Raw material risk management for mycotoxins — The ever-more-challenge for Indian poultry producer

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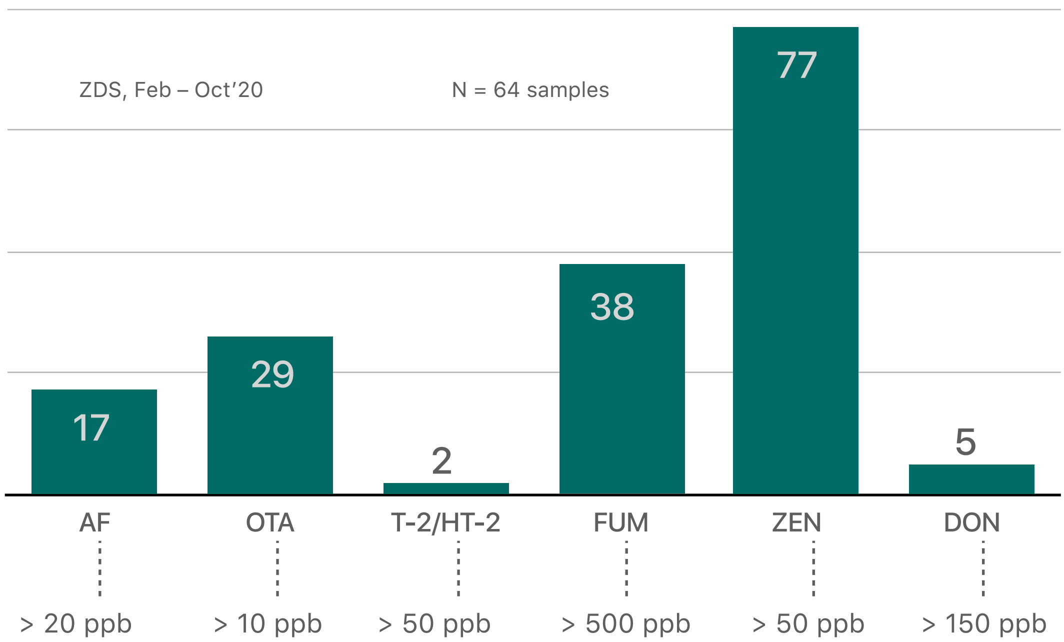
Amid concerns over a slowdown in the Indian economy during mid-Q3'19, worrying reports of economic distress from the poultry farm sector began hitting the headlines. During the period, the economic crisis in the sector owes largely to the hike of prices of raw materials viz., maize and rice bran, making upto 70-80% of feed formulation. The resulting hike in prices of poultry feed is speculated to be the highest in last 20 years. Short rainfall in preceding year affecting agriculture production is thought to be pivotal in precipitating the crisis. The odyssey of economic crisis was worsened by COVID 19 pandemic, until Q3'20, the reeling sector began spurting back to life with drastic reduction of maize and rice bran price — heaved a sigh of relief !

The economic growth in sector usurped the crisis apparently, while looming challenges of mycotoxicosis inflicted serious headaches to the farming community. Raw materials, especially the new strain of maize, registered higher mycotoxin levels as compared to previous year leading to various unprecedented complications in field — poultry productivity.

At Zydus AHL, our team of experts continuously strive to identify these stressors, analyse, and find right solution for the farming community. In next section, the retrospective analysis of mycotoxin levels in raw materials and finished feed studied by our laboratory is presented.

Fig 1. Contamination % of raw materials with various levels of mycotoxins in feed samples



AF = Aflatoxin, OTA = Ochratoxin A, T-2/HT-2 = Type A Trichothecenes, FUM = Fumonisin, ZEN = Zearalenone, DON = Dioxynivalenol

