EFFECT OF NON-ANTIBIOTIC GROWTH PROMOTANT ADDITIVES ON PERFORMANCE, CARCASS YIELD, TOTAL BACTERIA COUNTS, INTESTINAL PH, AND FEED PH IN BROILERS

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SUMMARY

The objective of this study was to evaluate the effect of non-antibiotic growth promotant additives on performance, carcass yield (parts and abdominal fat), total bacteria counts, intestinal pH, and feed pH in broilers from 1-42 days of age fed corn and soybean meal based diets, compared to antibiotics. The study involved a 7 x 2 factorial design, with seven sources of additives (antibiotic, basal, MOS, FOS, fumaric acid, mushroom extract and probiotic) and two genders (males and females). A total of 1,680 birds were allocated to 14 treatments, with 4 replicates per gender and 30 birds per experimental unit. Effects of growth promotant additives on feed conversion rates, feed efficiency and production efficiency factor were measured. Male birds showed better performance results than females in all parameters evaluated, except for viability. Additives showed positive effects on carcass yield, parts yield, and abdominal fat. Male birds were heavier at slaughter and showed higher leg yields than females. Additives also influenced total bacteria counts, intestinal content pH and feed pH. These changes in intestinal microbiota and pH values may contribute to a higher stability and better survival of microorganisms in the intestinal ecosystem, resulting in benefits for the host. The results of this study suggest the possible role of non-antibiotic growth promoters in replacing antibiotics, preventing diseases and promoting health and wellbeing of animals and humans.

Key-words: beneficial additives, performance, antibiotics, broilers

RESUMO

O objetivo deste trabalho foi avaliar o efeito de aditivos beneficiadores de crescimento cm substituição aos antibióticos sobre o desempenho, características de carcaça (partes e gordura abdominal) e bactérias totais do intestino de frangos de corte de 1 a 42 dias de idade, criados em cama reutilizada e alimentados com rações à base de milho e farelo de soja. O delineamento experimental utilizado foi o inteiramente casualizado com um arranjo fatorial 7 x 2, correspondendo a 7 fontes de aditivos (antibiótico, basal, MOS, FOS, ácido fumárico, cogumelo desidratado e probiótico) e dois sexos (macho e fêmea). Utilizou-se um total de 1680 pintos sexados distribuídos em 14 tratamentos com 4 repetições por sexo e 30 aves por parcela experimental. Observou-se efeito dos aditivos beneficiadores de crescimento sobre a conversão alimentar, eficiência alimentar e fator de produção e constatou-se que as aves machos apresentaram melhores resultados de desempenho em comparação às fêmeas cm todos os parâmetros avaliados, exceto viabilidade. A suplementação da dieta com aditivos influenciou positivamente o rendimento de carcaça, panes e gordura abdominal, sendo que as aves machos apresentaram melhores resultados de peso ao abate e rendimento de coxa, quando comparados às fêmeas.

Os aditivos também apresentaram efeito sobre a contagem total de bactérias do conteúdo intestinal, sendo que as mudanças ocorridas na microbiota intestinal podem contribuir para uma sobrevivência estável de microorganismos no ecossistema intestinal, proporcionando benefícios ao animal hospedeiro. Esses resultados mostram a possibilidade de substituição dos antibióticos pelos aditivos beneficiadores de crescimento, assim como o papel destes na prevenção de doenças e promoção da saúde e bem-estar dos animais e do homem.

Palavras-chave: Aditivos beneficiadores, desempenho, antibióticos, Frangos de corte.

INTRODUCTION

The development of poultry industry boosted soon after the 2nd World War, as poultry meant a new alternative source of animal protein easily produced in small areas. At the same time, antibiotics started to be used in poultry diets as growth promotants, improving animal productivity, reducing pathogenic bacteria, preserving intestinal integrity and allowing better nutrient absorption.

In the last years, poultry industry has showed an extraordinary development, due to major advances in areas such as genetics, nutrition, physiology and animal health. However, there's a constant search for alternatives to increase animal productivity, improve the quality of the final product, reduce production costs without affecting animal performance and to improve profitability.

