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Original Paper

Comparison of pig classification using Fat-O-Meater in Slovakia

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Pig carcass classification is based on instrumental prediction of lean meat content and application of the common SEUROP scale. Each member country uses an authorised apparatus with respective regression equation to predict the lean meat content. These equations may differ between countries since they are calculated on different populations. Differences in equations may lead to different predictions of lean meat content. In Slovakia, a significant portion of slaughtered fatteners come from abroad, especially from the Czech Republic and Hungary. Since the same apparatus is approved in neighbouring countries, our study was aimed on the Fat-O-Meater and the comparison of lean meat prediction using three equations from neighbouring countries. Overall, the Slovak equation overestimated the lean meat content by 2.1% compared to the equation from Czech Republic and 2.56% compared to the equation from Hungary. Higher differences were observed in the R, O, P classes and lower differences were observed in the S, E, U classes when individual classes were considered. Different predicted lean meat content led to different carcass distribution over the SEUROP classes. Most visible changes were in the S and E classes. These changes suggest that the inclusion of carcasses from different suppliers should be considered in the authorisation trial.

Keywords: SEUROP, grading, lean meat content, backfat thickness, muscle thickness, FOM

1 Introduction

Pig carcass classification in the EU is based on the objective measurements of selected carcass characteristics by approved methods in order to predict the lean meat content (LMC) and consequently to assign a classification class within the SEUROP scale. Approved classification methods are implemented by individual EU member countries based on a previous authorisation trial applied to the country's pig population. During the trial, several factors may affect the final equation, including pig types, butchers and the process of jointing and dissection (Nissen et al., 2006). Some authors (Krska et al., 2002, Engel et al., 2012) showed significant effect of sex, but concluded that universal equation for all sexes is sufficient. This is due to a small gain in terms of RMSEP and due to the possible difficulties with the identification of sexes during the slaughter process. Since the trials are undertaken on the national level, different equations for LMC prediction are used with the same apparatus across the member countries. These differences may lead to different classification of pig carcasses (Font-i-Furnols et al., 2016). There were three methods for pig carcass classification authorised in 2009 for use in the Slovak Republic based on the Commission Decision 2009/622/EC. These include manual two-point method (ZP), optical probe Fat-O-Meater (FOM) and ultrasound probe Ultrafom 300 (UFOM). ZP is used especially in smaller slaughterhouses and only as a backup alternative in big slaughterhouses, where FOM and UFOM are used routinely. When comparing the latter two methods, Font-i-Furnols et al. (2009) reported that even when two measurements are taken, the prediction of LMC using the FOM apparatus is more precise compared to the ultrasound method (UltraFOM) or VCS2000, but less precise when compared with more sophisticated systems including AutoFOM and computed tomography.

The pig sector in Slovakia has gone through changes over the last decades. The number of pigs decreased by seven percent in the period 2015–2019. The proportion of local producers has decreased, while the number of

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large farms has been growing. Moreover, producers and suppliers from neighbouring countries are delivering pigs to the slaughterhouses in Slovakia. This especially applies to the Czech Republic, Poland and Hungary (Tomka et al., 2021).

Based on the fact that the Czech Republic as well as Hungary have authorised the FOM apparatus for pig carcass classification and, additionally, that FOM was the most used method in the Czech Republic in the past (Kvapilik et al., 2009), we decided to compare the differences in the classification of pig carcasses coming from these countries using different equations approved for the FOM apparatus in the Slovak Republic, the Czech Republic and Hungary.

2 Material and methods

Data from four major slaughterhouses (more than 100 pigs slaughtered per week) from 2015 to 2019 in Slovakia were used in the study. It included 519 242 records from pigs coming from the Czech Republic (CZ) and Hungary (HU). According to EUROSTAT (2020) statistics, this number represents 18.2% of total pig slaughters in Slovakia during the 2015–2019 period. All four slaughterhouses were using the FOM apparatus, ZP method was used only as a backup alternative in case of problems with FOM. Data from ZP were not included in the study.

