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EFFECT OF CARCASS WEIGHT AND GENDER ON MAIN TISSUE DISTRIBUTION IN CARCASS MAIN CUTS

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ABSTRACT

The present study was carried out on 99 pig carcasses originated from PIC hybrid pigs slaughtered in PIK Vrbovec slaughterhouse. Animals were reared in the same environmental conditions and fed the same diet. Carcasses were dissected using PIK commercial method of cutting and dissection. From the 4 main cuts, shoulder, ham, loin and ribs, main tissues were dissected: lean, subcutaneous fat with skin and bones, respectively. According to carcass weight, carcasses were divided into 6 weight groups as follows; 120 kg, 130 kg, 140 kg, 150 kg, 160 kg and 170 kg. The objective of this study was to explore the effect of carcass weight and gender on the distribution of commercially dissected lean, fat and bone tissues in the main parts of pig carcass and to analyse the same components between six weight groups. It is confirmed that the gender had a significant effect on fat content. Lean meat content was reduced with increasing carcass weight, while the fat content increases with higher carcass weights. Declining trend is found by observing the relative values of bone content with significant differences between the lightest and heaviest groups.

Key words: pigs / gender / carcass weight / carcass composition / commercial dissection / main cuts

1 INTRODUCTION

Growth and distribution of muscle tissue in pig carcasses has been extensively investigated (Tess *et al.*, 1986; Wagner *et al.*, 1999; Wiseman *et al.*, 2007; Kusec *et al.*, 2010). Consequently, the acquired knowledge was used for production of pigs with carcasses that contain increased muscle and decreased fat content (Wiseman *et al.*, 2007). Trends in live slaughter weight, and not only concerning muscle content, have been changed. Reeds *et al.* (1993) review shows that over the last 50 years, muscle content has increased by 86%, while the live weight of pigs of the same age has increased by 20%. For the past ten years, similar pattern to the aforementioned one can be found in Croatia. Live slaughter weight, for instance increased from 102.10 kg in 2002 to 108.5 kg in 2011, while the meat percentage increased from 54.80% to 58.39% (Croatian Agricultural Agency, 2011). The highest accuracy to determine carcass composition of main tissues would be full carcass dissections. However, this methodology is expensive and laborious to perform (Beattie *et al.*, 1999) so the commercial butcher dissection offers a faster, cheaper and acceptable solution to determine composition of muscle and fat tissues. The objective of this study was to explore the effect of carcass weight and gender on the distribution of commercially dissected lean, fat and bone tissues in the main parts of the carcass and to analyse the same components between six weight groups.

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2 MATERIAL AND METHODS

The present study was carried out on 99 pig carcasses originated from PIC hybrid pigs slaughtered in PIK Vrbovec slaughterhouse. Animals were reared in the same environmental conditions and fed the same diet. Carcasses were dissected using PIK commercial method of cutting and dissection. From the 4 main cuts, shoulder, ham, loin and ribs, main tissues were dissected, loin, subcutaneous fat with skin and bones, respectively. According to carcass weight, carcasses were divided into 6 weight groups as follows; 120 kg (lower than 125 kg; N = 15), 130 kg (between 125 kg and 135 kg; N = 17), 140 kg (between 135 kg and 145 kg; N = 15), 150 kg (between 145 kg and 155 kg; N = 18), 160 kg (between 155 kg and 165 kg; N = 17) and 170 kg (higher than 165 kg; N = 17). The data was analysed using General Linear Model program to test the carcass weight and gender as main effects on the examined carcass tissue components. If the effect of weight group or gender was significant, the Bonferroni test was used to make comparisons between means. In order to analyse effect of carcass weight on percentage of main tissues in main cuts, polynomial regression was performed. All statistical analyses were accomplished using the Statsoft Statistica 8.0.

3 RESULTS AND DISCUSSION

In table 1, effects of gender and carcass weight on main tissues of dissected ham in absolute and relative values are presented. It could be seen that gender had a significant effect on fat content, while in terms of meat content, significant effect was only on relative values. Bone content was not influenced by gender. As expected, carcasses from the heaviest weight group had the heaviest hams; although in relative terms the difference between the groups was statistically significant only for the two heaviest weight groups. Regarding the fat tissue, significant differences were not found between the investigated groups except between the heaviest (120 kg) and lightest (170 kg). When observing the meat tissue in relative terms, the lightest group (120 kg) had the higher proportion of lean and was significantly different only from the heaviest (170 kg) weight group (66.860%). The hams from the heaviest group (170 kg) of pig carcasses had significantly higher bone content in absolute terms, comparing to the other groups, but bone percentage for the same group was lowest (8.514) and statistically different from the first four weight groups.