Antibiotics are commonly used in sub-therapeutic levels in broiler diets as growth promotants, resulting in benefits in productivity, mainly by improving weight gain and feed conversion rates and reducing mortality. However, there is a growing concern that this continuous use of subclinical antibiotic doses in animal feeds may represent a risk for human health, because of residues in animal products that can cause allergic reactions, toxicity or the induction of resistant bacteria.

Therefore, campaigns aiming at the ban of the use of antibiotics in poultry production have restricted their use in animal diets. So, several additives have been used in poultry diets as alternatives to antibiotics, such as mannanoligosaccharides, fructoligosaccharides, organic acids, mushroom extracts and probiotics. These additives promote the growth of beneficial microorganisms in the gastrointestinal tract, resulting in improved digestion and nutrient absorption (Vassalo et al., 1997; Dionízio, 2001), besides improving the quality of final products without posing risk for consumers (Henrique et al., 1998; Dionízio, 2001; Fuini, 2001).

The objective of this study was to evaluate the effect of some of these non-antibiotic feed additives on performance, carcass yield, total bacteria counts, intestinal pH and feed pH in broilers.

MATERIALS AND METHODS

The study was conducted at the experimental house of the Poultry Department at the Federal Federal institute of Education, Science and Technology, Inconfidentes, State of Minas Gerais, Brazil. A total of 1,680 Hybro day old broiler chicks were weighed and raised from 1 to 42 days of age. The study involved a 7 x 2 factorial design, with seven sources of additives (antibiotic, basal, MOS, FOS, fumaric acid, mushroom extract and probiotic and two genders (males and females) with 4 replicates by gender and 30 birds per experimental unit (4.4 m^2). The treatments groups consisted of: basal diet (control – without additives); basal diet plus antibiotic (avilamycin - 10 ppm); basal diet plus mannanoligosaccharide (MOS – 1.0 kg/t); basal diet plus fructoligosaccharide (FOS – 300 g/t), basal diet plus fumaric acid (10.0 kg/t); basal diet plus mushroom extract (2.7 kg/t), and basal diet plus probiotic (Viva

Vida Plus – 1.0 kg/t), containing *Lactobacillus acidophillus*, *Lactobacillus casei*, *Streptococcus lacteis*, *Streptococcus faecium*, *Bifidobacterium bifidum* and *Aspergillus oryzae*. The diets were corn and soybean meal-based, supplemented with minerals and vitamins and contained the following crude protein (CP) and metabolizable energy (ME) levels: 21.4% and 19.0% CP; 3,000 kcal/kg and 3,100 kcal/kg ME from 1 to 21 days and 22 to 42 days, respectively, according to the recommendations by Rostagno et al. (2000). The birds were housed on used litter in order to increase the challenge and test the effectiveness of the additives. No coccidiostats were added to the basal diets, and the additives were added to finished feeds. The performance of the birds was evaluated weekly and, by the end of experimental period, feed consumption, weight gain, feed conversion rates, feed efficiency, production efficiency factor and livability were evaluated. At the end of the experimental period 4 birds from each experimental unit were tagged and fasted for 6 hours. The birds were then weighed and slaughtered for carcass yield analysis. The carcasses were weighed with head, neck and feet and the carcass yield was calculated based on live weight and parts weight, compared to the weight of the eviscerated carcass. For microbiological analysis, samples of intestinal contents were collected at the end of the experimental period to determine pH values and total bacteria counts. Feed samples were also collected to determine pH values. Four birds per replicate were slaughtered, and small intestine and ceca content samples were collected and sent to the Microbiology Laboratory of the Federal Institute of South of Minas Gerais, Inconfidentes, MG. The samples were diluted, incubated and total bacteria counts were carried out. For pH analysis, crop, duodenum and caecum contents were collected in vials containing 15 ml of distilled water and homogenized to determine pH values according to Coon et al. (1990). Feed pH was measured according to the methodology described by Krause, Harrison and Easter (1994). Analysis of data used the statistical package SISVAR (Variance Analysis System for Balanced Data), according to Ferreira (2000). Means were compared using the Scott Knott test at a 5% probability level.

