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Effects of Cecal Cultures and Aspergillus Meal Prebiotic (Fermacto) on Growth Performance and Organ Weights of Broiler Chickens

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Abstract: Effects of matured caecal cultures (probiotic) of broiler breeders and Aspergillus meal prebiotic (Fermacto) on growth performance and organ weights of broiler chickens were studied from 1 to 42 days of age. 432 day-old Ross male broiler chickens were used in a 3×3 factorial arrangement with three levels of cecal cultures (0.0 , 5.0 and 10.0 mg L^{-1} in drinking water up to 7 days of age) and three levels of Aspergillus meal, Fermacto (0.0, 1.5 and 3.0 g kg^{-1}) in 4 replicates (12 chickens per replicate) per treatment. The parameters, including Feed Intake (FI), Body Weight Gain (BWG) and Feed Conversion Ratio (FCR) were measured weekly during trial and weight of organs were measured at the end of the experiment. A significantly higher ($p<0.01$) BWG was found in 1.5 g kg^{-1} Fermacto-fed broilers as compared to control broilers at 14-21 days of age. The BWG was also significantly higher ($p<0.01$) in Fermacto-fed broilers as compared to control treatment at 21-28, 28-35 and 35-42 days of age, overall growing (21-42 d) and rearing periods (0-42 d). FI was significantly ($p<0.01$) higher for 1.5 g kg^{-1} Fermacto-fed broilers than that of control broilers at 14-21 and 0-21 days of age. FI was significantly greater ($p<0.01$) in Fermacto-fed broilers than that of control at 21-28, 28-35 and 35-42 days of age, during growing (21-42 d) and experimental (0-42 d) periods. FCR was improved significantly ($p<0.05$) by 3 g kg^{-1} Fermacto as compared to control at fist week. FCR was decreased significantly ($p<0.05$) in Fermacto-fed broilers as compared to control broilers at 21-28, 21-42 and 0-42 day of age. Relative weight of breast and thigh to body weight were significantly ($p<0.01$) higher in Fermacto-fed broilers as compared to control group. Cecum was significantly ($p<0.01$) longer in 10 mg L^{-1} of cecal contents and 1.5 g kg^{-1} Fermacto-fed broilers than those of other treatments.

Key words: Prebiotic, fermacto, probiotic, cecal culture, broilers

Introduction

In view of the severe restriction or total ban on the use of antibiotics as growth promoters and therapeutic agents in poultry industry, probiotics and prebiotics have been suggested as alternatives to antibiotics. Probiotics have been defined as "live microbial feed additives which beneficially affect the host animal by improving its intestinal microbial balance" (Fuller, 1989). Prebiotics are known as "a nondigestible feed ingredient that beneficially affects the host by selectively stimulating the growth, or activity of a limited number of bacteria in the colon" (Gibson and Roberfroid, 1995). Several studies have shown that supplementation of probiotics and prebiotics in the diets of broilers leads to better performance (Aftahi *et al*., 2006; Kermanshahi and Rostami, 2006). Oral inoculation of cecal culture of healthy mature broilers increased body weight gain during the first 3 weeks of age and prevented salmonella infection in broilers (Yu *et al*., 1999). Fermacto is a feed supplement referred to Aspergillus mycelium meal and improves the digestive capacity of mono-gastric animals by providing nutrients and mycelial fiber for the proliferation of intestinal bacteria (Potter and Shelton, 1984). Several studies have shown that supplementation of Fermacto to poultry diets enhanced performance (Potter and Shelton, 1984; Grimes *et al*., 1997; Rodriguez *et al*., 2005). Using healthy cecal cultures from broiler breeders and Fermacto may enhance the new hatched chickens ability to establish balanced microorganisms in the digestive tract, and therefore improve the health and growth performance of broilers.

