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Tucumã meal in diets for broilers on performance, carcass traits and serum biochemical profile

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Additional keywords

Alternative food.
Feed intake.
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Triglycerides.

SUMMARY

The objective of this study was to evaluate broilers fed diets with increasing levels of tucumã meal (TM) on performance, carcass traits and serum biochemical profile. 192 broilers Cobb 500 were used distributed with same conditions of nutritional management and facilities. The experimental method was completely randomized with six treatments of inclusion levels of TM (0, 5, 10, 15, 20 and 25%) where each treatment had four replicates of eight birds each. Data collected were submitted to polynomial regression analysis. Feed intake and feed conversion showed differences (P<0.05) where inclusion of up to 5% of TM showed better results. In carcass traits, It was only the dorsum (back) that was significantly (P<0.05) influenced by the inclusion of TM in the diets. In serum biochemical profile, the triglycerides values and pH showed differences (P<0.05) where the inclusion of up to 20% of TM in diets showed better results. The tucumã meal can be used as alternative food in diets for broilers without causing negative changes on performance, carcass traits and serum biochemical profile.

Rendimiento, características de carcaça y parámetros bioquímicos séricos en pollos alimentados con fariña de tucumã

Palabras clave adicionales

Alimento alternativo.
Consumo de pienso.
Conversión alimenticia.
pH.
Triglicéridos.

RESUMEN

El objetivo de este estudio fue evaluar lo rendimiento, características de carcasa y parámetros bioquímicos séricos en pollos alimentados con fariña de tucumã (TM). Fueron utilizados 192 pollos Cobb 500 distribuidos con las mismas condiciones de manipulación e instalaciones. El diseño experimental fue al azar con seis tratamientos formados por niveles de inclusión de fariña de tucumã (0, 5, 10, 15, 20 y 25%) donde cada tratamiento contenía cuatro repeticiones de ocho aves cada. Los datos fueron recogidos y sometidos a análisis de regresión polinómica. Los resultados de consumo de pienso y conversión alimenticia presentarán diferencias (P<0.05) donde inclusiones ácima de 5% de TM presentarán mejores resultados. En las características de carcaça, a excepción do dorso, no fueran observado diferencias (P>0.05) a partir de la inclusión de TM na alimentación de los pollos. En parámetros bioquímicos séricos, los valores para triglicéridos y pH presentaran diferencias (P<0.05) donde inclusiones ácima de 20% de TM presentarán mejores resultados. A fariña de tucumã puede ser utilizado como alimento alternativo na alimentación de pollos sin causar cambios negativos en lo rendimiento, características de carcaça y parámetros bioquímicos séricos.

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INTRODUCTION

The increasing demand for technologies in the poultry industry, mainly in nutrition area, added to the high cost of conventional ingredients due its use for human consumption, are factors that have motivated the researchers in a great search for new alternative foods, especially those with potential for substitution the corn (energy source) and soybean meal (protein source) (Cruz et al., 2016).

In this context, the Amazon has innumerable native species of plants with economic, technological and nutritional potential, which have attracted the interest for scientific studies in several areas, such as food, pharmaceuticals, cosmetics, flavor and essences (Nascimento, 2010; Hanna et al., 2013). Among these,

the tucumã stands out due to its innumerable nutritional properties, such as calorie, fiber, pro-vitamin A (carotene) and lipids (Ferreira et al., 2008), besides producing a range of organic residues with biological potential for reuse.

But, the use of agroindustrial residues in animal feed has been studied on how feed alternative, mainly seeking to solve the problem of high feed final cost, besides minimizing the environmental impacts (Loureiro et al., 2007). It's very important mentioned that, in a productive context, the definition of agroindustrial residues is attributed to residues from the processing of agricultural crops, or what is left over them.

The references for the use of tucumã meal in poultry nutrition are scarce, as described by Miller et al. (2013) and Rufino et al. (2015). These authors also affirm that the tucumã meal, due to its biological and zootechnical potential, has economic viability for its inclusion in poultry diets.

Togashi et al. (2008) also affirm that the incorrect management and elimination of agroindustrial residues can cause great impact to the environment and economic disturbances. And, an alternative to use of these eventual losses of the agribusiness is the preparation of meals for inclusion in diets of low cost and high nutritional value.

From these information, the objective of this study was to evaluate the growth performance, carcass traits and serum biochemical profile of broilers fed diets with increasing levels of tucumã meal.

MATERIAL AND METHODS

The experimental protocol of the present study was approved by Ethics Committee on the Use of Animals – CEUA (protocol n. 008/2015) of College of Agrarian Sciences of Federal University of Amazonas.

