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Prediction of carcass composition based on specific carcass cuts in Simmental bulls

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ABSTRACT

Carcass data from 872 Simmental bulls were analysed to estimate the possibilities for prediction of muscle, fat and bone weight as well as percentage in the carcasses from measurement of specific cuts. The right carcass side was first cut into chuck, shoulder, front shank, rib roast, back, loin, tenderloin, brisket, rib, flank, leg and hind shank. Each specific cut was further separated into muscle, fat, bone and tendon. Data were analysed by multiple stepwise regression procedure. As independent variables dissected carcass side weight, weight and the percentage of specific cut and weight and the percentage of different tissues in a specific cut and their quadratic terms were included. The highest coefficient of determination was obtained from leg (for muscle, fat and bone weight 0.9678, 0.839, 0.7972 and for muscle, fat and bone percentage 0.7821, 0.7993, 0.5857). The carcass weight had no effect on average bias, whereas muscle percentage was underestimated in very lean carcasses and overestimated in very fatty one and vice versa for the predicted fat percentage.
(Keywords: beef, carcass, prediction, tissue weight, tissue proportion)

INTRODUCTION

One of the most important factors that define carcass value is carcass composition (*Augustini et al*., 1987). Hence the measurement of muscle, fat and bone content in the carcass is important for meat industry as well as for cattle breeding. The most accurate method for determining the carcass tissue composition is to weight the dissected carcass tissues. However this method is labour intensive and very costly and used only when high accuracy is needed (*Temisan*, 1987). In general, there are two types of prediction equations; it is possible to predict the weight or the proportion of different carcass tissues (muscle, fat and bone). A simple and accurate method for the prediction of carcass composition would bring reduction of labour and costs.

The purpose of this work was to estimate the possibilities for prediction the carcass composition from the composition of specific carcass cuts in Simmental bulls.

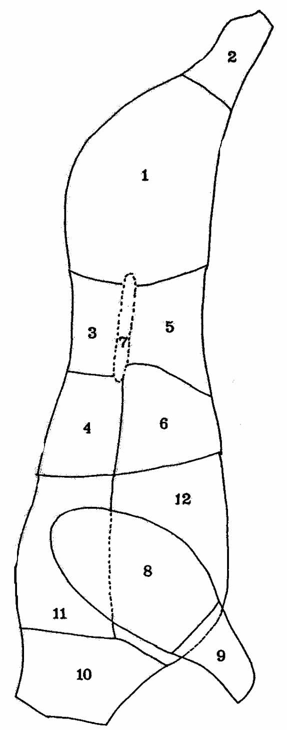
MATERIALS AND METHODS

Data from 872 Simmental bulls from progeny testing station were used in the present study. Bulls were fed with maize silage and concentrates and slaughtered at subjectively defined optimal fatness. After slaughter the right carcass sides were cut into quarters between the 6th and 7th rib and further dissected to the following cuts: chuck, shoulder, front shank, rib roast, back, loin, tenderloin, brisket, rib, flank, leg and hind shank

(*Figure 1*). Subsequently the cuts were dissected to muscle, fat, tendon and bone, and the percentage of tissues was calculated. Means and standard deviation for carcass cuts percentage and carcass cuts tissue composition are shown in *Table 1*. The average carcass side weight was 165±13.26 kg with almost 71% muscle, 12% fat and 16% bone. The rest up to 100% represented tendons. Leg and shoulder represented the highest proportion of the carcass. Flank, brisket and rib had the highest fat content and also the highest standard deviations.

Figure 1

Dissection of right carcass side



Leg(1), Hind shank(2), Loin(3), Back(4), Flank(5), Rib(6), Tenderloin(7), Shoulder(8), Front shank(9), Chuck(10), Rib Roast(11) Brisket(12).

The stepwise regression procedure (*SAS*, 1989) was used to predict the weight and percentage of muscle, fat and bone in the carcasses. Independent variables included in the statistical model, were: carcass side weight, weight and percentage of specific cut, weight and percentage of different tissue in specific cut. Accordingly, for prediction of muscle weight or the percentage in carcass from leg the following independent variables and their quadratic terms were included in the model: carcass side weight, weight of leg, the percentage of leg in the carcass, weight of muscle, fat, bone and tendon in the leg and the percentage of muscle, fat, bone and tendon in the leg. All variables left in the model were significant at the 0.15 level.

