# Evaluation of loin muscle area by pixel method

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Comparative evaluation of loin muscle area estimated by pixel method and empirical formula method in swine

Loin muscle area is a very important economic trait in the porcine performance test. Loin muscle areas of 163 pigs were evaluated through both the pixel method and empirical formula method (from Livestock Research for Rural Development).

## Abstract

## Introduction

In China, domestic consumption of pork has changed from quantity to quality with the living standard of city and country residents heightened, which results in that high quality pork will become one of the main objectives that breeders and producers pursued in breeding. In practice, lean percentage in the carcass (CLP) is one of the most important indices indicative of pork quality in the porcine performance test (Zhou et al 2001), and it was virtually a key economic trait to which attention has been paid by breeders in the past decades. At the same time, the involved procedures of lean percentage test in swine were inconvenient, time-consuming and costly, and those breeding farms or companies being short of funds had great difficulty to carry out lean percentage test in large scale. Because there exists relatively high positive correlation between lean percentage and loin muscle area in both phenotype and inheritance (Bush 1984; He et al 2000; Hua et al 2003), the loin muscle area was often used to replace lean percentage in the actual performance test in order to remarkably reduce the testing cost.

In common use, there are several direct or indirect methods for loin muscle area estimation in swine such as empirical formula method, ultrasonic method, integraph method, plotting paper method and etc (Gong et al 2000; Zhu et al 2002). On the other hand, these measurement methods represent some shortcomings more or less. For instance, the empirical formula method makes the high measuring error and low precision of measured results, while other measurement methods are device-dependent to a certain extent, and basic mathematical skills are required for users. In China, especially in inland, mainly when selecting the hybrid combinations for extensive application in rural regions, the empirical formula method is still frequently used because of lack of necessary apparatus. To tally with actual Chinese conditions, it is very necessary to develop other new methods to make more accurate measurement of loin muscle area. The objectives of this study are: (1) to measure the loin muscle areas of 163 pigs using both pixel method and empirical formula method to produce two traits, LMP and LME; (2) to compare the difference between these two traits through conventional statistical parameters; and (3) to conduct comparative genetics analyses of LMP and LME to systematically reveal the concrete influence of methodological difference upon genetic evaluation.

## Materials and Methods

# Sample

In this trial, five independent combinations of 163 pigs for slaughter came from State-owned Tongcheng Pigs Conservation Farm in Tongcheng county, which comprised 32 Large White (16 castrated sires and 16 spayed sows), 30 Landrace (10 castrated sires and 20 spayed sows), 34 Tongcheng (17 castrated sires and 17 spayed sows), 33 Landrace crossbred ( Landrace X [Large White X Tongcheng]) (16 castrated sires and 17 spayed sows), and 34 Large White crossbred (Large White X [Landrace X Tongcheng]) pigs (15 castrated sires and 19 spayed sows).

# Measurements of loin muscle area

## Empirical formula method

Loin muscle area at the 10/11th rib of nearside carcass was measured as described by Zhang (2004). Depth and width of transect of longissimus dorsi were measured by vernier calipers, and the value of area was calculated by the following empirical equation:

Area ~ depth X width X 0.7.

## Pixel method

Digital photos of transects of longissimus dorsi of each individual were photographed by NIKON 5700digital camera at an unchangeable vertical angle on a self-made temporary apparatus, on the surface of which affixed a small plastic with constant area as a reference object. Pretreatment that included cutting unwanted figures and bepainting surfaces of longissimus dorsi and reference object with different Visual Basic homochromatism was done in the software package of Photoshop 6.0.1 after digital photos were transmitted into PC computer. Number of pixels of the transect of longissimus dorsi and the reference object in the pretreated photos was automatically calculated by running the self-written program based on Visual Basic source code (Zhu et al 2005), and the actual area of transect of longissimus dorsi can be determined by the known area of reference object according to the proportion of number of pixels between them.

# Statistical and genetic analyses

## Estimation of conventional statistical parameters

Descriptive statistics including the test of normality (kurtosis coefficient and skewness coefficient) and other conventional statistical parameters were calculated to characterize the difference between LMP and LME by the UNIVARIATE procedure of SAS software (SAS Institute 1989).

## Estimation of EBVs

A single trait animal model was established to estimate the individual EBVs for LMP and LME (Sheng and Chen 2000), and the BLUP model was:

$$y_{ij} = \mu + C_i + Animal_{ij} + e_{ij} \quad (1)$$

where:

Here, the covariances between Animalij and eij were assumed to be zero.

## Estimation of rank correlation coefficient

After individual EBVs were estimated, conventional statistical parameters of which were calculated. And rank correlation coefficient was used to quantify the differences between the ranks of EBVs for LMP and LME on an identical individual ID. Rank correlation coefficient was computed by the following equation:

$$r = 1 - \frac{6\sum d^2}{n(n^2-1)} \quad (2)$$

where

$$\sum d^2$$

# Results

## Descriptive statistics

Results of comparison of conventional statistical parameters for LMP and LME were shown in Table 1. Mean, extremum and standard deviation of LMP were higher, broader or larger than those of LME, respectively, indicating that LMP contained more variation information. The distribution of data of LMP was closer to normal distribution revealed by the values of skewness and kurtosis as compared to LME. The skewness of LME was estimated as -0.469, which means the data are badly skewed left. Data of LMP distributed more dispersedly than that of LME, which was concluded from the estimation of kurtosis. Data sets of LME tended to have a distinct peak close to the mean, which hinted that there existed a systematical factor centralizing the data to mean. Descriptive statistical analyses elucidated that there was difference between two measurement methods.

