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Morphometric characteristics of finishing pigs fed cottonseed meal

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Abstract. The objective of this study was to evaluate the morphometric characteristics of finishing pigs fed cottonseed meal and enzymes. Thirty castrated male pigs with an average weight of 55.47 ± 5.3 kg were used in an experiment in a randomized block design, with 5 treatments and 6 replicates, whose treatments consisted of the following: control diet (0), control diet plus enzymatic complex (0E), diet with 5% (5E); 10% (10E) or 15% (15E) cottonseed meal plus enzymatic complex. The following measurements were taken: body length, thoracic perimeter, waist circumference, rump width, rump height, withers height and weight in the different periods of *in vivo* measurements. The measurements were performed in four different periods throughout the experiment at 105, 122, 137 and 154 days of age. The inclusion of the enzyme complex and cottonseed meal in the replacement of soybean meal in the diets of pigs in the finishing phase had no effect on the morphometric characteristics (P> 0.05) of body length, thoracic perimeter, abdominal circumference, rump width, rump height, withers height and weight in the different measurement periods.
Keywords: withers height, cottonseed meal, abdominal circumference, rump width, morphometric characteristics.

Introduction

The use of alternative feeds in the finishing phase of pigs has been the main focus to reduce production costs due to the greater volume of feed

consumed within the phase, and one of the possible ingredients considered is cottonseed meal. Cottonseed meal is an ingredient that can be used as a potential substitute for soybean meal in pig nutrition, and knowledge of the rate of growth and development of tissues is important for adjusting nutritional management to achieve the desired final body shape.

As with any other industrial byproduct, the waste is generated after the processing steps, which in the case of cottonseed is the extraction of oil. However, there is a difference between the industries regarding the adhered steps during processing, which results in the variation of the amount of fiber, protein and energy, and it is necessary to perform the laboratory analysis for a correct formulation of the diets of the animals. In addition, cottonseed meal has lower amounts of energy and amino acids than soybean meal.

Fiber has the characteristic of reducing diet digestibility because pigs do not produce enzymes capable of making use of it, and the use of exogenous enzymes seeks to improve the use of nutrients and fiber degradation (FISHER et al., 2002). Thus, it is necessary to investigate zootechnical parameters and extrinsic behavior in body development and muscle deposition through morphological measurements. The zoometric index has numerous evaluation functions, including demonstrating the harmony of the body mass distribution in agreement with the body weight of the animal according to the feeding management and the nutritional composition of the diets within a genetic pattern, which is interesting in the production of meat (REVIDATTI, 2009).

Thus, the objective of this study was to evaluate the morphometric characteristics of finishing pigs fed cottonseed meal and enzymes.

Materials and methods

The experimental procedures used in this study were approved by the Ethics Committee on the Use of Animals (CEUA), protocol Nº. 2310108.327837/2017-57.

The study was conducted in the performance laboratory of the Federal University of Rondonópolis, and served as a basis for the collection of data from *in vivo* measurements of pigs.

A total of 30 castrated male pigs with an initial age of 102 days and an initial weight of ± 55.47 kg were used. After weighing, the animals were distributed in randomized blocks by weight in individual masonry stalls, with 2.55 m², compact floor, provided with trough and trough drinker.

Table 1. Proximate and nutritional composition of diets with different levels of cottonseed meal with enzymatic complex in the finishing phase 1