Materials and Methods

432, day-old commercial Ross male broiler chickens were randomly assigned to 9 treatments (12 chickens/pen with 4 pens/treatment). Three levels of a healthy matured cecal culture of broiler breeders(0.0, 5.0 and 10 mg L^{-1} in drinking water) up to 7 days of age and three levels of Aspergillus meal, Fermacto (0.0, 1.5 and 3.0 g kg^{-1} into the basal diets) were used for 42 days of the experiment. Cecal culture was prepared based on the procedure of Revolledo *et al.* (2003), solved at the rate of 0.0, 5.0 and 10.0 mg L^{-1} in drinking water. Corn-soybean meal based diets (Table 1) as mash form were formulated to meet the nutrient requirements of broilers (NRC, 1994). Feed and water were provided *ad. libitum*. The broilers were raised on floor pens (1×1m), and maintained on 24-h continuous light. Feed intake and body weight gain of chickens were recorded weekly, 4

Table 1: Composition of experimental diets

Age (day)	0-21 d			21-42 d		
Ingredients (%)						
Corn	57.55	57.55	57.55	66.34	66.34	66.34
Soybean meal	36.62	36.62	36.62	29.43	29.43	29.43
Wheat bran	0.30	0.15	0.00	0.30	0.15	0.00
Fermacto	0.00	0.15	0.30	0.00	0.15	0.30
Dicalcium phosphate	1.46	1.46	1.46	1.03	1.03	1.03
Limestone	1.15	1.15	1.15	1.27	1.27	1.27
Vit. and min. premix[1]	0.50	0.50	0.50	0.50	0.05	0.05
Salt	0.42	0.42	0.42	0.31	0.31	0.31
Veg. oil	1.86	1.86	1.86	0.78	0.78	0.78
DL-Methionine	0.14	0.14	0.14	0.04	0.04	0.04
Calculated analysis						
ME (Kcal kg^{-1})	2900.00	2900.00	2900.00	2950.00	2950.00	2950.00
CP (%)	20.84	20.84	20.84	18.40	18.40	18.40
Ca (%)	0.91	0.91	0.91	0.83	0.83	0.83
Av. P. (%)	0.41	0.41	0.14	0.32	0.32	0.32
Na (%)	0.18	0.18	0.18	0.14	0.14	0.14
Arg. (%)	1.38	1.38	1.38	0.18	1.18	1.18
Lys. (%)	1.14	1.14	1.14	0.97	0.97	0.97
Met.+Cys. (%)	0.82	0.82	0.82	0.66	0.66	0.66

[1]Supplied per kilogram of diet: vitamin A, 10000 IU; vitamin D_3, 9790 IU; vitamin E, 121 IU; B_{12}, 20 µg; riboflavin, 4.4 mg; calcium pantothenate, 40 mg; niacin, 22 mg; choline, 840 mg; biotin, 30 µg; thiamin, 4 mg; zinc sulfate, 60 mg; manganese oxide, 60 mg;

Table 2: Effects of experimental diets on body weight gain (g) of broiler chickens

Age (day)	0-7	7-14	14-21	21-28	28-35	35-42	21-0	42-21	42-0
Cecal cultures (mg L^{-1})									
0.0	77.0	146.0	263.0	304.0	307.0	363.0	488.0	975.0	1463.0
5.0	79.0	152.0	268.0	283.0	325.0	415.0	500.0	1024.0	1524.0
10.0	77.0	143.0	271.0	288.0	280.0	405.0	492.0	974.0	1466.0
±SEM	1.58	3.50	0.47	10.7	12.80	21.00	8.20	29.00	32.50
Fermacto (g kg^{-1})									
0.0	79.0	142.0	256.0^{b}	248.0^{b}	265.0^{b}	321.0^{b}	475.0^{b}	835.0^{b}	1310.0^{b}
1.5	79.0	149.0	281.0^{a}	310.0^{a}	310.0^{a}	419.0^{a}	510.0^{a}	1039.0^{a}	1550.0^{a}
3.0	79.0	150.0	265.0^{b}	317.0^{a}	337.0^{a}	444.0^{a}	495.0^{ab}	1098.0^{a}	1594.0^{a}
±SEM	1.58	3.50	4.70	10.70	12.80	21.00	8.20	29.00	32.50
p-values									
Cecal cultures	0.52	0.21	0.54	0.38	0.06	0.19	0.61	0.38	0.34
Fermacto	0.20	0.19	0.004	0.0002	0.001	0.0007	0.02	0.0001	0.0001
Cecal cultures×Fermacto	0.43	0.62	0.33	0.78	0.35	0.73	0.50	0.82	0.81

