Bulgarian Journal of Agricultural Science, 21 (No 6) 2015, 1272-1277
Agricultural Academy

CARCASS COMPOSITION AND PHYSICOCHEMICAL CHARACTERISTICS OF *M. LONGISSIMUS DORSI* AND *M. SEMIMEMBRANOSUS* IN PIGS CROSSES OF YOUNA AND PIETRAIN

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Abstract

MARINOVA, P., M. IGNATOVA, J. NAKEV, T. POPOVA and M. TODOROVA, 2015. Carcass composition and physicochemical characteristics of *m. Longissimus dorsi* and *m. Semimembranosus* in pigs crosses of Youna and Pietrain. *Bulg. J. Agric. Sci.*, 21: 1272–1277

The study was carried out with 47 male castrated and female pigs, crosses of Youna and Pietrain. The aim of the work was to determine the meat productivity and quality of *m. Longissimus dorsi* (*m. LD*) and *m. Semimembranosus* (*m. SM*) in fattened pigs with a pre-slaughter weight of 105 kg (+ 2.5) and average weight of skinned and cooled carcass of 61.66 kg. The percentage of the valuable parts of the carcass was as follows: leg – 27.05%, loin - 16.89%, shoulder - 14.06%, neck - 14.76%, belly with bones - 13.74%. Muscle tissue in the half carcass had the highest percentage - 61.80%. The contents of the rest of the tissues were respectively: intermuscular fat - 8.31%, subcutaneous fat – 15.16% and bones – 14.64%. Values of pH 45 min *post mortem*, typical for PSE meat, were not found and those of pH 24 h in both muscles were within the normal range for pork. The quality traits had normal values for this kind of meat and were close for *m. LD* and *m. SM*. The content of intramuscular fat in *m. LD* was 2.61%, while in *m. SM* it was 2.36%. These values are relatively high (above 2%) and are important for the good sensory characteristics of the meat.

Key words: pigs, crosses, carcass, meat, quality

Introduction

In industry, pigs for fattening are a result of crossing of several pig breeds as in the terminal form for slaughter the aim is to increase the lean meat content and the economic effect of its breeding. In addition to Landrace GENE+ and Large White GENE +, Chinese multiparous breeds (Youna), Duroc DRB, Syra, etc. participate in some of the maternal crosses offered in the market. As a terminal sire breed Pietrain, PIC 410, etc., are used to improve the carcass composition towards increase of the muscle content and decrease of the fats (Latorre et al., 2003, 2008). However in many cases the selection toward rapid growth and more lean meat in pigs leads to deteriorated quality parameters in meat (Đurkin et al., 2012). Hence the choice and testing of suitable schemes of crossing are of great importance for the pig industry.

The aim of this study was to determine the content of the individual tissues in the carcass as well as the physicochemical parameters of *m. Longissimus dorsi* and *m. Semimembranosus* in pigs crosses of Youna and Pietrain.

Materials and Methods

Experimental animals

The study was carried out in the experimental farm of the Institute of Animal Science – Kostinbrod with 47 male castrated (24) and female (23) crosses of Youna ♀ x Pietrain ♂. The animals were included in the experiment with an average live weight of 51.55 kg, fed *ad libitum* concentrate containing 14.27% protein and had free access to water. The average pre-slaughter weight of the pigs was 105 kg (± 2.5).

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All the animals were slaughtered in a certified slaughterhouse at a distance of 5 km from the Institute, on the day of the transportation of the pigs. The carcasses were skinned, without head and feet.

Carcass analysis and physicochemical traits of the meat

The linear measurements, carcass analysis and sampling were performed on the left half of the carcasses after 24 h storage at + 4◦C. The cutting and dissection of the carcass were done according to the EU procedure (Walstra et al., 1996; Rules for assessing the breeding value, production and classification of breeding pigs, 1996).

The physicochemical analysis of the *Longissimus dorsi (lumborum) (m.LD)* and *Semimembranosus (m.SM)* muscles includes the following traits: values of pH1 45 min *post mortem*, pH2 24 h *post mortem*, colour/R (525 nm), water holding capacity (Grau and Hamm, 1952), myoglobin content (Hornsey et al., 1956), fats (Soxhlet), protein (Kjieldal), moisture and ash.

