

## Characteristics of pig carcasses of two genetic breeds

### Características de carcaças suínas de duas linhagens genéticas

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## ABSTRACT

The production of good quality carcasses is the main goal of modern commercial and industrial pig farming. The genetic potential of commercial breeds has changed considerably, especially in terms of deposition rates of lean meat and lard thickness. By morphology and analysis of the small intestine one can evaluate the utilization of nutrients for the deposition of fat and meat in swine carcasses. This study aimed to evaluate the quality of carcasses from two commercial genetic breeds, using quantitative traits, and to investigate if there is difference in length and absorptive surface of the intestine, verifying if these data are correlated with the yield of lean meat on the carcass. 60 animals from each breed were slaughtered and evaluations made for the characteristics: hot carcass weight (HCW), carcass length (CL), lard thickness (LT), percentage of lean meat (LM%), intramuscular fat (IMF) and intestinal length (IL). For the analysis of intestinal absorption (IA) were used only 62 of the animals previously studied, being 31 animals of each genotype. The average values of CL and IMF presented differences between breeds. The meat of the swines studied presented a low IMF content, existing correlation between the LM% and LT. The breeds had statistically equal IC, AI and LM%. There was also correlation between LM% and LT.

**Keywords:** Lard thickness. Lean meat. IMF. Intestinal length.

## RESUMO

A produção de carcaças de boa qualidade é o principal objetivo comercial e industrial da moderna criação de suínos. O potencial genético das linhagens comerciais vem mudando consideravelmente, sobretudo em termos de taxas de deposição de carne magra e espessura de toucinho. Através da morfologia e da análise do intestino delgado pode-se avaliar a utilização dos nutrientes para a deposição de carne e gordura na carcaça suína. O presente estudo teve como objetivo avaliar a qualidade das carcaças, de duas linhagens genéticas comerciais, através de características quantitativas e verificar se existe diferença no comprimento e superfície de absorção do intestino, verificando se esses dados estão correlacionados com o rendimento de carne magra na carcaça. Foram abatidos 60 animais por linhagem e feitas avaliações para as características: peso de carcaça quente (PCQ), comprimento de carcaça (CC), espessura de toucinho (ET), porcentagem de carne magra (CM%), gordura intramuscular (GIM) e comprimento intestinal (CI). Para a análise de absorção intestinal (AI) foram utilizados apenas 62 animais dos anteriormente avaliados, sendo 31 animais de cada genótipo. Os valores médios de CC e GIM apresentaram diferenças entre as linhagens. A carne dos suínos estudados apresentou baixo conteúdo de GIM, existindo correlação entre a CM% e ET. As linhagens apresentaram CI, AI e %CM estatisticamente iguais entre si. Sendo que houve correlação entre a %CM e a ET.

**Palavras-chave:** Espessura de toucinho. Carne magra. GIM. Comprimento intestinal.

## 1 INTRODUCTION

Pork is an important meat on the human menu around the world, but in Brazil is the third choice after chicken and beef (Souza et al., 2021). Then, the research with swine carcass in Brazilian conditions is interesting to improve the knowledge about.

National pig farming has given great emphasis to genetic improvement programs, attributed to the selection of pig carcasses with a high amount of lean meat instead of fat, looking to meet the demand of consumers not to consume animal fat, given the intense correlation with cardiovascular disease (Terra and Fries, 2000).

Pig breeds have been enhanced in order to obtain better zootechnical indexes, meeting the requirements of the pig industry and also to consider qualitative characteristics related to meat (ABCS, 2010). The intersections from the European breeds seek to achieve a higher carcass yield and meat quality (Lopes, 2010). Already on those from Chinese breeds the aim is to achieve better rates of productivity, such as: the number of piglets / sow / year (prolificacy). However in Chinese stocks it is noted a greater deposition of fat in the carcass, since a small fat reserve, during the pregnancy, may lead to higher wear of the female during lactation. This state of catabolism, thus, may affect its subsequent reproductive performance and may compromise proper fetal development in its next pregnancy (Panzardi et al., 2009).

Breeds that have undergone distinct selection pressure in different environments, management and linebreeding, as is the case of Chinese and European breeds, may have different performance characteristics.

