AMELIORATIVE POTENTIALS OF VITAMIN E AGAINST THE IMPACTS OF DIETARY FUMONISIN B_1 ON GROWTH PERFORMANCE OF FEMALE RABBITS

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ABSTRACT

Forty-nine young female rabbits were used to evaluate the ameliorative potentials of an antioxidant, vitamins E, against the growth-depressing effects of fumonisin B_1 (FB_1) –an environmental mycotoxin, on animals. The animals were randomly assigned to the control diet without FB_1 and six diets containing different concentrations of dietary FB_1 or with antioxidant (i.e. 0.25mg FB_1, 0.5mg FB_1, 0.75mg FB_1, 0.25mg FB_1 + 100mg Vitamin E, 0.5mg FB_1 + 100mg Vitamin E, and 0.75mg FB_1 + 100mg Vitamin E) for 8 weeks. The weight changes of the rabbits generally decreased significantly ($P<0.05$) with increase in the dietary FB_1 concentrations and the potentials of the antioxidant to ameliorate the effect of the toxin on the animals also decreased with increase in the dietary FB_1 concentrations. The weight gained by the animals fed diets containing only FB_1 were only about 38.6 – 58.6 % while those fed diets containing FB_1 plus vitamin E had 80.4 – 94.8 % of those on the control. The antioxidant also improved the feed efficiency of the animals fed diets containing FB_1 plus vitamin E over those fed diets containing varied concentrations of FB_1 only. The study has shown the ameliorative potentials of vitamin E on the impacts of FB_1 on animal growth performance. Vitamin E at 100mg/kg of feed is recommended as a nutritional strategy especially at concentrations of > 5.0 mg FB_1/kg, to alleviate the growth-depressing effect of FB_1 on animal. The strategy of using food additives, such as antioxidants, to protect livestock from the mycotoxin may also provide effective and economical new approaches to protecting human populations.

INTRODUCTION

Fungi produced diverse group of toxic secondary metabolites called mycotoxins (Kedera *et al.*, 1998). Mycotoxins are regularly implicated in toxic syndromes in animals and humans. No region of the world escapes the problem of mycotoxins and it is estimated that there are about 300 harmful mycotoxins. Food and Agricultural Organisation (FAO) estimates that about 25% of crops worldwide contain mycotoxins. They have been detected in various food commodities from many parts of the world and are considered as one of the most contaminants of food and feed (Ratcliff, 2002). Among such mycotoxins of significant health concern to both man and animals is fumonisin, produced by *Fusarium verticillioides*, which grows on any nourishing medium. Adverse effects of mycotoxin on animal health and production have been recognized in intensively farmed animals such as poultry, swine and cattle. Mycotoxins may cause gastrointestinal problems (Gbore and Akele, 2010), immune suppression (Richard, 2007), blood abnormalities (Ewuola and Egbunike, 2008), suppression in sperm production and reproductive performance (Gbore *et al.*, 2009). In the tropics, crops with large amounts of mycotoxins often have to be diverted into animal feeds, which pose a serious threat to the health and productivity of the animals, with attendant economic consequences. Considerable research has been directed at finding methods to prevent mycotoxicity in animals. Antioxidants have been reported (Petterson, 2004) to reduce the toxic effects of mycotoxins in animals. However, there are only few data about the positive effect of antioxidants on some important mycotoxins, including fumonisin B_1. This study was, therefore, designed to evaluate growth performance of female pubertal rabbit fed dietary fumonisin B_1 with or without vitamin E supplementation.

