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Cassava root scrapings for 22 to 42-day-old broilers in high-temperature environments[1]

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ABSTRACT - The objective of this study was to analyze the effect of whole cassava root scrapings at different levels in diets for broilers in the period of 22 to 42 days of age in high-temperature environments on performance, as well as to evaluate the metabolizability of dry matter (DM), crude protein (CP) and gross energy (GE) and nitrogen balance. A total of 400 male Ross broilers were used for evaluation of performance and 80 birds of the same strain were used in the metabolism experiment. The design was of randomized block with five treatments and four replications. The experimental unit was represented by twenty birds on the performance evaluation and four birds were housed in metabolic cages for the metabolism evaluation. The treatments consisted of diets containing inclusion levels of cassava root scrapings (0, 50, 100, 150 and 200 g/kg), formulated to meet the nutritional requirements accordingly to each phase of the birds. Whole cassava root scrapings can be included in diets for 22 to 42 day-old broiler chickens, at a level between 118.75 and 200 k/kg, in environments of high temperatures, with positive interference on weight gain and feed conversion, without affecting the coefficient of metabolizability of dry matter, crude protein, gross energy and nitrogen balance, or carcass characteristics, such as yields of main cuts and metabolically active organs of the birds.

Key Words: alternative feed, crude protein, dry matter, gross energy, metabolizability, performance

Introduction

Broilers, among the animals for human consumption, hold a prominent position in the capability to convert crop products into quality protein. However, in the production systems of these animals, expenses with feeding are equal to approximately 80% of the total cost, a fact that has led producers and technicians to seek alternative measures, evaluating products, co-products and by-products, in order to reduce these costs.

Bellaver (2005) draws attention to the use of alternative feedstuffs as ingredients in poultry diets, stressing the importance of commercial availability, quality and prices benchmarking with traditional foods, seeking the advantage in price, without ever overlooking the quality. He also stresses that a basic principle in the substitution of corn for alternative ingredients is to maintain balanced nutrients to energy, in order to produce a diet cheaper than the conventional.

Poultry traditional diets are mainly formulated with corn and soybean meal. However, these ingredients suffer a sharp price fluctuation, especially during the intercrop season. In this context, cassava (*Manihot esculenta, Crantz*), Brazilian plant, emerges as an alternative with agricultural area of about two million hectares, rich in carbohydrates, mainly in the form of starch. It is a food crop, which has several advantages such as high robustness, ease of cultivation and elevated productivity of roots, which may be exploited in marginal soils, responding appropriately to the use of high technology.

In animal feeding, both the root and the aerial part of the cassava can be used in various ways, such as fresh, ensiled, full scrape, flour, byproduct of the starch industry, among others.

Cassava root scrapings stand out as energy source, which is quantitatively the most important component of broiler diets; however, it presents minimal amounts of protein, vitamins and minerals, whose values must be

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considered and adjusted in the feed formulation (Almeida & Ferreira Filho, 2005).

Thus, this research was conducted to evaluate the effect of inclusion levels of cassava root scrapings (0, 50, 100, 150 and 200 g/kg) in diets for 22 to 42-day-old broilers on the variables performance and metabolism of nutrients.

Material and Methods

The performance test was carried out in the period of 22 to 42 days of broilers age; the variables weight gain, feed intake and feed conversion were evaluated. For the experiment to take place, 400 male Ross chicks were selected individually and according to body weight.

Birds were distributed in randomized block design, based on the animal weight, with five treatments, four replicates and the experimental unit was represented by 20 birds per pen, with an area of 3.00 m^2, distributed in a brick shed, covered with clay tiles, cement floor, containing curtains for temperature and air current control. The partitions between pens were made of smooth wire mesh.

The animal management in the pre-trial and trial was similar to the one recommended by the manual of Ross broiler production, and the bedding used in the stalls was made of rice straw, with a thickness of approximately 5 cm. During the first ten days, birds were subjected to heating system with incandescent light bulbs of 100 watts, and vaccination program against diseases of infectious bronchitis, Newcastle and Gumboro.

