Possibilities for development of methods for assessment of meat productivity in skinned pigs I. Value of some parameters determining the carcass composition and correlation between them in skinned pig carcasses

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SUMMARY

The aim of the study was to establish the value of some parameters for determination of the composition of carcass as well as the correlation between them in skinned pigs. In order to determine the slaughter characteristics and the morphological components of the carcass and its individual parts the information about the composition of the left half carcasses of 70 pigs, crosses of ♀Youna and ♂Pietrain was used. The animals were of the same sex and slaughtered at an average live weight of 105 kg (± 2.5%). The pigs were skinned, head and feet removed. The results of the carcass analysis showed that muscles had the highest percentage in the half carcass - 61.47%. The content of intermuscular fat was 8.10%, while that of subcutaneous fat was – 15.41%. The percentage of bones was 14.94%. The proportion of the valuable parts in the carcass of the pigs from the study was as follows: leg-27.74%, loin-17.46%, shoulder-14.10%, neck- 13.08% and belly– 14.45 %. The phenotypic correlation coefficients between the backfat thickness and the amount of subcutaneous and intermuscular fat were estimated at moderate to high positive levels. The depth of m. *Longissimus dorsi* (m. LD), measured 7 cm laterally above the last and between 3^{d} and 4th rib determined to a great extent (r_p= 0.612^{+++}**;** r_p= 0.578^{+++}**)** the amount of lean meat in the carcass of skinned pigs. Significant dependences were determined between the lean meat percentage and the backfat thickness, measured on the cutting line, laterally to m. *Gluteus medius* (m.GM) – L_1(r_p= - 0.640^{+++}**,** Rxy= - 0,782), L_2 (r_p= - 0.720^{+++}**,** Rxy= - 0,898), and L_3 (r_p= - 0.722^{+++}**,** Rxy= - 0,677).

Keywords: pigs, carcass, correlation, regression

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INTRODUCTION

The slaughter value in pigs is determined mainly by the ratio between the morphological components of the carcass. The lean meat percentage has been used as a main quality trait in Bulgaria since 2004 (Regulation 21/14.05.2004 of Ministry of Agriculture and Food). The methods applied for determination of this trait are direct and indirect, as the latter are based on precisely measured values at different points of the carcass, that strongly depend on the lean meat percentage (Busk, 2002).

The efficiency of the indirect models has been shown in numerous studies (Daumas et al. 1998 a, b; Pulkrábek et al., 2003; Čandek-Potokar et al., 2004; Lisiak et al., 2006; Vítek et al., 2008; Kvapilík et al., 2009; Pulkrábek et al 2011; Lisiak et al., 2012;Duziński et al., 2015).

The research on the dependences between the traits characterizing the slaughter value of the carcass are continuous process due to endogenous and exogenous changes (Pulkrábek and Pavlík, 2003). This allows updating of the prediction models for carcass classification and their use for the purpose of selection (Daumas et al., 1998 b; Duziński et al., 2015).

The aim of the study was to establish the values of some linear and weight measurements of the carcass, that determine its composition, as well as the correlation between them in skinned pigs.

MATERIAL AND METHODS

The experiment was performed in compliance with Directive 2010/63/EU on the protection of animals used for scientific purposes, the approval to carry out this study was given by the Ethical Board of the Agricultural Institute- Shumen. For determination of the slaughter characteristics and morphological components of the carcass and its individual parts in skinned pigs we used the information of the composition of the left half carcasses of 70 pig, crosses ♀Youna and ♂Pietrain, reared in the experimental farm of the Institute of Animal – Kostinbrod, Bulgaria. The animals were slaughtered in a certified abattoir, at a distance of 5 km from the Institute on the day of the transportation. The average live weight at slaughter was 105 kg /± 2.5%/. The carcasses were skinned, without head and feet.

The linear measurements of the carcass were performed on each left half after 24 h storage at + 4◦C, according to the Rules for assessing the breeding value, production and classification of breeding pigs, 1996. The left carcass halves were then divided into cuts according to the DLG method (Scheper and Scholze, 1985). After recording of the weight, each cut was subjected to further dissection and the weights of muscle, intermuscular fat, subcutaneous fat and bones were determined.

Data were statistically evaluated using JMPv.7 software.