According to Fialho et al. (1998), hybrid commercial pigs, with high genetic potential, are important to obtain progenies which produce carcasses with less lard thickness and greater lean meat yield.

Carcass characteristics are very important in the pig industry, especially those related to the higher yield of meat and less fat deposition (Barbosa et al., 2005). Increasing quantity and improving quality of meat in the carcass of pigs has been the goal not only of industry but also of the producer, as it improves profitability and reduces production costs (Dutra Jr et al., 2001).

According to Roppa (1999) 70 to 72% of pork fat is concentrated underneath the skin, in the lard. Only 22 to 24% lies between the muscles and 2 to 4% within them, which is called intramuscular fat, responsible for flavor, juiciness and tenderness of the meat, considered as a major organoleptic characteristics of meat.

The formation and accumulation of fat depends on animal genetics (Fukuda and Silver, 2001), existing strong genotypic and phenotypic correlations between levels of fat in various body stores, with significant improvements in lean tissue content in the carcass with the substantial reduction of lipid content in muscle (Barton-Gade and Bejerholm, 1986).

Another important feature that can be considered, when evaluating the quality of swine carcasses, is the morphology of organs, including the small intestine. According to Gomes et al. (2007) through this one can obtain information on: the animal's digestive ability, related to the

ability to intake and metabolize nutrients; the amount of excretes produced; the yield of carcass meat and production of high aggregate value meat cuts.

The same author also points out that the further development of the small intestine may be a form of animal metabolism to respond for a better absorption of nutrients from ingested food. That is, the greater its length the largest exhibition area of food nutrients to the intestinal absorptive cells, resulting in better utilization of those for muscle development and fat deposition.

The intestinal mucosal epithelium is composed of three cell types: absorptive or sheath, goblet cells and Paneth cells. The absorptive are simple columnar cells presenting, in their apical membrane, numerous microvilli composing an orderly arrangement (brush border). The acidophilic cytoplasm is finally granular, possessing an elongated nucleus located in its basal region. Such cells are actively involved in the absorptive process (Banks, 1992).

Another important economic characteristic that must be observed in different genetic pig breeds is Feed:Gain Ratio. This is conceptualized as an index provided by the relationship between food intake and weight gain of pigs, being a respectable indicator of feed efficiency of these animals (Meincke, 2009). It is therefore a characteristic that could possibly be influenced by the size and availability of the surface of intestinal absorption, since the higher the mentioned area, the better the animal's response in relation to the use of nutrients for the deposition of fat and meat in pig carcass, with an also greater weight gain (Gomez et al., 2007).

According to Guerrero et al. (1970), the absorptive capacity of the small intestine of pigs can be determined by the length, height, width and distance between their villi, which are measurements observed in histological or morphometric studies. And the villi should be measured for height, width and distance between the crypts, in order to quantify and compare the intestinal absorption surface, characteristic of each breed.

According to Giné et al. (2004), characteristics of carcass classification as: carcass length, lard thickness, lean meat yield, intestinal length, hot carcass weight and intramuscular fat are important tools to be used as selection criteria. Therefore, it is essential to know the heritability estimates of these characteristics, as well as existing correlations between these and the levels of fat and meat (related to carcass quality) and the growth rate in muscle (associated with the performance of the animal).

The assessment of the carcass is an important indicator of its quality (Land, 1998), and the measurements allow comparisons between breeds, weights and slaughter age (Silva et al., 2008).

Thus, this study aimed to evaluate the quality of carcasses through quantitative traits and to investigate the existence of difference in length and absorptive surface of the intestine of two distinct breeds and to verify if these data are correlated with lean meat yield in carcass.

## 2 MATERIAL AND METHODS

### BIOLOGICAL MATERIAL

A total of 120 pigs, approximately 150 days old, produced on commercial farms were studied. The animals belonged to two different breeds: Breed 1 -  $\frac{1}{2}$  (Large White and Pietran) x  $\frac{1}{2}$  (Large White and Landrace) and Breed 2 -  $\frac{1}{2}$  (Large White, Pietran, Duroc and Hampshire) x  $\frac{1}{2}$  (Large White, Landrace, Meishan and Fengjing). Being 60 animals of each genotype.

