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Effect of probiotic and prebiotic as antibiotic growth promoter substitutions on productive and carcass traits of broiler chicks

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Abstract The application of in-feed antibiotic growth promoters in livestock diet threatens consumer health and has arisen into a controversial issue worldwide. Thus,this study was designed to investigate the impact of probiotic and prebiotic as growth promoter agents compared to antibiotic on performance and carcass traits of broiler chicks. A total of two hundred and forty,one-day-old male broilers (Ross 308) were randomly assigned to four treatments with four replicates of fifteen chicks based on a completely randomized design. The dietary treatments consisted of the basal diet as control, experimental groups receiving 3 mg/kg flavophospholipol, 15mg/kg Protoxin^{TM} and, 1 g/kg manna oligosaccharide as AGP, probiotic and prebiotic, respectively.Body weight, feed intake, and feed conversion ratio were recorded at 2 week intervalsto week 7of the experiment. At 42 d, two birds per replicate were slaughtered for determination of carcass yield and internal organ weights.Diet supplementationwith probiotic and prebiotic increased body weight of broilers at 28 and 42 d of age (P<0.05) compared to control birds. Broilers fed probiotic statistically consumed more feed over the entire experimental periods. Feed efficiency improved slightly in different periodsin supplemented groups compared to control birds. Carcass yield and relative organ weights were not influenced by dietary treatments, but inclusion of prebiotic and antibiotic in the diet significantly reduced the weight of abdominal fat pad of birds in comparison to control birds. The results obtained in this study indicated that dietary inclusion of probiotic and prebiotic supported a superior performance of chicksand can be applied as antibiotic growth promoter substitutions in broilers diet.

Keywords: Broiler; Performance; Antibiotic; Probiotic; Prebiotic

1. Introduction

Antibiotics at sub therapeutic doses have been widely used in animal feed as growth promoters to enhance animal growth performance and production. In the presence of low levels of antibiotics, resistant cells survive and grow producing an antibiotic resistant population in the final products. Therefore, the application of antibiotics as growth promoters (AGP) in the animal feed has been limited in the European Union since January 2006. As a result, new commercial feed additives of plant origin considered to be natural products that consumers would accept, have been proposed to livestock producers. Herbs, spices, various plant extracts, prebiotics, and probiotics have received increased attention as possible antibiotic growth promoter substitutions.

Use of prebiotics or fermentable sugars instead of antibiotics is going to be popular in birds in order toimprove the useful microbial population of GIT [8].Prebiotics have been defined by Gibson and Roberfroid[7] as indigestible food ingredients which stimulate the growth and/or activity of a selected number of bacteria in the GIT and improve the host's health. Prebiotics have been shown to alter gastrointestinal microflora, alter the immune system, prevent colonic cancer, reduce pathogen invasion including pathogens such as Salmonella *Entritidi*s and *E.coli*and reduce cholesterol and odor compounds

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[4].Also, prebiotics supplementation of broilers diet result in an increase of the pH of the GIT and useful bacteriapopulation such as*lactobacillus* and*bifidobacteria*, due to increasing production of volatile fatty acids [21].

Probiotics are microorganisms that are fed to animals to colonize the intestinal environment and promote a better flora balance [6]. Besides, these microorganisms are responsible for production of vitamins of the B complex and digestive enzymes, and for stimulation of intestinal mucosa immunity, increasing protection against toxins produced by pathogenic microorganisms.Nevertheless, contradictory results have been reported by other researchers [18, 10, 16]. The strain of selected microorganisms, the dosage, method of preparation, and condition of animals could be partially responsible for such discrepancies. The number of viable microorganisms in probiotics has been considered a critical factor affecting the efficacy of probiotics [14]. Consequently the current study was designed to compare the efficacy of probiotic and prebiotic as antibiotic growth promoter substitutions on productive and carcass traits of male broiler chicks reared to 42 d of age.

2. Materials and methods

Animals and experimental design: Two hundred and forty, day-old female broiler chicks (Ross 308) were purchased from a local hatchery. On arrival, birds were weighed and randomly assigned to one of four treatments with four replicates of 15 birds based on a completely randomized design. The dietary treatments consisted of the basal diet as control, 3 mg/kgflavophospholipol as AGP,1 g/kg A-Max® (Mannan-oligosaccharides) as prebiotic and15 mg/kg Protoxin™ as probiotic added to the basal diet in inclusion of corn. The basal diet was formulated (UFFDA) to meet or exceed the nutrient requirements of broilers provided by Ross Broiler catalogue (2007). Chicks were raised on floor pens (120×120×80 cm) for 6 weeks and had free access to food and water throughout the experimental period (1-42d). The lighting program consisted of a period of 23 hours light and 1 hour of darkness throughout the experimental period.The ambient temperature was initially set at 33°C and gradually decreased by 3°C per week to 24°C on the third week and was then kept constant.

