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Digestibility of Feeds Containing Sorghum, With and Without Tannin, for Broiler Chickens Submitted to Three Room Temperatures

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ABSTRACT

The traditional method of total excreta collection was applied, using 30 to 40 day old male Ross 308 broiler chickens. One hundred and eight broiler chickens were used, randomly assigned to a 3x3 factorial experimental design. The room temperatures were 14 °C (cold), 25 °C (thermoneutral) and 32 °C (hot) and the three diets were 100% maize, 100% sorghum with tannin and 100% sorghum without tannin, with four replicates of each. The digestibility coefficients for the dry matter, crude protein, crude fibre, neutral detergent fibre, acid detergent fibre, ether extract, mineral matter and nitrogen-free extract were determined. It was observed that all the digestibility coefficients were higher in the hot chamber and lower in the cold chamber, and that these values tended to be higher for maize.

INTRODUCTION

Sorghum is an important cereal, ranking fifth in world production, behind wheat, corn, rice and barley and being used for both human and animal consumption throughout the world (Gualtieri & Rapaccini, 1990). In regions such as Asia, Africa, China, Russia and Central America, sorghum grains are mostly used for human consumption, whilst in South and North America, Europe and Australia, they are produced mostly for animal feed. Amongst the various different alternative foods, sorghum stands out as a resource capable of significantly reducing costs in poultry feeding, at a time of year when the final cost of broiler chickens is at its highest.

Despite similarities with maize with respect to the carbohydrate and protein compositions, sorghum presents a group of phenolic compounds in its structure, including tannins. All sorghum varieties contain phenolic compounds, which can influence the colour, appearance and nutritive value of the grain, and they can be divided into three groups: acidic phenolics, flavanoids and tannins. The presence of tannin reduces the nutritional value of a diet, mainly due to a decrease in the use of the protein and a reduction in the activity of digestive enzymes (Haslam, 1981). In consequence, nitrogen retention and use of the amino acids are reduced due to the reduction in protein digestibility (Mitaru *et al.*, 1984; Mustafa & El Zubeir, 1993; Elkin *et al.*, 1995).

The carbohydrates are also affected by tannin, possibly due to the formation of complex compounds, which are difficult to digest (Trevino *et al.*, 1992; Mahamood & Smithard, 1993). The vitamins and minerals, especially those of the B complex, plus iron and calcium are all affected by the presence of tannin in the diet (Bagepalli *et al.*, 1982; Mehansho *et al.*, 1987; Chang *et al.*, 1993).

The first study on the determination of nutrient digestibility for poultry, was carried out by Hill & Anderson (1958). According to Rostagno *et al.*

(1977), the addition of sorghum to broiler chicken diets could present some variations in nutrient digestibility when compared to feeds formulated with a corn base. These results could vary according to the tannin content of the sorghum grain and the environmental conditions to which the birds were submitted.

According to Gomes & Macari (2000), the tropical and sub-tropical countries present the greatest potential for the production of domestic fowl, one of the major obstacles being the hot climates in these regions. Daytime temperatures above 30 to 32 °C are considered stressful for the birds and have a negative effect on performance, reducing food ingestion. During heat stress, feed consumption decreases, the birds become slower and drink from 2 to 3 times more water, increasing the excretion of water via panting and urinating and increasing the digestibility of the diet nutrients.

Based on these considerations, the objective of this study was to evaluate the digestibility of feeds containing sorghum, with and without tannin, in broiler chickens submitted to three different room temperatures.

MATERIAL & METHODS

The experiment was carried out in the experimental facilities of the Faculty of Veterinary Science and Animal Production of UNESP, Botucatu, Brazil, initially installed in a broiler house constructed in an east-west direction, 8m wide, 40m long, 3.5m tall and covered with asbestos cement tiles. The broiler house was divided into 3.25 x 1.55m pens, providing an area of 5m^2/pen. The pens were separated from each other by 40cm brick walls, each being equipped with two tubular 20kg capacity feeders and a pendular drinker. The sidewalls were of brick up to 40cm, completed with galvanised wire fencing and protected by moveable curtains. Fans were distributed so as to provide uniform ventilation for all of the pens.

