9 : 2

LEAN CONTENT EVALUATION IN PIG CARCASSES USING THE DANISH FAT-O-MEAT'ER

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SUMMARY

A sample of 200 pig carcasses,selected to represent Italian production, was probed with Fat-o-Meat'er at 3/4 and 4/5 LV for fat thickness (8 and 10 cm laterally),at 2/3, 3/4 and 4/5 LR for fat thickness and muscle depth (7 , 9 and 11 cm laterally).Fat thickness was also measured on the dorsal midline at the gluteus medius,last rib and shoulder through FOM caliper. Total dissection was performed on 120 cold sides and a partial dissection formula was obtained.This was applied to 74 of the remaining sides and verified on the last 6 ones.Using a stepwise procedure,a comparison of multiple regression equations to predict lean yield % was carried out on the basis of the most interesting FOM measurements.The lowest RSD (1.9662)and the highest Rsq value (0.8946) were obtained combining fat thickness at 3/4 LV (10 cm) with fat and meat thicknesses at 3/4 LR (11 cm).This equation has been proposed as FOM formula.

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INTRODUCTION

Slaughter pigs in Italy are at present marketed and payed on a live weight basis.Parameters such as carcass conformation and dead weight are also used ,although occasionally,and only in the case of specific trade agreements (e.g.:Cooperatives and the likes).
The 2760/75 EEC regulation on pig carcass classification and grading has never been applied on a national scale in Italy and,moreover,has been since the beginning widely criticized.The last EEC regulation 3220/84, instead,will have to be compulsorily used in all EEC countries by 1/1/1989.
The need to fulfil such regulation has therefore given the stimulus to carry out a research on objective pig carcass evaluation.

MATERIALS AND METHODS

200 pig carcasses have been selected in a way to cover the most complete range of pigs marketed in Italy.
A sampling procedure was therefore set up so as to include pigs from 60 to over 180 kg dead weight,in the aim to test both light pigs,such as those common all over Europe,and heavy pigs of specific Italian production.
Besides and inside dead weight selection,carcasses were chosen according to lean meat content as visually assessed by parameters of the type suggested by EEC regulation 2760/75.
Carcasses,118 castrated males and 82 females,were taken with no consideration for their genetic background. Their final distribution as to dead weight and lean meat content is presented in Table 1.
Left sides of the chosen carcasses were probed at 45' post mortem for fat thickness and muscle depth using the Danish Fat-o-Meat'er (FOM).The instrument was free of any internal programming so to leave ample freedom of choice regarding number and type of probing sites.
Moreover two probes of different lenght (5-105 mm and 15-115 mm) were employed thus allowing proper measurements to be taken in relation to carcass size and fatness.
Probing sites were decided with reference to specific literature data (1,2,3,4).Carcasses were eventually probed: A)for fat thickness only at the 3/4 and 4/5 last lumbar vertebrae at 8 and 10 cm off the dorsal midline; B) for fat and meat thickness at the 2/3,3/4, 4/5 last rib at 7, 9 and 11 cm off the dorsal midline. In addition fat thickness was also measured on the dorsal midline at the gluteus medius,last rib and shoulder using the FOM caliper.
Right sides were cut according to standard "Parma" jointing method within an hour post mortem .This cutting procedure yields four lean cuts (ham,loin,shoulder and neck)and three fat ones (belly,backfat,collar fat). Left sides,after overnight chilling,were cut following a partially modified "Parma" jointing method.In this case the ribs are cut off from the loin at the end of their bending section.The loin is then weighted before and after covering fat is removed.
The first method was used to produce evidence on the variation of the most important joints,such as ham,loin, shoulder and neck,in relation with carcass weight and lean meat content (the results will be published elsewhere).The second method was adopted in view of setting up a partial dissection formula.
Each joint of the first 120 left sides was subsequently separated into subcutaneous (including skin) and intermuscular fat,bone and meat to establish lean meat content.
Total dissection results were processed and used to set up a partial dissection formula which was applied to 74 of the remaining sides.Concurrently 6 sides were totally dissected to verify the formula.

RESULTS AND DISCUSSION

Hot carcass weight ranged from 65.3 kg to 191.3 kg while lean meat content varied between 33.06 and 61.46 %.

