Brazilian Journal of Poultry Science
Revista Brasileira de Ciência Avícola

ISSN 1516-635X Oct - Dec 2008 / v.10 / n.4 / 227 - 232

Performance and Carcass Quality of Broilers Supplemented With Antibiotics or Probiotics

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■ Keywords

Additives, meat color, meat water holding capacity, polyprobiotics, zinc bacitracin.

■ Acknowledgments

The authors thank FAPESP for funding this research study (project n. 2003/07445-6) and Korin Agropecuária Ltda. for providing the birds, feeds, and facilities.

Projeto de pesquisa financiado pela Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP)

Arrived: May/2008
Approved: September/2008

ABSTRACT

The objective of this study was to evaluate the effects of different additives on broiler performance and meat quality. A total of 1620 one-day-old male Cobb broilers were distributed by a completely randomized experimental design into 5 treatments: positive control - zinc bacitracin (PC); negative control - without additives (NC); probiotic 1 - 10.000 g/ton (PR-I); probiotic 2 - 500 g/ton (PR-II); and probiotic 3 - 50 g/ton (PR-III). The PC treatment promoted better weight gain (WG) than PR-II (1-28 days) and PR-III (1-14; 1-28 days), better feed conversion (1-40 days period), and the highest WG among all treatments ($p<0.05$). The performance of broilers fed probiotics was not different than those in the negative control group in any rearing phase, but there were performance differences among probiotic-treated birds. Hot and cold carcass yields and breast pH were not influenced by the different additives as compared to the negative control treatment. The only observed differences were in breast color (a*) and carcass yield between PR-III and the negative control group. Probiotics increased water holding capacity (except for PR-II) ($p<0.05$). The treatment with antibiotic promoted the highest WG. Meat quality suffered little influence from the different additives.

INTRODUCTION

Research studies have reported feed residues in chicken meat products (Zaki *et al*., 2000) and the development of bacterial resistance to antibiotics used both in human medicine and poultry production (Edens, 2003; Zahrael *et al*., 2006). This concern led the European Union ban, since January 2006, the trade and use of antibiotics in food-producing animals (Pecue, 2003). In Brazil, there is an increasing demand for good quality and health animal products (Bolis, 2002; Aguiar, 2006).

Probiotics (Edens, 2003; Timmerman *et al*., 2004) are additives that can be used to replace antibiotics in poultry nutrition (Revington, 2002; Griggs & Jacob, 2005) and can be defined as a preparation of or a product containing viable, defined microorganisms in sufficient numbers, which alter the microflora in a compartment of the host and by that exert beneficial health effects in this host (Schrezenmeir & De Vrese, 2001).

The inclusion of probiotics in the diet has shown to produce contradictory results on broiler performance. Researchers have reported positive (Maiorka *et al*., 2001; Correa *et al*., 2003; Dematte Filho, 2004) none or negative effects (Vargas, 2001; Lima *et al*., 2003; Pelicano *et al*., 2004; Flemming & Freitas, 2005; Gunal *et al*., 2006) on broiler performance attributed to the action of probiotics. This variation in results was shown by Faria Filho *et al.* (2006) in their literature review. These authors indicate the need of further studies to verify the possible differences among probiotics sold in Brazil.

Factors such as nutrition, stress, environment, use of vaccines and/or antibiotics, microorganism types, associations (different microorganisms in the same product - polyprobiotics) (Timmerman *et al*., 2004), and quantities may affect the action of the microorganisms present in the probiotic product, causing unexpected results in broiler performance (Edens, 2003; Menten & Pedroso, 2005).

However, there are few studies that take into account the implications of the use of these additives on meat quality (Correa *et al*., 2003; Karaoglu *et al*., 2004; Aguiar, 2006; Huallanco, 2006). Therefore, the objective of the present experiment was to evaluate the effect of antibiotics or probiotics on the performance, carcass yield and quality of meat broilers.

MATERIAL AND METHODS

The experiment was carried out in the installation of the company Korin Agropecuária Ltda., Ipeúna, SP, Brazil, and the laboratory analyses were performed at the Meat Technology Lab of Escola Superior de Agricultura "Luiz de Queiroz" of the University of São Paulo, Piracicaba campus.

A total of 1620 non-vaccinated one day-old male Cobb broiler chicks was housed in a conventional broiler house. Birds were distributed according to a completely randomized experimental design into five treatments, with six replicates of 54 each, and at a density of 13 birds/m^2.