Table 1. Carcass measurements

Traits		$\bar{x}$	CV	Sx
Backfat thickness, mm	Last rib	13.42	25.58	0.41
	3/4 rib	12.60	39.28	0.59
Thickness of the backfat at m. GM, mm	L1 – cranial part	15.28	24.34	0.44
	L2 – widest part	9.66	38.25	0.45
	L3 – caudal part	16.21	30.12	0.58
Depth of m. GM	M, mm	21.08	25.48	0.56
Carcass big length, cm		92.70	3.66	0.41
Carcass small length, cm		76.80	3.35	031
Leg length, cm		45.35	6.03	0.32
Leg circumference, cm		56.61	14.07	0.95
F, mm		69.20	10.85	0.89
Fat thickness at withers, mm		28.36	19.35	0.65

F – depth of m. LD measured from the cranial end of m. GM to the dorsal end of rachidial canal; M – depth of m. GM at L2

RESULTS AND DISCUSSION

The linear measurements of the carcass are presented in Table 1. The measurement of the backfat thickness in certain anatomical locations is a principal selection criterion for determination of the carcass fat content in pigs, as the points of measurement for Bulgaria are specified in the Rules for assessing the breeding value, production and classification of breeding pigs (-1996). In the present study we measured the backfat thickness in locations that are used in the selection practice and completed the data with such mentioned in the available literature that are most frequently used for determination of the lean meat percentage. When selected, the anatomical location should be easily accessible for measurements without carcass dissection and also to be used as prediction trait. The results showed that the values of measurement of the backfat taken at the last rib and between 3^{d} and 4th rib are close. In contrast, the backfat thickness, measured over m. GM was within the range of 9.66 mm to 16.21 mm. In crossbred pigs (LW x LL) x (D x BL), Sládek et al. (2010) reported backfat thickness of 11.43 mm – 14.20 mm at slaughter weight of 84.95 kg and 124.80 kg, respectively. When developing the prediction equation in Poland, Lisiak et al. (2015) used representative sample of pigs with backfat thickness at L_2- 16.21 mm (Min - 7mm; Max - 32mm). According to Borzuta et al., (2010), in carcasses containing 50%, 55% and 60% lean meat, the thickness of the backfat was 10.87 mm, 8.75 mm and 5.68 mm, respectively. The variation coefficients were high which is typical for these traits.

The depth of m. LD and m. GM is important parameter used for prediction of the lean meat percentage in pig carcasses. The measurements of m. LD from the cranial end of m. GM to the dorsal end of rachidial canal,

as well as the thickness of the fat in L_2 are used to develop prediction models (Branscheid and Sack, 1988; Daumas and Dhorne, 1994; Machev and Valchev, 2001; Lisiak et al., 2015; Font-I-Furnols et al., 2016).

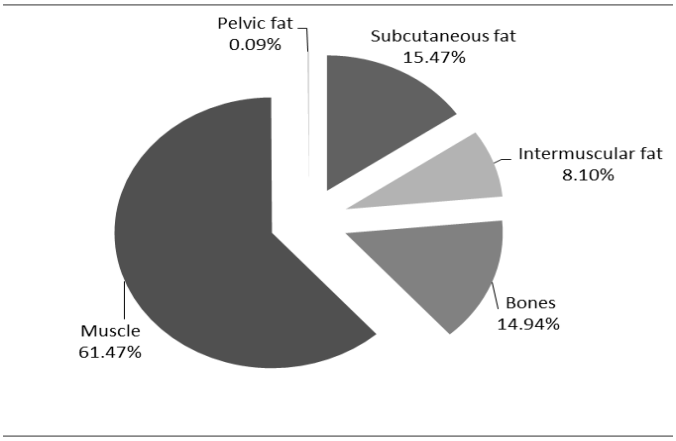
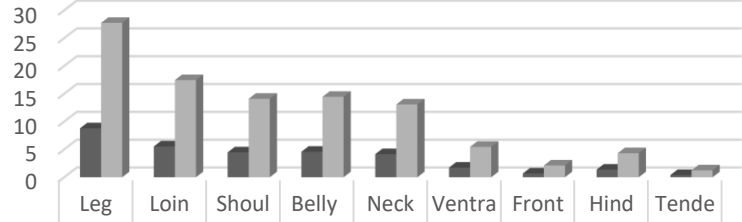


Fig.1 Content (%) of the tissues in the half carcass

The average cold weight of the half carcass was 31. 696 kg, as the percentage of the muscles was highest, followed by the fat and bones (Fig.1). The results of our study are difficult to be compare with literature due to the skinned carcasses, since in most of the European countries and the larger enterprises in Bulgaria the carcasses are scalded. The higher proportion of muscles in this research (61.59%) is due to the skinning of the carcasses and the removal of the head and feet, leading to lower weight but higher meat content. The results showed that subcutaneous fat had the highest percentage of the fats, followed by the intermuscular.



