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The repeatability effect to estimate the lean meat share in pigs

Vliv opakovatelnosti měření na odhad zmasilosti prasat

Michal ŠPRYSL*, Jaroslav ČÍTEK, Roman STUPKA, Monika OKROUHLÁ, Luboš BRZOBOHATÝ, Karel VEHOVSKÝ and Eva KLUZÁKOVÁ

Czech University of Life Sciences Prague, Faculty of Agrobiology, Food and Natural Sources, Department of Animal Husbandry, Kamýcká 129, 165 21, Prague 6 - Suchdol, Czech Republic, Phone: + 420 224 383 051, *correspondence: sprysl@af.czu.cz

Abstract

The aim of this work was to determine the accuracy of the lean meat share (LM) estimate with FOM instrumentation, in pigs. A total of 720 pigs were measured at slaughterhouses. The tests were carried out to determine the ability to measure the same value with repeated injections in the same point of the pig carcass, taking into account the operator, the equipment and the state. Based on the observed measurements it can be stated that the difference between measurements of the muscle and fat in the first and repeated injections is very low. The pigs´ LM estimation in the CR, compared to the SR is, for both punctures, higher. As regards repeatability, it is obvious that the pig measuring in the SR is performed more carefully. Also, CR operators, compared to SR, exhibit, in the case of repeated punctures, a greater variability.

Keywords: pigs, repeatability, SEUROP classification system

Abstrakt

Cílem práce bylo stanovení přesnosti odhadu podílu masa u prasat v systému SEUROP. Celkem bylo změřeno 720 prasat na běžném příhonu jatek. Za účelem stanovení chyby správného měření hloubky tuku a svalů, byly provedeny testy ke zjištění schopnosti měřit stejné hodnoty při opakovaném vpichu ve stejném místě JUT prasete, a to s ohledem na operátora, přístroj a stát. Na podkladě zjištěných měření lze konstatovat, že diference mezi měřením svalu a tuku při prvním a opakovaném vpichu je velice nízká. Odhad zmasilosti prasat v ČR, oproti SR je v případě obou vpichů vyšší. Pokud jde o opakovatelnost, je zřejmé, že v SR se realizace prasat provádí pečlivěji. Rovněž operátoři ČR, oproti operátorům SR vykazují v případě opakovaných vpichů větší variabilitu.

Klíčová slova: opakovatelnost, prasata, SEUROP

Detailní abstrakt

Cílem práce bylo stanovení přesnosti odhadu výšky tuku, svaloviny a podílu masa u prasat v případě opakovaných vpichů přístrojovou technikou v systému SEUROP. Celkem bylo změřeno 720 prasat na běžném příhonu jatek. Měření se realizovalo u 360 ks v ČR a 360 ks prasat ve SR. Za účelem stanovení chyby správného měření hloubky tuku a svalů (opakovatelnosti), byly provedeny testy ke zjištění schopnosti měřit stejné hodnoty při opakovaném vpichu ve stejném místě JUT prasete, a to s ohledem na operátora, přístroj a stát. Pro predikci zmasilosti u klasifikace jatečných prasat bylo použito rovnice FOM y = 81,8909 + 0,2006 * M + 14,1911 * ln S, kde M = výška svalu, S = výška tuku. Výpočet a porovnání výsledků bylo provedeno matematicko-statistickým programem SAS® Propriety Software Release 6.04. Rozdíly byly testovány analýzou variance. Na podkladě zjištěných měření lze konstatovat, že diference mezi měřením svalu a tuku při prvním a opakovaném vpichu je velice nízká. Přesnost odhadu LM činí r=0,943. Odhad zmasilosti prasat v ČR, oproti SR je v případě obou vpichů vyšší (o 1,82, resp. 2,31%). Pokud jde o opakovatelnost, je zřejmé, že v SR se realizace prasat provádí pečlivěji (0,964 vs. 0,930). Rovněž operátoři ČR, oproti operátorům SR vykazují v případě opakovaných vpichů větší variabilitu, přesahující doporučované odchylky.

