An Acad Bras Cienc (2024) 96(2): e20230577 DOI 10.1590/0001-3765202420230577
Anais da Academia Brasileira de Ciências | *Annals of the Brazilian Academy of Sciences*
Printed ISSN 0001-3765 I Online ISSN 1678-2690
www.scielo.br/aabc | www.fb.com/aabcjournal

ANIMAL SCIENCE

Buriti oil as an alternative to the use of antimicrobials in broiler diets

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Abstract: The objective of this study was to evaluate the effects and economic viability of diets containing different levels of antibiotic and buriti oil (BO) on performance, carcass and cut yields, and relative weight of organs of broilers. A total of 432 one- to 42-day-old male chicks were distributed in a completely randomized experimental design with six treatments, each consisting of six replicates of 12 birds. The treatments consisted of one diet with antibiotic without BO, one diet without antibiotic (DWA) without BO, and four DWA containing increasing levels of BO (0.2, 0.4, 0.6, and 0.8%). Average weight and weight gain (WG) of broilers fed with DWA + BO were similar to those of birds fed control diet. Feed intake and feed conversion (FC) were not different among treatments. Relative weight of pancreas linearly increased in the birds fed diets containing BO. The inclusion of 0.45 and 0.40% of BO in the diets promoted the improvement of WG and FC, respectively. Cost of feed management, ratio, gross margin, and gross income did not differ among treatments. It was concluded that the inclusion of 0.45% of BO in diets without antibiotics is economically feasible and allows recovering the performance of broilers.

Key words: *Gallus gallus*, phytogenic additives, performance-enhancing antibiotics, antimicrobial activity, essential oils.

INTRODUCTION

The performance-enhancing antibiotics (PEA) are present in most of the livestock diets. These antibiotics have played an important role in poultry development through the reduction of pathogens in the gastrointestinal tract and improvement in the nutrient absorption. In recent years, however, the use of PEA has been restricted due to the spread of antibiotic-resistant bacteria (Hong et al. 2012). Antibiotic resistance has become a public health problem at the global level, because it reduces future antimicrobial efficacy both in humans and animals (McCubbin et al. 2021).

In 2006, the European Union approved a resolution to ban the use of antibiotics as growth promoters for animals and currently, in Brazil, the Ministry of Agriculture, Livestock and Supply has restricted the use of some antibiotics, also based on the phenomenon of bacterial antibiotic resistance. This phenomenon is defined as a biological effect that enables microorganisms to multiply or persist in the presence of therapeutic levels of a particular antibiotic (Apata 2009).

Several studies using products extracted from some plants have been conducted to find out appropriate alternatives to the use of antibiotics (Huyghebaert et al. 2011, Traesel et al. 2011). In this context, the use of phytogenic additives (e.g. essential oils) has been considered, since they are plant secondary metabolites with antibacterial and growth promoter properties, and have positive effects on digestive physiology and microbiology of the gut (Franz et al. 2010).

Essential oils are generally recognized as safe by the U. S. Food and Drug Administration. These plant extracts inhibit the growth of pathogenic microorganisms in the gut and increase nutrient digestibility (Jang et al. 2007). The diets containing essential oils have beneficial effects on intestinal microflora and digestive enzymes, with significant results on the performance of broilers (Lee et al. 2003).

The potential uses of essential oils as feed additives depend on the properties of herbs, the comprehension of their principal and secondary components, knowledge of their mechanisms of action, the safety of animals and the products they produce. The natural origins of essential oils, their multifaceted benefits and alignment with consumer preferences make them a valuable addition to modern animal farming process. However, because of their inconsistent effects and inadequate knowledge of the mechanisms of action, their usage as a feed additive has been limited (Biswas et al. 2024). Therefore, it is essential to carry out further studies to consolidate the inclusion of these possible additives in animal feed.