	Leg	Loin	Shoulder	Belly	Neck	Ventral part of belly	Front shank	Hind shank	Tender loin
kg	8.793	5.533	4.469	4.581	4.146	1.733	0.673	1.371	0.396
%	27.74	17.46	14.1	14.45	13.08	5.46	2.12	4.32	1.24

Fig. 2 Weight and percentage of the carcass parts

Table 2. Weight and percentage of muscle, fat and bones in the carcass

Carcass parts	Item	$\bar{x}$	CV	Sx	%
Left half carcass	Weight, kg	31.696	9.48	0.359	100.00
Leg	Weight, kg	8.793	11.6	0.122	100.00
	Subcutaneous fat, kg	1.329	34.8	0.055	15.12
	Intermuscular fat, kg	0.286	32.5	0.011	3.25
	Pelvic fat, kg	0.027	65.8	0.002	0.31
	Bones ,kg	1.002	18.23	0.022	11.39
	Meat , kg	6.149	11.3	0.083	69.93
Loin	Weight, kg	5.533	15.95	0.058	100.00
	Subcutaneous fat, kg	0.962	31.82	0.045	17.38
	Intermuscular fat, kg	0.297	46.11	0.016	5.37
	Bones, kg	1.047	16.5	0.021	18.93
	Meat, kg	3.227	16.7	0.064	58.32
Shoulder	Weight, kg	4.469	10.8	0.058	100.00
	Subcutaneous fat, kg	0.749	31.8	0.028	16.76
	Intermuscular fat, kg	0.283	25.48	0.009	6.33
	Bones, kg	0.630	11.37	0.009	14.10
	Meat, kg	2.807	11.79	0.040	62.81
Belly	Weight, kg	4.581	27.92	0.153	100.00
	Subcutaneous fat, kg	0.811	44.57	0.043	17.70
	Intermuscular fat, kg	0.645	35.13	0.027	14.08
	Bones, kg	0.575	31.8	0.022	12.54
	Meat, kg	2.551	28.42	0.087	55.68
Neck	Weight, kg	4.146	21.1	0.105	100.00
	Subcutaneous fat, kg	0.364	44.2	0.019	8.79
	Intermuscular fat, kg	0.618	35.0	0.026	14.91
	Bones, kg	0.724	17.66	0.015	17.46
	Meat, kg	2.439	23.41	0.068	58.84
Ventral part of the belly	Weight, kg	1.733	16.62	0.034	100.00
	Subcutaneous fat, kg	0.466	41.66	0.023	26.89
	Intermuscular fat, kg	0.350	37.52	0.016	20.20
	Meat, kg	0.917	16.19	0.018	52.91
Tenderloin	Weight, kg	0.397	15.6	0.007	100.00
Front shank	Weight, kg	0.673	8.93	0.007	100.00
	Subcutaneous fat, kg	0.044	32.34	0.002	6.48
	Intermuscular fat, kg	0.030	56.9	0.002	4.38
	Bones, kg	0.296	11.0	0.004	44.02
	Meat, kg	0.304	13.5	0.005	45.12
Hind shank	Weight, kg	1.371	9.72	0.016	100.00
	Subcutaneous fat, kg	0.161	27.2	0.005	11.74
	Intermuscular fat, kg	0.057	41.7	0.003	4.16
	Bones, kg	0.460	10.3	0.006	33.55
	Meat, kg	0.693	13.0	0.011	50.55

The weight and proportion of the individual parts of the half carcass is an index for evaluation of the valuable parts in the carcass. The percentage of the leg was the highest, while those of loin, shoulder, belly and neck varied between 13.08 %-17.46 % (Fig. 2). According to Borzuta et al. (2010) in carcasses containing 50%, 55% and 60% lean meat, loin and leg were respectively - 9.96%; 10.76%; 11.75% and 27.43 %; 27.78 %; 29.29%. The dissection of the individual parts of the half carcass (Table 2) showed that the leg in the studied crossbred pigs had the highest muscle percentage (69.93%) and the lowest bone content (11.39%). Similar results were reported by Ukmar et al., (2008). At relatively close proportion of the rest valuable parts of the half carcass, the percentage of meat in the shoulder (62.81%) was considerably higher than that in the loin, belly and neck. The subcutaneous fat was within the range of 6.58% - 26.89%. The intermuscular fat in these parts that are not separated from meat at retail varied between 3.25 % (in the leg) to 20.20% (in the ventral part of the belly).