Digestibility assay was carried out at the Poultry Nutrition Laboratory of the Department of Animal Nutrition and Improvement of the Faculty of Veterinary Science and Animal Production (FMVZ) – UNESP – Botucatu, Brazil. The traditional method of total excreta collection was applied, using 30 to 40 day old intact male Ross 308 broiler chickens. One hundred and eight intact broiler chickens were used, randomly assigned to a 3x3 factorial experimental design. The room temperatures were 14 °C (cold), 25 °C (thermoneutral) and 32 °C (hot) and the three diets were 100% maize, 100% sorghum with tannin and 100% sorghum without tannin, with four replicates of each. The digestibility coefficients for the dry matter, crude protein, crude fibre, neutral detergent fibre, acid detergent fibre, ether extract, mineral matter and nitrogen-free extract were determined.

The breeding system used was that traditionally used in commercial operations. During the first week automatic cup-type pressure drinkers and infantile tubular feeders were used. As from the second week, pendular drinkers and tubular feeders were used. Initially heating was by way of 250W infrared lamps in each pen. Artificial lighting of the house was provided using 40W lamps in order to obtain 22 lumens per m^2 thus providing 24 hours light daily throughout the whole period. Wood shaving litter, 10cm deep, was used as the bedding.

The birds were vaccinated against Marek's disease in the incubator and against Newcastle's disease at 10 days of age, via the drinking water.

The birds received water and feed *ad libitum.* throughout the whole breeding period, which was divided into two phases: starter (1 to 21 days) and grower (22 to 35 days). The feeds were formulated according to the nutritional levels normally used commercially (Table 1).

At 30 days of age the birds were transferred to the acclimatised chambers and placed in digestibility cages. The internal temperatures of the acclimatised chambers were controlled throughout the entire period by sensors connected to a central control panel, which was monitored by a computer, which, in turn, recorded the temperature and humidity inside the chambers. An exhaustion system renewed the air within the chambers. The average temperature in the cold chamber was 14 °C, that of the thermoneutral chamber 25 °C and that of the hot chamber 32 °C.

The adaptation period to the experimental diets was from 30 to 37 days and the excreta were collected from day 38 to day 40. The excreta were removed from the collection trays every 12 hours during the three collection days. After collection the samples of excreta were frozen for later analysis. The analyses were carried out A.O.A.C. (1990) in the Laboratory of Animal Nutrition of the Faculty of Veterinary Science and Animal Production, UNESP, Botucatu, Brazil.

Table 1 - Composition of the experimental diets formulated with corn, sorghum with tannin (SWT) and sorghum without tannin (SNT).

Ingredients	Starter			Grower		
	Corn	SWT	SNT	Corn	SWT	SNT
Corn	57,060	-	-	61,650	-	-
Soybean meal	36,286	34,698	34,748	30,986	32,343	30,882
Sorghum	-	57,094	57,062	-	58,667	60,476
Soyben oil	2,977	4,400	4,400	4,000	5,536	5,236
DL-methionine	0,231	0,235	0,231	0,150	0,273	0,168
L-Lysine	0,150	0,264	0,263	0,192	0,196	0,249
Dicalcium Fosf.	1,814	1,824	1,814	1,614	1,578	1,582
Salt	0,350	0,350	0,350	0,350	0,350	0,350
Limestone	0,982	0,985	0,982	0,928	0,927	0,927
Vitamin Supl.[1]	0,100	0,100	0,100	0,080	0,080	0,080
Mineral Supl.[2]	0,050	0,50	0,050	0,050	0,050	0,050
Total	**100,00**	**100,00**	**100,00**	**100,00**	**100,00**	**100,00**
			Calculated			
ME (kcal/kg)	3000	3000	3000	3100	3100	3100
CP (%)	21,396	21,396	21,396	19,313	19,313	19,313
Ca (%)	0,960	0,960	0,960	0,874	0,874	0,874
Available P (%)	0,450	0,450	0,450	0,406	0,406	0,406
Met.(%)	0,492	0,492	0,492	0,453	0,453	0,453
Met + Cist. (%)	0,897	0,897	0,897	0,765	0,765	0,765
Lysine (%)	1,263	1,263	1,263	1,156	1,156	1,156
Triptophan (%)	0,207	0,207	0,207	0,238	0,238	0,238
Treonine (%)	0,795	0,795	0,795	0,752	0,752	0,752
K (%)	0,501	0,501	0,501	0,752	0,752	0,752
Na (%)	0,222	0,222	0,222	0,178	0,178	0,178
Cl (%)	0,195	0,195	0,195	0,242	0,242	0,242

