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Supplementation of extract of *Lafoensia pacari* in the diet of semi heavy laying hens

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ABSTRACT. It was intended to evaluate the supplementation of *Lafoensia pacari* standardized in tannins extract in the diet of laying hens on the performance, internal and external quality of eggs and metabolism of the feed nutrients. A total of 168 Isa Brown laying hens, aged 24 weeks, with the mean weight of 2.6 kg and the mean posture rate of 87% were used during 4 periods of 28 days each. The treatments consisted of Halquinol performance-enhancing antibiotic, Mannanoligosaccharide (MOS) prebiotic and three levels of pacari extract – 1,000, 2,000 and 3,000 mg $kg^{-1}$of feed. The experimental design was completely randomized, with six treatments and seven replicates of four hens each. The pacari standardized in tannin extract presented a percentage of albumen and an egg weight similar to the antibiotic ($p < 0.04$). The supplementation with the extract improved the shell quality, verified by the specific gravity ($p < 0.03$) and promoted the metabolizability of ether extract similar to antibiotic and MOS ($p < 0.04$), allowing its indication as a phytogenic additive.

Keywords: egg production, metabolism, performance, phytogenic additive.

Suplementação de extrato de *Lafoensia pacari* na ração de poedeiras semipesadas

RESUMO. Objetivou-se avaliar a suplementação do extrato de *Lafoensia pacari* padronizado em taninos na ração de poedeiras sobre o desempenho, a qualidade interna e externa de ovos e metabolizabilidade dos nutrientes da ração. Utilizaram-se 168 poedeiras Isa Brown com 24 semanas de idade, peso médio 2,6 kg e taxa de postura média 87% durante quatro períodos de 28 dias cada. Os tratamentos constituíram de rações com antibiótico melhorador de desempenho Halquinol, prebiótico Mananoligossacarídeo (MOS) e três níveis de extrato de pacari – 1.000, 2.000 e 3.000 mg kg^{-1} de ração. O delineamento experimental foi inteiramente casualizado com seis tratamentos e sete repetições com quatro aves cada. O extrato de pacari padronizado em teor de taninos apresentou porcentagem de albúmen e peso do ovo semelhante ao antibiótico ($p < 0,04$). A suplementação com o extrato melhorou a qualidade da casca, verificada pela gravidade específica ($p < 0,03$) e promoveu metabolizabilidade do extrato etéreo semelhante ao antibiótico e MOS ($p < 0,04$), sendo indicado como aditivo fitogênico.

Palavras-chave: aditivo fitogênico, produção de ovos, desempenho, metabolismo.

Introduction

The inclusion of performance-enhancing antibiotics (PEA) in animal feed is an important factor in the aviaryposture production, although its probable induction to bacterial resistance has influenced the restriction of their use. Thus, in order to replace the PEA, it has been investigated alternative enhancing promoters that can maintain or improve productive indexes, being innocuous and economically feasible (Dibner & Richards, 2005).

Phytogenic additives are included in animal feed as extracts or oils. Currently, they have been studied as performance enhancers because they present uses such as the reduction of the growth of pathogenic microorganisms, and they stimulate the production of digestive secretions and antioxidant action (Windisch, Schedle, Plitzner, & Kroismayr, 2007).

The pacari (*Lafoensia pacari*), which is native from the Brazilian cerrado, has bioactive compounds such as steroids, flavonoids, tannins and alkaloids (Santos, Coelho, & Pirani, 2009), with antimutagenic actions (Kaur, Grover, & Kumar, 1997), antimicrobial (Lima et al., 2006; Porfírio, MeloFilho, Alvino, Lima, & Sant'ana, 2009), anti-inflammatory, antioxidant (Solon, Lopes, Sousa Júnior, & Schmeda-Hirschmann, 2000) and antifungal agents (Lima et al., 2006, Porfírio, MeloFilho, Alvino, Lima, & Sant'ana, 2009). Its shell contains high content of ellagic acid and tannins. The

tannin is responsible for most of the properties of the pacari extract (Silva et al., 2012).

