THE USE OF PIG CARCASS GRADING DEVICES AND COMPUTER TOMOGRAPHY FOR PREDICTING LEAN MEAT IN THE CARCASS AND THE MAIN JOINTS

Marina Gispert and Maria Font i Furnols
IRTA-Finca Camps i Armet, 17121 Monells, Spain.

Abstract- Lean meat in the carcass and in the main joints is the most valuable criteria for defining composition. The aim of this study was to estimate the lean meat in the carcass and the main joints using 4 different pig carcass classification devices (Fat-O-Meat'er, Ultrafom, Autofom and VCS2000) and computed tomography. 77 carcasses, representing the Spanish pig population were analyzed using the above devices and then manually dissected. Results showed that computer tomography could be used for the determination of the lean meat content in carcasses and main cuts. The prediction of the leanness in the main joints is also possible with carcass grading devices used on line with more or less prediction error. Belly has the highest error of prediction while the ham has the lowest error of prediction.

Key words- pig classification, predicting cutting, non invasive techniques

I. INTRODUCTION

Lean meat percentage (LMP) is an important criterion for categorising carcasses and EU legislation establishes LMP as the parameter to classify pig carcasses at abattoirs. Although the definition of LMP varies from country to country, it is basically estimated in carcasses from high relationships among measurements (fat and muscle depths, areas, volumes, etc). Furthermore, the study of the composition of the main cuts is important because it can help to optimize the cutting method or in the decision taken on the most profitable market for the joint. The most useful devices used in EU, are semi-automatic probes (Fat-O-Meat'er-FOM, Henne-ssy Grading Probe, Capteur Gras-Maigre, Ultrafom –UFOM, etc) and other fully automatic devices such as Autofom, which is based on ultrasounds or VCS2000 and Image-meter, which are based on vision. All the devices used in the EU must be calibrated to predict the LMP according to EU Regulations (Commission Regulation (EC) 1234/2007 and 1249/2008) by means of manual cutting and dissection, or the use of Computer Tomography (CT). The advantage of CT is that it can measure entire carcasses and therefore it is unnecessary to cut and dissect them, which is hard, difficult and time consuming work.

According to EU legislation it is only compulsory to estimate LMP in the carcass, but these devices have a wide potential for estimating the LMP of different cuts.

The aim of this paper was to use 4 different pig classification devices and computer tomography to estimate the lean meat percentage in the carcass and the main joints.

II. MATERIALS AND METHODS

Carcass sampling and measurements

Ninety-nine carcasses from the same abattoir, distributed by fat thickness and sexes representing the pig population in Spain were studied. The selected carcasses were transported to the IRTA-CENTA facilities in Monells (Girona) under refrigerated conditions and manually dissected according to the EU Reference Method [1], within 48 h post mortem. LMP of the carcass was calculated according to the Commission Regulation (EC) 1249/2008. LMP of the main joints was also calculated.

AUTOFOM (Carometec AS, Herlev, DK) is the first piece of equipment which is able to measure whole carcass automatically. It was installed behind the dehairing machine and scanned the entire body. AUTOFOM measured 127 variables related to different fat and muscle thicknesses. The carcasses were then eviscerated and split, and in close proximity to the weighing point, two trained operators measured them first with FOM and then with UFOM (Carometec AS, Herlev, DK). FOM (based on reflectance) and UFOM (based on ultrasounds) which measure the fat depth and muscle thickness between the 3rd and 4th last ribs at 6 and 7 cm from the mid-line, respectively. Finally the VCS2000 (e+V

Technology GmbH, Oranienburg, DE) equipment carried out the classification of the carcasses automatically. VCS2000 is a vision system that measures the different fat depths, muscle thickness, areas and ratios between them (total 330 variables).

Scanning the computed tomography

A subsample of the carcasses (n=77), distributed by fat thickness and sexes as in the previous one, were also scanned with CT equipment (General Electric, HiSpeed Zx/i) located at IRTA-CENTA in Monells (Girona). The scanning parameters were 140 kV, 145 mA, matrix of 512 x 512, displayed field of view between 460 and 500 and reconstruction algorithm STD+. From the obtained DICOM images the volume associated to each Hounsfield attenuation value was obtained [2]. From 52 of the carcasses the 4 main joints (shoulder, ham, belly and loin) were also scanned.

Statistical analysis

For FOM and UFOM the ordinary regression was carried out with the REG procedure of SAS (SAS Institute, Cary, NC, USA). The root mean square error of prediction (RMSEP) obtained with the leave one out procedure was calculated by means of the PRESS statistic [3, 4]. For the AUTOFOM, VCS2000 and CT, Partial Least Square Regression (PLS) was used. The selection of AUTOFOM and VCS variables to be included in the model was performed with a SAS macro [5]. For CT the volume associated with attenuation Hounsfields values from -100 to +120 were used as independent variables because this range of variables provides good results [2]. The RMSEP with the leave-one-out procedure was calculated with a SAS macro [3].

III. RESULTS AND DISCUSSION

Table 1 presents the fitting parameters when the LMP of the carcass and main joints was estimated (RMSEP and R^2), as well as the mean value of this percentage obtained by dissection.