Data on subcutaneous backfat thickness (FT) and muscle thickness (MT) measured at site between the second and third last ribs, 70 mm beside the mid-line of the split line by FOM were obtained. Lean-meat content (LMC_SK) was calculated within the classification process according to the equation Y = 61.213 + 0.152* MT - 0.624 * FT, laid down in the Commission Decision 2009/622/EC and a SEUROP class was assigned according to predicted LMC. This calculation was done as a part of the routine classification process. In order to simplify the statistical evaluation, numbers 1 to 6 (1 referring to S and 6 referring to P class) were assigned to the individual classification classes.

In the next step LMC_EX was calculated inserting the provided data on FT and MT of carcasses coming from the neighbouring countries in the respective country's equation for the FOM apparatus. In the case of the carcasses from the Czech Republic, LMC was calculated according to the equation Y = 70.28164 - 0.75376 * BT + 0.00270 * MT, laid down in the Commission Decision 2005/1/EC, as amended by the Commission Implementing Decision 2013/187/EU and a SEUROP class was assigned according to the predicted LMC. In the case of the carcasses from Hungary, LMC was calculated according to the equation Y = 63.78987 - 0.77968 * BT + 0.10715 * MT, laid down in the Commission Decision 2005/382/EC, as amended by the Commission Implementing Decision 2011/507/EU and a SEUROP class was assigned according to the predicted LMC.

There are only slight differences between the measurement sites in the three countries. The position between the second and the third last ribs is the same, position from the midline of the split carcass varies from 6 cm (Hungary) to 6.5 cm (Czech) and 7cm (Slovakia).

Data was processed using SAS software v9.4. Means and standard deviations of carcass characteristics according to carcass origin are summarized in Table 1. Since the sample was large enough and only classified carcasses were included in the study, the range of carcass weights was from 60 to 120 kg. The GLM procedure (SAS) and the statistical model for the comparison of the LMC prediction was used as follows:

$$Y_{ij} = EQ_i + CW_j + e_{ij}$$

where:
Y_{ij} – predicted lean meat content determined by different equations; EQ_i – fixed effect of equation (Slovak, Czech, Hungarian); CW_j – possible regression on carcass weight and eij is random error

Scheffe`s test (with default significance level of $p \leq 0.05$) within GLM procedure was applied to test differences between least squares means. Comparison between the equations was firstly applied to the whole dataset, and consequently to the individual SEUROP classes according to Slovak classification results.

3 Results and discussion

3.1 Differences in predicted LMP

Average carcass weight was only slightly different between the groups of CZ and HU pig carcasses (Table 1). Carcasses in the HU group had a thicker backfat layer compared to CZ carcasses, while the muscle thickness was higher in the group of CZ carcasses. Higher negative effect of backfat thickness on lean meat content resulted in higher LMC and more valuable SEUROP class in the CZ group. When equations from the Czech Republic and Hungary were applied to the corresponding carcasses, predicted LMC was lower by 2.1 and 2.52%. Correspondingly, the average classification class increased by 0.37 and 0.45 towards less valuable SEUROP classes.

The linear model including the effect of equation applied to the whole dataset explained 11–12% of the LMC variability (Table 2). In total, statistically significant difference between the LMC predicted by the Slovak

Table 1 Carcass characteristics according to the country of origin

	CZ (n = 405,575)		HU (n = 113,667)	
	mean	SD	mean	SD
CW (kg)	91.46	10.05	90.22	8.89
FT (mm)	14.73	4.01	15.77	4.36
MT (mm)	62.03	8.69	59.92	8.90
LMC_SK (%)	61.45	2.89	60.44	3.26
CLASS_SK	1.30	0.52	1.47	0.62
LMC_EX (%)	59.35	3.02	57.92	3.68
CLASS_EX	1.67	0.65	1.92	0.78

CW – carcass weight, FT – backfat thickness, MT – muscle thickness, LMC_SK – predicted lean meat content according to Slovak equation, CLASS_SK – classification class according to Slovak equation, LMC_EX – predicted lean meat content according to foreign equation, CLASS_EX – classification class according to foreign equation