1 - Vitaminic Suplement: Vitamin A- 1.875.000 UI; Vitamin D3- 625.000 UI; Vitamin E- 3.750 mg; Vitamin K3- 300 mg; Tiamin- 375 mg; Riboflavin- 1.375 mg; Piridoxin- 500mg; Vitamin B12- 3125 mg; Niacin- 8750 mg; Pantotenate calcium- 2500 mg; Acid Folic- 150 mg; Biotin- 15 mg; Colin- 87.500 mg; Growth promoter- 10.000 mg; Coccidiostatic - 25.000 mg; Antioxidant- 5.000 mg. 2 - Mineral Suplement: Fe- 50.000 mg; Cu- 70.000 mg; Mn - 60.000; Zinc- 50.000 mg; I - 1.250 mg; Se - 200mg.

RESULTS AND DISCUSSION

Tables 2, 3, 4 and 5 shows the results for all the digestibility coefficients. For the digestibility coefficients of the dry matter, only the temperatures showed a significant effect ($p<.05$), the highest values being observed in the hot chamber.

For the digestibility coefficients for crude protein, significant effects ($p<.05$) were shown both for the temperatures, with the highest values being observed in the hot chamber, and for the diets, the birds fed on the maize based diets showing the highest values. There was no difference ($p>.05$) between the digestibility coefficients for crude protein obtained with the high tannin sorghum based diet and the values obtained with the low tannin sorghum based diet. The significant effect of the diets on the digestibility coefficients for crude protein is in agreement with the results obtained by Haslam (1981) who stated that tannin reduced the nutritional value of the diet, mainly by reducing the utilisation of the protein and the activity of the digestive enzymes. Consequently nitrogen retention and the utilisation of the amino acids were decreased due to the reduction in protein digestibility (Mitaru *et al.*, 1984; Mustafa & El Zubeir, 1993; Elkin *et al.*, 1995).

Neither diets nor temperatures showed a significant effect ($p>0.05$) on the digestibility of crude fibre. There was a significant effect for temperature ($p<0.05$) on the neutral detergent fibre, the greatest values being observed in the hot chamber, there being no difference ($p>0.05$) between the digestibility coefficients observed in the cold and thermoneutral chambers. Similar results were observed by Elkin *et al.* (1995).

The digestibility coefficients for acid detergent fibre showed a significant effect ($p<0.05$) for temperature, the greatest values being observed in the hot chamber. There was also a significant effect ($p<0.05$) for the diets, the highest values being observed for the birds fed on the maize based diet in agreement with the results of Elkin *et al.* (1995).

Neither temperature nor diet showed a significant effect ($p>0.05$) on the digestibility coefficients of the ether extract. However the digestibility coefficients for mineral matter showed a significant effect ($p<0.05$) for

Table 2 - Digestibility coefficients[1] for dry matter and crude protein determined by the digestibility assay using total excreta collection from broiler chickens fed on corn based, high tannin sorghum based (HT) and low tannin sorghum based (LT) diets and submitted to three room temperatures.

	Chambers	Diets			
		Corn	Sorghum (HT)	Sorghum (LT)	Mean
Dry Matter	Cold	82.953[2]	82.995	82.470	82.806 B
	Neutral	84.894	83.024	83.983	83.967 B
	Hot	87.605	86.300	87.569	87.158 A
	Mean	85.151	84.106	84.674	-
Crude protein	Cold	76.612	72.976	72.941	74.176 B
	Neutral	75.322	74.024	75.770	75.039 B
	Hot	79.635	76.257	76.115	77.336 A
	Mean	77.190 A	74.409 B	74.942 B	-

1 - Values expressed on a dry weight basis. 2 - Means followed by the same small letter in the same line and means followed by the same capital letter in the same column, do not differ according to Tukey's test (p>0.05).

