EFFECT OF CARCASS WEIGHT AND LENGTHS ON MEATINESS TRAITS OF YOUNG BOARS

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Introduction

To estimate value of pigs, control testing stations were established in Estonia in 1927. Since 1929, the price of pig carcasses has been based on carcass weight and value. Ultrasonic measurement of fat thickness was utilized first time in 1961. This technique was widely used from 1994 in farms and slaughterhouses. In 1995, the crossbreeding program Marble Pork of the Estonian Pig Breeding Association was introduced, targeted at measuring carcass traits of progeny of top boars in slaughterhouses (EPBA, 2005).

The objective of this study was to study the effect of carcass weight and lengths on meatiness traits of young boars.

Material and Methods

Estonian Landrace (EL), Estonian Large White (EY), Pietrain (Pi) and Hampshire x Pi young boars from four top breeding farms were included in study to predict meatiness traits both from live animal and carcass measurements.

Meat traits in live pigs were measured by ultrasonic equipment Piglog 105: backfat thickness at last (X1) and 11...12th (X3) rib, 7 cm from midline (mm); and diameter of loin eye (X2), 7 cm from midline (mm). Lean meat percentage (Y) was calculated using the formula (Piglog 105, 1991).

A total of 202 pigs were slaughtered in four slaughterhouses during 2006. Average age at slaughter was 172 days and carcass weight 72.6 kg (Table 1). Carcasses were divided lengthways into halves and hanged into monorail along back leg. Weight and lean meat percentage were recorded with Ultra-FOM 300, prior to chilling of carcasses, in a cooling chamber. 24 hours after slaughtering, carcass measurements were taken by meat technologist of the Estonian Pig Breeding Association. Measuring tape was used to determine backfat thickness at four points in one half of carcasses (Figure 1). Two carcass lengths were fixed.

Lean meat percentages of carcasses were calculated using two point method (ZP-method). For that purpose, fat thickness on thinner point above *m. glutaeus medius* (S), and distance between anterior part of *m. glutaeus medius* and upper edge of vertebrate spine (F) were measured.

$$ZP\% = 47{,}978 + (26{,}0429 \times \frac{S}{F}) + (4{,}5154 \times \sqrt{F}) - (2{,}5018 \times \lg S) - (8{,}4212 \sqrt{S})$$

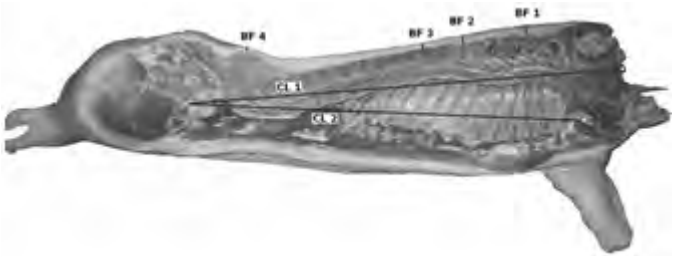

Figure 1. Measuring points of backfat thickness and carcass lengths. Backfat thickness was measured: BF 1 – thicker spot on shoulder; BF 2 – above between 6^{th}-7^{th} rib; BF 3 – thinner spot in dorsum; BF 4 – from the higher spot of *gluteus medius*. Carcass length: CL 1 – from cranial edge of first neck segment to anterior edge of the *symphysis pubis*; CL 2 – from *symphysis* of rib on the sternum to anterior edge of the *symphysis pubis*.

Right halves of carcasses were divided between 13th and 14th ribs, and the digital photo was taken from opened loin eye and rest of fat above it. PC program Scan Star was used to measure loin eye area, fat area, and two fat thicknesses (Figure 2).

Figure 2. Traits measured by PC program Scan Star. LSP – loin eye area, PP – fat area, KP I – fat thickness at thinnest point, KP II – fat thickness above *serratus dorsalis* (Scan Star, 2007).

