Comparison between computed tomography and dissection for calibrating pig classification methods

Daumas G. [1] and Monziols M. [1]

[1] IFIP - Institut du Porc, BP 35104, 35601 Le Rheu Cedex, France

Abstract— **Since 2009 the EU regulation concerning pig classification has authorised dissection as well as Computed Tomography (CT). The aim of this study was to compare the errors in both references when calibrating the French classification methods. A new CT procedure, which is both accurate and simple to use, was tested.**

A representative sample of sixty-three pig carcases were measured using two French classification methods, CGM and ZP. Left sides were jointed into the four primal cuts and scanned using a spiral CT, before dissection. The four cuts were then fully dissected.

The Lean Meat Percentage (LMP) was calculated according to the EU definition. LMPdis was calculated from the dissected weight of the lean meat. LMPct was calculated from the muscle volume multiplied by a constant density. Muscle volume was first measured by automatic thresholding, in the Hounsfield range 0-120.

Bias between LMPdis and LMPct was not significant.

The RSD value for the estimation of LMPct was slightly lower than the RSD for LMPdis. The same was observed from ZP depths. Nevertheless, these differences between RSD values were likely not significant.

The current French classification methods CGM and ZP have about the same error whatever the LMP reference is, either from this CT procedure or from partial dissection. Therefore, this CT procedure will be adopted in France when checking periodically the current equations and for calibrating the future classification methods, which will be based on ZP depths.

Keywords— **Pig classification, Computed Tomography, Dissection.**

I. INTRODUCTION

Since 2009 the EU regulation concerning pig classification has authorised dissection as well as Computed Tomography (CT). The aim of this study was to compare the errors in both references when calibrating the French classification methods. A new CT procedure, which is both accurate and simple to use, was tested.

II. MATERIALS AND METHODS

This study was based on the material measured in 2008, aiming primarily at checking the French CGM formula for pig classification [1] and secondarily at testing the French mobile CT.

A. Experimental design

A representative sample of pigs slaughtered in France was selected from two commercial slaughterhouses according to a balanced sex ratio (50 % females and 50 % castrated males).

Sixty-three left sides were classified according to the approved CGM and ZP methods. CGM fat and muscle depths were taken between the 3rd and 4th last ribs, 6 cm off the midline, parallel to the midline. The traditional ZP measurements at splitline were measured using an electronic calliper.

After chilling overnight, the left sides were prepared and cut according to the EU reference procedure (Fig.1) [2]. The four main cuts (ham, loin, shoulder and belly) were scanned using a Siemens Emotion Duo scanner (Siemens, Erlangen, Germany). Image acquisition and analysis were performed as described in [3].

Finally, the four cuts were dissected according to the EU reference procedure [2] completed by the French standards [4, 5], which were developed for a higher reproducibility of the EU procedure.

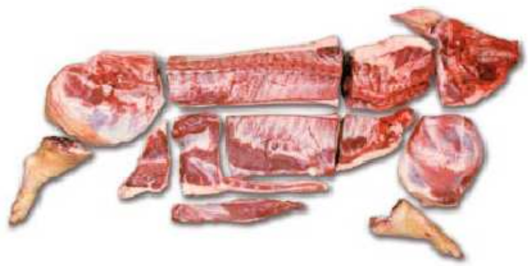

Fig. 1 EU reference cutting [2]

B. Calculation of Lean Meat Percentage (LMP)

LMP was defined in the Annex IV of the (EC) Regulation n° 1249/2008 [6]. The same definition held for both dissection and CT, the latter being considered as virtual dissection. Where partial dissection was carried out, LMP was defined as the muscle percentage in the four main cuts adding tenderloin, considered as 100 % muscle. This value was scaled by a multiplicative factor of 0.89 in order to get approximately the same level than in the carcase.

$$LMP = 0.89 * 100 \frac{\sum lean(shoulder, loin, ham, belly) + tenderloin}{\sum weight(shoulder, loin, ham, belly, tenderloin)}$$

Where dissection was carried out, the weight of lean meat was obtained following dissection. Where CT was carried out, the volume of lean meat was obtained following scanning and thresholding. The weight of lean meat was then calculated according to the method described by [3], i.e. thresholding the muscle between 0-120 HU and applying a constant muscle density of 1.04 [7].

C. Statistical analysis

The regressions were performed using Proc REG from SAS Software [8].

III. RESULTS

Table 1 contains the descriptive statistics of the main traits. LMPdis and LMPct had respectively a mean of 60.7 and 61.3 and a standard deviation of 3.65 and 3.59. The average bias (-0.6) between LMPdis and LMPct was not significant.

