Managing Mycotoxins in Maize – options when feeding animals

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Managing mycotoxins in maize is the aim of a project supported by the industry and GRDC. Effective use of contaminated maize by diverting it from human food to livestock feed is one key strategy. Some time ago, limits for aflatoxin and fumonisin in maize were introduced for maize supplied under NACMA contracts.

NACMA grade	Milling	Prime	Feed 1	Feed 2
Aflatoxin ppb	5	15	40	80
Fumonisin ppm	2	5	10	40

We are often asked what these limits mean in relation to their use in the feeding of animals, particularly:

- Which animals are most sensitive to these mycotoxins?
- Does the age or class of animal affect its sensitivity?
- How much should Feed grade be discounted compared to better grades?

These are simple questions with complex answers, since mycotoxin tolerance is affected by many factors, and recommendations for feeding levels vary internationally. We have reviewed the literature on mycotoxin tolerances in animal feed, set safety margins achievable in our situation, and suggest guidelines in the Table for limits in total diets.

From the aflatoxin guidelines, Prime grade maize can be used at up to 66% of the diet of all animals except ducks. Feed grade No 1 is intermediate, while Feed grade No 2 is most suitable for grower and finisher pigs, and mature non-dairy ruminants.

From the fumonisin guidelines, Milling and Prime grade could be used as the main dietary ingredient for all animals except perhaps horses and rabbits which are most sensitive to this toxin. Feed No 2 could be used at up to 75% in the complete diet of mature ruminants and poultry being raised for meat.

This brings us to the point that animal diets never consist solely of maize. Provided we know the approximate mycotoxin concentration, a simple calculation can be used to assess the maximum inclusion rate of Feed grade maize in a compounded feed, or given as a feed supplement.

Maximum inclusion of Feed grade maize in complete diet = maximum mycotoxin level for each animal class (table) divided by the maximum level permitted in that grade of maize. For example, if we seek to use Feed grade No 2 in a pig weaner diet, we divide 20 ppb aflatoxin by 80 ppb = 25%, and 5 ppm fumonisin by 40 = 12.5%. Consequently, the maximum inclusion rate should be the lesser of these - 12.5%.

But what if aflatoxin and fumonisin are both present – will they be more toxic as a result? Some studies indicate a small, additive effect in pigs and chickens, so this could warrant a lower inclusion rate than the calculation suggests.

Effective use of mycotoxin containing maize is all a matter of minimising risk while maximising profits. This is best achieved by using the cheapest grade that meets the animal's tolerance level for both aflatoxin and fumonisin. Of course, the potential impact of an adverse effect from mycotoxins on a given industry also varies. In the case of a pig or cattle enterprise, the risk of a slightly reduced growth rate is usually offset by a lower cost of feed ingredients. However, in the case of the pet food industry, potential costs of litigation and product recalls as occurred in America recently with aflatoxin in dog food, demands a stronger stance on risk aversion.

How much should Feed grade be discounted? That depend on how much risk the buyer assumes – if the mycotoxin concentrations are known and these guidelines are followed, the risk is very low, and $10 – $20/tonne should compensate. However, it also depends on supply and demand, and the skills of the negotiator!

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Table 1 Suggested guidelines for limits on total aflatoxin and fumonisin in total diets from a review of the literature and the basis for the recommendations.