The experiment was developed in the Poultry Sector of the Department of Animal and Plant Production (DPAV), College of Agrarian Sciences (FCA), Federal University of Amazonas (UFAM), located in the Southern Sector of the University Campus, Manaus, state of Amazonas, Brazil.

Table I. Centesimal composition of tucumã meal (Centesimal composição da refeição Tucumã).

Nutrients	Composition
Dry matter, %	89.78
Crude protein, %	9.33
Crude fiber, %	14.63
Neutral detergent fiber, %	53.98
Acid detergent fiber, %	38.63
Ether extract, %	12.66
Mineral matter, %	4.49
Metabolizable energy, kcal/kg^{-1}	3,267[1]

[1]Determined from previous metabolic test.

192 male broilers Cobb 500 were used, distributed in boxes (4 birds/m²) in an experimental aviary with 200 m² according the treatments proposed, with water and ration *ad libitum*.

The experimental design was completely randomized consisting of six treatments corresponding to the inclusion levels of tucumã meal (0, 5, 10, 15, 20 and 25%) in the diet, with four replicates of eight birds each.

The tucumã residue (formed by residue of the pulp extraction from the fruits) used for processing of meal were obtained in fairs and markets in Manaus City, Amazonas State, Brazil. After collection, the residue were selected, rejecting all material that was in decomposition process or that might cause health problems to birds. Then, the selected residue was washed, dried in an oven at 60 °C for 24 hours and grinding, obtaining the product called tucumã flour.

For determination of centesimal composition of tucumã flour, were used the composition proposed by Miller et al. (2013) showed in **Table I**.

The experimental diets were formulated according the production stages of broilers **(Table II)**, and nutritional requirements and reference values proposed by Rostagno et al (2011).

For performance of birds, were evaluated the feed intake (kg/bird), weight gain (kg/bird), feed conversion (kg/kg) and slaughter weight (kg/bird). With 42 days, after fasting of 12 hours, were selected eight birds of each treatment for collected of 1 mL of blood directly from the ulnar vein. The samples were packed in receptacles with heparin solution (anticoagulant), and, immediately, sent to the Laboratory of Poultry Technology of Poultry Sector (UFAM) and were analyzed for glucose, triglycerides, cholesterol and pH using a portable biochemical analyzer (Accucheck Trend, ROCHE) used specific reagent strips to each analysis, exception of pH, that was measured with a pHmeter (SENTRON, model 1001).

The birds (eight birds from each treatment) were there randomly selected, identified and weighed to evaluate the carcass traits. Next, these were electrically stunned (40 V; 50 Hz), with the birds slaughtered by cutting the jugular vein. The carcasses were immersed into hot water (60 ºC for 62 s), plucked and eviscerated according Mendes and Patricio (2004) recommendations. The carcass yield were obtained after weighing of the clean carcass without viscera, head and leg, being calculated the percentage of commercially carcass of each bird.

The gizzard, liver and heart were separated from the others viscera and individually weighed. The commercial cuts (neck, wing, thigh, drumstick, chest, dorsum (back) and legs), were evaluated from weighing them in analytical balance (0.01g). The fat percentage were estimated from the visceral fat weight in function of birds body weight

Data collected were tested by analysis of variance using the GLM procedure of the Statistical Analysis System -SAS (2008) software and subjected to the po-

Table II. Nutritional composition of experimental diets (Nutritional composition of experimental diets).