Introduction

The commercial production of pigs in the EU has been carried out since 1984. It is based on Council Regulation EEC 3220/84. This indicates that pigs are implemented on the basis of two criteria, namely their carcass weight and lean meat share (Pulkrábek, 2001). If the only effective factor of pig production is only the weight, the system would be ineffective. In this case the product would be aimed only at high mass, which in turn deteriorates the quality (Kyriazakis, Whittemore, 2005). This is also a function of diet, gender (Fortin et al., 2004; Dostalová, Koucký, 2008) and weight (Vališ et al., 2005; Šprysl et al., 2006). For an objective assessment of the LM share in pigs in the slaughterhouse, the instrument techniques are used (Busk et al., 1999). These are able to estimate the LM proportion in carcasses quickly and accurately with minimal error (Kyriazakis, Whittemore, 2006; Nissen et al., 2006). The principle of these techniques is the measurement of variables, backfat thickness and muscle depth (MLLT) in certain points by using reflection of light rays or ultrasound. These variables, entered into the prediction equation apparatus, provide an estimation of LM (Pulkrábek 2001, 2005). The equations are constructed via multiple regression of anatomical dimensions of the carcass and muscle, obtained through detailed dissection of a representative sample of pigs (Collewet et al., 2005, Walstra, 2000). The required accuracy of the estimation equations, according to Pulkrábek et al. (2004), must meet the allowable margin of error. That is expressed by the square root of the residual variance; which must show a lower value than 2.5. As a further condition for the accuracy of regression equations there exists the coefficient of determination ($R2 \geq 0.64$) and the minimum correlation between the estimate of muscle and dissection (Nissen et al., 2006) 0.8 (Pulkrábek et al., 2000, 2011; Steinhauser, 2000). As regards the instrumentation in the CR, it is an apparatus Fat-O-Meat'er ™, UltraFom 300 ™ and HGP. The most frequently used is the FOM

equipment (as it is in the SR), which, compared to the HGP, requires fewer repetitions to obtain satisfactory measurements (Bahelka et al., 2005; Busk et al., 1999; Font et al., 2009; Kempster et al., 1985). Each measurement may be affected by some error. The cause may be a shift of the measuring equipment or an operator error. He often has to repeat the measurements. What errors may occur in this case is the aim of this work.

Materials and Methods

A total of 720 pigs were measured in regular slaughterhouses. 360 pigs in the CR and 360 animals in the SR were measured. In order to determine the errors in the measuring of backfat and MLLT-muscle depth (repeatability), the tests were performed to determine the ability to measure the same value with repeated injection in the same spot of the pig carcass, with respect to operator, equipment and state. For this purpose, both for the CR and the SR, the study was performed according to Table 1. In the case of the CR/SR, 3 operators from the CR (CR1, CR2, CR3) and 3 operators from the SR (SR1, SR2, SR3) were evaluated. Each of them measure 60 pigs with 2 identical types of equipment FOM (F1, F2, F3, F4).

Table 1. Schematic example of determining the repeatability of operator (CR/CR) and measuring equipment

Tabulka 1. Schéma měření pro stanovení opakovatelnosti operátora a měřícího přístroje

Carcass	Equipment – F1						Equipment – F2						
in	Operator CR1		Operátor CR2		Operator CR3		Operator CR1		Operator CR2		Operator CR3		Σ
CR (n)	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	
1- 60	X	X							X	X			120
61-120			X	X							X	X	120
121-180					X	X	X	X					120
Σ													360

Carcass	Equipment – F3						Equipment – F4						
in	Operator SR1		Operator SR2		Operator SR3		Operator SR1		Operator SR2		Operator SR3		Σ
SR (n)	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	
1.60	X	X							X	X			120
61-120			X	X							X	X	120
121-180					X	X	X	X					120
Σ													360

P1 - measurements in spot to classify, P2 - repeated measurements in the same spot

For the classification the following equation was used to predict the LM in pigs. The equation was: y=81.8909+0.2006*M+14.1911*ln S, where: M - MLLT-depth, S - backfat thickness. Calculation and comparison of the results was performed by the

mathematical-statistical program, SAS ® Software Release paraphernalia 06.04. Differences were tested by analysis of the variance.

