LEANNESS AND CARCASS COMPOSITION OF PIGS IN CROATIA

Ukmar[1], R., I. Đurkin[2], Z. Maltar[2], G. Kralik[2], A. Petričević[2], G. Kušec[2]

SUMMARY

This study was performed on 146 pig carcasses, selected on the basis of back fat thickness measured at the position for "Two Points" method as described by the Croatian Regulation on Quality of Pig Carcasses on Slaughterhouse- line (National Gazette, No. 119/99). There was no stratification based on carcass weight. The leanness of pig carcasses was determined in three manners: estimation by the instrumental and "Two Points" method, as well as by applying dissection method. Dissection was performed as prescribed by the current EU legislation, which enforces the so called EU reference method. The results have shown that the estimated share of muscle tissue in pig carcasses was lower than the share of muscle tissue objectively determined by the EU reference method of dissection. Statistically significant differences ($p< 0.05$) were determined between the leanness objectively determined by dissection and the leanness estimated by the "Two Points" method. This indicates the need for establishing new coefficients in the equation for estimating muscle tissue in pig carcasses for the mentioned method. The study has found that the greatest share of pig carcasses consists of the leg, then loin, shoulder and belly. In four dissected parts of the carcass, the highest share of muscle tissue is in the leg, followed by the shoulder, loin and belly. The highest share of total fat tissue is in the belly, whereas its lowest share is found in the leg. The highest share of bones is in the loin, and the lowest in the belly. Detailed shares of tissue from the dissected parts of pig carcass in its total mass are also shown. The classification of pig carcasses into commercial classes according to SEUROP system by both methods of estimation, as well as by the method of dissection, determined that the evaluation methods classify around 15% of all pig carcasses to S class, whereas the EU reference method classifies as much as 27,40% of pig carcasses into the same class. The method of "Two Points" classified approximately 72% of carcasses to medium- quality commercial classes (E and U), whereas the dissection method determined that 58% of pig carcasses belong to these classes. It has been concluded that the Republic of Croatia needs changes in formulae for estimation of the lean percentage in pig carcasses. The best way to do that would be to use the methodology prescribed in the EU.

Key words: *pigs, leanness, carcass composition, methods of estimation*

INTRODUCTION

Determining the leanness of pig carcasses has always been an interesting subject, not only for scientists, but for pig breeders and meat processing industrialists as well, because the leanness of pig carcasses directly affects their market price. The leanness in this sense includes the percentage of meat in pig carcasses. That percentage can be objectively determined by destructive and nondestructive methods or estimated by mathematical terms especially constructed for that purpose. In the EU legislative, methods of objective determination of leanness have been regulated by the so called EU reference method of dissection, and statistical criteria of accuracy have also been regulated, which have to comply with the methods of estimation of muscle tissue percentage in pig carcasses (Commission Regulation (EC) No. 1197/2006). Therefore the European Regulation prescribes that the real share of muscle tissue (%) is determined in the standardized method of dissection, by separating tissues in at least 120 carcasses, in which process it is significant that samples must be representative for a country or a certain area. Many calculations show us that there are certain differences between pig populations in terms of composition of carcasses and tissue distribution (Evans and Kempster, 1979; Planella and Cook, 1991; Gu et al., 1992; Engel and

[1] **Robert Ukmar, graduate engineer, Žito Ltd., Đakovština 3, 31000 Osijek**
[2] **Ivona Đurkin, graduate engineer, assistant; Zlata Maltar, M.S., expert advisor; professor Gordana Kralik Ph.D., Dr.H.C.; Antun Petričević, Ph.D., professor emeritus; professor Goran Kušec, Ph.D., Agricultural College, Department of Special Zootechnics, Trg sv. Trojstva 3, 31000 Osijek. Author for correspondence: professor Goran Kušec, Ph.D. gkusec@pfos.hr**

Walstra, 1993; Daumas and Dhorne, 1997). Therefore it is important for the estimation to be precise and impartial. Nissen et al. (2005) were estimating the accuracy of the EU reference method in their research. Researches were performed in four EU countries on the total of 128 pig carcasses, which were stratified based on their mass, thickness of the leg, based on sex, and according to 8-member- team from different countries, who were dissecting the carcasses. After the statistical interpretation of data, the researchers agreed that the EU reference method has a very high degree of accuracy.

