EFFECT OF DIRECT-FED MICROORGANISMS ON BROILER GROWTH PERFORMANCE AND LITTER AMMONIA LEVEL

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Summary

Broilers were fed diets supplemented with various levels of a probiotic (mixture of the following direct-fed microorganisms: *Lactobacillus, Bacillus*, and *Streptococcus*). Growth performance, abdominal fat, excreta, and litter ammonia level were determined. The results showed that birds fed the probiotic-supplemented diets had better weight gain ($p < 0.01$) and feed conversion (gain : feed ; $p < 0.12$) when compared to the birds fed the unsupplemented diet. No differences in feed intake and abdominal fat were observed among birds fed the different experimental diets. Excreta ($p < 0.05$) and litter ($p < 0.01$) ammonia levels were reduced by dietary probiotic supplementation. A dosage of 0.25 g of the probiotic/kg of diet is needed to maiximize growth performance during both the starter and finisher periods. A higher dosage (approximate 0.5 g/kg) is needed to minimize litter ammonia production.
(**Key Words** : *Lactobacillus, Bacillus, Streptococcus*, Growth, Ammonia)

Introduction

Probiotic which includes viable microbials and microbial fermentation products, has been shown to decrease the undesirable microflora population in the gastrointestinal (GI) tract of chicks (Fuller, 1977; Watkins et al., 1982). Due to increasing concerns over drug residues in animal products and resistance build-up against antibiotics, the use of probiotics has received renewed emphasis. Results from trials conducted with broilers fed various probiotics were inconsistent. Some researchers reported positive responses in weight gain and feed conversion (Crawford, 1979; Merkley, 1985; Roth and KirchgeBner, 1986; Owings et al., 1990) while others reported no beneficial effects (Buenrostro and Kratzer, 1983; Watkins and Kratzer, 1983; Owings et al., 1990).

The harmfulness of ammonia (NH_3) to the health and performance of broilers is well established (Reece et al., 1980; Caveny et al., 1981; Attar and Brake, 1989). However, the effect of probiotic on broiler litter NH_3 level is not well documented. The objective of the present study was to investigate whether dietary supplementation of direct-fed microorganisms could improve the performance and reduce the litter NH_3 level in broilers.

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Materials and Methods

Seven hundred and twenty 1-d-old Arbor Acres broiler chicks were randomly assigned to six treatment groups. There were 30 (15 male and 15 female) chicks per replicate and four replicates per treatment group. All birds were fed a corn-soybean meal basal diet (table 1) supplemented with 1) 0, 0; 2) 0.25, 0.25; 3) 0.25, 0.5; 4) 0.5, 0.25; 5) 0.5, 0.5; or 6) 1, 0.5 g probiotic[2]/kg for 0 to 3 and 4 to 6 wk, respectively. Each gram of the probiotic contained the following colony-forming units (CFU) of microbials: *Lactobacillus acidophilus*, 1.5×10^8, *Bacillus subtilus*, 7.0×10^8; and *Streptococcus faecium*, 1.5×10^8. Birds were housed in floor pens bedded with new rice hull initially and the litter was top-dressed occasionally during the experiment. Feed (mash form) and water were offered for *ad libitum* consumption. Light was provided continuously. Weight gain, feed intake, and feed conversion (gain : feed) of the birds were determined at 3 and 6 wk of age. At the end of the experiment two males and two females with body weight closest to their sex mean replicate weights were killed by cervical dislocation for abdominal fat content determination.

Excreta samples were collected when birds were 3 and 6 wk of age. Two males and two females from each replicate were then randomly selected and housed in cages equipped with wire floors and excreta collection trays. The fresh excreta thus collected were homogenized by

TABLE 1. BASAL DIET COMPOSITION

Ingredients	Age 0-3 wk	Age 4-6 wk	Ingredients	Age 0-3 wk	Age 4-6 wk
	(g/kg)			(g/kg)	
Corn, yellow	442.1	555.9	DL-methionine	2.0	0.7
Soybean meal (44% CP)	434.1	344.6	Vitamin premix[2]	0.2	0.2
Soybean oil	85.0	65.7	Mineral premix[3]	1.0	1.0
Limestone	14.1	13.2	Choline chloride (60%)	1.0	1.0
Dicalcium phosphate	15.4	13.5	Calculated analyses		
Salt	4.0	4.0	Crude protein (%)	23.0	20.1
Coccidiostat[1]	0.1	0.1	ME (kcal/kg)	3,200	3,208
BHT	0.1	0.1	TSAA (%)	0.93	0.73

[1]Provided per kilogram of diet: salinomycin 10 mg.

