REPEATABILITY AND VARIATION CAUSED BY THE OPERATOR IN PIGS

Šprysl M., Stupka R., Čítek J.

Czech University of Life Sciences Prague, Czech Republic

Abstract

The aim of the study was to determine the repeatability and operator variability, which estimate the backfat thicknes (S-FOM), muscle depth (M-FOM) and lean meat share (LMP) measured twice in one pig with one instrument (FOM). The observed LMP-FOM estimations was also compared with the ZP method.

180 total hybrid pigs of common genotypes, using in the Czech Republic was measured at the abbatoir. For the lean meat share prediction and its comparison the FOM and ZP equations were used. Calculation and the results comparison was performed by mathematical-statistical program SAS® Propriety Software Release 6.04. Significance of differences was tested by analysis of variance.

The results showed that

- there are minimal differences in the LMP estimation between FOM and ZP,
- ZP method, compared to FOM, LMP estimate overstates,
- considerable differences between LMP estimates of operators are caused by punctures in the wrong place,
- repeatability S and M for the first and repeated injection is high, the accuracy of the estimate $LMP_{FOM/ZP}$ are 0.98351/0.838,
- accuracy of M_{FOM} determination is affected by operator,
- repeatability accuracy of LMP estimates is for all operators practically identical.

Key Words: Pig, backfat, muscle depth, lean meat share

The pigs realization in the EU are made by LMP and carcass weight determination (Pulkrábek et al., 2011). The legal basis of this method is the implementation of Council Regulation EEC 3220/84 (Pulkrábek, 2001).

Fast and reliable LMP determination in pigs implements various instrumental techniques (Causeur et al. 2000; Dhorne et al., 2002). It uses regression equations, which generally serves for fast estimate the actual amount of meat in the carcasses. The meat proportion can be determined by demanding detailed (Steinhauser, 2000; Pulkrábek, 2003) or shortened (Nissen et al., 2006) dissection.

The first step to estimate the LMP is to find appropriate anatomical dimensions that are highly correlated with the total carcass lean meat content. Using different techniques of LMP determination (planimeter as MRI) for the most reliable variables the backfat thicknes (S) and the MLLT muscle height (M) was determined, as described Pulkrábek (2001). The second step for LMP estimate is the regression equations construction from data describing the fact (Engel, Walstra, 1991; Nissen et al., 2006). The substitution of variables to the regression equations and the subsequent meat proportion calculation is the body mass component estimation (Pulkrábek et al., 2006). However, this is necessary due to the ever changing of swine population regularly correct (Collewet et al., 2005). The accuracy of reference dissection methods is given by the 0.87 repeatability, 1.10 SD reproducibility and R^2 0.87 (Nissen et al., 2006).

For carcass grading the ZP method (Zwei-Punkte-Messverfahren) in the CR is approved (Commission Decision 2005/1/EC). It is intended mainly for small slaughterhouses (Hennebach et al., 1980). Furthermore, the invasive techniques are FOM (Fat-O-Meater) and HGP (Hennessy Grading Probe). Both instruments operate on the measuring principle of variables according to the different reflectivity of the fat and muscle tissue (Fortin et al., 2004; Kempster et al., 1985). Measurement of S and M by this invasive technique assumed that necessity of repeated injection in the same carcass spot, instrument will measure maximum of the same data (Engel et al., 2003; Daumas et al., 2005). An important source of differences in the LMP estimation these techniques are operator errors (Olsen 2001, 2002).

The operators influenced measuring differently because of different slaughter conditions, even though they have the same education. Therefore some differences between them exist. Because the biggest variation of the measurement is expected to come from between operators, the trial was carried out under industrial conditions.

The aim of the trial was to determine the repeatibility and variation caused by operator, when measure with the same equipment to 1 animal twice.

Material and Method

The experiment was carryied out in abbatoir on a low speed line. 180 pigs were measured. These animals came from several production farms. It was a normal hybrid combinations used in the CR.

The determination of operator errors, thus the backfat thicknes and MLLT muscle depth accuracy measuring (repeatability) was carried out finding the ability of 3 operators to measure the same value with repeated injection in the same carcass spot in pig.

Each of them evaluated by the same instrument (FOM) 60 pigs by measuring pistols (equipment - FOM) as well as operators were changed between themselves according to the schema illustrated in Table 1.

Table 1. Scheme to determine the operator repeatability in pig realization

Number of pigs	FOM						ZP
	Operator 1		Operator 2		Operator 3		
	P1	P2	P1	P2	P1	P2	-
1-60	X	X					X
61-120			X	X			X
121-180					X	X	X

P1 – spot measurements at the classification, P2 – repeated measurements at the same spot

Lean meat share estimates, detected by operators were also compared with the ZP method. For the pig classification FOM and ZP equations were used of following shapes

$y_{FOM} = 81,8909+0,2006*M_{FOM}+14,1911*ln\ S_{FOM},$

$y_{ZP} = 76,6722–1,0485*M_{ZP}+0,00794*M_{ZP}^2–0,002884*S_{ZP}^2+9,0151*ln\ (M_{ZP}/S_{ZP}),$ where

$M_{(FOM,ZP)}$ = MLLT muscle height, $S_{(FOM,ZP)}$ = bacfat thicknes (Pulkrábek, 2001).

Calculation and comparison of the results was performed using mathematical and statistical program SAS® Propriety Software Release 6.04. Differences were tested by analysis of variance. Evaluation of the results was implemented

- without respect to operator, thus differences between FOM/ZP,
- with respect to operator, thus differences between operators 1,2,3.