Table 1

Means and standard deviations for carcass cuts percentage and their tissue composition in Simmental bulls

Carcass cut	Share of carcass cut, %	Carcass cut composition, %		
		muscle	fat	bone
Leg	28.61 ±1.09	76.16 ±2.08	9.2±1.96	13.12±1.01
Hind shank	3.53 ±0.25	39.87±2.28	5.06±2.37	6.65±2.09
Tender loin	2.32 ±0.21	83.17±4.10	16.83±4.10	-
Loin	3.75 ±0.33	68.33±3.89	6.65±3.00	23.09±3.51
Back	5.62 ±0.73	67.66±3.75	11.14±3.83	20.04±2.81
Rib roast	8.22 ±0.98	75.76±3.53	6.96±2.36	15.49±2.63
Chuck	8.86 ±1.00	78.75±3.32	7.10±2.58	12.57±2.03
Shoulder	14.79 ±0.91	72.41±2.49	11.66±2.67	14.45±1.17
Front shank	2.55 ±0.20	41.63±2.71	3.21±1.67	49.78±2.99
Brisket	9.33 ±0.96	59.95±4.42	23.44±5.15	16.61±2.05
Rib	6.46 ±0.91	65.41±4.37	17.37±5.23	17.23±2.43
Flank	5.98 ±0.79	70.09±6.30	25.62±6.30	-
Carcass side, kg	**165.45±13.26**	**70.73±2.34**	**11.97±2.52**	**15.88±1.05**

Statistical model:

$$\hat{Y}_{ij} = b_0 + b_1 * X_1 + b_2 * X_2 + ... + b_i * X_i + e_{ij}$$

$\hat{Y}_{ij}$ = dependent variable, kg or % of body tissue in the carcass,
b_0 = constant,
$b_1..b_i$ = partial regression coefficients,
$X_1..X_i$ = independent variables,
e_{ij} = estimation error.

RESULTS AND DISCUSSION

The coefficient of determination (r^2) and residual standard deviation (σ_e) for predicting weight of muscle, fat and bone in the carcass are shown in *Table 2*. The r^2 for predicting muscle weight in the carcass were all relatively high, ranking from 0.9678 to 0.867. The r^2 for predicting fat weight were lower than for muscle (between 0.8399 and 0.3517) and for predicting bone weight even lower than for fat (between 0.7972 and 0.4541). The highest r^2 and also the lowest σ_e for the muscle and fat weight in the carcass were predicted from leg and shoulder, whereas the lowest r^2 and also the highest σ_e were predicted from hind and front shank. The highest r^2 and the lowest σ_e for the bone weight in the carcass were predicted from leg and shoulder, whereas the lowest r^2 and the highest σ_e were predicted from tender loin and flank. *Fan et al*. (1992) reported slightly higher r^2 but also higher σ_e for muscle prediction using cold carcass weight, muscle weight in the cut and cut weight (r^2 between 0.932 and 0.978 for hip, loin, flank, rib, chuck, brisket, plate and shank).

The coefficient of determination and residual standard deviation for predicting the percentage of muscle, fat and bone in the carcass (*Table 3*) were much lower than for predicting weight of carcass components. The highest r^2 for percentage of muscle, fat and bone in the carcass were predicted from leg and shoulder whereas the lowest muscle and fat percentage were predicted from front shank and bone percentage from tender loin. Rib and flank represent very interesting cuts, because they can be easily cut from hind quarter and have only minor value. Combined together (data not shown), rib and flank are almost as effective in muscle percentage prediction as leg is, and even better in fat percentage prediction than leg. *Fan et al*. (1992) also reported lower r^2 for prediction of muscle percentage (r^2 0.156 from shank and 0.783 from chuck).