The ethanolic extract of pacari leaf and stem is effective against *Staphylococcus aureus*, and this antibiotic property is related to the presence of anthraquinones, flavonoids, and tannins (Lima et al., 2006). In a study by Silva Júnior et al. (2010) it was reported that the ethanolic extract of *Lafoensia pacari* and ellagic acid present activity against *Candida* and *Saccharomyces cerevisiae*, and the ellagic acid can be considered the main antifungal substance in the extract, because of its direct action on the physical integrity of the fungal cell wall.

Thus, derivatives of *Lafoensia pacari* may be presented as a possible alternative to PEA included in poultry diets. This study was carried out with the purpose of evaluating the effects of feed supplemented with standardized pacari extract in tannin content on performance, internal and external egg quality and nutrient digestibility of commercial laying hens.

Material and methods

This study was previously approved by the Animal Ethics Committee (CEUA) PRPPG / UFG, filed under nº. 075/12 and conducted in the facilities of the Poultry Sector of the Escola de Veterinária e Zootecnia of the Universidade Federal de Goiás.

A total of 168 Isa Brown laying hens of 24 weeks old were used, with mean weight of 2.6 kg and mean posture rate of 87%. The hens were housed in galvanized wire cages of dimensions 25x40x45 cm, equipped with linear feeder and nipple type drinking fountain. The experiment lasted for four periods of 28 days.

The experimental design was completely randomized, with six treatments and seven replicates of four laying hens each, and consisted of: (T1) control feedwith antibiotic performance improver Halquinol, (T2) control feed with MOS prebiotic, (T3) control feed without additives, (T4) control feed with 1,000 mg kg^{-1} of pacariextract (T5) control feed with 2,000 mg kg^{-1} of pacari extract and (T6) control feed with 3,000 mg kg^{-1} of pacari extract.

The hens received water and feed at will, with feeders being filled three times a day. The light program was of 17h according to recommendations of the lineage manual and itwas controlled by automatic clock.

The dry extract of pacari standardized by the tannin content was measured by a method validated by high performance liquid chromatography, with 4.52% of total tannins. The treatments had 45.2, 90.4 mg kg^{-1} and 135.6 mg kg^{-1} of total tannins of the feeding, in addition to the general content of 1.98% of ellagic tannin.

The basal feed (Table 1) was iso-nutritive and formulated according to the recommendations of Rostagno et al. (2011). The inclusion of halquinol, MOS and the extract of pacari were carried out in substitution of the starch, being the extract the first one to be added to the micro-ingredients and later, to the other ingredients in the mixer.

In the zootechnical performance it was evaluated thefeed consumption, obtained by the difference between the amount of feed supplied and the remnant in the week, the egg yield, obtained by the quantity of eggs produced in the period, in relation to 100%;the egg mass, obtained by the average egg weight multiplied by the total quantity of eggs produced during the period; the weight of the egg, obtained by the average egg weight in relation to the quantity produced in the period; the feed conversion (kg kg^{-1}), calculated by the feed consumption and the relation with the mass of eggs produced in the period; and the feed conversion (kg dz^{-1}) was calculated by the feed consumption and the relation with the quantity of dozens of eggs produced in the period.

In the evaluation of the internal and external quality of the eggs, during the last four days of each period, four eggs were used per plot, in which one egg was destined only to the specific gravity and the others to the evaluation of egg weight (g); albumin heights (mm) and yolk (mm), used in the calculation of the Haugh unit and the yolk index; percentages of yolk and albumen (%); and thickness (mm) and percentage of eggshell (%).

Table 1. Composition and calculated nutritional value of the basal feed.

Ingredients	Quantity (g kg^{-1})
Corn grain	65.82
Soybean meal 45%	20.79
Soybean oil	1.50
Limestone	9.16
Dicalcium Phosphate	0.99
Starch	0.50
Salt	0.45
DL-Metionine	0.25
L-Lysine HCL	0.25
L-Threonine	0.14
Vitini-ave*	0.10
Min-aves**	0.05
Total	100
Nutrients	**Calculated composition**
Metabolizable energy (kcal kg^{-1})	2,900
Protein (%)	15.6
Calcium (%)	3.85
Available phosphorus (%)	0.27
Digestible Lysine (%)	0.85
Digestible Methionine + Cystine (%)	0.69
Digestible Methionine (%)	0.47
Digestible Threonine (%)	0.63
Sodium (%)	0.21
Chlorine (%)	0.20
Potassium (%)	0.43