Results and Discussion

From the data in Table 2 it may be stated that the differences between measurements of muscle and fat at the first and repeated injection is -0.06, respectively +0.11mm.

As regards the repeatability of LM measuring, the detected difference -0.11% documented high accuracy measuring repeated estimation of the LM (r = 0.943), which is in accordance with Candek-Potokar (2003); Merks (2003); Pulkrábek et al. (2000); Pulkrábek (2003); Steinhauser (2000).

Table 2. Results of repeatability measurement regardless to state

Tabulka 2. Výsledky měření opakovatelnosti za oba státy

Variable	n	X	SD	r
MLLT-depth first (mm)	717	62.26	8.33	
MLLT-depth second (mm)	717	62.32	8.2	0.815
diff. *MLLT*-depth the 1st - 2nd (mm)	717	-0.06	5.02	
backfat first (mm)	717	17.43	4.67	
backfat second (mm)	717	17.32	4.74	0.972
diff. backfat the 1st - 2nd (mm)	717	0.11	1.11	
LM first (%)	717	54.97	4.16	
LM second (%)	717	55.08	4.21	0.943
diff. LM the 1st - 2nd (%)	717	-0.11	1.4	

Tables 3a, 3b shows the differences of repeated measurements to the LM estimate in the Czech Republic and Slovakia. Obviously, the pigs´ LM estimation in the CR was, in case of repeated puncture, always higher (0.31%). As regards the difference between repeated injection in the SR, the LM estimate was always lower. These differential values in the measurement make it obvious that the pig realization in the SR was carried out more carefully than in the CR. This is evidenced both according to the size differences of the variables (0.08 vs. -0.30%), as well as according to the correlations of the LM estimate of repeated injection (0.964 vs. 0.930). For this reason, it is necessary to solve the problem with the operator. This shows in Tables 4a, 4b and 5a, 5b.

Table 3a. Results of repeated measurements

Tabulka 3a. Výsledky opakovaného měření

State	MLLT-depth first (mm)		MLLT-depth second (mm)		Backfat first (mm)		Backfat second (mm)		LM first (%)	LM second (%)
	x	SD	x	SD	x	SD	X	SD		
CR	64.29	9.09	64.09	8.93	16.1	4.45	15.75	4.48	55.88	56.19
SR	60.24	6.95	60.56	7	18.75	4.52	18.88	4.48	54.06	53.98

Table 3b. Results and correlation of repeated measurements of variables

Tabulka 3b. Výsledky a korelace opakovaného měření proměnných

State	diff. the 1st - 2nd measurement			R		
	MLLT	Fat	LM	*MLLT*	Fat	LM
CR	0.20	0.35	-0.31	0.701	0.978	0.930
SR	-0.32	-0.13	0.08	0.979	0.963	0.964

The accuracy of the operator measuring is documented in Tables 4a, 4b. From this it is clear that CR operators in the case of repeated measuring of MLLT depth, measuring of the backfat and, therefore, the LM estimation of pigs, had considerable variability. This exceeds recommended deviations. According to Olsen et al., (2007) deviations concerning the backfat can not exceed respectively MLLT depth 0.2, or 0.9mm. In the case of repeated measuring, the LM estimate was always higher in the CR (about 0.21-0.27%), whereas in the SR lower (0.02-0.13%). Again, it is clear that the SR operators more precisely measured the pigs, as evidenced by the above correlations (0.961-0.968). The effect of the operator in the CR in the final classification is more significant, the correlation of interval is 0.863-0.920.

