Journal of Animal Production Advances

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J Anim Prod Adv 2013, 3(11): 311-317

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Original Article

Performance Assessment of Broiler Chickens Supplemented with Copaiba Oil-Resin

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Abstract

The aim of this research was to evaluate the use of Copaiba oil-resin, known for its medicinal properties on broiler performance from 1 to 42 days old. It had been also evaluated the carcass yield, cuts yield and relative weight of internal organs of males at 42 days old. Three hundred ninety-six, 1-day-old broiler chickens were housed and distributed in a completely randomized design, consisting of three treatments and six replicates of 22 birds each (11 males and 11 females). Treatments: Control - diet without additive, Antibiotic – diet with 10 ppm virginiamycin, Copaiba – diet with 200 ppm Copaiba oil-resin. Broilers treated with Copaiba oil-resin showed similar body weight (2325.17 g) to the control treatment (2279.36 g). The antibiotic treatment provided significantly higher body weight (2414.29 g), body weight gain (2364.14 g) and feed intake (4052.16 g). No differences in carcass yield, relative weight of the spleen and heart were observed. The antibiotic showed higher breast yield (37.72%) in broilers, and higher thigh + drumstick yield (28.01%) was observed in the control treatment. The inclusion of Copaiba oil-resin resulted in lower relative liver weight (2.12%). No significant differences in mortality and productive efficiency index between treatments were observed. The result of the present study showed that the inclusion of 200 ppm Copaiba oil-resin in the diet of broilers apart of liver weight, had no effect to variables studied, however, more studies are needed to better comprehend the influence of this phytogenic on the diet of broilers.

Keywords: Carcass yield, *copaifera officinalis*, performance enhancer, phytogenic additive.

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Received on: 01 Jul 2013.
Revised on: 28 Jul 2013.
Accepted on: 05 Nov 2013.
Online Published on: 30 Nov 2013.

Introduction

The poultry industry for a long time has used antimicrobials at subtherapeutic doses in order to improve animal performance and reduce mortality from clinical and subclinical infections. However, the growing concerns over the possible the transmission and the proliferation of resistant bacteria via the food chain has restricted its use as performance enhancer feed additives. The European Union, since 2006, does not use or import products of animal origin that were treated with antimicrobial for performance enhancing, being its use allowed only for the purpose of healing (Brenes & Roura, 2010). Given this scenario, the mobilization of researchers looking for alternatives to antimicrobial in animal diets is growing, aiming the reduction of economical and sanitary problems, as well as providing safe and quality products to consumers. Among the alternatives studied are phytogenic additives, consisting of substances derived from herbs or spices (e.g. essential oil, plants extracts, oil-resins) which have positive effect on production and animal health (Perić *et al.,* 2009). The broad vegetation diversity in Brazil favors the use of plants as an alternative therapeutic resource. The Copaiba (*Copaifera officinalis* L.) is a potential candidate, widely used in popular and indigenous medicine, as well as the pharmaceutical industry, due to its anti-inflammatory, antibiotic, pesticide property, among other uses (Veiga Junior & Pinto, 2002). The *Copaifera officinalis* plant belongs to the leguminous family, found mainly in the states of Para and Amazonas. Also, the oil from this plant can be extracted in a sustainable manner through an incision in its trunk (Biavatti *et al.,* 2006). Obtaining a resinous oil known as oil or balsam of Copaiba, however, the appropriate designation is Copaiba oil-resin, mainly composed of resinous acids and volatile substances (Veiga Junior & Pinto, 2002).

Studies confirm that the inclusion of phytogenic additives in broiler diets can provide positive effects on performance such as on body weight gain and feed conversion ratio (Ciftci *et al.,* 2005; Ertas *et al.,* 2005; Silva *et al.,* 2010; Khaligh *et al.,* 2011; Toghyani *et al.,* 2011; Hong *et al.,* 2012; Agostini *et al.,* 2012), important characteristics to obtain productive efficiency. However the benefits of its inclusion are not fully elucidated, and very little research with Copaiba applications *in vivo* had been published. Thereby, the present study was conducted to evaluate the inclusion of Copaiba oil-resin effects in broiler diets on performance and slaughter yield.

