Comparative Adsorption of Aflatoxin B1 in Palygorskite, Sepiolite and Smectite

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Aflatoxin in feed causes aflatoxicosis in birds and livestock, and also poses health hazards to the consumers. Among the clays, smectite is extensively studied for aflatoxin removal though complete control relates to the complex gut conditions. Sepiolite and/or palygorskite possess specific tunneled structure, and are available in Pakistan but need testing as potential aflatoxin binders. The objective was to determine mineralogical characteristics and evaluate the indigenous palygorskite- sepiolite reserves for aflatoxin B1 control in poultry. Eleven clays and two commercial mycotoxin binders were sampled and processed for mineralogical analysis through X-ray diffraction, structural characterization through FTIR, particle size distribution by Laser diffraction, and morphology by SEM and compared with the reference clays from international repository. Aflatoxin B1 maximum binding capacity and binding strength were determined through adsorption isotherms and fitting to the Langmuir model for each clay. Heat induced structural changes were studied for the selected clays for consequent impact on adsorption of aflatoxin. The X-ray diffraction identified three mineral groups in the indigenous clays: (i) well crystallized palygorskite, (ii) palygorskite- smectite mix, and (iii) interstratified smectite (HIS/HIV) with moderate amount of mica and minor palygorskite. The palygorskite appeared to be formed through devitrification of volcanic ash under Mg rich saline conditions and in the third group mica appeared to be detritus. The FTIR suggested that palygorskite contained AlMgAl octahedral sites with zeolitic and coordinated water. Indigenous palygorskite had greater crystallinity and purity than the reference palygorskite indicated through sharp and intense 001 diffractions at 10.5 Å. In a physical mixture of

palygorskite and smectite, smectite was identified as montmorillonite with Al dominance in octahedral sheet through IR spectra. The IR band at 1190 cm-1, assigned to Si-O-Si bonding was related to inversion of apical O in the alternating ribbons, a characteristic of palygorskite that was present in indigenous palygorskite. Aflatoxin B1 isotherms and fitting to the Langmuir model suggested that aflatoxin adsorption increased with increasing smectite content in the mixed clays. The palygorskite and palygorskite-smectite mix (group i and ii) had comparable or higher adsorption than the commercial and reference clays. The heat treatments induced structural changes in the selected clays and structural collapse occurred through dehydration and dehydroxylation when heated at 400 °C and above. Simulated gastrointestinal fluid caused reduction in aflatoxin adsorption probably through the interference of pepsin and lower pH. Sepiolite had highest selectivity for aflatoxin B1 among the selected clays and had the lowest adsorption capacity for pepsin. The indigenous clay sources have the potential for use in the poultry feed industry to reduce hazards of aflatoxin B1 contamination.