For the analysis of intestinal absorption were used only 62 of the animals previously studied, being 31 animals of each genotype. Breed 1 was called "European" and Breed 2 "Chinese".

### PROCEDURES IN THE REFRIGERATOR

The animals were conducted to a slaughterhouse-refrigerator plant under official inspection, in Uberlandia, Brazil, where they were slaughtered in 2009, as RIISPOA (Brazil, 1952).

After disembarking, the pigs were weighed and housed in piggeries where they remained for 12 hours at rest, fasting and water diet. After this period they were conducted to the slaughter room and subjected to electric stunning. The exsanguination procedure was performed immediately after stunning, with the animal positioned vertically, following the normatized time of three minutes (Brazil, 2000), proceeded to the other normal slaughtering operations: scalding at 65 ° C for five minutes, hair removal, evisceration, carcass division and washing (Brazil, 1952). Then they were weighed, using specific scales, which determined the hot carcass weight (HCW).

The animals were marked on the right ear after the scalding process, with specific pencil, for later identification in the slaughter line.

The abdominal cavity of each pig was opened by longitudinal incision, removing the gastrointestinal tract. After emptying, the small intestine was exposed longitudinally, washed with water and subsequently measured with conventional measure tape (zero to 100 cm) to determine the intestine length (IL), as illustrated in Figure 1.



Figure 1: Measurement of IL. Uberlândia-MG, 2010.

Were collected about 1cm long of small intestine fragments (the initial part of the jejunum) and these were opened longitudinally. Then the serosa was fixated with a specific paper, and the material was immediately placed in an aqueous solution of formaldehyde 10% immersed in sodium phosphate buffer (pH 7.4) for a period of at least 72 hours.

Carcass length (CL) was also evaluated with conventional measure tape, in inches, from the cranial edge of the pubic symphysis to the cranial ventral edge of the atlas, on the left half-carcasses, following the Brazilian method of carcass evaluation (Brazil, 1973).

Was measured with a ruler (in mm) lard thickness (LT), in the left half-carcasses, in the median sagittal plane at 15 cm from the tail insertion, between the penultimate and last lumbar vertebrae.

The values obtained for LT were used to determine the percentage of lean meat (LM%), using the formula described by Antunes (2002):

$$LM\% = 67.31240 - 0.47691 \times \text{ruler (mm)} \quad (1)$$

## LABORATORY PROCEDURES

After these measurements samples of *semimembranosus* muscle beef were taken for analysis of intramuscular fat (IMF), which in turn was held at the Laboratory of Animal Nutrition, Federal University of Uberlandia (LAMRA / UFU). Was used as a basis the Analytical Procedures Manual of the Brazilian Compendium for Animal Feed (Anfar, 2005).

The analysis of intestinal absorption (IA) was performed at the Laboratory of Histology, Federal University of Uberlandia.

The fragments of intestine were subjected to dehydration in ascending series of alcohols, clearing in xylene and embedded in paraffin, and then made cuts 5.0 µm thick. These sections were stained with hematoxylin-eosin (HE), and later was made the measurement of the villi. To perform the morphometric analysis, each image was captured in a 10 times increase, using the light microscope Olympus BX 40 with a Olympus OLY 200 camera, coupled to a computer and image analysis program Image HL 97 (*Western Vision Software*) from Federal University of Uberlandia.

Measurements of 10 villi and crypts 10 per slide were made, two slides per animal and 31 animals per treatment. The calculation of the number of times that the intestinal mucosal surface was increased (M) was done using the following formula (Kisielinski et al., 2002):

$$M = \frac{(L \times C) + \left( \frac{LV + L}{2} \right)^2 + \left( \frac{LC}{2} \right)}{\left( \frac{L + L}{2} \right)^2 + C} \quad (2)$$

Where:

LV = average width of the villus;

LC = average width of the crypt;

CV = Average length of the villus.

### STATISTICAL ANALYSIS

In the analysis of the results we used the Student's t test (Graner, 1966) for two independent samples, with significance of 5%, in order to verify differences between the means of quantitative variables evaluated between the two breeds. To investigate the relationship between variables, we used the Pearson correlation using BioEstat software (Ayres et al., 2005).