RESULTS AND DISCUSSION

Performance. The results of feed consumption (g), weight gain (g), feed conversion rates, feed efficiency (kg/kg), production efficiency factor and livability (%) are described in Tables 1 and 2. Antibiotics and tested additives have not resulted in increased feed consumption and/or weight gain (P>0.05), probably because of optimal management and feed quality. These results are in accordance to those reported by Alvares et al. (1994) and Dionízio (2001), who have not observed positive effects of feeding antibiotics, prebiotics and probiotics on the same parameters. However, these results are different from those obtained by Bertechini and Hossain (1993) and Henrique et al. (1998), who observed higher feed consumptions and weight gains in birds fed antibiotics and probiotics. Males showed better results at 42 days of age in all treatments, when compared to females (P<0.05). These results are in accordance to Loddi et al. (2000) and Dionízio (2001). Birds fed MOS showed better feed conversion rates when compared to other treatments, possibly due to the adsorption of pathogenic bacteria, reducing colonization and pormoting better intestinal digestion and absorption of nutrients. These results are similar to those obtained by Spring (2000), who observed better performance of birds fed MOS as a growth promotant due to the development of beneficial intestinal microbiota. However, Dionízio (2001) has not seen positive effects of mannose on feed conversion rates. Irrespective of the additive used, males always showed better feed conversion rates. There was no difference (P>0.05) between additives concerning livability. However, females showed higher livability when compared to males, that showed faster body growth and greater susceptibility to cardiopulmonary problems, with increased mortality rates. These data are not in accordance to Henrique et al. (1998), who observed reduced mortality in birds fed probiotics. Birds fed prebiotics (MOS and FOS) showed better feed efficiency when compared to birds fed other additives. Possibly, prebiotics reduced intestinal pH, thus preventing the growth of pathogenic microorganisms and favoring beneficial intestinal microbiota, leading to performance positive results even under health challenge conditions. Corrêa et al. (2000) and Dionízio (2001), however, have not observed improved performance in birds fed prebiotics. The production efficiency factor was higher in birds fed MOS, and can be related to reduced mortality rates and good management, optimizing productivity. These results are similar to those obtained by Henrique et al. (1998), who observed higher production efficiency factor values in birds fed probiotics.

TABLE 1. Feed consumption, weight gain and feed conversion rates of broilers fed different feed additives from 1 to 42 days of age.

Additive	Parameters		
	Feed Consumption (g)	Weight gain (g)	FCR
Control	4,524	2,347	1.92 B
Basal	4,488	2,331	1.92 B
MOS	4,367	2,416	1.80 C
FOS	4,394	2,323	1.88 B
Fumaric acid	4,516	2,276	1.98 A
Mushroom extract	4,454	2,320	1.92 B
Probiotic	4,515	2,360	1.90 B
Males	4,592 a	2,446 a	1.87 b
Females	4,339 b	2,232 b	1.94 a
General mean	4,465	2,339	1.90
CV (%)	3.64	4.66	2.87

Means followed by the same letter in a column are not statistically different according to the Scott-Knott test (P<0.05)

TABLE 2. Feed efficiency, production efficiency factor and livability of broilers fed different feed additives from 1 to 42 days of age.

Additive	Parameters		
	Feed Efficiency (kg/kg)	Production Efficiency Factor	Livability (%)
Control	0.51 B	284.87 B	98.75
Basal	0.51 B	277.87 B	97.00
MOS	0.55 A	315.37 A	99.12
FOS	0.54 A	292.00 B	95.25
Fumaric acid	0.50 B	265.37 B	97.37
Mushroom extract	0.51 B	273.50 B	95.62
Probiotic	0.51 B	278.12 B	97.37
Males	0.53 a	299.07 a	96.17 b
Females	0.51 b	268.67 b	98.25 a
General mean	0.52	283.87	97.21
CV (%)	3.65	9.23	3.68

Means followed by the same letter in a column are not statistically different according to the Scott-Knott test (P<0.05)

Carcass yield. The results of weight at slaughter (WS), carcass yield (CY), breast yield (BY), thigh yield (TY), leg yield (LY), wing yield (WY) and abdominal fat yield (AFY) are described in Tables 3 and 4. There was an interaction among factors (P<0.05) and male birds showed higher weight at slaughter when compared to females, mainly when fed antibiotics and prebiotics. However, birds fed fumaric acid, mushroom extract and probiotic showed higher carcass yield. Although males had higher weight at slaughter, there was no effect of gender on carcass yield. These results are in accordance to those obtained by Santos