The statistical evaluation of the results is done using JMP v.7 software.

Results and Discussion

Linear measurements of the carcass

The linear measurements of the carcass are presented in Table 1. Measurement of the fat thickness in certain anatomical locations is a main selection criterion for determination of the fat content in the pig carcasses (Wajda et al., 2004). This parameter is more important for the development of regression equations for prediction of lean meat content in the carcass for improvement of the breeds (Marinova et al., 2002; Różycki, 2003). In our study the fat thickness is measured at locations used in the selection and completed with such, reported in the literature that are most often used for determination of the lean meat content in the carcass. In the latter case the requirement for the choice of the anatomical location includes easily accessible location for measurement with invasive and noninvasive device without dissection of the carcass as well as the possibility for it to be used as a prediction trait. Jiang et al. (2012) reported an average thickness of 1.67 cm for the fat, measured at the first and last rib and last lumbar vertebra in scalded pigs.

In Pietrain pigs Tereszkiewicz et al. (2010) pointed fat thickness of 1.53 cm measured in five locations. In studies with crosses Youna x Pietrain values of 17.3, 32.9 and 13 mm for the fat thickness at the back, withers and L2 were determined. In crosses and hybrids raised in Bulgaria insignificant differences in the fat thickness in the mentioned locations were reported (Nakev et al., 2005; Slanev et al., 2006). The measurements of the backfat at the penultimate rib, along the dorsal midline and at 8 cm of it had close values contrary to those at ¾ rib. The variation coefficients are high which is typical for this parameter. The area and depth of *m. LD* and

Table 1
Carcass measurements in Youna x Pietrain pigs

Traits		$\overline{X}$	Sx	CV
Backfat thickness at penultimate rib, mm	Dorsal midline	13.73	0.6	26.63
	At 8 cm of the dorsal midline	12.59	0.76	24.97
Backfat thickness at 3/4 rib, mm	Dorsal midline	15.27	0.77	30.81
	At 8 cm of the dorsal midline	11.94	0.75	26.06
Depth of *m.LD*, mm	Last rib	59.4	1.4	14.33
	3/4 rib	57.5	1.14	12.07
Area of *m.LD*, cm ^{2}	Last rib	39.67	0.92	14.12
	3/4 rib	37.22	0.77	12.57
Fat thickness at *m. Gluteus medius*, mm	L1 - cranial part	15.51	0.62	24.32
	L2 - widest part	9.84	0.65	39.91
	L3 - caudal part	16.45	0.81	30.05
Depth of *m. Gluteus medius*	F	20.57	0.86	25.44
Carcass length, cm		93.78	0.61	3.97
Leg length, cm		45.43	0.28	3.7
Leg circumference, cm		53.11	1.01	11.59
Fat thickness at withers, mm		30.36	0.85	16.96

m. GM are other important traits used for prediction of the lean meat content in pig carcasses. In smaller slaughterhouses where it is not economically justifiable to use expensive devices, prediction models are developed using the measurements of *m. GM*. In our country there is no data for the thickness of *m. LD*, while Heyer et al. (2007) showed high values of the depth and the area in *m. LD* in Large White x Landrace crosses - 61.7 mm and 48.71 cm², respectively. In this study, the length of the carcass is smaller when compared to that of Youna x Pietrain crosses, raised in France up to 110 kg pre-slaughter weight - 99.7 cm (Agence de la Selection Porcine, 2009).

Carcass analysis

The average cold weight of the carcass was 30.83 kg as the percentage of the muscles is the highest, followed by the fats and bones (Figure 1). In pigs of three different genotypes, mainly crosses of Peitrain with Yorkshire and Hampshire, Bahelka et al. (2007) reported average meat content in the carcass of 55.13%, whereas that of the fats was - 19.69%. Jiang et al. (2012) determined average meat content of 66.40% and bone content of 13.43% in hybrids including Pietrain. In the same study they reported that the content of skin with fats was 20.17%. The percentage of the subcutaneous fats in crossbred pigs is higher when compared to that of Tereszkiewicz et al. (2010) reported for pure Pietrain pigs.