### 3 RESULTS AND DISCUSSIONS

In the present study, no significant differences were detected between carcass quality characters: HCW, LT, LM% and IL (p> 0.05), between the studied breeds (Table 1).

Table 1. Means, standard deviation (SD) and coefficient of variation (CV) of carcass quality characteristics of the "European" and "Chinese" breeds. Uberlândia - MG, 2010.

	"European" breed			"Chinese" breed			TESTE
	MEAN	SD	CV(%)	MEAN	SD	CV (%)	T
HCW (kg)	83,6	11,9	14,2	84,0	7,1	8,5	0,80
LT (mm)	13,1	4,4	33,7	14,4	5,6	38,7	0,14
LM (%)	61,0	2,1	3,4	60,4	2,6	4,4	0,14
IL (m)	20,8	1,6	7,7	20,8	2,5	12,0	0,93

For the HCW variable "European" breed average value was lower (83.6 kg) than in the "Chinese" breed (84.0 kg), but without statistical significance. However, Monteiro (2007) observed lower values for HCW (81.9 kg and 82.6 kg) in the same genotypes as well as Rosa et al. (2008) that in an assessment of three distinct genetic breeds (AGPIC<sup>®</sup>, Dalland<sup>®</sup> and Seghers<sup>®</sup>) found significant differences in HCW. Fisher et al. (2003) comparing the carcasses of three commercial breeds in which have been added genes from Landrace, Meishan and Pietran breeds, noted important differences in carcass quality, and the Pietran had the highest carcass weight and lowest fat percentage.

The average values of LT found in the two tested breeds were 13.1 mm and 14.4 mm respectively. Such values were below the mean of 24.2 mm found by Campos (2008). Which is desirable as the current market prioritizes carcasses with greater amounts of meat and lower LT (Rosa et al., 2008). According to the same author, animals with lower LT have a better ability to deposit lean tissue in the carcass, what can be reversed in a gain in production.

LM% average found in the "European" and "Chinese" breeds were 61% and 60.4%, respectively, without being statistically different. Lower values (55.6% and 56.5%) were found by Sencic et al. (2002) in crossings made with Pietran.

The mean IL of both breeds were equal (20.8 m). Similar results were found by Campos (2008), in two distinct breeds derived from the Large White breed. However, Gomes et al. (2007) in their study with three genetic breeds (AGPIC<sup>®</sup>, Dalland<sup>®</sup> and Seghers<sup>®</sup>) found differences between AGPIC<sup>®</sup> and Seghers<sup>®</sup> breeds, where AGPIC<sup>®</sup> animals were higher by 12%, showing a higher nutrition intake and metabolism. It is noteworthy that this breed is similar to that used in this study.

A higher IL results in greater absorption and utilization of nutrients for muscle development and fat deposition (Gomes et al., 2007). However, in this study no significant correlations were found ( $p > 0.05$ ) with LT with IL, LM% and CL measurements that could characterize this effect (Table 2).



Table 2. Pearson correlation between variables of carcass quality and IL of "European" and "Chinese" breeds. Uberlândia-MG, 2010.

	"European" breed			"Chinese" breed		
	CL	LM%	LT	CL	LM%	LT
IL	0,225	-0,143	0,143	0,136	0,197	-0,198
P	0,083	0,275	0,274	0,297	0,130	0,129

Different results were found by Gomes et al. (2007), who in his studies, comparing the morphology of the digestive and non-digestive organs of pigs, from two distinct modern breeds, observed that the digestive capabilities of these were not similar, resulting in differences in consumption and feed efficiency of the used breeds.

The results of this study are probably due to intensive breeding of pigs, which promoted an approach of the referred characteristic between the "European" and "Chinese lines." All of this aiming to seek improvement in the performance of animals, such as daily weight gain and Feed:Gain Ratio, which is related to intestinal absorption capacity, as elucidated by Gomes et al. (2007).

The mean, standard deviation and coefficient of variation values for CL and IMF, evaluated in swine carcasses in the "European" and "Chinese" breeds are shown in Table 3.