[a,b]Means in each column with different superscripts are significantly different ($p<0.05$)

hours after the removal of feed, and feed to gain ratio calculated as the unit of eaten feed per unit of body weight gain (g g^{-1}). At 42 days of age, 4 chickens (one chicken per replicate) from each treatment randomly selected, weighed and killed. Carcasses were opened and the liver, heart, pancreas, bursa of fabricius, gizzard and spleen were removed and weighted. Thigh and breast muscles were separated and weighted separately. The relative weight of organs, thigh and breast muscles to live body weights were calculated. Data were analyzed as a completely randomized design with a factorial arrangement using the General Linear Model (GLM) procedure of SAS (1999-2000), and when treatment means were significant ($p<0.05$), Duncan's multiple range test was used to compare means (Duncan, 1955).

Results and Discussion

Fermacto had a significant effect on body weight gain and feed to gain ratio ($p<0.05$) as shown in Table 2. Fermacto-fed broilers gained more weight during first and second weeks of age although this improvement was not significant. From 0-21 days of age, more significant gain was seen for 1.5 g kg^{-1} Fermacto-fed birds ($p<0.05$) as compared to control. The body weight gain showed a significant improvement from 14 days of age and later when birds fed 1.5 g kg^{-1} Fermacto ($p<0.05$). Using 3 g kg^{-1} Fermacto had no significant advantages on body weight gain when compared to 1.5 g kg^{-1} Fermacto. Rodriguez *et al.* (2005) supplemented Aspergillus meal (Fermacto) into the broiler diets containing normal or insufficient protein. They observed that Fermacto improved body weight gain in broilers fed low protein diets during the first 3 week of age. Potter (1972) reported that supplementation of 0.25% Fermacto to medium white male and female turkey diets from 1-56 days of age improved body weight gain, feed intake and feed efficiency in the absence of antibiotics. Waldroup *et al.* (1972) supplemented Fermacto in the

Table 3: Effects of experimental diets on feed intake (g) of broiler chickens

Age (day)	0-7	7-14	14-21	21-28	28-35	35-42	21-0	42-21	42-0
Cecal cultures (mg L^{-1})									
0.0	139.0	311.0	439.0	690.0	750.0	1078.0	890.0	2519.0	3409.0
5.0	143.0	328.0	449.0	673.0	804.0	1092.0	920.0	2570.0	3490.0
10.0	144.0	320.0	441.0	688.0	762.0	1065.0	906.0	2517.0	3424.0
±SEM	2.0	9.5	7.8	17.2	19.2	27.6	13.0	48.0	50.0
Fermacto (g kg^{-1})									
0.0	142.0	317.0	426.0^{b}	641.0^{b}	713.0^{a}	948.0	886.0^{b}	2303.0^{b}	3189.0^{b}
1.5	143.0	320.0	471.0^{a}	711.0^{a}	771.0^{b}	1130.0^{a}	935.0^{a}	2613.0^{a}	3548.0^{a}
3.0	141.0	322.0	432.0^{b}	699.0^{a}	832.0^{a}	1157.0^{a}	896.0^{b}	2690.0^{a}	3586.0^{a}
±SEM	2.0	9.5	7.8	17.2	19.2	27.6	13.0	48.0	50.0
p-values									
Cecal cultures	0.26	0.46	0.65	0.74	0.13	0.79	0.28	0.63	0.48
Fermacto	0.84	0.91	0.0006	0.018	0.0008	0.0001	0.03	0.0001	0.0001
Cecal cultures×Fermacto	0.30	0.71	0.37	0.98	0.95	0.21	0.49	0.74	0.73

^{a,b,c}Means in each column with different superscripts are significantly different ($p<0.05$)

Table 4: Effects of experimental diets on feed conversion ratio (g/g) of broiler chickens