The experimental diets (Tables 1 and 2) were formulated based on corn, soybean meal, soybean oil, dicalcium phosphate, limestone, salt, vitamin and mineral supplement containing different inclusion levels of cassava root scrapings (0, 50, 100, 150 and 200 g/kg) formulated to meet the nutritional requirements according to Rostagno et al. (2005). Cassava root scrapings, before being added to the diets, were dehydrated and ground in fodder machine.

The lighting program was ongoing during the 24 hours of the day; natural light from 06:30 to 17:30 h and artificial light during the rest of the time.

The monitoring of temperature and humidity in the shed was done through thermohygrometer of maximum and minimum, placed at intermediate height in relation to the

Table 1 - Composition and calculated nutrient levels of the experimental diets from 22 to 33 days of age

Ingredients (g/kg)	Inclusion levels of whole cassava root scrapings (g/kg)				
	0	50	100	150	200
Corn	653.350	586.080	522.080	458.030	392.930
Soybean meal	277.750	288.270	297.270	306.270	315.370
Vegetable oil	35.500	42.200	47.500	52.900	59.100
Cassava scrapings	0.000	50.000	100.000	150.000	200.000
Dicalcium phosphate	15.000	15.250	15.250	15.400	15.500
Calcitic lime	8.050	7.700	7.400	7.000	6.700
Sodium chloride	3.250	3.250	3.250	3.250	3.250
L-lysine	0.900	0.700	0.600	0.450	0.350
DL-methionine	1.200	1.550	1.650	1.700	1.800
Vitamin-mineral premix[1]	1.000	1.000	1.000	1.000	1.000
Inert material	1.400	1.400	1.400	1.400	1.400
Choline chloride	1.250	1.250	1.250	1.250	1.250
Virginiamycin	0.550	0.550	0.550	0.550	0.550
Coxistac	0.500	0.500	0.500	0.500	0.500
Butylated hydroxytoluene	0.100	0.100	0.100	0.100	0.100
Enzymes[2]	0.200	0.200	0.200	0.200	0.200
Total	1000.000	1000.000	1000.000	1000.000	1000.000
			Calculated composition[3]		
Dry matter (kcal/kg)	3150	3150	3150	3150	3150
Crude protein (g/kg)	180.30	180.30	180.30	180.30	180.30
Digestible lysine (g/kg)	10.17	10.17	10.17	10.17	10.17
Dig. methionine + cystine (g/kg)	7.32	7.32	7.32	7.32	7.32
Dig. tryptophan (g/kg)	1.73	1.73	1.73	1.73	1.73
Crude fiber (g/kg)	26.38	28.40	30.53	32.62	34.70
Calcium (g/kg)	7.63	7.60	7.63	7.63	7.63
Available phosphorus (g/kg)	3.80	3.80	3.80	3.80	3.80

[1] Composition of premix/kg: folic acid - 100 mg; antioxidant - 125 mg; copper - 15,000 mg; coccidiostats - 12,000 mg; iron - 10,000 mg; iodine - 250 mg; manganese - 24,000 mg; methionine - 135,000 mg; niacin - 2,000 g; calcium pantothenate - 2,000 mg; selenium - 50 g; excipient q.s.- 1,000 g; vitamin A - 300,000 IU; vitamin B1 - 400 mg; vitamin B12 - 4,000 mcg; vitamin B2 - 720 mg; vitamin D3 - 100,000 IU; vitamin E - 4,000 IU; vitamin K - 98 mg; zinc - 20,000 mg; growth promoter - 10,000 mg.
[2] Amylase, protease and cellulase along with phytase, were supplied according to the recommendation of the manufacturer.
[3] Calculated according to Rostagno et al. (2005).