* Vitaminsupplement - warrantylevelsby kg ofproduct:Vitamin A - 8,000 IU, Vitamin E 15,000 mg, Vitamin D3 2,300 IU, Vitamin K3 1,000 mg, Vitamin B1 200 mg, Vitamin B2 3,000 mg, Vitamin B6 1,700 mg, Vitamin B12 10,000 mcg, Niacin 20,000 mg, Folic acid 500 mg, Biotin 15.00 mg. ** Mineral supplement - warranty levels by kg of product: Manganese 120,000 mg, Zinc 120,000 mg, Iron 60,000 mg, Copper 18,000 mg, Iodine 2,000 mg, Calcium 9,600 mg.

At the end of the experiment, in the 41st week of age of the hens, a metabolic assay was performed for four days, using three replicates with two laying hens for each treatment. The excreta were collected twice a day (morning and afternoon) and stored in identified plastic bags, weighed and frozen for later analysis. The eggs were collected, identified and stored under refrigerated (4ºC) for analysis.

Samples of feeding, eggs and excreta were analyzed for dry matter, nitrogen and ethereal extract (Silva & Queiroz, 2002) in the Laboratory of Animal Nutrition of the Escola de Veterinária e Zootecnia/UFG, (and later, the nutrient metabolizability coefficients were calculated) (Sakomura & Rostagno, 2007).

The data were submitted to variance analysis and regression analysis for the controlled treatment and the levels of standardized pacari extract in tannin content were determinated with the aid of the Statistical Analysis System (SAS, 2004), and the means of the treatments were compared between each other by the Test of Duncan at the 5% level of significance.

Results and discussion

No regression effect was observed according to the supplementation of pacari extract in performance ($p > 0.09$), egg quality ($p > 0.08$) and nutrient digestibility of feed ($p > 0.10$). In Table 2, it is verified that no influence of the extract was observed in the first and second experimental periods.

In the fourth experimental period, the production ($p < 0.04$) and the mass of eggs produced ($p < 0.02$) were influenced (Table 3). Laying hens fed with halquinol and MOS supplemented feed showed higher egg production and mass in relation to the laying hens that consumed the feed supplemented with 1.000 and 2.000 mg kg^{-1} extract.

Table 2. Feed intake (FI), egg production (Production), egg mass (EM), egg weight (EW), feed conversion by dozen (FCDz) and by egg mass (FCEM) of laying hens of 24 to 32 weeks old, fed with ration supplemented with pacari extract.

Treatment	FI (g hen^{-1} day^{-1})	Production (% hen^{-1})	EM (g hen^{-1} day^{-1})	EW (g egg^{-1})	FCDz (kg dz^{-1})	FCEM (kg kg^{-1})
1st Period - 24 to 28 weeks						
Halquinol	94.05	86.71	47.05	53.81	1.329	1.958
MOS	95.76	88.03	47.21	55.96	1.314	1.950
Control	93.36	87.54	46.14	54.18	1.262	1.942
1.000 mg kg^{-1}	95.30	85.11	45.49	54.04	1.302	1.892
2.000 mg kg^{-1}	94.73	87.37	47.36	54.01	1.293	1.901
3.000 mg kg^{-1}	94.03	86.17	45.19	54.15	1.357	1.906
P value	0.90	0.64	0.41	0.44	0.35	0.20
C.V.%	6.34	5.82	6.21	3.92	5.10	5.79
MSE	0.007	0.082	0.089	0.065	0.005	0.006
2nd Period - 28 to 32 weeks						
Halquinol	95.01	90.52	50.92	56.31	1.298	1.922
MOS	94.08	90.18	51.37	58.07	1.258	1.808
Control	93.03	91.83	50.11	55.58	1.203	1.803
1.000 mg kg^{-1}	93.17	89.35	50.08	54.39	1.316	1.842
2.000 mg kg^{-1}	95.31	92.73	51.30	56.36	1.251	1.852
3.000 mg kg^{-1}	92.67	89.16	49.53	55.59	1.251	1.875
P value	0.88	0.75	0.50	0.11	0.63	0.35
C.V.%	6.74	6.40	6.76	4.18	7.08	6.88
MSE	0.006	0.079	0.094	0.059	0.003	0.005

C.V%: Coefficient of Variation. MSE: Mean Standard Error.