Material and Methods

Experimental Site

The experimental procedures were approved and performed under the guidelines of the ethic committee of Federal University of Santa Maria (UFSM). The study was conducted at Poultry Laboratory (LAVIC - Laboratório de Avicultura), Department of Animal Science, UFSM, for the period of January to March 2011.

Animals and Experimental Design

Three hundred ninety six, 1-day-old broiler chickens Cobb500 (198 males and 198 females) with an average body weight of 49.94 ± 0.95 g were housed, vaccinated at hatch for Marek, Gumboro and Fowlpox and sexed by observing the speed of wing warping. Chicks were distributed in a completely randomized design, consisting of three treatments and six replicates of 22 birds half of each sex. The treatments consisted of: Control (T1) – diet without additive; Antibiotic (T2) – diet with 10 ppm virginiamycin; Copaiba (T3) – diet with 200 ppm Copaiba oil-resin (Copaifera officinalis).

Diets

The experimental diets were mash form and isonutritives, formulated based on corn and soybean meal, according to the phases of rearing pre-starter (1-7 days), starter (8-21 days), grower (22-35 days) and finisher (36-42 days), as the levels of nutritional standards for mixed sexes provided by LAVIC (Table 1). The Copaiba oil-resin was added to vegetable oil, and then homogenized with the other diet ingredients. Throughout the experiment, water and experimental diets were provided ad libitum.

Table 1: Composition and nutritional values of broiler control diets (g/kg).

Ingredients	**Control diet**			
	Pre-starter (1-7days)	**Starter (8-21days)**	**Grower (22-35days)**	**Finisher (36-42days)**
Corn	572.5	576.6	579.8	604.4
Soybean meal	358.2	347.0	335.6	313.0
Soybean oil	25.0	32.0	45.0	47.9
Dicalcium phosphate	18.2	18.3	16.7	15.8
Limestone	10.4	9.1	8.9	8.4
Salt	4.0	4.0	4.0	4.0
Vit.& Min. Premix(1)	5.0	5.0	5.0	5.0
L-lysine	1.5	1.3	1.2	0.7
DL-methionine	1.7	1.8	1.9	0.7
L-threonine	-	0.1	0.3	0.1
inert	3.5	4.8	1.6	-
	Calculated composition			
Metabolizable energy (Kcal/kg)	3,000	3,050	3,150	3,200
Crude protein	220	215	210	200
Calcium	10.0	9.5	9.0	8.5
Available phosphorous	4.5	4.5	4.2	4.0
Lysine	13.6	12.5	12.1	11.0
Total sulphur AA	9.1	9.0	9.0	7.6
Methionine	5.7	5.7	5.7	4.4
Threonine	8.2	8.2	8.2	7.7
Tryptophan	2.2	2.2	2.1	1.9
Phenylalanine	10.5	12.5	9.9	9.5
Valine	10.0	9.8	9.5	9.1

(1) Supplying per kg of diet: Vitamin A - 2,200,000 UI; Vitamin D_3 - 500,000 UI; Vitamin E - 5,000 mg; Vitamin K_3 - 660 mg; Vitamin B_1 - 440 mg; Vitamin B_2 - 1,150 mg; Vitamin B_6 - 926 mg; Vitamin B_{12} - 3,600 mcg; Biotin - 36 mg; Folic Acid - 250 mg; Nicotinic Acid - 5,560 mg; Panthothenic Acid - 3,600 mg; Cu - 1,600 mg; Fe - 9,998 mg; I - 88 mg; Mg - 11,993 mg; Se - 40 mg; Zn - 10,996 mg; Choline - 60,000 mg; Methionine - 297,000 mg; Lysine - 78,000 mg; Coccidiostat - 12,000 mg.

Experimental Procedures

The birds were housed in an experimental shed, distributed in 18 pens of 2.25 m² containing wood shavings as bedding material, equipped with electric hood and lamp of 150 watts, pendular drinker, feeder trays in the pre-starter period and tubular feeder later. On the interval of 1 to 42 days the average maximum temperature recorded was 30.8 ± 6.42oC and the minimum was 22.5 ± 5.00oC.

In order to provide challenge to the birds, strategies were used for the production of stress by lighting, the bedding and drinking water. The lighting program used was a continuous (24 hours of light), the bedding was composed of 50% new wood shavings and 50% reused bed and the drinkers were washed in a low frequency.