Table 2 - Composition and calculated nutrient levels of the experimental diets in the period from 34 to 42 days of age

Ingredients (g/kg)	Inclusion levels of whole cassava root scrapings (g/kg)				
	0	50	100	150	200
Corn	613.680	546.030	481.000	416.400	353.400
Soybean meal	316.260	326.070	335.250	344.300	353.000
Vegetable oil	35.100	42.200	48.200	54.300	58.600
Cassava scrapings	0.000	50.000	100.000	150.000	200.000
Dicalcium phosphate	16.460	18.250	18.400	18.400	18.400
Calcitic lime	8.500	7.150	6.900	6.500	6.500
Sodium chloride	3.250	3.250	3.250	3.250	3.250
L-lysine	0.500	0.400	0.250	0.050	0.050
DL-methionine	1.250	1.650	1.750	1.800	1.800
Vitamin-mineral premix[1]	2.000	2.000	2.000	2.000	2.000
Inert material	0.400	0.400	0.400	0.400	0.400
Choline chloride	1.250	1.250	1.250	1.250	1.250
Virginiamycin	0.550	0.550	0.550	0.550	0.550
Coxistac	0.500	0.500	0.500	0.500	0.500
Butylated hydroxytoluene	0.100	0.100	0.100	0.100	0.100
Enzymes[2]	0.200	0.200	0.200	0.200	0.200
Total	1000.000	1000.000	1000.000	1000.000	1000.000
Calculated composition[3]					
Dry matter (kcal/kg)	3100	3100	3100	3100	3100
Crude protein (g/kg)	194.10	194.10	194.10	194.10	194.10
Dig. lysine (g/kg)	10.73	10.73	10.73	10.73	10.73
Dig. methionine + cystine (g/kg)	7.73	7.73	7.73	7.73	7.73
Dig. tryptophan (g/kg)	1.82	1.82	1.82	1.82	1.82
Crude fiber (g/kg)	27.70	29.80	31.88	33.90	36.05
Calcium (g/kg)	8.24	8.24	8.24	8.24	8.24
Available phosphorus (g/kg)	4.41	4.41	4.41	4,41	4,41

[1] Composition of premix/kg: folic acid - 100 mg; antioxidant - 125 mg; copper - 15,000 mg; coccidiostats - 12,000 mg; iron - 10,000 mg; Iodine - 250 mg; manganese - 24,000 mg; methionine - 135,000 mg; niacin - 2,000 g; calcium pantothenate - 2,000 mg; selenium - 50 g; vehicle q.s. - 1,000 g; vitamin A - 300,000 IU; vitamin B1 - 400 mg; vitamin B12 - 4,000 mcg; vitamin B2 - 720 mg; vitamin D3 - 100,000 IU; vitamin E - 4,000 IU; vitamin K - 98 mg; zinc - 20,000 mg; growth promoter - 10,000 mg.
[2] Amylase, protease and cellulase along with phytase, were supplied according to the recommendations of the manufacturer.
[3] Calculated according to Rostagno et al. (2005).

pens. The readings of the thermometers were made daily.

At 42 days of age, two birds per plot were selected based on the weight of the plot, for evaluations of carcass. Birds were subjected to fasting for six hours; then they were weighed and sacrificed, according to normal slaughter procedures: cervical dislocation, bleeding, plucking and evisceration.

After bleeding and plucking, birds were eviscerated and the carcasses (excluding head, neck and feet) were weighed. Afterwards, the entire abdominal fat was removed. The carcass output was determined by the ratio between the weight of the eviscerated carcass without feet, head or fat, and the live weight of birds on the slaughter platform. Also, the percentage yield of the carcass and prime cuts was determined.

The cuts (breast, back, wings, wingettes, thighs and chicken chops) were weighed on digital scales and their yields, calculated on the weight of the eviscerated carcass; the yield (g/100 g) of the carcasses (without head, or feet and neck), the aforementioned cuts and also the edible organs (heart, liver and gizzard) were evaluated. The results were submitted to analysis of variance and regression testing, according to PROC GLM from SAS (Statistical Analysis System, version 6.11). The study adopted $\alpha = 0.05$.