The buriti (*Mauritia flexuosa* L.) oil has potential to be used as an essential oil and stands out because of its chemical and pharmacological properties. Saturated fatty acids, unsaturated fatty acids, flavonoids, catechins, steroids, saponins, and terpenes present in the extract of buriti probably have antimicrobial activity against Gram-positive and Gram-negative bacteria (Silveira et al. 2005, Oliveira et al. 2016).

The therapeutic potential of *M. flexuosa* oil indicates good perspectives in the use of this product as essential oil and antibiotic growth promoter in broiler diets. However, there are no results in the literature either on the use of buriti oil as substitute for antibiotic growth promoters in feed for broiler chickens or on the activity of this extract on performance and health of broilers. Thus, the objective of the present study was to evaluate the effects and economic viability of diets containing different levels of buriti oil as an alternative to the use of antimicrobials on performance, carcass and cut yields, and relative weight of organs of broilers.

MATERIALS AND METHODS

The experiment was carried out in January 2018, in the poultry sector of the Technical School of Bom Jesus, at the Campus Professora Cinobelina Elvas of the Federal University of Piauí (UFPI), located in the municipality of Bom Jesus, PI, Brazil (latitude 9°04’57.8”S, longitude 44°19’36.8”W at an altitude of 277 m a.s.l.). The methodology applied in the use of animals as experimental models does not violate the ethical guidelines for the use of animals in scientific research defined by the National Council for the Control of Animal Experimentation (CONCEA). This study was approved by the Ethics Committee on the Use of Animals (CEUA/UFPI) with protocol number 007/2013.

A total of 432 one-day-old Ross AP95 male chicks with an average initial body weight of 44.59±0.24 g were used in a 42-day trial. The birds were distributed according to a completely randomized experimental design in 36 floor pens with 2 m^2 of area. There were six treatments, each consisting of six replicates of 12 birds (72 birds per treatment). Experimental pens had rice hulls as bedding, one bell drinker, and one tube feeder. In the first week, heating was provided by 150 watt halogen bulbs.

Treatments consisted of one diet containing antibiotic without buriti oil (BO) (control)[T1], one diet without antibiotic (DWA) without buriti oil (DWA + 0% BO)[T2], and four diets without antibiotic with inclusion of increasing levels of buriti oil (0.2% BO[T3]; 0.4% BO[T4]; 0.6% BO[T5]; and 0.8% BO[T6]). The experimental diets were formulated using corn, soybean meal, vitamin and mineral supplements (without antibiotic), and amino acids, to meet the nutritional requirements of male broilers (Tables I and II) recommended by Rostagno et al. (2017). The antibiotic Bacitracin Methylene Disalicylate 11% was used (100 g/ton of ration) only in the control diet of all

Table I. Composition of basal diets for broiler chickens fed according to ages.

Ingredients	Phase (days of age)			
	1-7	8-21	22-35	36-42
Corn	60.271	58.624	60.663	65.455
Soybean meal	32.778	33.478	30.807	26.795
Dicalcium phosphate	2.008	1.731	1.487	1.194
Limestone	0.807	0.871	0.824	0.714
L-lysine	0.663	0.377	0.355	0.332
Salt (NaCl)	0.522	0.518	0.493	0.466
Supplement[1]	0.500	0.400	0.350	0.300
DL-methionine	0.403	0.385	0.349	0.297
L-arginine	0.233	0.127	0.113	0.100
L-threonine	0.179	0.150	0.131	0.104
Calculated composition[2]				
Metabolizable energy (Mcal/kg)	2.950	3.050	3.150	3.200
Linoleic acid (%)	2.066	2.946	3.537	3.510
Crude protein (%)	21.05	20.73	19.60	18.05
Calcium (%)	0.920	0.878	0.792	0.666
Chlorine (%)	0.382	0.378	0.364	0.350
Available phosphorus (%)	0.470	0.419	0.370	0.311
Sodium (%)	0.220	0.218	0.208	0.197
Digestible arginine (%)	1.415	1.344	1.257	1.138
Digestible lysine (%)	1.310	1.256	1.175	1.064
Digestible Met + Cys (%)	0.944	0.929	0.870	0.787
Digestible methionine (%)	0.673	0.656	0.609	0.543
Digestible threonine (%)	0.852	0.829	0.776	0.702
Digestible tryptophan (%)	0.223	0.226	0.212	0.192
Digestible valine (%)	0.826	0.835	0.789	0.725

