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Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorijps@gmail.com

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Research Article

Using Different Feed Additives as Alternative to Antibiotic Growth Promoter to Improve Growth Performance and Carcass Traits of Broilers

H.M.A. Hassan, A. Samy, Amani W. Youssef and M.A. Mohamed

Department of Animal Production, National Research Centre, 12622 Dokki, Giza, Egypt

Abstract

Background and Objective: Several feed additives have been used to improve feed efficiency and growth performance of broiler. This growth experiment aimed to study the effect of using different feed additives compared to Bacitracin Methylene Disalicylate antibiotic growth promoter on growth performance and carcass traits. **Methodology:** Three hundred broiler chicks were divided into six treatment groups (5 replicates, 10 birds each treatment). A basal corn-soybean meal diet was formulated. Treatment 1 was basal diet without additives (as a control group); treatments 2, 3, 4, 5 and 6 were the control diet supplemented with 0.025% Bacitracin Methylene Disalicylate (antibiotic), 0.05% Saltose (probiotic), 0.05% Clostat (probiotic), 0.05% Clostri-stop (probiotic) or 0.1% Sangrovit (phytobiotic), respectively. **Results:** The results showed that supplementation of different feed additives or antibiotic significantly ($p<0.001$) improved body weight gain (BWG) and feed conversion ratio (FCR) in the finisher period (from 26-35 days of age) and the overall period (1-35 days) compared with the control (without additives). Results of carcass traits showed that there was a significant ($p<0.05$) increase in carcass weight and dressing percentage of broilers fed antibiotic or feed additives supplemented diets compared to those fed the control diet. However, internal organs were not affected by supplementation. **Conclusion:** Using probiotics or phytobiotics in broiler diet as feed additives appeared to be superior compared to antibiotic growth promoter. It could be concluded that, addition of feed additives containing *Bacillus* sp., *Clostridium butyricum* (probiotics) or *Sanguinarine* (phytobiotics) to broiler diets could significantly improve growth performance and carcass traits more efficiently and safely than antibiotic growth promoter. These could be good alternatives to antibiotic growth promoters in broiler diets.

Key words: Broiler, natural feed additives, growth promoter, performance

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Corresponding Author: M.A. Mohamed, Department of Animal Production, National Research Centre, 12622 Dokki, Giza, Egypt

Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Broiler production is the quickest way to produce high quality protein for human consumption. Many feed additives, antibiotics, phytogenics or phytobiotics, acidifier, prebiotics and probiotics, have been used not only to improve feed efficiency but also to improve the health and productive performance of birds[1-3]. Use of antibiotics in broiler diets as growth promoters has become unwanted because of the residues in meat products and development of antibiotic-resistant bacteria populations in human. So, in recent years, use of antibiotics as growth promoters in poultry feed has been banned or restricted and the use of other feed additives as alternative compounds has been included in poultry feed. Replacement of antibiotic growth promoters with other safe additives and natural alternatives may be an important goal of the poultry production[4].

Probiotics, known as direct-fed microbials are thus commonly used in broiler production. Probiotics are produced from selected beneficial microbials, mainly *Lactobacilli*, *Streptococci* and *Bacillus species*. *Bacillus amyloliquefaciens* produces many enzymes to increase digestibility and absorption of nutrients in addition to overall intestinal immune function[5]. Chaucheyras-Durand and Durand[6] revealed that many beneficial bacterial strains improved broiler performance and reduced the incidence of diseases caused by pathogenic bacteria. Inclusion of *Bacillus* direct-fed microbials could improve body weight, BWG and FCR in broiler compared with the control group and could be an alternative to the antibiotic growth promoters in broilers diets[7]. *Bacillus subtilis* is recognized as safe and has found application in feed industry[8]. Zhang *et al*.[9] reported that supplementation of *Clostridium butyricum* to broiler diets significantly improved BWG and no significant differences were observed between *Clostridium butyricum* or antibiotics supplemented diets. Also, Hossain *et al*.[10] found that supplementation of *Bacillus subtilis*, *Clostridium butyricum* and *Lactobacillus acidophilus* to broiler diets significantly improved growth performance, nutrient digestibility, meat quality and gut health. The results of Liao *et al*.[11] and Zhang *et al*.[12] proved that broilers fed diet supplemented with *Clostridium butyricum* probiotic had greater body weight and average BWG than those in the control group.