[2]Provided per kilogram of diet: vitamin A, 10,000 IU; cholecalciferol, 2,000 ICU, vitamin E, 15 mg; Vitamin K_3, 4 mg; thiamine, 2 mg; riboflavin, 6 mg; pyridoxine, 4 mg; vitamin B_{12}, 0.02 mg; pantothenate, 12 mg; niacin, 40 mg; folate, 1 mg.

[3]Provided per kilogram of diet: K, 40 mg; Mn, 65 mg; Zn, 46 mg; Mg, 40 mg; Cu, 3 mg; I, 0.315 mg; se, 0.15 mg.

TABLE 2. EFFECT OF DIETARY PROBIOTIC SUPPLEMENTATION ON GROWTH PERFORMANCE AND ABDOMINAL FAT CONTENT OF BROILERS[1]

Group	1	2	3	4	5	6	Pooled SE
Week	Probiotic added (g/kg)						
0 to 3	0	0.25	0.25	0.5	0.5	1	
4 to 6	0	0.25	0.5	0.25	0.5	0.5	
	Weight gain (g)						
0 to 3	611	619	623	610	618	625	7.1
4 to 6[2]	1,379	1,452	1,443	1,413	1,465	1,432	16.5
0 to 6[2]	1,993	2,074	2,067	2,024	2,084	2,059	3.3
	Feed intake (g)						
0 to 3	953	935	912	931	926	931	16.2
4 to 6	2,853	2,813	2,809	2,786	2,836	2,816	40.0
0 to 6	3,786	3,730	3,726	3,709	3,743	3,707	41.8
	Gain:Feed (g:g)						
0 to 3[2]	0.642	0.665	0.686	0.654	0.668	0.672	0.011
4 to 6[3]	0.491	0.515	0.513	0.505	0.513	0.509	0.003
0 to 6[4]	0.533	0.555	0.535	0.544	0.554	0.556	0.008
	Abdominal fat (% BW)						
6	2.5	2.3	2.6	3.0	2.4	2.6	0.20

[1]All live performance values are the least squares means of four replicates each with 15 males and 15 females, the abdominal fat values are the least square means of four replicates each with 2 males and 2 females.

[2]Supplemented vs. unsupplemented groups: $p < 0.01$.

[3]Supplemented vs. unsupplemented groups: $p < 0.001$.

[4]Supplemented vs. unsupplemented groups: $p < 0.12$.

homogenizer[3] and moisture content measured (AOAC, 1984). Aliquots of excreta from each replicate were taken, adjusted to same moisture content and incubated at 37℃ for 36 h in a 300 mL Erlenmeyer flask and the NH_3 concentration in the flask was determined by a NH_3 detector[4] for four times within a 3-min interval and the average value was recorded.

Litter NH_3 was determined by placing a NH_3 detector in the center of each pen, covered by a closed transparent acrylic box (45 cm × 35 cm × 50 cm) at 3 and 6 wk of age. The NH_3 concentration were read five times within a 1-min interval and the average value was recorded.

Data were subjected to statistical analysis using the General Linear Models procedure of SAS (SAS Institute, 1988). Orthogonal contrasts were used to test for significant differences among treatment groups in various performance measurements.

Results and Discussion

Broilers fed probiotic-supplemented diets had greater weight gain (4 to 6 and 0 to 6 wk; $p < 0.01$) and feed conversion (gain: feed; 0 to 3 wk, $p < 0.01$; 4 to 6 wk, $p < 0.001$; 0 to 6 wk, $p < 0.12$) when compared with those fed the unsupplemented diet (table 2). No significant differences in feed intake and abdominal fat content among treatment groups were observed. The results indicate that 0.25 g of probiotic (ie., *L. acidophilus*, 3.75 × 10^9; *B. subtilus*, 1.75 × 10^{10}; and *S. faecium*, 3.75 × 10^9 CFU)/kg of diet is sufficient to support maximum broiler growth from 0 to 6 wk of age. The positive effect of probiotic on performance of broiler in this study is consistent with the findings of Crawford (1979), Merkley (1985), and Roth and KirchgeBner (1986), but is contradictory to the findings of Buenrostro and Kratzer (1983), and Watkins and Kratzer (1983).

Owings et al. (1990) reported that even same probiotic product had different effects (positive vs. no effect) to broiler growth performance in their study.