[1]Composition per kg of product: 3,000 IU vitamin A, 9,500 IU vitamin E, 588 mg vitamin B1, 1,160 mg vitamin B2, 792 mg vitamin B6, 4,150 mg vitamin B12, 520 mg vitamin K3, 800 IU vitamin D3, 3,230 mg calcium pantothenate, 9,800 mg niacin, 200 mg folic acid, 20 mg biotin, 13 g zinc, 13 g iron, 15 g manganese, 3,120 mg copper, 254 mg iodine, 48 mg cobalt, 88 mg selenium, 52 mg etoxiquim, 40 mg butyl hydroxyanisole (BHA), 1,000 mg vehicle QSP.[2]Composition calculated according to the level of inclusion of all ingredients, including starch, soybean oil, and buriti oil (presented in Table II).

rearing phases. The buriti oil was obtained from a cooperative (Cooperativa dos Produtores da Região do Vale do Gurgueia) located in the municipality of Bom Jesus. The chemical composition of the buriti oil was determined in a previous study by Martins (2017).

The management of the birds followed recommendations of the Ross Broiler Management Handbook. All chicks were vaccinated (only in the incubator) against infectious bronchitis and Newcastle. Birds were submitted to conditions similar to commercial management, as for

Table II. **Inclusion levels of buriti oil and antibiotic in experimental control diets for broilers adjusting starch and soybean oil to maintain the dietary energy level shown in Table I.**

Ingredients	Treatments (inclusion of buriti oil) (%)					
	Control	0	0.2	0.4	0.6	0.8
1 to 7 days of age						
Buriti oil	0.000	0.000	0.200	0.400	0.600	0.800
Antibiotic	0.010	0.000	0.000	0.000	0.000	0.000
Soybean oil	1.322	1.315	1.190	1.065	0.940	0.815
Starch	0.300	0.317	0.242	0.167	0.092	0.017
Basal diet	98.364	98.364	98.364	98.364	98.364	98.364
Total	100.0	100.0	100.0	100.0	100.0	100.0
8 to 21 days of age						
Buriti oil	0.000	0.000	0.200	0.400	0.600	0.800
Antibiotic	0.010	0.000	0.000	0.000	0.000	0.000
Soybean oil	3.047	3.040	2.916	2.791	2.665	2.540
Starch	0.283	0.299	0.225	0.150	0.070	0.000
Basal diet	96.661	96.661	96.661	96.661	96.661	96.661
Total	100.0	100.0	100.0	100.0	100.0	100.0
22 to 35 days of age						
Buriti oil	0.000	0.000	0.200	0.400	0.600	0.800
Antibiotic	0.010	0.000	0.000	0.000	0.000	0.000
Soybean oil	4.133	4.126	4.001	3.876	3.751	3.626
Starch	0.282	0.299	0.224	0.149	0.074	0.000
Basal diet	95.572	95.572	95.572	95.572	95.572	95.572
Total	100.0	100.0	100.0	100.0	100.0	100.0
36 to 42 days of age						
Buriti oil	0.000	0.000	0.200	0.400	0.600	0.800
Antibiotic	0.010	0.000	0.000	0.000	0.000	0.000
Soybean oil	3.958	3.951	3.826	3.701	3.576	3.451
Starch	0.283	0.300	0.225	0.150	0.073	0.000
Basal diet	95.759	95.759	95.759	95.759	95.759	95.759
Total	100.0	100.0	100.0	100.0	100.0	100.0

example, a lighting program of 24 hours of light in the first week of age and an intermittent lighting program of 22 hours of light from 8 to 42 days of age. An automatic timer was used for intermittent lighting. Temperature and humidity inside the shed were monitored daily using a thermal hygrometer sensor placed at an intermediate height in relation to the floor pens. During the trial period, the mean values for the maximum and minimum temperatures, and relative humidity were 32.5°C, 22.8°C, and 67%, respectively. Feed and water were supplied *ad libitum*, and mortality was recorded daily.

