APPLICATION OF ULTRASOUND TECHNOLOGY ON CARCASS COMPOSITION TRAITS IN LANDRACE AND DUROC BOARS

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ABSTRACT

The real-time ultrasound provides the potential of predicting lean content in live animals. Thirty-four Landrace and 66 Duroc boars were used to find the suitable probing site and optimal location between ultrasound measurements at the tenth and the last ribs for prediction of lean content. Fat depths (scanned images and carcass) were measured along a line originating at right angles from both a point 1/2 and 3/4 of the length of the *longissimus* muscle and included the skin. Ultrasound tenth and last rib *longissimus* muscle area were measured using an Aloka SSD 900 real-time scanner. The best correlation for backfat thickness was obtained between ultrasound and carcass measured at the tenth rib ($r = 0.61$; $P < 0.001$). Correlations of ultrasound measured *longissimus* muscle area at the tenth and last rib with corresponded carcass measures at the last rib for Duroc were 0.60 and 0.59; and for Landrace boars were 0.57 and 0.64 ($P < 0.001$), respectively. The study found that the last rib was the best site for measuring the carcass lean in Landrace boars, however, conclusion remains uncertain in Duroc boars. Separate prediction equations for lean content should be formulated for the two breeds, and the accuracy of prediction equation for Duroc boars needs to be improved before it could be used in the selection program.

KEY WORDS: Carcass lean, Probing site, Swine, Ultrasound.

INTRODUCTION

The real-time ultrasound imaging in two-dimensions that allow fat depth and muscle area to be estimated provides the potential of predicting lean content in live animals. Studies have noted a great degree of variability among machine types, animal populations, transducer locations, operators and image interpreters (Sathaer *et al*., 1986 ; McLaren *et al*., 1991 ; Szbao *et al*., 1999). Regarding the locations, there is no general agreement on the probing sit to predict carcass lean content from literature reviewed. Some studies suggested the last rib be the best probing site to predict carcass lean content (McLaren *et al*., 1991 ; Dourmad *et al*., 2001 ; Youssao *et al*., 2002); while others recommended that the tenth rib was the most accurate probing site to predict carcass composition (Moeller and Christian, 1998 ; Johnson *et al*., 2004). In addition, several authors have previously measured the depth of subcutaneous fat at a point 1/2 or 3/4 the lateral length of the loin muscle perpendicular to the skin surface

(Moeller and Christian, 1998). The aim of this study was to find the suitable probing site between ultrasound measurements at the tenth and the last ribs for prediction of lean content in Landrace (L) and Duroc (D) boars in Taiwan. The optimal location to measure the depth of subcutaneous fat between a point 1/2 and 3/4 the lateral length of the loin muscle perpendicular to the skin surface was also studied.

MATERIALS AND METHODS

Live animal measurements Data were recorded at the Central Performance Testing Station in Chunan, Miaoli, Taiwan. Pigs were fed *ad libitum* before 110 kg of body weight and limited fed (75% of *ad libitium*) before slaughter. Pigs were slaughtered at an average age of 252 d with an average weight of 120 kg. Pigs were weighed and scanned 2 d prior to slaughter with an Aloka SSD 900 real-time ultrasound machine fitted with a 3.5 MHz, UST-5046 linear transducer (Kwang Ten Trading Co., Ltd., Taipei). To obtain good and clear images, and to avoid the presence of the thick and long hair, the site was shaved and cleaned, and clean gel was used. Fat depths (scanned images and carcass) were measured along a line originating at right angles from both a point 1/2 (UTRHBF, ULRHBFL, CTRHBF and CLRHBFL for ultrasonic and carcass measured at the 10th and last rib, respectively) and 3/4 (UTRTBF, ULRTBF, CTRTBF and CLRTBF for ultrasonic and carcass measured at the 10th and last ribs, respectively) of the length of the *longissimus* muscle and included the skin. Ultrasound tenth and last rib *longissimus* muscle area (UTRLMA and ULRLMA) were measured from tracings of ultrasound images using a tracing ball which was built in the ultrasound device.

