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Detoxified Castor Seed Cake for Broilers

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Broilers, performance, carcass yield, *Ricinuscommunis L*.

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ABSTRACT

The objective of the present study was to evaluate the effect of the dietary detoxified castor seed cake (DCC) inclusion on broiler performance and carcass traits. Two hundred and fifty Cobb-500® broilers were distributed according to a completely randomized experimental design consisting of five treatments (dietary inclusion of 0.0, 2.5, 5.0, 7.5, and 10.0% DCC) with five replicates of 10 birds each (five males and five females). Feed intake (FI), body weight gain (WG), and feed conversion ratio (FCR) were evaluated from one to 40 days of age. Carcass yield and the yields of the breast, leg (drumstick+thighs), and wings were determined when broilers were 40 days old. Live performance parameters were influenced by DCC dietary inclusion, and levels 2.00, 1.38, and 1.25% DCC impaired FI, WG, and FCR, respectively. Carcass and parts yields were not affected by dietary DCC inclusion. It was concluded that the addition of DCC levels up to 1.25% to broiler diets does not impair live performance or carcass traits.

INTRODUCTION

The oil extracted from castor seeds (*Ricinuscommunis L*) has been used for biodiesel production. The oil is extracted by mechanical means or with solvents, yielding castor seed cake and castor meal, respectively. Castor cake corresponds to approximately 55% of the castor seed weight (Azevedo & Lima, 2001), i.e., each metric ton of processed castor seed yields 550 kg of castor seed cake.

The nutritional composition of castor seed byproducts, reported by Moreira *et al*. (2003), Rostagno *et al*. (2011), and Matos Júnior *et al*. (2011), indicates their potential use in animal feeds, including poultry diets. Castor seed byproducts have been typically used as crop fertilizers due to the presence of toxic products and allergens in castor seeds. However, there currently are efficient methods available to detoxify castor seed byproducts (Anandan *et al*., 2005; Oliveira, 2008).

The dietary inclusion of alternative feedstuffs may reduce feed costs, which account for the largest part of production costs. The inclusion of up to 10% detoxified castor seed meal to starter (Ani & Okorie, 2004; Ani & Okorie, 2005) and finisher (Ani & Okorie, 2008) broiler diets did not impair broiler performance. However, considering that castor byproducts need to be detoxified and that their nutritional composition may widely vary, further studies need to be conducted to allow nutritionists to decide whether this product can be safely included in animal feeds.

This experiment aimed at evaluating the effects of the dietary inclusion of different levels of detoxified castor seed cake on the performance and carcass yield of broilers.

MATERIALS AND METHODS

The experiment was conducted at the Poultry Sector of the Institute of Agricultural Sciences of the Federal University of Minas Gerais, Montes Claros, state of Minas Gerais, Brazil.

Two hundred and fifty day-old Cobb-500® broilers were distributed according to a completely randomized experimental design consisting of five treatments (0.0, 2.5, 5.0, 7.5 or 10.0% DCC dietary inclusion) with five replicates of 10 birds each (five males and five females). Birds were housed in galvanized-iron cages (96-cm long x 48-cm wide x 63-cm high). Between 1-21 days, the experimental unit consisted of one cage housing 10 birds (housing density of 21.70 birds/m^2). Between 22-40 days, the experimental unit consisted of two cages housing five birds each (housing density of 10.85 birds/m^2).

The ingredient and calculated nutritional composition of the starter (1-21 days) and grower (22-40 days) diets is presented in Tables 1 and 2, respectively. Diets were based on corn and soybean meal were formulated to contain equal levels of metabolizable energy, crude protein, total methionine+cystine, calcium, available phosphorus, and sodium. The treatments consisted of the dietary inclusion of detoxified castor seed cake (DCC) at the levels of 0, 2.5, 5.0, 7.5, and 10%.

