EARLY PREDICTION OF CARCASS YIELD GRADE BY ULTRASOUND IN KOREAN HANWOO CATTLE

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Background

Real-time ultrasound instruments have been shown to be an accurate predictor of carcass 13th-rib fat thickness and longissimus muscle area (LMA) in beef cattle (Perkins et al., 1992; Robinson et al., 1992; Song et al., 2002). Smith et al. (1992) found that correlation coefficients between live animal ultrasound and carcass measurements of BFT and LMA varied from 0.81 to 0.82 and from 0.43 to 0.63, respectively. Research has also shown that accuracy is highly dependent on the technician and level of experience that the person possesses (McLaren et al., 1991). However, limited information has been published on the accuracy or precision of these systems (Brethour, 1994; Herring et al., 1998). Since 1992, the Korean Livestock Cooperatives Federation has provided a beef grading system for quantifying meat yield and quality factors by subjective evaluation. The possibility of using ultrasound to precisely and accurately estimate carcass measurements in live animals might be beneficial to the beef industry, allowing it to move away from the current practice of pricing cattle on pen averages towards a value-based marketing system.

Objectives

The objective of this study was to evaluate early prediction of yield grade by using ultrasound measurements.

Materials and methods

Two hundred and twenty three Korean Hanwoo cattle of 18, 21 and 24 months of age were ultrasonically scanned by Super-eye Meat (FHK Co. Ltd., Japan) with an electric linear probe (2 MHz frequency: 27 X 147 mm) at the 13th rib of their left longissimus muscle. Vegetable oil was used on the probe to obtain adequate acoustic contact. Scanned images were obtained using double frame display capabilities of the equipment. A transducer guide was used to minimize error that might occur due to animal back line curvature or the overlapping step required to produce one complete image of the longissimus muscle. The resulting ultrasound images were recorded on portable personal computer and later viewed on a display monitor to estimate both back fat thickness (BFT) and longissimus muscle area (LMA) using computer software (Image-Pro Express, Media Cybernetics, USA). In this study, ultrasonic estimate was compared to carcass value for increased prediction accuracy by two prediction methods: regression and decision tree. Regression techniques (SAS, Ver. 8.1; 2000) were used to evaluate the best-fit equation to explain variation in retail yield components (BFT, LMA and live weight (LW)) from ultrasonic. Decision trees that have too many nodes have great probability of prediction error when it is applied to new data. Thus, inappropriate branches were removed from the decision tree, and the remaining tree structure was used as a model for prediction.

Results and discussion

Differences in the ultrasonic and actual carcass measures in BFT and LMA are presented in Table 1. Ultrasonically measured value indicated thinner back fat and smaller longissimus muscle area. Regression equations for prediction carcass yield grade at different months of age are presented in Table 2. Table 3 presents the prediction accuracy of the regression method on the mean yield grade, which was predicted with 73.1% accuracy at 18 months, 83.2% at 21 months and 89.2 % at 24 months of age. However, different grades (A-C) were not predicted equally well at all ages, yield grade A being most predictable. Prediction accuracy was 75.2% for yield grade A and 72.3% for yield grade B at 18 months, 88.9% and 69.2% at 21 months, and 92.8% and 81.5% at 24 months, respectively. By using the decision tree method for carcass yield grades at 24 months of age, 75.8%, 84.8% and 91.0% of prediction accuracy were obtained at 18, 21 and 24 months of age, respectively. Also, if live weight was unknown (as in small farms), the decision tree method enabled prediction only using ultrasonic measurements (BFT and LMA).

Conclusions

The results of the present study suggest that the decision tree method predicted the yield grade of meat with 91% accuracy. The results obtained on image texture suggest that interfacing a computer with an ultrasound system may improve accuracy and precision of the procedure of estimating carcass quality. Such technology might thus serve as a useful tool and predicting aid in mechanical meat grading.