Ingredients, %	Termination 1				
	0[(1)]	0E	5E	10E	15E
Corn, chirera	80.74	83.14	81.08	78.72	76.46
Soybean, bran 46	15,09	14,09	9,94	6,00	1,96
Cotton, bran 39	-	-	5.00	10.00	15.00
Dicalcium phosphate	0,80	0,79	0,10	0,83	0,85
Calcium limestone	0,50	0,46	0,4	0,43	0,42
Soybean oil	1,38	-	1,14	2,32	3,50
Sodium chloride	0,40	0,38	0,38	0,38	0,38
Vitamin premix[(2)]	0,30	0,30	0,30	0,30	0,30
Mineral premix[(3)]	0,10	0,10	0,10	0,10	0,10
L-L-lysine HCL (80%)	0,35	0,35	0,42	0,49	0,55
DL-Methionine (99%)	0,10	0,09	0,10	0,11	0,12
L-Threonine (98%)	0,09	0,09	0,12	0,14	0,17
L-Tryptophan (99%)	0,05	0,05	0,06	0,07	0,08
Inert/enzyme complex[(4)]	0,10	0,16	0,11	0,11	0,11
Calculated Values [(5)]	100	100	100	100	100
Metabolizable Energy, Kcal/Kg	3348	3281	3281	3281	3281
Crude protein, %	13.07	13.07	13.07	13.07	13.07
Crude fiber, %	2.14	2.11	2.57	3.05	3.52
Digestible calcium, %	0,52	0,52	0,52	0,52	0,52
Available phosphorus, %	0,24	0,24	0,24	0,24	0,24
Lysine Dig., %	0,78	0,78	0,78	0,78	0,78
Met. + Cys. Dig. %	0.48	0.48	0.48	0.48	0.48
Threonine dig. %	0.51	0.51	0.51	0.51	0.51
Tryptophan dig. %	0.17	0.17	0.17	0.17	0.17
Sodium, %	0.17	0.17	0.17	0.17	0.17

[1]Levels of inclusion of cottonseed meal, with or without enzyme complex (E). [2] Premixture vitamin - amount per kg of feed: 0.112 mg of folic acid, 2.244 mg of Pantothenic Acid, 0.005 mg of Biotin, 5.386 mg of Niacin, 1.178 IU of Vitamin A, 0.168 mg of Vitamin B1, 6.565 mcg of Vitamin B12, 0.897 mg of Vitamin B2, 0.168 mg of Vitamin B6, 303 IU of Vitamin D3, 1.347 IU of Vitamin E and 0.673 mg of Vitamin K. [3]Mineral premix-amount per kg of product: 0.168 mg of Cobalt, 0.015 g of Copper, 0.025 g of Iron, 1.417 mg of Iodine, 0.040 g of Manganese, 0.075 g of Zinc, 0.101 mg of Selenium. 45 grams of enzyme complex per 100 kg of feed. 5Nutritional values of the ingredients proposed by ROSTAGNO et al. (2017).

Morphometry In Vivo

Weights and body measurements of the 30 animals were analyzed according to their respective treatments. The characteristics measured were thoracic perimeter (perimeter immediately caudal to the scapula passing through the sternum and through the spinal processes of the thoracic vertebrae) (Figure 1A), waist circumference (Figure 1B), rump width (maximum width between the trochanters of both femurs) (Figure 1C), body length (distance between the base of the tail, last sacral vertebra to the base of the neck, last cervical vertebra) (Figure 1D), height of the rump (distance from the ground to the coxal tuberosity) (Figure 1E) and height of the withers (distance from the ground to the height of the scapula). Weighting was performed on a digital scale (Figure 1F) and with Agrozootec® tape to calculate animal weight.

The measurements of thoracic circumference, waist circumference, length and height were performed with a Círculo® tape measure, whereas the rump width was measured with the aid of a compass. The evaluations were performed by a single evaluator at 105, 122, 137 and 154 days of age.

The data were subjected to simple analysis of variance for comparison of all diets (0, 0E, 5E, 10E and 15E). After this comparison, the control diet (0) was removed from the model, and regression analysis of the diets that included the enzyme complex (0E, 5E, 10E and 15E) was performed.

The GLM (General Linear Models) procedure of the SAS® statistical program (SAS Institute Inc., Cary, NC, USA) was used. The assumptions for the normality of the residuals and homoscedasticity of the variances were verified by the Shapiro–Wilk test.

