Journal of Animal and Veterinary Advances 9 (18): 2390-2395, 2010
ISSN: 1680-5593

Effects of Different Levels of Probiotic and Prebiotic on Performance and Carcass Characteristics of Broiler Chickens

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Abstract: An experiment was conducted to evaluate the effects of different levels of probiotic and prebiotic on growth performance and carcass characteristics of broiler chickens. About 48 sexed male Ross 308 hybrid chickens were used. The birds were assigned six treatment groups in a randomized complete block design. Each treatment allocated to 5 replicates of 16 male broilers and reared for 42 days. The broiler chickens were grown on starter (0-21 days) and grower (22-42 days) diets calculated to meet NRC recommendations and supplemented with different levels of probiotic PRIMALAC (0, 900 g ton^{-1}) and prebiotic FERMACTO (0, 1000 and 2000 g ton^{-1}). Body weight and feed consumption were determined weekly during the study. Each dietary was fed *ad libitum* in the whole of experiment. The result of present study showed that the interaction effect between different levels of PRIMALAC and FERMACTO was significant. The highest value of body weight gain was recorded for broilers fed the diet supplemented with mixed of PRIMALAC (900 g ton^{-1}) and FERMACTO (2000 g ton^{-1}) ($p<0.05$). Lowest feed conversion ratio was belonging to prebiotic (2000 g ton^{-1}) group and caused more efficient feed intake. The highest significant ($p<0.05$) value of carcass and breast were recorded for broilers fed diet supplemented with mixing PRIMALAC and FERMACTO. The percent of carcass, thigh and abdominal fat were not affected by treatments. The results of present study revealed that supplemented diets with mixed of PRIMALAC and FERMACTO (symbiotic) as growth promoters appeared to be superior compare to use alone and improve broiler chickens growth indices.

Key words: Primalac, feramcto, performance, carcass traits, broiler, symbiotic

INTRODUCTION

Feed additive antibiotics have been used as growth promoters for >50 years in the feed industry all over the world. Antibiotics induce their effect by stabilizing the intestinal microbial flora thereby preventing proliferation of specific intestinal pathogens (Visek, 1978; Shane, 2005).

Today, the non-prescription use of antibiotics in poultry feeds has been eliminated or severely limited in many countries because of concerns related to development of antibiotic-resistant human pathogenic bacteria and legislative action to limit their use in probable in many others. Since the proposed total ban on sub-therapeutic feed antibiotics, products such as prebiotics, organic acids and probiotics are receiving considerable attention in animal nutrition because of their non-residual and non-resistant properties (Mellor, 2000; Gill, 2001; Hertrampf, 2001; Plail, 2006; Kocher, 2005). Probiotics are pure cultures of one or more live microorganisms that exhibit a beneficial effect on the health of the host when they are ingested. Improved epithelial cell integrity, increased immune response, well balanced gut microflora, better utilisation and digestion of diet are also additive beneficial effects of dietary probiotics (Jin *et al*., 1998; Wenk, 2000; Panda *et al*., 2001; Linge, 2005). Gibson and Roberfroid (1995) defined a prebiotic as a non-digestible food ingredient which beneficially affects the host by selectively stimulating the growth of and/or activating the metabolism of one or a limited number of health-promoting bacteria in the intestinal tract, thus improving the host's microbial balance. It has been shown that prebiotics stimulate the growth of endogenous microbial population groups such as bifidobacteria and lactobacilli is specifically stimulated and these bacteria species are perceived as beneficial to animal health.