In table 2, effects of gender and carcass weight on main tissues of dissected shoulder in absolute and relative values are presented. In the case of dissected shoul-

Table 1: *Effect of gender and carcass weight on main tissues of dissected ham*

Trait	Gender			Weight group						
	Castrates	Gilts	Sign.	120 kg	130 kg	140 kg	150 kg	160 kg	170 kg	Sign.
N	50	49		15	17	15	18	17	17	
Ham (kg)	15.916	15.701	N.S.	13.646^{a}	13.894^{ab}	15.009^{bc}	16.407^{cd}	16.835^{d}	19.060^{e}	**
	(0.159)	(0.163)		(0.288)	(0.271)	(0.305)	(0.263)	(0.274)	(0.271)	
Ham (%)	27.052^{x}	27.638^{y}	N.S.	27.990^{a}	27.548	27.729	27.606	26.704^{b}	26.493^{c}	*
	(0.137)	(0.141)		(0.249)	(0.234)	(0.264)	(0.227)	(0.237)	(0.234)	
Fat (kg)	3.486^{x}	3.043^{y}	*	2.374^{a}	2.765^{abc}	2.929^{cde}	3.273^{cde}	3.613^{e}	4.631^{f}	*
	(0.074)	(0.076)		(0.134)	(0.126)	(0.142)	(0.122)	(0.128)	(0.126)	
Fat (%)	21.743^{x}	19.075^{y}	*	17.414^{ab}	19.928^{bc}	19.405^{bc}	19.895^{bc}	21.442^{cd}	24.370^{d}	*
	(0.421)	(0.432)		(0.763)	(0.717)	(0.808)	(0.695)	(0.727)	(0.717)	
Meat (kg)	10.918	11.197	N.S.	9.807^{a}	9.813^{a}	10.619^{ab}	11.592^{bc}	11.754^{ce}	12.758^{e}	*
	(0.131)	(0.135)		(0.238)	(0.224)	(0.252)	(0.217)	(0.227)	(0.224)	
Meat (%)	68.687^{x}	71.536^{y}	*	71.858^{a}	70.576^{a}	70.840	70.706^{a}	69.830	66.860^{b}	*
	(0.405)	(0.415)		(0.734)	(0.689)	(0.777)	(0.669)	(0.699)	(0.689)	
Bones (kg)	1.471^{x}	1.428^{y}	N.S.	1.338^{abd}	1.332^{abd}	1.440^{bc}	1.509^{ce}	1.457^{cd}	1.621^{e}	*
	(0.016)	(0.016)		(0.029)	(0.027)	(0.031)	(0.026)	(0.028)	(0.027)	
Bones (%)	9.302	9.172	N.S.	9.819^{a}	9.608^{a}	9.616^{a}	9.200^{abc}	8.665^{cd}	8.514^{d}	*
	(0.081)	(0.084)		(0.148)	(0.139)	(0.156)	(0.134)	(0.141)	(0.139)	

* = $P < 0.01$; N.S. = no significance

Table 2: *Effect of gender and carcass weight on main tissues of dissected shoulder*

