The content of meat – Is there a difference between left and right sides of pig carcasses?

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Abstract— **Manual dissection of pig carcasses for determination of lean meat content is typically based on dissection of only the left half of the carcass. Using manual dissection [1] found that the lean meat percentage (LMP) in the left half was 0.6 units lower compared to the right half, even though the splitting of the carcass in two halves was performed correctly.**

The aim of this study was to compare the meat content in both left and right halves using a medical CT-scanner.

35 carcasses were selected based on lean and weight in a commercial slaughterhouse. Only carcasses split correctly were used. The estimation of LMP using a CT-scanner is performed as described in [2] and the method is based on full 3D-scans with a resolution of 0.92 x 0.92 x 10 mm^3 voxels. Each scanned half carcass is segmented into three tissue types (fat, meat & bone) and related to physical weights, and thereby meat content. The procedure is termed Virtual Dissection and corresponds to manual dissection as performed by a butcher.

The left half is heavier (190 g) due to more fat in the middle part. The content of meat and bone is similar (no significant difference).

There is no statistically significant difference in the meat content in kg, between the left and the right halves. Splitting of the carcass was performed correctly in the dorsal vertebra and the sternum, while splitting the abdomen was more difficult.

Keywords— **CT, Lean Meat Percentage, Dissection**

I. INTRODUCTION

Classification in the EU is based on the lean meat percentage (LMP). The reference for instrument calibration is the content of red striated muscles. It is obtained either by total dissection of the carcass or by partial dissection (shoulder, loin, belly, and hind leg) in relation to the total weight or the weight of the four main cuts. The weights are obtained either by manual dissection or by computed tomography (CT) [3]. Normally only the left side is used for the dissection with the implicit assumption that the two halves are identical. However, even though the splitting is done very carefully for both the vertebral column and the sternum a variation is observed [1], which will result in the two sides not being completely identical. The LMP in the carcass and the joints has been observed to be significantly related to carcass side [1], and the right side carcass was significantly higher compared to the left side (0.6 LMP). However, is this difference a general anatomical trend?

The use of CT as a reference method for estimation of the lean meat content was proposed by [2], due to less variation compared to manual dissection. The method is also useful for investigating details regarding meat/fat distribution in cuts.

The aim for this study was to compare the meat content in both left and right halves measured with a medical CT-scanner and to investigate if previous results are reproducible. It is a further aim for the study to determine the origin of an anatomical asymmetry between the two sides in more detail.

II. MATERIALS AND METHODS

35 carcasses from a commercial Danish slaughterhouse (18 female and 17 castrate) were selected based on the LMP (measured with an AutoFom^{tm} [4]), the carcass length (from snout to hind leg), and the slaughter weight. Only carcasses split correctly were used. Both left and right sides of the carcasses were prepared identically before scanning according to the EU recommendation (except for leaving the hind foot on the carcass). Each sample was scanned the day after slaughter when the carcass temperature was 5-7° C. The scanning was performed using the following protocol settings: Standard reconstruction, 140 kV, 80 mA, 0.9x0.9x10 mm^3

voxel size, axial scanning. The prepared carcasses (figure 1) were weighed on a calibrated industrial scale before scanning.

Figure 1. Prepared carcass side ready for CT-scanning.

After scanning each half carcass was segmented into three tissue types (fat, bone and meat) and related to physical weight based on the average density of the three tissue types. The method is known as Virtual Dissection and correlates well to butcher dissection [2].

Using the software PigClassWeb as described in [5] the commercial cuts of the three primal joints are performed. The virtual weight and lean content in each carcass is calculated and the left and right sides are compared using a Students t-test (paired observations).

III. RESULTS

Table 1 shows the average AutoFom^{tm} LMP, slaughter weight, and carcass length for the material in the study.

Table 1. Selection parameters for the sample, average ± std.

	N	AutoFom LMP	Weight, kg	Length, cm
Female	18	60.34±3.01	81.4±7.70	172.5±5.19
Castrate	17	60.17±1.52	81.2±6.78	173.8±5.27

Due to the selection criteria there is very little difference between the two sexes and gender is not used in the following analyses.

Table 2 shows the LMP in the half carcasses and in the primal cuts. The calculation is based on virtual weight of meat and virtual total weight of the cuts.