Probiotics (Vanbelle *et al*., 1990; Jin *et al*., 1998) and prebiotics (Shane, 2005; Ferket, 2004) act as growth promoters feed savers, nutritional bio-regulators, immune stimulators and help in improving performance and health. The beneficial effects of the dietary supplementation of prebiotics (Hooge *et al*., 2003; Bozkurt *et al*., 2005) and probiotics (Jin *et al*., 1998; Abdulrahim *et al*., 1999; Alcicek *et al*., 2004) on broiler performance are well documented. A prebiotic preparation (MOS) has been shown to interfere with the use of antibiotics in diets of broilers (Waldroup *et al*., 2003) whereas no benefit has been found relating response of broiler live performance

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to dietary added MOS in the presence of a probiotic (Hofacre *et al*., 2003). On the other hand Hooge *et al*. (2003) reported that MOS alone supported live performance equivalent to antibiotic growth promoters but showed an additive effect when combined with antibiotics.

In simplest definition, symbiotic is a combination of probiotics and prebiotics (Collins and Gibson, 1999). This combination can improve the viability of probiotic microorganisms, since they are able to use prebiotics as a substra for fermentation (Bengmark and Bengmark, 2001) Therefore, the objective of the present study was to examine the performance and carcass characteristics of broiler chickens fed an experimental diet containing a prebiotic and a probiotic alone and also the prebiotic in combination with the probiotic to find the most effective synergistic combination of these products.

MATERIALS AND METHODS

In this study, 480 broiler chickens of the commercial Ross 308 strain in a randomized block design experiment arranged in a 2×3 factorial schedule (2 levels of prebiotic and 3 levels of probiotic) with 6 treatments (5 replicates in each treatment 16 birds/replicates) and reared on floor pens for 42 days. Before beginning this study, the dry matter, crude protein, ether extract, crude fiber and ash contents of main feed ingredients were determined (AOAC, 1984) in the laboratory to make sure of presence of sufficient amounts of protein and crude fiber content of the ration.

A basal diet was formulated and considered as control according to recommendation of NRC (1994) for starter (0-21 days) and grower (22-42 days) diets. The composition of the diets and the content of nutrients are shown in Table 1. Five tested diets were formulated by supplemented the basal control diet with FERMACTO (1000 and 2000 g ton^{-1}), PRIMALAC (900 g ton^{-1}), mixture of FERMACTO (1000 g ton^{-1}) + PRIMALAC (900 g ton^{-1}) and mixture of FERMACTO (2000 g ton^{-1}) + PRIMALAC (900 g ton^{-1}), respectively.

FERMACTO is a commercial prebiotic of the mannan-oligosaccharides family which is obtained by extraction from the outer cell wall of the yeast *Saccharomyces cerevisiae*. PRIMALAC is a kind of commercial probiotic, consisting of a combined preparation of live microorganisms including *Lactobacillus acidophilus*, *Lactobacillus casei*, *Enterococcus faecium* and *Bifidobacterim bifidum* (PRIMALAC® Star*labs). During the experiment, water and feed were given to the birds *ad libitum*. Air temperature and humidity were adjusted according to the ROSS technological procedure for broiler fattening. The ambient temperature in an experimental house was maintained at 32°C during the 1st week and gradually decreased by 3°C in the 2nd and 3rd week and exposed to natural environmental conditions thereafter. Chicks were vaccinated against Infectious Bursal Disease, New Castle Diseases HB1 and Lasota at days 14, 21 and 28, respectively, via the drinking water. During the 42 days experimental period, the growth performance of broiler chickens was evaluated by recording body weight, feed intake, feed conversion ratio. Weighing of the feed and chickens were made on a weekly basis. At the end of the experiment (at 42 day), 30 chickens birds of similar body weight to the group average were selected from each treatment group (1 chicken per replicate), weighted and killed by severing of the bronchial vein. After evisceration, hot carcasses were weighted immediately to determine the hot carcass yield. The weights of the Carcass, Breast, Thigh and abdominal fat were recorded individually. The weights of these selected internal parts were expressed as a percentage of preslaughter live weight of the broilers. Also, at the end of training period, feed intake, weight gain and feed conversion ratio were calculated.

