High occurrence of mycotoxins in Asian feedstuffs

Over the past few years, Biomin at their Asian affiliate has had a number of feed samples analysed to give customers insights into the occurrence of mycotoxins in their feed, thereby enabling better feed management. The results show that deoxynivalenol and fumonisin B1 are the main mycotoxins of concern. Furthermore, all samples of peanut meal were contaminated with aflatoxins.

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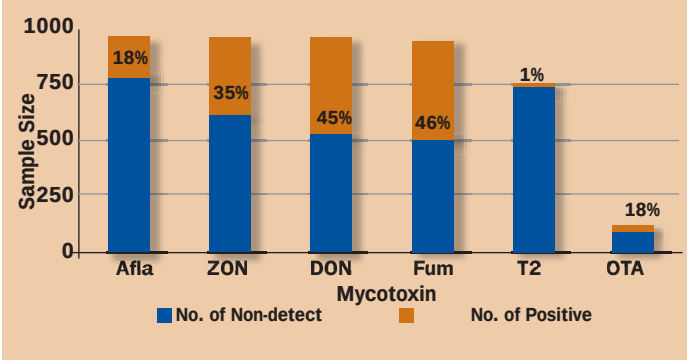
Peanuts used in animal feed are known for their sensitivity to mycotoxin contamination. (Photo: Oklahoma Farmbureau)

Mycotoxins are secondary metabolites produced by fungi when they grow on agricultural products before or after harvest or during transportation or storage. These toxic substances are known to be either carcinogenic (e.g. aflatoxin B1, ochratoxin A, fumonisin B1), estrogenic (zearalenone), neurotoxic (fumonisin B1), nephrotoxic (ochratoxin), dermatotoxic (trichothecenes) or immunosuppressive (aflatoxin B1, ochratoxin A and T-2 toxin).

For the Biomin Mycotoxin Survey Programme almost one thousand samples (in total 970) were analysed over a 24 month period from October 2003 to September 2005 for the major mycotoxins of interest; namely, aflatoxins, zearalenone (ZON), deoxynivalenol (DON), fumonisin (Fum), T2 toxin and ochratoxin A (OTA). The samples received were primarily from Asia *(Figure 1)*.

Figure 1 – Occurrence of Mycotoxin in all feed samples monitored from Oct 2003 to Sep 2005



The samples were categorised and analysed with two perspectives in mind: geographical origin and commodity type. The geographical regions were grouped into North Asia (China, Korea and Taiwan), South-East Asia (Malaysia, the Philippines, Thailand and Vietnam), South Asia (India, Bangladesh and Pakistan) and Oceania (Australia and New Zealand). The sample types were classified as feed ingredients (such as corn, soybean meal, wheat, rice, peanut meal, etc.) and finished feed samples *(Table 1)*.

For the purpose of data analysis, non-detect levels are based on the detection limits of the test method for each toxin:

- Total aflatoxins: < 4 µg/kg
- Zearalenone: < 32 µg/kg
- Deoxynivalenol: < 50 µg/kg
- Fumonisin B1: < 100 µg/kg
- T-2 Toxin: < 125 µg/kg
- Ochratoxin A: < 2 µg/kg.

High Performance Liquid Chromatography (HPLC) methodology was used for the analysis of all mycotoxin except T-2 Toxin which was performed using Thin Layer Chromatography (TLC).

