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Effect of Commercial or Bovine Yeasts on the Performance and Blood Variables of Broiler Chickens Intoxicated with Aflatoxins

W. Suksombat* P. Suksombat and R. Mirattanaphrai

***Abstract*—**The effects of commercial or bovine yeasts on the performance and blood variables of broiler chickens intoxicated with aflatoxin were investigated in broilers. Four hundred eighty broilers (Arbor Acres; 3-wk-old) were randomly assigned to 4 groups. Each group (120 broiler chickens) was further randomly divided into 6 replicates of 20 chickens. The treatments were control diet without additives (treatment 1), 250 ppb AFB1 (treatment 2), commercial yeast, *Saccharomyces cerevisiae,* (CY 2.5 x 10^7 CFU/g) + 250 ppb AFB1 (treatment 3) and bovine yeast, *Saccharomyces cerevisiae,* (BY 2.5 x 10^7 CFU/g + 250 ppb AFB1 (treatment 4). Complete randomized design (CRD) was used in the experiment. Feed consumption and body weight were recorded at every five-day period. On day 42, carcass compositions were determined from 30 birds per treatment. While chicks were sacrificed, 3-4 ml blood sample was taken and stored frozen at (-20°C) for serum chemical analysis to determine effects of consumption of diets on blood chemistry (total protein, albumin, glucose, urea, cholesterol and triglycerides). There were no significant differences in ADFI among the treatments(P>0.05). However, BWG, FCR and mortality were highly significantly different (P<0.01) between treatments. ADG was significantly reduced (P<0.05) by aflatoxin but was unaffected by aflatoxin supplemented with either commercial or bovine yeasts (P>0.05). In terms of carcass portions, percentage of carcass was unaffected by the treatments, however, percentages of drumstick were reduced by aflatoxin and aflatoxin supplemented commercial yeast. Abdominal fat was significantly reduced (P<0.01) when commercial or bovine yeasts were added to the aflatoxin contaminated diets. Percentage of liver were significantly increased by aflatoxin contamination but were unaffected when yeasts were added to the diets. Blood chemical parameters, i.e. albumin, blood urea nitrogen and glucose were unaffected the treatments, while total protein, cholesterol and triglycerides were significantly decreased by aflatoxin. When yeasts were supplemented, such effect was not differed from the control. It is clearly indicated in the present study that supplementation of either commercial or bovine yeasts had beneficial effects on performance of broiler chickens intoxicated with aflatoxins.

***Keywords*—**Aflatoxin, Commercial yeast, Bovine yeast, Growth performance, Blood chemical parameters, Broilers

W. Suksombat is with Suranaree University of Technology, Muang District, Nakhon Ratchasima, 30000. THAILAND. (phone: 66-44-224152; fax: 66-44-224150; e-mail: wisitpor@sut.ac.th).

P. Suksombat is with Suranaree University of Technology, Muang District, Nakhon Ratchasima, 30000. THAILAND. (phone: 66-44-224152; fax: 66-44-224150.

R. Mirattanaphrai is with Suranaree University of Technology, Muang District, Nakhon Ratchasima, 30000. THAILAND. (phone: 66-44-224152; fax: 66-44-224150; e-mail: gapgap1829@hotmail.com).

I. INTRODUCTION

AFLATOXINS are group of closely related mycotoxin that can be produced by three species of *Aspergillus; A. flavus, A. parasiticus* and the rare *A. romius* growing on a variety of feedstuffs, mainly maize, peanuts and cottonseed [1]. Aflatoxins B1 (AF B1) is produced by certain strains of fungi in greater quantities than in others [2]. Among aflatoxins, AFB1 is an extremely hepato-toxic and carcinogenic compound [3]. Aflatoxin B1 is more predominantly found than others and is the most toxic type to poultry and frequently contaminates animal's feeds at low levels.