Table 1: The ingredient and chemical composition of diets administered to broiler chickens

Ingredients	0-21 days	22-42 days
Corn	56.00	61.60
Soybean meal 44%	29.00	26.00
DCP	0.85	0.85
Corn gluten meal	3.50	0.00
Meat-born Meal	3.50	0.00
Fish meal	1.50	7.00
Sunflower oil	3.50	2.60
Limestone	0.50	0.60
DL-Methionine	0.35	0.05
Vitamin premix[1]	0.50	0.50
Mineral premix[2]	0.50	0.50
Salt	0.30	0.30
Calculated composition		
Cp	21.90	20.60
ME (kcal kg^{-1})	3,158	3,194
Lysine	1.18	0.99
Methionine and cystine	0.96	1.75
Calcium	0.90	0.89
Phosphorus	0.44	0.42

[1]The vitamin premix supplied the following per kilogram of complete feed: vitamin A, 4,500 IU (retinyl acetate); cholecalciferol, 1,000 IU; vitamin E, 25 IU (dl-α-tocopheryl acetate); vitamin B12, 0.02 mg; menadione, 1.5 mg; riboflavin, 3 mg; thiamine, 1.5 mg; pantothenic acid, 5 mg; niacin, 20 mg; choline, 150 mg; folic acid, 0.5 mg; biotin, 0.5 mg; pyridoxine, 2.5 mg. [2]The mineral premix supplied the following per kilogram of complete feed: manganese ($MnSO4•H_2O$), 60 g; zinc (ZnO), 40 mg; iron, ($FeSO4•7H_2O$), 80 mg; copper ($CuSO_4•5H_2O$), 8 mg; selenium (Na_2SeO_3), 0.2 mg; iodine (Iodized NaCl), 0.8 mg; cobalt ($CoCl_2$), 0.4 mg

Statistical analysis: All data were analyzed using the one-way ANOVA procedure of SAS (1998) for analysis of variance. Significant differences among treatments were identified at 5% level by Duncan (1955) multiple range tests.

RESULTS AND DISCUSSION

Supplemental effects of prebiotic, probiotic and Interaction effect between different levels of prebiotic and

Table 2: Body weight, feed intake and feed conversion ratio of broilers receiving diet supplemented with different levels of probiotic and prebiotic

	0-21 days			22-42 days			0-42 days		
Treatments	BW (g)	FI (g)	FC	BW (g)	FI (g)	FC	BW (g)	FI (g)	FC
Prebiotic									
P_0	566.29^{a}	1003.84^{a}	1.785^{a}	1635.58^{b}	3337.84^{a}	2.051^{a}	2194.86^{b}	4334.67^{a}	1.9790^{a}
P1	563.58^{a}	986.55^{a}	1.784^{a}	1635.29^{b}	3310.78^{a}	2.034^{a}	2191.87^{b}	4290.33^{a}	1.9640^{a}
P_2	597.19^{a}	1000.75^{a}	1.689^{a}	1728.88^{a}	3322.06^{a}	1.926^{a}	2319.07^{a}	4315.81^{a}	1.8650^{b}
SEM	11.36	21.57	0.039	27.44	41.48	0.048	30.86	50.3	0.0310
p-value	0.0933	0.833	0.159	0.0394	0.898	0.169	0.0046	0.733	0.0320
probiotic									
1	519.34^{b}	948.26^{b}	1.841^{b}	1614.54^{b}	3165.74^{b}	1.961^{a}	2126.87^{b}	4107^{b}	1.9350^{a}
2	632.04^{a}	1045.83^{a}	1.665^{a}	1718.63^{a}	3481.37^{a}	2.045^{a}	2343.67^{a}	4520.2^{a}	1.9360^{a}
SEM	9.26	17.58	0.032	22.35	33.81	0.039	32.89	52.19	0.0240
p-value	0.0001	0.001	0.001	0.004	0.0001	0.199	0.0001	0.0001	0.8533
Pro*pre									
1									
P_0	525.08^{b}	952.36^{b}	1.824^{ab}	1649.08^{bc}	3211.9^{b}	1.952^{ab}	2167.16^{dc}	4157.26^{b}	1.9210^{abc}
P1	495.98^{b}	954.41^{b}	1.944^{a}	1564.36^{d}	3161.75^{b}	2.027^{ab}	2053.34^{d}	4109.16^{b}	2.0060^{a}
P2	536.96^{b}	938.02^{b}	1.756^{bc}	1630.17^{bc}	3123.58^{b}	1.921^{b}	2160.13^{dc}	4054.6^{b}	1.8810^{bc}
2									
P_0	607.49^{a}	1055.32^{a}	1.747^{bc}	1523.07^{bc}	3463.78^{a}	2.15^{a}	2222.57^{bc}	4512.09^{a}	2.0370^{a}
P1	631.19^{a}	1018.68^{ab}	1.627^{c}	1706.22^{b}	3459.81^{a}	2.04^{ab}	2330.41^{b}	4471.5^{a}	1.9230^{abc}
P2	657.43^{a}	1063.49^{a}	1.623^{c}	1827.6^{a}	3520.53^{a}	1.931^{ab}	2478.02^{a}	4577.02^{a}	1.8500^{c}
SEM	16.02	30.42	0.1009	38.67	58.49	0.048	39.87	70.72	0.0450
p-value	0.262	0.6042	0.2016	0.024	0.4636	0.313	0.0062	0.3377	0.1029

