THE EFFECT OF ADDING A BINDING AGENT TO LAYER DIETS CONTAINING SORGHUM ERGOT *(Claviceps africana)*

G.K.Pranis [1,2] and J.G.Dingle [1]

ABSTRACT

Approximately 25% of the world's cereal grains are contaminated with known mycotoxins. Mycotoxins are now known as hidden killers that produce a wide range of harmful effects in animals and are a threat to humans. The pathogenic effect of aflatoxin (AF) on poultry has been well documented but the effects of a new mycotoxin to Australia, sorghum ergot (SE) **(Claviceps africana)** *alkaloid, have still to be fully explored.*

This study was undertaken to broaden our understanding of how to combat the effects of subtoxic levels of sorghum ergot alkaloids (SEA) on the egg production of layer chickens. After two weeks on the sorghum ergot diets it was found that laying hens fed a Mycosorb® (Alltech Inc.) supplement had greater feed intakes. After three weeks on the sorghum ergot diets, laying hens fed a Mycosorb® supplement had greater egg production and egg mass than the birds fed the non supplemented ergot diets. The egg production by layers fed the lower protein diets was poorer, but it recovered to be equal to the best production level , when Mycosorb® was added.

It is recommended that layer diets that contain ergot contaminated sorghum should be supplemented with a binding agent such as Mycosorb®.

Keywords: *effect, binding agent, layer diets, sorghum ergot (Claviceps africana).*

INTRODUCTION

Sorghum ergot, a fungal disease of sorghum caused by **Claviceps africana**, produces a toxic alkaloid, dihydroergosine, which has been found to reduce productivity of dairy cattle, pigs and broiler chickens (Blaney *et al.* 1998). Its effect on laying chickens appears to be unknown.

Australia grows and uses sorghum grain as its main ingredient in producing its stock feed and Papua New Guinea imports its sorghum grain from Australia. Sorghum ergot affects the yield and will increase the cost of importing sorghum into Papua New Guinea.

The use of yeast and yeast products as mycotoxin binders was initially found by Professor Devegowda and his group in India, and by others in Canada and the United States of America, to ameliorate the effect of aflatoxin (AF) in chickens and ducklings (Anonymous 2001). Mycosorb® (a yeast product) is shown to be an effective binder, not only for AF but also for zearalenone, ochratoxin and fumonisin (Devegowda *et al.* 1998). Deo (2000) found that Mycosorb® was a good binding agent for AF and ergot alkaloid in feeds for broiler chickens. No reports on the use of the adsorbent to reduce the effects of ergot alkaloids in laying hens have been published.

In this trial, the effects of sorghum ergot alkaloid on the egg production of laying hens were estimated and Mycosorb® (a binding agent) tested for its efficacy in preventing any negative effects of sorghum ergot alkaloids on laying hens.

MATERIALS AND METHODS

Experimental Design

The experimental design was a 4 x 2 factorial. The factors were (1) level of sorghum ergot alkaloid (24mgkg^{-1}, 12mgkg^{-1}, 6mgkg^{-1} and 0mgkg^{-1} alkaloid in the diet) and (2) with or without Mycosorb binding agent in each basal diet. There were six replications in a completely randomized design.

[1]School of Animal Studies, The University Queensland, Gatton Campus, Gatton, Queensland 4345 Australia
[2]Department of Agriculture, The University of Vudal, Private Mail Bag Service, Rabaul, East New Britain Province, Papua New Guinea.

Experimental Diets

Diets were formulated using the programme "User Friendly Feed Formula" (UFFF 1986).

The ingredient content of each treatment diet is shown in Table 1. The nutrient composition of the diets are shown in Table 2.

Half of each basal diet had a toxin binding agent (Mycosorb®) added, thus making eight diets for the experiment.

Assuming that the ergot contaminated sorghum contained 32 mgkg^{-1} sorghum ergot alkaloid (SEA), the SEA of each basal diet was as shown in Table 2.

