CARCASS LEAN MEAT PERCENTAGE DETERMINED WITH COMPUTED TOMOGRAPHY IMAGES OF LIVE PIGS AND CARCASSES

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I. INTRODUCTION

Carcass lean meat percentage (LMP) is an important carcass grading parameter used to determine the carcass value and, in the EU, its determination is compulsory. At the abattoir, on line devices are used for this purpose which need to be previously calibrated. Calibration can be performed either by dissecting the full carcass, which is very time consuming and devalues the carcass, or by using computed tomography (CT) equipment [1]. The determination of LMP can also be performed in live pigs, either with CT or Ultrasounds [2,3].
The aim of this work is to determine the carcass LMP, lean and fat content from CT images of live pigs (with and without viscera) and carcasses.

II. MATERIALS AND METHODS

Nineteen pigs from different genetics and sexes (body weight = 110.5±8.66 kg) were fully CT scanned with the device Philips Brilliance 16, taking helical 3 mm-thick images every 3 mm (pitch 0.938), at 120kV, 200mA, field of view (FOV) 500 mm, 512 x 512 matrix and collimation 16x1.5. Pigs were previously anaesthetized with azaperone (0.10 mL/kg) and ketamine (0.06 mL/kg). After scanning pigs were slaughtered at IRTA abattoir. After 24 h of cooling, the left half carcasses, without head, foot and hand but with cheek were also CT scanned. Additionally, 20 carcasses from pigs from different genetics and sexes were CT scanned. The final average half carcass weight was 44.5±5.12 kg.
After scanning, carcasses were cut and fully dissected to obtain its weight of the lean and fat tissues. Then, the LMP was calculated according to EU legislation [1].
From CT images of live pigs, the viscera and internal organs were manually removed with the software VisualPork. From images of the live pigs with viscera and without viscera and from carcasses images, the volume associated with each Hounsfield (HU) value was determined using the image thickness, matrix size and FOV values [3]. In live pig images, the volume between HU values -149 and -1, 0 and 140, 141 and 499, 500 and 999, 1000 and 1499, 1500 and 2000 and between 141 and 2000 were calculated. Additionally, in carcass images, the volume between HU values 0 and 120 was calculated and divided by EU reference carcass weight to obtain the LMPCT variable.
Regression equations were obtained with SAS software (v. 9.4) for the prediction of carcass LMP, lean weight and fat weight using the volumes as predictors. For live animal images, stepwise selection was used to select the most suitable predictor.

III. RESULTS AND DISCUSSION

Average LMP, lean weight and fat weight obtained by dissection were 58.7±4.04 %, 26.1±3.38 kg and 9.5±2.48 kg, respectively. The prediction equations for each parameter and its goodness of fit are presented in Table 1. Considering live pigs, the error of prediction for all the parameters was lower when viscera are removed from the images. Removing the viscera from the images is very time consuming and it is operator dependent. Thus, it is worthwhile to consider the improvement in error and the cost to remove the viscera from the images. Moreover, the lowest relative error (CV) was always for the LMP and the lean content and the highest for the fat content. The RMSEP for LMP prediction from carcass images was 0.95%, which was slightly higher than those reported in a previous

trials using similar methodology (0.81%) [4] or a different one using much more predictors and simplified dissection (0.82%) [3].

Table 1 – Regression equations to determine carcass lean meat percentages (LMP) from computed tomography images of live pigs, live pigs without viscera and left half carcasses.

Images of:	n	Predicted carcass trait:	Prediction equation[b]	RMSEP	CV (%)	R^2
Live pigs	18[a]	LMP (%)	54.68513 – 0.44395 * sum-149-1 + 0.52921 * sum0+140 – 2.55891 * sum141+499	1.29	2.16	0.955
Live pigs	18[a]	Lean (g)	8391.77601 + 838.08894 * sum0+140 – 1587.95822 * sum141+499	1068.57	2.06	0.970
Live pigs	18[a]	Fat (g)	1086.86129 + 665.51737 * sum-149-1 - 72.48307 * sum0+140	862.66	5.05	0.972
Live pigs without viscera	18[a]	LMP (%)	56.52898 – 0.45261 * sum-149-1 + 0.47771 * sum0+140 – 1.53063 * sum141+2000	1.11	1.86	0.966
Live pigs without viscera	18[a]	Lean (g)	-6.21985 + 129.81391 * sum-149-1 + 911.55643 * sum0+140	983.54	1.90	0.977
Live pigs without viscera	17[a]	Fat (g)	-3376.69834 + 775.06682 * sum-149-1 + 529.27463 * sum141+499	692.22	4.05	0.983
Carcasses	39	LMP (%)	7.30207 + 0.90332 * LMPCT	0.950	1.62	0.949
Carcasses[c]	38[a]	Lean (g)	-11611 + 360.95302 * sum-149-1 +830.59708 * sum0+140 +226.79518 * LMPCT	368.384	1.41	0.990
Carcasses[c]	38[a]	Fat (g)	437.96287 + 887.17979 * sum-149-1	304.350	3.22	0.986

[a] one/two carcass removed as outliers; the sums used as predictors (volumes) were in dm^3; [b] sumXY: volume associated to Hounsfield values between X and Y. [c] lean and fat of half carcass. RMSEP: root mean squared error of prediction; CV: 100*RMSEP/Mean; R^2 Coefficient of determination; LMPCT=sum0+120/carcass weight.

IV. CONCLUSION

In the conditions of the present trial, it is possible to predict the carcass LMP with a good error of prediction both, from CT images of live animals (with and without viscera) and from carcass, the last one being the most precise. The prediction of the lean content is more precise than those of the fat content in all the cases when images from live pigs or images from carcasses were used.

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