X-RAY COMPUTED TOMOGRAPHY AS AN OBJECTIVE METHOD OF MEASURING THE LEAN CONTENT OF A PIG CARCASS - A STUDY IN THE FRAMEWORK OF THE EUROPEAN EUPIGCLASS PROJECT

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Background

European regulations state that pig grading instruments must be calibrated by determining the lean meat content of a sample of at least 120 carcasses according to the EU reference method. This involves the dissection of the four main parts, the hind leg, loin, shoulder and belly, and was introduced as a time and cost saving measure compared to a full dissection. In addition to the possible loss of accuracy compared to a full dissection, other disadvantages of this method are that it is expensive, time consuming and it requires very skilled butchers. Therefore, an important part of the European project EUPIGCLASS is concerned with searching for an alternative objective method of determining the lean meat content of pig carcasses. This paper reports on the results achieved using spiral X-ray computed tomography (CT), a medical diagnostic imaging method that gives high quality images of the main tissues of the body. CT has been suggested by others as an alternative to dissection (Jopson et al., 1995 and Glasbey and Robinson, 1999 and 2002).

Objective

To determine the accuracy with which CT can indirectly measure the lean meat content of a pig half carcass.

Methods

To calibrate the CT a sample of 120 carcasses of three breed types and two sexes was selected from a commercial abattoir in Hungary (table 1). The right side of each carcass was scanned by a Siemens Somatom Plus 40 Spiral scanner (figure 1), covering the entire half carcass. Sixty of the left sides were randomly selected for scanning, as time constraints did not allow for all 120 to be scanned. The left sides were then jointed and dissected according to the EU reference method and the remaining parts were separated into the main tissues to determine the total lean meat content of the half carcass.

The usual way to make a quantitative evaluation of CT scans is to sum the pixels from all the scans that can be assigned to muscle tissue. This total area multiplied by the slice thickness gives the total volume of the lean meat in the carcass. There are two problems with adapting this method as a reference for grading. The first is that the basis of grading is lean muscle tissue weight as a percentage of the carcass weight, while the scanner delivers volume data. The second problem is the non-exact delimitation of the muscle tissue range on the Hounsfield-scale. Figure 2 shows the frequency distribution of the absorption values on the Hounsfield-scale for three carcasses of different fatness. Conventionally, the range between –200 and –20 is considered to originate from fat, the range from +20 to +200 corresponds to muscle, and bones have HU density values of over 1000 (not shown). The peak areas give the volumes of the corresponding tissues. While the position of the fat peak does not change with the fat content of the carcass that of the muscles shows a significant drift to the zero point with increasing fatness. This can be explained by the density decreasing effect of the infiltrating intramuscular fat. Accepting this explanation leads to the need to use different specific densities for different Hounsfield values when converting muscle volumes into weights, but this is not practical. The similarity of the frequency distribution diagrams with absorption spectra is evident. PLS-regression analysis is widely used in spectral analysis and it was supposed that it would be useful for analysing the CT data. This supposition proved to be right, moreover, the correct ranges of the different tissues were determined more exactly.

Results

The 60 left sides that were scanned and dissected were used to derive a calibration equation (Fig 3). The results were excellent with R=0.996 and SEC=0.232 kg (Fig 4). This error corresponds to 1% of the total lean meat weight, which is the supposed error of a very precise full dissection. Using the right-side scans from the same 60 carcasses to build a model with the left side dissection data resulted in a slightly higher standard error, with the same correlation as in the cross validation with the pure left-side model (R = 0.992, SEC = 0.332). This shows that asymmetry had a small influence on the model structure, that is, the model seems to be robust. This model was then used to predict the total lean meat weight in all 120 left sides with acceptable accuracy (R = 0.988. SEP = 0.455). Changing from lean meat weight to percentage it is to be expected that the statistical goodness would be lower. However, in this case the reduction in accuracy was small (Fig 5).

Conclusion

In view of the excellent results, CT can be considered as a potential substitute reference method to determine the lean meat content in the pig carcass, since:

⇒ The estimation of the lean meat content was robust.

⇒ There was no relevant influence of the carcass side used.

⇒ The error of the method was not higher than that of the dissection, but it should be easier to standardise.

⇒ A test of robustness on different genotypes and different scanning instruments is still required.