The results of our study could be hardly compared to those of other authors, since in most of the European countries and in the bigger slaughterhouses in Bulgaria the carcasses are scalded. The higher lean meat content (61.80%) in this trial is due to the skinned carcasses, without skin, heads and feet and so the weight is lower but the lean meat percentage is higher as a result of elimination of parts with low meat content. The results obtained showed that the subcutaneous fats had highest percentage, followed by the intermuscular, while the pelvic fats were in minor quantities. The weight of the separate parts of the half carcass (as % of its weight) is an indicator for evaluation of the valuable parts of the carcass. The percentage of the leg was the highest, while that of the loin, shoulder, belly with bones and neck was within the range of 16.89% - 14.76% (Figure 2). The dissection of the separate parts of the half carcass (Table 2) showed that in the studied pigs the legs had the highest percentage of muscles (71.46%) and with the exception of the neck, they displayed the lower percentage of subcutaneous fat as well (14.03 %). The meat percentage in the shoulder (63.13%) is considerably higher than that in the loin, belly with bones and neck at relatively close percentage of the rest of the valuable parts in the half carcass. The intermuscular fats in these parts that are not separated of the meat are within the range of 3.35% (leg) to 6.45% (shoulder) and have higher and closer values in the belly with bones and neck (14.65 - 14.94%).

Physicochemical composition of muscles

The pH values are indicative for changes in the muscles after slaughter and according to many authors they influence considerably the technological and sensory quality of meat (Monin and Sellier, 1985; Eikelenboom et al., 1995). In this study none of the three abnormalities in pork linked to the pH (Sellier, 1998) were observed, since the pH measured 45 min post mortem were above 6.00 (Table 3). The ultimate pH values were within the normal range in *m. Longissimus dorsi* and *m. Semimembranosus*. In Pietrain crosses, Jiang et al. (2012) reported values of pH 5.63, lower when compared to Duroc crosses. On the other hand Agence de la Seléction Porcine (2009) showed values of ultimate pH in Youna x Pietrain and Carlyne x Pietrain, respectively 5.69 and 5.66.

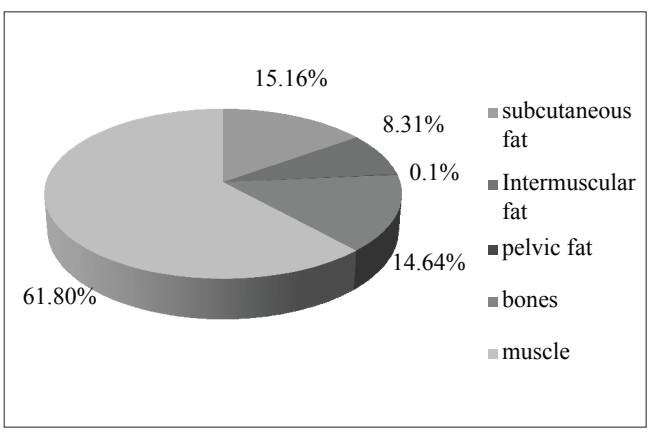

Fig. 1. Tissue content in the half carcass of Youna x Pietrain pigs, %

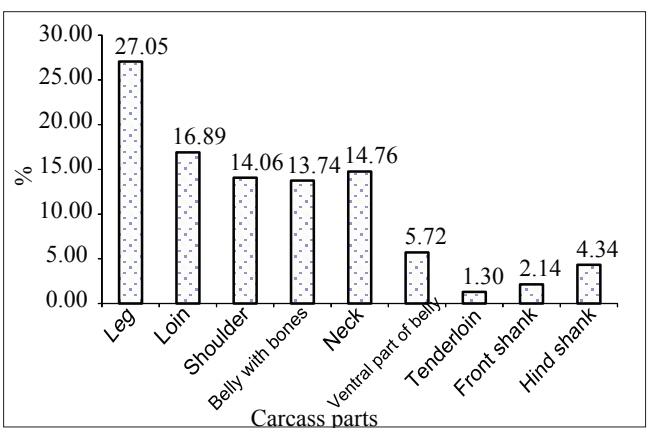

Fig. 2. Percentage of the separate parts in the carcass half in Youna x Pietrain pigs