Except for being the basis for developing the formulas used for market classification of pig carcasses, the EU reference method is also used for the purpose of estimating genetic progress in certain populations of pigs. General progress in pig breeding can be monitored by this method, and by long- term monitoring of leanness in a certain pig population, it can be determined which hybrids contribute to higher production of muscle tissue. So the studies in Slovenia during the period from 1996 to 2004 showed that the leanness of their pig population increased in the period of research. The average meat percentage in pig carcasses in 1996 was 51.9%, but in 2004 it increased to 55.9%. As the consequence of that, pig carcasses that were classified to S and E classes almost tripled. Whereas in 1996 21.3% of pig carcasses were allocated to these two classes, that percentage increased to 58.2% in 2004. That increase in leanness of pig carcasses in Slovenia was caused by the fact that the prices of pig carcasses were formed according to their leanness, and partly because of the better pig breeders' management, then because of the increased usage of Pietren sires (Čandek – Potokar and Kovač, 2004). Pulkrabek et al. (2006) were trying to determine the relation between meat quality and the percentage of muscle tissue in the Czech population of pigs. The study included carcasses of S, E, U and R classes, and then they carried out the dissection of four main parts. The authors haven't determined statistically significant differences ($p>0.05$) of quality characteristics of meat between the researched commercial classes, therefore it has been determined that the best quality meat of all the listed classes is in legs.

Petričević et al. (2000) were researching the share and quality of muscle tissue on 60 pig carcasses produced in farm breeding, divided into two groups based on sex. The first group consisted of 15 carcasses from female pigs (F1) and 14 carcasses from castrates (M1), crossbreeds of Swedish Landras and German Landras, and the other group consisted of 17 carcasses from female pigs (F2) and 14 carcasses of castrates (M2) of Swedish Landras. Differences were determined both between the breeds, as between the sexes within the breeds. Body weight of male castrates' carcasses of both groups (M1 = 82.71 kg, M2 = 80.71 kg) was higher than carcass weight of female pigs (F1 = 78.3 kg, F2 = 76.94 kg), and statistically significant differences ($P < 0.05$) were determined only between the male castrates of the first group and female pigs of the second group. The share of muscle tissue in carcasses was higher with female pigs from the first and the second group (F1 = 53.93%; F2 = 51.77%) than with male castrates of both groups. Statistically significant differences ($P < 0.01$) in the percentage of muscle tissue of loin were determined between female pigs and castrates of the first group (F1 = 9.58% and M1 = 8.30%), and castrates of the first group and female pigs of the second group (M1 = 8.30% and F2 = 9.57%). It can be seen from the listed results that sex can affect important traits of pig carcasses. If the differences between sexes regarding the share of muscle tissue are significantly expressed, there is the possibility for setting special formulas for evaluating the leanness of pig carcasses of such populations (Engel and Walstra, 1993; Daumas and Dhorne, 1997, 1998).

Kušec et al. (2006) conducted a similar research in pig population in eastern Croatia. Pig carcasses included in the research were dissected according to the EU reference method (Walstra and Merkus, 1995). By comparing the share of the most important tissues of basic parts in comparison to the total quantity of certain tissues, in the researched pig carcasses statistically significant differences ($P = 0.0407$) were determined between the sexes only in the share of bones in the leg in the total amount of bones. The authors have concluded that between the pig carcasses from the female pigs and castrates in the area of east Croatia there isn't any need for establishing separate equations for estimating the share of muscle tissue, but this statement should be confirmed on a larger number of pig samples. Although the significant influence of the sex (female and male castrates) on evaluation of percentage of muscle tissue was reported by researchers from several countries (The Netherlands: Engel and Walstra, 1993; Belgium: Casteels et al., 1996; France: Daumas et al., 1994, 1998; Germany: Bransheid et al., 1987), special equations for each sex are used only in France.