In the metabolism assay, at 34 days of age, 80 male Ross broilers were individually selected based on body weight and housed in metabolic cages, provided with open trough feeders and drinkers and excreta collection pans. The birds were distributed in a randomized block design based on the position of the cages in the shed, with five treatments and four replications. The experimental unit was represented by metabolic cages with four groups of birds housed.

The experiment lasted eight days (34 to 42 days of age); the first four days were for the chicken to adapt to the cages and experimental diets, and the last four days for collection of excreta.

The monitoring of temperature and humidity of the experimental shed was done through thermohygrometer of maximum and minimum placed at the intermediate height of the cages.

Water was provided *ad libitum* in trough drinkers during the experimental period and changed three times a day to avoid heating and fermentation. Feed was also provided *ad libitum*. The lighting program was continued for 24 hours a day; natural light was used from 06:30 to 17:30 h and artificial light was used during the rest of the time.

The diets used in the experimental period (Table 2) were formulated according to the recommendations of Rostagno et al. (2005).

During the four days, the total daily excreta collections in each experimental unit were performed with an interval of approximately twelve hours. Excreta were stored in plastic bags properly identified after collection, weighed and stored in a freezer at -5 °C until the final period of the experiment.

At the end of the experiment, all excreta from the same experimental unit were properly defrosted and mixed uniformly. After this procedure the excreta was pre oven -dried (48 hours, 65 °C). Then, the excreta were ground in a ball mill, packed in glass, and then the analyses of dry matter, crude protein and gross energy were performed according to Silva & Queiroz (2002).

All analyses were performed at the Nutrition Laboratory of DZO-CCA, UFPI. The calculations of the coefficients of metabolizability of the nutrients were performed according to Ramos et al. (2006).

The results were submitted to analysis of variance and regression analysis, according to the PROC GLM from SAS (Statistical Analysis System, version 6.11). The study adopted $\alpha = 0.05$.

Results and Discussion

The average values of temperature, obtained in the mornings and in the afternoons, were, respectively, 27.5±1.2 and 31.81.9 ^{o}C, and relative humidity, 64.7±1.3%. These results reveal that the research was conducted in an environment of high temperatures, with the birds subjected to heat stress, according to Ferreira (2005).

According to the results of performance (Table 3), it can be observed that there was no significant effect on feed intake (P>0.05). However, quadratic effect of inclusion levels of cassava root scrapings (CRS) was verified on weight gain (WG) and feed conversion (FC), represented respectively by the equations: WG = 1.87 – 0. 0019 CRS + 0.000008 CRS^2 ($R^2 = 0.92$; P<0.05) and FC = 1.887 + 0.0018 CRS – 0.000008 CRS^2 ($R^2 = 0.91$; P = 0.05). This finding indicates that the inclusion levels of cassava scrapings, even having no influence on feed intake, affected weight gain and feed conversion.

From the derivation of the equations, one can observe that at the level of 118.75 g/kg of CRS inclusion, the lowest weight gain occurred and there was an increase from this level. For FC, inclusions up to 112.50 g/kg of CRS caused worsening, and from this level, improvement in this parameter from 22 to 42 days; therefore, levels between 118.75 and 200 g/kg can be recommended for diets for broilers under high temperature conditions. This climate aspect is quite peculiar in northeast of Brazil during almost the whole year. Probably, the finding of improvement in performance for the weight gain and feed conversion, from the levels reported above, may be related to the increase in the proportion of vegetable oil in the diets with increasing inclusion of scrapings of cassava root. As in the metabolism of oil there is calorie reduction, likewise, in high temperature conditions, this benefit may have occurred in bird performance.