Figure 1. Morphometric parameters to measure body deveplment

Results and discussion

The animals during the finishing phase fed with levels of up to 15% inclusion of cottonseed meal and enzymatic complex in partial substitution of soybean meal in the diets of pigs in the finishing phase did not show differentiation (p> 0.05) on the morphometric characteristics of body length, thoracic perimeter, waist circumference, rump width, rump height, withers height and weight with digital scale and weighing tape at different measurement ages (Table 3).

Body development occurred according to

increasing body weight gain of the animals throughout the finishing phase between treatments. The initial body weight at 105 days was on average 55.30 kg (0), 55.45 kg (0E), 55.38 kg (5E), 55.63 kg (10E) and 55.60 kg (15E). demonstrating the similarity of the body weight obtained as a reference point for the starting point of the measurements. The same did not occur with the mean final body weight at 154 days of the animals, which were 110.16 kg (0), 107.13 (0E) kg, 110.01 (5E) kg, 110.76 kg (10E), and 114.02 kg (15E), which may be due to the experimental diets with cottonseed meal and enzyme complex used throughout the experiment.

Table 3 shows that the use of up to 15% cottonseed meal and enzyme complex for pigs in the finishing phase occurred according to the genetic and nutritional pattern used as a control diet in experiment (0).

In addition, graphs were generated showing the evolution of the animals in the variables studied in the different periods (Figure 2)

Table 3. in vivo morphometry of pigs fed different levels of cotton bran (CGF) and enzymes in the finishing phase

105 days	Levels of cotton bran with complex Enzymatic, %							Regression
	0*	0E[1]	5E[2]	10E	15E	CV[3] (%)	*P value*	*P value*
BL (cm)[4]	76.92	76.75	78.83	76.58	79.08	3.06	0.219	0.1670
TP (cm)[5]	83.97	84.60	84.33	85.83	84.00	2.76	0.636	0.6278
AC (cm)[6]	97.02	94.50	99.42	97.33	97.25	3.49	0.215	0.1103
CW (cm)[7]	26.00	25.17	24.93	25.35	24.95	3.62	0.280	0.8087
CH (cm)[8]	58.43	57.55	57.00	56.33	57.15	2.87	0.294	0.6333
WH (cm)[9]	53.02	52.17	51.83	50.70	52.25	3.22	0.233	0.3838
WDS (kg)[10]	55.30	55.45	55.38	55.63	55.60	0.86	0.712	0.7677
WWT (kg)[11]	66.83	63.25	71.33	67.25	67.75	7.85	0.173	0.0847
122 days	0*	0E[1]	5E[2]	10E	15E	CV[3] (%)	*P value*	Regression *P value*
BL (cm)	79.33	78.92	81.00	81.33	80.83	4.30	0.673	0.6364
TP (cm)	92.17	90.83	93.67	92.50	92.08	3.10	0.568	0.4361
AC (cm)	107.08	105.75	110.50	109.5	105.92	3.32	0.111	0.0648
CW (cm)	29.12	28.12	29.10	29.21	28.96	4.61	0.614	0.3467
CH (cm)	62.50	62.17	62.17	62.00	63.50	2.62	0.527	0.3745
WH (cm)	58.00	57.83	57.50	57.50	59.16	2.41	0.254	0.1766
WDS (kg)	74.53	71.80	74.15	74.11	75.25	3.96	0.352	0.2113
WWT (kg)	80.58	78.75	85.5	82.83	79.25	5.77	0.116	0.0833
137 days	0*	0E[1]	5E[2]	10E	15E	CV[3] (%)	*P value*	Regression *P value*
BL (cm)	85.67	86.67	87.42	86.67	88.50	3.45	0.578	0.4199
TP (cm)	99.83	98.00	99.42	99.92	100.75	2.94	0.593	0.3398
AC (cm)	115.95	114.42	118.67	115.75	116.17	2.92	0.324	0.1752
CW (cm)	30.50	30.08	30.37	30.31	30.41	3.18	0.957	0.9253
CH (cm)	64.67	64.83	65.00	64.50	66.16	1.80	0.150	0.1279
WH (cm)	59.83	59.50	60.00	59.83	61.33	2.02	0.122	0.1039
WDS (kg)	85.82	82.87	85.13	87.00	88.13	4.31	0.180	0.0765
WWT (kg)	93.67	90.33	98.17	93.00	94.33	6.19	0.264	0.1606
154 days	0*	0E[1]	5E[2]	10E	15E	CV[3] (%)	*P value*	Regression *P value*
BL (cm)	91.67	92.00	92.50	91.33	92.00	3.94	0.986	0.9576
TP (cm)	108.08	107.00	107.25	108.33	106.75	2.16	0.715	0.5876
AC (cm)	123.33	120.00	124.50	124.00	121.92	3.26	0.326	0.2528
CW (cm)	32.00	31.65	32.32	31.97	32.68	3.57	0.60	0.5013
CH (cm)	69.67	69.50	68.83	69.66	70.50	2.44	0.582	0.4579
WH (cm)	65.00	65.17	65.17	65.83	66.66	2.97	0.562	0.4552
WDS (kg)	110.16	107.13	110.01	110.76	114.02	4.87	0.323	0.1726
WWT (kg)	106.66	100.00	109.00	108.00	103.83	7.58	0.326	0.2528