Considering the mentioned above, the goal of this paper was to determine the leanness of pig carcasses from Croatia by using the methodology prescribed by the EU legislative (Commission Regulation EC No. 1197/2006). In practice, this means that after cutting up pig carcasses on four main parts in the method of their dissection, the share of muscle, fat and osseous tissue, as well as their share in the carcass will be determined in order to get as precise insight into their composition as possible. Except for that, the leanness of pigs in the Republic of Croatia will be determined by these data.

MATERIAL AND METHODS

Dissection experiment was made on 146 pig carcasses, which were chosen according to the back fat thickness proscribed for "Two Points" (TP) method by the Regulation on Quality of Pig Carcasses on Slaughterhouse- line (National Gazette, No. 119/99). There was no stratification based on the carcass weight. All the carcasses came from pig populations of both sexes bred in Croatia, and carcass processing was conducted by a specially trained group in leading Croatian slaughterhouses.

Before the cutting up of pig carcass, the percentage of muscle tissue was estimated by simulation of the instrumental method, i.e. by measuring the thickness of bacon and muscles at the point where probe of the device for classifying pig carcasses goes through, and by the "Two Points" method, as it was prescribed by the valid Regulation in the Republic of Croatia.

After that, the dissection was carried out according to the EU reference method, in the manner described in details by Walstra and Merkus (1995). In this procedure pig carcasses are first cut up on parts as shown in Figure 1. Such cuts of the carcass are: 1- leg, 2- loin, 3- neck, 4- head + cheek, 5- front shank + front foot, 6- hind shank + hind foot, 7- tenderloin, 8- shoulder, 9- jawl, 10- belly, 11- ventral flank of belly, 12- to ventral part of belly. After the cutting up, the four parts are further dissected to muscle tissue, fat tissue and bones, and these are the leg, shoulder, loin and belly. Separation of tissue is done as precise as possible, by a knife. By separating subcutaneous fat tissue, we separate the fat tissue located above the external muscle layers, without cutting muscles in the process. Figures from 2 to 5 show dissected parts of pig carcass. The calculation of fat tissue also includes the mass of tenderloin muscle as prescribed by the EU Regulation (Commission Regulation – EC 1197/2006). This regulation introduces a formula according to which a reference percentage of muscle tissue is calculated:

$$\text{Ref. \% of muscle tissue} = 0{,}89 \times 100 \times \frac{\text{Weight of tenderloin + weight of lean (fascia included) in 4 cuts}}{\text{Weight of tenderloin + weight of dissected cuts}}$$

The obtained data were statistically analyzed by the program package STASTISTICA 7.1 for Windows (StatSoft Inc., 1984 – 2006).

RESULTS AND DISCUSSION

The measures relevant for methods of estimation of the percentage of muscle tissue in pig carcasses, acquired on a slaughter line, are shown in Table 1. It is noticeable from the table that the average weight of cold carcasses was

Figure 1. EU reference method of dissection (Walstra and Merkus, 1995)

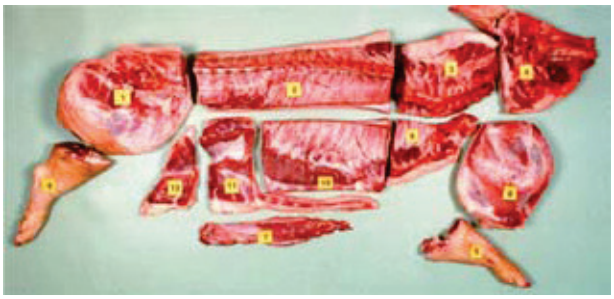


Figure 2. Dissected leg (muscle, osseous, fat tissue)

Figure 3. Dissected shoulder (muscle, osseous, fat tissue)

Figure 4. Dissected loin (muscle, osseous, fat tissue)