Table 3. Mean, standard deviation (SD) and coefficient of variation (CV) of the CL and IMF characteristics for "European" and "Chinese" breeds. Uberlândia - MG, 2010.

	"European" breed			TEST	"Chinese" breed			TESTE
	MEAN	SD	CV (%)	T	MEAN	SD	CV (%)	T
CL (m)	1,00	0,10	10,00	1,00a	0,90	0,04	4,00	0,90b
IMF (%)	1,00	0,20	26,00	1,00a	0,83	0,25	29,00	0,83b

Means followed by different letter differ significantly (P < 0.05).

For "European" breed animals, the average IMF found was 1%, while for the "Chinese" breed the average was 0.83%, below the ideal, since it is generally accepted that the increased level of IMF has a positive influence on the sensory quality of pork (Fernandez et al., 1999). Devol et al. (1988) suggested, as suitable for good quality meat, percentages from 2.5 to 3% to for tenderness and 4% for palatability.

Significant differences between the breeds for the mean characteristics of IMF were found, as shown in Table 3. As also found by Oliver et al. (2003), who in his studies analyzing different pig breeds, found a greater amount of IMF in crossings containing Duroc and Meishan compared with other breeds (Landrace, Large White and Pietran). In this work the "European" breed, which has a high percentage of Pietran on their crossing exhibited a larger amount of IMF compared to

"Chinese" breed, which in turn has a high percentage of Meishan and Fengjing breeds, which differs from the results found by the authors mentioned above.

The CL also differed among the tested breeds (Table 3). The mean value found was 100 cm for the "European" breed, higher than those findings by Freitas et al. (2004) and Campos (2008) in pigs originated from the Large White breed. However, the CL average of the "Chinese" breed animals (90 cm) was lower than that encountered by the authors. However, Monteiro (2007) found an average of 81.6 cm, lower than that found in this paper, and the analyzed animals were from identical genotypes to those used in this research.

Barbosa et al. (2005) evaluated a F<sub>2</sub> generation of pigs originated by crossing males of the native Brazilian Piau breed with female animals originating from Landrace, Large White and Pietran breeds, obtaining an average value of 86.1 cm for CL, inferior to those encountered in this study. According to Giné et al. (2004) longer animals may produce carcasses with better quality.

It was observed that there was significant negative correlation ( $p < 0.05$ ) between LT and LM% of the studied breeds (Table 4). Such fact is easily explained, since these measures are linked to the amount of fat, which is inversely proportional to the amount of meat, as outlined by Freitas et al. (2004). The HCW variable from "Chinese" breed was moderately correlated and further correlations were not statistically significant ( $p > 0.05$ ) (Table 5).

Table 4. Pearson correlation between variables of carcass quality and lean meat yield of "European" and "Chinese" breeds. Uberlândia - MG, 2010.

	"European" breed			"Chinese" breed		
	HCW	CL	LT	HCW	CL	LT
LM%	-0,326	-0,063	-1,000	-0,530	-0,140	-1,000
P	0,010	0,631	<0,0001	<0,0001	0,286	<0,0001

No significant differences of IA were detected between "European" and "Chinese" breeds ( $p > 0.05$ )

Table 5. T test for comparison of the mean IA feature, at 5% significance to the "European" and "Chinese" breeds. Uberlândia-MG, 2010.

Breeds	IA (µm)
European	5,0865 a
Chinese	4,9102 a

Means followed by different letter differ significantly ( $P < 0.05$ ).

Different results were found by Gomes et al. (2007), in their study comparing the morphology of the digestive and non-digestive organs of the pig, from two distinct modern breeds, observed that the digestive capabilities of these were not similar, resulting in differences in consumption and feed efficiency from the used breeds.

The results of this study are probably due to intensive breeding of pigs, which promoted an approach of that characteristic between the "European" and "Chinese" breeds. All of this aiming to improve the zootechnic performance of animals, such as daily weight gain and Feed:Gain Ratio, which is related to intestinal absorption capacity, as elucidated by Gomes et al.(2007).

Were not presented correlations between variables IA and IL in the "European" and "Chinese" breeds as shown in Figures 2 and 3. It is noted that the data are scattered in the charts, confirming the lack of correlation between variables.