Table 1 – Occurrence and concentration of mycotoxin in all feed samples analysed according to the geographical regions

	Aflatoxin	ZON	DON	FUM	T2	OTA
North Asia (includes China, Taiwan and Korea)						
No. of Tests	481	481	481	481	405	55
No. Positive	16	210	346	249	2	8
Percent Positive (%)	3	44	72	52	0	15
Average (µg/kg)	14	393	969	805	309	2.5
Maximumt (µg/kg)	45	6,468	18,991	10,577	309	4
South East Asia (includes Malaysia, Philippines, Thailand and Vietnam)						
No. of Tests	340	335	335	335	269	53
No. Positive	121	81	48	173	2	5
Percent Positive (%)	36	24	14	52	1	9
Average (µg/kg)	39	219	199	540	313.5	32.6
Maximum (µg/kg)	347	4,587	1,525	4,866	494	143
South Asia (includes India, Pakistan and Bangladesh)						
No. of Tests	19	19	19	19	14	6
No. Positive	10	6	1	6	0	3
Percent Positive (%)	53	32	5	32	-	50
Average (µg/kg)	85	1,182	76	533	-	3.7
Maximum (µµg/kg)	275	4,183	76	2,217	-	5
Oceania (includes Australia and New Zealand)						
No. of Tests	97	99	100	96	37	8
No. Positive	27	39	34	6	3	7
Percent Positive (%)	28	39	34	6	8	88
Average (µg/kg)	36	730	495	612	222	9.1
Maximum (µg/kg)	381	4,738	3,000	1,090	266	26

North Asia

Occurrence of mycotoxins in samples received from North Asia was 3%, 44% 72% 53% and 15% for aflatoxins, zearalenone, deoxynivalenol, fumonisin B1 and ochratoxin respectively. T2- toxin was found in less than 1% of the total sample population. For aflatoxin, the most important among the mycotoxins, only 3% of the samples from North Asia were found to be contaminated; the highest level detected was 45 ppb in a corn gluten meal sample from China. In contrast, DON was highly prevalent in this region (72%) and the highest level detected was in a wheat sample from China with 18,991 µg/kg. ZON and Fum, on the other hand, were found in 44% and 53% of the samples, respectively. The highest level of ZON found was 6,468 µg/kg in a corn sample from China. For fumonisin B1, it was 10,577 µg/kg in a corn sample also from China. Ochratoxin A was detected in 15% of the samples but the levels detected were rather low; 4 µg/kg in a feed sample from Korea was the maximum level analysed.

South-East Asia

Not surprisingly, the contamination profile of the samples from South-East Asian countries differs from that in North Asia in two major aspects. Firstly, the occurrence and concentration of aflatoxins in the samples were found to be significantly higher, up to 65-69% (e.g. from Vietnam and the Philippines). The highest level detected was 347 µg/kg in a corn sample from Vietnam. Secondly, deoxynivalenol, on the other hand, had a relatively low prevalence rate with only 14% of all samples affected.

South Asia

Despite the small number of samples (in total 19) received from this region, there is a clear indication of high aflatoxin occurrence (53%). The highest level found was 275 µg/kg in a peanut meal sample from India. Similar prevalence of ZON and Fum were observed with 32% affected. OTA was found in 50% of the samples; the levels detected were low at less than 5 µg/kg. DON and T-2 toxin were not detected in any samples analysed from South Asia.

Oceania

With Australia accounting for the bulk from this region, more than half of the samples analysed were cattle feed, such as straws and silages. The prevalence of mycotoxins in silage/straw samples is ochratoxin A (75%), ZON, (48%), DON (44%) and aflatoxins (31%). Fum and T-2 toxin account for less than 10% of the contamination each. However, since the occurrence of mycotoxins is also dependent on the commodity type, we found a peanut meal sample from Australia that yielded the highest level of aflatoxins in all the samples analysed to-date at 381 µg/kg. The overall sample contamination profile is similar to that with the silage/straw samples as follows: ochratoxin A (88%), ZON (39%), DON (34%) and aflatoxins (28%). Again, Fum and T-2 toxin contamination were found in less than 10% of all tested samples.

For OTA, as the sample size (13% of total samples) for this toxin is relatively small compared to the other toxins, the figures obtained in the current data may not be conclusive. More data points are required to provide a better indicative trend.

The highest level found was 26 µg/kg in a full fat soy sample.