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Table 1. Carcass traits of Hanwoo steers by ultrasonic and carcass measures

Items	Age (months)			
	18	21	24	24
	--------------------------	ultrasound	-------------------	carcass
LW[1] (kg)	376.70 ± 65.28^{c}	470.64 ± 59.63^{b}	544.27 ± 53.16^{a}	-
CW[2] (kg)	-	-	-	313.05 ± 36.50
BFT[3] (㎜)	3.21 ± 2.06^{c}	5.05 ± 2.56^{b}	6.59 ± 3.07^{a}	6.94 ± 3.38^{a}
LMA[4] ( )	53.13 ± 9.14^{d}	64.04 ± 8.76^{c}	71.45 ± 9.33^{b}	75.88 ± 7.81^{a}

[1] Live animal weight, [2] Carcass weight, [3] Back fat thickness, [4] Longissimus muscle area.
[a,b,c] Means with different superscripts in the same row are significantly different ($p<0.05$).

Table 2. Regression equation for prediction carcass yield grade at 18, 21 and 24 months of age

Age	Regression equation
18 months	$Y = 69.6967 - 0.5487 \times UBF^{***} + 0.0387 \times ULMA^{***} - 0.00323 \times LW$
21 months	$Y = 69.2308 - 0.4793 \times UBF^{***} + 0.0420 \times ULMA^{***} - 0.00045 \times LW$
24 months	$Y = 69.3991 - 0.4419 \times UBF^{***} + 0.0403 \times ULMA^{***} - 0.00024 \times LW$

Yield grade A : $69 \leq Y$, B : $66 \leq Y < 69$, C : $Y < 66$.
* $p<0.001$.

Table 3. Prediction accuracy of carcass yield grade at 18, 21, and 24 months of age by the regression method

YGC[1)]	YGU[2)]	18 months		21 months		24 months	
		n	Accuracy	n	Accuracy	n	Accuracy
A	A	115	75.2%	136	88.9%	142	92.8%
	B	38		17		11	
	C	0		0		0	
B	A	18		20		11	
	B	47	72.3%	45	69.2%	54	81.5%
	C	0		0		0	
C	A	0		0		0	
	B	4		0		1	
	C	1	20.0%	5	100.0%	4	80.0%
Total		223	73.1%	223	83.2%	223	89.2%

[1)] Carcass yield grade, [2)] Ultrasonic yield grade.

Table 4. Prediction accuracy of carcass yield grade at 18, 21, and 24 months of age by the decision tree method

YGC	YGU	18 months		21 months		24 months	
		n	Accuracy	n	Accuracy	n	Accuracy
A	A	124	81.0%	138	90.2%	142	92.8%
	B	29		15		11	
	C	0		0		0	
B	A	22		19		8	
	B	43	66.2%	46	70.8%	57	87.7%
	C	0		0		0	
C	A	0		0		0	
	B	3		0		1	
	C	2	40.0%	5	100.0%	4	80.0%
Total		223	75.8%	223	84.8%	223	91.0%

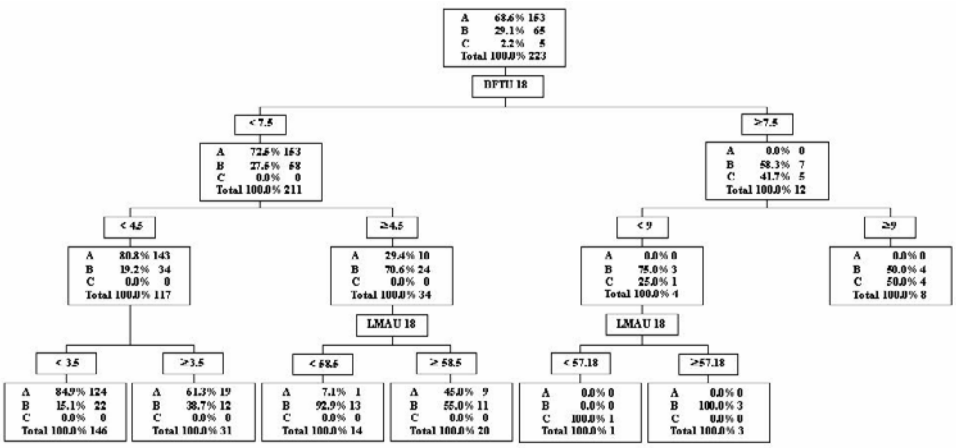

Fig. 1. Distribution pattern of carcass yield grade at 18 months of age by the decision tree method