The value found in the present study was higher than the 10.24% cassava scrapings inclusion recommended by Nascimento et al. (2005), once the authors found quadratic effect on weight gain and feed conversion, by replacing corn with cassava root scrapings levels (0, 5, 10, 15, 20 and

Table 3 - Performance of broilers fed diets containing different inclusion levels of cassava root scrapings (CRS), from 22 to 42 days of age

Inclusion level of CRS (g/kg)	Parameters		
	Feed intake (kg)	Weight gain (WG, kg)[1]	Feed conversion (FC, kg/kg)[2]
0	3.537	1.880	1.885
50	3.477	1.782	1.955
100	3.522	1.757	2.002
150	3.482	1.782	1.955
200	3.470	1.800	1.927
CV	3.00	3.30	3.70
	P value	P value	P value
Linear	0.4486	0.1163	0.4663
Quadratic	0.9602	0.0277	0.0500
Cubic	0.6489	0.4139	0.7134
Quartic	0.5040	0.8910	0.5422

[1] WG = 1.87 – 0.0019 CRS + 0.000008 CRS^2.
[2] FC = 1.887 + 0.0018 CRS – 0.000008 CRS^2.

25%). In the fattening stage, due to the negative results, with decrease of weight gain and worsening of feed conversion of animals, the authors did not recommend the use of the product. On the other hand, the values found in this study were consistent with those reported by Cotta (2003), who recommended the inclusion of up to 15 or 30% cassava in the diet of young and adult birds, respectively. However, in preliminary studies, the replacement of over 20% of corn by cassava in diets for growing chickens caused significant economic losses in relation to weight gain and feed conversion. Research studies by Smith et al. (1968) and Osei & Twumasi (1989) found that corn can be replaced by cassava scrapings in up to 10% without affecting weight gain of animals.

The inclusion levels of cassava scraping did not affect (P<0.05) percentage of carcass, beast, back, thighs, chicken chops, wings, wingettes, heart, liver or gizzard (P>0.05) (Table 4). This finding is contrary to the results obtained by Oliveira Neto et al. (2000) and Oliveira Neto et al. (2006), as they conclude that broilers from 1 to 49 days of age, subjected to high temperature environments (32 ^{o}C), have the performance and yield of prime cuts compromised. This study was conducted in an environment with temperature ranging from 27.5±1.2 and 31.8±1.9 ^{o}C, and the percentage of vegetable oil, at the 20% CRS inclusion level was around 5.9% in the two feeding programs, which may have contributed to yield drop in carcass and prime cuts.

There was no effect of the inclusion levels of cassava root scrapings on intake, excretion or metabolizability, neither dry matter nor crude protein and gross energy (Table 5; P>0.05).

The inclusion levels of cassava root scrapings in diets for 22 to 42-day-old broilers did not affect (P>0.05) nitrogen intake or excretion, nor nitrogen balance, with all experimental treatments showing positive results (Table 6).

The metabolism results of dry matter, gross energy, crude protein and nitrogen balance suggest that whole cassava root scrapings can be included up to 200 g/kg in diets for 22 to 42-day-old broilers, since the variables, especially the metabolization coefficients, were not influenced by increasing inclusion levels of that ingredient,

Table 4 - Values of the yield of the carcass, cuts and major organs (g/100 g) of broilers fed diets containing different levels of inclusion of cassava root scrapings (CRS), from 22 to 42 days of age

Inclusion levels of CRS (g/kg)	Parameters									
	Carcass	Breast	Back	Thighs	Chicken chops	Wings	Wingettes	Heart	Liver	Gizzard
0	77.49	29.58	23.49	14.21	15.66	4.83	6.70	0.50	2.07	2.94
50	76.91	30.34	23.36	13.87	14.77	5.02	6.70	0.69	2.27	302
100	76.96	30.27	22.42	14.02	15.02	5.03	6.83	0.62	2.41	3.38
150	76.50	30.45	23.95	13.96	14.48	4.72	6.61	0.65	2.17	3.01
200	77.26	30.31	23.02	13.66	15.26	4.97	6.59	0.59	2.37	2.24
CV (%)	1.51	5.91	7.75	4.16	5.34	3.84	14.16	18.10	6.66	9.88
P value										
Linear	0.6466	0.5879	0.9033	0.2900	0.4097	0.9770	0.8537	0.4008	0.0592	0.2544
Quadratic	0.3384	0.6497	0.8014	0.9100	0.1121	0.5706	0.8489	0.0593	0.2037	0.4695
Cubic	0.7522	0.8628	0.5712	0.4378	0.8949	0.2530	0.9972	0.3397	0.0598	0.5326
Quartic	0.5719	0.8251	0.2940	0.7840	0.2441	0.2203	0.7744	0.2345	0.0934	0.0843

CV - coefficient of variation.