Table 1 Descriptive statistics

(n=63)	Mean	Std. Dev	Min	Max
LMPct	61.3	3.59	54.6	67.7
LMPdis	60.7	3.65	52.7	67.0
Fat CGM	13.3	3.31	8	21
Muscle CGM	59.0	5.72	45	70
Fat ZP	13.8	3.71	6.0	23.1
Muscle ZP	74.1	6.6	60.6	87.7
Carcass weight	91.7	8.19	77.8	112.8

Figures 2 to 5 show first the regression line of either LMPdis or LMPct on CGM and then the studentized residuals. Figures 6 to 9 show the same on ZP.

The RSD value for the estimation of LMPct from CGM (1.96) was slightly lower than the RSD for LMPdis (2.03). The same was observed from ZP depths (1.81 *vs* 1.84). Nevertheless, these differences between RSD values were likely not significant.

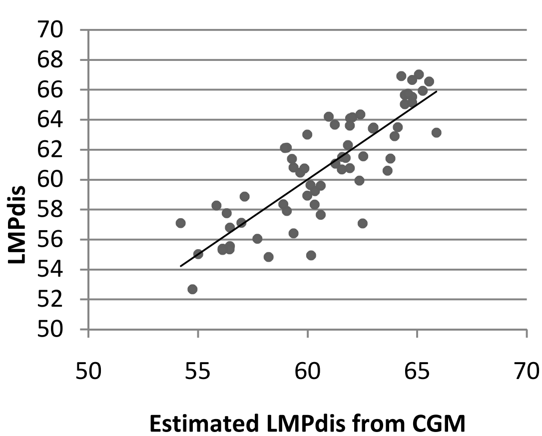

Fig. 2 Regression line of LMPdis on CGM

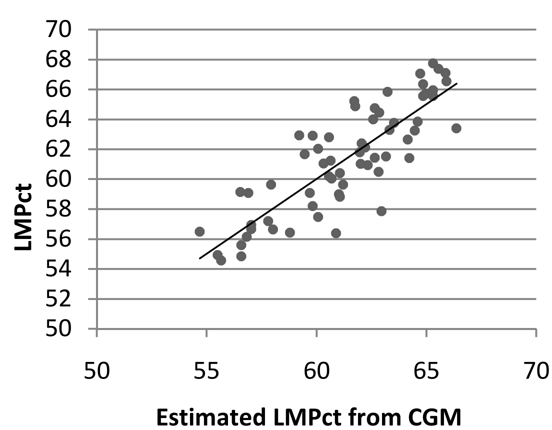

Fig. 3 Regression line of LMPct on CGM

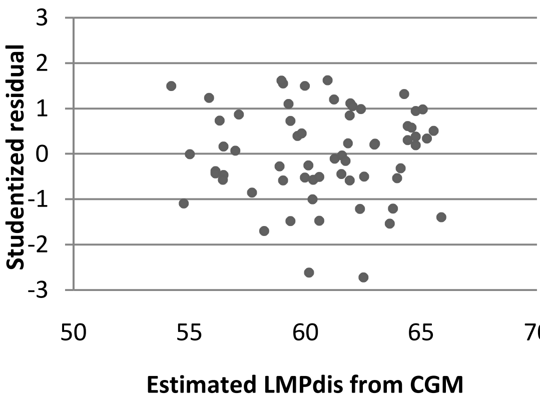

Fig. 4 Studentized residuals of the regression of LMPdis on CGM

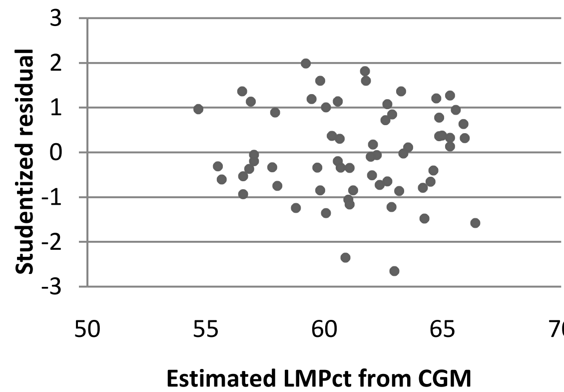

Fig 5 Studentized residuals of the regression of LMPct on CGM

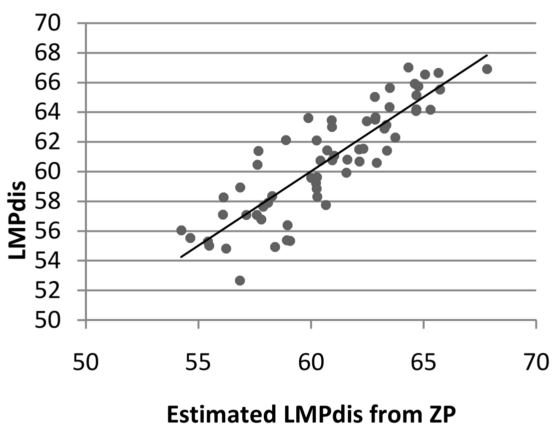

Fig. 6 Regression line of LMPDis on ZP

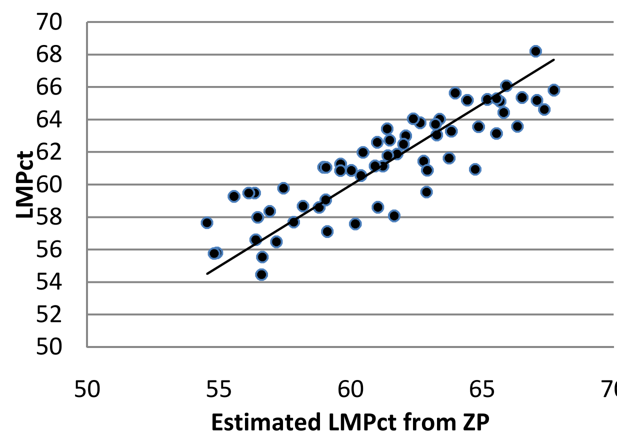

Fig. 7 Regression line of LMPRX on ZP

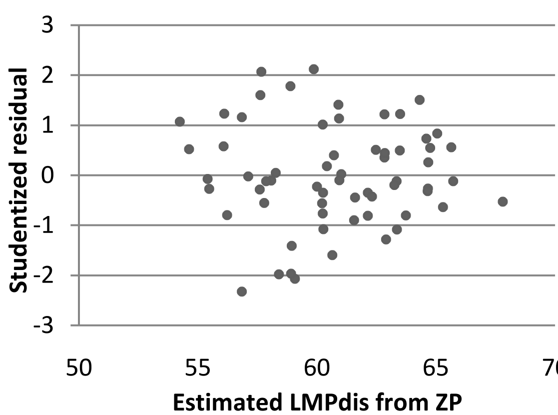

Fig. 8 Studentized residuals of the regression of LMPdis on ZP

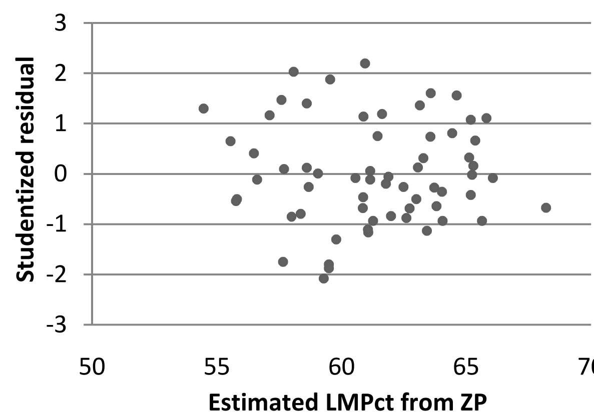

Fig 9 Studentized residuals of the regression of LMPct on ZP

IV. DISCUSSION

The descriptive statistics of the sample were comparable with those of the pig population slaughtered in France. The RSD of the regression of LMPdis on CGM had the same level than the approved equation [1]. Surprisingly, RSD was lower in the present study for ZP. Nevertheless, as the sample size was rather low (n=63) confidence intervals were rather large.

Our results show that the calibration error of the classification methods against CT has approximately the same level than against dissection. In both cases the reference suffers from noise which contributes to an artificial increase in the RSD. We therefore deduce that the noise on LMPct would be close to the noise on LMPdis.

The noise on LMPdis comes from both cutting and dissection. To limit this noise all the carcases were cut by one skilled technician and the cuts were dissected according to high reproducibility standards. This procedure consists of an anatomical individualization of each muscle, allowing thus an accurate control of the fat removal.

The noise on LMPct originates essentially from the difficulty to separate completely the muscle tissue from rind, fat tissue and bones. More detail is given in [3]. Separating between muscle and fat is particularly difficult in the belly because thin layers alternate. Nevertheless, this difficulty is similar for both CT and dissection, leading presumably to a similar noise.

V. CONCLUSIONS

The current French classification methods CGM and ZP have approximately the same error whatever the LMP reference is, either measured using this CT procedure or partial dissection. This is thus additional proof that this CT procedure is equivalent to dissection, complying with the EU pig classification framework. This CT procedure will therefore be used in France to periodically check the current equations and when calibrating future classification methods, based on ZP depths.

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