Table 3. Feed intake (FI), egg production (Production), egg mass (EM), egg weight (EW), feed conversion by dozen (FCDz) and by egg mass (FCEM) of laying hens of 32 to 40 weeks old, fed with ration supplemented with pacari extract.

Treatment	FI (g hen^{-1} day^{-1})	Production (% hen^{-1})	EM (g hen^{-1} day^{-1})	EW (g egg^{-1})	FCDz (kg dz^{-1})	FCEM (kg kg^{-1})
3rd Period - 32 to 36 weeks						
Halquinol	94.50	85.12	47.24	55.33	1.305	1.969
MOS	94.11	84.31	47.53	56.74	1.361	1.962
Control	91.89	84.10	46.82	55.66	1.314	1.967
1.000 mg kg^{-1}	92.73	82.08	45.24	54.77	1.322	2.165
2.000 mg kg^{-1}	88.47	83.55	45.96	55.05	1.345	1.951
3.000 mg kg^{-1}	90.23	82.87	44.33	54.78	1.342	2.043
P value	0.40	0.59	0.27	0.08	0.56	0.37
C.V.%	6.50	7.40	6.48	3.66	6.78	9.37
MSE	0.008	0.085	0.098	0.062	0.004	0.007
4th Period- 36 to 40 weeks						
Halquinol	95.81	85.50a	48.99a	57.33	1.355	1.974
MOS	96.91	82.90a	49.69a	59.95	1.415	1.968
Control	92.28	80.52a	46.34a	57.51	1.260	1.824
1.000 mg kg^{-1}	90.89	74.23b	38.96b	58.72	1.684	2.088
2.000 mg kg^{-1}	79.16	73.88b	39.17b	56.56	1.385	2.045
3.000 mg kg^{-1}	85.42	77.27ab	44.36ab	57.52	1.328	1.923
P value	0.09	0.04	0.02	0.16	0.08	0.11
C.V.%	8.71	8.77	8.90	6.26	8.90	8.44
MSE	0.007	0.092	0.086	0.058	0.005	0.008

C.V%: Coefficient of Variation. MSE: Mean Standard Error. *Averages followed by lowercase letter in the column differ between each other by Duncan's Test ($p < 0.05$).

The complexing ability of the tannins with the protein, insolubilizing it and inactivating digestive enzymes, may have reduced egg production and egg mass, although the increase in extract supplementation has improved these characteristics.

In this sense, Imik et al. (2006) replaced corn by low tannin sorghum at a rate of 22%, but did not present tannin content, supplemented the feed with amino acid for laying hens, and verified no change in production, just an increase in feed intake in 5.7% and egg weight in 2.4%.

Jacob, Mitaru, Mbugua, and Blair (1996) also provided high tannin sorghum feed for laying hens at the rate of 64.7% in the diet and although they did not mention total tannin content, they had a better feed conversion, but lower egg production in relation to the corn formulated diet, evidencing that the tannin affected the productive characteristics of the laying hens.

During the total production period, no change in feed intake ($p > 0.37$), egg production ($p > 0.24$), egg mass ($p > 0.08$), egg weight ($p > 0.11$) feed conversion per dozen ($p > 0.18$) and egg mass ($p > 0.10$) were observed, so there was no cumulative effect of experimental treatments (Table 4).

The tannin content present in the feed of laying hens may affect the laying rate, especially if the ingredient used presentslower energy content (Moreno, Espíndola, Santos, Freitas, & Gadelha, 2007). Tannin contents below 0.5% did not impair the performance of the hens (Jacob et al., 1996), which possibly kept the total performance unchanged, since the addition of the pacari extract increased the tannin content in the feed between 0.005 and 0.014%.

In relation to the internal and external quality of the eggs, no effect of the treatments was observed on egg weight, shell percentage, shell thickness, yolk percentage, yolk index, haugh unit and egg specific gravity (Table 5). However, during the first period the percentage of albumen was higher ($p < 0.04$) for the eggs of the hens that consumed the feed supplemented with MOS.