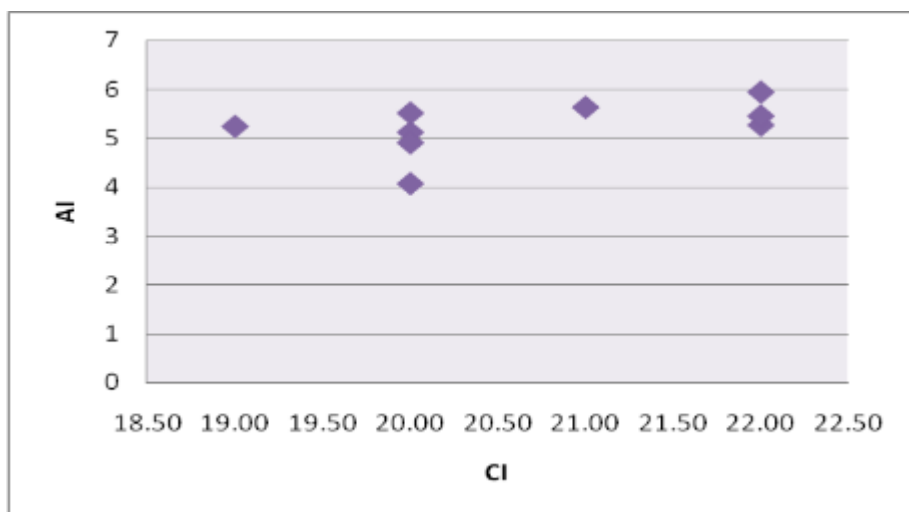


Figure 2: Graph of the Pearson correlation to the characteristics of IA and IL, after analysis of samples collected in the "European" breed. Uberlândia-MG, 2010.

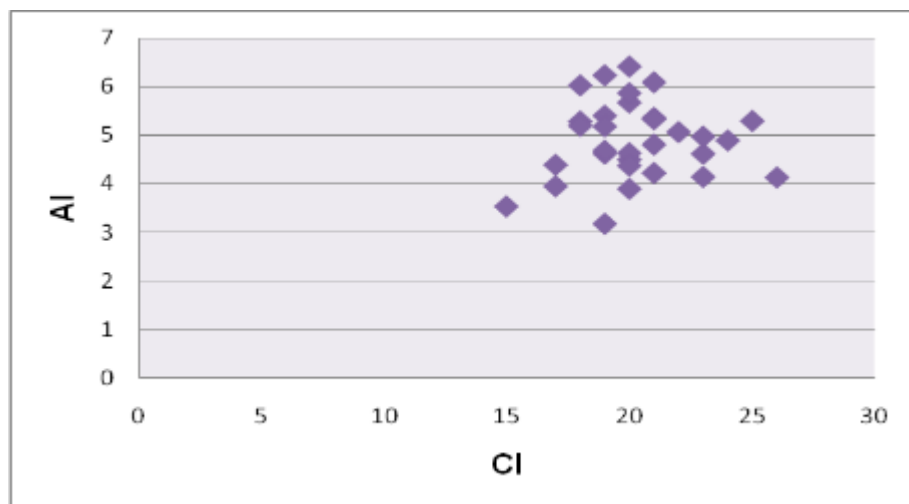


Figure 3: Graph of the Pearson correlation to the characteristics of IA and IL, after analysis of samples collected in the "Chinese" breed. Uberlândia-MG, 2010.

The lack of significant differences between variables may be due to the number of animals evaluated. We worked with small sampling, narrowing the possibility of verifying possible difference. Such an event is explained by the fact that these animals are facing almost the same

conditions in the field. Therefore, to observe distinct results it would require further studies with a larger sample.

The evaluated bloodlines presented very similar carcass characteristics, however significant differences for carcass length and intramuscular fat, with no correlation between length and intestinal absorption surface.

The meat of the studied animals showed a low content of intramuscular fat, existing correlation between lean meat percentage and lard thickness.