Statistical Analysis

All birds were weighed to 1, 7, 14, 21, 28, 35 and 42 days for monitoring body weight (BW). The body weight gain (BWG), feed intake mortality corrected (FI) and feed conversion ratio mortality corrected (FCR) were determined in each phases of rearing. Mortalities (Mo) were recorded daily during the overall period. The productive efficiency index (PEI) was calculated to the overall period using the following formula: PEI = average daily weight gain x (100 - mortality)/ feed conversion x 10.

At the age of 42 days, three males from each experimental pen that had presented total variation of 5% from average body weight were selected and identified, remaining fasting of solid food for 6 to 8 hours. After stunning, the birds were killed by bleeding in the jugular vein, plucked and eviscerated, being the head and feet removed. The carcass yield was calculated based on the body weight of the bird before slaughter. The yields of breast and thigh + drumstick, as well as the relative weight of the spleen, heart and liver were calculated based on carcass weight.

The results were submitted to analysis of variance by PROC GLM (General Linear Models) of SAS (Statistical Analysis System, 2009), and means were compared by Tukey test at level the 0.1 of probability. Experimental model used: $Y_{ij} = \mu + t_i + \varepsilon_{ij}$, where Y_{ij} dependent variable; μ overall mean value; t_i effect of treatments (Control, Antibiotic or Copaiba oil-resin), and ε_{ij} random residual error. The level of 0.1 probability was adopted due to the lack of studies on application of Copaiba oil-resin for broilers.

Results and Discussion

The performance of broilers with antibiotic treatment at 7, 28, 35 and 42 days showed the highest body weight (P<0.1) when compared to the birds of the treatment control and Copaiba (Table 2). However, the control treatment at 7 and 28 days did not differ statistically from the other treatments. These results are similar to those found by Hernandez *et al.*, (2004), which found that body weight was higher in birds put on diets with avilamycin when compared to the phytogenic feed additive composed of essential oils of oregano, cinnamon and pepper.

Table 2: Body weight of birds subjected to experimental treatments [(1)].

	Treatments					
Body weight (g)	**Control**	**Antibiotic**	**Copaiba**	**Means**	**SEM**	**P-value**
1 day	49.65	50.14	50.04	49.94	0.112	0.1641
7 days	172.50 ^{ab}	177.32 ^{a}	169.83 ^{b}	173.22	1.371	0.0684
14 days	454.37	464.40	456.04	458.27	3.528	0.4891
21 days	737.39	745.87	737.24	740.17	2.273	0.2151
28 days	1293.43 ^{ab}	1316.68 ^{a}	1284.14 ^{b}	1298.08	5.222	0.0207
35 days	1883.31 ^{b}	1946.08 ^{a}	1890.26 ^{b}	1906.55	10.429	0.0154
42 days	2279.36 ^{b}	2414.29 ^{a}	2325.17 ^{b}	2339.60	15.641	<0.0001

[(1)]Means in the same row with different superscript (a, b, c) differ significantly (P<0.1) by Tukey test.

The performance of broilers in pre-starter phase treated with Copaiba oil-resin showed a lower weight gain (P<0.1) when compared to the antibiotic treatment (Table 3). The lowest feed intake (P<0.1) was presented by the control treatments and Copaiba. During the starter phase no difference was observed in body weight gain between treatments. But, the birds of Copaiba treatment had lower feed intake (P<0.1) and better feed conversion ratio (P<0.1) when compared to the antibiotic treatment. These findings are part of the majority of experimental results, which indicate reduced feed intake at largely unchanged body weight gain or final body weight, leading to an improved feed conversion ratio when broilers feeding with phytogenic compounds (Windisch *et al.*, 2008; Brenes & Roura 2010). Many of these products increase the activity of digestive enzymes, for example, the trypsin and a amylase when the birds are supplemented with thyme essential oil (Ben-Mahdi *et al.*, 2010), and chymotrypsin with the addition of oregano essential oil (Basmacioğlu *et al.*, 2010), promoting better nutrient digestibility. The control treatment in the growth phase, had lower weight gain (P<0.1) when compared to the antibiotic treatment. The birds that received Copaiba oil-resin in the finishing phase, had lower feed intake (P<0.1) in relation to antibiotic treatment, but no difference in body weight gain and feed conversion between treatments was observed. fernandes Neto *et al.*, (2010), found that inclusion 0.15 ml of essential oil of Copaiba (Copaifera reticulata), provided birds of similar body weight in comparison to antibiotic treatment. Those authors, however, haven't found significant differences in the parameters of feed intake, feed conversion and rearing viability among the other treatments. The data from 1 to 42 days showed that antibiotic treatment provided higher weight gain (P<0.0001) and feed intake (P<0.1) when compared to other treatments, and showed better productive efficiency index, however the last one did not differ statistically. During the experimental period, no significant difference in mortality between treatments was observed.