Table 4. Feed consumption (FC), egg production (Production), egg mass (EM), egg weight (EW), feed conversion by dozen (FCDz) and by egg mass (FCEM) of laying hens fed with ration supplemented with pacari extract in the total period.

Treatment	FC (g hen^{-1} day^{-1})	Production (%/hen)	EM (g hen^{-1} day^{-1})	EW (g egg^{-1})	FCDz (kg dz^{-1})	FCEM (kg kg^{-1})
Halquinol	95.02	86.96	48.55	55.69	1.322	1.980
MOS	95.10	86.35	48.95	57.93	1.336	1.923
Control	90.56	85.99	47.35	55.73	1.360	1.983
1.000 mg kg^{-1}	93.02	82.69	44.94	55.47	1.356	2.084
2.000 mg kg^{-1}	89.41	84.38	45.94	55.49	1.304	1.962
3.000 mg kg^{-1}	90.58	83.87	45.85	55.50	1.319	1.982
P value	0.37	0.24	0.08	0.11	0.18	0.10
C.V.%	6.67	8.48	7.87	3.29	7.27	7.79
MSE	0.009	0.077	0.090	0.052	0.005	0.006

C.V%: Coefficient of Variation. MSE: Mean Standard Error.

Table 5. Egg weight (EW), percentage (C) and eggshell thickness (ET), percentage (Y) and yolk index (YI), albume percentage (A), haugh unit (HU) and specific gravity (SG) of eggs of laying hens of 24 to 32 weeks old fed with ration supplemented with pacari extract

Treatment	EW(g)	C (%)	ET(mm)	Y (%)	YI	A (%)	HU	SG(g L^{-1})
1st Period - 24 to 28 weeks								
Halquinol	53.81	10.93	0.390	23.85	0.47	65.22b	96.96	1099
MOS	55.97	10.76	0.390	22.72	0.48	66.52a	97.60	1104
Control	54.18	10.77	0.391	23.48	0.47	65.75b	96.66	1101
1.000 mg kg^{-1}	54.04	10.97	0.393	23.62	0.48	65.41b	98.32	1104
2.000 mg kg^{-1}	54.02	10.93	0.391	23.71	0.47	65.36b	96.05	1103
3.000 mg kg^{-1}	54.15	10.79	0.395	24.1	0.47	65.10b	97.17	1102
P value	0.09	0.69	0.52	0.15	0.17	0.04	0.06	0.09
C.V.%	4.48	5.11	2.74	4.34	3.91	1.86	2.73	0.35
MSE	0.057	0.032	0.009	0.090	0.013	0.010	0.17	0.002
2nd Period - 28 to 32 weeks								
Halquinol	56.31	10.36	0.386	24.93	0.45	64.71	90.61	1103
MOS	57.07	10.31	0.389	24.48	0.45	65.21	89.79	1103
Control	56.58	10.45	0.400	24.21	0.45	65.34	89.07	1103
1.000 mg kg^{-1}	56.39	10.00	0.385	24.80	0.45	64.20	90.96	1103
2.000 mg kg^{-1}	56.36	10.42	0.382	24.82	0.45	64.76	89.69	1104
3.000 mg kg^{-1}	55.59	10.53	0.388	24.57	0.45	64.90	89.97	1104
P value	0.09	0.52	0.39	0.47	0.80	0.19	0.10	0.08
C.V.%	3.99	5.53	5.37	5.18	3.18	2.35	3.12	0.36
MSE	0.062	0.027	0.011	0.080	0.011	0.11	0.14	0.001

C.V%: Coefficient of Variation. MSE: Mean Standard Error. *Averages followed by lowercase letter in the column differ between each other by Duncan's Test ($p < 0.05$).

As observed in Table 6, in the third period, the diet added with MOS promoted a higher egg weight ($p < 0.04$) in relation to the other treatments, and feeds supplemented with extract of pacari and halquinol presented similar results.