On the other hand, phytobiotics (phytogenics) are natural products such as essential oils, herbs and oleoresins can be supplemented in poultry diet to improve performance, feed utilization and quality of products derived from these birds[13]. So, phytobiotics have gained increasing interests, because of exhibited improvement in growth performance and immune response of birds. Newton *et al*.[14] reported that different varieties of non-phenolic substances, including limonene and compounds from *Sanguinaria canadensis* had high antibacterial activities. *Sanguinarine* is the main compound of Sangrovit produced from the rhizome or herbs of bloodroot plant. *Sanguinarine* has been shown to possess pharmacological properties including antibacterial[15], antifungal[16] and anti-inflammatory[17]. Vieira *et al*.[18] found that birds fed Sangrovit (*sanguinarine*) supplemented diets showed improvement ($p<0.05$) in body weight and FCR at 21 days of age. They concluded that addition of Sangrovit to broiler diets were possibly beneficial for feeding programs designed without the addition of antibiotic growth promoters. Yang *et al*.[19] reported that the antimicrobial action of phytogenics feed additives vary by the location of their functional hydroxyl groups.

Therefore, this study was designed to further evaluate the effect of using some natural feed additives compared to Bacitracin Methylene Disalicylate antibiotic growth promoter on growth performance and carcass traits of broiler chicks.

MATERIALS AND METHODS

Four commercial products of feed additives (three probiotics being Saltose®, Clostat® and Clostri-stop® and a phytogenic material, Sangrovit®) along with Bacitracin Methylene Disalicylate® (BMD) were used. Saltose® (Industry Consultant Company PIC-BIO, Inc., Tokyo, Japan) composed of cell wall lyaze 3,700 U g^{-1}, *Bacillus* sps. 1.8×10^9 CFU g^{-1}, *Enterococcus* sps. 2.5×10^8 CFU g^{-1}, protease, lipase, cellulase, amylase 12,000 U g^{-1} and beta-xylanase 350 U g^{-1}. Clostat® (Kemin Industries, Inc., USA) is a mixture of Bacillus subtilis. Clostri-stop® contained viable bacteria at 5.6×10^9 CFU g^{-1} of *Clostridium butyricum*. Sangrovit® (GmbH, Etville, Germany) is phytobiotic (sanguinarine) obtained from the aerial parts of *Macleaya cordata*.

Three hundred one-day old Cobb broiler chicks were divided into six treatment groups (5 replicates, 10 chicks each group). Replicates were randomly allocated in batteries. Gas heaters were used to keep the required temperature (started with 32°C and decreased up to 2°C every week) and light was provided 23 h a day throughout the experimental period. Three experimental basal diets, starter, grower and finisher were formulated to meet the nutrient requirements of the chicks. Ingredients and nutrient composition of the basal diets are shown in Table 1. Six dietary treatments were examined, diets: (1) Control, without additives, (2) Control+250 g t^{-1} BMD, (3) Control+500 g t^{-1} Saltose, (4) Control +500 g t^{-1} Clostat, (5) Control+500 g t^{-1} Clostri-stop and

Table 1: Ingredients used and calculated composition of the basal diets

Ingredients (%)	Starter diet (1-12 days of age)	Grower diet (13-25 days of age)	Finisher diet (26-35 days of age)
Yellow corn	55.65	60.00	63.00
Soybean meal (48%)	34.00	30.00	27.00
Corn gluten meal (60%)	4.00	3.00	2.00
Soybean oil	2.20	2.95	4.15
Di-calcium phosphate	1.70	1.50	1.40
Limestone	1.40	1.40	1.30
Vitamin and mineral mix[1]	0.30	0.30	0.30
NaCl	0.25	0.25	0.25
L-lysine HCl	0.20	0.30	0.30
DL-methionine	0.20	0.20	0.20
Choline chloride	0.10	0.10	0.10
Total	100	100	100
Calculated composition[2]%			
Crude protein (%)	23.57	21.47	19.65
ME (Kcal kg^{-1})	3051.00	3131.00	3220.00
Lysine (%)	1.42	1.37	1.28
Methionine (%)	0.65	0.60	0.53
Methionine+Cystine (%)	0.99	0.90	0.88
Calcium (%)	1.02	0.95	0.90
Nonphytate P (%)	0.50	0.45	0.40