The following performance variables were evaluated from 1 to 42 days of age: weight gain; feed intake; and feed conversion. The feed intake was corrected for mortality according to Sakomura & Rostagno (2016). On day 42, two birds from each experimental unit were selected based on the average weight of that unit. They were identified with numbered plastic labels, fasted for 8 hours, weighed, and submitted to standard slaughter procedures. Carcass yield was calculated in relation to the weight of fasted birds prior to slaughter. Eviscerated carcasses (with no head and feet) were used to evaluate yields of carcass, commercial cuts (breast, thighs, drumsticks, and wings), and viscera (liver, heart, and gizzard). Gizzards were weighed after they were opened to remove their feed content. Lymphoid organs (pancreas, thymus, splen, and bursa of Fabricius) were separated and weighed on a precision scale. The yield percentage or relative weight of cuts and viscera were calculated based on the eviscerated carcass weight.

In order to calculate the economic viability of the diets, the following primary variables were considered: average feed intake (AFI, kg), feed cost (FC, kg), average weight gain (AWG, kg), average live weight (ALW, kg), and price of the live chicken (PLC, kg). Based on the observed values for these primary variables, the following economic indicators were obtained, according to Togashi (2004): average feed cost (AFC) = AFI x FC; AFC/AWG ratio; average gross income (AGI) = ALW x PLC; and average gross margin (AGM) = AGI – AFC. Gross margin (GM) was calculated as GM = (kg of chicken produced x selling price of chicken) – (feed price x feed consumed), considering the prices of feed ingredients.

Data were subjected to analysis of variance using the GLM procedure of the statistical program SAS (Statistical Analysis System, version 9.1). Means were compared by the SNK test at 5% probability. Subsequently, the control treatment was removed and the estimates of the levels of buriti oil were obtained using linear and polynomial regression models.

RESULTS AND DISCUSSION

Average weight (AW) and weight gain (WG) were different among treatments throughout the experimental period ($P<0.05$; Table III). The birds that received diets without antibiotic had lower AW and WG than those fed with diets containing antibiotic. However, the inclusion of buriti oil promoted recovery of weight and weight gain of birds fed diets without antibiotic. Similarly, Koiyama et al. (2014) reported that broiler chickens fed diets with blend of essential oils from rosemary, clove, ginger, and oregano had performance similar to birds fed diets containing antibiotic.

In the present study, the performance of broilers fed diets containing buriti oil suggest that this extract may be beneficial for gut flora and nutrient digestibility, since the buriti oil has antimicrobial and anti-inflammatory properties, and probably inhibits the growth of some bacteria species (Batista et al. 2012). This phenomenon is probably due to the high carotenoid content in the buriti oil. Carotenoids

Table III. Performance of 1 to 42-day-old broilers fed diets containing different levels of antibiotic and buriti oil (BO)[1].