Bird Management and Measurement

Ninety-six ISA Brown layers (45 weeks old) were housed in wire back-to-back conventional cages. All chickens were fed a commercial layer diet with 17% crude protein and metabolisable energy of 13.8 MJ kg^{-1} for four days. On the fifth day the chickens were weighted and then randomly allocated two per cage to make 48 experimental units. The chickens were

Table 1. **Formulation of Basal Diets (percent).**

Ingredient	Diet 1(%)	Diet 2 (%)	Diet 3 (%)	Diet 4 (%)
Sorghum (Ergot) (14.7% CP)	76	38	19	0
Sorghum (Normal) (8.9% CP)	0	38	57	76
Fish Meal (65% CP)	13	13	13	13
Vegetable Oil	2	2	2	2
Limestone	9	9	9	9
Vit & Min Premix *	0.1	0.1	0.1	0.1
DL Methionine	0.1	0.1	0.1	0.1

*The vitamin and mineral premix added the following nutrients to the ration: vitamins A, 9.375 m i u; D_3, m I u; E, 512.5 i u; K, 1 087.5; B_2, 3737.5, Ca pantothenate, 2 200; nicotinamide, 5 000; Cobalt, 660; Copper, 2 200; Iron, 22 000; Manganese, 55 000; Iodine, 883.75; Molybdate, 500; Zinc, 40 000; Sodium, 12 500; Selenium, 45mgtonne^{-1}.

Table 2. **Calculated nutrient content of basal diets (percent)**

Nutrient Calculated	Diet 1	Diet 2	Diet 3	Diet 4	Recommended	
					NRC (1994)	ISA Brown (1996)
Crude Protein	19.6	17.6	16.6	15.7	15.0	19.5
ME (MJkg^{-1})	11.4	12.0	12.3	12.6	12.1	11.6
Calcium	3.7	3.7	3.7	3.7	3.25	4.1
Av. Phosphorus	0.38	0.38	0.38	0.38	0.25	0.40
Av. Lysine	0.78	0.79	0.79	0.79	0.69	0.88
Methionine+						
Cystine	0.64	0.64	0.64	0.64	0.58	0.76
Ergot Alkaloid (mgkg^{-1})	24	12	6	0		

fed experimental diets *ad libitum* from day 5 to 25. Artificial light was provided from 4.00 pm to 8.00 am (16 hrs).

Weekly feed intake was recorded. Egg were collected and recorded daily and laying percentage calculated. Eggs from one day's production were weighed each week to calculate egg mass and feed conversion ratio. Chickens were monitored daily for signs of sickness and mortality.

Statistical Analysis

The measurements were analysed using ANOVA (SAS Institute, Inc. 1990) and the results of each treatment were expressed as mean ± standard error (SEM). The significances between the means was estimated from least significant difference (LSD).

RESULTS

The egg laying percentage, average egg weight, egg mass, feed intake and feed conversion ratio (FRC) for the three weeks that the laying hens were fed the experimental diets are given in Table 3, 4 and 5.

In the first week of the trial, there was no significant effect of the level of sorghum ergot alkaloid or of the addition of Mycosorb® on the egg production, egg weight, egg mass, feed intake or FCR of the laying hens (Table 3). The level of production was normal for ISA Brown hens of this age, but feed intake was less than expected.

In the second week of the trial, there was no significant effect of the level of sorghum ergot alkaloid on egg production, egg weight, egg mass or FCR. However feed intake was significantly ($P<0.05$) affected by sorghum ergot and Mycosorb®. The feed intakes of hen fed the diets containing 24 and 6 $mgkg^{-1}$ were significantly greater ($P<0.05$) than the intake of hens fed control diet. The mean feed intake of hens fed Mycosorb® - supplemented diets was significantly greater than hens fed the unsupplemented diets (Table 4).