Table 2. Virtual LMP in carcass and primal joints, N=35

Lean meat %	Right	Left	Sign.
½ Carcass	67.54 ± 3.41	67.23 ± 3.33	**
Hind leg	73.98 ± 2.79	73.69 ± 2.84	**
Middle	63.91 ± 4.07	63.45 ± 3.88	**
Fore end	65.22 ± 3.47	65.09 ± 3.33	NS

Significance level: p<0.00 =***, p<0.01=**, p<0.05=*, NS= non significance

Even though the carcasses in the study were spilt correctly, there could still be a weight difference between the two sides, influencing the LMP.

Table 3 shows the weight of the carcasses before scanning, the virtual weight of the same carcasses and the estimated virtual tissue weights. Table 4 shows the virtual weights of the primal joints.

Table 3. Weights of carcasses and tissues for left and right sides. Mean ± std., N=35

Weight, kg	Right	Left	Diff.	Sign.
½carcass Scale	37.34 ± 3.32	37.53 ± 3.35	0.19	*
½carcass virtual	37.32 ± 3.30	37.50 ± 3.36	0.19	*
Virtual meat	25.06 ± 2.12	25.11 ± 2.22	0.04	NS
Virtual fat	8.72 ± 1.82	8.85 ± 1.79	0.14	***
Virtual bone	3.54 ± 0.31	3.55 ± 0.31	0.01	NS

Significance level: p<0.00 =***, p<0.01=**, p<0.05=*, NS= non significance

The virtual and the scale weights are similar, and the left side is heavier, due to more fat.

Table 4. Virtual weights of primal joints. Mean ± std., N=35

Weight, kg	Right	Left	Diff.	Sign.
Hind leg	11.62 ± 0.99	11.68 ± 1.03	0.06	NS
Middle	13.29 ± 1.47	13.52 ± 1.52	0.23	***
Fore end	11.34 ± 1.03	11.24 ± 0.98	-0.10	NS

Significance level: p<0.00 =***, p<0.01=**, p<0.05=*, NS= non significance

All of the weight difference between the two sides belongs to the middle part of the carcass.

Figure 2 and 3 show the difference in virtual weight (Left-Right) versus slaughter weight and carcass length, respectively.

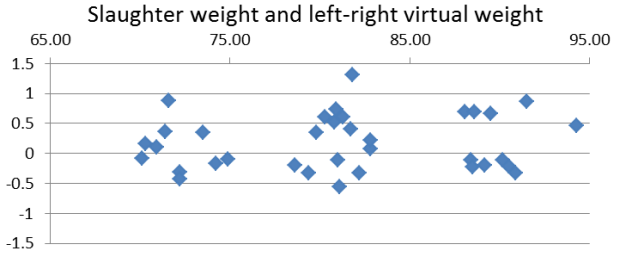

Figure 2. Slaughter weight (kg) versus difference in carcass side virtual weight.

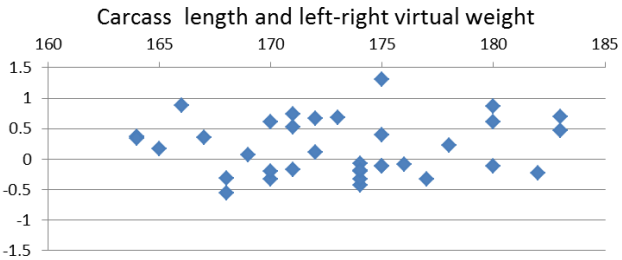

Figure 3. Carcass length (cm) versus difference in carcass side virtual weight.

Looking only at the amount of the virtual meat there is no difference between left and right side. Figure 4 shows the correlation between virtual meat in left and right sides.

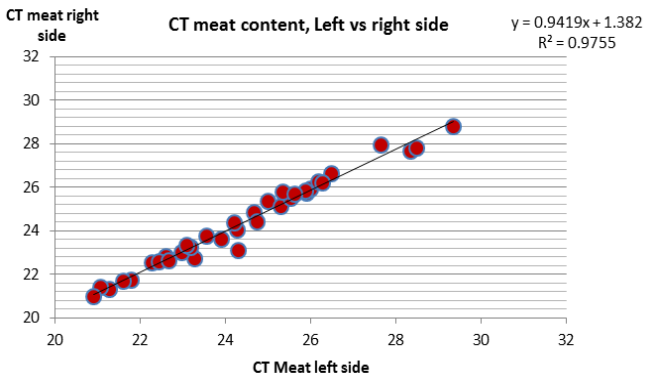

Figure 4. Virtual meat content left versus right sides.

