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Development of new pig carcasses classification formulas and changes in the lean meat content in Latvian pig population

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Abstract. Pig classification is based on objective estimation of the lean meat content of the carcasses. The European Union established a common framework for the classification of pig carcasses. Carcass classification serves as a quality development tool to encourage the breeding of animals, from which it is possible to get high quality carcasses for processors and consumers. It is a common practice to recalculate pig carcasses classification formulas and update existing classification methods (or develop new methods) after every five years.
The representative samples of 145 pig carcasses from all regions of Latvia were used for the dissection trial. The precisely dissected carcasses with the warm carcass weight 60–110 kg were selected according to fat thickness and gender of pigs (the sex ratio were 50% females and 50% castrated males). From the experimental data were developed new formulas for the four methods Intrascope (Optical Probe); Manual method (ZP); Pork Grader (PG200); Optigrade MCP. During sampling the average warm carcass weight was 89.31 kg. New coefficient was detected and formula was developed for calculation of carcass standard presentation in all cases if some of the carcass parts are missing; for the missing head 8.345, for the missing tail 0.072, for the missing forefeet 0.764, for the missing hind feet 1.558. The comparison between the currently used and new experimentally obtained formulas showed difference up to 1.86% in lean meat content. The results suggest high accuracy of new regression formulas, which fully meets requirements of EU legislation.

Key words: pigs, carcass classification, lean meat content, meat quality.

INTRODUCTION

The domestic pig is an important livestock species and an important protein source worldwide (Larson et al., 2007). All abattoirs slaughtering more than 200 pigs a week are required to classify pig carcasses under the European Union (EU) rules. The basic functions of the grading scheme are making price quotations comparable throughout all EU member states, enable accurate monitoring of the market situation, enabling producers to be rewarded for producing carcasses according to market requirements, and establishing an average price for pig carcasses for reference price calculations. Pig classification is based on objective estimation of the lean meat content of the carcass. The EU established a common framework for the classification of pig carcasses. Carcass

classification serves as a quality development tool to encourage the breeding of animals, from which it is possible to get high quality carcasses for processors and consumers (Causeur et al., 2003; Šprysl et al., 2007). As a consequence, all member states had to carry out a new dissection trial and assess new classification methods (Brondum et al., 1998; Busk et al., 1999; Scholz et al., 2002; Collewet et al., 2005).

Pig carcases are graded at the time of weighing (within 45 minutes after slaughtering); according to their estimated lean meat content. An EU grade (SEUROP) can then be allocated to a carcase by using the lean meat percentage.

Quality of animals can be affected by various factors (such as genetics, feeding etc.). Based on the above mentioned, it is a common practice to recalculate pig carcasses classification formulas and update existing classification methods (or develop new methods) after every five years.

MATERIALS AND METHODS

A calibration trial was carried out in November 2013. Subsequently, the data analysis was also carried out in accordance with the description in Protocol part I (Jansons et al., 2013). The work was executed in the licensed slaughterhouse ZS 'Kumelītes' (approval number A006677).

Precisely splitted carcasses with the warm carcass weight of 60–110 kg were selected for the trial. Data collection was performed on 145 carcases by means of four instruments. The criteria of selection of sample population were fat thickness (as the reference method used with Intrascope) and sex of the pigs. The representative samples of 145 pig carcasses (Commission Regulation No 1249/2008) were used for the dissection trial. The pigs were collected by transport to the slaughterhouse from largest farms of four regions of Latvia (Vidzeme, Kurzeme, Zemgale, Latgale).

Based on the simplified detailed slaughter dissections, the lean meat content (Y) were established according to the approved formula in accordance with Commission Regulation (EC) No 1249/2008:

$$Y = 0.89 \times 100 \times \frac{TL + LM}{TL + DC}, \quad (1)$$

where *TL* – weight of tender loin, kg; *LM* – weight of lean meat in the shoulder, loin, ham and belly, kg; *DC* – weight of dissected cuts, kg.

To determine lean meat percentage in the carcass, measurements with Intrascope (Optical Probe) were carried out by inserting the device at 6 cm of the splitted carcass midline from the last rib.

The back fat thickness was determined by measuring with Intrascope. According to this index, the corresponding leanness class was established for the carcasses.