0* - reference feed; [2]0E - reference feed plus enzyme complex; [3]CV - Coefficient of Variation; [4BL] - Body Length; [5]TP - Thoracic Perimeter; [6]AC - Abdominal Circumference; [7]CW - Croup Width; [8CH] - Croup Height; [9]WH - Withers Height; [10]PBD - Weighing on Digital Scale; [11]PFP - Weighing with Weighing Tape.

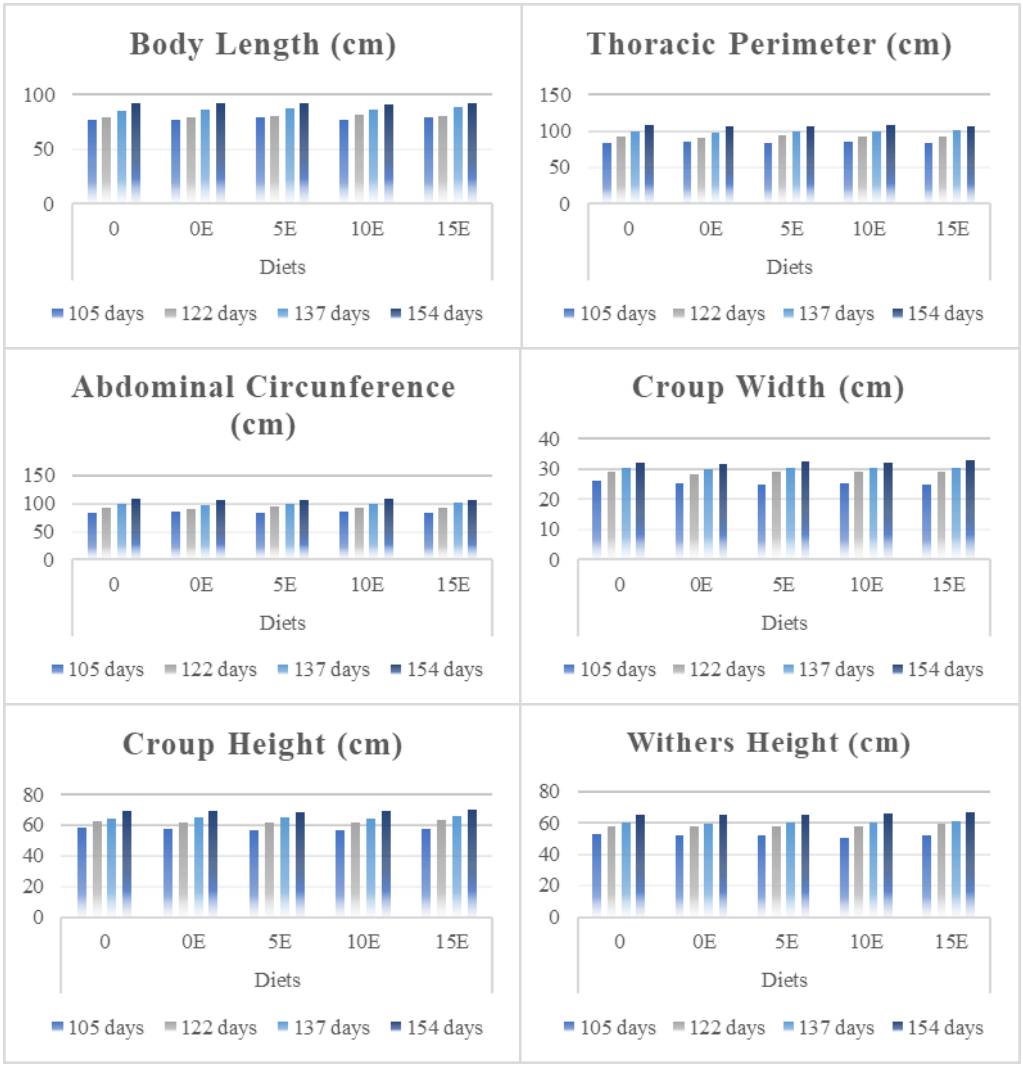

Figure 2. Graph of grouped columns representing the mean values attributed to the *in vivo* morphometric characteristics of the animals subjected to the treatments: control diet (0), control diet with enzymatic complex (0E), diet with 5% cottonseed meal plus enzymatic complex (5E), diet with 10% cottonseed meal plus enzyme complex (10E), diet with 15% cottonseed meal plus enzyme complex (15E).

In the present study, there was no effect of cottonseed meal and enzyme complex on the morphometric characteristics of body length, thoracic perimeter, waist circumference, rump width, rump height, withers height and weight with digital scale and weighing tape of the animals in the termination phase. This can be attributed to the use of the enzyme complex in diets containing cottonseed meal, since the diets with the enzyme complex had the nutritional matrix reduced to 2% crude protein, lysine, methionine, threonine, tryptophan and metabolizable energy, demonstrating the better use of nutrients on the growth and deposition of animal tissues.

The homogeneous results between treatments confirm that the diets met the nutritional requirements of the animals, including digestible energy. The maintenance of energy in the diet of pigs is essential for the occurrence of muscle deposition within the genetic potential, as well as amino acids, especially lysine (Schinckel & Einstein, 2000) which occurred in the present experiment.