Aflatoxins (a structurally similar group of polysubstituted coumarins) have been recognized as important mycotoxins due to their toxicity and their occurrence as natural contaminants of feeds. Aflatoxin B1 (AFB1) and 3 structurally similar compounds (AFB2, AFG1, and AFG2) have been detected as contaminants of crops before harvesting and drying, in storage, and after processing and manufacturing. The frequent contamination of agricultural commodities with aflatoxin and the chronic exposure of poultry to these toxins can greatly affect the profitability of poultry production. Consequently, large-scale, practical, and cost-effective methods for detoxifying aflatoxin-containing feedstuffs currently are in great demand.Aflatoxins cause a variety of effects in poultry including decreased feed utilization, poor growth, egg production and break in immunity. Even small amounts of AFB1 in feeds may cause poor growth, hatchability and increase susceptibility to disease. Liver damage and bleeding decreased egg production and overall performance and suppressed immunity have been noted in animals consuming relatively low dietary levels of aflatoxin [2] [4] [5]. High dosages cause acute loss of appetite, depression, haemorrhage, diarrhoea and death. Susceptibility of animals to aflatoxins varies with species and age. Among poultry, ducks and turkey poults are more susceptible for aflatoxicosis than any other species. In general, younger animals are more susceptible than adult animals. Broilers are more susceptible than layers.Several nutritional, physical, chemical and biological approaches have been proposed to detoxify mycotoxin contaminated feed and feedstuffs. There has been a great deal of interest in using natural biological products to reduce the bioavailability of mycotoxins in animal production systems. The potential usefulness of these types of materials was first demonstrated in poultry in the early 1990s. Initially used as a nutritional aid and a growth promoter, a commercially available viable yeast culture preparation based on Saccharomyces cerevisiae strain 1026 (Yea-Sacc), was found to improve hatchability [6] and broiler body weights [7]. Live yeast contains numerous enzymes that could be released into the intestine and aid existing enzymes in the digestive tract in the digestion of feed. Also, yeast contains vitamins and other nutrients that may produce beneficial production responses [8]. In addition, [9] and [10] showed that yeast additives reduce the toxic effects of Alfatoxin. While, [11] and [12] revealed that yeast can improve immune response of birds. Investigators attributed the yeast culture preparation's ability to alter growth patterns of poultry to its ability to bind toxins found in the diets used in these studies. In controlled studies, viable yeast cultures added to broiler diets containing aflatoxin resulted in significant improvement in weight gain and enhanced immune response [13]. Additionally, in vitro studies clearly established up to 90% adsorption of aflatoxin to yeast cells in a dose-dependent fashion [14]. The present study aimed to determine the effect of live yeast supplementation on growth performance, feed conversion efficiency, carcass composition and blood chemical parameters in broiler chickens.

II. Materials And Methods

A. Experimental Animals

All experiments were conducted in accordance with the principles and guidelines approved by the Suranaree University of Technology Animal Care and Use committee which followed Guidelines for the Care and Use of Agricultural Animals in Agricultural Research and Teaching. Four hundred eighty broilers (Arbor Acres; 3-wk-old) were randomly assigned to 4 groups. Each group (120 broiler chickens) was further randomly divided into 6 replicates of 20 chickens. Chicks were kept under conditions of evaporative cooling system and lighting program (16L: 8D) throughout the entire experiments Chickens were fed diets and water *ad libitum* during the entire experimental period.

B. Experimental Diets

The experimental diets were isonitrogenous and isocaloric and formulated to meet the National Research Council (1994) requirements. Chickens were fed experimental diets containing 3,267 kcal of ME/kg, 20.1% crude protein, 1.11% lysine, 0.72% methionine + cystine, 0.99% calcium, and 0.60% available phosphorus. Chemical analysis of the diets was made for crude protein, crude fiber, ether extract, and ash [15]. Feed ingredients and chemical compositions of the experimental diets are presented in Table 1. The chicks were randomly assigned to the following treatment groups. Control diet without additives (treatment 1), 250 ppb AFB1 (treatment 2), commercial yeast (CY 2.5 x 10^7 CFU/g) + 250 ppb AFB1 (treatment 3) and bovine yeast (BY 2.5 x 10^7 CFU/g + 250 ppb AFB1 (treatment 4). The respective aflatoxin and commercial yeast were obtained from Shanghai PI Chemicals Ltd. and Alltech Inc., while bovine yeasts were obtained from rumen-fistulated non-lactating dairy cows, then they (*Saccharomyces cerevisiae*) were isolated and purified for using in the experiment. Evaluation of yeast cells was obtained by haemacytometer [16]. The toxin was measured by spectrophotometric methods and it was estimated to be 250 ng/g.

C. Growth Performance, Carcass Quality and Blood Chemical Parameters

Feed consumption and body weight were recorded at every five-day period. Broiler chicks were daily examined in the morning and at evening for any sign of toxicosis and mortality. On day 42, 30 birds per each treatment, were stunned and slaughtered by neck cutting and exsanguinated after 12 hours fasting. Carcasses were then plucked, and eviscerated to determine carcass weight, as a percentage of live weight, and abdominal fat (considered to be the fat extending within the ischium, surrounding the cloaca, and adjacent to the abdominal muscle) and breast, thigh and drumstick muscle weight as a percentage of carcass weight. Samples of breast, thigh and drumstick muscles were stored frozen (-20°C) for further analysis. While chicks were sacrificed, 3-4 ml blood sample was taken and stored frozen at (-20°C) for serum chemical analysis to determine effects of consumption of diets on blood chemistry (total protein, albumin, glucose, urea, cholesterol and triglycerides) using an automatic analyzer according to recommendation of the manufacturer.