Table 3: Broiler growth performance at stages of rearing and for the entire experiment[(1)].

	Treatments					
	Control	**Antibiotic**	**Copaiba**	**Means**	**SEM**	**P-value**
Pre-Starter (1 - 7 d)						
BWG (g)	122.85 [ab]	127.18 [a]	119.79 [b]	123.28	1.309	0.0584
FI (g)	136.33 [b]	147.29 [a]	136.73 [b]	140.12	1.733	0.0052
FCR (g:g)	1.11	1.16	1.14	113.71	0.011	0.1870
Starter (8 - 21 d)						
BWG (g)	564.89	568.55	567.40	566.95	1.938	0.7564
FI (g)	900.66 [ab]	942.59 [a]	881.34 [b]	908.20	9.814	0.0219
FCR (g:g)	1.59 [ab]	1.66 [a]	1.55 [b]	1.60	0.018	0.0509
Grower (22 - 35 d)						
BWG (g)	1145.92 [b]	1200.21 [a]	1153.02 [ab]	1166.38	9.135	0.0193
FI (g)	1778.31	1847.16	1771.17	1798.88	16.295	0.1045
FCR (g:g)	1.55	1.54	1.54	1.54	0.009	0.7687
Finisher (36 - 42 d)						
BWG (g)	396.05	468.21	434.91	433.05	14.424	0.1205
FI (g)	1035.57 [ab]	1095.41 [a]	1033.08 [b]	1054.68	12.482	0.0596
FCR (g:g)	2.62	2.42	2.38	2.48	0.079	0.4500
Overall (1 - 42 d)						
BWG (g)	2229.71 [b]	2364.14 [a]	2275.13 [b]	2289.66	15.614	<0.0001
FI (g)	3840.95 [b]	4052.16 [a]	3791.63 [b]	3894.91	38.110	0.0043
FCR (g:g)	1.72	1.71	1.67	1.70	0.015	0.2804
Mort (%)	3.79	3.03	3.79	3.53	4.285	0.9840
PEI (%)	296.31	319.56	312.65	309.50	4.915	0.1390

[(1)]Means in the same row with different superscript (a, b, c) differ significantly (P<0.1) by Tukey test. BW - body weight, BWG -body weight gain, FI - feed intake, Mort – mortality, FCR - feed conversion ratio, PEI -Productive Efficiency Index.

The average values of body weight of slaughtered birds showed significant difference (P<0.0001) according to the live weight of males from each experimental unit, being the birds from the treatment with Copaiba the lightest (Table 4). The highest thigh + drumstick yield (P<0.1) was from the control treatment, followed by Copaiba treatment. The chicken breast yield of antibiotic treatment was higher (P<0.1) than the Copaiba treatment, however, the control treatment did not differ statistically from those treatments presented previously. Contrarely, Isabel & Santos (2009), analyzing the effects of the use of essential oils and organic acid, found a higher breast yield by inclusion (100 ppm) of the mixture of essential oils of clove and cinnamon in the broilers diet. Birds that received the dietary inclusion of Copaiba had lower relative liver weight (P<0.1) compared to the other treatments. The exact reason for this difference is unknown, due to the pioneering research and its strict investigative purposes. Nevertheless, this result may be due to a small liver toxicity, or associated with carcass yield, which was slightly higher in Copaiba treatment, causing decreasement of the percentage contribution of the internal organs. Similarly, Barreto *et al.*, (2008) observed that birds fed diets containing red pepper extract had lower relative liver weight (P<0.05). Contrary results, in which treatment with antibiotics had a lower relative weight and phytogenic feed additives the highest relative liver weight, were described by Bozkurt *et al.*, (2009) using a mixture of plant extract of hop and essential oil of oregano, and Simsek *et al.*, (2007) using the essential oil of anise.

Table 4: Slaughter yield of males at 42 days old [(1)].