The reasons for these discrepancies were not known. Differences in microbial strains, product stability, dosage of probiotics used, or feed processing (e.g., pelleting) among these studies might be involved.

For excreta and litter NH_3 level, the treatment by age interaction was not significant. Therefore, data from 3 and 6 wk of age were combined and were presented in Table 3. The excreta and litter NH_3 levels were reduced ($p < 0.05$) by the probiotic supplementation, although a higher level of probiotic (0.5 g/kg) was needed to minimize litter NH_3 ($p < 0.01$) as compared with improving weight gain.

The reasons for the reduction of excreta (35.0%) and litter (12.9%) NH_3 levels by the probiotic supplementation are not known. This may be related to the fact that probiotic may improve dietary protein digestibility and thereby reduce excreta nitrogen content, and/or probiotic may reduce the uric acid cleaving microbials in excreta. Further studies on the effects of probiotic on the protein digestibility and on the gut microbial population are needed to elucidate these hypotheses.

TABLE 3. EFFECT OF DIETARY PROBIOTIC SUPPLEMENTATION ON EXCRETA AND LITTER NH_3 LEVEL OF BROILERS[1]

Group	1	2	3	4	5	6	
Week	Probiotic added (g/kg)						Pooled SE
0 to 3	0	0.25	0.25	0.5	0.5	1	
4 to 6	0	0.25	0.5	0.25	0.5	0.5	
	(mg NH_3/kg)						
Excreta[2]	35.8	24.7	24.8	22.0	20.2	24.6	4.6
Litter[2,3]	43.7	44.1	37.5	36.1	36.4	36.2	2.4

[1]Ammonia level values are least squares means of eight replicates each with 2 males and 2 females for excreta and 15 males and 15 females for litter.

[2]Supplemented vs. unsupplemented groups ($p < 0.05$).

[3]Groups 1 and 2 vs. 3, 4, 5 and 6 ($p < 0.01$).

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Literature Cited

Association of Official Analytical Chemists. 1984. Official Methods of Analysis. 14 ed. Association of Official Analysis Chemists. Arlington, VA.

Attar, A. J. and J. Brake, 1989. An economic analysis of the effects of ammonia and its control in broiler houses. Poultry Sci. 68 (Suppl. 1):167. (Abstr.)

Buenrostro, J. L. and F. H. Kratzer. 1983. Effects of *Lactobacillus* inoculation and antibiotic feeding of chickens on availability of dietary biotin. Poultry Sci. 62:2022-2029.

Caveny, D. D., C. L. Quarles and G. A. Greathous. 1981. Atmospheric ammonia and broiler cockerel performance. Poultry Sci. 60:513-516.

Crawford, J. S. 1979. "Probiotics" in animal nutrition. in: Proceedings, 1979 Arkansas Nutrition Conference, page: 45-55. University of Arkansas, Fayetteville, AR.

Fuller, R. 1977. The importance of *Lactobacilli* in maintaining normal microbial balance in the crop. Br. Poult. Sci. 18:85-94.

Merkley, J. W. 1985. Probiotic supplementation of broiler diets and RTC carcass yields. Poultry Sci. 64 (Suppl. 1):145. (Abstr.)

Owings, W. J., D. L. Reynolds, R. J. Hasiak and R. Ferket. 1990. Influence of dietary supplementation with *Streptococcus faecium* M-74 on broiler body weight, feed conversion, carcass characteristics, and intestinal microbial colonization. Poultry Sci. 69:1257-1264.

Reece, F. N., B. D. Lott and J. W. Deaton. 1980. Ammonia in the atmosphere during brooding affects performance of broiler chickens. Poultry Sci. 59:486-488.

Roth, F. X. and M. KirchgeBner. 1986. Nutritive effects of *Streptococcus faecium* strain M-74 in broilers chicks. Arch. Geflugelkd. 50:225-228.

SAS Institute. 1988. SAS User's Guide: Statistics. SAS Institute Inc., Cary, NC.

Watkins, B. A., B. F. Miller and D. H. Neil. 1982. *In vivo* inhibitory effects of *Lactobacillus acidophilus* against pathogenic *Escherichia coli* in gnotobiotic chicks. Poultry Sci. 61:1298-1308.

Watkins, B. A. and F. H. Kratzer. 1983. Effect of oral dosing of *Lactobacillus* Strains on gut colonization and liver biotin in broiler chicks. Poultry Sci. 62: 2088-2094.