Loin eye area (LSP) : fat area (PP) ratio is expressed by meatiness index (MI).

$$MI = \frac{PP(cm^2)}{LSP(cm^2)}$$

Carcass weight and lengths were divided into classes to estimate their effect on meatiness traits. Carcass weight classes were <65, 65-69, 70-74, 75-79, 80-85, and >85 kg. Carcass length 1 classes were <95, 95-99, 100-105, and >105 cm; and carcass length 2 classes <80, 80-84, 85-90, and >90 cm.

A least square analysis of variance using GLM of SAS (SAS, 1999) was performed to evaluate carcass measurements for sources of variation. The model included fixed effects of breed, year of evaluation, and slaughterhouse.

$$Y_{ijklmn} = \mu + B_i + E_j + W_k + L_l + M_m + e_{ijklmn}$$

Y = dependent variable; B_i = breed (n = 1-4); E_i = season of evaluation (n = 1-4); W_k = carcass weight class (n = 1-6); L_l = carcass length 1 class (n=1-4); M_m = carcass length 2 class (n=1-4); e_{ijklmn} = random residual effect.

Table 1. General statistics of carcass measurements (n=202)

Traits	Mean	Std. dev.	Min.	Max.
Slaughter age, days	172.18	10.65	148.00	200.00
Carcass weight, kg	72.59	7.58	53.70	92.70
Carcass length 1, cm	100.78	5.16	84.00	116.00
Carcass length 1, cm	84.35	4.25	72.00	99.00
Ruler				
BF 1, mm	24.75	3.66	10.00	35.00
BF 2, mm	16.80	3.57	8.00	28.00
BF 3, mm	13.01	3.12	6.00	24.00
BF 4, mm	9.29	1.41	5.00	14.00
Avg BF 1-4, mm	15.96	2.51	8.75	23.25
Avg BF 1-3, mm	16.95	2.49	9.00	23.67
Scan Star				
KP I, mm	7.86	2.53	4.00	18.00
KP II, mm	15.87	4.53	5.00	27.00
Fat area, cm^2	12.69	2.82	7.50	22.10
Loin eye area, cm^2	49.44	6.20	36.00	68.50
MI	0.26	0.06	0.15	0.42
Piglog 105				
X1, mm	9.41	2.33	6.00	16.00
X3, mm	9.95	2.18	6.00	17.00
X2, mm	57.16	5.29	43.00	72.00
Lean meat%				
Piglog 105,%	64.29	1.82	58.96	67.68
ZP,%	61.80	1.56	57.30	65.90
Ultra-FOM 300,%	61.82	1.64	56.50	65.90

Levels of significances are expressed conventionally: a, b, c, d – least square means within each effect with one letter in common do not differ significantly; *** - P<0.001, ** - P<0.01, * - P<0.05. Pearson product-moment correlation (PROC CORR) coefficients were used to analyse relationship between carcass measurements (SAS, 1999).

Results and Discussion

Carcasses were evaluated by three procedures**.**

Ruler. Pig carcasses lighter than 65 kg had significantly thinner backfat than carcasses over 65 kg, except in backfat 1 and 4, where significant difference was observed in heavier carcasses. Backfat thicknesses were uniform at the weight from 65 to 79 kg, but increased significantly in heavier carcasses. Fat was distributed evenly at all four points measured.