Recommendation

CT can be recommended as a suitable method to determine the lean meat content of pig carcasses. The long-term international standardisation of the reference lean meat content should be easier with CT than by dissection. By using a second hand instrument, the initial capital and installation costs could be under 200,000 $.

Acknowledgement

This research was conducted under the EC project G6RD-CT-1999-00127 EUPIGCLASS of the Measurements and Testing activity (Competitive and Sustainable Growth programme). The authors acknowledge the valuable contribution of the late Dr Hans Busk of DMRI.

References

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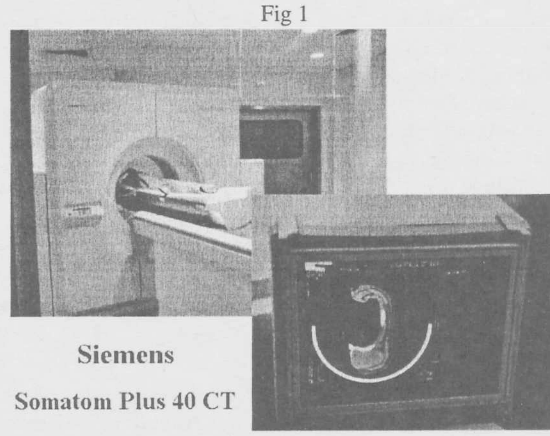
Tab 1

	Breed type								Total
	Dalland		LW/LR		Seghers		Total		Total
Sex / Fat group	Female	Male	Female	Male	Female	Male	Female	Male	both sexes
Lean	6	1	5	5	16	8	27	14	41(34%)
Average	6	12	4	2	6	3	16	17	33(28%)
Fat	7	9	8	16	3	3	18	28	46(38%)
Total	19	12	17	23	25	14	61	59	120

Fig 1



Siemens

Somatom Plus 40 CT

Fig 2

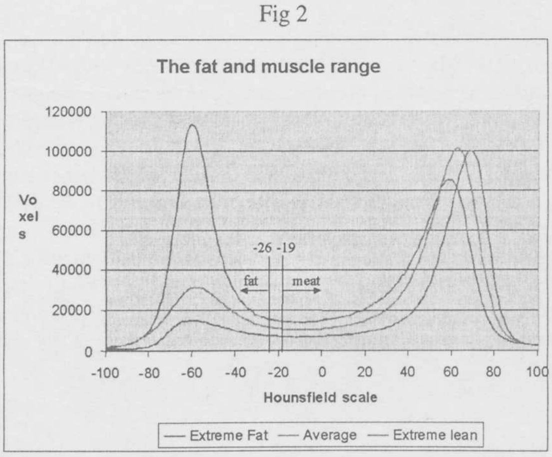


Fig 3

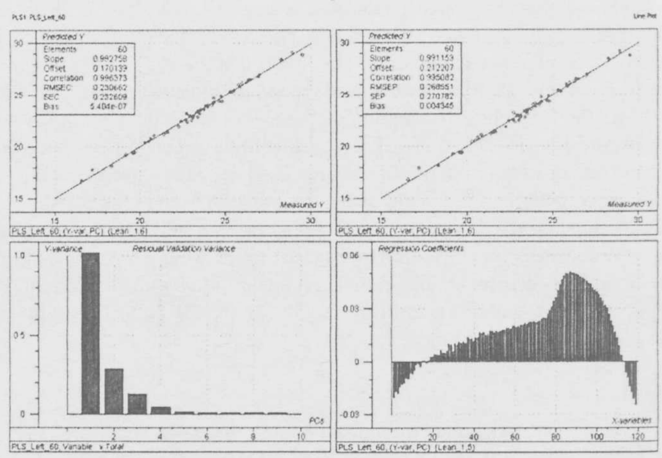


Fig 4

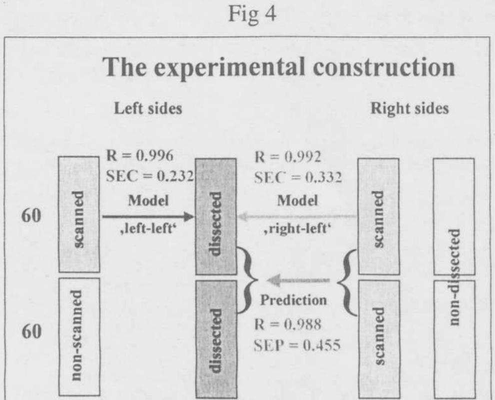


Fig 5