



Effects of the Dietary Inclusion of a Probiotic, a Prebiotic or their Combinations on the Growth Performance of Broiler Chickens

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ABSTRACT

A total of 350-one-day old chicks were placed in 70 cages, with 14 cages per treatment. The following five treatment diets were fed for 14 days: T1 = non-supplemented, control diet (CONT); T2 = diet with antimicrobial growth promoter (AGP); T3 = diet with a probiotic (PROB); T4 = diet with a prebiotic (PREB), and T5 = diet with the probiotic and the prebiotic (SYM). The growth experiment was carried out from 1 to 14 days of age. Feed and water were provided *ad libitum* and birds were maintained at 24-h light schedule. Diets were formulated to contain 3000 kcalME/kg and 21.5% crude protein, and the test materials were added on top. The cumulative results of 1 to 14 days of age revealed that broiler fed the AGP and PREB diets presented the highest BWG (305.5 and 297.3 g, respectively), while those fed the CONT diet had the lowest BWG (273.2 g) ($p < 0.05$). On the other hand, the best FCR was obtained in broilers AGP and PROB (1.296 and 1.299 g:g, respectively), while chicks on the CONT and SYM diet had the worst FCR (1.423 and 1.372 g:g, respectively) ($p < 0.01$). The results showed broilers fed the non-supplemented diet consistently presented poor performance. It was concluded that PROB or PREB can serve as alternatives to antibiotic in broiler starter feeds, with no performance impairment.

INTRODUCTION

Antimicrobial growth promoters (AGPs) have been used at subtherapeutic doses in poultry diets to prevent diseases and to promote growth performance. The positive effects of AGPs on performance are well documented (Vissek, 1978). AGPs improve broiler growth performance and reduce the populations of potentially-pathogenic organisms such as *Clostridium perfringens*, *Salmonella* and *E. coli* (Hume *et al.*, 2011). However, the risk of developing cross-resistance and multiple antibiotic resistance in human pathogenic bacteria, which could result in proliferation of antibiotics-insensitive bacteria, has led to the ban or severe limitations of the use of AGPs in many countries. The objective of this study was to test a variety of safer products which could be used alternatives to AGPs in broiler diets during the starter period.

Many feed additives are presently used in the animal industry, such as probiotics, prebiotics, and symbiotics. Probiotics are live organisms which have been studied for their antimicrobial and growth promoter abilities (Teo & Tan, 2006; Hume, 2011). Probiotics have been reported to prevent gut colonization by pathogenic bacteria, such as *Clostridium perfringens* and *Salmonella* spp., by the mechanism of competitive exclusion (Teo & Tan, 2006; Abudabos *et al.*, 2013). Prebiotics are a possible alternatives to AGPs in poultry diets. Prebiotics typically refers to



oligosaccharides that are not digested by the animal's enzymes, but can selectively stimulate the replication of selected intestinal bacterial species, which have potential beneficial effects on the host's health. Prebiotics present more advantages compared with probiotics: while probiotics supply microbes beneficial to the gut, prebiotics are thought to selectively stimulate the beneficial microbes that already live in the gut (Yang *et al.*, 2009).

Another possible alternative to AGPs are symbiotics. Symbiotics are combinations of probiotics and prebiotics, as well as other growth-promoting substances. Symbiotics have shown to have positive effects on gut health, diet digestibility, and live performance of broilers (Patterson and Burkholder, 2003).

The objective of the current study was to examine the effects of prebiotics, probiotics, and symbiotics on the growth performance of broilers during the starter period (1 to 14 days of age) in comparison with a standard AGP.

