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Izvorni znanstveni članak
Original scientific paper

CHANGES IN PIG CARCASS COMPOSITION DURING GROWTH

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Summary

The aim of present study was to investigate the changes in carcass composition of pigs during growth. The study was performed on 60 pigs (30 gilts and 30 barrows) aged 49 to 215 days. During the experiment every animal was weighed once a week. Every three weeks according to average group weight four representative animals were slaughtered at slaughterhouse. Main parts of the carcasses (ham, shoulder, loin, ribs and neck) were dissected into muscles, bones, intramuscular (IMF) and subcutaneous fat with skin. Muscle growth was most intense when pigs aged between 83 and 167 days. Differences in tissue composition of pigs within a breed are markedly influenced by sex. Gilts had higher muscle tissue percentage in relation to distribution of the other tissues in carcasses. At the end of fattening period muscle growth slows down; the time and the rate at which this occurs are dependent on sex and genetic structure of the animal. Significant accumulation of fat tissue starts at higher live weight.

Key words: growth, pigs, tissue composition.

Introduction

In the last 30 years investigations on muscle tissue development of fatteners intensified (Davies and Pryor, 1977; Davies and Kallweit, 1979; Shelds et al., 1983; Tess et al., 1986; Gu et al., 1992; Wagner et al., 1999, Landgraf et al., 2006).

This led to useful discoveries which made effective selection on weight gain and muscle tissue growth possible (Wiseman et al., 2007). Animal growth is a result of many biological processes. Genotype determinates the maximum level to which this processes occur, while environment affects the degree to which genotype potential manifests. Usually growth curve is sygmoidly shaped: at the beginning it slightly rises, after which acceleration to certain age (inflection point) occurs. At the end it declines and finally stops after the body weight reaches its maximum. Growth is important physiological activity of all living creatures, but within domestic animals it is of special interest in meat producing species such as pigs, beef, sheep, poultry etc. Traditionally in pig research, body composition is investigated by sequential slaughter of experimental animals followed by total dissection into main tissues (Davies and Kallweit 1979, Gu et al., 1992) or by grinding of the cuts of interest and subsequent chemical analysis (Shields *et al*., 1983, White 1995). More recently, non-destructive methods of investigating the animal growth, especially in pigs are often used e.g. computer tomography or CT scanning (Giles et *al*., 2009), magnetic resonance imaging or MRI (Baulain 1997, Kusec et al., 2007). The aim of present study was to investigate the changes in carcass composition of pigs during growth; especially the influence of gender on growth of pigs in live weight and the weight of economically important tissues.

Materials and methods

The study was performed on 60 pigs (30 gilts and 30 barrows) aged 49 to 215 days (Figure 1). Investigated pigs were three-way crosses with Landras x Pietrain sire and Duroc dam, a typical fattening type of pig in Batalle breeding program.

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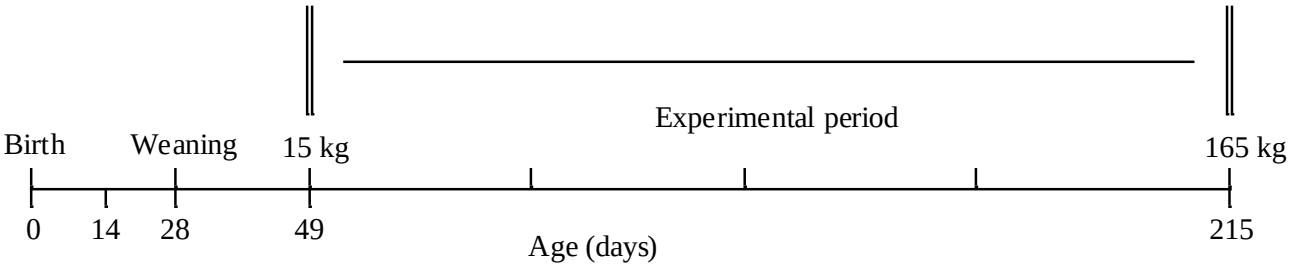


Figure 1 – OBSERVATION PERIOD SCHEME (ADOPTED FROM Arthur *et al.*, 2008)
Slika 1 – SHEMA PROMATRANOG RAZDOBLJA (PRILAGOĐENO PREMA Arthuru i sur., 2008.)