probiotic on performance of broiler chickens are shown in Table 2. Symbiotic group (PRIMALAC+FERMACTO) showed higher feed intake in each period and all over of the trial. In the starter period, prebiotic (FERMACTO) had lower feed intake and there wasn't any significant difference between different levels of FERMACTO ($p>0.05$). Interaction effect between different levels of prebiotic and probiotic had no additive benefit at 0-21 days. The results of this experiment clearly showed that the supplemented diet with prebiotic and probiotic stimulated the growth of broilers during the grower and whole of experimental period. In all periods of the experiment, probiotic group showed higher feed consumption whereas different levels of FERMACTO hadn't significant difference ($p>0.05$). The results of current trial showed that the substitution of the control by probiotic (900 g ton^{-1}) resulted in significantly higher body weight gain at different periods of the experiment. The Probiotic (PRIMALAC), prebiotic (FERMACTO 2000 g ton^{-1}) and Symbiotic (PRIMALAC+FERMACTO) had best performance on weight gain of chicks.

In the grower period, the differences of weight gain for FERMACTO (2000 g ton^{-1}) group was significantly higher than compare to other levels of FERMACTO ($p<0.05$). In the birds under treatment of primal in the starter of experiment the feed conversion ratio improved significantly when compared to control group ($p<0.05$). The dietary supplemented with different levels of FERMACTO had no effect on weight gain and feed conversion ratio in the starter period of current study. During the entire experimental period, the dietary supplemented with FERMACTO (2000 g ton^{-1}) were increased the weight of birds to 128 and 125 g, respectively compared to control diet. The weight gain was increased for birds fed PRIMALAC by 10.2% compared to control diet. The interaction effect between different levels of PRIMALAC and FERMACTO was significant. The highest value of body weight gain was recorded for broilers fed the diet supplemented with mixture of PRIMALAC (900 g ton^{-1}) and FERMACTO (1000 and 2000 g ton^{-1}). Also, from 1-42 days, supplemented diet with FERMACTO had no effect on the feed consumption of the birds. In the birds under treatments of FERMACTO (2000 g ton^{-1}), the feed conversion ratio improved significantly when compared to control group ($p<0.05$).