Table 2. Effect of carcass weight on meatiness traits

Traits	Carcass weight, kg					
	<65	65-69	70-74	75-79	80-85	>85
n	29	45	59	33	25	11
Ruler						
BF 1, mm	23.50^{a}	25.11^{ab}	25.42^{b}	25.69^{b}	26.72^{bc}	28.37^{c}
BF 2, mm	14.83^{a}	16.91^{b}	17.63^{b}	18.28^{bc}	19.83^{c}	22.40^{d}
BF 3, mm	11.14^{a}	12.70^{b}	13.19^{b}	13.81^{b}	15.47^{c}	17.05^{c}
BF 4, mm	8.58^{a}	9.00^{a}	9.09^{a}	9.31^{ab}	9.80^{bc}	10.54^{c}
Avg BF 1-4, mm	14.51^{a}	15.93^{b}	16.33^{b}	16.77^{b}	17.95^{c}	19.59^{d}
Avg BF 1-3, mm	15.64^{a}	17.01^{b}	17.38^{b}	17.76^{bc}	18.78^{c}	20.44^{d}
Scan Star						
KP I, mm	6.35^{a}	6.66^{a}	8.37^{b}	7.22^{a}	8.60^{b}	10.50^{c}
KP II, mm	10.88^{a}	13.89^{b}	13.64^{b}	14.66^{bc}	16.46^{cd}	18.87^{d}
Fat area, cm^2	10.31^{a}	11.66^{b}	12.72^{c}	12.46^{bc}	14.42^{d}	16.79^{e}
Loin eye area, cm^2	46.45^{a}	48.83^{ab}	49.70^{b}	51.31^{bc}	52.72^{c}	53.75^{c}
MI	0.225^{a}	0.242^{ab}	0.259^{bc}	0.245^{ab}	0.276^{c}	0.318^{d}
Piglog 105						
X1, mm	8.41^{a}	9.24^{ab}	9.62^{b}	10.07^{bc}	11.03^{cd}	12.56^{d}
X3, mm	9.03^{a}	9.61^{ab}	10.19^{bc}	10.41^{bc}	10.82^{c}	13.38^{d}
X2, mm	59.24^{a}	59.72^{a}	60.28^{a}	61.50^{ab}	61.72^{ab}	63.29^{b}
Lean meat%						
Piglog 105,%	65.36^{a}	64.87^{ab}	64.53^{ab}	64.46^{ab}	63.99^{b}	62.37^{c}
ZP,%	62.19^{ab}	62.23^{a}	61.97^{ab}	62.03^{a}	61.72^{ab}	60.94^{b}
Ultra-FOM 300,%	62.25^{ab}	62.41^{a}	61.77^{abc}	62.38^{a}	61.49^{bc}	60.79^{c}

ScanStar. Fat thickness at the thinnest point (KP I) was 6.35-10.50 mm, and above *serratus dorsalis* (KP II) 10.88-18.87 mm, measured using PC software ScanStar. Fat thickness was uniform at the weight up to 79 kg, but it increased significantly along with further weight increase. Since fat thickness is related to fat area, similar difference was found regarding this trait. Loin eye area increased

constantly in each carcass weight class, while growth rate did not vary significantly in weight classes of 65-69, 70-74 and 75-79 kg. Meatiness index showed a significantly better loin and fat area relationship in <65 and 65-69 kg classes, while pigs over 85 kg had a significantly higher (0.318) meatiness index value, compared with other classes.