After farrowing four offspring's (two males, castrated after 7 days, and two females) of each sow were selected. The piglets were tattooed and marked. During the experiment pigs were kept in the same conditions and fed the same diet. Feeding regime was *ad libitum*. The animals were fed diets used for commercial slaughter pigs with energy content of 13.3 MJ ME per kg and 19.56% crude protein in the growth phase and 13.6 MJ ME per kg and 17.43% crude protein in the finishing phase, respectively. During the experiment every animal was weighed once a week. Every three weeks according to average group weight four representative animals were slaughtered at slaughterhouse (Table 1). Right sides of the carcasses were dissected according to Weniger et al. (1963). This part of experiment was performed on 30 animals.

Table 1. – SAMPLING SCHEME FOR CARCASS DISSECTION
Tablica 1. – SHEMA UZIMANJA UZORAKA ZA DISEKCIJU SVINJSKIH TRUPOVA

Dissection stage	Age (days)	Sex	
		♂ (barrows)	♀ (gilts)
I	62	1	1
II	83	2	2
III	104	2	2
IV	125	2	2
V	146	2	2
VI	167	2	2
VII	188	2	2
VIII	209	2	2

Main parts of the carcasses (ham, shoulder, loin, ribs and neck) were dissected into muscles, bones, intramuscular (IMF) and subcutaneous fat with skin. Head muscle tissue was not calculated into total carcass muscle weight, while weights of the chin fat and kidney fat were calculated into total fat weight. Statistical analyses were performed using SAS/STAT (SAS Inst. Inc., 2003, Version 9.1) software. Graphs were made with KaleidaGraph 4.03 software package.

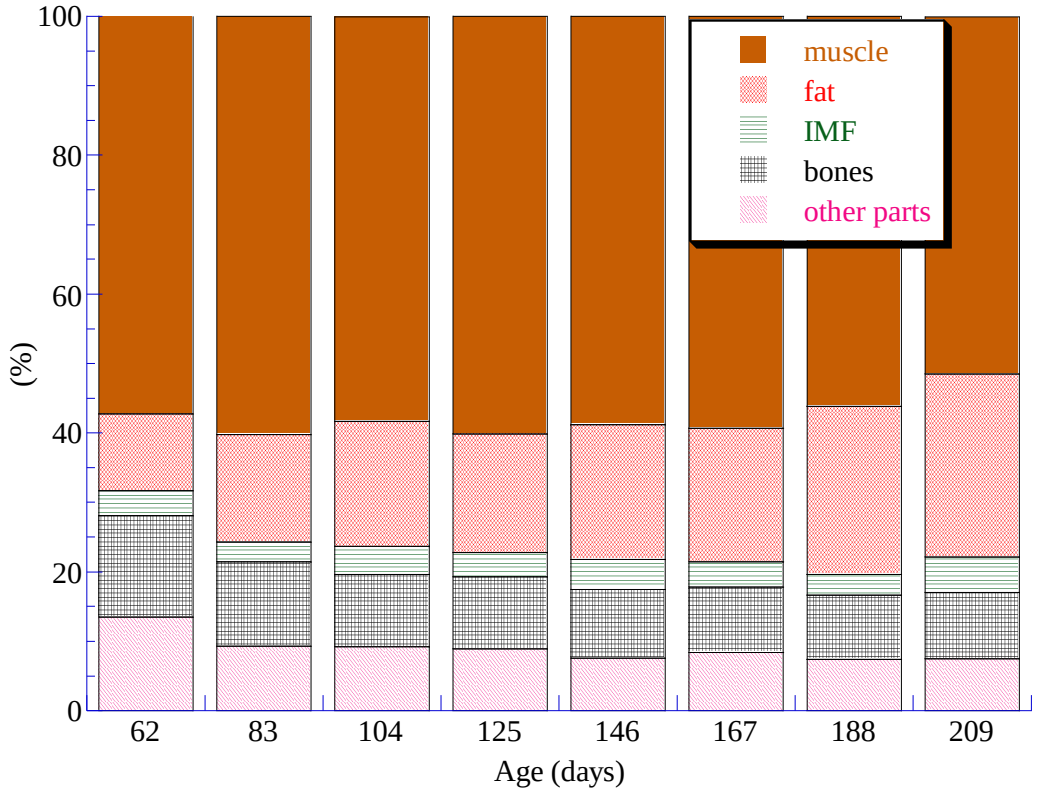
Results and discussion

Results of the dissection into main tissues in different time periods are shown in Table 2. Results show that muscle tissue grows proportionally with live weight (LW) of the pigs. Bone growth was similar to patterns reported by Wagner et al. (1999). It can be noticed that bones grow considerably slower than muscles (Davies, 1983; Fortin et al., 1987).