Figure 5. Dissected belly (muscle, osseous, fat tissue)

Table 1. Measures collected at slaughter line for methods of estimation of lean percentage in a pig carcass

Measure	N	Mean	Min.	Max.	Standard deviation	Standard error
Cold carcass, (kg)	146	39,7	25,49	56,46	57,59	4,77
Back fat thickness (inst.). S (mm)	146	18,57	3,00	51,00	8,56	0,70
Muscle thickness (inst.). M (mm)	146	61,22	32,60	80,00	9,90	0,82
Back fat thickness (TP). S (mm)	144	16,30	4,00	45,00	7,35	0,61
Muscle thickness (TP). S (mm)	144	68,35	50,00	81,00	6,53	0,54

39.71 kg; the back fat thickness measured at the point for the instrumental method prescribed by the Croatian Regulation was 18.57 mm, whereas the thickness of muscles was 61.22 mm in average. The measure of back fat thickness taken for the estimation of the leanness by the "Two Points" method was 16.30 mm, and the thickness of muscles was 68.35 mm.

Table 2 shows the shares of muscle tissue estimated by the "Two Points" and the instrumental methods and the percentage of meat determined by the EU reference method of dissection. It can be noticed from the table that the relative share of muscle tissue in pig carcasses determined by both methods prescribed by the Croatian Regulation, was significantly lower ($p < 0.05$) from the share of muscle tissue determined by the EU reference method of dissection. This implies to insufficient accuracy of the estimation of muscle tissue percentage in pig carcasses by the methods from the Regulation valid in the Republic of Croatia at the time of the research, and by that, this also implies to the need for establishing new equations for the estimation of muscle tissue in pig carcasses.

Table 2. Results of applying different methods for determining muscle tissue in pig carcasses

Statistic indicators	Instrumental method	TP method	% of muscle tissue (EU reference method)
Arithmetic mean	54,35[a]	55,44[a]	56,32[b]
Min.	40,91	41,79	34,34
Max.	68,09	69,65	69,97
Standard deviation	5,34	5,39	6,41
N	146	144	146

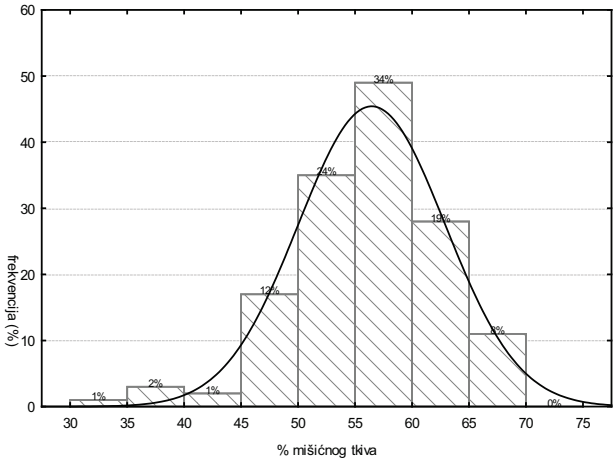
a, b ($p<0.05$)

Graph 1 shows that the leanness was from 50 to 65 % in 77% of pig carcasses which allocates the same share of pigs to three commercial classes (S, E and U). Because of that, curve of the distribution of the muscle tissue percentage shows a slight deviation to the left.

Table 3 shows absolute and relative composition of carcasses from the dissection experiment carried out on a representative sample of pig carcasses from the Republic of Croatia. The highest share in researched pig carcasses is leg (24.79 %), followed by loin (14.92 %), shoulder (12.06 %) and belly (9.36 %). Pulkrabek et al. (2006) studied the leanness of carcasses from the Czech pig population. If we compare the results of our research to the results of the listed authors, it can be seen that the average share of leg in carcasses of the Croatian pigs is higher for 4.80 percent point in comparison to the population researched in the Czech Republic, the average share of loin is higher for 2.78, average share of shoulder is higher for 1.06, and the share of belly in the pig carcass is lower for 0.82 percent points in comparison o pig carcasses from the Czech Republic.