Table 5 - Metabolism of dry matter (DM), gross energy (GE) and crude protein (CP) of diets containing different inclusion levels of cassava root scrapings (CRS), from 22 to 42 days of age

Inclusion levels of CRS (g/kg)	Dry matter			Gross energy			Crude protein		
	Consumed (g/bird/day)	Excreted (g/bird/day)	Metabol. coef. (g/g)	Consumed (g/bird/day)	Excreted (g/bird/day)	Metabol. coef. (g/g)	Consumed (g/bird/day)	Excreted (g/bird/day)	Metabol. coef. (g/g)
0	124.938	31.768	0.741	512.875	131.580	0.743	25.112	10.765	0.571
50	123.970	34.805	0.719	509.800	128.098	0.749	24.495	11.362	0.536
100	122.148	29.453	0.759	502.575	108.750	0.784	25.810	8.882	0.656
150	121.778	31.498	0.741	498.900	115.425	0.768	26.145	9.817	0.625
200	120.745	35.900	0.703	496.925	122.848	0.753	23.907	10.210	0.573
CV (%)	1.78	11.58	4.41	1.78	10.80	3.59	1.83	9.00	6.49
P value									
Linear	0.1100	0.4236	0.2347	0.1008	0.1716	0.3821	0.3188	0.9250	0.1554
Quadratic	0.7525	0.1781	0.2073	0.7383	0.0749	0.0977	0.1004	0.1058	0.1259
Cubic	0.9566	0.0977	0.1162	0.6879	0.4384	0.5033	0.0616	0.1086	0.1035
Quartic	0.6382	0.2129	0.2574	0.8038	0.2442	0.2774	0.5095	0.0686	0.1189

CV - coefficient of variation.

Table 6 - Balance of nitrogen of diets containing different inclusion levels of cassava root scrapings (CRS), for 22 to 42-day-old broilers

Inclusion levels of CRS (g/kg)	Consumed N (g/bird/day)	Excreted N (g/bird/day)	N balance (g/bird/day)
0	4.017	0.645	3.372
50	3.920	0.625	3.290
100	4.130	0.660	3.470
150	4.182	0.670	3.512
200	3.827	0.610	3.212
CV	1.83	2.05	1.86
Linear	0.3330	0.1529	0.3340
Quadratic	0.1014	0.1211	0.1014
Cubic	0.0623	0.1042	0.1122
Quartic	0.4987	0.0670	0.4708

CV - coefficient of variation.

a fact that characterizes the proper utilization of the nutrients evaluated.

Thus, the results of the metabolism of nutrients are in consonance with the ones obtained in this research.

As an enzyme complex containing amylase, protease, cellulase and phytase was used, for all treatments, this product may have contributed to improvement in the metabolizability of nutrients and energy (Fuente & Soto-Salanova, 1997). In this context, Classen (1996) and Piquer (1996) reported that exogenous enzymes were produced artificially and added to the animal diets to increase digestibility, to neutralize anti-nutritional factors, as well as to reduce the viscosity of intestinal contents and to decrease the proliferation of undesirable microorganisms. In the present study, the values of coefficients of the metabolizability of dry matter and energy obtained suggest that the enzyme complex contributed to the better utilization of nutrients and energy.

Conclusions

Whole cassava root scrapings in well-balanced diets may be included in diets for broilers from 22 to 42 days of age, between 118.75 and 200 g/kg, with positive interference on weight gain and feed conversion. The inclusion levels of cassava scrapings in properly-balanced diets do not affect the coefficient of metabolizability of dry matter, crude protein, gross energy, nitrogen balance or the inherent variables in the percentage of carcass, major cuts and metabolically active organs of 22 to 42-day-old broiler chickens.

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