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Abstract

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In a six-week feeding trial, a total of 48 crossbred weaned male rabbits of 7 weeks old were randomly allotted to four dietary treatments, with 12 replicates per treatment to determine growth indices and nutrient digestibility of rabbits fed fumonisin-contaminated diets. Maize grains contaminated with fumonisin B₁ were incorporated into rabbit diets excluding the control diet (treatment 1, 0.13mgKg⁻¹), at varied inclusion levels of 5.0mgKg⁻¹, 7.5mgKg⁻¹ and 10.0mgKg⁻¹ fumonisin B₁, constituting treatments 2, 3 and 4 respectively. The results showed that the average final live weight of rabbits fed treatments 3 and 4 were significantly ($P < 0.05$) lower than those fed treatment 2 and the control. The average daily dry matter intake of the animals fed the dietary treatments was not significantly different. The mean daily weight gain of rabbits fed 5.0mgKg⁻¹, 7.5mgKg⁻¹ and 10.0mgKg⁻¹ however declined significantly ($P < 0.05$) by 91.23, 83.92 and 81.88% respectively, relative to the mean daily weight gain of 12.31g/rabbit/day of animals fed the control diet. The result further showed that digestibility of the nutrients of the experimental diets except crude protein, were similar among the treatments. The crude protein digestibility of rabbits fed 7.5mgKg⁻¹ and 10.0mgKg⁻¹ were identical but significantly ($P < 0.05$) lower than those fed 5.0mgKg⁻¹ and the control diet. This suggests inhibition of nitrogen utilization and depressed performance in the animals fed diets containing ≥ 5.0 mg fumonisin B₁/Kg. Diets containing up to 7.5 mg fumonisin B₁/Kg will depress live weight and daily weight gain as a result of reduced protein utilization in weaned rabbits.

Key Words: Male rabbits, Performance, dietary fumonisin B₁**Introduction**

The rate and level of performance in the livestock industry in Nigeria have in recent years fallen below expectation due to shortage of feed supplies, rising prices of ingredients, poor quality of feed due to the presence of mycotoxins or anti-nutritional factors, inadequate and unbalanced nutrition and prevalence of diseases, among other factors (Fetuga, 1977).

Mycotoxins are secondary metabolites of fungal origin that are harmful to both man and animals. The diseases caused by the ingestion of food or feed containing these fungal metabolites are known as mycotoxicoses. Irrespective of nutritional composition of the diet, the contamination

of the feed with mycotoxin leads to health problems.

A survey of contemporary literatures has considered these mycotoxins in feed to be involved in a chain of physiological and pathological disorder in animals. For instance, aflatoxin has been implicated to cause severe testicular degeneration and impaired spermatocytogenesis in rats (Egbunike, 1995). The carcinogenicity, hepatotoxicity, mutagenicity of aflatoxins have been well documented (Wilson, 1979). Some of the agriculturally important mycotoxins produced by *Fusarium* species include deoxynivalenol, zearalenone, aflatoxin, ochratoxin and fumonisins.

Fumonisin produced by species of

Fusarium causes different physiological and pharmacological responses in plants and animals. The fumonisin producing fungus – *F. verticillioides* is one of the most prevalent seed-born fungi associated with maize (*Zea mays* L.) intended for human and animal consumption throughout the world (Marasas *et al.*, 1984). *F. verticillioides* contaminated homegrown maize has been associated with the high incidence of human oesophageal cancer in areas of the Transkei, Southern Africa (Marasas *et al.*, 1984 and 1988). Leucoencephalomalacia in horses (Kellerman *et al.*, 1990), porcine pulmonary oedema in pig (Colvin and Harrison, 1992), hepatotoxic and carcinogenic activities in Vervet monkeys, rats and rabbits (Jaskiewicz *et al.*, 1987; Gelderblom *et al.*, 1991; Ewuola *et al.*, 2003) have been induced following the consumption of culture material of *F. verticillioides*. With the above in mind, this

experiment was designed to assess the performance response of weaned rabbits exposed to fumonisin-contaminated diets. The aim of this experiment was to study the influence of increased fumonisin concentration in rabbit diet on growth of animals and nutrient utilization.