The results of the performed dissection shown in table 4 have enabled insight to the most important tissues (muscle, fat tissue and bones) in each of four dissected parts, as well as to the shares of these tissues in entire pig carcass. The highest percentage of muscle tissue with the lowest share of the total fat tissue has been determined in the leg (69.60, i.e. 22.31%), whereas in the belly the situation is reverse; the most represented tissue that was determined is fat tissue (40.16%) and the least represented is muscle tissue (53.42%). The highest share of bones has been determined in the loin (12.25%), and the lowest in the belly (6.42%). From the results shown, it can be seen that the largest share of muscle tissue of pig carcasses is in the leg (18.17%), followed by loin (8.68%), shoulder (7.50%) and belly (4.94%). The highest share of the total and dissected subcutaneous fat tissue with skin in a carcass comes from the leg (4.79%), then from the loin (3,36%), shoulder (2,78%) and belly (0.03%). The

Graph 1. Distribution of muscle tissue percentage determined by the EU reference method (N = 146)



share of intramuscular fat tissue in a carcass is mostly contributed to by the leg (0.80%), then belly (0.72%), the loin (0.64%) and shoulder (0.56%). The highest share of bones in a carcass comes from the leg (2.00%), it is followed by bones from the loin (1.82%), shoulder (1.31%) and belly (0.59%). Similar studies were carried out by Kosovac et al. (2006) in Serbia. The following has been determined by comparing the results: percentage- share of the muscle tissue in the leg is higher in the Croatian

Table 3. Composition of the investigated pig carcasses (N = 146)

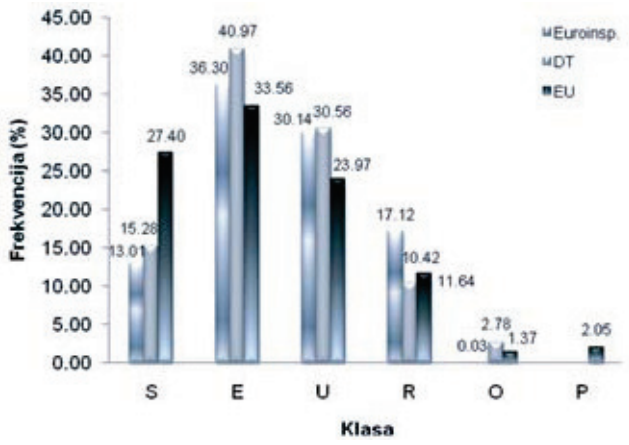
Part of the carcass	Weight (g)	Share in the carcass (%)
Cold carcass (kg)	39,02	-
Leg (kg)	9,82	24,79
Loin (kg)	5,95	14,92
Shoulder (kg)	4,78	12,06
Belly (kg)	3,74	9,36
Tenderloin (kg)	0,40	1,01
Head with cheek (kg)	2,93	7,40
Front shank + foot (kg)	1,20	3,06
Hind shank + foot (kg)	1,99	5,06
Jawl (kg)	2,59	6,50
Ventral part of belly (kg)	1,71	4,30
To ventral part of belly(kg)	0,82	2,07

Table 4. Shares of the most important tissues in dissected parts and cold pig carcasses

Part of the carcass	Share in the part of carcass (%)	Share in the carcass (%)
LEG		
Muscle tissue	69,60	18,17
Total fat tissue	22,31	5,59
Subcutaneous fat tissue with skin	19,08	4,79
Intramuscular fat tissue	3,23	0,80
Bones	8,09	2,00
LOIN		
Muscle tissue	58,47	8,68
Total fat tissue	29,28	4,00
Subcutaneous fat tissue with skin	25,04	3,36
Intramuscular fat tissue	4,24	0,64
Bones	12,25	1,82
SHOULDER		
Muscle tissue	62,34	7,50
Total fat tissue	27,03	3,34
Subcutaneous fat tissue with skin	22,41	2,78
Intramuscular fat tissue	4,62	0,56
Bones	10,62	1,31
BELLY		
Muscle tissue	53,42	4,94
Total fat tissue	40,16	0,75
Subcutaneous fat tissue with skin	32,5	0,03
Intramuscular fat tissue	7,66	0,72
Bones	6,42	0,59

population of pigs for 4.78 percent points, the average share of skin and the subcutaneous fat tissue of the leg is lower for 5.92 percent points. The average share of bones of the leg is lower for 2.09 percent points, and the average share of intramuscular fat tissue is higher for 0.60 percent