Table 3 - Digestibility coefficients[1] for crude fibre and neutral detergent fibre (NDF) determined by the digestibility assay using total excreta collection from broiler chickens fed on corn based, high tannin sorghum based (HT) and low tannin sorghum based (LT) diets and submitted to three room temperatures.

	Chambers	Diets			
		Corn	Sorghum (HT)	Sorghum (LT)	Mean
Crude fibre	Cold	32.597[2]	35.484	34.259	34.113
	Neutral	32.738	33.105	34.540	33.461
	Hot	33.483	33.247	32.737	33.156
	Mean	32.939	33.945	33.845	-
NDF	Cold	64.135	64.339	63.398	63.957 B
	Neutral	65.603	64.384	64.756	64.914 B
	Hot	73.649	68.881	68.927	70.486 A
	Mean	67.796	65.868	65.693	-

1 - Values expressed on a dry weight basis. 2 - Means followed by the same small letter in the same line and means followed by the same capital letter in the same column, do not differ according to Tukey's test (p>0.05).

Table 4 - Digestibility coefficients[1] for acid detergent fibre (ADF) and ether extract determined by the digestibility assay using total excreta collection from broiler chickens fed on corn based, high tannin sorghum based (HT) and low tannin sorghum based (LT) diets and submitted to three room temperatures.

	Chambers	Diets			
		Corn	Sorghum (HT)	Sorghum (LT)	Mean
ADF	Cold	27.982[2]	26.479	24.281	26.247 B
	Neutral	29.573	27.786	25.879	27.746 B
	Hot	35.394	33.482	36.815	38.564 A
	Mean	30.983 A	29.249 AB	28.992 B	-
Ether extract	Cold	90.878	89.074	89.200	89.717
	Neutral	91.445	89.362	90.592	90.466
	Hot	91.615	90.217	91.367	91.067
	Mean	91.313	89.551	90.386	-

1 - Values expressed on a dry weight basis. 2 - Means followed by the same small letter in the same line and means followed by the same capital letter in the same column, do not differ according to Tukey's test (p>0.05.

Table 5 - Digestibility coefficients[1] for mineral matter and nitrogen free extract (NFE), determined by the digestibility assay using total excreta collection from broiler chickens fed on corn based, high tannin sorghum based (HT) and low tannin sorghum based (LT) diets and submitted to three room temperatures.

	Chambers	Diets			
		Corn	Sorghum (HT)	Sorghum (LT)	Mean
Mineral matter	Cold	63.288[2]	63.251	54.515	60.351 B
	Neutral	66.032	60.169	56.473	60.891 B
	Hot	73.919	66.011	63.821	67.917 A
	Mean	67.746 A	63.144 AB	58.270 B	-
NFE	Cold	88.509	89.761	89.036	89.102 B
	Neutral	90.990	90.374	90.490	90.618 B
	Hot	93.057	92.512	93.626	93.065 A
	Mean	90.852	90.882	91.050	-

1 - Values expressed on a dry weight basis. 2 - Means followed by the same small letter in the same line and means followed by the same capital letter in the same column, do not differ according to Tukey's test (p>0.05).

temperature and the greatest values for the acid detergent fibre digestibility coefficients were observed in the hot chamber. There was also a significant effect ($p<0.05$) for the diets, the greatest digestibility coefficients being observed for the birds fed on the maize-based feed with results similar to those found by Mustafa & El Zubeir (1993).

The digestibility coefficients for the nitrogen free extract only showed a significant effect ($p<0.05$) for temperature, the greatest values for dry material being observed in the hot chamber.

In general temperature had a greater effect and the digestibility coefficients of the birds housed in the hot chamber were higher. These results agree with those of Gomes & Macari (2000) who stated that feed consumption decreased under heat stress, the birds becoming lighter and drinking two or three times more water, increasing water excretion via panting and urinare, and increasing the digestibility of the nutrients in the diet.

CONCLUSION

Based on the results it was concluded that all the digestibility coefficients were higher in the birds housed in the hot chamber and lower in the cold chamber. The values also tended to be greater for the birds fed on corn.

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