Trait	Gender			Weight group						
	Castrates	Gilts	Sign.	120 kg	130 kg	140 kg	150 kg	160 kg	170 kg	Sign.
N	50	49		15	17	15	18	17	17	
Shoulder (kg)	9.080^{x}	8.745^{y}	N.S.	7.195^{a}	8.963^{bcde}	8.402^{cd}	9.059^{de}	9.379^{e}	10.478^{f}	*
	(0.101)	(0.104)		(0.184)	(0.172)	(0.194)	(0.167)	(0.175)	(0.172)	
Shoulder (%)	15.485	15.424	N.S.	14.739^{a}	17.769^{b}	15.506^{a}	15.241^{a}	14.887^{a}	14.585^{a}	*
	(0.119)	(0.122)		(0.215)	(0.202)	(0.228)	(0.196)	(0.205)	(0.202)	
Fat (kg)	2.140^{x}	1.763^{y}	*	1.349^{a}	1.830^{b}	1.902^{b}	1.913^{b}	2.167^{b}	2.549^{c}	*
	(0.049)	(0.050)		(0.089)	(0.083)	(0.094)	(0.081)	(0.085)	(0.083)	
Fat (%)	23.397^{x}	19.934^{y}	*	18.682^{a}	20.328^{ab}	22.551^{bcf}	21.076	23.058^{be}	24.297^{ef}	*
	(0.447)	(0.458)		(0.810)	(0.760)	(0.857)	(0.738)	(0.771)	(0.760)	
Meat (kg)	5.821	5.869	N.S.	4.803^{a}	6.067^{bde}	5.417^{acd}	6.019^{d}	6.060^{def}	6.705^{bf}	*
	(0.076)	(0.078)		(0.137)	(0.129)	(0.145)	(0.125)	(0.131)	(0.129)	
Meat (%)	64.153^{x}	67.224^{y}	*	66.741	67.773^{a}	64.532^{b}	66.489	64.610	63.989^{bc}	*
	(0.411)	(0.422)		(0.745)	(0.700)	(0.789)	(0.679)	(0.709)	(0.700)	
Bones (kg)	1.102	1.098	N.S.	1.028^{a}	1.024^{a}	1.073^{a}	1.126	1.142	1.207^{b}	*
	(0.014)	(0.015)		(0.026)	(0.025)	(0.028)	(0.024)	(0.025)	(0.025)	
Bones (%)	12.265	12.667	N.S.	14.348^{a}	11.450^{b}	12.805^{b}	12.419^{b}	12.217^{b}	11.557^{b}	*
	(0.141)	(0.145)		(0.256)	(0.241)	(0.271)	(0.234)	(0.244)	(0.241)	

* = P < 0.01; N.S. = no significance

Table 3: *Effect of gender and carcass weight on main tissues of dissected loin*

Trait	Gender			Weight group						
	Castrates	Gilts	Sign.	120 kg	130 kg	140 kg	150 kg	160 kg	170 kg	Sign.
N	50	49		15	17	15	18	17	17	
Loin (kg)	10.124x	9.613y	N.S	8.013^{a}	8.243^{ab}	8.820^{bc}	10.073^{cd}	11.076^{d}	12.985^{e}	*
	(0.153)	(0.157)		(0.278)	(0.261)	(0.294)	(0.253)	(0.265)	(0.261)	
Loin (%)	17.051	16.770	N.S	16.423^{a}	16.345^{a}	16.211^{a}	16.943	17.533	18.005^{b}	*
	(0.148)	(0.152)		(0.269)	(0.253)	(0.285)	(0.245)	(0.256)	(0.253)	
Fat (kg)	3.139x	2.498y	*	1.884^{a}	2.169^{a}	2.370^{a}	2.578^{a}	3.360^{b}	4.550^{c}	*
	(0.084)	(0.087)		(0.153)	(0.144)	(0.162)	(0.139)	(0.146)	(0.144)	
Fat (%)	30.351x	25.153y	*	23.417^{ab}	26.171^{bc}	26.383^{bc}	25.415^{bc}	30.095^{c}	35.030^{d}	*
	(0.604)	(0.620)		(1.095)	(1.028)	(1.159)	(0.997)	(1.042)	(1.028)	
Meat (kg)	5.122	5.241	N.S	4.454^{a}	4.433^{a}	4.808^{abc}	5.496^{cde}	5.703^{de}	6.194^{de}	*
	(0.091)	(0.094)		(0.166)	(0.156)	(0.175)	(0.151)	(0.158)	(0.156)	
Meat (%)	50.976x	55.052y	*	55.622^{a}	53.785^{a}	54.721^{a}	54.680^{a}	51.659^{a}	47.619^{b}	*
	(0.523)	(0.537)		(0.948)	(0.891)	(1.004)	(0.864)	(0.903)	(0.891)	
Bones (kg)	1.896	1.895	N.S	1.714^{ac}	1.653^{a}	1.769^{abd}	1.974^{bcde}	2.045^{de}	2.216^{e}	*
	(0.031)	(0.031)		(0.056)	(0.052)	(0.059)	(0.051)	(0.053)	(0.052)	
Bones (%)	18.989x	20.043y	*	21.454^{ab}	20.160^{bd}	20.155^{bd}	19.654^{bd}	18.517^{de}	17.157^{e}	*
	(0.257)	(0.264)		(0.467)	(0.438)	(0.494)	(0.425)	(0.445)	(0.438)	