Treatments	Variables			
	AW (g/bird)	FI (g/bird)	WG (g/bird)	FC (%)
CONTROL[2]	3,433.3^{a}	5,696.8	3,388.7^{a}	1.68433
DWA + 0.0% BO	3,216.0^{b}	5,646.6	3,169.8^{b}	1.78320
DWA + 0.2% BO	3,371.5^{ab}	5,691.3	3,326.7^{a}	1.71125
DWA + 0.4% BO	3,353.6^{ab}	5,529.6	3,308.6^{ab}	1.67100
DWA + 0.6% BO	3,332.5^{ab}	5,832.5	3,287.2^{ab}	1.77350
DWA + 0.8% BO	3,299.6^{ab}	5,712.4^{a}	3,253.8^{ab}	1.75640
ANOVA Prob	0.0536	0.3846	0.0524	0.1174
SEM	104.83			
Polynomial regression analysis (levels of BO)				
ANOVA Prob	0.0457			
Regression	0.0097^{Q}			
SE	76.94			

[1]Means followed by different letters in the same column significantly differ by SNK test, at 5% probability. AW, average weight; FI, feed intake; WG, weight gain; FC, feed conversion; DWA, diet without antibiotic; SEM, standard error of the mean; ANOVA, analysis of variance; Prob, probability; ^{Q}quadratic; SE, standard error. [2]Control diet values shown in Table II.

are natural pigments also used as additives, which have antioxidant properties and are related to important physiological actions such as antimicrobial activities (De Rosso & Mercadante 2007).

Feed intake and feed conversion were not significantly different (P<0.05) among birds fed with the diets evaluated in this study. Similar results were reported by Ghazanfari et al. (2015) and Hong et al. (2012), who did not find significant differences in feed intake and feed conversion among broilers fed with diets containing antibiotic and birds fed diets containing essential oils from different plant extracts. Surely the buriti oil has pleasant flavor and aroma (Bovi et al. 2017), so that changes in feed intake associated with buriti oil could be due to these characteristics. However, this assumption has not been confirmed.

The regression equation for the different levels of inclusion of buriti oil showed quadratic effect for average weight, weight gain, and feed conversion (Table IV). The inclusion of 0.45% buriti oil in diets without antibiotics maximized average weight and weight gain, whereas the 0.40% inclusion level optimized feed conversion. The regression equations did not fit feed intake data. According to Lee et al. (2003), the increase in performance, macronutrient digestibility, and plasma lipids could be associated with the presence of essential oils in the feed of broiler chickens, since the essential oil components stimulate endogenous secretion of digestive enzymes.

Buriti oil hydrates and regenerates the hydrolipidic barrier of the skin that is frequently subjected to lesions (Zanatta et al. 2008). It is believed that beta-carotene is the major carotenoid found in the buriti oil. This carotenoid has provitamin A activity and, when administrated along with vitamin E transfer additional protection against cell damages and work as antioxidants, since they act as prophylactic agents and potential therapeutics

Table IV. Regression equations for average weight (AW), weight gain (WG), and feed conversion (FC) for 1 to 42-day-old broilers fed diets containing different levels of antibiotic and buriti oil (BO).

Regression equation	Derivative of the equation	*P*-value	R^2
$AW = 3{,}231.76 + 607.14\ BO - 670.38\ BO^2$	0.45%	0.0097	0.780
$WG = 3{,}185.7 + 612.99\ BO - 677.44\ BO^2$	0.45%	0.0096	0.800
$FC = 1.775 - 0.376\ BO + 0.468\ BO^2$	0.40%	0.0498	0.520

in various diseases (Ratnam et al. 2006). Because of these properties, the inclusion of buriti oil in broiler diets is a beneficial alternative to the use of performance-enhancing antibiotics, since the buriti oil could improve the recovery of the gut epithelium, which is frequently invaded by microorganisms responsible for subclinical infections.

The phytotherapeutic activities of buriti oil as well its popular use are known to reduce inflammatory processes, so that the efficacy of this plant extract is due to its use, for many years, by different ethnic groups (Barbosa et al. 2017). The findings of the present study show the performance of broilers fed diets containing buriti oil (as essential oil or additive). In addition, we investigated the possibility of using this product as an alternative to the use of growth promoter antibiotics in broiler diets. According to Perić et al. (2009), essential oils have positive effects on production and health of broiler chickens.

