PREDICTION OF CARCASS LEAN PERCENTAGE FROM FAT AND MUSCLE MEASUREMENTS IN DIFFERENT BREEDS, HALOTHANE SENTIVITIES AND CONFORMATION CLASSES.

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SUMMARY: Prediction of dissected lean percentage from fat thickness measurements taken on the mid-line, mid-rump (**MR**), mid-back (**MB**) and mid-shoulder (**MS**), over the muscle **M. longissimus** 60 mm from the mid-line 3/4 last rib (**3/4 LR**) and last rib (**LR**) and **M. longíssimus** depth (**MLD**) and surface (**MLS**) at 3/4 last rib were studied in a sample of 153 gilts from Pietrain (**P**), Belgian Landrace (**BL**), Landrace (**L**), Large White (**LW**) and Duroc (**D**) breeds. Among the mid-line fat measurements, **MR** was the best predictor (R.s.d=4.20%). The prediction was significantly better from fat measurements taken over **M. longíssimus. MLS** was more precise than **MLD** (R.s.d. 3.37% vs 4.46%). When predictors were analyzed individually, a significant effect of breed, conformation and halothane sensitivity was observed. Only **MLS** was not significantly affected by the conformation class. In the regressions using more than one predictor the precision was improved significantly. However a significant effect of breed, conformation and halothane sensitivity was still observed. Only when **MLS** was tested combined with **LR** and with **LR** and **MR**, breed and conformation effects were removed. These results show that **M. longíssimus** shape is more useful in predicting lean percentage than simple muscle depth measurements for grading purposes.

INTRODUCTION: The aim of the revised EEC pig grading scheme is reporting carcass prices from representative markets to Brussels on a common basis. The estimated lean percentage using objective measurements is recorded by approved equations in every Member State. The scheme should improve market transparency, leading to price differentials for different classes of carcasses and reflecting the payments to producers. Several methods including various predictors have been approved. The aim of this communication is to study the effect of breed, halothane sensitivity and the visual assessment of conformation in the prediction of lean percentage using the most common predictor measurements in grading systems.

MATERIALS AND METHODS: One hundred and fifty three gilts were studied. The animals used were 27 Large White (**LW**), 58 Landrace (**L**), 40 Belgian Landrace (**BL**), 16 Duroc (**D**) and 12 Pietrain (**P**) purebred reared under the same conditions.
Stress-susceptivity was evaluated in all the animals using the halothane test procedure at aproximately 20 kg live weight.
They were slaughtered at the IRTA abbatoir within the normal commercial slaughter weight (90-100 kg) and used in meat quality trials at our Centre. After slaughter the folowing predictors of lean percentage were recorded:
Fat thickness on the mid-line (mm):
Mid-rump (MR), minimum depth over the exposed section of M.

gluteus medius.

Mid-back (**MB**), depth at the level of the posterior edge of the last rib.

Mid-shoulder (**MS**), greatest depth of fat in the region of the shoulder.

On cut surface fat thickness over **M. longíssimus** at 60 mm from the mid-line (mm):

Last rib (**LR**), depth at the level of the head of the last rib.

3rd to 4th last rib (**3/4 LR**), depth between the 3rd and 4th ribs.

On cut surface muscle measurements:

M. longíssimus depth (**MLD**), depth at 60 mm from the mid-line (mm).

M. longíssimus surface (**MLS**), between the 3rd and 4th ribs (cm^2).

A visual assessment of overal shape or conformation was made in 102 carcasses. They were classified in 21 very good conformation (VG), 33 good conformation (G), and 48 normal conformation (N).

After chilling, the left sides of the carcass were cut and dissected using the IRTA method (Diestre **et al.**, 1985).

Our dissection technique is the same described by Cuthbertson (1968), where each joint was dissected into lean, subcoutaneous fat, intermuscular fat, bone and waste. The lean of the head was not dissected. The lean meat percentage of each carcass was transformed to the EC reference lean percentage using the formula obtained in the CEC (1979) study for British bacon carcasses.

Multiple linear regression analyses were calculated to study the relative precision of the predictors measuremets to estimate lean meat percentage using up to three independent variables.

The usefulness of the predictor (single and combined) was being assessed by the resulting Residual s.d. and coefficient of determination. Regression analyses were carried out both overall data and within breed, conformation class, and halothane sensitivity. To study this last factor a subsample of LB and P gilts were used, being 45 halothane positive and 53 halothane negative.