The castor seed cake was detoxified using 60g microprocessed calcium oxide for each kg of castor seed cake (Oliveira, 2008). Calcium oxide was diluted in 10 parts of water and mixed with the castor seed cake (Oliveira, 2008). Eight hours later, the castor seed cake was air-dried at environmental temperature (Oliveira, 2008). According to Oliveira (2008), this method completely eliminates ricin, which is the main toxic compound of the castor seed.

The nutritional composition of the DCC was determined according to the AOAC (2000). The following results, on as-fed basis, were obtained: 20.6% crude protein, 18.2% ether extract, 32.9% crude fiber, 9.1% non-nitrogen extract, 11.0% ashes, 3.97% calcium, 0.57% total phosphorus, and 0.05% sodium. The level of 1829 kcal metabolizable energy per kg of DCC on as-fed basis, reported by Matos Júnior *et al*. (2011), was adopted. The total methionine+cystine, lysine, threonine, tryptophan, valine, isoleucine, arginine, and available phosphorus values applied for the DCC were taken from Rostagno *et al*. (2011). The diets were formulated on total amino acid basis, as the digestible amino acid values of DCC are not known. Feed and water were supplied *ad libitum* and birds were managed according to the recommendations of Cobb®'s manual (2008).

Live performance parameters (feed intake, body weight gain, and feed conversion ratio) were evaluated between 1 and 40 days of age. On day 40, two birds per experimental unit were selected, fasted for six hours, stunned by brain concussion and bled by severing the jugular vein. Carcasses were then scalded, plucked, and eviscerated. Carcass were weighed and their yield was calculated as a percentage of live weight. Breast, leg (drumstick+thigh), and wings were cut up, and their yields were calculated as a percentage of hot carcass weight with head and feet.

Data were verified for the presence of outliers, and then analyzed for normality of studentized residuals (Cramér-von-Mises test), and homoscedasticity

Table 1 – Experimental diets fed during the starter phase (1-21 days of age)

Ingredients	Detoxified castor seed cake (%)				
	0.0	2.5	5.0	7.5	10.0
Corn	55.10	53.29	51.48	49.68	47.87
Soybean meal	37.40	36.59	35.78	34.98	34.17
Detoxified castor seed cake	0.00	2.50	5.00	7.50	10.00
Soybean oil	3.57	3.95	4.33	4.71	5.09
DL-methionine	0.31	0.30	0.29	0.28	0.27
Dicalcium phosphate	1.72	1.71	1.70	1.69	1.68
Calcitic limestone	0.99	0.75	0.50	0.26	0.01
Salt	0.51	0.51	0.50	0.50	0.50
Premix*	0.40	0.40	0.40	0.40	0.40
Total	100.00	100.00	100.00	100.00	100.00
Energy and nutrients	Calculated values (on as fed basis)				
Metabolizable energy (kcal/kg)	3020	3020	3020	3020	3020
Crude protein (%)	21.50	21.50	21.50	21.50	21.50
Total methionine+cystine (%)	0.97	0.97	0.97	0.97	0.97
Total lysine (%)	1.17	1.16	1.16	1.15	1.14
Total threonine (%)	0.84	0.85	0.86	0.87	0.87
Total tryptophan (%)	0.27	0.28	0.29	0.29	0.30
Total valine (%)	1.03	1.05	1.07	1.09	1.11
Total isoleucine (%)	0.94	0.96	0.99	1.01	1.03
Total arginine (%)	1.45	1.50	1.55	1.59	1.64
Available phosphorus (%)	0.43	0.43	0.43	0.43	0.43
Calcium (%)	0.91	0.91	0.91	0.91	0.91
Sodium (%)	0.22	0.22	0.22	0.22	0.22
Crude fiber (%)	2.98	3.72	4.47	5.22	5.97

*Guaranteed levels per kg product: vitamin A 167,000 IU; vitamin D 335,000 IU; vitamin E 2,500 mg; vitamin K 417 mg; vitamin B1 250 mg; vitamin B2 835 mg; vitamin B6 250 mg; vitamin B12 2,000 mcg; folic acid 100 mg; biotin 9 mg; niacin 5835 mg; pantothenic acid 1,870 mg; choline 116,670 mg; copper 1,000 mg; iodine 170 mg; iron 8,335 mg; manganese 10,835 mg; zinc 7,500 mg; selenium 35 mg; coccidiostats 13,335 mg; growth promoter 13,335 mg; antioxidant 2,000 mg; excipient qsp 1,000 g.

