Evaluation of Knife Separable Lean Content of Cull Sows at Harvest and Development of a Prediction Equation for Pounds Lean

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Caitlyn Abell, research assistant, Department of Animal Science; Kenneth Stalder, professor, Department of Animal Science; Robert Fitzgerald, graduate student, Department of Animal Science;
Haven Hendricks, Utah Pork Producers Association, Provo, UT

Summary and Implications

A study was conducted to measure the quantity of fat and muscle from 4 primal cuts of cull sows from the four USDA market grades based on weight, and to develop prediction equations for estimating cull sow knife separable lean content. Lean and fat weights by primal within and across the USDA cull sow weight classes. These prediction equations could assist processors in their decision to purchase cull sow weight classes that meet the processors needs for pork products with defined lean:fat content, such as brats and sausage. Hot carcass weight and 10th rib backfat resulted in a prediction equation that had an R-square greater than 0.90. This equation was developed across weight classes and was more predictive that any one single class equation.

Introduction

Predicting carcass percent lean is an effective way for cull sows processors to predict individual sow value and establish the price paid to producers for cull sows. Cull sow processors can use this information to buy the correct USDA sow class or mix of sows in order to get optimum lean and fat content for the types of further processed pork products they market such as sausage, brats, chorizo, etc. It is important to establish if a single equation for all market weight classes is as predictive as separate equations for each weight class. Backfat and loin muscle area, which are used to establish carcass percent lean, can be measured on the carcass or on live sows prior to harvest using ultrasonic technology. Ultrasound measurements do not require slicing the carcass at the 10th rib to measure loin area and backfat. Further, measuring loin area and back fat on live sows does not require the plant to integrate carcass measurements in-line and may allow plants to more easily adopt this methodology.

Materials and Methods

Cull sows (N = 212) were purchased for this study from local commercial pork producers. The sows' genetic background consisted of commercially available maternal lines. Ultrasonic backfat and loin muscle area estimates and live body weight were obtained on individual sows prior to slaughter. Sows were slaughtered at a commercial processing facility. On each harvest day, 6 to 10 sows were processed under USDA inspection. Each carcass was weighed and split down the spine. Half of the carcass (side chosen at random by plant staff) was weighed and divided into the loin, belly, ham, shoulder, and rib primal cuts. The primal cuts were then divided into knife separable bone, lean, fat and skin tissue components and individually weighted. Both carcass and live weights were used to calculate percentages for the primal cuts. This information was used to determine the lean and fat percentage by primal cut within each USDA cull sow live-weight class. USDA cull sow weight classes are based on the following live weight classes live weight class I (300 to 450 lbs), class II (451 to 500 lbs), class III (501 to 550 lbs), and class IV (551 lbs and greater). The number of sows in each category was 84, 43, 41, and 44 for MWC I, II, II, and IV, respectively.

Because actual carcass lean content based on fat and muscle components was measured, backfat and loin muscle area were utilized to develop lean equations similar to what is commonly used to calculate percent lean in most market hog buying programs. A stepwise regression analysis was used to develop carcass lean prediction equations. A maximum r option was utilized to determine the optimum number of traits to be included in the prediction equation in order to maximize the predictive ability of the equation. Traits evaluated for inclusion in the prediction equations were hot carcass weight, backfat, and loin muscle area. Separate equations were derived using for carcass and ultrasound measurements. Five equations were developed, one equation for each of the 4 USDA weight classes and an overall equation using all of the sows. R-square values were recorded from each model and used to determine which prediction equation was optimal. Percent lean was estimated by using the intercept and slopes from the model to predict pounds of knife separable lean and dividing the pounds of lean by the hot carcass weight.

Results and Discussion

Lean and fat percents from sows in different market weight classes are shown in Table 1. Across USDA cull sow weight classes, there were significant percent lean and fat differences in the primal cuts. Larger differences in percent knife separable lean and fat were found in the primal cuts compared to total body weight. The two lighter market

weight classes had a higher numeric percent lean and lower numeric percent fat based on the carcass when compared to the two heavier weight classes. This information could be used by processors to target cull sows that are more likely to have appropriate lean to fat ratios, either from individual primal or from entire carcasses, that are desirable for the food products they manufacture (brats, sausage, chorizo, etc.).

Estimates of intercepts, slopes for traits included in the predication, and r-squared values are shown for ultrasound and carcass measures in Tables 2 and 3, respectively. Across the USDA cull sow weight classes, two primary traits, hot carcass weight and 10^{th} rib backfat, contributed to lean prediction equations that resulted in the greatest r-square values. One could argue that the USDA cull sow weight classification arbitrarily divides the sows into classes that have little predictive value relative to the knife separable lean within each carcass. Hence, an analysis predicting knife separable lean irrespective of USDA cull sow weight class was conducted. Again, hot carcass weight and backfat were the two most predictive variables for predicting carcass lean content resulting in an R-square value of 0.90.