Age (day)	0-7	7-14	14-21	21-28	28-35	35-42	21-0	42-21	42-0
Cecal cultures (mg L^{-1})									
0.0	1.805	2.130	1.669	2.270	2.443	2.970	1.824	2.584	2.330
5.0	1.810	2.158	1.675	2.378	2.474	2.631	1.840	2.510	2.290
10.0	1.870	2.238	1.627	2.389	2.721	2.630	1.841	2.584	2.336
±SEM	0.023	0.069	0.039	0.057	0.123	0.149	0.029	0.071	0.047
Fermacto (g kg^{-1})									
0.0	1.797^{a}	2.232	1.664	2.585^{a}	2.691	2.954	1.865	2.758^{a}	2.434^{a}
1.5	1.810^{ab}	2.148	1.676	2.294^{b}	2.487	2.697	1.833	2.515^{b}	2.289^{b}
3.0	1.785^{b}	2.147	1.630	2.205^{b}	2.469	2.606	1.810	2.450^{b}	2.250^{b}
±SEM	0.023	0.006	0.039	0.057	0.123	0.146	0.029	0.071	0.047
p-values									
Cecal cultures	0.08	0.36	0.74	0.16	0.11	0.09	0.87	0.51	0.63
Fermacto	0.015	0.57	0.60	0.0004	0.41	0.08	0.38	0.0107	0.02
Cecal cultures×Fermacto	0.11	0.66	0.28	0.45	0.51	0.48	0.21	0.47	0.69

^{a,b}Means in each column with different superscripts are significantly different ($p<0.05$)

rate of 0.075% to diets of turkey breeder hens beginning at 30 weeks of age for five 28-day periods and fed corn-soybean meal based diets with or without 5% fish meal. They observed that Fermacto significantly increased the number of eggs/turkey breeder hen when added to diet with fish meal ($p<0.05$). Yusrizal and Chen (2003) reported that supplementation of inulin and chicory fructans to broiler diets improved body weight gain and feed to gain ratio. Fermacto may provide nutrients and mycelial fiber, effectively stimulates the growth of beneficial microflora in the small and large intestine and the result would be better balance of bacterium population. These new bacteria population produce different digestive enzymes which add to existing broiler endogenous enzymes (Potter and Shelton, 1984). The observed improvement in performance of Fermacto-fed broilers may be due to the beneficial effects of Fermacto. The result of FI was similar to that of body weight gain (Table 3). A Significantly higher ($p<0.05$) feed intake was observed in 1.5 g kg^{-1} Fermacto as compared to 3 g kg^{-1} and control broilers from 14-21 days of age and later (21-28, 28-35, 35-42, 0-21, 21-42 and 0-42 d). FCR was significantly improved ($p<0.05$) when 1.5 or 3.0 g kg^{-1} Fermacto added into the broiler diets from 0-7, 21-28, 21-42 and 0-42 days of age when compared to control treatment (Table 4). Between two levels of 1.5 and 3.0 g kg^{-1} Fermacto at the above mentioned periods, the effect on FCR was not significant. Grimes *et al.* (1997) reported that feed conversion significantly improved by including 0.2% Fermacto into the normal and insufficient protein diets for both young and old laying hens. They suggested that Fermacto increased retention time of feed in the gastrointestinal tract and a non significant improvements in the ME and protein digestibility were observed. Harms and Miles (1988) evaluated the effect of adding Fermacto in the rate of 454 g/ton to basal diet containing 0.5% sulfur amino acids in laying hens. They reported that supplementation of Fermacto to basal diet improved egg production, egg mass, feed intake and feed efficiency, however, in the presence of various levels of added methionine (0.033-0.133%), the effect of Fermacto was not detected. Huang *et al.* (2005) observed that supplementation of chitosan oligosaccharides (150 mg kg^{-1} from 1-21, 100 and 150 mg kg^{-1} from 21-42 days of age) improved feed efficiency. Therefore they suggested this improvement might be due to better ileal digestibility of nutrients. The cecal cultures had no significantly effects on BWG, FI,