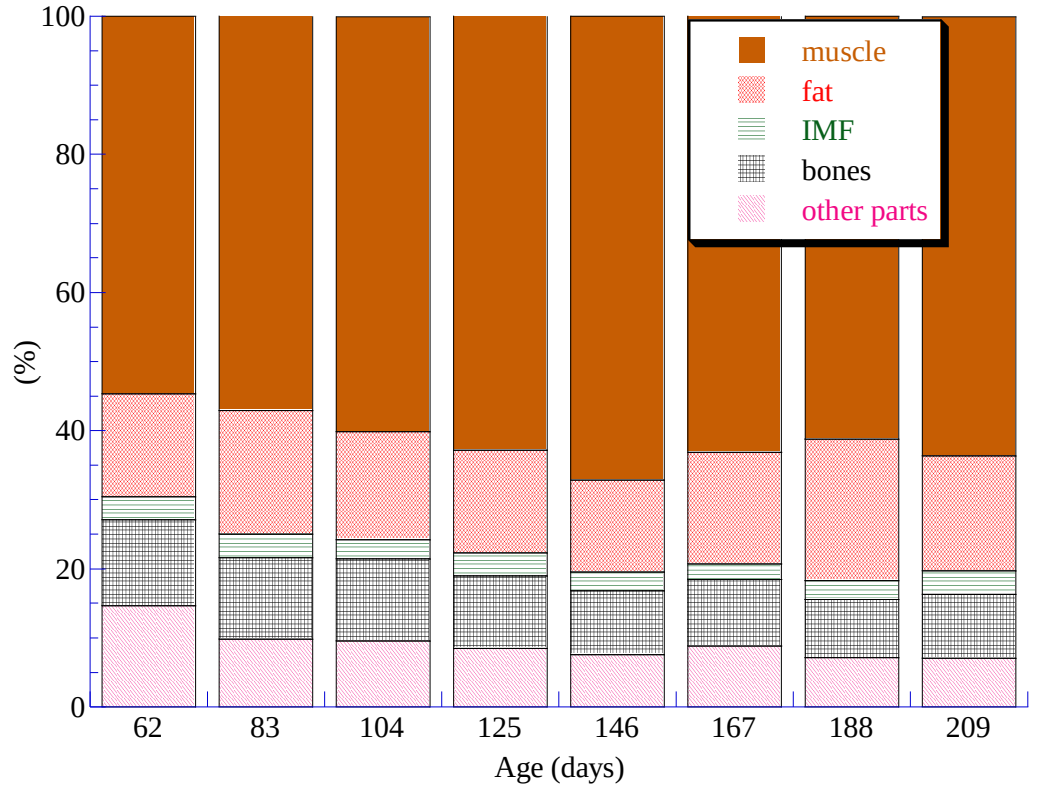
Table 2. – RESULTS OF CARCASS DISSECTION INTO MAIN TISSUES (kg)
Tablica 2. – REZULTATI RASIJECANJA SVINJSKIH TRUPOVA NA OSNOVNE DIJELOVE TIJEKOM ISTRAŽIVANOG RAZDOBLJA (kg)