Carcass composition: The effect of experimental treatments on the composition of the bird carcasses are shown in Table 3. The Slaughter weight of the birds under FERMACTO (2000 g ton^{-1}) treatment was significantly higher as compared with the other levels of FERMACTO ($p<0.05$). The Slaughter weight and Carcass weight of the birds obtaining a ration containing symbiotic (900 g ton^{-1} PRIMALAC+2000 g ton^{-1} FERMACTO) showed a higher mean as compared with the control treatment ($p<0.05$). Also in the birds under treatments of PRIMALAC (900 g ton^{-1}) the Slaughter weight, Carcass weight and

Table 3: The effect of treatment on slaughter weight, carcass yield and abdominal fat of male broilers receiving diet supplemented with different levels of probiotic and prebiotic

Treatments	Weight (g)	Carcass weight (g)	Carcass yield (%)	Breast (%)	Thigh (%)	Abdominal fat (%)
Prebiotic						
P0	2177^{b}	1594.5^{b}	73.140^{a}	27.320^{b}	31.25^{a}	2.940^{a}
P1	2232^{b}	1586.38^{b}	71.840^{a}	29.550^{a}	31.22^{a}	2.520^{a}
P2	2374.5^{a}	1763.25^{a}	74.230^{a}	29.690^{b}	30.82^{a}	2.500^{a}
SEM	26.31	31.2	1.520	0.600	0.84	0.160
p-value	0.0002	0.009	0.315	0.021	0.4995	0.254
Probiotic						
1	2177^{b}	1592.83^{b}	72.330^{a}	28.090^{b}	30.69^{a}	2.520^{a}
2	2345.33^{a}	1703.25^{a}	73.180^{a}	29.630^{a}	30.07^{a}	2.800^{a}
SEM	24.3	28.32	1.220	0.490	0.68	0.160
p-value	0.0001	0.006	0.648	0.042	0.151	0.247
Pro*pre						
1						
P0	2209.5^{dc}	1630.7^{bc}	73.520^{a}	26.900^{c}	31.7^{a}	2.500^{ba}
P1	2092.4^{d}	1510.7^{c}	72.120^{a}	28.900^{abc}	31^{a}	2.100^{b}
P2	2229.5^{c}	1637^{bc}	73.800^{a}	28.300^{abc}	31.3^{a}	2.800^{b}
2						
P0	2144.5^{dc}	1558.2^{bc}	72.400^{a}	27.700^{bc}	30.4^{a}	3.200^{a}
P1	2372^{b}	1662^{b}	70.180^{a}	30.100^{ab}	31.2^{a}	2.800^{ab}
P2	2519.5^{a}	1889.5^{a}	74.700^{a}	31.000^{a}	30.1^{a}	2.200^{b}
SEM	41.8	44.2	2.250	0.860	0.6	0.280
p-value	0.0002	0.0046	0.712	0.458	0.233	0.071

percent breast improved significantly when compared to control group ($p<0.05$). Supplemented diet with different levels of FERMACTO and PRIMALAC treatments had no effect on the efficiency of the thigh, carcass yield and percent abdominal fat of the birds. In general, the positive effect of experimental additives tested on performance is in agreement with the results reported by several researchers. Kermanshahi and Rostami (2006) and Nayebpor *et al.* (2007) reported that prebiotics and probiotics can improve the weight of birds. Moreover, adding probiotic and synbiotic to the ration has been effective in improving the feed conversion ratio (Zulkifli *et al.*, 2000; Cavit, 2004). In contrast, Ignacio (1995) reported that the use of prebiotics in the ration of broiler chickens reduces the feed conversion ratio. Yalcinkayal *et al.* (2008) reported that using the probiotic and prebiotic in broiler ration had no significant effects on body weight gain and feed ration after experiment period of 42 days. In agreement with the result of this study, there are numerous reports showing that the use of such additives has no effect on the feed consumption (Yalcinkayal *et al.*, 2008; Willis *et al.*, 2007).