MATERIALS AND METHODS

Growth Experiment and treatments

The prebiotic, probiotic, symbiotic and antibiotic products were obtained commercially. Neoxyval (Sogeval Laboratory, France) was used as the reference AGP; each g contains 200 mg oxy-tetracycline and 200 mg neomycin. GalliPro is a probiotic (microbial feed additive) supplied by Biochem (Zusatzstoffe Handels- und Produktionsgesellschaft mbH | Küstermeyerstraße 16 | 49393 Lohne, Germany). GalliPro® is a probiotic based on a naturally-occurring, superior, high-activity strain of *Bacillus subtilis* (DSM 17299) at a minimum concentration of 1.6×10^9 viable spores/g. TechnoMos is a prebiotic product supplied by Biochem (Zusatzstoffe Handels- und Produktionsgesellschaft mbH | Küstermeyerstraße 16 | 49393 Lohne, Germany). It is derived from the cell wall of the baker's yeast *Saccharomyces cerevisiae*, rich in mannanoligosaccharides (MOS) and beta-1,3-glucans.

The experiment was conducted at the environmentally controlled battery room at King Saud University.

A total of 350 one-day-old Ross 308 broiler chicks were obtained from a commercial hatchery and were grouped by weight. Birds were then allotted to 70 experimental cages with five chicks per cage in a four-deck cage system, equipped with electrically heated battery brooders with raised wire floors. The dimension

for each cage was 50 cm length, 60 cm width and 36 cm depth. The environmental temperature was kept at 22°C until the end of the experiment. At the hatchery, the chicks were vaccinated against Infectious Bronchitis, Marek's disease and Newcastle disease. Vitamins were supplemented in the drinking water for the first three days. The growth experiment was carried out from 1 to 14 days of age. Feed and water were provided *ad libitum* and birds were maintained at 24 h light schedule.

Chicks were given the experimental diets from 1 to 14 days of age. Corn-soybean meal based diets were formulated to contain 3000 kcalME/kg and 21.5% crude protein, respectively. The test materials were added on the top (Table 1).

Table 1 – Ingredient and analyzed nutrient content of the control starter diet

Ingredients	%
Yellow corn	62.45
Soybean meal	31.0
Palm oil	2.19
Di-calcium phosphate	2.50
Ground limestone	0.73
Choline chloride	0.05
DL-methionine	0.26
L- lysine	0.18
Salt	0.25
Threonine	0.07
V-M premix ¹	0.20
Total	100
<i>Chemical Analysis</i>	
ME, kcal/kg	3000
Crude protein, %	21.5
Non phytate P, %	0.50
Calcium, %	1.00
Lysine, %	1.20
Methionine, %	0.55
SAA, %	0.90
Threonine, %	0.85

¹Vitamin-mineral premix contains the following per kg: vitamin A, 2400000 IU; vitamin D, 1000000 IU; vitamin E, 16000 IU; vitamin K, 800 mg; vitamin B1, 600 mg; vitamin B₂, 1600 mg; vitamin B₆, 1000 mg; vitamin B₁₂, 6 mg; niacin, 8000 mg; folic acid, 400 mg; pantothenic acid, 3000 mg; biotin 40 mg; antioxidant, 3000 mg; cobalt, 80 mg; copper, 2000 mg; iodine, 400; iron, 1200 mg; manganese, 18000 mg; selenium, 60 mg, and zinc, 14000 mg.

Chicks received one of the five dietary treatments as follows:

- 1) Control (CONT).
- 2) Control + 0.05 g antibiotic/kg (AGP).
- 3) Control + 0.2 g probiotic/kg (PROB).
- 4) Control + 0.75 (starter) and 0.6 (finisher) g prebiotic/kg (PREB).
- 5) Control + (0.2 g probiotic/kg + 0.6 g prebiotic/kg) (SYM).



Measurements

Feed intake and body weight were recorded weekly by pen, and feed conversion ratio (FCR) was calculated. Mortality was checked daily and weights of dead birds were used to adjust FCR.

Statistical analysis

Data were submitted to analysis of variance (ANOVA) for a complete randomized block design using the general linear models procedure of SAS software (SAS, 2003). When the ANOVA shows significant differences, Fisher's protected test was applied to compare the means. The overall level for statistical significance was set at $p < 0.05$. All values were expressed as mean \pm standard error of the mean (SEM).