Partial dissection formula

Total dissection parameters were selected on the basis of their relationship with lean meat percentage.The most interesting of them have been fitted into multiple regression equations using a stepwise procedure of variables selection.Various regression equations have been obtained,the best of which is the following one:

$$Y = 45.305 - 0.158\,X_1 + 0.729\,X_2 - 0.184\,X_3 - 0.365\,X_4 - 0.540\,X_5 + 0.294\,X_6 - 0.040\,X_7$$

where:
Y = carcass lean meat (%)

$$X_1 = \frac{\text{(skin+subcut.fat) of the ham + loin fat}}{\text{ham + loin}} \cdot 100$$

N.B.:-loin fat stands for covering fat removed from the loin according to the second jointing method;
-loin is the entire above-mentioned cut including fat

X_2 = ham lean meat (%)

X_3 = belly fat (skin+adipose tissue in total) (%)

X_4 = (meat+intermuscular fat+bone) of the ham (%)

X_5 = perirenal fat (% on the side)

X_6 = loin (% on the side).In this case loin is without fat but with the entire (reconstituted) ribs

X_7 = minimum backfat thickness on the gluteus medius(mm).

This equation has a RSD of 0.8833 and a Rsq of 0.9771. It is required for its use to: 1)measure minimum backfat thickness at the gluteus medius on the dorsal midline (hot sides); 2)cut cold sides according to the "Parma" modified procedure; 3)totally dissect ham and belly.
The formula can be employed within the following ranges

of the considered variables:

Y=36.01-61.46% X_1=16.85-51.03%

X_2=48.34-73.15% X_3=41.50-80.48%

X_4=60.88-84.48% X_5= 0.72-5.26%

X_6=11.67-20.53% X_7=10 - 72 mm

FOM measurements

Simple correlation coefficients (r) between FOM measurements and lean meat content are presented in Tab.2. The most interesting observations are the following:

- lumbar region = relationships are higher for the 4/5 LV site but probing is in this case less easy to perform.As for as 3/4 LV site correlation coefficient improves from 8 to 10 cm;
- thoracic region = relationship between fat measurements and lean content increases from 2/3 to 3/4 LR and,at the same time,from 7 to 11 cm,while r values, although high,behave in a nearly reverse manner at 4/5 LR.Meat measurements,on the other side,show correlation coefficients decreasing from 7 to 11 cm at all probing sites,highest at 3/4 LR (7cm) and lowest at 3/4 LR (11 cm);
- dorsal midline = all fat measurements are highly correlated with meat content,the best one being at the gluteus medius.

FOM formula

Using a stepwise procedure,a comparison of multiple regression equations to predict lean yield was carried out on the basis of the most interesting FOM measurements.A preliminary selection of variables and equations was made keeping in mind EEC requirements and similar experiences of other European countries.EEC regulation 2967/85 fixes a minimum Rsq of 0.64 and a maximum RSD of 2.50.Therefore only equations fulfilling such requirements were considered.On account also of slaughtering rates normally existing in Italy it was decided that a two probing sites procedure could be acceptable.The measurement of gluteus medius fat thickness,in terms of working times,would be feasible as well,and therefore it was introduced into a first group (A) of regression equations.A second comparable set of equations (B) was obtained by using the same variables of group "A",in which gluteus medius fat thickness was replaced with hot carcass weight.The variables used in such equations,together with their RSD and Rsq values,are shown in Table 3.It has to be stressed that,although hot carcass weight had been proposed in all set B,equations 3B and 4B do not contain such parameter as it was refused by the stepwise procedure. Set B compared with A is consistently characterized by a lower degree of precision whether dead weight is employed or not.

Within set A it can be observed that the two best choices are 2A and 4A.The former (2A)is based on fat thickness measured at 3/4 LV (10 cm) and fat thickness plus muscle depth at 3/4 LR (9 cm).The latter (4A) only differs from 2A as regarding lumbar fat thickness which is measured at 4/5 LV (8 cm);it is not so good as far as precision is concerned and,furthermore,it requires the uneasy probing at the 4/5 LV site.The first (2A), hence,is better from a statistical and a technical point of view.The precision of 2A is well above minimum EEC requirements and therefore a further attempt was made in order to reduce the variables,i.e.fat thickness at gluteus medius (Tab.4-1).At the same time,since the best equations (2A,4A)so far obtained came from the most lateral thoracic probing sites,a new equation was set up with fat thickness and muscle depth always at 3/4 LR but at 11 cm (Table 4-2).