Materials and Methods

Generation of infected Maize grains.

Fumonisin contaminated maize grains used for this study were generated at Plant Pathology Unit, *International Institute for Tropical Agriculture (IITA)*, Ibadan, Nigeria by inoculating the maize grains with fumonisin producing fungus- *Fusarium verticillioides* as described by Nelson and Ross (1992).

Fumonisin Quantification / Analysis:

Fumonisin quantification of the maize grains and diets were done using the Neorgen's veratox® fumonisin quantitative

Table1: Gross composition (%) of experimental diets

Ingredients	Treatments			
	1(Control)	2 (5.0 mgkg ⁻¹)	3 (7.5 mgkg ⁻¹)	4 (10.0 mgkg ⁻¹)
Non-infected maize	30.00	28.26	27.39	26.52
Infected maize*	----	1.74	2.61	3.48
Rice husk	23.00	23.00	23.00	23.00
Wheat Offal	27.00	27.00	27.00	27.00
Soybean meal	15.00	15.00	15.00	15.00
Fish meal	2.00	2.00	2.00	2.00
Calcium diphosphate	2.00	2.00	2.00	2.00
Salt	0.50	0.50	0.50	0.50
Premix**	0.45	0.45	0.45	0.45
Methionine	0.03	0.03	0.03	0.03
Lysine	0.02	0.02	0.02	0.02
Total	100.00	100.00	100.00	100.00
Calculated Nutrients				
Crude Protein (%)	16.11	16.11	16.11	16.11
Crude Fibre	10.79	10.79	10.79	10.79
Digestible Energy (Kcal/Kg)	2555	2555	2555	2555

* Inoculated with *Fusarium verticillioides*

**To provide per Kg diet: Vit. A (10,000 i.u), Vit.D (20,000i.u), Vit E (5 i.u), Vit. K (2.5mg), Choline (350mg), Folic acid (1mg), Manganese (56mg), Iodine (1mg), Iron (20mg), Copper (10mg), Zinc (50mg), and Cobalt (1.25mg).

test kits following the procedure below: Samples from maize and the four diets were ground separately to a size less than 2mm for fumonisin extraction. 25grams of ground sample mixed with 125ml of 70% methanol were blended for 12 minutes in a high-speed blender. The extract was filtered using a Whatman filter paper and the filtrate was collected as a sample for fumonisin quantification.

The quantitative analysis of the fungal toxin in the samples (filtrate) were determined in Milligrams per Kilogram diet (equivalent to part per million-ppm) at the pathology laboratory, International Institute for Tropical Agriculture (IITA), Ibadan, Nigeria using the fumonisin quantitative test kit (Neogen Corp; U.S.A) – a competitive direct enzyme – linked immunosorbent assay (CD-ELISA), and optical density was scanned with a microplate reader at 650nm wave length.

Feeding Trial: A total of forty-eight crossbred (New Zealand White x Chinchilla) weaned male rabbits aged 7 weeks, weighing averagely 757.50g were equally, by live weight, assigned to four dietary treatments in a completely randomized design. Diets 1(control), 2, 3 and 4 comprise *Fusarium verticillioides* – infected maize-based diets containing 0.13, 5.0, 7.5 and 10.0 mg fumonisin /Kg respectively as shown in Table 1. The diets were not pelleted. Each treatment has twelve replicates housed individually in a metal cage of 75cm x 36cm x 30cm in dimension and the experiment lasted for six weeks. The animals were fed daily at 8.00 and 16.00h *ad libitum*. Feed consumption was measured on daily basis and live weight changes of the animals were monitored weekly throughout the experimental period.