RESULTS AND DISCUSSION

Body weight gain (BWG), feed intake (FI) and feed conversion ratio corrected for mortality (FCR) are presented in Table 2.

During week 1, no significant differences in FI were detected ($p > 0.05$). This could be explained by the small quantity of feed consumed during the first week.

However, BWG was affected by the treatments ($p < 0.01$). Broilers fed the CONT, AGP, and PREB diets gained more weight compared with those fed the SYM diet (94.6, 93.3, 89.3 and 87.3 g gain, respectively). Birds fed the PROB diet presented intermediate weight gain (89.3 g). On the other hand, those fed the CONT, AGP, PROB, and PREB diets converted feed more efficiently (1.281, 1.254, 1.245, and 1.287 g:g,

respectively) compared with those receiving the SYM (1.417g:g) diet ($p < 0.05$).

During week 2, all broilers consumed similar amounts of feed ($p > 0.05$), but their BWG and FCR were influenced by treatment (both at $p < 0.01$). The broilers fed the supplemented diets (treatments 2 to 5) gained more weight than the CONT birds ($p < 0.01$). On the other hand, the birds on the supplemented diets (treatments 2 to 5) converted feed more efficiently compared with those fed the CONT diet ($p < 0.01$). Numerically, chicks which received AGP had the best FCR (1.315 g:g), but it was not statistically different from other supplemented groups (1.315, 1.324, and 1.353 g:g, for PROB, PREB and SYM, respectively).

When data were analyzed for the entire experimental period (weeks 1 and 2), the results revealed that FI was not affected by any dietary treatments ($p > 0.05$), while BWG and FCR were influenced by the dietary treatments ($p < 0.05$ and $p < 0.01$, respectively). Chicks fed the AGP and PREB diets presented had the highest BWG (305.5 and 297.3 g, respectively); however, the obtained values were not different from those obtained with the PROB and SYM diets (288.9 and 287.9 g, respectively). The broilers that received the CONT diet had the lowest BWG during the two-week period (273.2 g).

The best FCR values during the cumulative period were obtained by the birds fed the AGP and PROB diets (1.296 and 1.299 g:g, respectively), which, however, were not statistically different from that presented by PREB birds (1.335 g:g). The birds in the CONT group (non-supplemented diet presented the worst FCR (1.423 g:g) followed by SYM (1.372 g:g).

Table 2 – Feed intake, body weight gain, and feed conversion ratio of broiler chickens during the trial

	CONT	AGP	PROB	PREB	SYM	SEM	p
Week 1							
FI (g)	120.5	117.0	111.0	118.7	123.5	± 3.62	NS
BWG (g)	94.6 ^a	93.3 ^{ab}	89.3 ^{bc}	92.3 ^{ab}	87.3 ^c	± 1.60	0.008
FCR(g:g)	1.281 ^b	1.254 ^b	1.245 ^b	1.287 ^b	1.417 ^a	± 0.039	0.015
Week 2							
FI (g)	264.5	278.4	263.7	277.0	270.9	± 5.67	NS
BWG (g)	178.7 ^b	212.2 ^a	200.0 ^a	204.9 ^a	200.7 ^a	± 5.67	0.005
FCR (g:g)	1.511 ^a	1.315 ^b	1.324 ^b	1.358 ^b	1.353 ^b	± 0.043	0.001
Cumulative							
FI (g)	385.1	395.4	374.8	395.7	394.4	± 7.36	NS
BWG (g)	273.2 ^b	305.5 ^a	288.9 ^{ab}	297.3 ^a	287.9 ^{ab}	± 6.62	0.019
FCR(g:g)	1.423 ^a	1.296 ^c	1.299 ^c	1.335 ^{bc}	1.372 ^{ab}	± 0.025	0.003

^{abc} means in the same row with different superscripts differ significantly.