In the third week of the trial, the level of sorghum ergot had no significant effect on feed intake, FCR or egg weight. However, in week three, the level of sorghum ergot had a significant ($P<0.05$) effect on egg production and egg mass and there was a significant interaction between sorghum ergot and Mycosorb® on egg production and egg mass. The egg production of hens fed the ergot free diet was significantly ($P<0.05$) less than the egg production of hens fed the diets containing 24 and 12 $mgkg^{-1}$ sorghum ergot alkaloid. The egg production of hens fed the Mycosorb® supplemented ergot diets increased (significantly for the 6 $mgkg^{-1}$ SEA diets) but it decreased for the non ergot diet.

In week three, egg mass production of hens decreased as dietary protein level decreased. The lowest protein diet (CP 15.7%) (basal 4) produced significantly smaller egg mass than basal diets 1 and 2 (CP 19.6, 17.6% respectively).

Table 3. The performance of layer chickens fed SEA and Mycosorb® binding agent (week one).

Sorghum Ergot Alkaloid ($mgkg^{-1}$)	Mycosorb®	Egg Production (%)	Av. Egg Weight (g)	Egg Mass (g)	Av. Feed Intake (g/d)	FCR
24	+	80.9	59.3	48.2	82.8	1.71
	-	67.8	61.6	41.6	83.0	2.15
12	+	72.6	58.0	42.1	71.4	1.79
	-	71.4	60.3	42.6	71.3	1.74
6	+	82.1	58.9	48.5	86.2	1.80
	-	76.2	60.5	45.4	84.4	1.98
0	+	78.6	60.4	47.4	74.5	1.62
	-	73.8	58.4	43.3	73.2	1.75
SEM		± 8.3	± 1.7	± 5.0	± 7.8	± 0.23

Table 4. **The performance of layer chickens fed SEA and Mycosorb® binding agent (week two)**

Sorghum Ergot Alkaloid (mgkg^{-1})	Mycosorb®	Egg Production (%)	Av. Egg Weight (g)	Egg Mass (g)	Av. Feed Intake (g/d)	FCR
24	+	82.1	57.6	47.4	86.2^{a}	1.91
	-	58.3	60.3	35.5	80.4^{ab}	3.06
12	+	75.0	58.5	44.4	95.1^{a}	2.86
	-	69.0	57.9	40.0	59.7^{c}	1.52
6	+	85.7	58.8	50.2	89.2^{b}	1.82
	-	69.0	59.7	41.2	83.0^{ab}	2.13
0	+	66.6	63.4	41.6	67.3^{bc}	1.69
	-	73.6	60.4	43.8	70.8^{bc}	1.70
SEM		± 9.1	± 1.7	± 5.6	± 5.8	± 0.48

a, b, c; means with different superscripts are significantly different ($P<0.05$).

Table 5. **The performance of layer chicken fed SEA and Mycosorb® binding agent (week three).**

Sorghum Ergot Alkaloid (mgkg^{-1})	Mycosorb®	Egg Production (%)	Av. Egg Weight (g)	Egg Mass (g)	Av. Feed Intake (g/d)	FCR
24	+	82.1	57.6	47.4	86.2^{a}	1.91
	-	58.3	60.3	35.5	80.4^{ab}	3.06
12	+	75.0	58.5	44.4	95.1^{a}	2.86
	-	69.0	57.9	40.0	59.7^{c}	1.52
6	+	85.7	58.8	50.2	89.2^{b}	1.82
	-	69.0	59.7	41.2	83.0^{ab}	2.13
0	+	66.6	63.4	41.6	67.3^{bc}	1.69
	-	73.6	60.4	43.8	70.8^{bc}	1.70
SEM		± 9.1	± 1.7	± 5.6	± 5.8	± 0.48

a, b, c: means with different superscripts are significantly different ($P<0.05$).

When Mycosorb® was added to the ergot containing diets, egg mass increased, significantly ($P<0.05$) in the case of basal diet 3 (6 mgkg^{-1} SEA) (Table 5).

No signs of any pathogenic effects or wet droppings were seen for laying hens fed 6 – 24 mgkg^{-1} sorghum ergot.