	Treatments					
	Control	**Antibiotic**	**Copaiba**	**Means**	**SEM**	**P-value**
Body weight (g)	2564.38 ^{b}	2649.63 ^{a}	2500.8 ^{c}	2571.60	12.779	<0.0001
Carcass Yield (%)	73.13	74.04	74.20	73.79	0.294	0.2849
Relative Weight of Carcass (%)						
Breast	36.74 ^{ab}	37.72 ^{a}	36.25 ^{b}	36.90	0.234	0.0306
Thigh + drumstick	28.01 ^{a}	27.14 ^{b}	27.79 ^{ab}	27.65	1.170	0.0955
Spleen	0.16	0.14	0.16	0.15	0.005	0.1413
Heart	0.60	0.57	0.58	0.58	0.009	0.4425
Liver	2.29 ^{a}	2.30 ^{a}	2.12 ^{b}	2.24	0.034	0.0568

[(1)]Means in the same row with different superscript (a, b, c) differ significantly (P<0.1) by Tukey test.

There were no significant differences between treatments on carcass yield and on the relative weight of the spleen and heart of males slaughtered at age of 42 days (Table 4). Kirkpinar *et al.*, (2010) using essential oil of oregano and garlic, and Çabuk *et al.*, (2006) using essential oil mixture (oregano, laurel leaf, sage leaf, myrtle leaf, fennel seed and citrus peel), also found no difference in carcass yield and organ weights of birds.

The positive effects of phytogenic feed additives can not always be demonstrated, if the combined influence of the quality of the chicks, environmental and health conditions in production (Peric *et al.*, 2009). Besides the effect depends on the period of growth and level of inclusion (Mountzouris *et al.*, 2011), which needs to be more accurately identified, considering that this level should not be necessarily fixed to all phases of rearing.

Phytogenic feed additives are a new class of performance enhancers, and its future is dependent on the knowledge of its chemical structure, value and characteristics of practical herbs or their extract physiological needs and well-being of animal, and, above all on consumer's preferences and their expectations (Hashemi & Davoodi, 2011). The lack of researches with the use of Copaiba oil-resin in broiler diets makes it difficult to compare data.

Conclusion

The new segment of the market that search the use of alternatives to antibiotics of subtherapeutic doses, products extracted from plant has attracted considerable interest and demonstrated positive results on animal production. Due to the wide diversity of the plants associated to scientific advances, phytogenics could play an essential role in animal production . The results of this study showed that supplementation of 200 ppm of Copaiba oil-resin in broiler diet did not improve the broiler performance such as body weight gain and feed conversion ratio. Futher studies are needed to elucidate the mechanisms of action and the optimal dose of the Copaiba oil-resin on the performance of broiler.

References

Agostini PS, A-Oriol D. Sol, Nofrarias M, Barroeta AC, Gasa J, Manzanilla EG (2012). Role of in-feed clove supplementation on growth performance, intestinal microbiology, and morphology in broiler chicken. Livest. Sci., 147: 113-118.

Barreto MSR, Menten JFM, Racanicci AMC, Pereira PWZ, Rizzo PV (2008). Plant extracts used as growth promoters in broilers. Braz. J. Poult. Sci**.,** 10(2): 109-115.

Basmacioğlu MH, Baysal S, Misirlioğlu Z, Polat M, Yilmaz H, Turan N (2010). Effects of oregano essential oil with or without feed enzymes on growth performance, digestive enzyme, nutrient digestibility, lipid metabolism and immune response of broilers fed on wheat-soybean meal diets. Br. Poult. Sci., 51(1): 67-80.

Ben-Mahdi MH, Djellout B, Bouzagh-Belazouz T, Yahiaoui F, Ben-Mahdi NR (2010). Intérêt de l'huile essentielle de thym dans l'amélioration des performances zootechniques et sanitaires du poulet de chair. Livest. Res. Rural Dev., 22(6): 112.

Biavatti MW, Dossin D, Deschamps FC, Lima MP (2006).Copaiba oil-resin analysis: contribution to quality control. Braz. J. Pharmacogn., 16(2): 230-235.

Bozkurt M, Küçükyilmaz K, Çath AU, Çinar M (2009). Effect of dietary mannanoligosaccharide with or without oregano essential oil and hop extract supplementation on the performance and slaughter characteristics of male broilers. S. Afr. J. Anim. Sci**.,** 39(3): 223-232.