Abreu et al. (2007) evaluated the levels of digestible lysine on the deposition of lean meat from pigs using the concept of ideal protein and observed a reduction in carcass yield as they reduced the digestible lysine, which could also be reflected in the morphometric characteristics of the animals. Kim et al. (2006) reported improvements in the CIAD of AA by the supplemental carbohydrase complex, consisting of galactose, mannanase and mannosidase.

Thus, the use of morphometric measurements in pigs can be used as a parameter of body and tissue development with different diets, evaluating the nutritional effects on the traits in growth and deposition, since in animal production, the search for efficiency in the production of meat is constant. The *in vivo* measurements are not commonly used to evaluate the nutritional effects as

occurs with other species, and their importance is related to the determination of a developmental point reached by the animal that brings economic benefits combined with the required carcass characteristics.

Conclusions

The use of up to 15% cottonseed meal in diets for finishing pigs with enzymatic complexes does not affect the morphometric characteristics *in vivo*. The inclusion of up to 15% cottonseed meal with enzymatic complex did not affect the carcass characteristics, organ weight or weight of the meat cuts of the animals.

Treatments with levels of cottonseed meal and enzyme complex did not affect the *in vivo* body characteristics of pigs in the finishing phase, which showed similar values for the measurements obtained.

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Conflict of interest

The authors declare that they have no conflicts of interest.

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