Feed consumption measured during the last seven days of the feeding trial as well as the

faeces excreted were used for digestibility studies. The faecal droppings were thoroughly mixed per replicate and 10% aliquot taken, weighed and dried at 60 - 70°C in an air circulating oven for 48 hours before analyzed for chemical composition of the feed and faecal samples as described by AOAC (1990). Nutrient digestibility was computed as stated below:

$$\frac{\text{Nutrient intake} - \text{Nutrient in faeces} \times 100}{\text{Nutrient intake}}$$

Data analysis: All data obtained from the experiment were subjected to analysis of variance using the ANOVA programs of the Statistical Analysis System Program (SAS, 1999). The treatment means were compared using the Duncan procedure of the same software.

Results

Performance of rabbits

The final live weights, average daily weight gain, average daily feed consumption and feed conversion ratio of rabbits fed varied levels of dietary fumonisin, at the end of the feeding trial are as shown in Table 2. The average final live weight of rabbits fed treatments 3 and 4 were significantly ($P < 0.05$) lower than those fed treatment 2 and the control. The average daily dry matter intake of the animals fed the four dietary treatments were not significantly ($P > 0.05$) different from one another. The average daily weight gain of the rabbits fed control diet was statistically the same with those rabbits fed diet 2, however, both were significantly $P < 0.05$ higher than those fed diets 3 and 4 which were not significantly different from each other. The average daily weight gain was highest 12.31g/rabbit in rabbits fed control diet and the least value of 10.08g/rabbit was recorded for animals fed

Table 2. Performance of Rabbits Fed Varied of Levels of Dietary Fumonisin B₁

Parameters	1 (Control)	2 (5.0mgKg ⁻¹)	3 (7.5mgKg ⁻¹)	4 (10.0mgKg ⁻¹)
Initial live weight (g)	758.00±98.95	756.00±93.61	758.00±90.53	758.00±83.02
Final live weight (g)	1275.00±67.19 ^a	1228.00±80.70 ^a	1191.67±98.19 ^b	1181.25±89.49 ^b
Daily dry matter intake (g)	66.11±7.89	57.43±6.88	58.52±6.59	59.60±6.64
Daily weight gain (g)	12.31±2.07 ^a	11.23±3.80 ^{ab}	10.33±3.14 ^b	10.08±3.11 ^b
Feed conversion ratio	0.19±0.03	0.20±0.08	0.18±0.05	0.17±0.04

ab: Means in the same row with different superscripts are significantly ($P < 0.05$) different.

diet 4 containing 10.0mg fumonisin B₁/Kg. The feed conversion ratio was not statistically different among the dietary treatments.

Nutrient digestibility: The nutrient digestibilities dry matter, crude protein, crude fibre, ether extract, ash and nitrogen free extract values of the dietary treatments are shown in Table 3. The nutrient digestibility values, except crude protein were not significantly ($P > 0.05$) influenced by the dietary treatments. However, dry matter digestibility apparently decreased with increase in dietary fumonisin levels while crude protein digestibility was significantly $P < 0.05$ influenced by the dietary treatments. The crude protein digestibility of rabbits fed diets 1 and 2 were

significantly $P < 0.05$ higher than those fed diet 4. Conversely, the crude protein digestibility of rabbits fed the control diet was the highest 78.74 while rabbits fed diet 4 recorded the lowest 54.67 crude protein digestibility.