Species	Category	Aflatoxin ppb (total)	Basis of Aflatoxin recommendation	Fumonisin ppm	Basis of Fumonisin recommendation
Pig	Weaner	20	(Vincelli et al., 1995) recommendation and twice level (Anon, 1997) for afla B_1	5	(CFSAN/FDA, 2001c; DeWolf et al., 2004)
	Grower	100	(Vincelli et al., 1995) recommendation and twice level (Anon, 1997) for afla B_1	10	(CFSAN/FDA, 2001c)
	Finisher	100*	(Vincelli et al., 1995) allows 385ppb, go with twice level (Anon, 1997) for afla B_1	10	(CFSAN/FDA, 2001c)
	Breeder	50	(Vincelli et al., 1995) recommendation and (Anon, 1997) for afla B_1	10	(CFSAN/FDA, 2001c)
Chicken	Meat	20*	(Vincelli et al., 1995)} recommendation and twice level (Anon, 1997) for afla B_1	30	(CFSAN/FDA, 2001c), **
	Breeder	20	(Vincelli et al., 1995)} recommends nil, go with twice level (Anon, 1997)for afla B_1	15	(CFSAN/FDA, 2001c)
	Layer hen	20	(Vincelli et al., 1995) allows 50ppb, go with (Anon, 1997) for afla B_1	15	(CFSAN/FDA, 2001c)
Turkey	Meat	10	(Vincelli et al., 1995) recommendation and (Anon, 1997) for afla B_1	30	(CFSAN/FDA, 2001c) **
	Breeder	10	No specific data, so use meat turkey recommendations	15	(CFSAN/FDA, 2001c)
Duck	Meat	5	(Vincelli et al., 1995) allows 20ppb, (Anon, 1997) allow only 1 ppb for afla B_1	30	(CFSAN/FDA, 2001c) **
	Breeder	5	No specific data, use meat duck recommendations	15	(CFSAN/FDA, 2001c)
Cattle	Weaner	50	(Vincelli et al., 1995) allows 100ppb, go with (Anon, 1997)	10	(CFSAN/FDA, 2001c)
	Lot-fed	100*	(Vincelli et al., 1995) reported tolerance to 300ppb, go with 2x (Anon, 1997)for afla B_1	30	(CFSAN/FDA, 2001c)
	Breeder	50	(Vincelli et al., 1995) allows 20ppb, go with (Anon, 1997)	15	(CFSAN/FDA, 2001c)
	Dairy cow	20	(Vincelli et al., 1995) and (Anon, 1997) for afla B_1	15	(CFSAN/FDA, 2001c)
Sheep	Lamb	50	(Vincelli et al., 1995) and (Anon, 1997) for afla B_1	15	(CFSAN/FDA, 2001c)
	Meat	100*	Based on cattle (ruminant classes) recommendations. Also sheep regarded as very tolerant to aflatoxin	30	(CFSAN/FDA, 2001c)
	Breeder	50	Based on cattle (ruminant classes) recommendations	15	(CFSAN/FDA, 2001c)
	Dairy	20	Based on cattle (ruminant classes) recommendations	15	(CFSAN/FDA, 2001c)
Goat	Kid	50	Based on cattle (ruminant classes) recommendations	15	(CFSAN/FDA, 2001c)
	Meat	100*	Based on cattle (ruminant classes) recommendations	30	(CFSAN/FDA, 2001c)
	Breeder	50	Based on cattle (ruminant classes) recommendations	15	(CFSAN/FDA, 2001c)
	Dairy	20	Based on cattle (ruminant classes) recommendations	15	(CFSAN/FDA, 2001c)
Horse		50	(Vincelli et al., 1995) allows 10ppb, use (Anon, 1997) allows 50ppb	1	(CFSAN/FDA, 2001c)
Rabbit		20	Used broadest safety estimate, no specific data	1	(CFSAN/FDA, 2001c)
Dog		10	Safety estimate based on (Hussein et al., 2001) reported effects at 50 ppb. Acute toxicity has involved >100 ppb	5	(CFSAN/FDA, 2001a)
Cat		10	Safety estimate based on (Hussein et al., 2001) reported effects at 50 ppb ? No other data for cats – so use conservative dog limit	5	(CFSAN/FDA, 2001a)
Fish		20	Safety estimate based on trout being sensitive (Arana et al., 2002)and cat fish (Manning et al., 2005) very resistant to aflatoxin & because Australian aquaculture based on salmon/trout/barramundi	10	(CFSAN/FDA, 2001a)
Prawns		10	Safety estimate with (Ostrowski-Meissner et al., 1995)allowing 50ppb but (Bintvihok et al., 2003) research suggesting problem at 5ppb	-	No information

** Australian maize has had much lower levels, thus allowing a greater safety margin and also to enable Feed Grade 2 maize to be use at 75% inclusion in diets

*Higher concentrations tolerated for short periods