Iso-nutritive feeds, based on corn and soybean meal, without animal by products and no inclusion of anticoccidials, were formulated according to rearing phase (Table 1). Feed was offered *ad libitum*. The diets were formulated by the company Vaccinar® according to the standards used in commercial farms, and to supply the nutritional requirements determined by Rostagno (2005) and the NRC (1994). The following treatments were applied: negative control - no additives (NC); positive control - zinc bacitracin (50 ppm), between 1-7 days; 60 ppm between 8-21 days, and 70 ppm between 22-40 days (PC); Probiotic 1 - 10.000 g/ton (PR-I); Probiotic 2 - 500 g/ton (PR-II); Probiotic 3 - 50 g/ton (PR-III). Additive inclusion levels followed the recommendation of the manufacturers (Table 1).

The following performance parameters were measured: feed intake (FI), weight gain (WG), and feed conversion ratio (FCR) for the cumulative periods of 1-14, 1-28, and 1-40 days of age. At the end of the experimental period (40 days), 90 birds per treatment were used for meat physical-chemical analyses and meat yield. All rearing and slaughter procedures were performed according the Ethical Principles of Animal Experimentation as recommended by the Brazilian College of Animal Experimentation. The yield of eviscerated carcasses with no feet, head, neck was calculated in relation to live weight before (hot carcass) and after chilling (cold carcass).

The following measurements were made: pH (average of 4 points - digital pHmeter Digimed DM2), instrumental color (average of 4 readings in the internal part of the muscle - Minolta CR300 colorimeter, 8-mm diameter measurement area, 10 observation angle, D65 illuminant and specular component), water holding capacity - WHC (according to the method of Nakamura & Kataoh, 1985), cooking loss - CL (according to the method of Mead, 1987), and e shear force - SF (determined according to the technique described by Froning and Uijtteenboogart (1988), using the texturemeter Texture Test System coupled to a Warner-Bratzler apparatus with velocity of 20 $cm.min^{-1}$ and load of 100 kg. The results were expressed as kgf/cm^2, in breast meat samples (Pectoralis major) 24 hours after slaughter.

Performance and carcass yield and quality data were submitted to analysis of variance for a completely randomized experimental design. Means with significance level of $p<0.05$) were compared by the test of Tukey.

RESULTS AND DISCUSSION

Feed intake (FI) and weight gain (WG) of the birds fed probiotics were similar to those of the NC birds in all rearing stages, except for those fed PR-III in the period of 1-40 days, which WG was lower than the NC birds ($p<0.05$) (Table 2). Previous studies also found similar weight gain (Vargas *et al.*, 2001; Lima *et al*., 2003; Pelicano *et al.*, 2004) and feed intake (Pelicano *et al*., 2004; Flemming & Freitas, 2005) in birds supplemented or not with probiotics. According to Pelicano *et al*. (2004), the similar or lower performance of birds fed probiotics as compared to negative control groups, may be due to an unbalance of the bird's gastrointestinal microflora consequent to the high number of microorganisms as compared to the quantities normally found in the digestive tract.

In the present experiment, no difference in the performance parameters between the PR-II treatment (which included only *B. subtilis*) as compared to the other treatments with probiotics (polyprobiotics), except for PR-III, which presented lower FI during the

Table 1 - Ingredients, nutritional levels, and probiotic compositions.

Ingredients	PRE-STARTER (1 - 7 days)	STARTER (8 - 21 days)	GROWER (22 - 35 days)	FINISHER (36 - 42 days)
Corn - grain (%)	58.04	62.15	69.47	71.68
Deactivated soybeans (%)	2.50	6.80	10.00	11.50
Soybean meal (%)	36.3	27.90	17.00	13.60
DL-Methionine (%)	0.08	0.05	0.09	0.05
L-Lysine (%)	0.03	0.05	0.09	0.12
Enzyme supp. (%)[1]	0.05	0.05	0.05	0.05
Premix (%)[2]	3.00	3.00	3.00	3.00
Nutritional levels				
Crude protein (%)	23.00	20.99	17.98	16.98
Fiber (%)	3.64	3.52	3.26	3.20
Ether extract (%)	3.00	3.95	4.78	5.13
Mineral matter (%)	5.22	4.91	4.50	4.52
ME poultry (kcal/kg)	2.952	3.049	3.170	3.210
Total methionine (%)	0.57	0.55	0.50	0.37
Total Met + Cys (%)	0.96	0.91	0.81	0.67
Total lysine (%)	1.29	1.17	1.06	0.95
Sodium (mg/kg)	1.767	1.743	1.721	1.712
Calcium (%)	0.89	0.78	0.89	0.87
Total phosphorus (%)	0.63	0.62	0.57	0.54
Dig. phosphorus (%)	0.39	0.38	0.35	0.32
Linoleic acid (%)	1.34	1.89	2.37	2.57
Composition of the probiotic products				