MATERIALS AND METHODS

Forty-nine clinically normal matured crossed bred female rabbits weighing between 1.65 and 2.0 kg were obtained from a commercial rabbit farm for the experiment. Each animal was housed individually in wire-meshed in-door cages for a period of two weeks for physiological adjustment before the commencement of the feeding trial. Maize grits in 500 g quantities were placed into autoclavable polypropylene bags and soaked with 200 ml of distilled water for 2 h, then autoclaved for 1 h at 121°C and 120 kPa. The maize medium was inoculated with mycelia from seven-day-old cultures of *Fusarium verticillioides* (MRC 286) grown on Potato Dextrose Agar (PDA) and incubated at 26°C for 15 days to produce FB_1. Uncultured maize grits and the cultured maize grits were used to formulate seven diets - the control diet without FB_1 and six diets containing different concentrations of dietary FB_1 or with antioxidant (i.e. 0.25mg FB_1, 0.5mg FB_1, 0.75mg FB_1, 0.25mg FB_1 + 100mg Vitamin E, 0.5mg FB_1 + 100mg Vitamin E, and 0.75mg FB_1 + 100mg Vitamin E) constituting Diets A, B, C, D, E, F, and G, respectively. Samples of homogenously mixed diets were quantified in replicates for FB1 and other common *Fusarium* mycotoxins. The pelleted diets provided ~19% crude protein, 5% crude fibre and 2. kcal of digestible energy/g (Table 1). After 2 weeks of physiological adjustment period, the rabbits were randomly allocated to each of the diets (n = 13 rabbits per treatment). The animals were provided with fresh clean water and appropriately weighed feed daily, and the weights of feed portions given and left uneaten after 24 h were determined. The body weight was determined weekly. All the data obtained were subjected to statistical analysis using ANOVA procedure of SAS (2008). The significant treatment means were compared using the New Duncan Multiple Range test option of the same software.

RESULTS AND DISCUSSION

Table 2 shows the feed intake, weights and feed conversion ratios of rabbits fed varied concentrations of dietary FB_1 supplemented with or without vitamin E. Rabbits on Diet G had significantly ($p < 0.05$) higher feed intake than all those fed the other diets. However, the feed conversion efficiencies of rabbits fed Diets A, E, and F containing no FB_1, and 2.5 and 5.0 mg FB_1 plus vitamin E, respectively were significantly ($p < 0.05$) higher than those fed other diets containing higher concentrations of FB_1 and FB_1 plus vitamin E (i.e., Diets B, C, D, and G). Rabbits on Diets A, E, and F had higher daily weight gains than those on other diets. Animals fed Diet D containing 7.5 mg FB_1 without vitamin E had the lowest daily weight gain compared with those on the other diets. Also, the final weights of rabbits on Diets A, E, and F had higher daily weight gain while animals fed Diet D, containing 7.5 mg FB_1 without vitamin E, had the lowest daily weight gain compared with those on other diets. The total weight gained by the animals fed diets containing varied concentrations of FB_1 were only about 38.6 – 58.6 % of those on the control diet compared with 80.4 – 94.8 % for those fed diets containing FB_1 supplemented with vitamin E. Similarly, animals fed diets containing varied concentrations of FB_1 had only 37.8 – 57.8 % efficiency in feed conversion while those fed diets containing FB_1 supplemented with vitamin E had feed conversion efficiency of 70.2 – 94.8 % compared with those on the control diet. The general decline in the total and final weight gains with increase in dietary FB_1 of animals exposed to varied concentrations of dietary FB_1 (i.e., diets B, C, and D) is an indication of the role that FB_1 could play in animal nutrition and subsequent weight gain. The reduced weight gains by rabbits with increase in the concentrations of dietary FB_1 in this study compared with those fed the control diet, may be attributed to the adverse effects of the mycotoxin on feed intake and nutrient utilization as observed in pigs fed dietary FB_1 by Gbore and Egbunike (2007). The significantly lower relative change in live weights and the significantly increased feed conversion ratio of rabbits fed Diets B, C, and D compared to controls are in agreement with results from similar studies that dietary FB_1 depressed live weight gain in rats (Gelderblom *et al.*, 1988; Swamy *et al.*, 2002; Theumer *et al.*, 2002, Gbore *et al.*, 2010) and lowered feed conversion efficiency in animals (Gbore, 2009). Gelderblom *et al.* (1988) reported that the mean body weights of BD IX rats consuming a diet containing 1 g FB_1/kg during a 4-week promotion treatment were 50% lower than those of the controls. Also, a declining relative change in body weights with increase in dietary fumonisin was reported in rabbits fed ≥ 12.30 mg fumonisin/kg for five weeks (Gbore *et al.* 2006). The total weight gain of 220.60, 209.50 and 145.10 g for rabbits fed diets B, C, and D, respectively, compared with 376.20 g for rabbits fed the control diet for 84 days, was similar to the report by Gbore and Akele (2010) that the relative live weight gains decline with an increase in dietary fumonisin in pregnant rabbits exposed to a ≥5 mg fumonisin/kg diet. Rotter *et al* (1996) found out that average daily weight gain of male pigs fed a 10 ppm pure fumonisin B_1 diet through 8 weeks decreased by 11% compared to a 0 ppm diet. However, the values obtained for weight gain and FCR for rabbits fed diets E and F containing 2.5 and 5.0 mg FB1 supplemented with vitamin E, which were similar to those on Diet A (i.e., control diet) is an indication of the ameliorative roles that the antioxidant could play on the adverse impacts of