Table 2
Carcass composition of Youna x Pietrain pigs

Parts of the carcass	Trait	$\bar{X}$	Sx	CV	%
Cold carcass	Left half, kg	30.83	0.462	10.30	100.00
Leg	weight, kg	8.34	0.125	10.30	100.00
	subcutaneous fat, kg	1.17	0.066	39.00	14.03
	intermuscular fat, kg	0.28	0.012	30.30	3.35
	pelvic fat, kg	0.03	0.003	63.20	0.36
	bones,kg	0.9	0.013	10.40	10.79
	meat, kg	5.96	0.097	11.20	71.46
Loin	weight, kg	5.21	0.12	15.90	100.00
	subcutaneous fat, kg	0.92	0.059	44.00	17.66
	intermuscular fat, kg	0.27	0.012	33.90	5.18
	bones, kg	0.99	0.024	16.50	19.00
	meat, kg	3.03	0.071	16.10	58.16
Shoulder	weight, kg	4.34	0.068	10.80	100.00
	subcutaneous fat, kg	0.71	0.034	33.10	16.37
	intermuscular fat, kg	0.28	0.01	25.80	6.45
	bones, kg	0.61	0.01	11.70	14.05
	meat, kg	2.74	0.048	12.20	63.13
Belly with bones	weight, kg	4.23	0.206	33.50	100.00
	subcutaneous fat, kg	0.8	0.062	52.90	18.91
	intermuscular fat, kg	0.62	0.036	40.40	14.65
	bones, kg	0.51	0.026	36.30	12.05
	meat, kg	2.3	0.109	32.50	54.37
Neck	weight, kg	4.55	0.112	16.90	100.00
	subcutaneous fat, kg	0.42	0.023	38.70	9.23
	intermuscular fat, kg	0.68	0.034	34.70	14.94
	bones,kg	0.77	0.017	15.90	16.92
	meat, kg	2.68	0.077	19.70	58.9
Ventral part of belly	weight, kg	1.76	0.047	18.50	100.00
	subcutaneous fat, kg	0.46	0.031	46.70	26.13
	intermuscular fat, kg	0.35	0.019	37.70	19.88
	meat, kg	0.95	0.023	17.10	53.97
Tender loin	weight, kg	0.40	0.009	15.60	100.00
Front shank	weight, kg	0.66	0.009	10.10	100.00
	subcutaneous fat, kg	0.04	0.001	26.80	6.06
	intermuscular fat, kg	0.03	0.002	56.90	4.54
	bones, kg	0.28	0.004	11.00	42.42
	meat, kg	0.31	0.006	13.50	46.97
Hind shank	weight, kg	1.34	0.021	10.80	100.00
	subcutaneous fat, kg	0.15	0.005	27.40	11.19
	intermuscular fat, kg	0.06	0.003	39.70	4.48
	bones, kg	0.45	0.006	10.40	33.58
	meat, kg	0.68	0.014	14.40	50.75

Table 3
Physicochemical composition of *m. Longissimus dorsi* and *m. Semimembranosus* in Youna x Pietrain pigs

Trait	x	Sx	CV
m. Longissimus dorsi			
pH45	6.36	0.05	4.09
pH24	5.62	0.02	2.84
Colour /R (525)	28.52	0.41	9.92
Water holding capacity, %	41.59	0.34	5.65
Myoglobin, mg /g	1.16	0.02	14.65
Fats, %	2.61	0.13	34.48
Proteins, %	21.71	0.11	3.54
Moisture, %	73.64	0.16	1.49
Ash, %	1.16	0.03	15.51
m. Semimembranosus			
pH24	5.72	0.03	3.32
Colour/R (525)	26.23	0.34	8.84
Water holding capacity, %	41.37	0.45	7.42
Myoglobin, mg /g	1.27	0.03	14.96
Fats, %	2.36	0.12	35.59
Proteins, %	21.44	0.11	3.73
Moisture, %	74.22	0.15	1.38
Ash, %	1.14	0.03	16.66