CT was the most precise device for all the predictions but it cannot be used on line. However, it can be used as a reference method as an alternative to the butchers' cutting procedure to avoid errors. The results obtained with CT were lower in R^2 and higher in RMSEP, compared with those obtained with magnetic resonance imaging (MRI) [6]. This could be due to the fact that MRI technology is better suited to muscle evaluation than CT and because of the different cutting procedures carried out in the two studies. The R^2 of the estimation of joints with CT is always higher than 0.82. In this study it was 0.96 when the prediction of the lean meat in the carcass was estimated.

A part of CT, FOM, that only measures one fat and muscle depth in the loin, presented the lowest prediction errors for the estimation of carcass and joints LMP.

For all the pig grading devices, the belly presented the highest errors of prediction of the LMP, indicating the difficulty of this prediction. This could be due to the fact that belly is the most difficult cut to dissect manually due to the different layers of fat and muscle [7] and the lower accuracy of butchers could affect the accuracy of the estimation.

In previous studies, the error of prediction of the estimation of the muscle content of the belly with MRI was found to be 1.48 [6] and between 1.57 and 2.54% [8] depending on the genotype. In our study it was 2.14%.

Ham presented the most accurate estimation with all the devices. In the case of FOM and UFOM measures are taken in the loin only, and this indicates that there is a good relationship between loin characteristics and ham composition.

IV. CONCLUSION

Computer tomography could be used as an alternative to the dissection carried out by butchers to obtain the lean meat content in the carcasses and main cuts with high accuracy. The devices used on line for pig carcass grading could also be useful to predict the LMP of carcass and main joints with different errors, belly being the most difficult to predict. Cutting rooms could profit from the information obtained by the classification devices to determine the composition, not only of the carcass, but also of the main cuts. Therefore improving their production and optimizing the use of each cut according to market demands and the way of processing the final product.

REFERENCES

1. Walstra, P. & Merkus, G. S. M. (1995). Procedure for the assessment of lean meat percentage as a consequence of the New EU reference dissection method in pig carcass classification. DLO_Research.
2. Font i Furnols, M., Teran, M. F., & Gispert, M. (2009). Estimation of lean meat percentage of pig carcasses with computer tomography images by means of PLS regression. Chemometrics and Intelligent Laboratory Systems 98:31-37.
3. Causeur, D., Daumas, G., Dhorne, T., Engel, B., Font i Furnols, M. & Højsgaard, S. (2003) http://ec.europa.eu/agriculture/markets/pig/handbook.pdf
4. Engel, B., Lambooij, E., Buist, W. G., Reimert, H., & Mateman, G. (2006). Prediction of the percentage lean of pig carcasses with a small or a large number of instrumental carcass measurements – An illustration with HGP and Vision. Animal Science 82: 919–928.
5. Judas, M., & de Smet, S. (2008). Optimierung der Variablen-Selektion für die PLSRegression. In R.-D. Hilger, N. Heussen, W. Herff, & C. Ortseifen (Eds.). Proceedings der 12. Konferenz für SAS-Anwender in Forschung und Entwicklung (KSFE) (pp. 133–139). Aachen: Shaker Verlag.
6. Monziols, M., Collewet, G., Bonneau, M., Mariette, F., Davenet, A., Kouba, M. (2006). Meat Science 72: 146-154.
7. Nissen, P., Busk, H., Oksama, M., Seynaeve, M., Gispert, M., Walstra, P., Hanson, I., & Olsen, E.V. (2006). The estimated accuracy of the EU reference dissection method of pig carcass classification. Meat Science 73: 22–28.
8. Baulain, U. and Henning, M. (2001). Studies of carcass and meat quality by mean of MR tomography and MR spectroscopy. Archiv. Tierzucht-Archives of Animal Breeding 44: 181-192.

Table 1 Fitting parameters in the prediction equation for LMP in the carcass and the main joints (n=99)

Joint (average LMP)		**RMSEP**	**Nº of PLS factors**	R^2
Carcass (61.6%)	FOM	1.80	-	0.77
	UFOM	2.33	-	0.64
	Autofom	1.94	2	0.78
	VCS2000	2.33	4	0.70
	CT *	0.96	6	0.96
Ham (74%)				
	FOM	2.22	-	0.66
	UFOM	2.70	-	0.52
	Autofom	2.19	2	0.71
	VCS2000	2.51	3	0.63
	CT**	1.60	3	0.86
Loin (63.6%)				
	FOM	2.30	-	0.81
	UFOM	2.93	-	0.71
	Autofom	2.89	-	0.70
	VCS2000	3.66	2	0.56
	CT**	2.44	3	0.82
Shoulder (69.1%)				
	FOM	2.14	-	0.64
	UFOM	2.54	-	0.51
	Autofom	2.40	1	0.54
	VCS2000	2.70	2	0.45
	CT**	1.65	4	0.82
Belly (61.7%)				
	FOM	3.32	-	0.64
	UFOM	3.79	-	0.55
	Autofom	3.54	1	0.59
	VCS2000	3.84	2	0.55
	CT**	2.14	3	0.88

RMSEP: Root mean standard error of prediction; R^2: Determination coefficient; *: n=77; ** n=52
FOM: Fat-O-Meat'er; UFOM: Ultrafom; CT: Computed Tomography; LMP: Lean meat percentage.