FB1 on animal growth performance. Various nutritional strategies have been proposed to alleviate the adverse effects of mycotoxins on livestock. Most of the mycotoxins (Balogh *et al.*, 2007; Pál *et al.*, 2009) including FB_1, provoke oxygen free radical formation. For this reason, the addition of natural and synthetic antioxidants have been reported to be potentially efficacious in ameliorating mycotoxicosis because of the ability of these compounds to act as superoxide anion scavengers (Dvorska *et al.*, 2007). Antioxidants and vitamins act on liver, tissue or cells in order to reduce the toxic effects of mycotoxins (Petterson, 2004) due to their anti-oxidative properties which enable their participation in metabolism of all cells and delay or inhibit oxidative damage to cellular molecule as reported by Gutteridge and Halliwell (1994). The mechanisms by which vitamin E might provide this protection include its function as an antioxidant and its roles in anti-inflammatory processes (Greenberg, 2005). This study has shown the ameliorative potentials of vitamin E on the impacts of FB_1 on rabbit growth performance. Vitamin E at 100mg/kg of feed is recommended as a nutritional strategy, especially at concentrations of > 5.0mg/kg, to alleviate the growth-depressing effect of FB_1 on animal. The strategy of using food additives, such as antioxidants, to protect livestock from the mycotoxin may also provide effective and economical new approaches to protecting human populations.

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Table 1: Gross composition (%) of the experimental diets

Ingredients	Composition (%)
Maize	40.68
Groundnut cake	11.78
Wheat offal	22.58
Palm kernel cake	19.63
Fish meal	1.96
Dicalcium phosphate	1.96
Salt	0.23
Methionine	0.10
Lysine	0.96
Minerals/vitamins premix	0.12

Table 2. Performance of female rabbit fed with fumonisin B_1 supplemented with or without vitamin E

Parameters (g)	Diet A Control	Diet B 2.5mg FB1	Diet C 5.0mg FB1	Diet D 7.5mg FB1	Diet E 2.5mg FB1 Vitamin E	Diet E 5.0mg FB1 + Vitamin E	Diet F 7.5mg FB1 + Vitamin E	± sem
Initial weight	1099.40	1090.40	1111.30	1099.30	1103.00	1099.30	1032.30	13.56
Final weight	1487.5^{a}	1320.90^{b}	1299.90^{b}	1244.80^{c}	1459.80^{a}	1451.10^{a}	1334.60^{b}	188.42
Total weight gain	376.20^{a}	220.60^{c}	209.50^{c}	145.10^{d}	356.80^{a}	351.80^{a}	302.30^{b}	92.36
Daily weight gain	13.44^{a}	7.88^{c}	7.48^{c}	5.18^{d}	12.74^{a}	12.56^{a}	10.79^{b}	5.62
Total feed intake	1659.00^{b}	1680.00^{b}	1594.00^{b}	1765.00^{b}	1684.20^{b}	1680.00^{b}	1895^{a}	301.45
Daily feed intake	59.25^{b}	60.00^{b}	56.92^{b}	60.30^{b}	60.50^{b}	60.00^{b}	67.67^{a}	9.46
FCR*	4.40^{c}	7.61^{ab}	7.60^{ab}	11.64^{a}	4.75^{c}	4.77^{c}	6.27^{b}	2.94

*FCR – Feed conversion ratio; ^{abcd}: Means in the same row with different superscripts are significantly ($P < 0.05$) different.