To determine lean meat percentage in the carcass with Manual ZP method, two manual measurements with caliper or electronic caliper were carried out:

muscle thickness measurement – M (distance between the cranial end of the *Gluteus medius* muscle and the edge of the *canalis vertebralis*);

backfat thickness measurement – G (the narrowest place over the *Gluteusmedius* muscle).

For the measurements, appropriate easy-to-use metal ruler or electronic caliper and data matrix were used.

Carcass lean meat percentage were calculated based on the measurement points.

The manual method ZP, should only be authorised in slaughterhouses having the limit of slaughters of not more than 200 pigs per week and using an electronic data input method with the limit of slaughters of not more than 500 pigs per week.

Electronic data input method is advanced Manual ZP method by using the electronic caliper. Caliper is fitted to computer via Blue-tooth connection. Lean meat content was calculated when input measured G and M in special slaughterhouse computer program. Caliper have no any wire. When first dimension (G) is measured operator must push measures key one time. Second dimension (M) could be measured same – pushing on measure key second time. After receiving of data (G, M) program make calculations and automatic classification in SEUROP classes, data also is writing in program data base automatically. For preventing of mistakes caliper shows measured fat depth and thickness of the muscle on led screen. This method was accurate and increases the speed of carcasses classification.

'Pork Grader 200', optical-electronic measurements were carried out. The measurements were taken from the last rib; puncture injection was within limits of 7 ± 1 cm, puncture output was 4 ± 0.5 cm from the carcass midline, perpendicularly to the carcass.

The Pork Grader 200 device consists of a measuring probe fitted to the gun-shaped case, data sheet printer and gage – test block. The pistol contains calculation software. At the end of the probe, 8–9 mm wide blade is placed, as well as a led-light with an adjacent light receiver (photodetector). Muscle tissues and fat tissues reflect different light wavelengths to the light indicator. Puncture of the measuring probe shall pass through the carcass by injecting it from the last rib at 7 cm and outputting it at 4 cm from the carcass midline. Probe withdrawing give the result in mm-s, which accuracy is ± 0.5 mm. The measurement indicates muscle tissue and fat tissue thickness with skin thickness. The measured values were converted into lean meat percentage by the help of a calculation program.

To determine lean meat percentage in the carcass, measurements with Optigrade MCP device were carried out. The puncture was injected between the last rib and the second to last rib; puncture injection was within limits of 7 ± 1 cm, puncture output was 4 ± 0.5 cm from the carcass midline, perpendicularly to the carcass.

The operation of the Optigrade MCP device was similar to the operation of the PG 200 (Pork Grader). It shows measurements of muscle tissue thickness and fat tissue thickness including skin thickness. The measured values were converted into lean meat percentage by the use of a calculation program.

Statistical analysis. Estimation of regression parameters for the instruments used in measurements were obtained with ordinary least square (OLS) regression by use of R programming tools (R version 2.14.0, The R Foundation for Statistical Computing). In total, data of 145 pig carcases were used in calculations. Root mean square error of prediction (RMSEP) was calculated by using leave-one-out approach (RMSEP(loot)) and k-fold cross-validation (RMSEP(mc)) approach. Cross-validation was performed by Monte Carlo method, randomly splitting the dataset into Training set including 1/3 of the data (37 observations), and Test set (108 observations). RMSEP(mc) was calculated as a mean from 1,000 iterations.

RESULTS AND DISCUSSION

The distribution of pigs in the Latvia represents the breed and crossbreeds (Large White, Landrace, Large White x Landrace, Pietrain Hampshire, Duroc which are approved for meat production.

The carcases corresponded to the standard presentation in accordance with EU legislation, without bristles, hooves, thoracic, abdominal, and pelvic viscera, genital organs, diaphragm and flare fat, with head, feet and tail.

The carcasses were selected according to gender: the sex ratio was 50% females and 50% castrated males (73 females and 72 castrated males).