Table 2

Coefficient of determination (r^2) and residual standard deviation (σ_e) of models selected by stepwise procedures for predicting muscle, fat and bone weight in the carcass side

	Muscle, kg		Fat, kg		Bone, kg	
	r^2	σ_e	r^2	σ_e	r^2	σ_e
Leg	0.9678	1.8390	0.8399	1.8979	0.7972	0.9715
Shoulder	0.9508	2.2726	0.7734	2.2604	0.7550	1.0683
Brisket	0.9483	2.3261	0.7780	2.2358	0.6024	1.3572
Rib	0.9438	2.4248	0.7820	2.2132	0.6117	1.3428
Flank	0.9422	2.4580	0.7586	2.3305	0.4902	1.5367
Back	0.9387	2.5353	0.7314	2.4596	0.6568	1.2639
Rib roast	0.9330	2.6540	0.7044	2.5787	0.6128	1.3385
Loin	0.9221	2.8613	0.6356	2.8682	0.5968	1.3681
Tender loin	0.9108	3.0532	0.5325	3.2392	0.4541	1.5920
Chuck	0.9097	3.0561	0.4954	3.3750	0.6104	1.3440
Hind shank	0.8971	3.2836	0.5117	3.3182	0.6462	1.2794
Front shank	0.8671	3.7301	0.3517	3.8189	0.6977	1.1848

Table 3

Coefficient of determination (r^2) and residual standard deviation (σ_e) of models selected by stepwise procedures for predicting muscle, fat and bone percentage in the carcass side

	Muscle, %		Fat, %		Bone, %	
	r^2	σ_e	r^2	σ_e	r^2	σ_e
Leg	0.7821	1.0989	0.7993	1.1321	0.5857	0.2134
Shoulder	0.6684	1.3542	0.7146	1.3502	0.4595	0.2437
Brisket	0.6459	1.4015	0.7132	1.3517	0.0479	0.3225
Rib	0.6161	1.4563	0.7293	1.3157	0.1068	0.3128
Flank	0.6151	1.4581	0.7065	1.3699	0.3360	0.2705
Back	0.5746	1.5337	0.6582	1.4783	0.1547	0.3046
Rib roast	0.5396	1.5947	0.6281	1.5404	0.0756	0.3184
Loin	0.4715	1.7125	0.5473	1.7034	0.0752	0.3185
Tender loin	0.3956	1.8261	0.4162	1.9289	0.0322	0.3256
Chuck	0.3918	1.8450	0.3617	2.0204	0.1165	0.3116
Hind shank	0.3017	1.9685	0.3869	1.9812	0.2725	0.2826
Front shank	0.0971	2.2345	0.1884	2.2768	0.1697	0.3025

To test the accuracy of prediction, we plotted residuals together with carcass side weight and carcass fat percentage. As an example we chose the prediction of percentage of muscle, fat and bone in the carcass from leg.

Figure 2

The effect of carcass side weight residuals of estimated meat percentage from leg

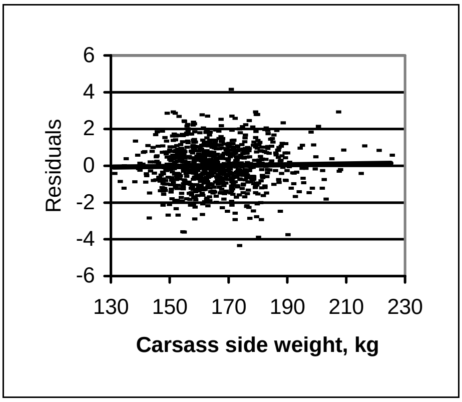
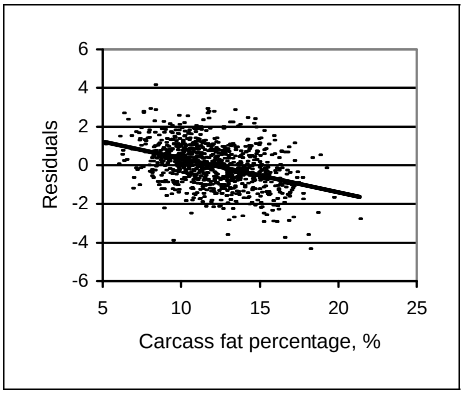


Figure 3

The effect of carcass fat on residuals of estimated meat percentage from leg



Figures 2, *4* and *6* evidently show that carcass side had no effect on bias. In contrast to carcass side weight, carcass fat percentage exhibited an effect on bias. The muscle percentage (*Figure 3*) was underestimated in carcasses with low percentage of fat and overestimated in carcasses with high percentage of fat. Just the opposite was true for the predicted fat percentage (*Figure 5*). It was overestimated in carcasses with low percentage of fat and underestimated in carcasses with high percentage of fat. The accuracy of bone prediction was not affected by fat percentage in the carcass (*Figure 7*).