IV. DISCUSSION

A. Calculation of LMP

Within the EU-countries the carcass quality is described by the estimated lean meat in the carcass, LMP. The reference method is the ratio between the weight of lean meat and the total side weight. Consequently, the weight of the carcass side will have a great influence on the calculated LMP. As shown in table 2 and 3 we found a significant difference of 0.3 units in virtual LMP due to 190 gram more left side carcass. Compared with the results from [1] the difference in virtual LMP between the two sides is lower than butcher LMP.

Splitting: The splitting of the carcass was made at a fully automated slaughter line, and the carcass is kept in position and stretched approximate 5 cm before the splitting of the vertebra column [6]. There is no difference in the virtual bone weight indicating that the vertebral column was not split correctly.

The sternum and the abdomen was also split with automated equipment [6], but the particular machine that was used had a tendency to cut incorrectly in the abdomen, which could explain why the left carcass sides contain more virtual fat, even though only carcasses split correctly at the sternum were used in this study.

The virtual weights of the primal joints - table 4, indicate that the left middle is heavier, but there is no difference for hind leg and fore end. This indicates that automated splitting is more difficult in the middle part of the carcass. Table 3 shows that only the virtual fat quantity in the left side is significantly higher, and that the virtual meat and bone are the same.

In [1] all the operations for dissection of the total carcass were done manually, both the splitting and the cutting, which resulted in no significant difference in LMP between left and right belly, but did for all other cuts. In this study the splitting was done similarly to [1] but only the abdomen was difficult to split correctly.

Figure 2 and 3 show that the side difference in virtual weight was not influenced by weight nor length of the carcass.

B. Anatomical difference in lean meat content

The correlation between virtual lean meat in left and right carcass sides was very high as shown in figure 4. Only looking at the meat quantity in kg there is no systematic difference between left and right sides, table 3. The random differences may be explained by the preparation of the carcass side or by tissue classification rather than by an anatomical difference between left and right side.

The difference in virtual estimated LMP of the sides will depend more on the weight of the carcass then on the weight of the lean meat because the difference is due to the amount of fat on either side.

Manual dissection where the carcass has to be cut in joints before dissection [1], could lead to a systematic difference between the two carcass sides, because it is difficult to do accurately.

V. CONCLUSIONS

A difference with respect to LMP between left and right side of a carcass is observed, i.e. previous results [1] are reproduced, but at a lower level. Observations indicate that part of the difference is related to splitting of the abdomen.

Both automated and manual splitting might lead to weight differences between half carcass sides. The preparation of the carcass before dissection and CT-scanning is very important for the final result. But the influence from cutting into joints before manual dissection is avoided using CT-scanning.

Consequently, the error using only the left half carcass when estimating LMP in the complete carcass can be minimized using CT scanning as described in the study.

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REFERENCES

Nissen P.M., H. Busk, M. Oksama, M. Seynaeve, M. Gispert, P. Walstra, I. Hansson, E. Olsen (2006) The estimated accuracy of the EU reference dissection method for pig carcass classification. Meat Science 75 (94-102)

Vester-Christensen M., S.G.H. Erbou, M.F. Hansen, E. Olsen, L.B. Christensen, M. Hviid, B.K. Ersbøll, R. Larsen (2009) Virtual dissection of pig carcasses. Meat Science 81 (699–704)

1. THE COMMISSION OF THE EUROPEAN COMMUNITIES: COMMISSION REGULATION (EC) No 1249/2008 of 10 December 2008 laying down detailed rules on the implementation of the Community scales for the classification of beef, pig and sheep carcases and the reporting of prices thereof

http://www.carometec.com/Products/Carcass_Grading/AutoFom.aspx, read the 29th june 2011.

Christensen L. B., S.G.H. Erbou, M.Vester-Christensen, M. F. Hansen, M. Darré, M. Hviid, and E. V. Olsen (2010) Optimized Workflow and Validation of Carcass CT-Scanning, 56th ICoMST , Korea.

http://www.danishcrown.dk/custom/horsens/3768.asp read 30th June 2011