The results of the current study obtained with the evaluated probiotic agree with previous reports. Lund *et al.* (2005) conducted a series of feeding trials at different locations in EU and concluded that *B. subtilis* improved the body weight of broilers from 1% to 7%. Similarly, Mountzouris *et al.* (2007) reported that the overall FCR of probiotic-fed broilers was not different from those fed an antibiotic. Both Rostagno *et al.* (2006) and Mokhtari *et al.* (2010) compared the efficacy of the same *B. subtilis*-based probiotic evaluated in the present experiment with the antibiotic avilamycin, and concluded that the broilers fed the probiotic presented similar performance than those fed the antibiotic.

Several mechanisms have been proposed to explain the positive effect of probiotics on growth performance. Probiotics have been reported to prevent gut colonization by pathogenic bacteria, such as *C. perfringens*, *Escherichia coli*, *Campylobacter* spp. and *Salmonella* spp. through the mechanism of competitive exclusion (Stern *et al.*, 2001; Teo & Tan, 2005; 2006; Cartman *et al.*, 2008; Abudabos *et al.*, 2013). Yurong *et al.* (2005), and Teo & Tan (2006, 2007) showed that *B. subtilis* is capable of producing an antimicrobial factor against many bacteria, including *C. perfringens*, the causative agent of necrotic enteritis in broilers, by the immune modulation activity of the *B. subtilis*. Wilson *et al.* (2005) proposed that the growth-suppressing effect of pathogenic bacteria was due to the production of toxic metabolites that irritate the gut mucosa, thereby inhibiting nutrient absorption. In the current study, the probiotic group (PROB) presented similar performance as the antibiotic group, suggesting that the evaluated probiotic product may replace in-feed antibiotics without any negative effect on broiler performance from 1 to 14 days of age.

The prebiotic product (PREB) used in the current study also improved broiler performance to a similar level as that obtained with the antibiotic (AGP). Hooge (2003) analyzed data from 24 trials on the effects of a prebiotic (mannanoligosaccharide) on broiler performance and reported that FCR improved by 2.27% as a result of prebiotic supplementation.

Whereas probiotics are meant to bring beneficial microbes into the gut, prebiotics hypothetically act by selectively stimulating the beneficial microbes that are already present in the gut. Prebiotics serve as fuels for the endogenous microflora, thus providing the host with energy, metabolic substrates, and essential micronutrients (Gibson and Roberfroid, 1995; Yang *et al.*, 2009). Prebiotic supplementation was shown to improve broiler growth and FCR (Podmaniczky *et al.*, 2006; Zakeri and Mahdavi, 2006; Rozen, 2007). Several

mechanisms are proposed to explain the positive effects of prebiotics on broiler performance and health. Such mechanisms include reducing disease incidence by inhibiting gut lining colonization by pathogenic bacteria, preventing them from proliferating and producing toxins (Valancony *et al.*, 2001; Benites *et al.*, 2008), reduction of intestinal pathogen counts (Benites *et al.*, 2008), enhancement of the immune system (Ferket, 2002), and improvement of the morpho-functional characteristics of the gut (Ferket, 2002; Podmaniczky *et al.*, 2006).

Symbiotics are a combination of probiotics and prebiotics (Collins and Gibson, 1999). Generally, prebiotics provide substrate for fermentation and this improves the survival of the probiotic organism. In the current study, the combination of the probiotic and the prebiotic products impaired broiler as compared to feeding the additives individually. Li *et al.* (2008) showed that combinations of prebiotics and probiotics (symbiotics) are often more effective when compared with the individual additives. Similarly, Awad *et al.* (2009) reported beneficial effects of a symbiotic over a probiotic on broiler performance. However, this was not the case in the current study.

CONCLUSIONS

The evaluated antibiotic growth promoter (neoxyval), probiotic (GalliPro), and prebiotic (TechnoMos) products improved broiler performance when compared with the control diet and with the symbiotic. Broilers fed the probiotic and the prebiotic products, individually, presented similar performance as those fed the antibiotic. The results of the present experiment show that both the evaluated probiotic and prebiotic products can serve as alternatives to the AGP in broiler feeds during the first two weeks of rearing without any adverse effects on their performance.

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