The colour of the muscles (R-525 nm) was closer to that of Pietrain and Belgian Landrace (Marinova, 2000). This trait affects the consumers preferences but also indicates PSE meat if it exists. The water holding capacity displayed values above 41%, that are unfavourable for meat that would be consumed fresh or processed products (den Hertog-Meischke et al., 1997). The main factors influencing the water holding capacity are the genotype (HAL and RN genes), preslaughter treatment and stunning methods (Claeys et al., 2001; Schäfer et al., 2002). According to den Hertog-Meischke et al. (1997), another important parameter affecting the water holding capacity is the predominant type of the muscle fibers, as muscle with higher content of glycolytic fibers have lower water holding capacity, faster pH decline *post mortem* (Lawrie, 2005), and lower ultimate pH. Glycolytic fibers are predominant in the muscles in the study as the lighter zone of *m. SM* is close to the traits of *m. LD.*

According to Park et al. (2002), the latter two are linked to the values of pH 24 h *p.m*., as the water holding capacity decreases and the meat has lighter colour when the values of pH are lower. The total content of intramuscular fat (called also marbling fat) is an important quality trait, since it is linked to the tenderness and juiciness of meat (Kaufmann and Warner, 1993). The recommended values of the content of intramuscular fat vary between 2% and 4% (Verbeke et al., 1999). In this study the average content of intramuscular fat is within 2.36 - 2.61%. The role of the intramuscular fat is very important since as a result of the selection toward more lean meat, the content of intramuscular fat decreases below 1% in the modern pig breeds (Wood et al., 2008). In a study with pigs Wood et al. (1986) reported intramuscular fat content of 0.55, 0.66, 0.96% in *m. Longissimus dorsi* and fat thickness respectively 8, 12 and 16 mm. Many studies however conclude that intramuscular fat content below 2.5% is not favourable for the organoleptic traits of the meat (Enser and Wood, 1991; Fernandez et al., 1999). The values of the variation coefficient for this trait are relatively high (34.38-35.59%). In Landrace pigs as well as in crosses Hapshire x Pietrain and Yorkshire x Pietrain, Bahelka et al. (2007) reported variation coefficients 30.17 for intramuscular fat content of 2.25%.

The results of our study showed moisture content in m. *Longissimus dorsi* and *Semimembranosus*, close to those determined by Stanišić et al. (2013) in *m. LD* 73.52 - 73.85% in Swedish Landrace and of Kim et al. (2008) - 75.51% and 75.48%, respectively for *m. LD* and *m. SM* in commercial pigs. The latter found protein content of 21.79% and 20.89% in these muscles and ash content that is relatively lower - 0.99% average for both muscles. Our results for protein content are lower than those determined by Radović et al. (2009) in *m. LD* in Swedish Landrace and Large Yorkshire - 24.11% and 24.09%, respectively, and are close to those for ash content - 1.17% and 1.17%.

Conclusions

The male castrated and female pigs crosses of Youna♀ and Pietrain ♂, with cold weight of the carcass of 61.66 kg had the following percentages of the valuable parts of the carcass: leg – 27.05% , loin - 16.89%, shoulder - 14.06%, neck - 14.76%, belly with bones - 13.74%.

The muscles had the highest content (61.80%), followed by that of the subcutaneous fat (15.16%), bones (14.64%) and the intermuscular fat (8.31%).

Values of pH 45 min post mortem typical for PSE meat were not determined in *m. Longissimus dorsi* (*m. LD*). The physicochemical composition of both muscles was within the normal range for pork. The content of intramuscular fat in m. LD was 2.61% and that in *m. SM* – 2.36%. These contents are relatively high (above 2%) and important for the good sensory characteristics of the meat.

References

Agence de la Seléction Porcine, 2009. TechniPorc, Résultats du 29-éme Test de Contrôle des Produits Terminaux, vol.32, №4, *Ministere de l'Agriculture*, France.