	Microorganisms	CFU/g
Probiotic 1	Anaerobic bacteria	$1.00\ 10^6$
	Lactose-fermenting enterobacteria	$1.00\ 10^6$
	Enterococus ssp	$1.00\ 10^6$
	Lactobacillus acidophilus	$1.00\ 10^6$
Probiotic 2	*Bacillus subtilis*	$> 1.6\ 10^9$
Probiotic 3	*Lactobacillus plantarium*	$1.26\ 10^8$
	Lactobacillus bulgaricus	$2.06\ 10^8$
	Lactobacillus acidophilus	$2.06\ 10^8$
	Lactobacillus rhamnosus	$2.06\ 10^8$
	Bifidobacterium bifidum	$2.00\ 10^8$
	Streptococcus thermophilus	$4.10\ 10^8$
	Enterococcus faecium	$6.46\ 10^8$

1 - Supplied at 0.0005 g/kg feed: Betaglucanase 0.20 u/g; Xylanase 0.14 u/g; VitB2.15000 mg; Vit. B1 500 mg; Vit. B6 1,000 mg; Vit. B12 15,000 mg; pantothenic acid 12,000 mg; niacin 20.000 mg; BHT 500 mg. 2- Supplied at 30 g/kg feed: Vit. D3 66,700 IU; Vit. E. 541 IU; Vit.A 267,000 IU; Vit.B1 36.5mg; Vit. B2.63 mg; Vit. B6 73mg; Vit. B12 570 mg; Vit. K3 81.5 mg; folic acid 18.5 mg; pantothenic acid 490 mg ; biotin 1.8 mg; choline 8,850mg; methionine 41,580 mg; niacin 523 mg; Ca 236g; Co 33 mg; F 930 mgFe 2,478 mg; I 23 mg; Mn 2.600 mg; Na 52g; P 85 mg; Se 6 mg; Zn 1.830 mg; BHT 87 mg.

period of 1-28 days ($p<0.05$). Therefore, the assertion of Timmerman *et al*. (2004) that probiotics containing several bacterial strains promoted better performance results was not confirmed here.

The group of birds fed zinc bacitracin (positive control) obtained, for the total rearing period (1-40 days), the highest FI as compared to the other treatments ($p<0.05$) (Table 2), whereas in the periods of 1-14 and 1-28 days, FI of positive control group was similar to the probiotics groups 1 and 2, and higher than the NC and PR-III groups ($p<0.05$).

The inclusion of the antibiotic in the feed also promoted higher weight gain (1-40 days) as compared to the other treatments ($p<0.05$). These results are consistent with those found by Dematê Filho (2004) and Sugeta *et al*. (2004), but are opposite to those of Correa *et al*. (2003), Flemming & Freitas (2005), and Gunal *et al*. (2006). Considering the period of 1-14 days, the birds fed probiotics 1 e 2 had similar WG as to the birds in the PC treatment. For the period of 1-28 days, only PR-I WG was similar to the treatment that included the antibiotic. According to Dematê Filho (2004), the beneficial effect of antibiotics may be due to a possible change in the ratio between Gram-positive (G+) and Gram-negative (G-) bacteria present in the gastrointestinal tract, with an increase in G+ and a decrease in G- bacteria.

NC feed conversion ratio during the period of 1-40 days was lower than in the PC and PR-I treatments ($p<0.05$). FCR was not different among the other treatments. Considering the total rearing period, authors such as Vargas *et al*. (2001), Correa *et al*. (2003), and Flemming and Freitas (2005), also did not find statistical differences in FCR among experimental

Table 2 - Feed intake (FI), weight gain (WG) and feed conversion ratio (FCR) of broilers according to age and treatment.

	1-14 days			1-28 days			1-40 days		
	FI (kg)	WG (kg)	FCR	FI (kg)	WG (kg)	FCR	FI (kg)	WG (kg)	FCR
CN[1]	0.51b	0.38b	1.35ab	2.10bc	1.30b	1.62ab	4.03bc	2.36b	1.71b
CP[2]	0.57a	0.44a	1.29b	2.27a	1.42a	1.60b	4.48a	2.49a	1.80a
PR-I[3]	0.54ab	0.40ab	1.36a	2.17ab	1.34ab	1.63ab	4.23b	2.37b	1.78a
PR-II[4]	0.54ab	0.40ab	1.35ab	2.16ab	1.31b	1.65a	4.05bc	2.32bc	1.75ab
PR-III[5]	0.50b	0.37b	1.35ab	2.04c	1.25b	1.63ab	3.87c	2.23c	1.73ab
P	0.0037	0.0021	0.0427	0.0002	0.0004	0.0785	<0.0001	<0.0001	0.0096
CV (%)	5.91	7.00	2.57	3.14	3.99	1.94	3.45	2.15	3.19

a,b,c - Means followed by different letters in the same column are different by the test of Tukey (p<0.05). 1 - NC: negative control. 2 - PC: positive control. 3 - PR-I: Probiotic 1. 4 - PR-II: Probiotic 2. 5 - PR-III: Probiotic 3.

groups supplemented with probiotics, antibiotics, or without antibiotics.