Keeping always as a comparison equation 2A (Tab.3),it can be observed that the first attempt (Tab.4-1)is somewhat less satisfying while the second one (Tab.4-2), although without gluteus medius fat thickness,has practically the same degree of precision.

Both equations,though,on the basis of residuals analysis,show a certain trend towards underestimation of lean in the carcasses with the highest meat content. For this reason two further parameters were derived from the same FOM measurements employed in the equations 1 and 2 (Tab.4),that is:

$$a = \frac{\text{meat}}{\text{meat + fat}} \quad \text{(both at 3/4 LR)}$$

$$b = \left[\frac{\text{3/4 LR fat + 3/4 LV fat}}{2}\right]^2$$

These were separately added to the other variables thus obtaining 4 additional combinations (1a,1b,2a,2b-Table 4).The introduction of such parameters in all cases improves the precision of lean meat evaluation and this is more marked for the "b" combinations.Between these ones,2B shows the lowest RSD (1.9662) and the highest Rsq (0.8946) and has therefore been proposed as FOM formula.

The equation in full is as follows:

$$Y = 61.12975 - 0.44024\ X_1 + 0.13368\ X_2 - 0.29067\ X_3 + 0.00415564\ X_4$$

where:

Y = carcass lean meat (%)

X_1= fat thickness at 3/4 LR - 11 cm

X_2= muscle depth at 3/4 LR - 11 cm

X_3= fat thickness at 3/4 LV - 10 cm

$$X_4 = \left[\frac{X_1 + X_3}{2}\right]^2$$

The ranges of its validity are:

Y = 33.06-61.46 % X_1= 10-66 mm

X_2= 23-79 mm X_3= 13-74 mm

Such an equation,as regards the 200 carcasses of the sample,has correctly placed 68.5 % of them;lean meat content has been overestimated in 19.5 % and underestimated in 12 %,but in both cases by just one class.

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Table 1 = Carcasses distribution: dead weights on rows and lean meat content on columns.
(Each group of three values shows number of carcasses, row percent and column percent.
Bottom row: sum of carcasses of the column and percent on total.
Extreme right column: sum of carcasses of the row and percent on total).

Meat % / Weight	Number / Row (%) / Column (%)	S ≥ 60.0	E 55.0÷59.9	U 50.0÷54.9	R 45.0÷49.9	O 40.0÷44.9	P <40.0	Row total
> = 60 < 80			10 47.6 33.3	10 47.6 20.4	1 4.8 1.9			21 10.5
> = 80 < 100			7 23.3 23.3	14 46.7 28.6	8 26.7 15.4	1 3.3 2.1		30 15.0
> = 100 < 120			8 21.6 26.7	7 18.9 14.3	13 35.1 25.0	8 21.6 16.7	1 2.7 5.0	37 18.5
> = 120 < 140			1 2.6 3.3	7 18.4 14.3	11 28.9 21.2	16 42.1 33.3	3 7.9 15.0	38 19.0
> = 140 < 160		1 2.6 100.0	2 5.3 6.7	6 15.8 12.2	10 26.3 19.2	12 31.6 25.0	7 18.4 35.0	38 19.0
> = 160 < 180			2 6.3 6.7	4 12.5 8.2	8 25.0 15.4	10 31.3 20.8	8 25.0 40.0	32 16.0
> = 180				1 25.0 2.0	1 25.0 1.9	1 25.0 2.1	1 25.0 5.0	4 2.0
	Column Total	1 0.5	30 15.0	49 24.5	52 26.0	48 24.0	20 10.0	200 100.0

Table 2 = Simple correlation coefficients (r) between FOM measurements and lean meat content.