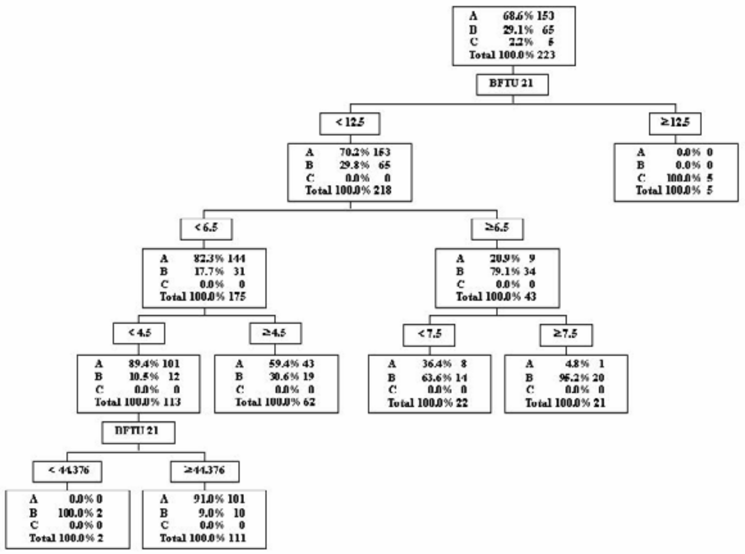

Fig. 2. Distribution pattern of carcass yield grade at 21 months of age by the decision tree method

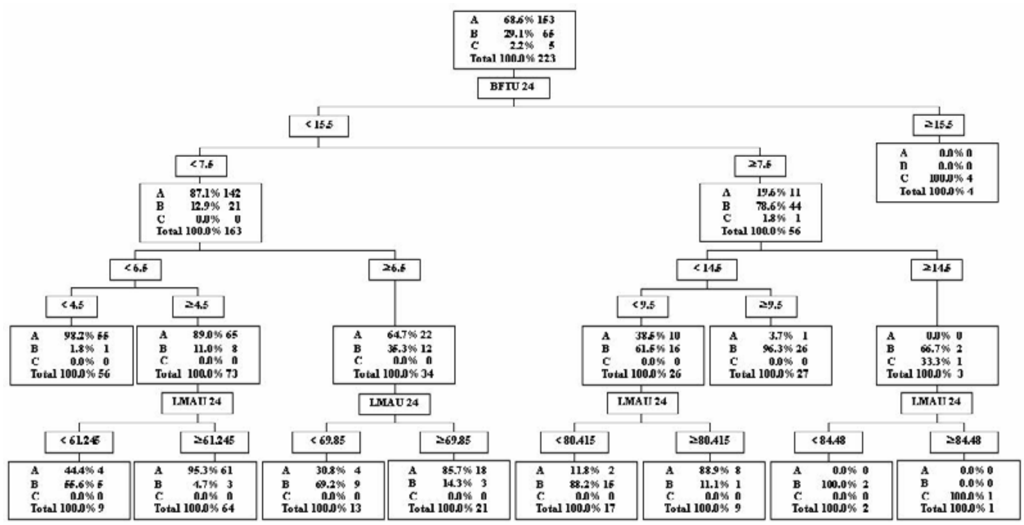

Fig. 3. Distribution pattern of carcass yield grade at 24 months of age by the decision tree method