Table 3. Coefficient of phenotypic correlation between the morphological parts of the half carcass and some measurements found at dissection

Dependencies		Muscle, kg		Subcutaneous fat, kg		Intermuscular fat, kg		Muscle, %	
		r_p	Rxy	r_p	Rxy	r_p	Rxy	r_p	Rxy
Backfat thickness, mm	Last rib	-0.038	-0.021	0.616^{+++}	0.254	0.638^{+++}	0.098	-0.572^{+++}	-0,759
	3-4 rib	-0.238	-0.094	0.299^{+}	0.056	0.440^{+++}	0.047	-0.324^{++}	-0,298
	L_1	-0.194	-0.109	0.621^{+++}	0.236	0.655^{+++}	0.093	-0.640^{+++}	-0,782
	L_2	-0.105	-0.056	0.766^{+++}	0.297	0.626^{+++}	0.090	-0.720^{+++}	-0,898
	L_3	-0.150	-0.060	0.749^{+++}	0.218	0.682^{+++}	0.074	-0.722^{+++}	-0,677
	Withers	-0.161	-0.057	0.598^{+++}	0.154	0.560^{+++}	0.054	-0.564^{+++}	-0,468
M, mm		0.250^{+}	0.113	0.224	0.074	0.112	0.014	-0.105	-0.111
F, mm		0.526^{+++}	0.137	0.155	0.030	-0.017	-0.001	0.072	0.044
m. LD last rib, mm		0,612^{+++}	0.161	0.028	0.005	-0.270	-0.019	0.228	0.140
m. LD ¾ rib, mm		0.578^{+++}	0.129	0.130	0.019	-0.114	-0.007	0.140	0.073
Big length, cm		0.434^{+++}	0.250	0.454^{+++}	0.190	0.229	0.036	-0.165	-0.222
Small length, cm		0.311^{++}	0.236	0.406^{+++}	0.223	0.242^{+}	0.050	-0.218	-0.385
Leg length, cm		0.270^{+}	0.193	0.218	0.113	0.078	0.015	-0.105	-0.175
Leg circumf. cm		0.369^{++}	0.090	0.327^{++}	0.058	0.050	0.003	-0.188	-0.107

M- depth of m. GM at L_2, mm

F –the distance between L_1 and the dorsal end of rachidial canal, mm

The coefficients of the phenotypic correlation (Table 3) between the backfat thickness and the amount of subcutaneous and intermuscular fat were determined at moderate to high positive levels ($P \leq 0.001$), except the dependence between the backfat thickness measured between 3^{d}and 4th rib and of the subcutaneous fat in the carcass.

The thickness of the backfat was in negative dependence with the amount of muscles and determined to a greater extent the proportion of

the muscles in the carcass ($P \leq 0.01$; $P \leq 0.001$). The depth of m. LD measured from the cranial end of m. GM to the dorsal end of rachidial canal, and the lengths of the carcass and leg were in positive dependence with the content of muscles in the carcass. The depth of m. LD at the last rib determined insignificantly ($r_p = 0.612^{+++}$) the amount of the lean meat compared to m. LD at $3^d/4^{th}$ rib ($r_p = 0.578^{+++}$). The correlation between the studied trait and the measurements at F displayed closer value F ($r_p = 0.526^{+++}$). The dependence between the lengths of the carcass and the amount of muscles and subcutaneous fat were significant ($P \leq 0.001$). Lisiak et al. (2015) reported significant correlations between the lean meat percentage and the backfat thickness measured at L_2 ($r = -0.78$) and the depth of the muscle in F ($r = 0.41$). Csato et al. (2002) found positive genetic correlation between the percentage of lean meat in the carcass and the area of m. LD, while negative between the backfat thickness, measured at different points and the lean meat content. In a study with 192 Large White pigs, Tvrdon et al. (1999) reported significant negative correlation between the backfat thickness and the percentage of lean meat in the carcass ($r_p = -0.73$). Skałecki (2006) also found negative correlations between the thickness of the backfat at different locations and the content of the lean meat ($R = -0.60$ up to $R = -0.84$)

Regression coefficients showed that the proportion of lean meat (%) increased considerably with decreasing the backfat thickness at L_2 ($Rxy = -0,898$), L_1 ($Rxy = -0.782$) and the last rib ($Rxy = -0.759$).

CONCLUSIONS

The results of this study showed that muscle had the highest percentage in the half carcass followed by the subcutaneous fat, bones and intermuscular fat, while in regard to the carcass parts, leg exhibited the highest proportion, followed by the loin, belly shoulder and neck in descending order. The coefficient of the phenotypic correlation between the backfat thickness and the amount of the subcutaneous and intramuscular fat were estimated at moderate to high positive values.

The depth of m. LD, measured at 7 cm laterally above the last and $3^d/4^{th}$ rib correlated to a significant extent with the amount of lean meat in the carcass of the skinned pigs, whereas the backfat thickness was in negative dependency with the percentages of the muscles. The dependences between the backfat thickness measured on the cutting line of the carcass, laterally to m. GM – L_1, L_2 and L_3 and the lean meat percentage were significant.

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