During the initial rearing stages, PC presented better FCR as compared to the groups probiotics 1 (1-14 days) and 2 (1-28 days) (p<0.05). FCR was not different among the other treatments during these periods. Better FCR during the first stages of rearing for broilers fed antibiotics as compared to those supplemented with probiotics was also observed by Demattê Filho (2004).

Considering the carcass yield, PR-III resulted in the lowest hot carcass yield relative to PC and PR-I (p<0.05). PR-III also caused lower cold carcass yield as compared to PC (p<0.05). There were no differences among the other treatments. Similar carcass yields in broilers supplemented or not with probiotics were found by Maiorka *et al*. (2001) and Correa *et al*. (2003).

In the present experiment, the parameters L* (lightness) and b* (yellowness) were not influenced by additive supplementation (Table 3), as breast meat sample presented normal lightness values - between 50 and 56. Higher or lower values will cause dark or pale meat, respectively (Petracci *et al*., 2004), which are usually rejected by the consumers.

The breast meat of broilers fed PR-III obtained lower a* (redness) values as compared to PC and NC treatments (p<0.05), indicating a trend for paler color (Table 3). However, according to Pelicano *et al*. (2003), a* values were significantly higher in the treatment with probiotics (4.52) than those in the negative control treatment (3.79), when meat was analyzed 45 minutes post mortem. Aguiar (2006) evaluated the breast meat of broilers raised under conventional, free-range, and natural (with probiotics) systems, and did not find any differences in L* and a* values among systems; however, the meat of natural broilers were considered less yellow (lower b* values) (Aguiar, 2006).

There was no influence of the applied treatments on pH values (Table 3) in the present experiment. Jones & Grey (1989), Sams & Mills (1993), and Aguiar (2006) found normal pH values at the end the post-mortem process of 5.60 to 5.80, 5.78 to 5.86, and 5.75 to 5.96, respectively. The pH results observed in the present experiment are within these ranges, independently of the use of probiotics. Therefore, the use of probiotics did not affect meat pH.

WRC was not different between the probiotic and the PC groups, while the NC treatment resulted in lower WHC as compared to probiotics 1 and 3 (p<0.05) (Table 3). The analysis of cooking loss (CL) also did not show any difference among treatments. In the study of Pelicano *et al*. (2003), no differences in WHC or CL were detected among the different probiotics tested,

Table 3 - Carcass yield (CY), color, pH, water retention capacity (WRC), cooking loss (CL), and shear force (SF) of breast meat according to treatment.

	Negative control	Positive control	Probiotic 1	Probiotic 2	Probiotic 3	P	CV (%)
Yield							
RC quente (%)	67.61ab	68.84a	68.59a	67.32ab	66.74b	0.001	5.14
RC frio (%)	71.06ab	72.64a	71.59ab	70.86ab	70.88b	0.001	5.07
Cor							
L*	51.87a	51.54a	52.64a	51.15a	51.66a	0.413	5.18
a*	3.42a	3.38a	2.90ab	3.19ab	2.42b	0.005	31.89
b*	8.49a	8.61a	8.41a	8.69a	8.23a	0.868	15.97
pH	5.83a	5.81a	5.83a	5.77a	5.83a	0.671	2.54
WRC (%)	48.81b	50.45ab	54.37a	52.41ab	57.16a	0.005	4.81
CL (%)	26.79a	27.09a	26.28a	28.57a	27.00a	0.873	13.04
SF (kgf/g)	3.47a	3.01b	2.95b	3.39ab	3.47a	0.047	17.96

a,b - Means followed by different letters in the same column are different by the test of Tukey (p<0.05).

or between probiotics and the control treatment. According to Dabés (2001), lower WHC implies in nutrient losses in the exsudate, resulting in a drier and, therefore, less tender meat.

When the objective meat tenderness (shear force) was assessed, the breast meat of broilers in treatments NC and PR-III presented the lowest tenderness, and were significantly different from the meat of broilers in treatments PC and PR-I, which were the tenderest. However, Pelicano *et al*. (2003) did not find any statistical difference in shear force between the negative control and treatments with different probiotics. Lyon & Lyon (1990) related objective tenderness to sensorial assessment, and observed that, for acceptable chicken breast meat tenderness, a shear force value of 8.8 kgf/g meat sample was considered as "very tough", and values below 3.6 kgf/g were appraised as "very tender". Therefore, taking into account the range of shear force values obtained in the present experiment (2.9 to 3.4 kgf/g), the use of probiotics did not have a significant influence on meat tenderness.

CONCLUSIONS

The performance of broilers in the groups supplemented with probiotics was similar among these groups and to those in the negative control treatment, but lower than those in positive control group (supplemented with antibiotic). The use of probiotics had little influence on meat quality, and no negative effects on color parameters, pH, drip loss, or tenderness.

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