COMPARISON OF METHODOLOGIES FOR ASSESSMENT OF PORK LOIN EYE AREA[1]

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ABSTRACT: The determination of loin eye area (LEA) is one of the most common methods to assess carcass quality and it is possible to adjust calculations to predict meat amount in the carcass which is one of the important features in the classification process. The aim of this study was to compare different methodologies used to determine LEA in swine. Fifteen crossbred pigs, Landrace x Large White, males and females, were slaughtered at 140 days of age. After 24 hours of cooling at 4°C, the *Longissimus dorsi* muscle was removed from the left half part of carcasses for evaluation of LEA between the 12th and 13th rib. The methods were: point counting on plastic grid of 1 cm^2 and 0.25 cm^2 (PCGP 1 cm^2 and PCGC 0.25 cm^2), circumference method by Echo Image Viewer (ECHO), circumference method using AutoCad ® program (CAD) and method of weighing paper (WP). The design was completely randomized with 15 replications per treatment and the data were subjected to Pearson correlation and variance analysis. Averages were compared by Tukey test at a significance level of 5%. LEA values were: 35.84, 35.69, 33.86, 34.22 and 36.71 cm^2, for the PCGP 1 cm^2, PCGP 0.25 cm^2, ECHO, CAD and WP methods, respectively. The LEA values determined by methods PCGP 1 cm^2, PCGP 0.25 cm^2 and WP were similar; however they were higher than those obtained by the ECHO and CAD methodologies ($P<0.0001$). PCGP 1 cm^2, PCGP 0.25 cm^2 and WP methods may overestimate LEA values. The choice of method to be used should be based on its practicality and availability of resources, since the difference obtained between them is low.

Keywords: AutoCAD®, Echo Image Viewer, paper weight, plastic grid, point counting.

COMPARAÇÃO DE METODOLOGIAS PARA DETERMINAÇÃO DA ÁREA DE OLHO DE LOMBO EM SUÍNOS

RESUMO: A determinação da área de olho de lombo (LEA) é o método mais comum para análises de qualidade de carcaça, sendo possível ajustar cálculos para predizer o grau de musculosidade na mesma, sendo um recurso importante nos processos de classificação. Objetivou-se com este trabalho comparar diferentes metodologias utilizadas na determinação da LEA em suínos. Quinze suínos mestiços Landrace x Large White, machos e fêmeas, foram abatidos aos 140 dias de idade. Após 24 horas de refrigeração a 4°C o músculo *Longissimus dorsi* foi retirado da meia carcaça esquerda para avaliação da LEA entre a 12ª e 13ª costela. Os métodos utilizados para avaliação foram: contagem de pontos em gabarito plástico de 1 cm^2 e de 0,25 cm^2 (CPGP 1 cm^2 e CPGC 0,25 cm^2), método de circunferência por meio do programa Echo Image Viewer (ECHO), método de circunferência por meio do programa AutoCad® (CAD) e método de pesagem do papel (WP). O delineamento foi inteiramente casualizado, com 15 repetições por tratamento e os dados foram submetidos a teste de correlação e análise de variância. As médias foram comparadas pelo teste de Tukey, ao nível de 5% de significância. Os valores médios de LEA observados foram de 35,84, 35,69, 33,86, 34,22 e 36,71 cm^2, para os métodos CPGP 1 cm^2, CPGP 0,25 cm^2, ECHO, CAD e WP, respectivamente. Os valores de LEA determinados pelos métodos CPGP 1 cm^2, CPGP 0,25 cm^2 e WP

foram semelhantes entre si, entretanto superiores aos obtidos pelas metodologias ECHO e CAD (P<0,0001). Os métodos CPGP 1 cm², CPGP 0,25 cm² e WP podem superestimar os valores de LEA. A escolha do método a ser utilizado deve ser feita com base em sua praticidade e disponibilidade de recursos, uma vez que a diferença entre eles é de pequena ordem.

Palavras-chave: AutoCAD®, Echo Image Viewer, peso do papel, gabarito plástico, contagem de pontos.

INTRODUCTION

From 2004 to 2011 Brazilian pork production increased 25% while exports increased 13%, with 3.22 million tons produced and 0.58 million tons exported (ABIPECS, 2012). In the last 35 years, the growth of herd was 4.4% while production increased 283% indicating a significant rise in productivity. Many improvements were achieved in the final product offered to consumers, which was possible due to the use of techniques to estimate the quantity of meat in the carcass, and to evaluate its quality.