Table 2 Comparison of predicted LMC using different equations (Slovak, Czech, Hungarian)

	CZ					HU				
	R^2	RMSE	LSM (SK)	LSM (CZ)	LSM signif.	R^2	RMSE	LSM (SK)	LSM (HU)	LSM signif.
Total	0.11***	2.96	61.45	59.35	***	0.12***	3.48	60.44	57.92	***
S	0.26***	1.82	62.80	60.65	***	0.27***	1.87	62.56	60.27	***
E	0.25***	1.64	58.24	56.32	***	0.45***	1.53	58.06	55.30	***
U	0.31***	1.64	53.43	51.22	***	0.56***	1.56	53.34	49.79	***
R	0.31***	2.31	48.36	45.61	***	0.67***	1.59	48.44	43.94	***
O	0.47***	1.96	43.25	39.60	***	0.75***	1.61	42.98	37.44	***
P	0.74***	1.15	38.77	35.22	***	0.83***	1.50	38.05	31.61	***

***P <0.001, R^2 – coefficient of determination, RMSE – root mean square error, LSM – least squares means

and the Czech equations was 2.1%, while statistically significant difference between LMC predicted by the Slovak and the Hungarian equations was 2.56%. When carcass weight was included in the model, only a slight improvement of R^2 was observed in the whole CZ group and a negligible improvement in the individual classes and the HU group.

When the predicted LMC was calculated in the individual SEUROP classes according to the Slovak and the foreign equations, the differences varied according to these classes. Statistically significant differences 2.15–2.21% were observed when LMC was predicted by the Slovak and the Czech equations in class S, E and U, while differences 2.75–3.65% were observed in classes R, O and P. Similarly, lower differences (2.29 and 3.55%) were observed in the classes S and E when the Slovak and the Hungarian equations were applied, while higher differences (4.50–6.44%) were observed in the classes R, O and P. Higher R^2 values and differences in less valuable classes could be attributed to the smaller number of carcasses classified in these classes.

Differences in the predicted LMC, based on different equations applied, result from different pig populations that were used in the authorisation trials. Differences between twelve national equations (two-point method) were shown on the pooled dataset of carcasses from 5 countries (Font-i-Furnols et al., 2016). Although they reported a difference of 4.6% LMC between the lowest and the highest predicted LMC, most of the equations differed by around 1% LMC. Although studying a different method (optical probe), the results from our study showed slightly higher differences in the predicted LMC.

3.2 Overestimation of the Slovak equation

Differences between the predicted LMC using the same apparatus may be due to different effects. According to Olsen et al. (2007) difference of 2% LMC may be attributed to uncertainties, which could be explained by differences between operators, environments and other uncertainties that can't be explained. In this respect difference in the whole group could be acceptable, but a closer look on the differences of the predicted LMC shows that only a negligible part of the differences is negative, showing that the Slovak equation is overestimating the LMC of pig carcasses from neighbouring countries compared to both the Czech and the Hungarian equations (Table 3). In

Table 3 Comparison of differences according to equation

	Mean (%)	1.Q (%)	3.Q. (%)	Last negative percentile (%)
SK vs CZ	2.1	1.16	2.97	5 (-0.14)
SK vs HU	2.53	2.04	3.00	1 (-0.50)

Table 4 Distribution of carcasses

Class	CZ (SK)	CZ (SK)	CZ (CZ)	CZ (CZ)	HU (SK)	HU (SK)	HU (HU)	HU (HU)
	n	%	*n*	%	*n*	%	*n*	%
S	297,271	73.30	172,805	42.61	67,460	59.35	34,646	30.48
E	97,364	24.01	197,888	48.79	39,943	35.14	56,851	50.02
U	10,297	2.54	32,025	7.90	5,728	5.04	18,811	16.55
R	602	0.15	2,557	0.63	470	0.41	2,934	2.58
O	35	0.01	263	0.06	51	0.04	350	0.31
P	6	0.00	37	0.01	15	0.01	75	0.07

CZ(SK) – Czech carcasses, Slovak equation, CZ(CZ) – Czech carcasses, Czech equation, HU(SK) – Hungarian carcasses, Slovak equation, HU(HU) – Hungarian carcasses, Hungarian equation

Czech group only around 5% of the predicted LMC was higher when the Czech equation was applied compared to the LMC predicted with the Slovak equation. In the Hungarian group only around 1% of the predicted LMC was higher when the Hungarian equation was applied compared to the LMC predicted with the Slovak equation.