Performance: Chicks were individually weighed upon arrival and after the initiation of the experiment body weight was recorded on a pen basis at 14, 28, and 42 days of age after a 12-hour feed withdrawal. Feed intake was measured in groups in similar periods, individual feed consumption was calculated with regard to bird mortality during the experiment, and consequently, feed conversion ratio (feed intake / weight gain) was calculated.

Carcass components: At 42 days of age, two birds per replicate were randomly chosen slaughtered and abdominal fat, liver, pancreas, gizzard, heart, proventriculus small intestine, and cecum were collected, weighed and calculated as a percentage of live body weight and also carefully examined to detect any pathological lesion or damages. The length of small intestine andcecumwere also measured and recorded.

Statistical analysis: Performance data (derived from pen means) were subjected to analysis of variance procedures appropriate for a completely randomized design using the General Linear Model procedure of SAS Institute. Data analysis for the carcass traits were performed using Mixed Model procedure of SAS followed by considering birds within experimental unit as repeated measures. Tukey–Kramer method was used to assess any significant differences at the probability level of $P \leq 0.05$ among the experimental treatments.

3. Results and discussion

The performance indices of control and supplemented chicks are summarized in Table 1. Diet supplementation with probiotic and prebiotic statistically increased chicks body weight at 28 and 42 days of age relative to the control chicks ($P<0.05$) and similar to antibiotic group. Chicks in probiotic group significantly exhibited a higher feed intake over 14-28 d and entire period compared to control chicks ($P<0.05$). Feed efficiency of birds receiving the supplemented diets improved over different periods in comparison to control birds. Mortality rate was not influenced by experimental treatments over any phases.

The various benefits of feeding antibiotic growth promoters have been reviewed widely [9, 1, 5] and will not be repeated herein but in brief antibiotics may control and limit the growth and colonization of a variety of pathogenic and nonpathogenic species of bacteria in chicks gut [5]. A more balanced biota population in gut could lead to a greater efficiency in digestibility and utilization of food, resulting in an enhanced growth and improved FCR [2]. The significant benefits of antibiotic supplementation observed on chick growth and food conversion in the present study, were similar to those reported widely in the reviews just mentioned and consistent across all ages.

Probiotics on one hand suppresses the growth of pathogenic microorganisms in the intestine and incidence of diarrhea, on the other hand have the potential to increase the bioavailability of dietary minerals resulting in an improved growth rate and feed efficiency. In addition, it has been demonstrated that probiotics inhibit the in vitro growth of many enteric pathogens [3]. In accord to our results, Pandaet al. [14]reported that application of probiotics in broilers diet increased final body weight gain and improved FCR at week 6 of age.

Prebiotic group marginally consumed more feed compared with control group, throughout the experimental period. The improvement in feed intake by dietary prebiotic supplementation has been reported to account for the improved growth performance of broiler chicks. However, the principle effects of prebiotics have been reviewed by Cummings and Macfarlane [4] and include improvement of calcium and magnesium absorption, production of short-chain fatty acids, and selective increases in the population of lactate producing bacteria like *Lactobacillus* and *Bifidobacterium.* It has been shown that increased lactate concentration often decreases intestine pH and is a potent anti-microbial substance to several pathogenic species such as *E.coli*[15]. Thus, prebiotic helps to balance the intestinal microflora of poultry, consequently an improved utilization of diet nutrients (protein and energy) and higher feed intake leading to better performance criteria. In accord to our findings, several studies have shown that addition of prebiotics to the diet of broilers, leads to improved performance through improving gut microflora and feed utilization [17, 20]. However, Midilliet al.[11] failed to observe any improvement on productive traits of broilers fed prebiotic supplemented diets.

Table1. Effect of experimental diets on performance of broilers at different ages.