Table 2 – Experimental diets fed during the grower phase (22-42 days of age)

Ingredients	Detoxified castor seed cake (%)				
	0.0	2.5	5.0	7.5	10.0
Corn	58.87	57.06	55.25	53.44	51.64
Soybean meal	32.74	31.93	31.13	30.32	29.51
Detoxified castor seed cake	0.00	2.50	5.00	7.50	10.00
Soybean oil	4.79	5.17	5.56	5.94	6.32
DL-methionine	0.25	0.24	0.23	0.22	0.21
Dicalcium phosphate	1.48	1.47	1.46	1.45	1.44
Calcitic limestone	0.99	0.75	0.50	0.26	0.01
Salt	0.48	0.48	0.48	0.48	0.48
Premix*	0.40	0.40	0.40	0.40	0.40
Total	100.00	100.00	100.00	100.00	100.00
Energy and nutrients	Calculated values (on as fed basis)				
Metabolizable energy (kcal/kg)	3150	3150	3150	3150	3150
Crude protein (%)	19.70	19.70	19.70	19.70	19.70
Total methionine+cystine (%)	0.86	0.86	0.86	0.86	0.86
Total lysine (%)	1.05	1.04	1.03	1.03	1.02
Total threonine (%)	0.77	0.78	0.79	0.80	0.80
Total tryptophan (%)	0.24	0.25	0.26	0.27	0.27
Total valine (%)	0.94	0.96	0.98	1.00	1.02
Total isoleucine (%)	0.85	0.87	0.90	0.92	0.94
Total arginine (%)	1.31	1.36	1.40	1.45	1.50
Available phosphorus (%)	0.38	0.38	0.38	0.38	0.38
Calcium (%)	0.84	0.84	0.84	0.84	0.84
Sodium (%)	0.21	0.21	0.21	0.21	0.21
Crude fiber (%)	2.79	3.54	4.28	5.03	5.78

*Guaranteed levels per kg product: vitamin A 167,000 IU; vitamin D 335,000 IU; vitamin E 2,500 mg; vitamin K 417 mg; vitamin B1 250 mg; vitamin B2 835 mg; vitamin B6 250 mg; vitamin B12 2,000 mcg; folic acid 100 mg; biotin 9 mg; niacin 5835 mg; pantothenic acid 1,870 mg; choline 116,670 mg; copper 1,000 mg; iodine 170 mg; iron 8,335 mg; manganese 10,835 mg; zinc 7,500 mg; selenium 35 mg; coccidiostats 13,335 mg; growth promoter 13,335 mg; antioxidant 2,000 mg; excipient qsp 1,000 g.

(Brown-Forsythe test). After checking the compliance of these assumptions, data were submitted to analysis of variance using the General Linear Model procedure of SAS® software package (Littell *et al*., 2002). In case of significance ($p<0.05$), data were fit to polynomial regression equations (Freund & Littell, 2000). The optimal DCC inclusion level was determined by the first derivative of the dependent variable relative to the independent variable, equaling the equation to zero.

RESULTS AND DISCUSSION

There was a quadratic response of feed intake, body weight gain, and feed conversion ratio during the period of 1-40 days of age as a function of DCC inclusion, with levels of 2.00, 1.38, and 1.25% DCC calculated for optimal FI, WG, and FCR, respectively (Table 3). Carcass traits were not influenced by DCC inclusion levels (Table 3).