(2003), Moreira et al. (2001), who observed better results in male birds fed antibiotics. However, Runho (1995) has not observed any effect of fumaric acid on carcass yield of broilers. Likewise, Dionízio (2001) has not observed any influence of prebiotics and antibiotics on carcass yield of 42-day-old broilers. Although there was no effect of gender on breast yield (P>0.05), birds fed antibiotic and MOS showed higher yield, compared to other additives. Similar results were observed as to slaughter weight. This may have occurred due to higher lysine levels in the diet, possibly favoring the synthesis of muscles, or because of the lipotropic factor. Similar results were obtained by Moreira et al. (2001), although Loddi et al. (2000) and Dionízio (2001) have not observed any differences between birds fed antibiotics, prebiotics and probiotics. Thigh and wing yields were not influenced by additives (P>0.05). Thigh yield was affected by gender, with male birds showing better results, while leg yield was not affected by this variable. However, birds fed antibiotics, MOS, mushroom extract and probiotic showed higher yields compared to those fed the basal diet, fumaric acid and FOS, what suggests that birds with higher leg yield kept growing while birds from other treatments had already reached a growth plateau. Different results were obtained by Santos (2003), Loddi et al. (2000), who has not observed any effect of antibiotic and probiotic on these parameters in broilers. Corrêa et al. (2000), in turn, reported positive effects of antibiotics and probiotics in males. Although the differences were not statistically significant (P>0.05), birds fed additives showed mean abdominal fat reduction of 22.0%, compared to birds fed the antibiotic. Females showed higher fat deposition compared to males and this effect can be attributed to the lipolytic action in birds supplemented with additives.

TABLE 3. Weight at slaughter (WS), carcass yield (CY), breast yield (BY) and thigh yield (TY) of broilers fed different feed additives from 1 to 42 days of age.

Additive	Parameters[1]				
	WS (kg)		CY (%)	BY (%)	TY (%)
	Males	Females			
Control	2,654 A a	2,279 A b	70.09 B	32.53 A	14.96
Basal	2,502 B a	2,399 A a	70.44 B	31.07 B	14.08
MOS	2,833 A a	2,194 A b	69.00 B	32.91 A	14.32
FOS	2,681 A a	2,339 A b	70.60 B	30.82 B	13.89
Fumaric acid	2,356 B a	2,204 A a	74.65 A	31.53 B	14.10
Mushroom extract	2,503 B a	2,329 A a	73.10 A	31.74 B	13.84
Probiotic	2,389 B a	2,318 A a	72.59 A	30.72 B	13.49
Males	2,560 a		70.62	31.63	14.49 a
Females		2,294 b	72.38	31.70	13.71 b
General mean	2,427		71.50	31.62	14.10
CV (%)	6.98		4.76	4.92	6.21

Means followed by the same letter in a column are not statistically different according to the Scott-Knott test (P<0.05)

TABLE 4. Leg yield (LY), wing yield (WY) and abdominal fat yield (AFY) of broilers fed different feed additives from 1 to 42 days of age.

Additive	Parameters[1]		
	LY (%)	WY (%)	AFY (%)
Control	16.31 A	10.34	2.07
Basal	14.94 B	10.43	2.13
MOS	15.70 A	10.68	2.16
FOS	14.74 B	11.07	2.22
Fumaric acid	14.36 B	11.35	1.73
Mushroom extract	15.37 A	11.04	2.26
Probiotic	15.50 A	10.82	2.46
Males	15.49	10.83	1.04 b
Females	15.06	10.81	2.45 a
General mean	15.28	10.82	2.15
CV (%)	6.40	7.61	22.14

Means followed by the same letter in a column are not statistically different according to the Scott-Knott test (P<0.05)