Brenes A, Roura E (2010). Essential oils in poultry nutrition: Main effects and modes of action. Anim. Feed Sci. Technol., 158: 1-4.

Ciftci M, Güler T, Dalkiliç B, Ertas ON (2005). The effect of anise oil (*Pimpinella anisum* L.) on broiler performance. Int. J. Poult. Sci., 4(11): 851-855.

Çabuk M, Bozkurt M, Alçiçek A, Akbaş Y, Küçükyilmaz K **(**2006). Effect of a herbal essential oil mixture on growth and internal organ weight of broilers from young and old breeder flocks. S. Afr. J. Anim. Sci**.,** 36(2): 135-141.

Ertas ON, Güler T, Çiftçi M, Dalkiliç B, Simsek ÜG (2005). The effect of an essential oil mix derived from oregano, clove and anise on broiler performance. Int. J. Poult. Sci., 4: 879-884.

Fernandes Neto DL, Aguilar CAL, Lima KRS, Manno MC, Tavares FB, Viana MAO. (2010) Effects of the levels of inclusion of essential oil of copaiba (*Copaifera reticulata*) on the performanceof broilers. Proceedings of the Reunião Anual da Sociedade Brasileira de Zootecnia, 47, Salvador: SBZ, 2010. CDROM.

Hashemi SR, Davoodi H (2011). Herbal plants and their derivatives as growth and health promoters in animal nutrition. Vet. Res. Commun., 35: 169-180.

Hernández F, Madrid J, Garcia V, Orengo J, Megías MD (2004). Influence of two plant extracts on broiler performance, digestibility, and digestive organ size. Poult. Sci., 83: 169-174.

Hong JC, Steiner T, Aufy A, Lien TF (2012). Effects of supplemental essential oil on growth performance, lipid metabolites and immunity, intestinal characteristics, microbiota and carcass traits in broilers. Livest. Sci., 144: 253-262.

Isabel B, Santos Y (2009). Effects of dietary organic acids and essential oils on growth performance and carcass characteristics of broiler chickens. J. Appl. Poult. Res**.,** 18: 472-476.

Khaligh F, Sadeghi G, Karimi A, Vaziry A (2011). Evaluation of different medicinal plants blends in diets for broiler chickens. J. Med. Plant. Res., 5(10): 1971-1977.

Kirkpinar F, Bora Ünlü H, Özdemir G (2010). Effects of oregano and garlic essential oils on performance, carcase, organ and blood characteristics and intestinal microflora of broilers. Livest. Sci., 137(1-3): 219-225.

Mountzouris KC, Paraskevas V, Tsirtsikos P, Palamidia I, Steinerb T, Schatzmayrc G, Fegerosa K (2011). Assessment of a phytogenic feed additive effect on broiler growth performance, nutrient digestibility and caecal microflora composition. Anim. Feed Sci. Technol., 168(3): 223-231.

Perić L, Žikić D, Lukić M (2009). Aplication of alternative of growth promoters in broiler production. Biotech. Anim. Husb., 25(5-6): 387-397.

Silva MA, Pessotti BMS, Zanini SF, Colnago GL, Nunes LC, Rodrigues MRA, Ferreira L (2010). Brazilian red pepper oil use on the performance and intestinal morphometry of broilers. Cienc. Rural., 40: 2151-2156.

Simsek ÜG, Ciftci M, Dalkilic B, Üler TG, Ertas ON (2007). The effects of dietary antibiotic and anise oil supplementation on body weight, carcass characteristics and organoleptic analysis of meat in broilers. Revue Med. Vet., 158(10): 514-518.

Toghyani M, Toghyani M, Gheisari A, Ghalamkari G, Eghbalsaied S (2011). Evaluation of cinnamon and garlic as antibiotic growth promoter substitutions on performance, immune responses, serum biochemical and haematological parameters in broiler chicks. Livest. Sci., 138: 167-173.

Veiga Junior F, Pinto AC (2002). O gênero *Copaifera* L. - A review. Quim. Nova, 25(2): 273-286.

Windisch W, Schedle K, Plitzner C, Kroismayr A (2008). Use of phytogenic products as feed additives for swine and poultry. J. Anim. Sci., 86(E. Suppl.): E140-E148.