Results from this study suggest that either ultrasonic or carcass measures could be used in lean muscle prediction equations for cull sows. The prediction equation developed across weight classes resulted in an R-square value greater than the R-square value for any equation developed for a single class. Since the overall equation was more predictive than the single class equations, prediction equations should be developed across USDA cull sow weight classes, thus ignoring class.

Table 1. Percentage of knife separable lean and fat by USDA cull sow weight class and carcass primal[1]

	Primal component	Total	MWC1[2]	MWC2	MWC3	MWC4
Loin	**Lean of Loin, %**	49.1	52.4	52.6	55.3[a]	43.8[a]
	Fat of Loin,%	15.0	13.0	11.9	15.5	21.6[a]
	Lean of Carcass,%	10.6	11.4	11.5	9.2[a]	9.4[a]
	Fat of Carcass,%	3.3	2.9	2.7	3.2	4.6[a]
Shoulder	**Lean,%**	70.8	70.1[a]	72.5[b]	72.0[b]	69.3[a]
	Fat,%	9.3	9.2	8.0	8.9	11.1[a]
	Lean of Carcass, %	21.4	21.5[a]	22.3[a]	21.4[ab]	20.4[b]
	Fat of Carcass,%	2.8	2.8[ab]	2.5[a]	2.6[a]	3.3[b]
Ham	**Lean, %**	67.4	68.5[a]	68.5[a]	66.6[ab]	65.2[b]
	Fat, %	8.4	6.5	6.5	9.7[a]	12.5[b]
	Lean of Carcass, %	18.2	18.0	18.1	18.8	18.0
	Fat of Carcass, %	2.3	1.7	1.7	2.8[a]	3.5[b]
Rib and Belly	**Lean ,%**	69.9	73.8[a]	70.8[ab]	66.8[bc]	64.7[c]
	Fat, %	8.7	4.4	6.8	11.4[a]	16.0[b]
	Lean of Carcass, %	11.2	11.6[a]	10.8[b]	10.9[ab]	11.0[ab]
	Fat of Carcass, %	1.5	0.7	1.1	2.1[a]	2.9[b]
Total	**Lean of Carcass, %**	61.3	62.5	62.7	60.3[a]	58.8[a]
	Lean of body weight %	41.0	41.1	41.5	41.1	40.2
	Fat of Carcass, %	9.8	8.1	7.9	10.6[a]	14.2[b]
	Fat of body weight, %	6.6	5.4	5.3	7.2[a]	9.7[b]

[1]Row means with different superscripts are significantly different ($P < 0.05$).

[2] USDA cull sow weight classes are based on the following live weight classes live weight class I (300 to 450 lbs), class II (451 to 500 lbs), class III (501 to 550 lbs), and class IV (551 lbs and greater), MWC = Market Weight Class

Table 2. Models to predict carcass pounds of knife separable lean by USDA cull sow market weight class using all market weight classes and ultrasound backfat and loin muscle area[1]

USDA Cull Sow Weight Class[2]	Intercept	HCW[4]	BF[4]	LMA[4]	R-Squared
1	-11.51	0.66	-40.04	-3.11	0.84
2	-4.89	0.72	-59.31	*[3]	0.72
3	26.74	0.60	-59.20	*	0.60
4	15.65	0.61	-39.24	*	0.61
Overall	23.20	0.60	-44.51	*	0.90

[1]R-Square values represent model R-Squares
[2]USDA cull sow weight classes are based on the following live weight classes live weight class I (300 to 450 lbs), live weight class II (451 to 500 lbs), live weight class III (501 to 550 lbs), and class IV (551 lbs and greater)
[3]Fixed effects with * are not significant ($P > 0.05$) and removed from the final equation
[4] HCW= hot carcass weight (lbs), BF= backfat (in), and LMA = loin muscle area (in^2). Traits were measured at approximately between the 10^{th} and 11^{th} rib using an Aloka 500v real time ultrasound machine.

Table 3. Models to predict carcass pounds of knife separable lean by USDA cull sow market weight class using all market weight classes and carcass measured backfat and loin muscle area[1]

USDA Cull Sow Weight Class[2]	Intercept	HCW[4]	BF[4]	LMA[4]	R-Squared
1	-13.46	0.60	-12.96	3.72	0.84
2	-29.12	0.76	-17.61	*[3]	0.76
3	1.45	0.63	-7.85	*	0.48
4	37.05	0.50	*	*	0.52
Overall	6.48	0.57	-9.69	1.78	0.89

[1]R-Square values represent model R-Squares
[2]USDA cull sow weight classes are based on the following live weight classes live weight class I (300 to 450 lbs), class II (451 to 500 lbs), class III (501 to 550 lbs), and class IV (551 lbs and greater)
[3]Fixed effects with * are not significant ($P > 0.05$) and removed from the final equation
[4] HCW= hot carcass weight (lb), BF= backfat (in), and LMA = loin muscle area (in^2). Traits were measured on the carcass approximately between the 10^{th} and 11^{th} rib.