No significant differences were observed when carcass and cut yields were compared among 42-day-old broilers fed diets containing different levels of antibiotic and buriti oil ($P<0.05$; Table V). Similarly, some authors did not find any differences in carcass and cut yields of broilers fed diets containing different essential oils (without antibiotic) in comparison to birds fed diets containing antibiotic (Hong et al. 2012, Khattak et al. 2014, Koiyama et al. 2014).

The results of the present study indicate that the relative weights of spleen, thymus, pancreas, and bursa of Fabricius in 42-day-old broiler chickens were not influenced ($P<0.05$) by the different treatments. Similarly, Hernández et al. (2004) did not find differences in relative weights of organs of broilers fed diets containing essential oil (sage, thyme, and rosemary) in comparison to birds fed diet containing antibiotic. Carrijo et al. (2005) and Toghyani et al. (2011) also did not observe increase in the weights of lymphoid organs in broilers fed with different phytogenic feed additives.

Relative weight of pancreas had positive linear effect, according to the equation $RWP = 0.1888 + 0.043\ BO$ ($R^2 = 0.66$). The increase in the weight of pancreas is probably related to the inclusion of buriti oil in the diet, due to the fatty acids present in this plant extract. According to Xavier et al. (2008), high levels of fatty acids stimulate the increased secretion of digestive enzymes, because of the hypertrophy of secretory cells, thus resulting in an increase in pancreas size in broilers. In contrast, there are no reports of results similar to the above mentioned using essential oils instead of performance-enhancing antibiotics.

Kirkpinar et al. (2011) did not observe any increase in pancreas when broilers were fed diet containing essential oils from oregano and garlic. Efficiency of digestion, absorption, and increased utilization of nutrients in broilers rely on the age. The reasons are the development of

Table V. Carcass yield and relative weight of organs of 42-day-old broilers fed diets containing different levels of antibiotic and buriti oil (BO)[1].

Treatments	Variables (%)											
	CY	BY	TY	DY	WY	LY	GY	RWH	RWP	RWT	RWS	RWBF
CONTROL[2]	78.5	37.8	12.9	15.1	10.2	2.25	1.86	0.49	0.17	0.39	0.12	0.11
DWA + 0.0% BO	78.6	36.5	13.0	15.2	10.3	2.12	1.95	0.56	0.18	0.39	0.11	0.10
DWA + 0.2% BO	78.6	37.2	13.4	15.2	10.1	2.14	2.05	0.56	0.22	0.35	0.11	0.12
DWA + 0.4% BO	79.1	37.1	13.4	14.9	10.2	1.96	1.98	0.52	0.22	0.38	0.09	0.12
DWA + 0.6% BO	78.1	36.9	13.8	15.5	10.1	2.08	1.93	0.57	0.20	0.42	0.11	0.12
DWA + 0.8% BO	78.5	36.8	13.4	14.9	10.2	2.18	1.91	0.59	0.23	0.36	0.1	0.13
Probability	0.5989	0.8522	0.1450	0.7884	0.9438	0.5061	0.8816	0.1407	0.1544	0.7012	0.4872	0.7637
Regression Prob	ns	ns	ns	ns	ns	ns	ns	ns	L*	ns	ns	ns
CV%	1.14	4.41	3.97	4.95	4.07	11.51	13.68	11.54	19.16	20.72	16.86	35.31

[1]Means followed by different letters in the same column significantly differ by SNK test, at 5% probability. CV, coefficient of variation; L*, linear; CY, carcass yield; BY, breast yield; TY, thigh yield; DY, drumstick yield; WY, wing yield; LY, liver yield; GY, gizzard yield; RWH, relative weight of heart; RWP, relative weight of pancreas; RWT, relative weight of thymus; RWS, relative weight of spleen; RWBF, relative weight of the bursa of Fabricius; and Prob, probability. [2]Control diet values shown in Table II. [ns]Nonsignificant.

intestines, liver, and pancreas, since the enzyme system is selective for each group of fatty acids and is modified according to the development of the digestive tract (Kato et al. 2011).

