Mineral Characterization of Bentonites for Aflatoxin B1 Adsorption

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Aflatoxin, a class 1 carcinogen, comes in animal feeds via mold contamination in feed grains particularly through Aspergillus species. Aflatoxin is controlled by bentonite as a feed additive that is mostly imported in the country while sufficiently large clay deposits of medium to high quality with potential for use in feed industry are available. Limited research on the mineral details of the country's clay deposits have hindered their specified use. To study mineralogy in detail and determine their potential as aflatoxin binder for animal and poultry feed, 27 active bentonite quarries were sampled. Two commercial binders and three bentonites from China were included as reference. The mineral phases and structural characteristics were identified through XRD and Fourier transform infrared (FTIR), respectively while the Laser diffraction. Analyser was used for particle size distribution. Aflatoxin maximum binding capacity and strength was determined through adsorption isotherms and model fitting in the Langmuir equation. The organic carbon content, cation exchange capacity and pH of the clay suspensions were also measured. Structural modification of smectite was carried out through Al/Al-Fe pillaring and cations (Ca, Zn, Mg and Li) saturation coupled with heat treatments at 200 and 400 °C for improving aflatoxin selectivity. Based on the dominance of the minerals determined through XRD of the bulk samples, four clay mineral groups were identified and named as:(i) smectite, (ii) smectite-hydroxy interlayered smectite (HIS), (iii) HIS-smectite, and (iv) kaolinite. Smectite was dominant mineral with mica, kaolinite, and

quartz presence as minor minerals. The maximum aflatoxin adsorption capacity varied with the mineral purity and smectite dominance in each clay and was highest in smectite dominated clay quarries. Sorbatox® (kaolinite) had lower adsorption, 130 µg g-1 clay, while Toxisorb® (bentonite) had greater adsorption capacity of 665 µg g-1 clay indicating kaolinite, an ineffective binder for aflatoxin. The Al/Al-Fe pillaring in smectite enhanced aflatoxin adsorption by 65 % over unmodified smectite. The greater adsorption is related with the expansion of interlayer through pillaring. Smectite saturated with (Li, Mg and Zn) cations of comparable size, caused greater aflatoxin adsorption at 200 °C while larger cation (Ca) had greater adsorption at 400 °C. The study demonstrates feasibility of using local clays as aflatoxin adsorbent.