According to Guidoni (2000) one of the important features in the classification process is planning the dissection of carcasses. It starts with the selection of equipment for prediction of lean meat and fat levels, size and representativeness of the sample, conceptualization the carcass and its cuts, conceptualization of meat and fat, defining the positions of evaluation of predictors in carcass, selection of appropriate scales, and operator training to ensure the quality standard.

From these information, it is possible to adjust calculations to predict meat amount in the carcass. Among carcass measurements, the loin eye area (LEA) is a strong indicator of carcass quality and carcass composition (Smith and Pearson, 1986; Mclaren *et al*., 1987). The determination of LEA is one of the most common methods for assessing the quality of carcass. This measurements allows to predict the degree of muscularity by observing the cross-sectional area of the *Longissimus dorsi* in the last rib (Bridi and Silva, 2007) and predict the percentage of meat of the whole carcass since both variable were strongly correlated (Suguisawa *et al*., 2006).

Therefore the evaluation of LEA, usually obtained between the 12th and 13th thoracic vertebrae, have been widely accepted and used as an indicator of carcass composition (Luchiari Filho, 2000). The utilization of LEA as indicator of carcass composition is convenient to overcome other laborious and time-consuming actions.

The LEA measurement has traditionally been conducted by using of a grid pattern, which was accurately used in cattle (Pinheiro, 2007), swine (Freitas *et al*., 2004), sheep (Menezes *et al*., 2008) and even in wild animals (Pinheiro *et al*., 2007). Meanwhile, there are some alternative techniques which may have advantages compared to the traditional method. This study aimed to compare alternative methods to assess the LEA of pigs compared to traditional plastic grid square.

MATERIAL AND METHODS

In a commercial farm, fifteen crossbred Landrace x Large White, males and females, were selected and subjected to the same nutritional and health management. They were slaughtered at 140 days of age, with an average weight of 90 kg. The animals were pre slaughtered fasted for 14 hours and transported to the slaughterhouse. Immediately after electronarcosis stunning the animals were bled by jugular incision, submitted to scalding, depilated, gutted and divided into two half carcasses. After 24 hours of cooling to approximately 4ºC, the left half carcass was sectioned between the 12th and 13th rib. After proceeding with the cuts, the area to be measured was cleaned and covered with a transparent plastic, size 20x15 cm, which drew the outline of the muscle *Longissimus dorsi*. This LEA was limited to this muscle, according to the carcass swine standardized assessment methodology by the Brazilian Association of Swine Breeders (ABCS, 1973). The following methods were applied to loin eye area, based on the circumference of the area:

1) Point counting over a 1 cm² square plastic grid (PCGP 1 cm²). From a sheet of graph paper divided into squares of one cm² were made copies on transparent plastic sheet, obtaining the grid (Figure 1). This paper was placed over the original contours in transparent plastic, and a number of 1 cm² squares was initially marked. The sum of the squares was performed to obtain the total area.

2) Point counting over a 0.25 cm^2 square plastic grid square (PCGP 0.25 cm^2). From a sheet of graph paper, divided into squares of 0.25 cm^2 were prepared copies transparent plastic sheet, obtaining the grid (Figure 1). This paper was placed over the original contours in a transparent plastic, and a number of 25 cm^2 squares was initially marked. The sum of the squares was performed to obtain the total area.

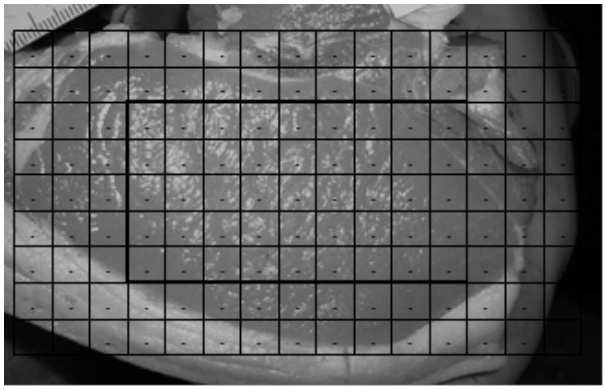

Figure 1. Point counting method using the plastic grid.