LUMBAR REGION	8 cm	10 cm	
- 3/4 LV	-0.8682**	-0.8778**	
- 4/5 LV	-0.8970**	-0.8828**	
THORACIC REGION	7 cm	9 cm	11 cm
- 2/3 LR fat	-0.8624**	-0.8884**	-0.8938**
meat	0.3557**	0.3024**	0.1482
- 3/4 LR fat	-0.8892**	-0.9082**	-0.9143**
meat	0.4197**	0.3252**	0.1294
- 4/5 LR fat	-0.8924**	-0.8816**	-0.8832**
meat	0.4060**	0.3332**	0.1470

DORSAL MIDLINE
- gluteus medius - 0.8701**
- last rib - 0.8299**
- shoulder - 0.8148**

N.B. ** = 0.01 significance
no stars = no significance

Table 3 = Groups of variables (A, B) used for a first search of a FOM formula (see text for explanation).

1A		1B	
3/4 LR (7 cm) fat		3/4 LR (7 cm) fat	
3/4 LR (7 cm) meat		3/4 LR (7 cm) meat	
3/4 LV (10 cm) fat	RSD = 2.1790	3/4 LV (10 cm) fat	RSD = 2.2850
gluteus medius	Rsq. = 0.8706	dead weight	Rsq. = 0.8576
2A		2B	
3/4 LR (9 cm) fat		3/4 LR (9 cm) fat	
3/4 LR (9 cm) meat		3/4 LR (9 cm) meat	
3/4 LV (10 cm) fat	RSD = 2.0986	3/4 LV (10 cm) fat	RSD = 2.1450
gluteus medius	Rsq. = 0.8799	dead weight	Rsq. = 0.8746
3A		3B	
3/4 LR (7 cm) fat		3/4 LR (7 cm) fat	
4/5 LV (8 cm) fat	RSD = 2.2440	3/4 LR (7 cm) meat	
gluteus medius	Rsq. = 0.8627	4/5 LV (8 cm) fat	RSD = 2.3267
			Rsq. = 0.8524
4A		4B	
3/4 LR (9 cm) fat		3/4 LR (9 cm) fat	
3/4 LR (9 cm) meat		3/4 LR (9 cm) meat	
4/5 LV (8 cm) fat	RSD = 2.1420	4/5 LV (8 cm) fat	RSD = 2.1940
gluteus medius	Rsq. = 0.8749		Rsq. = 0.8688
5A		5B	
4/5 LR (7 cm) fat		4/5 LR (7 cm) fat	
4/5 LR (7 cm) meat		4/5 LR (7 cm) meat	
3/4 LV (10 cm) fat	RSD = 2.2069	3/4 LV (10 cm) fat	RSD = 2.2542
gluteus medius	Rsq. = 0.8672	dead weight	Rsq. = 0.8615
6A		6B	
4/5 LR (7 cm) fat		4/5 LR (7 cm) fat	
4/5 LR (7 cm) meat		4/5 LR (7 cm) meat	
4/5 LV (8 cm) fat	RSD = 2.2556	4/5 LV (8 cm) fat	RSD = 2.3126
gluteus medius	Rsq. = 0.8613	dead weight	Rsq. = 0.8542

Table 4 = Final variables processing for FOM formula

1	
3/4 LR (9 cm) fat	
3/4 LR (9 cm) meat	
3/4 LV (10 cm) fat	RSD = 2.1666
gluteus medius	Rsq. = 0.8720
1a	
3/4 LV (10 cm) fat	
Variable "a"	
	RSD = 2.0764
	Rsq. = 0.8825
1b	
3/4 LR (9 cm) fat	
3/4 LR (9 cm) meat	
3/4 LV (10 cm) fat	RSD = 2.0082
Variable "b"	Rsq. = 0.8900
2	
3/4 LR (11 cm) fat	
3/4 LR (11 cm) meat	
3/4 LV (10 cm) fat	RSD = 2.1027
	Rsq. = 0.8795
2a	
3/4 LR (11 cm) fat	
3/4 LV (10 cm) fat	
Variable "a"	RSD = 2.0720
	Rsq. = 0.8830
2b	
3/4 LR (11 cm) fat	
3/4 LR (11 cm) meat	
3/4 LV (10 cm) fat	RSD = 1.9662
Variable "b"	Rsq. = 0.8946