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## REFERENCES

- ABCS. Associação Brasileira de Criadores de Suínos. Raças de Suínos - Evolução Genética. 2010. Available at [<http://www.abcs.org.br/producao/genetica/176-racas-de-suinos>]. Accessed July 21, 2010.
- ANFAR (2005). Compêndio Brasileiro de Alimentação Animal – Métodos Analíticos, 2005. 204p.
- Antunes RC (2002). Efeito das linhas maternas e paternas, do genótipo Hal e do aminoácido sintético taurina sobre a qualidade da carne de suínos. Doctoral thesis, Universidade Federal de Uberlândia, Uberlândia.
- Ayres M, Ayres Jr M, Ayres DL and Santos AS. (2005). BioEstat 4.0: Aplicações estatísticas nas áreas das ciências biológicas e médicas. Belém: Sociedade Civil Mamirauá, 324p.
- Banks WJ (1992). Histologia Veterinária Aplicada. 2 ed. São Paulo: Malone, 629 p.
- Barbosa L, Lopes PS, Regazzi AJ, Guimarães SEF, et al. (2005). Avaliação de características de carcaça de suínos utilizando-se a análise dos componentes principais. R. Bras. de Zootec. 34:2209-2217 (E. Supl.).
- Bejerholm C and Barton-Gade PA (1986). Effect of intramuscular fat level on eating quality of pig meat. Manuscript n° 720 E. Danish Meat Research Institute, Roskilde, Denmark.
- Brasil, Associação Brasileira De Criadores De Suínos – ABCS (1973). Método brasileiro de classificação de carcaças. 2. ed. Rio Grande do Sul: Estrela, 17p.
- Brasil (1952). Ministério da Agricultura, Pecuária e Abastecimento. Secretaria de Defesa Agropecuária-DAS. Departamento de Inspeção de Produtos de Origem Animal-DIPOA. Divisão de Normas Técnicas-DNT. Decreto Lei n° 30.691, de 29 de março de 1952, alterado pelos Decretos n° 1.255, de 25 de junho de 1962, n° 1.812, de 18 de janeiro de 1996 e n° 2.224 de 4 de junho de 1997. Regulamento de Inspeção Industrial e Sanitária de Produtos de Origem Animal. D.O.U., Brasília, DF, p.10785.
- Brasil (2000). Instrução Normativa N° 03. Regulamento Técnico de Métodos de Insensibilização para o Abate de Animais de Açougue. Brasília: M.A.A., D.O.U., Brasília, seção 1, p.14.
- Campos DI (2008). Desempenho, qualidades de carcaça e de carne em suínos Large White de linhagens distintas. Master thesis. Universidade Federal de Uberlândia, Uberlândia.
- Devol DL, McKeith FK, Bechtel PJ, Novakofski J, et al. (1988). Variation in composition and palatability traits and relationship between muscle characteristics and palatability traits and relationships between muscle characteristics and palatability in a random sample of pork carcasses. J. Anim. Sci. 66:385-395.
- Dutra Jr WM, Ferreira AS, Tarouco JU, Euclides RF, et al. (2001). Estimativas de rendimentos de cortes comerciais e de tecidos de suínos em diferentes pesos de abate pela técnica de ultra-sonografia em tempo real. R. Bras. de Zootec. 30:1243-1250.

Fernández X, Monin G, Talmant A, Mourot J, et al. (1999). Influence of intramuscular fat content on the quality of pig meat – 1. Composition of the lipid fraction and sensory characteristics of m. longissimus lumborum. *Meat Sci.* 53:59–65.

Fialho ET, Oliveira AIG, Lima JAF, Bertechine AG, et al. (1998). Influência de planos de nutrição sobre as características de carcaça de suínos de diferentes genótipos abatidos entre 80 e 120 kg. *R. Bras. de Zootec.* 27:1140-1146.

Fisher AV, Green DM, Whittemore CT, Wood JD, et al. (2003). Growth of carcass components and its relation with conformation in pigs of three types. *Meat Sci.* 65: 639-650.

Freitas RTF, Gonçalves TM, Oliveira AIG, Ferreira DF et al. (2004). Avaliação de carcaças de suínos da raça large white utilizando medidas convencionais. *R. Bras. de Zootec.* 33:2037-2043.