Total bacterial counts, intestinal pH and feed pH. The results of total bacterial counts in small intestine and caecum, feed pH and gastrointestinal tract content pH (crop, duodenum and caecum) are described in Tables 5 and 6. Antibiotics resulted in reduced bacterial populations (P<0.05) when compared to the other additives. These results suggest that the intestinal microflora was controlled, possibly without changes in total bacterial counts. However, changes in the ratios of some microorganisms may have resulted in changes in their metabolism. All additives resulted in higher total bacterial counts when compared to antibiotics, except for fumaric acid, with similar results to antibiotics for intestinal and cecal counts. Although the literature describes the species forming the microflora of diffenrent portions of the intestinal tract, Leedle (2000) notes that probably there's not a typical microbiota, since feed composition, environmental conditions, drugs and pathogens have different effects on bacterial species. These results are in accordance to those reported by Dionízio (2001), who evaluated the effect of antibiotics, prebiotics and probiotics as growth promotants. However, the results of the present study are different from those obtained by Apajalaht and Bedford (1999), who observed bacterial population density of approximately 10 CFU/g in the caecum and in the small intestine. Similar values were reported by Fuini (2001) with different levels of mushroom extract and antibiotic in broilers diets. There was no difference (P>0.05) between genders concerning bacterial counts, with males and females showing a stability of bacterial populations, with some microorganisms prevailing over others. There was interaction (P<0.05) for additives and gender in crop pH measurements. Males had lower pH values, possibly benefiting digestive processes. Fumaric acid supplementation resulted in lower pH in both sexes. This was not observed when probiotic was used, since it contains lactic acid-producing lactobacilli, reducing pH to values lower than 5.0 and possibly affecting the microbial population in the small intestine. There was an interaction (P<0.05) between factors in the duodenum, an extremely important portion for digestion, where MOS and probiotic resulted in higher duodenal pH in females, however without significant differences between genders. These values are higher than those obtained by Santos (2003), Silva et al. (2000) and Dionízio (2001). In the caecum, there was interaction (P<0.05) between factors, where male birds fed MOS showed higher pH. These data indicate that the action of beneficial bacteria may result in better performance in males. Feed pH values were similar to those observed by Henrique et al. (1998) and Dionízio (2001), who have not seen any effect of additives on feed pH. However, the quality of corn and soybean used as feed ingredients may pH values of the finished feed.

TABLE 5. Total bacterial counts in intestinal and cecal samples and feed pH values. (Broilers fed different feed additives from 1 to 42 days of age).

	Parameters		
Additive	**Intestine Log (UFC/g)**	**Caecum Log (UFC/g)**	**Feed (pH)**
Control	7.23 D	7.39 E	6.27 A
Basal	7.63 C	8.85 B	6.26 A
MOS	8.41 A	8.46 C	6.25 A
FOS	8.52 A	8.67 C	6.25 A
Fumaric acid	7.32 D	7.37 E	6.01 C
Mushroom extract	8.13 B	8.17 D	5.98 C
Probiotic	8.33 A	9.27 A	6.18 B
Males	7.93	8.34	6.18
Females	7.94	8.28	6.16
General mean	7.94	8.31	6.17
CV (%)	2.93	2.55	0.80

Means followed by the same letter in a column are not statistically different according to the Scott-Knott test (P<0.05)

TABLE 6. pH values of crop, duodenal and cecal contents obtained from broilers fed different feed additives from 1 to 42 days of age.

Additive	Parameters					
	Crop (pH)		Duodenum (pH)		Caecum (pH)	
	Males	Females	Males	Females	Males	Females
Control	4.62 C a	4.67 B a	6.35 A a	6.13 C b	6.54 C a	6.51 A a
Basal	4.47 C a	4.43 C a	6.14 A a	6.26 B a	6.90 B a	6.47 A b
MOS	4.42 C a	4.66 B a	6.29 A a	6.44 A a	7.17 A a	6.49 A b
FOS	4.65 C b	5.74 A a	6.10 A a	6.03 C a	6.48 C a	6.56 A a
Fumaric acid	4.20 C a	4.22 C a	6.17 A a	6.28 B a	6.65 C a	6.50 A a
Mushroom extract	4.79 B a	4.78 B a	6.12 A a	6.12 C a	6.88 B a	6.50 A b
Probiotic	5.11 A a	4.90 B a	6.20 A b	6.48 A a	6.41 C a	6.62 A a
Males	4.61 b		6.20		6.72 a	
Females		4.77 a	6.25			6.52 b
CV (%)	4.30		2.27		2.83	

Means followed by the same letter in a column are not statistically different according to the Scott-Knott test (P<0.05)

CONCLUSIONS

The use of non-antibiotic growth promotants resulted in better performance and higher carcass, parts and viscera yields in 42-day-old male broilers, besides changing total bacteria counts, intestinal content pH and feed pH. These results suggest the possible use of alternative additives to replace AGP.'s under field challenge conditions.

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