[1]Vitamin and mineral mix supplied/kg of diet, Vit A: 12000 IU, Vit D_3: 2200 IU, Vit E: 10 mg, Vit K_3: 2 mg, Vit B_1: 1 mg, Vit B_2: 4 mg, Vit B_6: 1.5 mg, Vit B_{12}: 10 mg, Niacin: 20 mg, Pantothenic acid: 10 mg, Folic acid: 1 mg, Biotin: 50 mg, Copper: 10 mg, Iodine: 1 mg, Iron: 30 mg, Manganese: 55 mg, Zinc: 50 mg and Selenium: 0.1 mg. [2]Calculated according to NRC[20]

(6) Control+1000 g t^{-1} Sangrovit. Dose of additives were added as recommended by the producers. Feed and water were allowed for *ad libitum* consumption. The experiment lasted from 1-35 days of age through three periods, starting (1-12 days), growing (13-25 days) and finishing (26-35 days).

At 12, 25 and 35 days of age, after fasting overnight birds were individually weighed and feed intake (FI) was recorded per replicate. Body weight gain and FCR were calculated. At day 35, five representative chicks with body weight close to the group average were selected from each group for carcass traits. Chicks were fasted for 12 h then individually weighed, slaughtered, de-feathered and eviscerated. Weights of carcass, dressing, liver, heart and gizzard were recorded and calculated as percent of live body weight. Throughout the experiment, birds were vaccinated against AI, ND, IB and IBD. After such medical treatments a dose of vitamins (AD_3E) was offered in the drinking water for three successive days. Data were statistically analyzed (one way analysis of variance) using General Liner Model of SAS[21]. Significant differences among treatment means were separated using Duncan's new multiple range test[22] at $p<0.05$.

RESULTS

Growth performance: Growth performance included body weight gain (BWG), feed intake (FI) and feed conversion ratio (FCR) of birds in the control and additives supplemented groups shown in Table 2 and 3. The results showed that dietary supplementation of natural feed additives or BMD antibiotic growth promoter resulted in a significantly ($p<0.001$) improved BWG at the finisher period (from 26-35 days of age) and the overall experimental period (1-35 days) compared to the control group. There were no significant differences in average BWG during the overall experimental period (1-35 days) among all feed additives and antibiotic BMD treatments. Meanwhile, dietary treatments did not significantly affect BWG at 12 and 25 days of age. The recorded average BWG at the end of the experiment was 1591, 1679, 1695, 1734, 1728 and 1690 g for treatments 1, 2, 3, 4, 5 and 6, respectively. Maximum weight gain was achieved with Clostat and Clostri-stop followed by Saltose and Sangrovit then antibiotic BMD in the last, with no significant differences among treatment means. Significantly lower ($p<0.05$) weight gain was obtained with the control group (without additives). Feed conversion ratio significantly ($p<0.001$) improved with all additives included BMD antibiotic compared with the control group at growing, finishing and overall experiment period. At the starting period (1-12 days) no significant differences were detected. The mean FCR values at the end of experiment were 1.81, 1.73, 1.74, 1.72, 1.74 and 1.74 for all treatments (1-6), respectively. Treatment 4 (Clostat) recorded the best FCR (1.72) compared to the other treatments. The worst FCR (1.81) was recorded with the control group. No significant differences were detected in FCR among all the additives

Table 2: Performance of broiler chickens fed different of feed additives at 12 and 25 days of age

	1-12 day of age			1-25 day of age		
Items	BWG	FI	FCR	BWG	FI	FCR
Control (without additives)	363	547	1.51	890	1512	1.70[a]
BMD	392	582	1.49	920	1489	1.62[b]
Saltose	371	559	1.51	907	1487	1.64[b]
Clostat	395	591	1.50	895	1460	1.63[b]
Clostri-stop	382	573	1.50	929	1531	1.65[b]
Sangrovit	388	585	1.51	887	1479	1.66[b]
SE of mean	±5.33	±7.97	±0.01	±6.10	±11.19	±0.01
Significance	NS	NS	NS	NS	NS	**

[a,b]Values within each column not sharing a common superscript differ significantly at $p<0.05$. NS: Not significant ($p>0.05$), **$p<0.01$