This shows the need for the harmonisation of classification methods as concluded by Font-i-Furnols et al. (2016). Although it is very difficult to identify individual genotypes in industrial practice as stated by Lisiak et al. (2012), it would be valuable to at least consider taking into account imported animals in authorisation trials in countries where a significant portion of fatteners comes from abroad. Sampling of carcasses based on a geographical location does not need to cover all major genotypes slaughtered in the country.

3.3 Site of measurement

Another source of different predicted LMP could be different distance from the midline of the spilt carcass. Fortin et al. (1984) reported that there was only a little effect of measurement position (5, 7, 9 cm from midline of the split carcass) on the relation between lean meat and fat thickness and fat thickness and muscle depth. In this respect differences of 0.5 and 1.0 cm in the measurement site should not result in significant differences of predicted LMP. And even the difference of muscle depth might be higher due to the shape of the longissimus dorsi muscle as presented by Lowe et al. (2011), this difference has only a limited effect in the prediction formula. Furthermore, it is not expected that the backfat thickness would change rapidly (especially in the lean fatteners) over the MD muscle in the direction from the midline of the split carcass and thus significantly change the difference of predicted LMP. Following these assumptions, let us assume the example where only the backfat thickness is changed gradually. In that case increasing backfat thickness by 1mm decreases predicted LMP (CZ) by 0.75% and vice versa leading us to the fact that the backfat thickness measured at CZ point (5 mm closer to midline than SK) would have to be almost 2 mm lower. In the case of the Hungarian equation increasing backfat thickness by 1 mm while keeping the same muscle depth decreases predicted LMP by 0.78% while keeping the same BT and increasing MD by 1 mm increases predicted LMP by 0.11%. When comparing the Hungarian equation, the backfat thickness measured at HU point (1 cm closer to midline than SK) would have to be almost 2 mm lower and additionally, muscle depth would have to be thicker by 5 mm. Differences in backfat thickness and muscle depth may also result from different angle with which operator inserts the needle of the apparatus.

3.4 Distribution of carcasses

Finally, the distribution of carcasses over SEUROP classification classes changed considerably (Table 4). When the Slovak equation was applied, 97% of Czech pig carcasses and 94.5% of Hungarian pig carcasses were classified within the S and E classes. When the Czech and the Hungarian equations were applied, 91.4% of Czech pig carcasses and 80.5% of Hungarian pig carcasses were classified within S and E class. However, the most visible change was the ratio between the carcasses in S and E. The original ratio 73:24 according to the Slovak equation changed after applying the Czech equation to 42:48. This ratio is closer to the ratio 46:46 presented by David et al. (2014) when using only the FOM apparatus. Similar change happened after the application of the Hungarian equation, when the ratio 59:35 changed to 30:50. Also in this case the ratio is closer to the ratio 32:52 (NFCSO, 2017, as cited in Szőllősi et al., 2017). An increase in other classes after applying the Czech and the Hungarian equations can be also seen from data in Table 4.

4 Conclusions

Results of the study showed different predicted LMC using different equations from the neighbouring countries (Czech Republic and Hungary). Further research could help in evaluating the presence and effect of anatomical changes in FT and MD on LMP prediction using a FOM apparatus in these populations. An overestimation of the Slovak equation was observed. This finding shows the need to ensure the inclusion of carcasses from different suppliers in the authorisation trial. Including different suppliers according to the genotype of fatteners or at least the breeding program seems to be more representative than following geographical distribution. In cases where a significant portion of the slaughtered animals come from abroad, these should also be considered in the authorisation trial.

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