Bahelka, I., E. Hanusova, D. Peškovičova and P. Demo, 2007. The effect of sex and slaughter weight on intramuscular fat content and

its relationship to carcass traits of pigs. *Czech J. Anim. Sci.,* **52** (5): 122-129.

Claeys, E., S. De Smet, D. Demeyer , R. Geersand N. Buys, 2001. Effect of rate of pH decline on muscle enzyme activities in two pig lines. *Meat Sci.*, **57**: 257-263.

den Hertog-Meischke, M. J., R. J. van Laack and F. J. Smulders, 1997. The water-holding capacity of fresh meat. *Vet. Q.*, **19**: 175-181.

Đurkin, I., B. Lukić, G. Kušec, Ž. Radišić, Z. Maltar and V. Sili, 2012. Meat quality traits and chemical composition of hybrid pigs originating from two different terminal sire lines. *Meco*, **14** (1): 61-65.

Eikelenboom, G., P. G. van der Wal and A. G. de Vries, 1995. The significance of ultimate pH for pork quality. 1995, In: 41st Annual Int. Con. of Meat Sci. and Tech., 20 - 25 August, 1995, San Antonio,Texas, USA, pp. 654-655.

Enser, M. and J. D.Wood, 1991. Factors Controlling Fat Quality in Pigs, Berlin, Germany, *EAAP*, 42, 32 pp.

Fernandez, X., G. Monin, A. Talmant, J. Mourot and B. Lebret, 1999. Influence of intramuscular fat content on the quality of pig meat – 2. Consumer acceptability of *m. longissimus lumborum*. *Meat Sci.*, **53**: 67-72.

Grau, R. and R. Hamm, 1952. Eine einfache methode zur bestimmung der wasserbindung in fleisch. *Fleischwirschaft*, **4**: 295-297.

Heyer, A. and B. Lebret, 2007. Compensatory growth response in pigs: Effect on growthperformance, composition of weight gain at carcass and muscle levels, and meat quality. *J. Anim. Sci.*, **85**: 769-778.

Hornsey, H. C., 1956. The colour of cooked cured pork. I. Estimation of the nitric oxide haem-pigments. *J. Sci. Food Agric.*, **7**: 534-540.

Jiang, Y. Z., L. Zhu, G. Q. Tang, M. Z. Li, A. A. Jiang, W. M. Cen, S. H. Xing, J. N. Chen, A. X. Wen, T. He, Q. Wang, G. X. Zhu, M. Xie and X. W. Li, 2012. Carcass and meat quality traits of four commercial pig crossbreeds in China. *Genet. Mol. Res***. (in press).**

JMP, 2007. Version 7, *SAS Institute Inc*., Cary, NC.

Kaufmann, R. G. and R. D. Warner, 1993. Evaluating pork carcasses for composition and quality. In: G. R. Hollis (Ed) Growth of the Pig. *CABI*, Oxon, England, 141 pp.

Kim, J. H., P. N. Seong, S. H. Cho, B. Y. Park, K. H. Hah, L. H. Yu, D. G. Lim, I. H. Hwang, D. H. Kim, J. M. Lee and C. N. Ahn, 2008. Characterization of nutritional value for twenty-one pork muscles, Asian-Aust. *J. Anim. Sci.,* **21** (1): 138-143.

Latorre, M. A., P. Medel, A. Fuentetaja, R. Lázaro and G. G.Mateos, 2003. Effect of gender, terminal sire line and age at slaughter on performance, carcass characteristics and meat quality of heavy pigs. *Anim. Sci.*, **77**: 33-45.

Latorre, M. A., C. Pomar, L. Faucitano, C. Gariépy and S. Méthot, 2008. The relationship within and between production performance and meat quality characteristics in pigs from three different genetic lines. *Livest. Sci.,* **115**: 258-267.

Lawrie, R. A., 2005. Ciência da Carne. 6th ed., *Artmed*, Porto Alegre.

Marinova, P., 2000. Study on the post-natal development and breed characteristics of the muscle tissue in pigs and on the relation between its quantity and quality parameters. DSc Dissertation, *Agricultural Academy*, Sofia (Bg).