Table 1. Comparison of statistical parameters for LMP and LME

| Traits | Minimum | Maximum | Mean | Standard Deviation | Skewness | | Kurtosis | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Statistic | Std. Error | Statistic | Std. Error |
| LMP | 14.1 | [illegible] | 36.7 | 11.8 | [illegible] | [illegible] | [illegible] | [illegible] |
| LME | 14.8 | 47.3 | 31.9 | 7.66 | -0.469 | 0.191 | [illegible] | [illegible] |

## Comparison of EBVs

Results of EBVs of each individual didn't been presented in detail in this paper. Summarizing from the results of EBVs, we could find that the ID of individual with maximal EBV in LMP and in LME was different, and vice versa for the ID of individual with minimal EBV, from which the conclusion could be made that the influence of methodological difference upon genetic evaluation was not ignorable. The orders of IDs of most individuals were repugnant by arranging the value of EBVs in LMP and LME, respectively, but those individuals with EBV above zero or below zero in LMP and LME were mostly coincident except twelve individuals. As shown in Table 2, difference between maximum and minimum of EBVs for LMP was 1.31, and the range of EBVs for LMP was larger than that for LME, which only was 0.994. Synchronously, the variation of EBVs for LMP was larger than that for LME, and the difference of standard deviations between LMP and LME was 0.146. Rank correlation coefficient, which is used to quantify the accordant degree of the orders of EBVs of all individuals between LMP and LME, was estimated as 0.242 ($P<0.01$). The result indicated that the methodological difference had a significant influence on genetic evaluation and that they could not be replaced each other in practical genetic evaluation. Generally speaking, denoted by the parameters in

 

Table 2, statistical properties of results of EBVs for LMP were more predominant than that for LME. To all appearances, EBVs for LMP were more variable and LMP was a more appropriate indicator for genetic evaluation.

Table 2. Statistical description of EBVs for LMP and LME

| Traits | Minimum | Maximum | Standard deviation | Skewness | Kurtosis | Rank correlation coefficient |
|---|---|---|---|---|---|---|
| LMP | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| LME | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |

# Discussion

Pixel method is a recently developed method for loin muscle area measurement without having been evaluated advantage and disadvantage compared with other commonly used methods in China. Generally, a digital picture contains millions number of pixels with maximum resolution of digital cameras to express its content, and the areas of figures in a digital picture can directly denoted by the number of pixels. This is just the basic principle of pixel method for loin muscle area estimation. Since the area of a figure in a digital picture is measured by millions of pixels, the precision of measurement of pixel method is higher than a kite, and the fact that pixel method has been widely applied in other domains of biological science and technology has shown its superiority (He 2004; Li et al 2002; Liu et al 2002; Tang et al 2002). Obviously, the precision and veracity of pixel method are higher than empirical formula method in loin muscle area estimation. Additionally, Xiao et al (2003) conducted a study that proved there were no statistically significant difference among empirical formula, integraph and plotting paper methods. Given this, pixel method is a precise measurement method compared with other commonly used methods in China. In this study, the results showed that conventional statistical property of measured results of pixel method for loin muscle area exceeded that of empirical formula method, and such result sustained the conclusion above.

Although empirical formula method for loin muscle area was widely used in field performance test in China, the real-time ultrasound technology used in performance test was most popular for loin muscle area estimation in modern pig industry, which allows producers to measure muscle depths, width and an ellipse fitted for loin muscle area (Rodney and Robert 2000). Ultrasound measurement directly scales the depths and width of longissimus dorsi in live pigs, and meets the loin muscle area in an approximate elliptical estimation. The treatment of approximate elliptical estimation for loin muscle area in ultrasound measurement complies the same essence as empirical formula method. So we considering, the relationship between pixel method and empirical formula method can partially reveal that between pixel method and ultrasonic method. Namely, influence of the difference between pixel method and ultrasonic method can be partially revealed by that between pixel method and empirical formula method in the process of genetic evaluation. Obviously, this research on the methodological difference between pixel method and empirical formula method, to some extents, could provide some clues of difference between pixel method and ultrasonic method, which was significantly meaningful in actual Chinese conditions.

In general, a positive relationship exists between larger loin muscle area and higher lean percentage in the carcass, and thus loin muscle area, the replaced indicator for lean percentage, is usually an important trait recorded in the porcine performance test (Peng et al 1994). Because there are replaceable methods, the potential influence of different methods upon the precision and veracity of genetic evaluation should be under consideration in practice. In this study, the result has proved that the loin muscle areas estimated by pixel method and empirical formula method had significantly different influence upon genetic evaluation specially revealed by the comparison of estimates of EBVs. The variation of EBVs for LMP is larger than that for LME. According to the breeding principle, compared with LME, the more variable EBVs for LMP, the larger selection difference in inheritance in the actual selection procedure. It is clear that LMP is a more appropriate indicator for indirect evaluation of lean percentage in the carcass, which means that if LME is replaced by LMP in the actual genetic evaluation programme, larger genetic gain can be realized. Of course, further work for validating the above conclusion is necessary.

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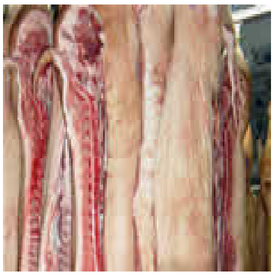

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