Table 3: Performance of broiler chickens fed different feed additives from 26-35 and 1-35 day of age

	26-35 days of age			1-35 days of age		
Items	BWG	FI	FCR	BWG	FI	FCR
Control (without additives)	701[d]	1372[c]	1.96[a]	1591[b]	2884	1.81[a]
BMD	759[c]	1417[bc]	1.86[b]	1679[a]	2906	1.73[b]
Saltose	788[b]	1459[b]	1.85[b]	1695[a]	2945	1.74[b]
Clostat	838[a]	1524[a]	1.82[b]	1734[a]	2985	1.72[b]
Clostri-stop	799[b]	1471[ab]	1.84[b]	1728[a]	3002	1.74[b]
Sangrovit	803[b]	1461[b]	1.82[b]	1690[a]	2939	1.74[b]
SE of mean	±10.73	±13.01	±0.01	±12.72	±15.64	±0.01
Significance	**	**	**	**	NS	**

[a-d]Values within each column not sharing a common superscript differ significantly at $p<0.05$. NS: Not significant ($p>0.05$), **$p<0.01$

Table 4: Carcass traits of broiler chickens fed different feed additives at 35 days of age

Items	Carcass weight (g)	Dressing (%)	Liver (%)	Heart (%)	Gizzard (%)
Control (without additives)	1176[b]	72.00[c]	2.37	0.60	1.92
BMD	1269[a]	73.67[ab]	2.17	0.58	1.69
Saltose	1263[a]	72.67[b]	2.41	0.59	1.87
Clostat	1297[a]	73.00[ab]	2.20	0.57	1.88
Clostri-stop	1310[a]	74.00[a]	2.53	0.56	1.87
Sangrovit	1271[a]	73.33[ab]	2.55	0.60	1.70
SE of mean	±10.20	±0.20	±0.06	±0.01	±0.06
Significance	*	*	NS	NS	NS

[a,b,c]Values within each column not sharing a common superscript differ significantly at $p<0.05$. NS: Not significant ($p>0.05$), *$p<0.05$

including BMD. However, FI was significantly ($p<0.001$) increased by dietary treatments at the finishing period (from 26-35 days of age) only.

Carcass traits: Values of the different carcass traits recorded at the end of the experiment are presented in Table 4. Carcass weight and dressing percentages of birds fed the different additives recorded significantly higher values than the control, as body weight did. A significant ($p<0.05$) increase in carcass weight and dressing percentage of broilers fed antibiotic BMD or feed additives supplemented diets compared to the control group was detected. The mean values of dressing percentage were 72.00, 73.67, 72.67, 73.00, 74.00 and 73.33 for treatments from 1-6, respectively. Treatment 5 (Clostri-stop) recorded the best dressing percentage (74.00 %) compared to the other treatments. Meanwhile, the worst dressing percentage (72.00%) was recorded with the control group. However, internal organs (liver, heart and gizzard %) were not affected by dietary treatments.

DISCUSSION

The results of the present study showed that dietary treatments significantly ($p<0.05$) improved growth performance and carcass weight of broilers. Addition of probiotics or phytogenic to broilers diets improved BWG and FCR as BMD antibiotic growth promoter did. These results confirmed the previous studies[23-25], who found that probiotics could promote growth performance and improve feed utilization in broilers. Zhao *et al.*[26] and Zhang *et al.*[12] found that addition of *Clostridium butyricum* as a probiotic to broiler diets improved growth performance and nutrient utilization. Knap *et al*.[27] reported that addition of *Bacillus* in broiler diets increased growth performance and reduced mortality. Melegy *et al*.[28] concluded that addition of *Bacillus subtilis* in broiler diets improved growth performance, dressing yield and immune response. Jayaraman *et al*.[29] reported that addition of *Bacillus subtilis* in broiler diets significantly ($p<0.05$) improved BWG and FCR. Recently, Manafi *et al*.[30] reported that addition of BMD or *Bacillus subtilis* to broiler diet significantly ($p<0.01$) improved body weight and FCR and increased the digestibility of nutrients.