Carcass measurements Pigs were then transported to Taiwan Farm Industry Co., Ltd., Pingtung, Taiwan, for slaughter and carcass evaluation. Skinned fat thickness was measured parallel to the middle line of the carcass at the first rib, tenth rib (CTRBF), last rib (CLRBF), and last lumbar vertebra of the right side of the warm carcass. The average of the three measures was recorded as the average backfat thickness (CAVBF). Carcass measurements included lean, bone and fat weights of closely trimmed ham, loin, belly, and shoulder were taken 24 h postmortem. The images of LMA at the 10th (CTRLMA) and last rib (CLRLMA) including the skinned fat depths were traced using a tracing paper, and later measured the depth of the fat using a ruler and traced the area using a planimeter at the laboratory.

Statistical analyses Ultrasonic and carcass measured data were analyzed using the GLM procedure of SAS (SAS Inst., Inc., Cary, NC). A linear model that included the fixed effects of breed and scanned date, and the interaction between breed and scanned date was used. Covariables of scan weight and carcass weight were used when analyzing ultrasound and carcass measured data, respectively. Pearson product-moment correlation coefficients were used to analyze the relationships between and among scan and corresponding carcass measurements. Regression analyses were carried out using regression procedure of SAS.

RESULTS AND DISCUSSION

Higher correlation coefficients between serial scan and corresponded carcass measurements of BF and LMA were found for Landrace than those for Duroc boars (Tables 1 and 2). Regarding BF measurements, the best correlation was obtained between UTRTBF and CTRTBF ($r = 0.61$; $P < 0.001$; Table 2). Correlations of UTRLMA and ULRLMA with corresponded CTRLMA and CLRLMA for Duroc were 0.60 ($P < 0.001$) and 0.59 ($P < 0.001$), respectively, whereas for Landrace boars were 0.57 ($P < 0.001$) and 0.64 ($P < 0.001$), respectively (Tables 1 and 2). Regarding lean percentage, highest correlation was obtained with ULRLMA ($r = 0.57$, $P < 0.001$) for Landrace boar. Results of this study were similar to the findings of Smith *et al*. (1992) and Youssao *et al*. (2002). Correlations between carcass and ultrasonic measurements of LMA were generally higher than those of BF. Source of variation was mainly from the skinned carcass in which the first layer of fat had lost during the skinned process. Regardless breed, ultrasonic and corresponded carcass measured backfat thickness was higher correlated at the 10th rib ($r = 0.28$ to 0.61) compared with last rib ($r = 0.21$ to 0.58) in this study (Tables 1 and 2). This is in agreement with results of Moeller and Christian (1998) using a Aloka SSD 500 real-time ultrasound.

Table 1. Correlation coefficients between carcass traits, lean percentage, and ultrasound measurements of Duroc boars (n = 66)

Variables	Scan wt.	UTRHBF	UTRTBF	UTRLMA	ULRHBF	ULRTBF	ULRLMA
CTRBF	0.068	0.058	0.141	0.087	0.274*	-0.003	0.101
CLRBF	0.396**	0.458***	0.474***	-0.027	0.307*	0.197	0.064
CAVBF	0.345*	0.340*	0.371**	-0.064	0.216	0.134	0.048
CTRHBF	0.237	0.395**	0.395**	-0.018	0.175	0.229	0.045
CTRTBF	0.158	0.413**	0.283**	0.087	0.278*	0.193	0.101
CTRLMA	0.335*	0.148	0.135	0.603***	0.133	0.298*	0.602***
CLRHBF	0.263	0.471***	0.248	0.378**	0.251	0.207	0.357**
CLRTBF	0.285*	0.532***	0.423**	0.436**	0.229	0.265	0.380**
CLRLMA	0.416**	0.064	0.031	0.520***	0.159	0.262	0.594***
Lean Wt.	0.727***	0.211	0.274*	0.208	0.346*	0.187	0.197
Lean Percentage	-0.016	-0.015	-0.125	0.348*	0.177	-0.067	0.258
MARB	0.207	0.250	0.288*	0.260	0.139	0.095	0.331*

* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$.