* = P < 0.01; N.S. = no significance

Table 4: *Effect of gender and carcass weight on main tissues of dissected ribs*

Trait	Gender			Weight group						
	Castrates	Gilts	Sign.	120 kg	130 kg	140 kg	150 kg	160 kg	170 kg	Sign.
N	50	49		15	17	15	18	17	17	
Ribs (kg)	11.796	11.381	N.S	9.468^{a}	9.692^{a}	11.214^{b}	11.806^{b}	12.688^{b}	14.662^{c}	*
	(0.156)	(0.160)		(0.283)	(0.265)	(0.299)	(0.258)	(0.269)	(0.265)	
Ribs (%)	20.004	19.846	N.S	19.418^{ab}	19.183^{b}	20.634^{c}	19.843	20.110	20.361	*
	(0.147)	(0.151)		(0.267)	(0.251)	(0.283)	(0.243)	(0.254)	(0.251)	
Fat (kg)	2.494	2.431	N.S	1.488^{ab}	1.926^{bc}	2.261^{cd}	2.623^{d}	2.590^{d}	3.886^{e}	*
	(0.071)	(0.073)		(0.129)	(0.121)	(0.136)	(0.117)	(0.123)	(0.121)	
Fat (%)	20.727	20.708	N.S	15.711^{a}	19.547^{b}	20.077^{b}	22.130^{b}	20.343^{b}	26.494^{c}	*
	(0.456)	(0.469)		(0.828)	(0.777)	(0.876)	(0.754)	(0.788)	(0.777)	
Meat (kg)	8.307x	7.885y	N.S	7.054^{ac}	6.725^{a}	7.840^{bcd}	8.268^{d}	8.961^{de}	9.728^{e}	*
	(0.111)	(0.114)		(0.202)	(0.189)	(0.214)	(0.184)	(0.192)	(0.189)	
Meat (%)	70.661	69.727	N.S	74.468^{a}	69.697^{bc}	69.915^{bc}	70.030^{bc}	70.659^{b}	66.395^{c}	*
	(0.426)	(0.438)		(0.773)	(0.726)	(0.819)	(0.704)	(0.736)	(0.726)	
Bones (kg)	1.076	1.060	N.S	0.947^{ab}	1.003^{bc}	1.080	1.033^{bc}	1.125^{cd}	1.221^{d}	*
	(0.019)	(0.019)		(0.034)	(0.032)	(0.036)	(0.031)	(0.032)	(0.032)	
Bones (%)	9.231	9.536	N.S	10.031^{abc}	10.439^{b}	9.746	8.810^{ce}	8.913^{ce}	8.360^{e}	*
	(0.168)	(0.173)		(0.305)	(0.286)	(0.323)	(0.278)	(0.290)	(0.286)	

* = $P < 0.01$; N.S. = no significance

der, gender had an effect on fat and lean relative content, while no effect was obtained in bone tissue. Carcass weight on the other side had an effect on all observations. Significant differences were found between the investigated groups in shoulder weight as naturally expected. Heaviest group of carcasses (170 kg) had significantly more kilograms of fat in shoulder than other groups, while in relative terms the situation is similar. Regarding the meat percentage, significant differences were found between the heaviest (170 kg) and some of the lighter investigated groups. Dissection of the shoulder resulted with significant effect of carcass weight on bone content, with noticeable descending trend by increase of the carcass weight.

The influences of gender and carcass weight on main tissues of dissected loin in absolute and relative values are presented in table 3. Gender showed the effect on relative values of fat, lean and bone content. Like the case of ham and shoulder, carcass weight had an effect on all observed contents. The weight of loin significantly differs among the all carcass weight groups, although differences weren't significant between all groups. Also important to point out, unlike ham and shoulder percentage, loin percentage increases by increase of carcass weight of pigs. Percentage of fat in loin was affected by the carcass weight of slaughtered pigs, and carcasses differ among the groups significantly. In addition, fat percentage in loin area is increasing by the increasing the carcass weight. The values of meat percentage differed significantly between the heaviest (170 kg) and all other groups and the lowest percentage of meat was found in the loins from the heaviest group of pig carcasses.