Table 4a. Repeatability of the operators

Tabulka 4a. Opakovatelnost operátorů

Operator	MLLT-depth first (mm)		MLLT-depth second (mm)		Backfat first (mm)		Backfat second (mm))		LM first (%)	LM second (%)
	x	SD	x	SD	x	SD	x	SD		
CR1	71.00	8.37	70.70	8.57	13.52	3.71	13.21	3.59	59.69	59.96
CR2	61.62	7.84	61.57	7.22	17.61	4.66	17.38	4.77	54.03	54.24
CR3	59.28	7.41	59.40	7.35	19.13	3.76	18.82	3.78	52.16	52.42
SR1	61.51	6.91	61.62	6.96	19.34	4.43	19.53	4.34	53.70	53.57
SR2	59.10	6.90	59.46	7.01	17.58	4.48	17.63	4.46	54.84	54.83
SR3	60.12	6.89	60.60	6.94	19.34	4.46	19.50	4.40	53.63	53.54

Table 4b. Repeatability and correlations of repeated measurements of the operators´ variables

Tabulka 4b. Opakovatelnost a korelace opakovaného měření proměnných operátorů

Operator	diff. the 1st - 2nd measurement			r		
	MLLT	Fat	LM	*MLLT*	Fat	LM
CR1	0.30	0.31	-0.27	0.61	0.974	0.907
CR2	0.04	0.22	-0.21	0.36	0.974	0.863
CR3	-0.12	0.32	-0.26	0.832	0.971	0.92
SR1	-0.11	-0.18	0.13	0.979	0.961	0.961
SR2	-0.36	-0.05	0.02	0.977	0.968	0.968
SR3	-0.48	-0.16	0.09	0.981	0.958	0.96

The differences determining the backfat, MLLT depth and LM between the first and subsequent measurement using different equipment of the same type is documented in Table 5a, 5b. From this it is clear that the CR equipment, compared to the SR, show, during repeated LM pig measuring, lower reliability (0.20-0.30, vs. 0-0.16%) which is a function of their appropriate adjustment and control (Collewet et al., 2005). The margin of the error may be associated with differences between copies of the same equipment, which resulted in some of operators who had more than one copy of the same equipment (Olsen et al., 2007). The deviation with manual probes may vary from state to state. This is for the backfat, respectively MLLT-depth, 0-1.2, respectively 0-3.2 mm, for the LM prediction 0-1.6%.

Table 5a. Repeatability of the equipments

Tabulka 5a. Opakovatelnost přístroje

State	Equipment	MLLT-depth first (mm)		MLLT-depth second (mm)		Backfat first (mm)		Backfat second (mm))		LM first (%)	LM second (%)
		x	SD	x	SD	x	SD	X	SD		
CR	F1	64.74	9.83	64.36	9.74	17.38	5.27	17.08	5.31	55.08	55.28
CR	F2	63.82	8.27	63.81	8.04	14.8	2.88	14.4	2.88	56.7	57.11
SR	F3	60.81	7.03	61.04	6.99	18.46	4.51	18.47	4.43	54.3	54.3
SR	F4	59.67	6.84	60.08	7.01	19.05	4.53	19.3	4.5	53.82	53.66

Table 5b. Repeatability and correlation of repeated measurements of the equipment variables

Tabulka 5b. Opakovatelnost a korelace opakovaného měření proměnných přístroje

State	Equipment	diff. the 1st - 2nd measurement			R		
		MLLT	Fat	LM	*MLLT*	Fat	LM
CR	F1	0.38	0.30	-0.20	0.983	0.983	0.963
CR	F2	0.01	0.40	-0.41	0.950	0.950	0.810
SR	F3	-0.23	-0.01	0.00	0.977	0.977	0.977
SR	F4	-0.41	-0.25	0.16	0.950	0.949	0.952

Conclusions

Based on the observed measuring can be stated that the differences between measuring MLLT and backfat during first and repeated injection is very low; the accuracy of the LM estimate indicates correlation r = 0.943. LM pigs´ estimation in the CR compared to the SR is, in the case of repeated injection, always higher. In regard to this study, repeatability differences and the level of LM estimate correlations it is obvious that the SR measuring of the pigs is carried out more carefully (0.964 vs. 0.930). The CR operators in comparison to those of the SR reported, in the case of repeated injections, a considerable variability, exceeding their recommended values for deviations. The CR equipment in comparison to those of the SR recognized, over repeated measurements variables with lower reliability (0.20-0.30, vs. 0-0.16%), which may be associated with differences between copies of the same equipment.

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