Buriti oil has approximately 73.3 to 78.73% of oleic acid and 2.4 to 3.93% of linoleic acid (Pérez et al. 2018). The linoleic acid is known as metabolically essential for broilers, since these birds are not able to synthesize this acid, thus needing its inclusion in the diets (Tufarelli et al. 2016). According to Pinto et al. (2014), the presence of unsaturated fatty acids in the diets is beneficial for the productive performance and immune system of broilers. This could partially explain the results found in the present study. Latshaw (2008) reported that the combination of various unsaturated fatty acids in broiler diets has positive impact in the reduction of the passage rate of digestive content through the gastrointestinal tract. This allows better absorption and utilization of nutrients and, consequently, more effective utilization of nutrients of the diet.

For the economic indicators, no significant differences were observed among treatment means during the experimental period ($P<0.05$; Table VI), except for the average gross income. Average feed cost (AFC), AFC/AWG ratio, and average gross income (AGI) did not differ between broilers fed diets containing up to 0.4% buriti oil and birds fed the control diet. However, when these indicators are compared among chickens fed the DWA + 0.6% BO and DWA + 0.8% BO diets and birds fed the control diet, AFC increased 10.3% (for both inclusion levels of BO), whereas AFC/AWG ratio increased 11.9 and 13.7%, respectively. On the other hand, AGI decreased 23.52% when the inclusion levels of buriti oil above mentioned were compared to the control diet. These findings show that the inclusion of up to 0.4% of buriti oil as performance enhancer in broiler diets is economically viable.

In conclusion, broilers fed diets without antibiotic with inclusion of 0.45% buriti oil have similar performance to birds fed diets containing antibiotic. Furthermore, the inclusion of buriti oil in broiler diets is economically feasible, so

Table VI. **Economic evaluation of 1 to 42-day-old broilers fed diets containing different levels of antibiotic and buriti oil[(1)].**

	Variables			
Treatments	**ACF**	**ACF/AWG**	**AGI**	**AGM**
CONTROL[(2)]	5,513.8[b]	1.65186[b]	9,088.4	3,574.6 [a]
DWA + 0.0%	5,449.0[b]	1.70575[b]	8,670.7	3,221.7[a]
DWA + 0.2%	5,636.0[b]	1.69475[b]	9,035.6	3,399.6[a]
DWA + 0.4%	5,629.0[b]	1.70120[b]	8,987.0	3,358.0[a]
DWA + 0.6%	6,082.2[a]	1.84850[a]	8,987.0	2,849.0[b]
DWA + 0.8%	6,082.2[a]	1.87800[a]	8,843.0	2,733.8[b]
Probability	0.0001	0.0001	0.3975	0.0046
CV(%)	3.57	4.51	3.53	10.87

[(1)]Means followed by different letters in the same column significantly differ by SNK test, at 5% probability. ACF, average cost of feed management; AWG, average weight gain; AGI, average gross income; AGM, average gross margin; and CV, coefficient of variation. [(2)]Control diet values shown in Table II.

that the buriti oil could be a viable alternative for antibiotic use in poultry feeding.

Acknowledgments

The authors are grateful to Evonik, for supply of the crystalline amino acids used in the present study, and the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES), Brazil – Finance code 001.

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How to cite

CARVALHO FLA, LOPES PM, MOURA FAS, DOURADO LBR, DE SOUZA RG, FEITOZA AC, DE OLIVEIRA AN & BIAGIOTTI D. 2024. Buriti oil as an alternative to the use of antimicrobials in broiler diets. An Acad Bras Cienc 96: e20230577. DOI 10.1590/0001-3765202420230577.

Manuscript received on May 27, 2023;
accepted for publication on March 3, 2024

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