The average warm carcass weight was 89.31 kg and fat thickness with Intrascope 17.88 mm (Table 1). In most European countries slaughter pigs are brought to slaughterhouses at the age of six months, which means that their carcass weight is in the range of 75–90 kg and the average lean meat percentage ranges from 55 to 60% (Šprysl et al., 2007). The share of pigs with extremely low or high carcass weight represents only 1.3% of all the pigs slaughtered. The average pig carcass weight in Czech Republic was 87.2 kg (Kvapilk et al., 2009), which is higher than in Slovenia – 81 to 83 kg (Čandek-Potokar et al., 2004) and comparable with Netherlands – 86.2 kg (Van Wijk et al., 2005).

Table 1. Results of weighing and measurement of fat thickness of the carcasses, n 145

Characteristics	Mean	Standard Deviation	Minimum	Maximum
Carcass weight (warm), kg	89.31	8.90	58.72	110.00
Carcass without the head (warm), kg	81.87	8.25	53.17	103.16
Carcass left side (cold), kg	39.91	8.25	25.67	50.25
Fat thickness (with Intrascope), mm	17.58	3.43	11.00	27.00

In the trial new formulas for four methods were calculated, which are approved by the European Commission and can be used for the Latvian pig population in order to carry out the carcasses grading. Relationship between residuals, lean meat percentage predicted and dissected shown in (Fig. 1, 2).

Intrascope (Figs 1, 2a)

The lean meat content ($\hat{Y}$) in pig carcass can be predicted by Intrascope based on the equation (N = 145; RMSEP(loot) = 1.968; RMSEP(mc) = 1.967):

$$\hat{Y} = 66.6708 - 0.3493 \times F \quad (2)$$

where F – fat thickness.

Manual ZP method (Figs 1b, 2b)

The lean meat content ($\hat{Y}$) in pig carcass can be predicted by ZP method based on the equation (N = 145; RMSEP(loot) = 2.001; RMSEP(mc) = 2.000):

$$\hat{Y} = 60.5214 - 0.2579 \times G + 0.0525 \times M \quad (3)$$

where G – fat thickness, M – thickness of muscle.

Pork Grader 200 (Figs 1c, 2c)

The lean meat content ($\hat{Y}$) in pig carcass can be predicted by Pork Grader 200 based on the equation (N = 145; RMSEP(loot) = 1.839; RMSEP(mc) = 1.841):

$$\hat{Y} = 64.4502 - 0.4364 \times F + 0.0381 \times M \quad (4)$$

where F – fat thickness; M – muscle thickness.

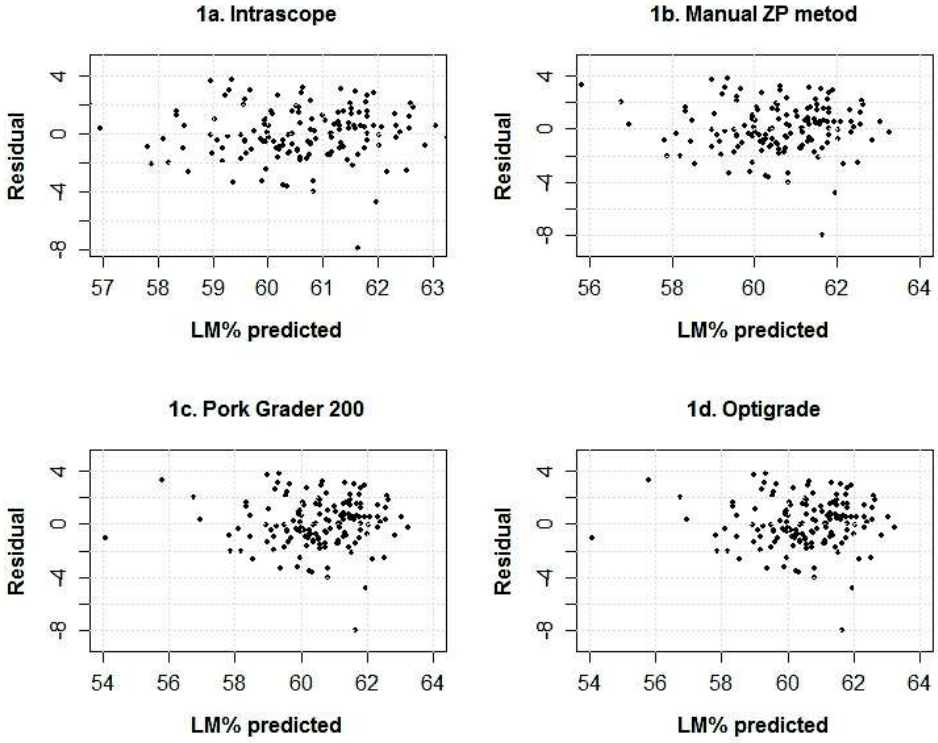

Figure 1. Relationship between the predicted lean meat percentage (LM%) and the residuals.