Karimi *et al*.[31] observed that supplementation of Sangrovit at 1% of broiler diets had significantly ($p<0.05$) improved average BWG and FCR in the starter period. Lee *et al*.[32] reported that supplementation of Sangrovit or antibiotic growth promoter (avilamycin) to broilers diets significantly improved ($p<0.05$) body weight, BWG and FCR at 22-35 days of age or overall period from 1-35 days of age compared with the control diet.

Different investigators proposed the mode of actions of using probiotics as feed additives in broilers. Melegy *et al*.[28] reported that *Bacillus subtilis* have an antimicrobial effect against *Clostridium perfringens* in broiler chicks. Tactacan *et al*.[33] reported that *Bacillus subtilis* supplemented diet was as effective as Bacitracin Methylene Disalicylate in mitigating the subclinical effects of necrotic enteritis in broiler chickens. Pan and Yu[34] reported that probiotics could produce molecules with antimicrobial activities, such as bacteriocins, that target specific pathogens or may prevent the adhesion of pathogens or the production of pathogenic toxins. Hassan *et al*.[35] found that the enhanced growth performance of broiler chicks fed different direct-fed microbials is correlated with increases in relative weights of lymphoid organs. This indicates improvement in immune response and physiological status of chickens. Lei *et al*.[7] reported that addition of *Bacillus amyloliquefaciens* to broiler diets improved gut histological structure that lead to a greater absorption surface in intestine. Abd El-Azeem *et al*.[36] reported that supplementation of direct-fed microbials (a mixture of *Enterococcus faecium*, *Bacillus subtilis* and *Saccharomyces cerevisiae*) to broilers diet increased body weight and improved some histological change of bursa, thymus and spleen organs which may result in improvement of chicks immunity and growth performance. Zhang *et al*.[12] reported that *C. butyricum* improved intestinal barrier function and digestive enzyme activities in broilers. No significant differences were detected between the C. *butyricum* probiotic and the antibiotic treatment group (Colistin sulfate). So, C. *butyricum* probiotic may be considered an alternative to antibiotic as a growth promoter for broiler chickens. Jayaraman *et al*.[29] found that addition of *Bacillus subtilis* to broiler diets significantly ($p<0.05$) improved intestinal structure traits which lead to improve nutrient absorption compared to the control and BMD and avilamycin treatments. The resulted improvement in growth performance associated with addition of phytogenic products may be related to increase in intestinal mucus production. This may contribute to the relief from pathogen pressure through inhibiting adherence to the mucosa[37]. Also, some studies have shown that phytobiotics can enhance the digestive enzyme activity and absorption capacity[38,39]. So, natural feed additives (phytogenics or phytobiotics) have been widely promoted as alternatives to antibiotic growth promoters in poultry feed due to their abilities to improve production and feed efficiency[40]. Hassan *et al*.[41] reported that supplementation of artichoke extract (*Cynara scolymus*) as phytogenic to broilers diet improved ($p<0.05$) body weight, FCR and digestibility of crude protein and crude fibre compared with the control diet of no feed additives. Wati *et al*.[42] found that supplementation of phytogenic feed additives to broilers diets improved body weight and FCR and decreased digesta transit time as compared with the control group ($p<0.01$). They concluded, therefore, that phytogenic materials can be used as an effective replacement for antibiotic (BMD) to enhance broiler performance. Hassan *et al*.[43] observed that addition of *Moringa oleifera* leaves (phytogenic) to broilers diet up to 0.3% significantly ($p<0.05$) improved BWG and FCR but had no significant effect on carcass relative weight, liver, gizzard, heart, abdominal fat, breast and thigh. The positive impact of dietary feed additives in enhancing broiler performance may be related to improved gut health and an increase in digestive enzymes. So, replacing BMD with such natural feed additives (phytogenics or probiotics like *Bacillus subtilis* or *Clostridium butyricum*) may be reasonable and profitable in the commercial industry.

CONCLUSION

Feed additives (probiotics and phytogenics) evaluated in this study were as efficient as BMD for improving growth performance and carcass traits of broilers. Using natural feed additives in broiler diets, with good managerial and biosecurity measures, may be a beneficial tool for improving growth performance and successfully used as growth promoters.

SIGNIFICANCE STATEMENT

This study discovers that natural feed additives are more efficient than the antibiotic growth promoters for improving growth performance and carcass traits of broilers. This study will help the researcher to uncover the critical area of using probiotics or phytobiotics in broiler diet as feed additives.

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