of adsorption is higher in very specific locations in the animal (livers, kidney and intestines…).

Zeolite and regulatory aspects: Zeolites are extensively used for agricultural uses, especially after their classification as 'non-toxic' by International Agency for Research on Cancer (IARC) and 'safe for human consumption' by the Food and Drug Administration (FDA). Furthermore, the Codex Alimentarius Commission acknowledged pest control agents in food commodities and listed zeolite as an approved substance in organic food production and plant protection. The European Food Safety Authority (EFSA) Panel on Food Contact Materials, Enzymes, Flavorings and Processing Aids (CEF) approved zeolites (clinoptilolite type) as one of the safe substances in food and feed additives. Moreover, the EFSA Panel of Additives and Products or Substances used in Animal Feed (FEEDAP) declared that the use of zeolite additives in feed was safe for all animal species and does not pose a risk to the environment.

The use of clinoptilolite as a mycotoxin binder and also as an anti-caking agent and coagulant has been recognized and suggested by the European Union for use in swine, rabbit and poultry breeding (Directive 70/524/EEC, Commission Regulation No. 1245/1999 of 16 June 1999). The FDA, in contrast, allowed the use of zeolite in animal feeds only as an anti-caking agent (CFR 582–2727).

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Website to visit: https://mycotoxinsite.com/in-vitro-in-vivo-studies-on-minazel-plus/?lang=en - **Download the pdf file of Min-a-zel Plus.**