Discussion

The mean daily dry matter intake of the animals fed diets 4, 3 and 2 were similar to those rabbits fed the control diet. This result corroborates with the report of US NTP 1999 that there was no significant difference in feed consumption in male rats fed fumonisin B₁ when compared to rats on control. Contrary to this result was the report of Bondy *et al.* 1998 who reported

Table 3. Nutrient digestibility (g/100gDM) of male rabbits fed dietary fumonisin B₁

Nutrients	Treatments			
	1	2	3	4
Dry matter	77.23±1.25	75.59±1.41	73.80±2.01	70.37±1.89
Crude protein	78.74±2.18 ^a	74.14±3.69 ^{ab}	68.41±4.28 ^b	54.67±5.10 ^c
Crude fibre	66.12±3.02	66.57±3.41	65.43±3.16	66.00±3.08
Ether extract	54.02±2.89	55.60±3.14	55.92±3.62	54.88±2.96
Ash	52.00±2.51	52.01±2.68	51.09±2.14	52.00±2.02
Nitrogen free extract	64.08±4.10	65.01±4.62	66.30±3.80	66.04±4.25

abc: Means in the same row with different superscripts are significantly ($P < 0.05$) different

significant depression in feed intake of female Sprague-Dawley rats administered purified fumonisin B₁ at gavage doses of 35 and 75mg fumonisin B₁/kg body weight per day. However, the effect was not significant on feed intake at doses of 1, 5 and 15mg FB₁/kg body weight per day, which was similar to the observation in this study.

The mean daily weight gain and final live weight of rabbits fed dietary treatments declined with increase in the level of dietary fumonisin B₁. The weight gain of animals that were fed 10.0mg Kg⁻¹, 7.5mg Kg⁻¹ and 5.0mg Kg⁻¹ dietary fumonisin B₁ declined by 91.63, 83.92 and 81.88% respectively, relative to the mean daily weight gain (12.31g/rabbit) of animals fed the control diet. The reduction in weight gain may be attributed to the influence of dietary fumonisin B₁, as observed by Yoo *et al.* 1992 who reported that there is a concentration-dependent association between the inhibition of sphingolipid biosynthesis, which modulate cellular regulatory processes that are known to be important in the control of normal cell growth and differentiation, by fumonisin and growth inhibition. This result was also in agreement with the report of Gelderblom *et al.* 1988 that mean body weight gain of rats fed diet containing 1g fumonisin B₁/kg during a 4-week promotion treatment were 50% lower than those of non-treated rats. In another study with female Sprague-Dawley rats administered purified FB₁ at different doses of FB₁/kg body weight per day, Bondy *et al.* 1998 reported that significant depression of body weight was observed at 35 and 75mg FB₁ /kg body weight per day. Similar effect of depressed body weight gain induced by fumonisin has also been reported Voss *et al.*, 1990; Powell *et al.*, 1996; Ewuola *et al.*, 2003.

The nutrient utilization and absorption from

the intestinal tract of animals are indicated by the nutrient digestibility of the dietary treatments by the animals. The result showed that nutrient digestibility of rabbits fed varied levels of dietary fumonisin B₁ except crude protein, were identical among the dietary treatments. However, the crude protein digestibility were significantly influenced by dietary fumonisin resulted in significantly decreased nitrogen digestibility values of the rabbits fed diets containing 7.5mgKg⁻¹ and 10.0mgKg⁻¹ fumonisin concentration compared to the control diet. This probably suggests an inhibition of nitrogen utilization and/or absorption in the intestinal tract of the animal resulting in depressed weight gain of the animals. This result agrees with the report of Ewuola *et al.* 2003 that observed similar effect in adult rabbit bucks fed micro-doses of fumonisin for a short period of 5 weeks. Merrill *et al.* 1993 reported that sphingolipids modulate cellular regularity and differentiation processes. Its inhibition by the toxin has been reported to adversely affect normal epithelial morphology Yoo *et al.*, 1992 which could impede absorption of the feed nutrient crude protein of the experimental diets.

Conclusion

This study has demonstrated that feeding young rabbits with diet formulated with feed ingredients contaminated with fumonisin B₁ up to 10mg fumonisin/Kg diet would not adversely affect the dry matter intake. A concentration above 5.0mg fumonisin B₁/Kg diet would however significantly impair nitrogen utilization and consequently depress daily weight gain of the animal when fed for a period of six weeks.

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