RESULTS AND DISCUSSION: Means and s. d. of the main carcass characteristics are shown in Table 1. The sample analised in this study had less variation in carcass weight compared with a representative commercial sample (Diestre **et al.**, 1989). However, more extreme variation in carcass composition was observed providing a wide range data to test the precision of predictor measurements. This variation is because extreme types in muscularity were included. Pietrain carcasses had 12% of lean more than Duroc, halothane positive had 6% more lean than halothane negative, and very good conformation carcasses had 8% more than normal conformated carcasses.

Fat thickness measurements made on the mid-line produced prediction equations for lean percentage with larger Residual s. d. and lower coefficient of determination compared with on cut surface fat measurements over **M. longissimus** (Table 2). This is in agreement with results of several studies where fat measurements over the loin were more precise than fat measurements along the dorsal mid-line on split carcass (de Boer **et al.**, 1978; Kempster and Evans, 1979; Diestre and Kempster, 1985). However, among dorsal mid-line measurements mid-rump performed well combined with fat measurements over the loin muscle. The surface of **M. longissimus** was slighly better predictor of lean percentage compared with muscle depth, either as a simple predictor or combined with fat measurements. The two muscle measurements of the loin (depth and surface) improved prediction of lean percentage combined with fat thickness measurements as it was expected from previous findings (Pedersen and Bush, 1982; Kempster et al., 1985; Diestre **et al.**, 1989). This is because muscle measurements remove some of the effect of muscularity. However the precision of measurements used alone or combined was significantly better for separate equations (within) using different intercepts and the same regression coefficients for the breeds, conformation classes and halothane types.

In single equations only the prediction of lean percentage from **M. longissimus** surface was not affected by the conformation class. When the surface of the loin was used combined with LR and LR plus MR fat measurements the effects of breed and conformation were removed, however the effect of halothane type was still observed. Wood and Robinson (1989) found that **M. longissimus** depth did not remove the breed effect on leaness at constant fat thickness in a sample of Large White and Pietrains pigs. Branschied **et al.** (1989) say that one of the main causes of breed bias under German conditions is the crossbreeding with or without Pietrains. Recently, Planella **et al.** (1990) found significant differences in the regression equations fitted for populations, sexes and feeding regimes.

In table 3, the degree of bias (predicted minus actual lean percentage) are presented when equations using overall data and within each of the fixed factors included are applied to each individual breed, conformation class and halothane type. The results show that in Pietrain and Belgian Landrace, halothane positive and very good conformation carcasses, the estimation of lean percentage using pooled equations (overall) is underrated. Whereas, in Large White and Duroc, halothane negative and normal conformated carcass the estimation lean percentage is overrated. Differences of actual minus predicted lean percentage tend to be lower in pooled equation where loin surface was use as predictor. The degree of bias is minimised when using separated equation (different intercepts and the same regression coefficients) for each breed, halothane type and conformation class.

We can conclude that present techniques used for pig carcass grading can not eliminate the effect of muscularity. The area of the loin is not used as a predictor at present. Therefore, muscle shape or measurements that can describe conformation more precisely should be studied in further developments of automatic grading equipments, with the aim of eliminating systematic subevaluation of well conformated carcasses.

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TABLE 1. Means and standard deviation (s.d.) of the main carcass characteristics.