▼ **Graph 2.** Allocating pig carcasses to commercial classes (SEUROP)



points. The share of muscle tissue in the loin is higher for 8.73, the share of muscle tissue at the shoulder is lower for 3.16 percent points, whereas at the belly the share of muscle tissue is approximately equal, i.e. it is lower for 0.26 percent points in the Croatian pig population.

If we compare the results of our researches to the results of Paulkrabek et al. (2006), who were determining the leanness of pig carcasses in the Czech Republic, it can be seen that the share of muscle tissue in the leg in carcasses from the Croatian pig population is lower for 1.82, the share of muscle tissue in the loin is lower for 3.46, the share of muscle tissue in the shoulder is lower for 3.50 and the share of muscle tissue in the belly is lower for 5.24 percent points.

Graph 2 shows the shares of pig carcasses in commercial classes estimated by the valid methods of estimation (TP and the instrumental method), as well as those determined by the method of dissection. It can be seen from the shown graph that 15.28% of pig carcasses have been allocated to the best- quality commercial class S by the TP method, 13.01% by the instrumental method, whereas it has been determined by dissection that 27.40% of pig carcasses actually belong to the mentioned class. By the "Two Points" method around 72% of pig carcasses have been allocated to medium- quality commercial classes (E and U), whereas by the EU reference method of dissection only around 58% of pig carcasses have been allocated to the same classes. It can be also noticed from the graph that by both methods of estimation not one carcass has been allocated to the lowest class (P), whereas by the EU reference method 2.05% of carcasses have been allocated to the same class. Čandek- Potokar and Kovač (2004) were researching the leanness of pig carcasses in Slovenia, so they classified them to classes (SEUROP) by the EU reference method. But, at the time when the Slovenian authors publicized their results, the EU legislative was prescribing a different manner of calculation of the referent lean share by dissection, so it is not possible to compare their results with the results shown in our research.

CONCLUSION

From the results of the conducted study, the following can be concluded:

The relative share of muscle tissue in pig carcasses estimated by both methods prescribed by the Croatian Regulation was lower from the share of muscle tissue determined by the EU reference method of dissection. Statistically significant differences ($p < 0.05$) were found out between the leanness objectively determined by dissection and the leanness estimated by the "Two Points" method.

Leg is the part of carcass with the highest share of muscle tissue with the lowest share of the total fat tissue, whereas the most of the total fat tissue was found out in the belly, with the least muscle tissue. The share of bones was the highest in the loin, and the lowest in the belly.

In the total muscle tissue of a pig carcass, the highest share is in the leg, followed by the loin, shoulder and belly. The leg also contributes with the highest share of the total and subcutaneous fat tissue with the skin in the entire carcass, after which follows the loin, shoulder, and belly. The share of intramuscular fat tissue in a pig carcass is most contributed by the leg again, after which follow the belly, loin and shoulder.

By classifying pig carcasses into commercial classes (SEUROP) by both methods of estimation, as well as by the method of dissection, it has been found out that around 15% of pig carcasses were allocated to S class, whereas by the EU reference method as much as 27.40% of pig carcasses were allocated to the same class. By the TP method around 72% of carcasses were allocated to medium- quality commercial classes (E and U), whereas it has been found out by dissection that only 58% of pig carcasses belong to these classes.

The results of this research point out the need of establishing new equations for estimation of lean percentage in pig carcasses produced in the Republic of Croatia.

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Received: October 3, 2008
Accepted: November 26, 2008