In table 4, gender and carcass weight effects on main tissues of dissected ribs are presented. From the presented data it could be seen that gender did not have an effect on rib main tissue contents. Carcass weight showed effect on all main tissue contents of ribs. The values of weight of this part are significantly increasing by the increase of carcass weight, as well as the percentage of fat. Significantly higher values of meat percentage were found in the ribs of the lightest group than in other groups and therefore, growth pattern could be seen. In absolute and relative terms of bone tissue, values differed between all weight groups of pig carcasses with declining trend when carcass weight increases.

In table 5, effect of gender and carcass weight on total values of carcass dissected contents. From these results generally could be confirmed that the growth pattern of carcass cuts weight increases by increasing the carcass weight. Furthermore, gender had an influence on fat and lean percentage values, where castrates had significantly higher fat content and lower lean percentage than gilts.

Table 5: *Effect of gender and carcass weight on total content of main tissues*

Trait	Gender			Weight group						
	Castrates	Gilts	Sign.	120 kg	130 kg	140 kg	150 kg	160 kg	170 kg	Sign.
N	50	49		15	17	15	18	17	17	
FAT (kg)	12.203^{x}	10.516^{y}	*	7.807^{ab}	9.234^{bc}	10.215^{cd}	11.288^{de}	12.798^{de}	16.818^{f}	*
	(0.253)	(0.260)		(0.459)	(0.431)	(0.486)	(0.418)	(0.437)	(0.431)	
FAT (%)	20.436^{x}	18.049^{y}	*	15.989^{ab}	18.207^{bc}	18.711^{c}	18.922^{ac}	20.234^{c}	23.393^{d}	*
	(0.347)	(0.356)		(0.629)	(0.590)	(0.666)	(0.573)	(0.599)	(0.590)	
LEAN (kg)	34.042	34.187	N.S	29.475^{ac}	30.270^{ac}	32.467^{cd}	35.527^{de}	36.768^{e}	40.178^{f}	*
	(0.375)	(0.385)		(0.681)	(0.639)	(0.720)	(0.620)	(0.648)	(0.639)	
LEAN (%)	57.873^{x}	60.275^{y}	*	60.487^{a}	60.079^{a}	59.941^{a}	59.805^{a}	58.341	55.791^{b}	*
	(0.358)	(0.368)		(0.650)	(0.610)	(0.687)	(0.592)	(0.618)	(0.610)	
BONE (kg)	6.571	6.460	N.S	5.934^{a}	5.895^{a}	6.205^{abc}	6.691^{bc}	6.881^{cde}	7.488^{e}	*
	(0.076)	(0.078)		(0.138)	(0.129)	(0.146)	(0.125)	(0.131)	(0.129)	
BONE (%)	11.214	11.444	N.S	12.186^{ab}	11.719^{bc}	11.477	11.274^{cd}	10.922^{cde}	10.397^{e}	*
	(0.105)	(0.108)		(0.191)	(0.179)	(0.202)	(0.174)	(0.182)	(0.179)	

* = P < 0.01; N.S. = no significance

This could be explained by the effect of male castration, since castrates usually have higher fat content. In the study of Beattie et.al. (1999), gilts had higher fat content, but they compared it with boar carcasses. Gender had no effect on bone content. Carcass weight showed influence on all dissected tissues. The same growth is found in many other studies about the growth of tissues (Kusec et.al. 2010: Gu *et al.*, 1992; Davies and Kallweit, 1979). In terms of relative values of fat content, growth is present by increase of carcass weight. Contrary to fat content, percentage of meat content in carcasses decreases by increase of carcass weight. In the study of Kusec et.al. (2010) and Valis *et al.* (2008) the same declining trend of meat content was found. Observing the relative values of bone content, declining trend could be found with significant differences between the lightest and heaviest group.

In figure 1 is shown the effect of carcass weight on total percentage of fat, meat and bone tissue in carcass obtained by polynomial regression. As stated above, this pattern confirms the excepted fact that by increase of carcass weight, percentage of fat tissue increases while the percentage of meat and bone tissues decreases.