Marinova, P., E. Raicheva and D. Katsarov, 2002. Manual for classification of living animals and carcasses of sheep, cattle and pigs according to SEUROP, *IAS - Kostinbrod*, RDP Livestock services B.V. (Bg).

Monin, G. and P. Sellier, 1985. Pork of low technological quality with a normal rate of muscle pH fall in the immediate post-mortem period: The case of the Hampshire breed. *Meat Sci*., **13**: 49-63.

Nakev, J., S. Slanev, A. Stoikov and Y. Marchev, 2005. Comparative study of the slaughter characteristics and meat quality in two-bred hybrid pigs with participation of Danube White breed. *J. Anim. Sci*., **4**: 13-18 (Bg).

Park, B. Y., S. H. Cho, Y. M. Yoo, J. H. Kim, H. S. Chae, J. N. Ahn, Y. K. Kim, J. M. Lee, S. G. Yun, 2002. Comparison of pork quality by different postmortem pH24 values**.** *J. Anim. Sci. Technol*., **44**: 233-238.

Radović, Č., M. Petrović, O. Kosovac, N. Stanišić, D. Radojković and M. Mijatović, 2009. The effect of different fixed factors on pig carcass quality and meat traits. *Biotechnol. Anim. Husbandry*, **25**: 189-196.

Różycki, M., 2003. Selected traits of Polish pedigree pigs – Progress in the carcass of meatiness and pork quality. *Anim Sci. Pap. Rep*., **21** (Suppl. 1): 163-172.

Rules for Assessing the Breeding Value, Production and Classification of Breeding Pigs, Shumen, 1996.

Schäfer, A., K. Rosenvold, P. P. Purslow, H. J. Andersen and P. Henckel, 2002. Physiological and structural events post mortem of importance for drip loss in pork. *Meat Sci.*, **61**: 355-366.

Sellier, P., 1998. Genetics of meat and carcass traits. In: M. F. Rothschild and A. Ruvinsky (Eds.) The Genetics of the Pig, *CAB International*, Wallingford, pp. 38-45.

Slanev, S., J. Nakev, A. Stoikov and A. Apostolov, 2006. Study on the carcass slaughter value and meat quality of two crosses regarding to creation of high productive synthetic boars and hybrids. *J. Anim. Sci.,* **5:** 26-31(Bg).

Stanišić, N., M. Petrović, Č. Radović, M. Gogić, N. Parunović, S. Stajić and M. Petricević, 2013. The effect of gender and breed on some properties of pig meat. *Biotechnol. Anim. Husbandry,* **29**: 651-658.

Tereszkiewicz, K., P. Molenda, M. Ruda and R. Korona, 2010. Fat content and fat Distribution in the carcasses of Pietrain pigs**.** *Acta Sci. Pol., Zootechnica,* **9** (1): 31-40.

Verbeke, W., M. J. van Oeckel, N. Warnants, J. Viaene and Ch. V. Boucque, 1999. Consumer perception, facts and possibilities to improve acceptability of health and sensory characteristics of pork. *Meat Sci*., **53**: 77-99.

Wajda, S., R. Winarski and K. Borzuta, 2004. Usefulness of fat thickness measurements for assessment meat content in pig carcasses. *Zesz. Nauk. Prz. Hod*., **72** (2): 177 (Pl).

Walstra, P. and G. Mercus, 1996. Procedure for Assesment of the Lean Meat Percentage as a Consequence of the New EU Reference Dissection Method in pig Carcass Classification, Report ID-DLO 96.014.22.

Wood, J. D., R. C. D. Jones, M. A. Francombe and O. P. Whelehan, 1986. The effects of fat thickness and sex on pig meat quality with special reference to the problems associated with overleanness. 2. Laboratory and trained taste panel results. *Anim. Prod*., **43**: 535-544.

Wood, J. D., M. Enser, A. V. Fisher, G. R. Nute, P. R. Sheard, R. I. Richardson, S. I. Hughes and F. M. Whittington, 2008. Fat deposition, fatty acid composition and meat quality: A review. *Meat Sci.* **78**: 343-358.

Received December, 17, 2014; accepted for printing October, 5, 2015