In the fourth period, feeds supplemented with MOS, halquinol and 1,000 mg kg^{-1} and 3,000 mg kg^{-1} of extract promoted a similar result for egg weight ($p < 0.04$), and hens fed with pacari extract feed presented a better percentage of shell ($p < 0.03$) and specific gravity ($p < 0.04$) (Table 6), although Haslam (1996) points out that there is a relationship between the tannins and the reduction of egg shell weight, due to the complexation and unavailability of metallic ions, such as calcium.

Data for the total egg production period are given in Table 7. As in the fourth period, the pacari extract promoted a better result for the specific gravity ($p < 0.03$), in other words, better shell resistance, as reported by Roberts (2004), a factor that directly influences the loss of eggs by the occurrence of cracks.

Imik et al. (2006) evaluated the internal and external egg quality of laying hens fed with corn and low tannin sorghum, supplemented with amino acids, and found that replacing corn by sorghum increased the yolk index, without affecting shell thickness, albumen thickness and haugh unit. However, in the present study, none of these variables was influenced by the extract.

The inclusion levels of the pacari extract promoted a digestibility coefficient of the ethereal extract similar to halquinol and MOS ($p < 0.04$), possibly due to antimicrobial properties, attributed to the tannins present in the pacari extract, allowing a better use of the nutrients (Haslam, 1996, Hernandes, Pereira, Palazzo, & Mello, 2010). No regression effect was observed as a function of the levels of pacari extract for the studied variables (Table 8).

In a study to evaluate the effects of tannins from barbatimão (*Stryphnodendronsp*) extract on the digestibility of nutrients in diets for Nile tilapia at levels 0; 0.23; 0.46; 0.69; 0.92; 1.3 and 1.82% of total tannins, it was verified that the tannin at concentrations equal to or greater than 0.46% in the diet reduced the digestibility of dry matter and crude protein, mainly digestibility of ethereal extract, from the concentrations of 0.23% of tannins (Pinto, Pezzato, Miranda, Baros, & Furuya, 2004).

The tannins inhibiting the growth of certain microorganisms among them *Staphylococcus aureus*, *Streptococcus pneumonia* and *Bacillusanthracis* (Monteiro, Albuquerque, Araújo, & Amorim, 2005),besides stimulating the production of saliva and gastric and pancreatic juice, increasing the digestibility of nutrients (Platel & Srinivasan, 1996), and consequently reducing the presence of substrate necessary to the development of undesirable microorganisms, resulting in improved animal performance.

Although the results observed by Pinto et al. (2004) are different from those found in the present study, they cannot be accurately related to the present research, even if tannin is the major active ingredient of the extracts used, because both vegetal extract and the animals studied are different, making it difficult to clarify the results.

Table 6. Egg weight (EW), percentage (C) and eggshell thickness (ET), percentage (Y) and yolk index (YI), albume percentage (A), haugh unit (HU) and specific gravity (SG) of eggs of laying hens of 32 to 40 weeks old fed with ration supplemented with pacari extract.

Treatment	EW(g)	C (%)	ET(mm) (mm)	Y (%)	YI	A (%)	HU	SG(g L^{-1})
3rd Period – 32 to 36 weeks								
Halquinol	55.33b	10.55	0.388	24.38	0.45	65.07	94.62	1105
MOS	57.54a	10.13	0.388	23.77	0.44	65.10	93.57	1105
Control	55.67b	10.40	0.385	24.62	0.44	64.98	92.48	1106
1.000 mg kg^{-1}	54.77b	10.06	0.390	24.44	0.44	64.50	92.62	1106
2.000 mg kg^{-1}	55.06b	10.51	0.393	24.02	0.44	65.48	92.79	1105
3.000 mg kg^{-1}	54.78b	11.04	0.400	24.61	0.44	65.36	92.75	1106
P value	0.04	0.09	0.48	0.23	0.44	0.08	0.63	0.09
C.V.%	5.18	4.80	7.52	5.42	3.66	2.29	4.83	0.46
MSE	0.053	0.025	0.010	0.090	0.010	0.13	0.15	0.001
4th Period- 36 to 40 weeks								
Halquinol	57.33ab	10.33b	0.380	25.74	0.44	63.93	88.35	1100b
MOS	59.55a	10.26b	0.384	25.17	0.51	64.57	87.89	1102b
Control	57.51ab	10.35b	0.381	25.07	0.43	64.58	86.35	1100b
1.000 mg kg^{-1}	58.72ab	11.03a	0.383	24.86	0.44	64.11	86.90	1106a
2.000 mg kg^{-1}	56.66b	11.03a	0.383	24.58	0.44	64.38	86.21	1107a
3.000 mg kg^{-1}	57.52ab	11.01a	0.383	25.12	0.44	63.87	86.10	1108a
P value	0.04	0.03	0.44	0.06	0.25	0.51	0.56	0.04
C.V.%	5.07	5.28	2.03	5.65	7.66	2.42	5.64	0.36
MSE	0.060	0.030	0.011	0.07	0.011	0.11	0.16	0.002