D. Statistical Analysis

The observed effects between treatment groups were statistically analyzed by ANOVA in a completely randomized design [17] and significant differences between means were compared by Duncan's New Multiple Range Test (DMRT) according to the methods previously described by [18].

II. Results And Discussion

A. Broiler Performance

Ingredient and calculated nutrient composition of finisher diets are presented in Table 1. The calculated nutrient composition is based on NRC recommendation [19]. The effects of commercial or bovine yeasts on body weight gain (BWG), ADG, ADFI, feed conversion ratio (FCR) and mortality are shown in Table (2). As compared to control group, the mold-contaminated diet chicks showed no significant difference on ADFI during 22-42 d ($p>0.05$). Consumption of contaminated diet alone resulted in reduction in BWG and poorer FCR when compared to the control diet and other treatments. Similar results were also reported [2] [20]. Reference [2] reported that inclusion of AFB1 at 80 µg/kg diet resulted in a significant lower body weight gain and feed efficiency. Reference [20] also recorded significant decreased body weight gain in broiler chicken fed contaminated feed at both 78 and 170 µg aflatoxin/kg diets. In the present study, either commercial yeast or bovine yeast supplementation to the contaminated diet significantly improved mortality, BWG, FCR ($p<0.01$) and ADG ($p<0.05$) during 22-42 d. The positive response on mortality, BWG, FCR and ADG as a result of adding either commercial yeast or bovine yeast may be due to that mannan oligosaccharides (MOS) from yeast cell walls have been researched with respect to their value in immune modulation [21] [22] and in reduction of intestinal pathogen colonization [23]. Some research studies suggest that MOS may improve growth performance in young pigs [24] [25]. Furthermore, yeast can inhibit pathogenic bacteria as reported by [26].

TABLE I
INGREDIENT AND CALCULATED NUTRIENT COMPOSITION OF BASAL DIETS (AS-FED-BASIS)

	Composition
Ground corn	60.00
Soybean meal	20.00
Fish meal	8.50
Sunflower meal	5.00
Soybean oil	5.00
Dicalcium phosphate	1.00
Premix[1]	0.50
	100.00
Metabolizable energy (kcal/kg)	3267
Crude protein (%)	20.1
Crude fat (%)	7.94
Crude fiber (%)	9.36
Calcium (%)	0.99
Available phosphorus (%)	0.60
Arginine (%)	1.30
Lysine (%)	1.11
Methionine + cystine (%)	0.72
Tryptophan (%)	0.25
Valine (%)	1.05
Threonine (%)	0.79

[1]Premix (/kilogram diet): vitamin A, 400 IU; vitamin D_3, 250 IU; vitamin E, 30 mg; vitamin C, 30 mg; vitamin K_3 13 mg; vitamin B_1 10 mg; vitamin B_2 16 mg; vitamin B_6 12 mg; vitamin B_{12} 0.1 mg; Ca pantotinate 60 mg; folic acid 0.2 mg; nicotinic acid 83 mg; choline 105 mg; Co 0.4 mg; Cu 3.7 mg; I 0.5 mg; Mn 86 mg; Mg 108 mg; Zn 62 mg; Fe 42 mg; Ca 11 mg; Na 390 mg; Cl 671 mg; K 78 mg; Met 45 mg

B. Slaughter Data

The percentages of carcass, drumstick, thigh, breast, liver and abdominal fat of chicks fed commercial yeast or bovine yeast are presented in Table 3. The data showed that no significant differences (P>0.05) were observed on body weight, percentages of carcass, thigh and breast as a result of adding yeasts to growing broiler diet. However, broilers fed control or yeast supplemented diets showed that percentages of liver and abdominal fat were increased when compared with those chicks fed aflatoxin contaminated diet. There were no significant differences in these parameters between commercial and bovine yeast supplemented groups. The lack of change in BW response to aflatoxin was perhaps the chicks used in the present study, when 22 d old, were more resistant to intoxication, as demonstrated by [27]. Increase in percentage of liver reflected an increase in relative liver weight. Reference [28] found increased liver weight with addition of aflatoxin, however, the weight of liver decreased with addition of MOS to the aflatoxin added diet. This observation supports the earlier works of [3] [29] [30].