Trend in occurrence in commodities

Though it is impossible to correlate the occurrence of a specific mycotoxin to a specific commodity from the data studied, there is apparent prevalence of

some mycotoxins to some specific sample types. For instance, 100% of the peanut meal samples analysed was found to be contaminated with aflatoxins with the highest level of 381 µg/kg and an average of 202 µg/kg. For wheat samples, 88% were affected by DON with the highest level found at 18,991 µg/kg and an average contamination level of 1,181 µg/kg, while no aflatoxins were detected in any of the wheat samples. More than 80% of the corn gluten meal samples were ZON (87%) and Fum (83%) positive *(Table 2)*.

Corn

As the most commonly used ingredient in feed, corn accounts for 24% of all the feed ingredients analysed. With the exception of T-2 toxin, the other five major toxins were present in 19-68% of the corn samples. Aflatoxins were found in 19% of the samples, ZON 40%, DON 67% and Fumonisin B1 68% of the samples. For OTA, the result was elevated by one highly contaminated corn sample from Malaysia with a level as high as 143 µg/kg. This same corn sample was also found to have high levels of aflatoxins, ZON and Fumonisin B1. T-2 toxin accounted for less than 1% of contamination in the corn samples.

Soybean meal/products

Of the 90 soybean meal samples studied, occurrence and concentration of mycotoxin contamination were relatively low. Aflatoxins were found in 3%, ZON in 14%, DON in 7% and Fumonisin B1 also 7%. One out of the 20 samples tested was contaminated with a low level of OTA, and T2-toxin was not detected in any soybean meal samples tested.

Wheat

More than 70 wheat/wheat bran samples were analysed. No aflatoxins were found in any of the wheat samples tested. DON accounted for 85% of the contamination. ZON was found in 24% of the samples and Fum in 5%. Only one sample each was contaminated with T-2 toxin and OTA.

Corn gluten meal

The corn gluten meal samples showed widespread prevalence for ZON with 88% and Fum with 85%. DON accounted for 27% and aflatoxins 8%. Both OTA and T-2 toxin were not detected in the corn gluten meal samples.

Peanut meal

Though less than 10 samples were analysed, 100% of the peanut meal samples were found to have high levels of aflatoxins. ZON was found in 57% and 14% with Fum for one out of seven samples with a level of 249 µg/kg. DON and T-2 toxin were not detected and ochratoxin analysis was not performed on these peanut

Table 2 – Occurrence of the various mycotoxins in feed samples according to commodity type

Corn	Aflatoxin	ZON	DON	FUM	T2	OTA
No. of Tests	232	233	233	233	191	25
No. Positive	43	93	156	159	0	5
Percent Positive (%)	19	40	67	68	-	20
Average (µg/kg)	57	397	1,120	1,117	-	32
Maximum (µg/kg)	347	6,468	10,626	10,577	-	143
Soybean meal						
No. of Tests	88	88	88	88	65	20
No. Positive	3	12	6	6	0	1
Percent Positive (%)	3	14	7	7	-	5
Average (µg/kg)	9	75	325	190	-	3
Maximum (µg/kg)	13	99	1,347	331	-	3
Wheat / bran						
No. of Tests	73	74	74	74	62	1
No. Positive	0	18	63	4	1	1
Percent Positive (%)	-	24	85	5	2	100
Average (µg/kg)	-	205	1,180	310	266	2
Maximum (µg/kg)	-	1,489	18,991	646	266	2
Corn gluten meal						
No. of Tests	26	26	26	26	11	15
No. Positive	2	23	7	22	0	0
Percent Positive (%)	8	88	27	85	-	-
Average (µg/kg)	22	633	1,488	643	-	-
Maximumt (µg/kg)	45	3,150	4,423	3,740	-	-
Rice / bran						
No. of Tests	23	23	23	23	17	1
No. Positive	3	4	1	2	0	0
Percent Positive (%)	13	17	4	9	-	-
Average (µg/kg)	10	82	79	532	-	-
Maximumt (µg/kg)	11	162	79	929	-	-
Peanut Meal						
No. of Tests	7	7	7	7	3	0
No. Positive	7	4	0	1	0	-
Percent Positive (%)	100	57	-	14	-	-
Average (µg/kg)	202	3,116	-	249	-	-
Maximum (µg/kg)	381	4,587	-	249	-	-
Other feed ingredients (include Canola meal, DDGS, Fullfat Soy, Fish meal etc.)						
No. of Tests	46	48	48	48	35	12
No. Positive	3	14	16	7	0	1
Percent Positive (%)	7	29	33	15	-	8
Average (µg/kg)	6	394	261	294	-	26
Maximum (µg/kg)	8	2,727	869	331	-	26
Finished feed						
No. of Tests	407	401	401	401	344	50
No. Positive	90	144	135	241	4	12
Percent Positive (%)	22	36	34	60	1	24
Average (µg/kg)	24	247	628	421	311	5
Maximum (µg/kg)	330	3,170	4,994	3,398	494	24
Straw / silage						
No. of Tests	61	60	61	61	20	4
No. Positive	19	29	27	2	2	3
Percent Positive (%)	31	48	44	3	10	75
Average (µg/kg)	10	913	450	720	200	3
Maximum (µg/kg)	17	4,738	1,860	733	266	4