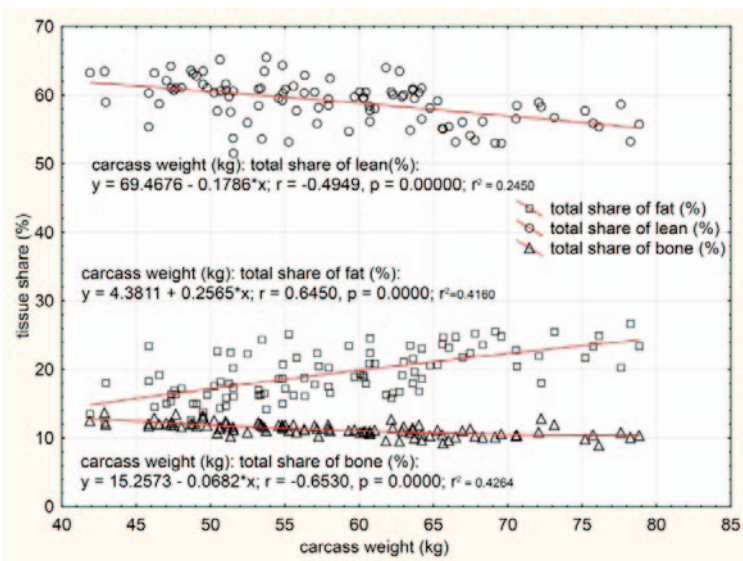

Figure 1: *Effect of carcass weight on total percentage of meat, fat and bone tissue in carcasses*

4 CONCLUSION

From the results presented in this study can be concluded that gender had a significant effect on absolute and relative values of fat content in all carcass main parts with exception in ribs. The effect of gender could also be seen on relative meat content in ham, shoulder and loin. Generally, it is confirmed that the relative lean meat content was reduced with increasing carcass weight, while the relative fat content increases with higher carcass weights. Observing the relative values of bone content, declining trend is found with significant differences between the lightest and heaviest group. It is crucial to study these relations with a representative sample in order to determine optimum slaughter weight and desired carcass composition. In addition, full dissection of cuts is also required to check for the accuracy of used methodology.

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6 REFERENCES

Croatian Agricultural Agency.2011. Annual report. Internet link: http://www.hpa.hr/LinkClick.aspx?fileticket=fSJfu2uWres%3D&tabid=227&language=en-US

Beattie V.E., Weatherup R.N., Moss B.W., Walker N. 1999. The effect of increasing carcass weight of finishing boars and gilts on joint composition and meat quality. Meat Science, 52: 205–211

Davies A.S., Kallweit E., 1979. The effect of body weight and maturity on the carcass composition of the pig. Zeitschrift für Tierzüchtung und Züchtungsbiologie, 96: 6–17

Gu, Y., Schinckel, A.P., Martin, T.G. 1992. Growth, development, and carcass composition in five genotypes of swine. Journal of Animal Science 70, 1719–1729

Kusec G., Petričević A., Kralik G., Djurkin I., Lukić B., Maltar Z., Radisić Ž. 2010. Influence of pig carcass weight on distribution of tissues in main parts. In: 18th International Symposium "Animal Science Days", Kaposvar, Hungary, 21–24 Sept. 2010. Acta Agraria Kaposvariensis, 14, 2: 245–250

Reeds P. J., Burrin D. G., Davis T. A., Fiorotto M. A., Mersmann M. J., Pond W. G. 1993. Growth Regulation with Particular Reference to the Pig. In:Growth of the Pig. Hollis G.R. (ed.). Wallingford, UK, CAB International.

Tess M. W., Dickerson G.E., Nienaber J.A., Ferrel C.L. 1986. Growth, development, and body composition in three genetic stocks of swine. Journal of Animal Science, 62: 986–979

Valis L., Vítek M., David L., Pulkrábek J. 2008. Lean meat content and distribution in pig carcasses. Research in Pig Breeding, 2, 2: 39–41

Wagner J. R., Schinckel A. P., Chen W., Forrest J. C., Coe B. L. 1999. Analysis of Body Composition Changes of Swine During Growth and Development. Journal of Animal Science, 77: 1442–1466

Wiseman T. G., Mahan D. C., Loeller S. J., Peters J. C., Fastinger N. D., Ching S., Kim Y. Y. 2007. Phenotypic measurements and various indices of lean and fat tissue development in barrows and gilts of two genetic lines from twenty to one hundred twenty five kilograms of body weight. Journal of Animal Science, 85: 1816–1824