C.V%: Coefficient of Variation. MSE: Mean Standard Error. *Averages followed by lowercase letter in the column differ between each other by Duncan's Test ($p < 0.05$).

Table 7. Egg weight (EW), percentage (C) and eggshell thickness (ET), percentage (Y) and yolk index (YI), albume percentage (A), haugh unit (HU) and specific gravity (SG) of eggs of laying hens fed with ration supplemented with pacari extract, in the total period

Treatment	EW(g)	C (%)	ET(mm) (mm)	Y (%)	YI	A (%)	HU	SG(g L^{-1})
Halquinol	55.70b	10.54	0.385	24.72	0.45	64.73	92.89	1100b
MOS	57.93a	10.36	0.386	24.04	0.47	65.60	92.21	1101b
Control	55.73b	10.49	0.386	24.35	0.45	64.16	90.39	1101b
1.000 mg kg^{-1}	55.48b	11.02	0.388	24.43	0.46	65.55	92.20	1105a
2.000 mg kg^{-1}	55.50b	10.72	0.384	24.28	0.45	65.00	91.44	1103a
3.000 mg kg^{-1}	55.51b	10.84	0.382	24.60	0.45	64.56	91.75	1103a
P value	0.03	0.10	0.38	0.11	0.19	0.14	0.10	0.03
C.V.%	3.49	2.03	4.43	2.28	5.06	2.40	3.01	0.25
MSE	0.055	0.026	0.010	0.080	0.010	0.12	0.17	0.001

C.V%: Coefficient of Variation. MSE: Mean Standard Error. *Averages followed by lowercase letter in the column differ between each other by Duncan's Test ($p < 0.05$).

Table 8. Coefficient of metabolizability of dry matter (CMDM), of nitrogen (CMN), of egg's nitrogen (N egg), nitrogen retention by egg mass (mg N ret g^{-1} egg), Coefficient of metabolizability of ether extract (CMEE), egg's ether extract (EE egg) and retained ether extract by egg mass (mg EE ret g^{-1} egg), of the feed supplemented with pacari extract.

Treatment	CMDM (%)	CMN (%)	N egg (g)	mg N ret g^{-1} egg	CMEE (%)	EE egg(g)	mg EE ret g^{-1} egg
Halquinol	81.40	55.36	6.98	23.91	90.89ab	0.785	83.91
MOS	79.70	56.21	6.99	22.75	90.68ab	0.802	105.80
Control	79.16	53.55	6.21	27.23	89.57b	0.685	135.22
1.000 mg kg^{-1}	75.95	35.57	9.70	12.25	93.74a	0.970	88.75
2.000 mg kg^{-1}	76.59	40.38	7.13	17.17	94.31a	0.715	121.20
3.000 mg kg^{-1}	78.27	48.14	6.16	17.39	93.97a	0.615	151.92
P value	0.60	0.10	0.31	0.40	0.04	0.46	0.11
C.V.%	5.16	19.97	27.15	44.81	2.08	6.56	26.75
MSE	0.21	0.34	0.17	0.14	0.12	0.18	0.19

C.V%: Coefficient of Variation. MSE: Mean Standard Error. *Averages followed by lowercase letter in the column differ between each other by Duncan's Test ($p < 0.05$).

Conclusion

The standardized pacari extract content in tannin promoted a percentage of albumin and egg weight similar to the antibiotic. The extract improved the quality of the shell and promoted the metabolizability of the ethereal extract similar to the antibiotic and MOS, being indicated as a phytogenic additive.

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