C. Blood parameters (Total serum protein, serum albumin, cholesterol, triglycerides, urea nitrogen and glucose)

The main effects of aflatoxin are related to liver damage. The inhibition of protein synthesis in the liver [31] and changes of serum variables such as cholesterol and triglyceride concentrations [32]. Aflatoxin has been shown to cause inhibition of protein synthesis [33]. Total protein levels in the serum proved to be sensitive indicators of aflatoxicosis in broilers. Reference [34] reported that serum total protein as a result of aflatoxicosis was decreased. The present results are consistent with the finding by [35, who observed a decrease in serum uric acid and cholesterol in birds fed a contaminated diet. In the present study, the total protein for broilers fed diets containing yeasts and aflatoxin did not completely return to normal values, showing an inhibition of protein synthesis. These results are parallel with the finding reported by [33], who observed a decrease in total protein and an inhibition in protein synthesis during the aflatoxicosis in poultry. Furthermore, data showed that albumin, blood urea nitrogen and blood glucose were unaffected by the treatments. Cholesterol and triglycerides were reduced by adding aflatoxin to broiler diet, however, supplementing commercial yeast or bovine yeast to broiler diets showed no significant different in these parameters when compared with the control diet. Similar

TABLE II
EFFECT OF COMMERCIAL OR BOVINE YEAST SUPPLEMENTATION ON PERFORMANCE OF BROILERS FED AFLATOXIN INTOXICATED DIETS

	Treatments				SEM	Pr>F
	Control	250 ppb AFB_1	CY + 250 ppb AFB_1	BY + 250 ppb AFB_1		
ADFI (g)	98.57	96.19	101.90	100.47	0.07	0.305
BWG (g)	1279[a]	1091[c]	1263[b]	1270[ab]	0.09	0.008
FCR	1.63[b]	1.89[a]	1.70[b]	1.66[b]	0.06	0.002
ADG (g/d)	62.21[a]	53.28[b]	60.87[a]	61.03[a]	2.30	0.016
Mortality (%)	0.6[c]	1.4[a]	0.8[b]	0.8[b]	0.03	0.003

CY = commercial yeast; BY = bovine yeast; SEM = standard of the mean; ADFI = Average dairy feed intake; BWG = Body weight gain; FCR = Feed conversion ratio; ADG = Average dairy gain

TABLE III
EFFECT OF COMMERCIAL OR BOVINE YEAST SUPPLEMENTATION ON BODY WEIGHT AND PERCENTAGE OF CARCASS PORTIONS

	Treatments				SEM	Pr>F
	Control	250 ppb AFB_1	CY + 250 ppb AFB_1	BY + 250 ppb AFB_1		
Body weight (g)	1900	1817	1949	1885	0.09	0.390
% Carcass	67.65	66.89	67.04	67.35	0.93	0.775
% Liver	2.15[b]	2.42[a]	2.14[b]	2.22[b]	0.06	0.006
% Abdominal fat	1.88[ab]	1.99[a]	1.75[bc]	1.65[c]	0.10	0.009
% Drumstick	14.5[a]	14.0[c]	14.5[ab]	14.1[bc]	0.13	0.027
% Thigh	18.8	18.6	19.2	18.8	0.39	0.385
% Breast	21.1	21.2	21.1	20.9	0.37	0.930

CY = commercial yeast; BY = bovine yeast; SEM = standard of the mean result was also reported by [36] who found a reduction in serum triglyceride in broiler chicken received aflatoxin. However, [37] reported that in aflatoxin intoxicated laying hen, cholesterol concentrations were not significantly different from control values, but triglyceride concentrations decreased in aflatoxin intoxicated group. Thus, it can be concluded in the present study that either commercial or bovine yeast could be used to enhance performance of aflatoxin intoxicated broilers.

TABLE IV
EFFECT OF COMMERCIAL OR BOVINE YEAST SUPPLEMENTATION ON BLOOD CHEMICAL PARAMETERS

	Treatments					
	Control	250 ppb AFB_1	CY + 250 ppb AFB_1	BY + 250 ppb AFB_1	SEM	Pr>F
Total protein (g/dL)	3.37[a]	3.04[b]	3.30[a]	3.50[a]	0.07	0.028
Albumin (g/dL)	1.50	1.41	1.55	1.83	0.25	0.293
Cholesterol (mg/dL)	132.89[a]	115.32[b]	127.94[ab]	123.46[ab]	5.18	0.041
Triglycerides (mg/dL)	105.94[a]	91.13[b]	115.99[a]	112.78[a]	3.42	0.024
BUN (mmol/L)	1.62	1.98	1.85	1.79	0.09	0.389
Glucose (mmol/L)	8.32	9.33	8.50	8.46	1.10	0.658

CY = commercial yeast; BY = bovine yeast; SEM = standard of the mean; BUN = blood urea nitrogen

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