	Overall		Breed										Halothane phenotype				Conformation					
			Pietrain		Belgian Landrace		Landrace		Large White		Duroc		Positive		Negative		Very good		Good		Normal	
	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.
Live weight (kg)	94.4	4.16	94.9	4.92	94.3	4.56	93.6	3.79	95.1	4.19	96.1	3.38	93.0	4.05	94.7	4.04	94.3	5.24	93.4	3.80	93.9	4.07
Carcass weight (kg)	71.0	4.30	73.0	4.24	72.4	4.02	69.0	4.32	71.8	3.74	70.4	3.40	70.0	4.80	70.8	4.24	72.0	4.48	70.0	3.94	69.4	4.04
Leg length (cm)	39.0	1.93	39.6	2.27	40.2	1.50	39.5	2.02	39.3	2.13	39.8	1.89	39.6	1.75	39.9	1.93	39.4	1.70	39.6	2.40	39.6	2.58
Carcass length (cm)	80.3	3.10	76.3	2.17	80.3	2.44	81.4	2.98	80.7	2.86	78.4	1.80	79.4	2.38	82.2	2.50	79.2	3.79	79.6	1.89	80.7	1.90
Fat thickness on the mid-line (mm)																						
MR	17.2	5.52	10.6	3.70	14.8	3.51	17.8	4.51	22.5	6.23	17.2	4.16	14.7	4.26	18.1	3.88	12.1	3.97	17.1	4.80	17.9	4.83
MB	21.3	5.75	18.0	5.72	20.3	4.57	19.7	4.87	25.6	6.65	24.8	4.69	18.9	4.56	20.8	4.74	18.9	5.24	21.0	6.17	21.4	5.91
MS	32.2	6.93	29.0	9.55	29.4	6.13	31.3	5.99	37.7	6.25	35.5	3.79	28.5	5.66	32.3	5.93	26.7	6.23	30.0	6.39	33.1	6.36
Fat thickness over M. longissimus (mm)																						
LR	16.2	5.53	10.6	3.06	12.7	3.21	17.5	5.02	19.3	6.00	19.8	4.47	12.8	3.64	17.6	4.83	11.4	3.62	15.9	4.94	18.2	5.79
3/4LR	15.8	5.91	10.0	2.86	12.6	2.97	16.5	4.44	18.1	5.89	21.9	8.86	12.8	3.36	16.4	4.35	11.8	4.38	15.3	4.82	18.2	6.80
MLD	55.4	9.53	63.6	7.41	63.8	6.55	51.9	7.31	51.5	6.27	46.7	9.65	62.7	7.19	52.5	7.96	64.8	5.26	58.7	8.56	50.8	8.71
MLS (cm^2)	42.3	7.46	52.3	6.66	47.6	5.59	38.7	5.76	40.2	5.06	36.5	5.27	46.9	6.08	39.0	5.96	51.9	6.10	43.3	6.73	38.2	5.33
Carcass composition (%)																						
Lean	51.8	5.66	59.6	3.20	55.7	3.84	50.3	4.94	48.5	4.70	47.5	3.25	55.8	3.90	49.6	4.57	57.6	5.12	53.1	4.97	49.4	4.60
Subcutaneous fat	16.9	4.82	11.9	3.59	14.0	3.52	18.1	4.29	19.7	4.99	18.7	3.95	14.0	3.35	18.5	4.22	12.6	4.47	16.1	4.65	17.7	4.13
Intermuscular fat	5.0	1.06	4.6	0.75	4.9	1.03	5.2	1.12	4.7	0.98	5.6	0.90	5.0	0.83	5.2	1.26	5.2	1.02	5.0	0.82	5.5	1.11
Flare fat	1.3	0.46	1.0	0.45	1.1	0.32	1.5	0.52	1.4	0.37	1.3	0.29	1.1	0.32	1.5	0.54	1.1	0.51	1.3	0.44	1.4	0.45
Bone	10.0	1.00	9.3	1.19	10.1	0.80	9.8	1.08	10.3	0.90	10.4	0.77	0.8	0.97	10.0	0.98	9.9	0.84	9.7	1.14	10.2	0.86

TABLE 2. Coefficients of determination (R^2) and Residual standard deviations (R.s.d.) for the prediction of carcass lean percentage from different measurements.