Rações[4]	Tucumã meal (%)																	
	---------- 0% ----------			---------- 5% ----------			--------- 10% ---------			--------- 15% ---------			--------- 20% ---------			--------- 25% ---------		
Ingredients	Ini.	Gro.	Term.	Ini.	Gro.	Term.	Ini.	Gro.	Term.	Ini.	Gro.	Term.	Ini.	Gro.	Term.	Ini.	Gro.	Term.
Corn (7.88)	59.50	63.33	66.13	53.20	57.89	60.68	47.76	52.43	55.25	39.10	47.00	49.80	35.47	41.55	44.37	34.90	36.10	38.92
Soybean meal (46%)	33.75	30.06	27.41	34.99	30.06	27.41	34.99	30.06	27.40	35.33	30.06	27.40	33.94	30.06	27.40	29.26	30.06	27.40
Tucumã meal	0.00	0.00	0.00	5.00	5.00	5.00	10.00	10.00	10.00	15.00	15.00	15.00	20.00	20.00	20.00	25.00	25.00	25.00
Limestone	0.98	1.18	1.10	0.97	1.17	1.09	0.96	1.17	1.09	0.97	1.16	1.08	0.96	1.15	1.07	0.95	1.15	1.06
Dicalcium phosphate	1.89	1.37	1.12	1.89	1.39	1.14	1.91	1.41	1.15	1.91	1.42	1.17	1.93	1.44	1.19	1.96	1.46	1.21
Salt	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
DL-methionine 99%	1.03	0.03	0.05	0.17	0.04	0.07	0.19	0.06	0.09	0.34	0.08	0.11	0.23	0.10	0.12	0.58	0.12	0.14
Vit./Min. supplement	0.50[1]	0.50[2]	0.50[3]	0.50[1]	0.50[2]	0.50[3]	0.50[1]	0.50[2]	0.50[3]	0.50[1]	0.50[2]	0.50[3]	0.50[1]	0.50[2]	0.50[3]	0.50[1]	0.50[2]	0.50[3]
Soybean oil	2.00	3.18	3.34	2.93	3.60	3.76	3.34	4.02	4.17	6.50	4.43	4.59	6.62	4.85	5.00	6.50	5.26	5.42
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Nutritional levels[5]																		
Met. Energy (kcal/kg)	3.000	3.100	3.150	3.000	3.100	3.150	3.000	3.100	3.150	3.000	3.100	3.150	2.999	3.100	3.150	2.999	3.100	3.150
Crude Protein (%)	21.00	19.00	18.00	21.00	19.00	18.00	21.00	19.00	18.00	21.00	19.00	18.00	21.00	19.00	18.00	21.00	19.00	18.00
Calcium (%)	0.960	0.900	0.800	0.960	0.900	0.800	0.960	0.900	0.800	0.960	0.900	0.800	0.960	0.900	0.800	0.960	0.900	0.800
Methionine + Cystine (%)	0.800	0.630	0.625	0.800	0.625	0.625	0.800	0.625	0.625	0.924	0.625	0.625	0.800	0.625	0.625	1.124	0.625	0.625
Methionine (%)	0.599	0.335	0.341	0.608	0.338	0.350	0.617	0.348	0.359	0.752	0.357	0.369	0.636	0.366	0.378	0.972	0.375	0.387
Lysine (%)	1.114	0.987	0.919	1.102	0.975	0.907	1.089	0.962	0.894	1.075	0.950	0.882	1.067	0.937	0.869	1.041	0.924	0.856
Threonine (%)	0.815	0.741	0.703	0.797	0.724	0.685	0.780	0.706	0.668	0.747	0.689	0.650	0.734	0.671	0.633	0.710	0.654	0.615
Tryptophan (%)	0.264	0.234	0.219	0.261	0.231	0.215	0.257	0.228	0.212	0.252	0.225	0.209	0.250	0.221	0.206	0.244	0.218	0.202
Available phosphorus (%)	0.450	0.350	0.300	0.450	0.350	0.300	0.450	0.350	0.300	0.450	0.350	0.300	0.450	0.350	0.300	0.450	0.350	0.300
Sodium (%)	0.157	0.157	0.157	0.156	0.156	0.156	0.155	0.155	0.155	0.156	0.154	0.154	0.154	0.153	0.153	0.153	0.152	0.152

[1]Vit./mineral supplement – initial – content in 1 kg = Folic Acid 800 mg, Pantothenic Acid 12.500 mg, Antioxidant 0,5 g, Biotin 40 mg, Niacin 33.600 mg, Selenium 300 mg, Vit. A 6.700.000 UI, Vit. B1 1.750 mg, Vit. B12 9.600 mcg, Vit. B2 4.800 mg, Vit. B6 2.500 mg, Vit. D3 1.600.000UI, Vit. E 14.000 mg, Vit. K3 1.440 mg. Mineral supplement– content in 0,5 kg = Manganese 150.000 mg, Zinc 100.000 mg, Iron 100.000 mg, Copper 16.000 mg, Iodine 1.500 mg

[2]Vit./mineral supplement – growth – content in 1 kg = Folic Acid 650 mg, Pantothenic Acid 10.400 mg, Antioxidant 0,5 g, Niacin 28.000 mg, Selenium 300 mg, Vit. A 5.600.000 UI, Vit. B1 0,550 mg, Vit. B12 8.000 mcg, Vit. B2 4.000 mg; Vit. B6 2,080 mg, Vit. D3 1.200.000 UI, Vit. E 10.000 mg, Vit. K3 1.200 mg. Mineral supplement – content in 0,5 kg = Manganese 150.000 mg, Zinc 100.000 mg, Iron 100.000 mg, Copper 16.000 mg, Iodine 1.500 mg