Table 3 – Highest level of mycotoxins found, commodity type and country of origin

Mycotoxin	Sample size	Positives (%)	Average level (µg/kg)	Highest level (µg/kg)	Found in commodity	Country of origin
Aflatoxins all	965	18	39	381	Peanut meal	Australia
Zearalenone	963	35	409	6,468	Corn	China
Deoxynivalenol	963	45	866	18,991	Wheat	China
Fumonisin B1	960	46	664	10,577	Corn	China
T-2 toxin	748	1	273	494	Finished feed	Thailand
Ochratoxin A	128	18	11.7	143	Corn	Malaysia

meal samples.

Rice

As in the soybean meal samples, mycotoxin occurrence and contamination in rice samples were at relatively low levels. 13% were found to be contaminated with aflatoxins and 17% for ZON. Less than 10% were positive for DON and Fum. Again, OTA and T-2 toxin were not detected.

Feed

In the overall finished feed samples, 60% were found to be contaminated with Fum. DON and ZON were detected in 34% and 36% respectively. OTA occurred in 24% of the samples tested and 22% of the sample were found to be contaminated with aflatoxins. T-2 toxin accounted for only 1% of the contaminated samples.

Straw/silage

All the straw and silage samples were received from Australia. Of the 60 samples, only 4 samples were subjected to ochratoxin analysis. Hence, the 75% occurrence of OTA in straw/silage samples may not be conclusive. Nonetheless, the levels detected were low (maximum of 4 µg/kg). DON and ZON occur in 44% and 48% respectively and aflatoxin was found in 31% of the samples.

The occurrence and highest levels of mycotoxins detected based on commodity type and country of origin is summarised in the *Table 3*.

In conclusion

In summary, from the survey samples, aflatoxins and ochratoxin A, accounted for 18% of the sample contamination; 35% were positive for zearalenone, 45% for deoxynivalenol and 46% for fumonisin B1.

Given the vast diversity of commodities that may be infected by fungi, it is important to acknowledge the fact that the presence of specific fungi does not necessarily mean that a fungal toxin is present. It is, therefore, pertinent to analyse for the presence of the mycotoxins in all cases as far as possible. The results will help ensure better quality assurance in the feed as well as a tool for management decision on the fate of feeds that do not meet the required standards. ●

The Biomin Mycotoxin Survey Programme was initiated and backed by Biomin Laboratory Singapore to provide customers insights in the occurrence of mycotoxin in their feed samples thereby enabling better feed management. All tests have been conducted by Romer Labs Singapore Pte Ltd, a company specialised in mycotoxin analysis.