Table 2. Correlation coefficients between carcass traits, lean percentage, and ultrasound measurements of Landrace boars (n = 34)

Variables	Scan wt.	UTRHBF	UTRTBF	UTRLMA	ULRHBF	ULRTBF	ULRLMA
CTRBF	0.340*	0.559***	0.605***	-0.068	0.362*	0.258	0.019
CLRBF	0.313	0.311	0.436*	-0.043	0.349	0.336	-0.153
CAVBF	0.222	0.324*	0.436*	-0.009	0.444*	0.402*	-0.162
CTRHBF	0.259	0.357*	0.488**	-0.080	0.523**	0.340	-0.180
CTRTBF	0.340	0.559***	0.605***	-0.216	0.465**	0.258	-0.267
CTRLMA	0.142	-0.331	-0.435*	0.574***	-0.211	-0.098	0.528**
CLRHBF	0.292	0.329	0.460**	-0.135	0.427*	0.263	-0.194
CLRTBF	0.219	0.499**	0.548**	-0.148	0.577***	0.408*	-0.111
CLRLMA	0.397*	0.022	-0.259	0.599***	-0.096	0.033	0.635***
Lean Wt.	0.755***	0.227	0.170	0.588***	0.155	0.322	0.497**
Lean Percentage	0.175	-0.013	-0.283	0.415*	-0.300	-0.107	0.574***
MARB	0.126	0.429**	0.313	-0.033	-0.184	-0.061	0.109

* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$.

To predict the lean content, four multiple regression models comprising of scan weight (SCAN WT), UTRHBF, UTRTBF, UTRLMA, ULRHBF, ULRTBF, and ULRLMA were used (Table 3). Prediction of lean content from SCAN WT, and real-time ultrasound BF and LMA gave the accuracy (R^2) from 0.534 to 0.804 at the 10th rib, and from 0.532 to 0.849 at the last rib, respectively. Regression models of Landrace boars had the higher accuracy than those of Duroc boars, indicated the breed effect was important and thus separate prediction equations should be formulated for the two breeds. Is was found that the last rib was the best site for carcass lean measurement in Landrace boars in this study, however, conclusion remains uncertain for Duroc boars (Table 3). Moeller and Christian (1998) indicated that breed effects were the important bias for LMA and BF10. The degree of bias in LMA related to the size of the loin muscle was not the average fat thickness of a particular breed. In this study, source of variation while obtaining the image of the *longissimus* muscle existed in Duroc breed which might be due to its hard and tough skin coat. The accuracy of prediction equation for Duroc boars needed to be improved before it could be used in the selection program. Further research should be focused on the improvement of the precision of ultrasound and carcass measurements, and accuracies of the prediction equations with more data analyzed.

Table 3. Selected prediction equations on lean weight by breed

Breed	Model	Multiple regression	R^2
L	1	–3.6028 + 0.1941 SCAN WT + 0.0047 UTRHBF + 0.1809 UTRLMA	0.8008
	2	–3.1788 + 0.1991 SCAN WT – 0.1130 UTRTBF + 0.1801 UTRLMA	0.8044
	3	–2.6741 + 0.2230 SCAN WT – 0.3784 ULRHBF + 0.1405 ULRLMA	0.8486
	4	–3.8145 + 0.2176 SCAN WT – 0.2078 ULRTBF + 0.1518 ULRLMA	0.8390
D	1	1.3476 + 0.2137SCAN WT – 0.2155 UTRHBF + 0.0469 UTRLMA	0.5448
	2	1.6505 + 0.2047 SCAN WT – 0.0460UTRTBF + 0.0340 UTRLMA	0.5341
	3	1.6505 + 0.1989 SCAN WT – 0.0833 ULRHBF + 0.0263 ULRLMA	0.5321
	4	2.0981 + 0.2079 SCAN WT – 0.1449 ULRTBF + 0.0337 ULRLMA	0.5348

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