[3]Vit./mineral supplement – termination – content in 1 kg = Pantothenic Acid 7.070 mg, Antioxidant 0,5 g, Niacin 20.400 mg, Selenium 200 mg, Vit. A 1.960.000 UI, Vit. B12 4.700 mcg, Vit. B2 2.400 mg, Vit. D3 550.000 UI, Vit. E 5.500 mg, Vit. K3 550 mg. Mineral supplement – content in 0,5 kg = Manganese 150.000 mg, Zinc 100.000 mg, Iron 100.000 mg, Copper 16.000 mg, Iodine 1.500 mg

[4]P-Init. = Pre-Initial; Init. = Initial; Gro. = Growth; Term. = Termination

[5]Estimated levels based on dry matter.

Table III. Performance of broilers fed diets with tucumã meal (Desempenho de frangos alimentares alimentados com refeição Tucumã).

Variables	Tucumã meal levels (%)						P Value	R^2	CV, %
	0	5	10	15	20	25			
Feed intake, kg/bird*	4.50	4.17	4.31	4.50	4.63	4.77	0.05	0.79	4.09
Weight gain, kg/Bird	2.23	2.51	2.56	2.33	2.34	2.24	0.07	-	7.39
Feed conversion, kg/kg*	1.75	1.61	1.62	1.68	1.80	2.01	0.04	0.83	11.06
Slaughter weight, kg/bird	2.62	2.88	2.66	2.70	2.58	2.63	0.45	-	8.53

*Quadratic effect (P<0.05). CV – Coefficient of variation. P value – Coefficient of probability. R^2 – Coefficient of determination.

Table IV. Carcass traits of broilers fed diets with tucumã meal (Traços de carcaça de frangos alimentares alimentados com Tucumã refeição).

Variables	Tucumã meal levels (%)						P Value	R^2	CV, %
	0	5	10	15	20	25			
Carcasso yield, %	76.13	77.89	76.02	76.05	73.53	77.95	0.88	-	7.31
Neck, kg	6.47	5.62	5.23	6.65	7.65	4.66	0.12	-	21.26
Wing, %	10.42	9.96	9.07	10.92	9.97	11.38	0.58	-	14.01
Thigh, %	14.25	14.19	14.10	14.33	16.05	14.92	0.08	-	7.28
Drumstick, %	13.66	14.16	13.69	13.37	14.89	13.70	0.10	-	10.09
Chest, %	35.15	34.86	36.26	33.56	29.68	33.99	0.67	-	15.19
Dorsum, %*	20.05	21.21	21.65	21.17	21.76	21.35	0.04	0.78	9.46
Fat, %	2.15	1.86	1.74	2.05	1.49	1.80	0.60	-	19.09
Legs, g	82.00	92.00	90.00	90.00	85.00	85.00	0.56	-	9.90
Liver, g	32.50	40.00	37.50	32.50	37.50	27.50	0.31	-	23.36
Gizzard, g	37.50	35.00	35.00	35.50	37.50	32.50	0.77	-	17.90
Heart, g	10.10	10.12	10.14	10.15	10.20	12.50	0.44	-	19.60

*Quadratic effect (P<0.05). CV – Coefficient of variation. P value – Coefficient of probability. R^2 – Coefficient of determination.

Table V. Serum biochemical profile of broilers fed diets with tucumã meal (Soro bioquímico perfil de frangos alimentados dietas com Tucumã refeição).

Variables	Tucumã meal levels (%)						P	R^2	CV, %
	0	5	10	15	20	25			
Glucose, mg/dl	184.25	184.50	171.00	168.00	187.75	182.75	0.81	-	13.68
Cholesterol, mg/dl	181.25	173.00	171.25	167.75	178.00	191.50	0.06	-	5.97
Triglycerides, mg/dl *	260.50	269.00	264.75	259.75	195.25	205.50	0.02	0.47	14.84
Ph *	7.18	7.30	7.28	7.29	7.22	7.28	0.02	0.42	0.82

*Quadratic effect (P<0.05). CV – Coefficient of variation. P value – Coefficient of probability. R^2 – Coefficient of determination.

lynomial regression analysis at the 5% level of significance.

