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

General statement: Zeolites are crystalline, hydrated aluminosilicates of alkali and alkaline earth cations which possess three-dimensional crystal structures. 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.

Aflatoxin: origin, toxicity and effects: Aflatoxins, a group of closely related, extremely toxic chemicals, are produced by *Aspergillus flavus* and *Aspergillus parasiticus* and can occur as natural contaminants of animal foods and particularly poultry (Edds and Bortell, 1983; Leeson *et al.*, 1995). The occurrence and the production of aflatoxins in foodstuffs before harvest and during storage are strictly related to the humidity and the temperature. The prevalence of the toxic amounts in animal feed leads to aflatoxicosis.

Aflatoxins affect different species in different ways; but aflatoxicosis in poultry is characterised by listlessness, anorexia with lowered growth rate, poor food utilisation, decreased weight gain, decreased egg production, increased susceptibility to environmental and microbial stresses, and increased mortality (Arafa *et al.*, 1981). Signs of aflatoxicosis also include anaemia (Kececi *et al.*, 1998), inhibition of immune function (Campbell *et al.*,1983; Celik *et al.*, 1995), hepatotoxicosis (Oguz, 1997; Kiran *et al.*, 1998), mutagenesis, teratogenesis, carcinogenesis, and haemorrhage (Edds and Bortell, 1983; Schull, 1985).
For that reason, aflatoxins are a potential threat to poultry health and cause severe economic losses in the poultry industry (Kaya, 1984).

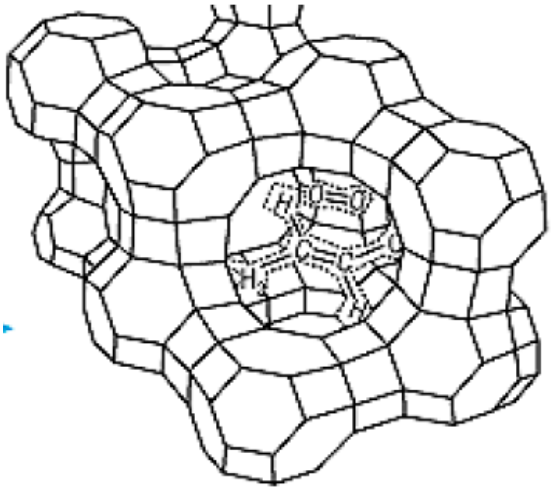

Fig.1 Zeolite structure with windows, cages and super cages

Zeolite an effective adsorbent to eliminate aflatoxins: Clinoptilolite like zeolites are used as effective adsorbents of toxic agents, particularly aflatoxins from the feeds (Parlat *et al.*, 1999; Phillips, 1999; Oguz and Kurtoglu, 2000; Ortatatli and Oguz, 2001; Rizzi *et al.*, 2003). Due to their chemical structure with windows, they effectively minimize adverse effects of aflatoxins on feed intake, performance and nutrient conversion (Parlat *et al.*, 1999; Oguz and Kurtoglu, 2000) and reduce mycotoxin concentration in the livers of affected animals (Rizzi *et al.*, 2003).

Mechanisms of action: Adsorbing agents such as zeolites are substances of high molecular weight that, upon reaching the gastrointestinal system (aqueous medium), are capable of binding mycotoxins(aflatoxins,fumonisins…),preventing their absorption, and allowing fecal excretion of this adsorbent-toxin complex (Tapia-Salazar *et al.*, 2010). The authors concluded by asserting: "*In chemical adsorption or chemisorption, there is an effective exchange of electrons between the adsorbent and adsorbate, forming a single layer on a solid surface in an irreversible way, involving a considerable amount of energy*".

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Zeolite efficient against aflatoxins at very lower dosage - Benefits and advantages: According to Oguz and Kurtoglu 2000, a lower concentration (15 g/kg) of zeolite in the animal diet is sufficient to eliminate the deleterious effect of aflatoxicosis and seems to more effective than a higher concentration (25 g/kg).

Zeolite supplemented diets are well tolerated by the animals; they support biomass production and improve the health status of the animals (Martin-Kleiner et al., 2001; Papaioannou et al., 2004). This translates into a significant increase on food consumption, body weight gain and food conversion ratio.

The use of aluminosilicates such as zeolites has grown to be common practice with respect to combining mycotoxin binding agents in the feed and food industry with the aim of effectively adsorbing mycotoxin. The ability of clinoptilolite and other zeolites to absorb aflatoxins (aflatoxin B1, aflatoxin B2 and aflatoxin G2) that contaminate animal feeds has resulted in measurable improvements in the health of different farm animals. These specific silicate minerals have been indicated to bind with aflatoxin as consequence of chelating the β-dicarbonylmoiety in aflatoxin with uncoordinated metal ions in the clay materials. There are some established criteria to evaluate the functionality of any binding additive, such as a supremely low inclusion rate, stability over a wide pH range, huge capacity and an affinity to absorb various concentrations of mycotoxins. The supplementation of mycotoxin binders to contaminated diets has been suggested as the most advantageous dietary approach for decreasing the effects of mycotoxins.

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