Fig 2a. ZEN level in feed samples

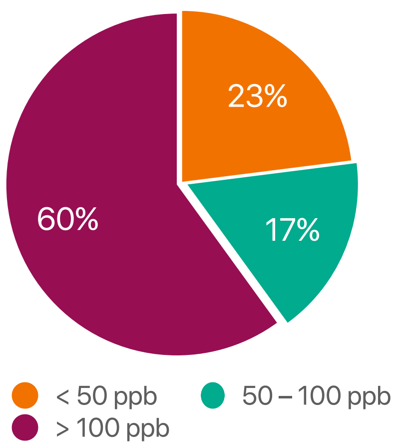
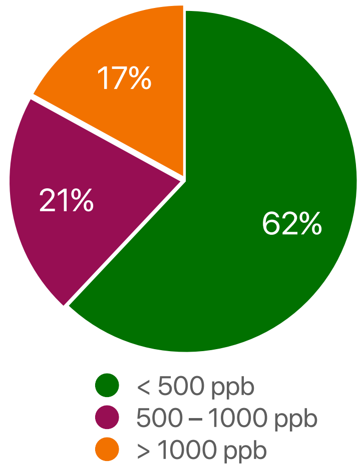
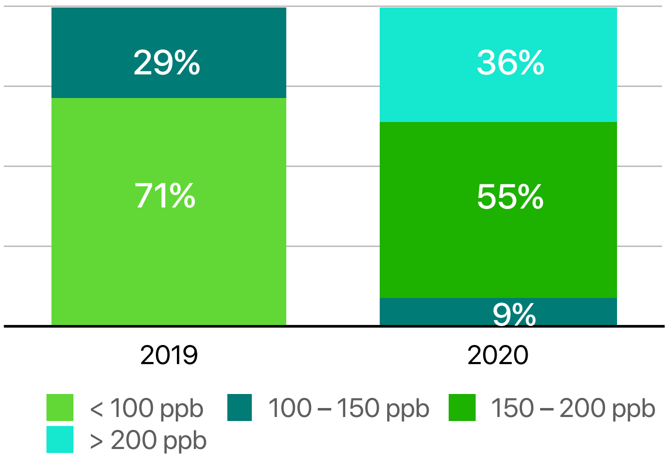


Fig 2b. FUM level in feed samples



Total 64 feed samples were analysed during Feb – Oct'20 and showed very high levels of ZEN and FUM (Fig 1). 77% feed samples had registered ZEN level > 50 ppb, while 38% feed samples had FUM level > 500 ppb (Fig 2a & 2b).

Fig 3. Comparison of ZEN level in maize (2019 vs. 2020)



N = 50 maize samples in 2019 and 2020

A comparison of 50 maize samples for ZEN level in 2019 and 2020, respectively clearly highlights significantly higher contamination in 2020. In 2019, only 29% maize samples had registered ZEN level > 100 ppb, while all maize samples (100%) had ZEN level > 100 ppb in 2020 (Fig 3). Such higher ZEN level in association with FUM had visible implications on poultry productivity, as will be discussed in forthcoming sections.

Besides higher ZEN level in maize/finished feed, the co-occurrence of more than one mycotoxin – multiple mycotoxicosis had far reaching detrimental effects primarily because of the synergism existing across different mycotoxins. It means that mycotoxins exert ill-effects at significantly lower concentration than alone resulting in lowering of their threshold limits in feed e.g. ZEN level upto 500 ppb can be tolerated by broiler breeder hens while chronic consumption of AF + ZEN or ZEN + DON at 20-&-50 ppb or 50-&-150 ppb, respectively may have deleterious effect on hatchability and egg shell quality.

% Co-contamination of different mycotoxins in feed samples > 20 ppb (Fig 4a) and > 50 ppb (Fig 4b)

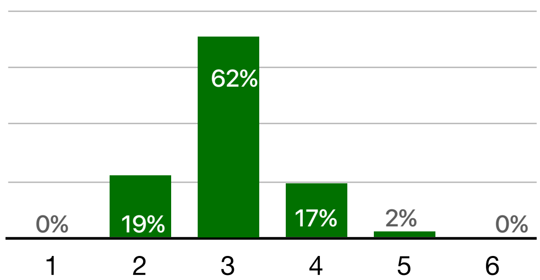


Fig 4a

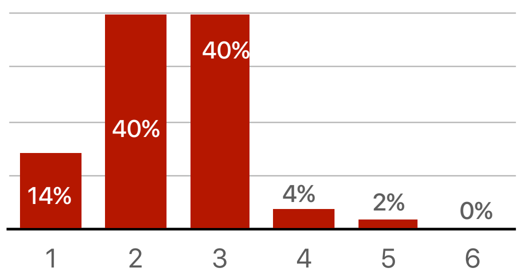


Fig 4b

N = 64 samples; ZDS, Feb – Oct'20

In 2020, our laboratory data on mycotoxin analysis showed that 46% and 81% feed samples were co-contaminated with 3 or more mycotoxins >20 ppb and >50 ppb, respectively (Fig 4a & 4b).