Variance among reports of researchers could be related to differences in management and environmental conditions that be exist in various experiments. It's suggested that under benefit management and/or environmental conditions, the effect of such feed additives may be worthless. The results of current experiment indicate that broilers fed the FERMACTO plus PRIMALAC were more efficient at converting feed to body mass during the rearing period. To stimulate the growth of beneficial bacteria in the gut using a prebiotic and probiotic combination was more effective than the supplemented with prebiotic and probiotic alone. In general, improvements in feed efficiency were attributed to an encouraged growth of the beneficial micro flora in the GIT induced by dietary supplementation of prebiotric and probiotic. In addition to an antimicrobial activity, a significantly increased intestinal amylase enzyme activity was determined in a recent study when adding L. acidophulus and a mixture of Lactobacilli to the diets (Jin *et al.*, 1997). Furthermore, (Yeo and Kim, 1997) reported that the improvement in feed efficiency of birds receiving probiotic supplemented diets could be due to decreased urease activity in the GI tract of the broiler chicks. Present findings shown that consumption of PRIMALAC-FERMACTO mixture had a positive effect on the body weight gain. The reason may be ascribed to the synergism of PRIMALAC and FERMACTO. Following the concurrent action of prebiotics fermentation by lactic acid bacteria in the GI tract and production of some acids by this group of bacteria, the pH of the GI tract is further reduced (Fuller, 1989). Reduction in pH is effective in controlling the population of pathogenic bacteria. During the infections due to pathogenic bacteria, lymphocytes crowd up to kill them and after inflammation, the thickness of the muscular layer increases (Gunal *et al.*, 2006). It seems that in the study, due to the synergism between PRIMALAC and FERMACTO followed by absorption of nutrients by the GI system, the birds under symbiotic treatment had a better feed conversion ratio.

Use of PRIMALAC in diet improved body weight at slaughter. The growth-promoting effects of probiotics are dependent on the specific probiotics, the application level of probiotics, the age of birds as well as the delivery method (i.e., via water and/or feed). Kabir *et al.* (2004) have reported that adding 2 g probiotic per each liter of water consumed by broiler chickens would increase the efficiency in their thigh and breast as compared with the control treatment that confirm the positive effect of PRIMALAC on breast yield in this study. In the Ammerman *et al.* (1989) study adding 0.375% oligofructose to the birds ration on day 47, decreased the percent of abdominal fat. However, present findings on carcasse composition were in contrast to those of Plail (2006) and Willis *et al.* (2007). As pointed out before, these differences between reported results could be related to management and environmental conditions.

In this study, it seems that the use of mixture of PRIMALAC and FERMACTO by improving the uptake of nutrients and increase in nitrogen stability can improve the carcass quality. Also, by observing a reduction in the fat level of birds fed by prebiotic, it is suggested that this product can interfere in the accessibility to fat for formation of fat tissue in the birds. The effects of feed additives used in this study were associated with growth stimulation, enhanced nutrient digestion and absorption, though this enhancement was not converted to carcass yield. Similar observations were reported by Panda *et al.* (2001) and Alcicek *et al.* (2004) for probiotics and by Bozkurt *et al*., 2005; Waldroup *et al.*, 2003) for prebiotics. Dietary treatments had no significant effect on abdominal fat pad accumulation in the present study. Similar results were observed by researchers who studied supplementation of prebiotics (Waldroup *et al*., 2003; Bozkurt *et al.*, 2005) and probiotics (Denli *et al.*, 2003; Alcicek *et al*., 2004) to broiler diets.

The results of some studies shown that growth stimulating probiotic, increase the growth of broiler chickens by an increase in the uptake of nutrients (especially fatty acids and glucose), fixation of nitrogen and reduction in excretion of fat in the feces and microbial urea (Willis *et al*., 2007). The prebiotic reduces the number of bacteria, toxins and their secondary products in the GI tract (Gunal *et al*., 2006).

CONCLUSION

The results of present study showed that supplementation of broiler diets with a prebiotic and a probiotic significantly increased the body weight gain with slightly improved feed conversion ratios, compared with the unsupplemented control. Combining strategies of prebiotic with probiotic proved additive benefit in growth performance and feed conversion ratio than that of individual use of these additives. In this case, it was shown that a prebiotic preparation is an ideal match with a probiotic preparation to optimize digestion, thus to convert feed to body mass more effectively.

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