3) Circumference method by Echo Image Viewer (ECHO). Commonly used program for ultrasound photos was used to measure the LEA through an adaptation in which a transparency with LEA images was placed on the computer screen, it was opened up a standard Bitmap format image only to use the program tools (Figure 2), then the image of the transparency was outlined in actual size scale 1:1 through the tool that determines the area and the values of each figure were written down.

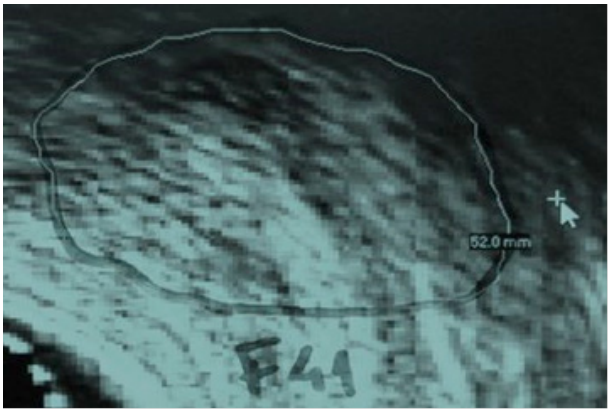

Figure 2. Circumference method by Echo Image Viewer.

4) Method of circumference by AutoCad® (CAD) program. The images of LEA in the transparent film were placed on the computer screen and then outlined with a spline tool (Figure 3). Once linked the initial and final point of the image, the software allowed the determination of the area through its drawing properties. This dimension needed to be converted to the actual size, and the actual distance of one centimeter was measured on the computer screen through the software. This measure was the correction factor for each centimeter, being the dimension determined by the program divided by the correction factor.

Figure 3. Circumference method by AutoCad® software.

5) Method of weighing paper (WP). A known area of paper (standard) was cut off and its weight (standard weight) determined (Figure 4). After this procedure, the drawing of loin eye area (LEA) was transcripted from tracing paper to the standard paper and, by the ratio between the weight of the sample and the standard, the rib-eye area was measured. In this method it is essential to use gloves, and the samples were kept in vacuum desiccator and weighted on an analytical precision balance in a vertical laminar flow chapel.

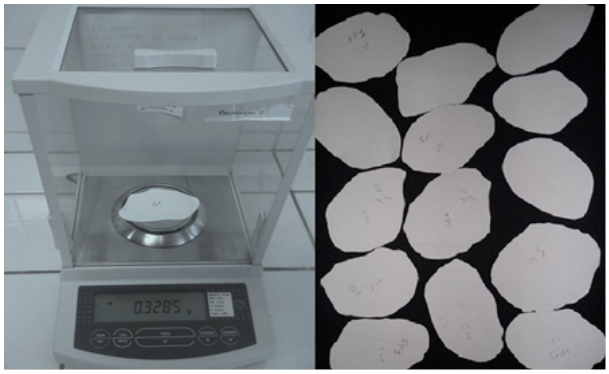

Figure 4. Weighing paper method.

The experimental design used to determine the statistical comparison of the methods was completely randomized, with five treatments and 15 replications per treatment. Data were subjected to pearson correlation, and variance analysis, and means were compared by Tukey test at a significance level of 5% using SAS (SAS Inst., Inc., Cary, NC).

RESULTS AND DISCUSSION

The LEA values evaluated by PCGP 1 cm², PCGP 0.25 cm² and WP methodologies were similar ($p > 0.05$), but differed ($p < 0.0001$) from those measured by ECHO and CAD methods (Table 1). The simple correlations between methods are shown in Table 2.

Table 1. Values from loin eye area of pigs obtained by different measurement methods

Method	LEA mean[1] (cm²)
Plastic grid 1 cm² (PCGP 1 cm²)	35.84ab
Plastic grid 0.25cm² (PCGC 0.25 cm²)	35.69b
Echo Image Viewer (ECHO)	33.86c
AutoCad® (CAD)	34.22c
Weighing paper (WP)	36.71a
	Pr>F
Method	<0.0001
CV%	2.32

[1]Means followed by the same letter in the column line do not differ by Tukey test (P > 0.05).