	BREED					CONFORMATION					HALOTANE				
	Overall		Within			Overall		Within			Overall		Within		
	R^2	R.s.d	R^2	R.s.d.		R^2	R.s.d.	R^2	R.s.d.		R^2	R.s.d.	R^2	R.s.d.	
Fat Thickness (mm)															
On mid-line															
MR	45.62	4.20	60.94	3.61	***	45.51	4.22	56.05	3.88	***	37.31	4.17	51.40	3.69	***
MB	29.15	4.80	57.48	3.77	***	29.70	4.85	52.67	4.02	***	16.60	4.81	42.30	4.02	***
MS	27.85	4.85	55.22	3.88	***	37.93	4.55	50.77	4.10	***	18.59	4.75	40.40	4.09	***
On cut surface															
LR	65.47	3.37	72.20	3.07	***	69.94	3.22	73.77	3.04	**	60.48	3.37	66.30	3.13	***
3/4 LR	55.13	3.88	66.55	3.37	***	56.51	3.87	64.13	3.55	***	60.71	3.36	68.90	3.00	***
LR+3/4LR	69.39	3.19	74.74	2.94	***	73.40	3.04	76.57	2.89	**	66.89	3.11	72.10	2.87	***
MR+LR	69.44	3.19	75.01	2.93	***	73.23	3.07	76.56	2.90	**	63.45	3.26	68.30	3.10	***
3/4LR+LR+MR	72.09	3.06	76.40	2.86	***	75.59	2.94	78.42	2.80	**	69.00	3.02	73.40	2.80	***
On cut surface muscle measurements.															
MLS (cm^2)	57.69	3.73	63.32	3.53	***	58.28	3.80	58.62	3.83	N.S	49.66	3.78	54.90	3.60	**
MLD (mm)	39.54	4.46	51.96	4.03	***	33.14	4.80	40.58	4.57	**	35.40	4.31	45.00	4.00	***
Best conbinations															
LR+MLS	76.64	2.78	78.09	2.74	N.S	79.38	2.69	79.76	2.69	N.S	70.97	2.89	72.40	2.80	*
3/4LR+MLD	59.91	3.65	67.21	3.34	***	57.73	3.83	64.14	3.57	***	66.34	3.13	70.47	2.95	***
LR+MLD	70.50	3.13	73.79	2.99	**	72.31	3.10	74.32	3.02	*	65.35	3.18	68.10	3.07	**
LR+MR+MLS	78.86	2.67	79.94	2.64	N.S	80.88	2.61	81.62	2.59	N.S	72.25	2.83	73.50	2.79	*
3/4LR+MR+MLD	68.56	3.25	76.49	2.85	**	66.66	3.44	70.06	3.30	**	70.90	2.92	73.58	2.80	**
LR+3/4LR+MLD	72.03	3.06	75.35	2.91	**	74.01	3.02	76.57	2.90	**	70.29	2.96	73.12	2.83	**

*** $P<0.001$; ** $P<0.01$; $P<0.05$; N.S. not significative differences from using pooled (overall) equations or with different intercepts and the regression coefficients within each fixed factor.

TABLE 3. Predicted minus actual lean percentage using different equations.

	Breed										Halothane phenotype				Conformation					
	Pietrain		Belgian Landrace		Landrace		Large White		Duroc		Positive		Negative		Very Good		Good		Normal	
	Overall	Within	Overall	Within	Overall	Within	Overall	Within	Overall	Within	Overall	Within	Overall	Within	Overall	Within	Overall	Within	Overall	Within
LR	-3.2	0.0	-1.0	0.0	0.4	-0.5	3.2	0.1	2.0	0.6	-1.2	0.0	0.9	-0.1	-1.5	-0.1	-0.8	-0.4	1.0	-0.2
MR + LR	-2.4	0.0	-1.0	0.0	0.5	-0.4	-0.2	0.0	1.9	0.0	-1.1	0.0	0.9	0.0	-1.0	0.0	-0.6	0.0	1.0	-0.1
LR + MLS	-1.5	0.0	-0.3	-0.2	-0.5	-0.5	0.8	0.1	0.3	0.2	-0.7	0.1	0.4	0.0	-0.1	-0.2	-0.7	-0.2	0.2	-0.1
34LR + MLD	-3.3	0.0	-0.8	0.0	0.4	-0.5	1.3	0.0	-0.6	0.0	-0.9	0.0	0.8	0.0	-2.2	0.0	-0.3	-0.2	0.9	-0.1
LR + MR + MLS	-1.0	0.0	-1.3	-0.1	-0.4	-0.4	0.1	0.1	1.3	0.0	-0.7	-0.1	0.4	0.0	0.1	-0.2	-0.8	-0.2	0.2	-0.1
34LR + MR + ML	-2.0	0.0	-0.6	0.0	0.4	-0.4	-0.2	0.0	0.7	0.1	-0.8	0.0	0.6	0.0	-1.2	0.0	-0.7	-0.1	0.8	0.0
LR + 34LR + MLD	-2.6	0.0	-0.3	0.0	0.1	-0.5	0.6	0.3	-0.1	0.0	-0.1	0.0	0.4	0.0	-1.2	0.0	-0.6	-0.2	-0.6	-0.1