RESULTS AND DISCUSSION

Differences were observed (P<0.05) in feed intake ($Y = 4.5269 – 0.0913x + 0.0102x^2$) with the highest feed intake (4.35 kg/bird) from inclusion of 4.47% of tucumã meal in the diets. These results corroborate with those obtained by Sousa et al. (2012) that study the inclusion of cassava bagasse in diets for broilers observed differences, however, with linear effect on feed intake **(Table III)**,

It was observed that in its chemical composition, the tucumã meal presents a significant amount of fibers, being this a concern of the technicians nowadays, mainly because the fiber level directly affects the performance results of broilers, especially in the final stages (Braz et al., 2011), and may prevent the good use of several potentially alternative foods. In this context, from the inclusion of tucumã meal in the diets for broilers, the additional fibrous content may have influenced the feed intake (Toghyani et al., 2010) and, consequently, affect its growth performance.

In feed conversion results ($Y = 1.84 – 0,1132x + 0.0112x^2$), were estimated the best feed conversion (1.56 kg of ration/kg of body weight) in inclusion level

of 2.68% of tucumã meal in the diets. This result is directly associated to those obtained in feed intake, because they are directly proportional, and an increase in feed intake can affect all performance results of broilers.

In a similar context, Lira et al. (2010), using tomato residue meal in diets and working with systems of equations to estimate better levels of performance, also observed great results at inclusion levels below 5%, that according Feijó et al. (2016) can be attributed to the inclusion of exacerbated levels of alternative foods in diets that can change the feeding efficiency of the birds due dysfunctions in the feed intake.

Already in the results of carcass traits of broilers **(Table IV),** differences ($P<0.05$) were observed for dorsum yield ($Y = 19.223 + 1.1254x - 0.1295x^2$) where were observed great dorsum yield (21.66 %) in inclusion level of 4.34% of tucumã meal in the diets, discording of results obtained for Bastos et al. (2007), that don't observed differences in the carcass traits of broilers fed diets with coconut meal how energetic alternative food.

Differences weren't observed ($P>0.05$) in others variables of carcass traits, corroborated with results observed by Togashi et al. (2008), that study passion fruit by-products, empathized the positive influence of use of agroindustry by-products with high levels of fiber and energy, such as tucumã meal, have on carcass traits and its characteristics.

As for serum biochemical profile of broilers **(Table V)**, differences ($P<0.05$) were observed in concentrations of triglycerides and blood pH of analyzed samples. For triglycerides ($Y = 253.87 + 14.70x - 4.14x^2$), were obtained the great triglycerides concentration (266.91 mg/dl) in inclusion level of 1.77% of tucumã meal in the diets. Comparing these results with those described by González et al. (2001) and the reference values provided by Evans et al. (1977), were observed that from intake of diets with up to 20% of tucumã meal, there was a decrease in the blood triglycerides concentration of broilers, including approaching the considered ideal values for the metabolism for these. Melo et al. (2016) also comment that modifications, even if small, in the diet of birds, can cause changes in all serum profile of these, regardless of the alternative food used.

For blood pH ($Y = 7.10 + 0.121x - 0.018x^2$), were obtained the better blood pH (7.30) in inclusion level of 3.36% of tucumã level in diets. Observed too that from inclusion of tucumã meal in diets, there was an increase in the blood pH of the broilers. Teeter et al. (1985) observed that the normal blood pH of birds varies on optimal physiological conditions between 7.2 and 7.3. These reference values characterize that the results obtained in this study, even with the subtle elevation of pH from the inclusion of tucumã meal, as according to normality patterns.

Recently, the researchers have emphasized the relevance of the studies related to acid-base balance of birds, aiming to observe the normality curves on the vital processes of their metabolism. However, for this, is very important that the pH of body fluids be according to the physiological limits of the animals. In addition, a variation in blood acid-base balance can decrease the efficiency of animal metabolism, resulting in low physiologic productivity (Ait-Boulahsen et al. 1995; Melo et al. 2016), a fact that is connected with the results obtained in this study, mainly due a possible stress that the broilers may have obtained during the experimental period, since the conditions of temperature and humidity to which they were submitted in this (32 °C of temperature and 85% of relative air humidity) due the geographical location where it was installed. Thus, the thermal stress, besides releasing large amount of organic acids, changes the electrolytes balance in bloodstream (Lisboa et al. 2014).

Don't were observed differences ($P>0.05$) in concentrations of blood glucose and cholesterol, corroborated with the results obtained by Raber et al. (2008). However, these results of blood glucose and cholesterol are above the reference values proposed by Ross et al. (1978) how standard of normality for these indexes, being directly related to the composition of the alternative food and its influence on physiology of the birds.

CONCLUSIONS

The tucumã meal can be used as alternative food in diets for broilers without causing negative changes on performance, carcass traits and serum biochemical profile. Up to 25% of inclusion, there was an increase in feed intake, feed conversion and bloodstream triglycerides concentration.

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