DISCUSSION

The diets used contained only sorghum as the grain component to maximize the level of sorghum ergot in the diets. This may have reduced production from what may have been achieved for a mixed grain diet. The ergot contaminated sorghum had a higher crude protein content than the non contaminated sorghum, resulting in decreasing content of protein in the diets as one sorghum was replaced by the other. This appears to have caused a decrease in production, even though the nutrient levels were adequate by National Research Council (1994) standards. Only the diets containing the highest level of contaminated sorghum were adequate for protein recommended by the ISA company (ISA 1996).

Even though the production of laying hens fed ergot contaminated sorghum was acceptable, nevertheless their production increased when Mycosorb® was added to their diet. It therefore appears that SEA did cause effect in egg production of layers, and that Mycosorb® combated this effect.

After three weeks feeding sorghum ergot, it was found that the effect of Mycosorb® supplement appeared to be greater in the diets containing the lower ergot alkaloid concentrations. Therefore high protein concentrations appeared to prevent the severe effects of sorghum ergot alkaloid on egg production and egg mass. Thus Mycosorb® appeared to be less effective in higher protein diets than in lower protein diets.

Thus Mycosorb® seems to be an effective agent to use to combat the effects of SEA and help in promoting laying performance of chickens fed with SE contaminated sorghum. These results are similar to the findings of Devegowda and co-workers (1998) and Deo (2000) that Mycosorb™ was an effective binding agent for several mycotoxins including ergot alkaloids.

CONCLUSION

In the absence of an effective binding agent, the feeding of sorghum contaminated with ergot tends to result in changes that reduce the production efficiency of laying hens. This study has shown that increased dietary protein level and Mycosorb® binding agent effectively combat such changes. Both appear to be efficient solutions to the problem of feeding sorghum contaminated by sorghum ergot. However it is not recommended that Mycosorb® be added to diets not containing sorghum ergot.

Within any sorghum/protein level, mycosorb appears to be beneficial and at higher protein levels, mycosorbs may not be so effective.

This report deals with the response of laying hens fed sorghum ergot diets for three weeks only. In view of the production changes seen in the first three weeks it is recommended that the response of layers fed the diets with level of nitrogen (Lysine) over a longer period be examined before more definite conclusions are drawn

ACKNOWLEDGEMENTS

I would like to thank my supervisor, Dr. John G. Dingle, Mr. Barry J. Blaney (Principal Chemist) and Mr. John Kopinski from DPI Queensland, Dr. A. Kumar and Mr. B. Englebright for their technical assistance.

My special thanks to the Australian Grain Research and Development Corporation, and the Australian Egg Industry Association for financially supporting the research, and the University of Vudal (PNG) for providing the scholarship.

REFERENCES

ANONYMOUS (2001). Mycosorb – A nutritional alternative to clay supplements for Mycotoxin – contaminated feed. Alltech, Nicholasville, Kentucky, USA.

BLANEY, B. J., MANNION, P. F., DEO, P. and DINGLE, J. G. (1998). Implications of sorghum ergot *(Claviceps africana)* for the Queensland poultry industry. *Queensland Poultry Science Symposium* 7, 3.5 – 3.6.

DEO, P. (200). Effects of aflatoxin and sorghum ergot *(Claviceps africana)* alkaloids on the production and immunity of poultry. Thesis (Master of Applied Science), University of Queensland, Gatton.

DEVEGOWDA, G., RAJU, M. V. M., AFZALI, N. and SWAMY, H. V. L. N. (1998). Mycotoxin Picture worldwide: novel solutions for their counteractions. In Proceedings of Alltech's Fourteeth Annual Symposium (T. P. Lyons and K. A. Jacques, eds.), pp. 256. Nottingham Uni Press, Loughborough Leics, UK.

ISA (1996) ISA Brown, Annex management guide, Commercial layers, ISA Lyon, France.

NRC (1994). Nutrient Requirement of Poultry (ninth revised edition). National Research Council, National Academy Press, Washington, D. C.

SAS (1990). SAS/STAT User's Guide, Vol. 2, SAS Institute. Cary, NC, USA.