Table 5: Effects of experimental diets on relative breast and thigh to live body weight and cecum length

Cecum length (cm)	Thigh weight (%)	Breast weight (%)	Treat-ments
Cecal cultures (mg L^{-1})			
0.0	25.7	20.4	36.0[b]
5.0	24.8	20.1	37.0[b]
10.0	25.4	20.1	40.0[a]
±SEM	0.52	0.33	0.80
Fermacto (g kg^{-1})			
0.0	23.3[b]	19.4[b]	36.0[b]
1.5	26.2[a]	20.6[a]	39.0[a]
3.0	26.4[a]	20.7[a]	37.0[b]
±SEM	0.52	0.33	0.80
p-values			
Cecal cultures	0.48	0.76	0.002
Fermacto	0.0003	0.015	0.05
Cecal cultures×Fermacto	0.73	0.20	0.38

[a,b]Means in each column with different superscripts are significantly different ($p<0.05$)

and FCR (Table 2-4). Priyankarage *et al.* (2003) observed that addition of various levels of protexin (commercial probiotic) to broiler diets did not improved the performance. YU *et al.* (1999) observed that oral inoculation of cecal culture of healthy mature broilers improved body weight gain ($p<0.05$) during the first 3 weeks of age and suggested this may be due to alternation in cecal mucosa, high concentrations of VFAs and also lower pH. These changes may improve the intestinal microorganisms balance. Yeo and kim (1997) found that broilers fed diet containing 0.1% lactobacillus casei had significantly higher average daily gain at 1-21 day of age as compared to other treatments and suggested it might be due to improving animal health, and decreasing urease activity in small intestinal contents of broilers fed diet containing probiotic. Khaksefidi and Ghoorchi (2006) reported that the supplementation of Bacillus subtilis in the rate of 50 mg kg^{-1} diet improved body weight gain of broilers from 1-21 and 21-42 and feed to gain ratio from 21-42 days of age when compared with control birds. The effects of treatments on breast and thigh weights and cecal length are shown in Table 5. Macroscopic observation of the organs did not show any difference in their appearance. The relative weights of heart, liver, pancreas, bursa of fabricius, gizzard and spleen were not significant among treatments. The cecum length (cm) was significantly higher ($p<0.01$) in broilers fed 10 mg L^{-1} cecal culture than those of 5 mg L^{-1} cecal culture and control birds. The cecum length was significantly higher ($p<0.05$) for 1.5 g kg^{-1} Fermacto-treated broilers as compared to other treatments. It is shown that (Pelicia *et al.*, 2004) addition of prebiotic and probiotic into the diets of broilers have no effect on the digestive system (liver, proventriculus, gizzard, pancreas, duodenum, jejunum, ileum and cecum). Kalavathy *et al.* (2003) evaluated 12 Lactobacillus strains in broiler diets and reported no significant differences in the relative weights of liver, spleen, heart and pancreas among treatments at different ages (21, 28, 35, 42 d). The increase in cecum length in 10 mg L^{-1} cecal culture and also 1.5 g kg^{-1} Fermacto in broilers might be due to their effect on cecal fermentation by microflora as already seen by Kermanshahi and Rostami (2006). Relative breast and thigh weights to live body weights were significantly ($p<0.01$) higher for Fermacto-fed broilers as compared to control treatment. The cecal cultures had no effect on these parameters. Kabir *et al.* (2004) reported that supplementation of 2 g Protoxin per 10 liter of drinking water significantly improved breast and thigh yields of broilers as compared to control group. Conversely, Takahashi *et al.* (2005) reported no effect of adding prebitic and probiotic into the diets of broilers on carcass, breast, breast meat, thigh, back and wing yields among treated groups when compared to control birds.

Conclusion: Under the conditions of this study, it was concluded that supplementation of Fermacto in broiler diets at 1.5 g kg^{-1} of feed may increase performance and profitability of broilers. Addition of matured healthy cecal cultures of broiler breeders into the drinking water of broilers at early ages did not show any significant effect on performance. This result may show that the levels used in this study have been too low or the time of usage might be changed. More research is needed to clarify this.

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