Optigrade MCP (Figs 1d, 2d)

The lean meat content ($\hat{Y}$) in pig carcass can be predicted by Optigrade MCP based on the equation (N = 145; RMSEP(loot) = 1.841; RMSEP(mc) = 1.842):

$$\hat{Y} = 66.7787 - 0.4464 \times F + 0.0018 \times M \quad (5)$$

where F – fat thickness, M – muscle thickness.

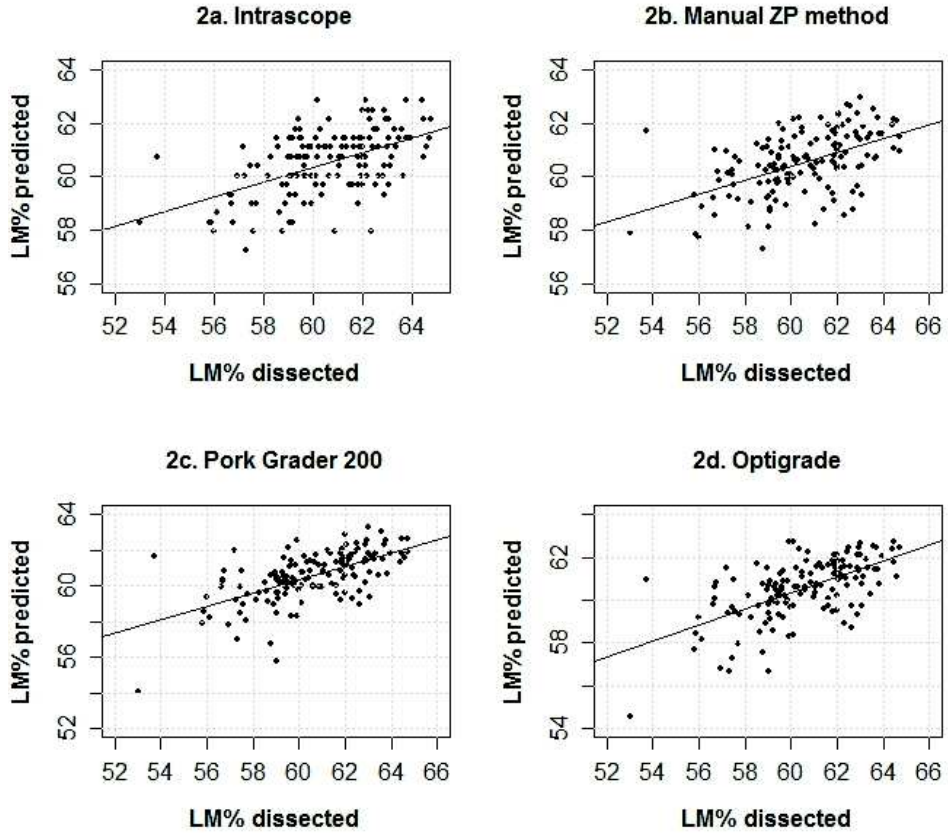

Figure 2. Relationship between the dissected and predicted lean meat percentages (LM%).

While testing different devices on carcasses in Poland in 2011, following evaluation errors RMSEP were reported: UltraFom 300 – 2.07%, IM-03 – 1.89%, CGM – 2.16%, Fat-o-Meat'er II – 2.18% (Lisiak et al., 2012; Lisiak et al., 2015). These evaluation errors were lower than with the ZP method (2.33%) obtained in current research. Research carried out by other researchers has also confirmed this: Engel et al. (2012) found the following RMSEP errors of different devices: HGP7 – 2.10% and CGM – 2.20%. Font-i-Furnols & Gispert (2009) proved a 1.8% RMSEP error for the Fat-o-Meat'er, 2.3% for UltraFom 300, 1.9% for AutoFom and 2.3% for VCS 2000. RMSEP error values determined for the ZP method were slightly greater reaching 2.52% in Germany, 2.38% in Sweden, 2.45% for gilts and 2.49% for castrated males in France (Daumas & Dhorne, 1998). Regardless of the differences found in RMSEP values, all methods in Latvia represents a legal and acceptable RMSEP value below 2.5% that is within the EU allowed limit.