Figure 4

The effect of carcass side weight on residuals of estimated fat percentage from leg

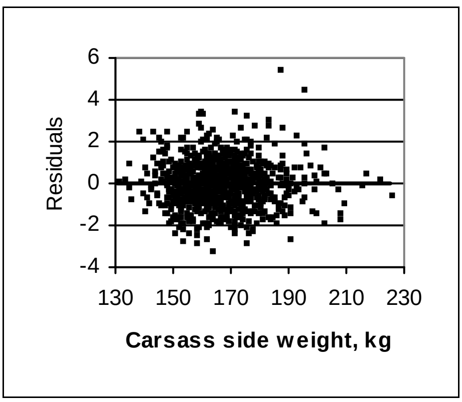


Figure 5

The effect of carcass fat on residuals of estimated fat percentage from leg

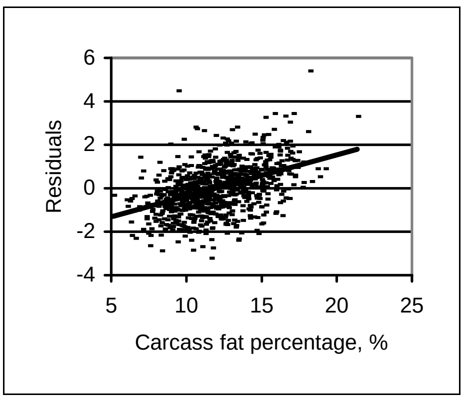


Figure 6

The effect of carcass side weight on residuals of estimated bone percentage from leg

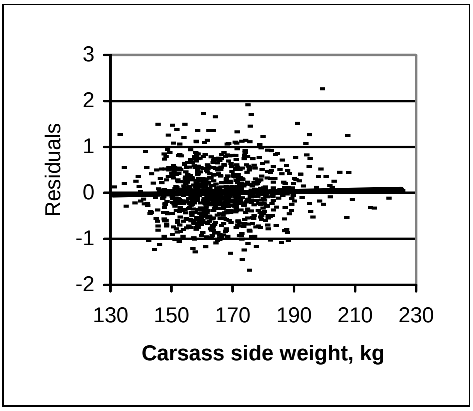
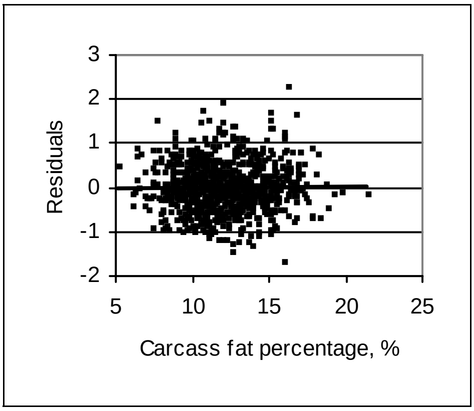


Figure 7

The effect of carcass fat on residuals of estimated bone percentage from leg



CONCLUSIONS

The obtained results lead to the conclusion that the coefficient of determination for muscle, fat and bone weight prediction from carcass side weight and different carcass cuts composition is higher than the prediction of muscle, fat and bone percentage. The highest r^2 and the lowest σ_e were obtained from leg as well as for weight and for the percentage of different carcass tissues. The carcass side weight had no effect on bias of estimated carcass components, whereas the muscle percentage was underestimated in very lean carcasses and overestimated in very fatty ones. Fat percentage was overestimated in lean carcasses and underestimated in fatty carcasses. The accuracy of bone prediction was not affected by fat percentage in the carcass.

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