Zearalenone (ZEN), one of the most prevalent estrogenic mycotoxins, is mainly produced by *Fusarium* fungi and has been proven to affect the reproductive capacity of poultry. Exposure of poultry to ZEN is a global public health concern because of its toxicity and wide distribution in poultry feeds, carry over effect in egg and meat, and being stable/unaffected by feed/food processing conditions (150 °C for 44 h). Biotransformation of ZEN carried out by poultry liver leads to the formation of two metabolites: α-zearalenol and β-zearalenol. All ZEN forms are estrogenic, with the α-zearalenol being the highest. It has synergistic effect with Aflatoxin (AF) and Dioxynivalenol (DON), while additive effects with Fumonisin (FUM).

In 2020, higher levels of ZEN along with other mycotoxins (AF, FUM, DON, and OTA) in maize/finished feed samples were correlated with poultry production trend and following were our observations.

Egg laying hens (Breeder/Commercial layer)	Commercial broiler
Reduced egg egg production (3 - 8%)	Inflammation of bursa — bursitis (Feb – Jun'20) — Fig 6a & 6b
Fluctuation in egg production	Increased incidence of Gumboro disease (July – Oct'20)
Poor eggshell strength	
Watery albumin	
Reduced egg size — Fig 5	

Fig 5. Reduced egg size (right egg); normal size egg (left); Zearalenone and Fumonisin level in layer feed was 220 ppb and 540 ppb, respectively; condition reversed with broad spectrum toxin binder (AntaFerm® MT80 @ 1 kg per MT feed)

Fig 6a & 6b. Inflammation of bursa in commercial broiler flock at day 26. Flock registered mean 4500 (IDEXX) IBD titer suggesting seroconversion against vaccination only. The Zearalenone and Fumonisin level in starter feed was 260 ppb and 640 ppb, respectively.

Controlling multiple mycotoxicosis, especially ZEN, FUM and DON, is challenging for poultry producer as they are pre-harvest mycotoxins and are extremely stable in feed processing conditions. Moreover, they are produced by same genera of fungi viz, *Fusarium spp.,* and presence of one mycotoxin e.g. ZEN potentially increase the contamination risk of other mycotoxins e.g. FUM and DON. Therefore, two way approach in checking the menace of multiple mycotoxicosis is recommended.

- First, eliminating the growth of Fusarium fungi by mould inhibitors. Combination of buffered organic acids (SCFAs) and formaldehyde (Zanitizer™) is very effective and ensures feed sanitisation before consumption by poultry.

- Secondly, pre-formed mycotoxins should be adsorbed completely by combination of inorganic and organic adsorbents before they are absorbed by chicken GI tract. Mycotoxin adsorbents (Bentonite, β-glucans, MOS, Diatomaceous earth, etc.) ensure that the mycotoxins are not bioavailable in systemic circulation after consumption by chicken. In this context, the right choice of mycotoxin adsorbents is critical. Mycotoxin like ZEN is non-polar in nature and require organic adsorbent (e.g. β-glucans) for effective binding in chicken GI tract, while AF (polar) requires inorganic adsorbent (e.g. Bentonite). Furthermore, the prevalence of mycotoxins vary widely, spatially and temporally (as we have shown for ZEN level in 2019 vs 2020), and therefore, ideal mycotoxin binders for poultry use should incorporate adsorbents dedicated for both polar and non-polar mycotoxins for optimum protection.

In conclusion, multiple mycotoxicosis is a serious threat to poultry producers. These mycotoxins exert synergistic and additive action in combination and, in most part, work in significantly lower concentration in combination capable of causing deleterious effect on poultry production and significant financial losses.