In the present study, performance and carcass traits were not influenced when levels up to 1.25% DCC were added to the diet. Literature reports indicate that up to 10% detoxified castor meal can be added in starter (Ani & Okorie, 2004; Ani &Okorie, 2005) and finisher (Ani & Okorie, 2008) broiler feeds. No negative effects of detoxified castor byproducts added to the diets of Japanese quail (Santos, 2011) and laying chickens (Bueno *et al*., 2014) during lay up to 10% and 5.7% on performance or egg quality were observed.

In the present experiment, feed intake was reduced when more than 2.00% DCC was included in the diet, with broilers fed 10% DCC presenting the lowest FI, which was 4.58% lower than those fed no DCC (Table 3). This result may be attributed to the low palatability and to the presence of an appetite-suppressing factor present in that feedstuff (Ani & Okorie, 2008). In addition, dietary oil and crude fiber contents also increased with increasing

Table 3 – Feed intake (FI, g); weight gain (WG, g), feed conversion ratio (FCR, g/g), carcass yield (CY, %), breast yield (BY, %), leg yield (LY, %), and wing yield (WY, %) of 1- to 40-day-old broilers fed diets with castor seed cake inclusion (DCC, %)

DCC	FI	WG	FCR	CY	BY	LY	WY
0.0	3911±83	2304±31	1.700±0.054	84.20±0.33	29.95±0.68	26.60±0.24	9.10±0.26
2.5	3918±49	2283±44	1.718±0.037	84.67±0.42	30.81±0.42	26.53±0.58	9.31±0.12
5.0	3892±44	2273±24	1.713±0.027	84.23±0.50	30.80±0.31	26.70±0.25	9.00±0.07
7.5	3839±40	2143±20	1.793±0.031	83.35±0.54	30.06±0.36	26.35±0.43	9.32±0.23
10.0	3732±99	2002±53	1.865±0.041	83.07±0.49	29.17±0.42	26.27±0.54	9.50±0.22
Probability	<0.0001	<0.0001	0.0002	0.09	0.11	0.95	0.42
CV (%)	2.56	3.12	3.58	1.18	3.40	3.66	4.67

Mean ± standard error of the mean. CV = coefficient of variation. Carcass yield expressed as a percentage of live weight. Breast, leg, and wing yields are expressed as percentages of hot carcass weight with head and feet.

$FI = -2.914\ DCC^2 + 11.66\ DCC + 3909$ ($R^2 = 0.81$; optimal level = 2.00)

$WG = -4.114\ DCC^2 + 11.38\ DCC + 2298$ ($R^2 = 0.69$; optimal level = 1.38)

$FCR = 0.002\ DCC^2 - 0.005\ DCC + 1.704$ ($R^2 = 0.37$; optimal level = 1.25)

DCC inclusion levels (Tables 1 and 2), which may have also contributed for the FI reduction.

The weight gain reduction was proportionally higher than that of FI with the dietary inclusion of DCC. The WG of broilers fed 10% DCC was 13.1% lower compared with those fed no DCC, indicating that another factor, in addition of FI reduction, may have contributed to that result. Matos Júnior *et al.* (2011) determined crude protein digestibility in the same DCC used in the present experiment as 77.2%, which is lower compared with that of soybean meal (91.0%) and corn (87.0%) for broilers (Rostagno *et al.*, 2011). Therefore, the digestible amino acid levels in the diets containing DCC possibly did not supply the broilers' requirements. The determination of the digestibility of the amino acids in DCC is suggested to allow better utilization of DCC in the formulation of poultry diets. Another factor that should be considered is the possible presence of ricin, which is the main toxic factor in DCC, although the detoxification method applied ensures the elimination of ricin (Oliveira, 2008). However, the DCC used in the present experiment was not analyzed for ricin.

CONCLUSIONS

It was concluded that the addition of detoxified castor seed cake levels up to 1.25% to broiler diets does not impair their live performance or carcass traits.

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ETHICAL CONSIDERATIONS

The experimental procedures adopted in this study were approved by the Committee on Ethics in Animal Experimentation of the Federal University of Minas Gerais, under protocol n. 59/2008.

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