Giné GAF, Freitas RTF; Oliveira AIG, Pereira IG, et al. (2004). Estimativa de parâmetros genéticos para características de carcaça em um rebanho de suínos large white. *R. Bras. de Zootec.* 33:337-343.

Gomes JDF, Putrino SM, Martelli MR, Ishi MP, et al. (2007). Morfologia de órgãos digestivos e não digestivos de suínos de linhagens modernas durante as fases de crescimento, terminação e pós-terminação. *Acta Sci. Anim. Sci* 29:261-266.

Graner, EA (1966). *Estatística*. Ed. Melhoramentos. São Paulo, 187 p.

Guerrero AM, Gonzáles AA and Ortiz QF (1970). Histochemical and ultrastructural changes absorbed in the mucosa of the ileal conduit. *J. Urol.*104:406-412.

Kisielinski K, Willis S, Prescher A, Klosterhalfen B, et al. (2002) A simple new method to calculate small intestine absorptive surface in the rat. *Clin. Exp. Med.*2:131-135.

Lopes PS (2010). *Melhoramento Genético de Suínos*. Available at [<https://www2.ufersa.edu.br/portal/view/uploads/setores/183/arquivos/MELHORAMENTO%20DE%20SUINOS.pdf>]. Accessed July 21, 2010.

Meinke W (2009). A importância da fase de terminação no sistema de produção de suínos. 2009. Available at [<http://www.suino.com.br/GeneticaNoticia.aspx?codigoNot=RSY4DBXUxBE=&title=A+IMPOR+TANCIA+DA+FASE+DE+TERMINACAO+NO+SISTEMA+DE+PRODUCAO+DE+SUINOS.+P+POR+WERNER+MEINCKE>]. Accessed July 21, 2010.

Monteiro JMC (2007). *Desempenho, composição da carcaça e características de qualidade da carne de suínos de diferentes genótipos*. Doctoral thesis, Universidade Estadual Paulista Júlio de Mesquita Filho, Jaboticabal.

Oliver MA, Gil M, Gispert M, Guerrero L, et al. (2003). Quality pork genes: variation in phenotypic traits for functional genomic analysis of meat quality for economical production of high quality meat. In: *Proceedings of the 49<sup>o</sup> International Conference of Meat Science and Technology, Campinas, 47-48 (Abstract)*.

Panzardi A, Marques BMFPP, Heim G, Bortolozzo FP, et al. (2009) Fatores que influenciam o peso do leitão ao nascimento. *Acta Sci. Vet.* 37: s49-s60. (E. Suppl.).

Prata LF and Fukuda RT (2001). Fundamentos de higiene e inspeção de carnes. Jaboticabal: Funep. 326p.

Roppa L (1999). Atualização sobre os níveis de colesterol, gordura e calorias da carne suína. In Proceedings of the 36° Reunião Anual da Sociedade Brasileira de Zootecnia, Porto Alegre.

Rosa AF, Gomes JDF, Martelli MR, Sobral PJA, et al. (2008). Características de carcaça de suínos de três linhagens genéticas em diferentes idades ao abate. Ciênc. Rural. 38:1718-1724.

Sencic D, Antunovic Z and Sperandam M (2002). Meatiness and meat quality in pigs crossed with Piétrain. Stocarst. 56:191-196.

Silva NV, Silva JHV, Coelho MS, Oliveira ERA, et al. (2008) Características de carcaça e carne ovina: uma abordagem das variáveis metodológicas e fatores de influência. Acta Vet. Bras. 2:103-110.

Souza, M. C. M., Palencia, J. Y. P., Lemes, M. A. G., Gonçalves, A.C.S., Piza, P.C., Fonseca, L. da Silva (2021). Consumption of pork meat and derivatives by the population of Juiz de Fora, Minas Gerais, Brazil. Brazilian Journal of Animal and Environmental Research. V4, n.2, p. 3314-3327.

Terra NN (1998). Apontamentos de tecnologia de carnes. São Leopoldo: Unisinos, 216p.

Terra NN and Fries LLM (2000). A qualidade da carne suína e sua industrialização. In: Proceedings of the 1° Conferência Internacional Virtual sobre Qualidade de Carne Suína, Concórdia, 147-151.