Performance Parameters	Dietary treatments					
	Control	Prebiotic	Antibiotic	Probiotic	SEM	P-value
Body Weight (g)						
14 d	275.85	282.28	306.68	299.93	10.25	0.63
28 d	946.88^{b}	985.75^{ab}	1043.75^{a}	1019.65^{a}	29.09	0.05
42 d	1956.45^{b}	2110.18^{a}	2091.03^{a}	2138.30^{a}	36.09	0.04
Daily fee intake (g/d)						
1-14 d	28.95	28.95	30.55	31.52	0.99	0.36
14-28 d	73.90^{b}	85.55^{a}	74.90^{b}	76.82^{b}	1.76	0.05
28-42 d	171.18	180.72	173.98	181.18	5.05	0.55
1-42 d	90.88^{b}	94.55^{a}	93.08^{ab}	95.58^{a}	1.21	0.03
FCR (g:g)						
1-14 d	1.78^{a}	1.73^{ab}	1.66^{b}	1.75^{ab}	0.0111	0.05
14-28 d	1.43^{ab}	1.58^{a}	1.32^{b}	1.39^{b}	0.0120	0.05
28-42 d	2.37^{a}	2.24^{b}	2.32^{ab}	2.27^{b}	0.0309	0.03
1-42 d	1.95^{a}	1.88^{b}	1.86^{b}	1.88^{b}	0.0060	0.04

a–b values in rows with no common superscripts differ significantly ($P \leq 0.05$)

As Table 2 indicates broilers fed diets supplemented with prebiotic and antibiotic significantly had a lower percentage of abdominal fat in comparison with control birds ($P<0.05$). Other carcass traits evaluated including liver, pancreas, gizzard, heart, small intestine and cecum weights, small intestine, and cecum lengths were not markedly affected by dietary treatments.

Fat deposition in the abdominal area of broilers is regarded as waste in the poultry industry; since it represents a loss in the market and consumer acceptability, and enhances expense during the treatment of effluent produced when processing broilers. The obtained results of this study indicate that prebiotic supplementation of broilers diet has the potential to lessen this type of waste by reduction of the fat content

in the abdominal area of birds. In accord to our results, Mohamed et al.[12] reported that the highest abdominal fat percentage value was recorded for birds fed the control diet (2.21%) while the lowest value was recorded for birds fed the MOS supplemented diet (1.78%). Similarly, they did not notice any significant impact of supplements on dressing percentage, liver, heart, and gizzard relative weight.

No clear mechanisms have been reported responsible for the reduction of lipid synthesis by prebiotics and herb oligosaccharides. It might in part be due to increasing beneficial bacteria such as *Lactobacillus* that decrease the activity of acetyl-CoA carboxylase, which is the rate-limiting enzyme in fatty acids synthesis. The results reported by Zhou et al.[22] also agree with our findings, these scientists reported that application of chitooligosaccharide in diet reduced abdominal fat pad of broiler chicks. In addition, it has been reported that diet supplementation with mushroom extract plus probiotic result in a marked reduction of fad pad in male and female broilers slaughtered at 49 d [19]. However, Midilli et al. [11] did not observe any significant impact of prebiotic and Mannan-oligosaccharides on carcass traits and internal organ relative weight in broiler chicks.

Table2. Effect of experimental diets on carcass yield, abdominal fat and internal organ weight of broilers at d 42.

Carcass traits	Dietary treatments					
	Control	Prebiotic	Antibiotic	Probiotic	SEM	P-value
Carcass yield*	73.8	73.6	73.5	74.8	0.69	0.67
Abdominal fat*	1.76^{a}	1.22^{b}	1.25^{b}	1.36^{ab}	0.18	0.05
Liver*	2.17	2.22	2.33	2.15	0.14	0.34
Gizzard*	2.05	2.48	2.08	2.13	0.16	0.58
Heart*	0.591	0.572	0.588	0.580	0.048	0.63
Pancreas*	0.228	0.273	0.244	0.238	0.41	0.24
Intestine*	3.22	3.30	3.34	3.23	0.18	0.65
Cecum*	0.618	0.561	0.685	0.614	0.07	0.47
Intestine length**	173.5	174.8	177.6	173.3	7.14	0.58
Cecum length**	38.3	38.4	38	39.1	1.85	0.46

a–b values in rows with no common superscripts differ significantly ($P \leq 0.05$)
*Percentage of live body weight
** cm

4. Conclusion

The obtained results of the current study suggest that probiotics and prebiotics exerted beneficial on performance parameters of broiler chicks even in some periods superior to antibiotic. In addition, prebiotic supplement could reduce abdominal fat pad at 42 d of age. Therefore, it could be concluded that the foregoing additives have the potential to be applied as effective substitutes for in-feed antibiotics.

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