Table 3. Effect of carcass lengths on meatiness traits

Traits	Carcass length 1, cm				Carcass length 2, cm			
	<94	95-99	100-104	>105	<79	80-84	85-89	>90
n	25	40	96	41	27	72	82	21
Ruler								
BF 1, mm	25.23^{a}	26.33^{a}	26.06^{a}	25.57^{a}	26.83^{a}	26.20^{a}	25.30^{a}	24.88^{a}
BF 2, mm	18.72^{a}	18.83^{a}	18.44^{a}	17.26^{a}	19.84^{a}	18.35^{a}	17.18^{a}	17.88^{a}
BF 3, mm	15.16^{a}	13.41^{a}	13.67^{a}	13.33^{a}	14.21^{a}	14.32^{a}	13.77^{a}	13.28^{a}
BF 4, mm	9.66^{a}	9.16^{a}	9.58^{a}	9.15^{a}	9.58^{a}	9.46^{a}	9.12^{a}	9.40^{a}
Avg BF 1-4, mm	17.19^{a}	16.93^{a}	16.94^{a}	16.33^{a}	17.61^{a}	17.08^{a}	16.34^{a}	16.36^{a}
Avg BF 1-3, mm	17.87^{a}	18.11^{a}	18.03^{a}	17.33^{a}	18.75^{a}	18.00^{a}	17.20^{a}	17.38^{a}
ScanStar								
KP I, mm	9.04^{a}	7.96^{a}	7.67^{a}	7.14^{a}	6.81^{a}	8.58^{a}	8.23^{a}	8.18^{a}
KP II, mm	16.05^{ab}	15.90^{a}	14.23^{ab}	12.77^{b}	14.83^{a}	14.11^{a}	14.57^{a}	15.42^{a}
Loin eye area, cm^{2}	50.51^{ab}	48.25^{a}	50.46^{ab}	52.62^{b}	48.59^{a}	50.34^{a}	50.90^{a}	52.01^{a}
Fat area, cm^{2}	14.45^{a}	12.23^{b}	12.85^{ab}	12.72^{ab}	12.00^{a}	13.89^{a}	12.99^{a}	13.29^{a}
MI	0.287^{a}	0.255^{a}	0.257^{a}	0.245^{a}	0.254^{ab}	0.278^{a}	0.257^{b}	0.255^{ab}
Piglog 105								
X1, mm	9.66^{a}	10.56^{a}	10.38^{a}	10.02^{a}	10.95^{a}	10.14^{a}	9.79^{a}	9.75^{a}
X3, mm	9.82^{a}	10.89^{a}	10.81^{a}	10.78^{a}	12.10^{a}	10.55^{ab}	9.95^{b}	9.70^{b}
X2, mm	61.25^{a}	60.24^{a}	60.21^{a}	62.13^{a}	61.22^{a}	61.06^{a}	60.55^{a}	61.00^{a}
Lean meat%								
ZP,%	61.46^{a}	61.91^{a}	61.73^{a}	62.28^{a}	63.24^{a}	64.30^{a}	64.65^{a}	64.86^{a}
Piglog 105,%	64.86^{a}	63.88^{a}	63.97^{a}	64.35^{a}	61.59^{a}	61.62^{a}	62.11^{a}	62.06^{a}
Ultra-FOM 300,%	61.22^{a}	61.99^{a}	61.78^{a}	62.40^{a}	61.92^{a}	61.55^{a}	62.04^{a}	61.88^{a}

Piglog 105. Backfat measuremets carried out using Piglog 105 showed that lighter pigs (<65 kg) had significantly thinner fat compared with heavier (>85 kg) pigs. Backfat was relatively even in weight classes 65-69, 70-74 and 75-79. Diameter of *longissimus dorsi* was only 2.48 mm longer in the class 80-85 kg compared with lighter carcasses (<65 kg). However, major increase was found in carcasses over 85

kg weight, where diameter of *longissimus dorsi* was significantly bigger, compared with <65, 65-69 and 70-74 kg classes.

Lean meat% measured by using three different methods showed that heavier carcasses had lower lean meat percentage. The biggest difference in lean meat percentage between the lightest and heavier carcass classes was recorded with Piglog 105 (2.99%), while it was almost two times lower using ZP-method and Ultra-FOM 300 (1.25% and 1.46%, respectively). Piglog 105 showed also higher lean meat percentage, whereas ZP-method and Ultra FOM 300 had similar results. Lean meat percentage did not differ significantly between classes <65, 65-69, 70-74, and 75-79 kg.

Carcass lengths did not have a significant effect on fat thickness, except for carcass length 1, where significant difference in fat thickness 2, measured with ScanStar, was found between classes 95-99 and >105. Significantly thinner fat in carcass length 2 was also registered in classes 85-89 and >90, compared with class <79. Although significant difference in fat thickness was not found between carcass classes, a slight trend, that longer carcasses had thinner fat, could still be noticed.

With the ScanStar system we recorded the most significant differences between carcass length classes. As for carcass length 1, the loin eye area was 4.37 cm^2 larger in class >105 cm, compared with class 95-99 cm. On the other hand, the fat area was significantly larger in class <94 cm, compared with class 95-99 cm.

Carcass length had no major effect on lean meat percentage.

Conclusions

Lighter pig carcasses had thinner fat, while the loin eye records were also smaller. Meatiness traits changed slightly, being between 65 and 79 kg. However, lighter and heavier carcasses showed major changes. Lighter carcasses were leaner and therefore it is not justified to fatten pigs heavier, as shorter fattening time is more effective and leaner carcasses more valuable. Since the carcass price is based on its weight, farmers should find a balance between these two controversial traits.

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