Standard carcass presentation is required under EU rules. There are slaughterhouses in Latvia which separate carcass parts during pig carcass processing, therefore it is necessary to determine quotients of these parts. The following fixed coefficients were calculated if some of the following carcass parts are missing and shall be applied in all cases (Table 2).

Table 2. Index of the separated carcass parts, n 145

Cuts	Mean, kg	Standard deviation	Minimum, kg	Maximum, kg	Quotient
Head	7.446	0.865	5.460	9.620	8.345
Tail	0.069	0.063	0.040	0.800	0.072
Forefeet	0.677	0.034	0.601	0.736	0.764
Hind feet	1.387	0.109	1.059	1.595	1.558

Notwithstanding the standard presentation laid down in point B. III of Annex IV to Regulation (EU) No 1308/2013, pig carcasses in Latvia may be presented without the head, the tail, the forefeet and/or the hind feet before being weighed and graded.

In order to establish quotations for pig carcasses on a comparable basis, the following fixed coefficients shall be applied in all cases if some of the following carcass parts are missing:

- for the missing head 8.345;
- for the missing tail 0.072;
- for the missing forefeet 0.764;
- for the missing hind feet 1.558.

The standard presentation carcass weight shall be calculated according to the formula:

$$SPCW = \frac{100 \times W}{(100 - C)}, \quad (6)$$

where: $SPCW$ – standard presentation carcass weight; W – carcass weight (without missing part(s)); C – coefficient(s) for missing part(s)).

The comparison between the currently used and in the new formula for prediction of lean meat percentage showed difference up to 1.856% in average (Table 3).

Table 3. Comparision of the lean meat content with old and new formulas

Traits	ZP	Intrascope	Pork Grader 200	Optigrade
Lean meat by old formula, %	59.99	58.67	59.51	59.43
Lean meat by new formula, %	60.53	60.53	60.53	60.52
Difference, %	**0.532**	**1.856**	**1.020**	**1.094**
Lean meat dissected, %	60.53	60.53	60.53	60.53
Lean meat by old formula %	59.99	58.67	59.51	59.44
Difference, %	**0.532**	**1.857**	**1.0167**	**1.096**
Lean meat dissected,%	60.53	60.53	60.53	60.53
Lean meat by new formula, %	60.53	60.53	60.53	60.53
Difference, %	**0.001**	**0.000**	**-0.003**	**0.002**

Differences in lean meat content between dissected carcasses and currently used old formulas were up to 1.857% on average per carcase. In contrast, the comparison with the new formula, difference does not exceed 0.003%. Consequently, we found that the lean meat percentage content in carcasses for pig population in the Latvia changed slightly. Various factors such as genetics, feeding, etc. affected the changes in quality of

pig herds, results of our research showed lean meat content in carcasses of the Latvia pig population has decreased.

CONCLUSIONS

Trial for four methods (Intrascope (Optical Probe); manual method (ZP); Pork Grader (PG 200); Optigrade MCP) to estimate formulas for grading pig carcasses were developed. The comparison between the currently used and in the new formula for prediction of lean meat percentage showed difference up to 1.856% in average These methods and new formula have been approved in the EU and allowed to use in Latvia.

New coefficient was detected and formula was developed for calculation of carcass standard presentation in all cases if some of the carcass parts are missing; for the missing head 8.345, for the missing tail 0.072, for the missing forefeet 0.764, for the missing hind feet 1.558. Differences in lean meat content between dissected carcasses and the new formula does not exceed 0.003%. The results suggest high accuracy of new regression formulas, which fully meets requirements of EU legislation. They represent good presumption for more objective pig grading and equitable payment for pig producers in the Latvia.

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