Results and Discussion

Differences of the FOM/ZP classification method without respect to operator documented Table 2. From the table it is clear thatin the range of measurement was proved there are minimal differences in the LMP estimation between FOM and ZP. It can be stated that the lean meat share estimation according to ZP-method, compared to FOM, leads to overestimation (Šprysl et al., 2006); the difference was 0.71%.

As regards the monitoring of the differences in the measurement of the operators, then differences of LMP between operators, namely by both techniques (FOM/ZP), are high. This is due to different measurement variables at the backfat thicknes and MLLT muscle height. As regards the equipment FOM, Table 3 shows that when measured one operator variable differences between repeated punctures are minimal. It is also evident that the differences are greater for the M_{FOM} than for the S_{FOM} (Dhorne et al., 2002).

As regards the differences in variables between operators, which states Olsen (2001; 2002), the size of their differences creating the impression that one operator implemented a puncture in the wrong place. In this regard, it has been demonstrated that most often, the differences consist in a systematic shift between measurements, how Dhorne et al. (2002) states. Operator 1 could not also measure the variables for estimating LMP_{ZP} (M_{ZP} and S_{ZP}) in the right place. This caused a difference in the estimation of LMP between operators 10% practically. It is a value that exceeds the recommended deviation (Causeur et al., 2000; Olsen et al., 2007).

When comparing the two methods among themselves we can say that repeated measurement of each operator always showed a smaller error in the LMP estimation. This means that they measured carefully.

Correlation of operator repeatability shows Table 4. It documents the high overall reliability (0.98351) the LMP estimation, however, also the fact that particulary accuracy of M_{FOM} determination is affected by operator, not by the appropriate adjustment and equipment control, as shown Collewet et al. (2005).

The study also assesses the reliability of repeated LMP_{ZP} estimates in individual operators. The fact documented Table 5. From that it is clear that the repeatability of accuracy of LMP estimates is practically identical, which also applies to the estimates of individual operators.

Table 2. SEUROP realization with respect to FOM and ZP system in pigs

Variable	N	Min.	Max.	μ	SD	SE
LMP FOM	180	45.00	70.40	55.08	5.77	0.43
LMP ZP	180	43.03	75.63	55.79	6.15	0.46
LM_{FOM} - LM_{ZP}	180	-11.23	8.86	- 0.71	3.41	0.25

Table 3. Differences of the FOM/ZP classification method with respect to operator 1-3

Variable	Operator 1 (n=60)			Operator 2 (n=60)			Operator 3 (n=60)		
	μ	SD	SE	μ	SD	SE	μ	SD	SE
LMP_{FOM} 1.measuring	61.40	4.58	0.59	52.16	3.19	0.41	51.68	2.99	0.38
LMP_{FOM} 2. measuring	61.62	4.38	0.57	52.42	3.07	0.39	51.81	3.39	0.44
LMP_{ZP}	61.77	6.01	0.77	53.07	3.39	0.45	52.53	3.51	0.45
1.-2.FOM measuring	- 0.22	1.94	0.25	- 0.26	1.26	0.16	- 0.13	1.46	0.92
FOM-ZP 1. measuring	- 0.37	4.28	0.55	- 0.91	2.76	0.36	- 0.85	3.02	0.39
FOM-ZP 2. measuring	- 0.16	4.33	0.56	- 0.65	2.66	0.34	- 0.72	3.03	0.39
S_{FOM} 1.measuring	12.53	3.96	0.51	19.13	3.76	0.48	20.48	4.21	0.54
S_{FOM} 2.measuring	12.18	3.81	0.49	18.82	3.78	0.48	20.25	4.38	0.56
1.-2. S_{FOM} measuring	0.35	0.66	0.08	0.32	0.91	0.12	0.23	1.24	0.16
M_{FOM} 1.measuring	73.42	9.02	1.16	59.28	7.41	0.95	61.52	6.30	0.81
M_{FOM} 2.measuring	72.57	9.93	1.28	59.40	7.35	0.95	61.10	5.55	0.72
1.-2. M_{FOM} measuring	0.85	9.02	1.16	- 0.12	4.27	0.55	0.42	4.43	0.57

Table 4. Repeatability – correlations (r) with respect to operator

Operator		S_{FOM}	M_{FOM}	LMP_{FOM}
1	r	0.98641	0.55047	0.90666
2	r	0.97082	0.83246	0.91975
3	r	0.95906	0.72660	0.90170
In sum	r	0.98351	0.79398	0.96284

Table 5. Correlation coefficients (r) with respect to ZP method and operator

Sum			
		1.measurement	2.measurement
ZP	r	0.83792	0.83866
Operator 1			
		1.measurement	2.measurement
ZP	r	0.70314	0.69398
Operator 2			
		1.measurement	2.measurement
ZP	r	0.64903	0.66559
Operator 3			
		1.measurement	2.measurement
ZP	r	0.57783	0.61428

Conclusion

Based on the observed measurements we can say that

- there are minimal differences in the LMP estimation between FOM and ZP,
- ZP method, compared to FOM, overestimates the LMP estimation,
- high differences in LMP estimates between operators are caused by punctures in the wrong spot,
- repeatability of the S and M measurement for the first and repeated puncture is very high; precision of the $LMP_{FOM/ZP}$ estimate is 0.98351/0.838,
- accuracy of M_{FOM} determination is affected by operator,
- repeatability of accuracy of the LMP estimates is for all operators practically identical.

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Corresponding Address:
Doc. Ing. Michal Šprysl, CSc.
Faculty of Agrobiology, Food and Natural Resources
Czech University of Life Sciences Prague
Kamýcká 129, 165 21, Praha 6 - Suchdol, Czech Republic
E-mail: sprysl@af.czu.cz