Comparing four methods of LEA determination (PCGP 0.25 cm², AutoCad ®, planimeter and weighing paper) Teixeira *et al.* (2011) found no difference between the methodologies and concluded that the process of PCGP 0.25 cm² showed easily implementation, practicality and reliability for use in research.

The ECHO methodologies and CAD have the same principle, in which the tool for determining the areas allows a perfect outline of LEA, and it shows more accurate values, avoiding the possibility of overestimation of data, likely to happen to PCGP and PW methods. The 1 cm² PCGP process is commonly used in studies that assess LEA of cattle. For smaller animals, and consequently smaller LEA measures, such as pigs, goats and sheep, it is usually recommended pattern of 0.25 cm² (Yáñez *et al.*, 2006). Despite the easiness and low cost of implementation; the grid pattern method needs proper care when applying the juxtaposition while fixing the original design for counting the squares. The process is considered practical, with the chance to be used with no need of drawing, directly in court or even immediately after obtaining the area to be measured, in the cold chamber (Teixeira *et al.*, 2011)

According to current literature (Peres *et al.*, 2011; Teixeira *et al.*, 2011) the use of the software (AutoCad®) is a standard process which presents the lowest chance of error, and consequent higher accuracy than other methods. However, after scanning, the image must be reset by the operator of the program, thereby requiring some skill in handling and greater expenditure of time. It should also be taken into consideration the necessity of previous digitization of images in digital scanner device for insertion into the program. Nevertheless, according to the authors, it is possible, with minimal training, handling the program without difficulty. It should be considered the need to acquire hardware and software.

Measurements by Echo Image Viewer® and AutoCad® programs with transparency on the computer screen is presented as an innovative methodology for determination of LEA, with no need to scan the image.

The practical use of the method observed in ECHO demonstrated to be superior to PCGP methods, since there is no need to determine the subsequent calculation of LEA. It is necessary to program it to 1:1 scale on computer screen and, it does not allow LEA measurement directly on the carcass. If the operator cannot get an actual scale draw on the software screen, it is necessary to calculate a factor to correct its scale.

When the practical use of the Echo Image Viewer® program occurs in animals "*in vivo*", Perkins *et al.* (1992) using heifers to evaluate the accuracy of ultrasound in thickness measurements of fat thickness (FT) and LEA between the 12th and 13th ribs, obtained 24 hours before the slaughter, found differences in absolute value between the measurements with ultrasound and actual measurements in the housing, taken 48 hours after slaughter, which expressed as a percentage of error, were 20.6% for FT and 9.4% for LEA. The authors concluded that the use of the ultrasound process, performed before slaughter, can predict with relative accuracy carcass characteristics. However, there has been described the methodology used to determine the LEA after 48 hours of cooling the carcass. The precision found in software like CAD and ECHO methods which provide a tool for

Table 2. Simple correlations between methods

	Plastic grid 0.25cm²	ECHO VIEWER	AutoCad®	Weighing Paper
Plastic grid 1cm²	0,9153*	0,9276*	0,9629*	0,9618*
Plastic grid 0.25cm²	1,0000	0,9396*	0,9605*	0,9638*
ECHO VIEWER		1,0000	0,9829*	0,9814*
AutoCad®			1,0000	0,9986*
Weighing paper				1,0000

*Significant correlation (P<0,05).

determining area circling LEA, the higher reliability of the analyzes.

The WP process was demonstrated less practical and more expensive than the others, as well as the need to obtain analytical balance and papers with LEA draws, it needs to be handled carefully cut, requiring the longest time among the methods evaluated. In addition, it should avoid the direct contact of the cuttings with both hands and with the environment due to the paper having the ability to absorb moisture contained in the air interfering with the weight of the sample.

In a study which compares the techniques developed by Peres *et al*. (2011), the WP design presented the highest standard deviation in relation to PCGP 0.25 cm² and the AutoCAD® methodologies with the scanned image. However, no comparison could be made with the PCGP 1 cm² process due to the high standard deviation presented.

CONCLUSION

The method of LEA measurement with the aid of 1 cm² plastic grid pattern can be used more practically as compared to 0.25 cm² due to easier counting of points, however overestimation of both LEA values was observed. The ECHO ® and AutoCad ® software enabled precise measurement and practice of LEA, suggesting potential for a software development which enable directly the LEA measurement from a computer screen. The choice of the method to be used should be based on available resources and its practicality in every condition.

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