Age	Sex	n	Live weight	Warm carcass weight	Muscles	Fat	IMF	Bones
62	♂	1	30.00±	11.01±	6.31±	1.22±	0.40±	1.60±
	♀	1	30.50±	11.03±	6.03±	1.64±	0.37±	1.37±
	♂+♀	2	30.25±0.353	11.02±0.014	6.17±0.197	1.43±0.301	0.39±0.021	1.48±0.165
83	♂	2	41.75±0.495	15.49±1.110	9.33±0.792	2.39±0.258	0.46±0.018	1.87±0.021
	♀	2	40.30±3.253	14.54±0.590	8.31±0.466	2.60±0.113	0.50±0.057	1.71±0.187
	♂+♀	4	41.03±2.075	15.01±0.909	8.82±0.791	2.49±0.200	0.48±0.040	1.79±0.142
104	♂	2	56.00±	21.60±0.140	12.59±0.416	3.89±0.225	0.87±0.245	2.25±0.012
	♀	2	53.90±0.566	20.54±0.973	12.34±0.014	3.22±0.518	0.58±0.014	2.42±0.294
	♂+♀	4	54.95±1.255	21.06±0.831	12.47±0.280	3.56±0.504	0.73±0.218	2.34±0.196
125	♂	2	71.65±2.333	25.59±0.361	15.41±0.530	4.37±0.389	0.88±0.106	2.65±0.021
	♀	2	71.55±2.051	28.20±1.442	17.75±1.817	4.17±0.049	0.94±0.311	2.98±0.021
	♂+♀	4	71.60±1.794	26.89±1.737	16.58±1.738	4.27±0.254	0.91±0.193	2.81±0.191
146	♂	2	90.00±	33.79±0.976	19.87±2.821	6.56±1.859	1.49±0.431	3.32±0.247
	♀	2	91.50±2.121	35.19±0.693	23.64±0.354	4.69±0.184	0.94±0.049	3.26±0.028
	♂+♀	4	90.75±1.500	34.49±1.063	21.75±2.729	5.62±1.524	1.22±0.409	3.29±0.147
167	♂	2	104.05±0.071	40.49±0.009	24.05±0.325	7.78±0.759	1.47±0.256	3.81±0.003
	♀	2	106.20±5.374	43.34±2.768	27.81±1.798	7.00±0.625	0.99±0.044	4.14±0.089
	♂+♀	4	105.13±3.342	41.92±2.294	25.93±2.414	7.39±0.725	1.23±0.315	3.97±0.197
188	♂	2	120.55±0.778	45.89±3.553	25.81±1.538	11.09±1.926	1.36±0.164	4.24±0.028
	♀	2	118.20±15.556	46.75±6.909	28.65±4.206	9.56±1.342	1.26±0.299	3.95±0.443
	♂+♀	4	119.38±9.094	46.32±4.512	27.23±3.063	10.32±1.618	1.31±0.205	4.09±0.307
209	♂	2	132.60±4.808	52.22±3.370	26.86±0.558	13.79±2.843	2.65±0.623	4.98±0.294
	♀	2	123.75±16.051	47.87±6.783	30.44±3.203	7.99±2.512	1.62±0.358	4.43±0.417
	♂+♀	4	128.18±10.941	50.04±5.042	28.65±2.793	10.89±4.001	2.15±0.735	4.71±0.434

Although there is large variation with regard to genotype, in most lean pig breeds muscle weight increases between 80 and 100 kg LW. Landgraf *et al*. (2006) showed that the highest increase of muscle tissue in primal cuts was between 90 and 120 kg LW, whereas fat tissue of the same cuts increased extremely between 120 and 140 kg LW. This investigation shows similar results. Muscle growth was most intense when pigs aged between 83 and 167 days (Graph 1 and 2). In this period muscle gain was between 3.26 kg and 5.89 kg. It should be stated that muscle gain dramatically falls after 167 days of life. At 188 days of life muscle gain was 0.84 kg in gilts and 1.76 kg in barrows. In this study the highest percentage of muscle tissue in gilts was achieved at the age of 146 days or 91.5 kg LW (67.18%), while in barrows the highest muscle percentage (60.22%) was recorded at 125 days of life. From that moment significant fat accumulation in barrows began. In the half carcass of Large White x Landrace castrates, Davis and Pryor (1977) reported for fat and lean tissue of 0.9 and 2.6 kg, respectively, at 19.8 kg LW and 5.8 and 9.7 kg at 62 kg LW. In Landrace, Davis and Kallweit (1979) reported for fat and lean tissue 0.9 and 3.2 kg at 17.5 kg LW and 17.2 and 24.0 kg at 121 kg LW. Landgraf *et al*., (2006) on the left carcass side, on 48 experimental pigs (17 females and 31 castrated males), reported for fat and lean tissue of 0.9 and 3.1 kg, respectively, at 20 kg LW and 5.9 kg and 25.5 kg at 120 kg LW.



Graph 1. – DISTRIBUTION OF TISSUES IN RELATION TO AGE OF THE BARROWS
Grafikon 1. – DISTRIBUCIJA TKIVA U ODNOSU NA DOB KASTRATA



Graph 2. – DISTRIBUTION OF TISSUES IN RELATION TO AGE OF THE GILTS
Grafikon 2. – DISTRIBUCIJA TKIVA U ODNOSU NA DOB NAZIMICA

Differences between studies may partly be due to the use of different cutting systems. Many authors reported late finishing of fat tissue growth (Davies and Kallweit, 1979; Shields *et al*., 1983; Tess *et al*., 1986; Fortin *et al*., 1987; Gu *et al*., 1992). These results are supported by current investigation. In their studies on gilts with 100 kg LW experts in Seleccion Batalla (2006) breeding company reported 1.83% of intramuscular fat content. This is much higher than IMF content in gilts presented in this study (1.15%). Results of Reixacha *et al*. (2008) indicate the existence of genetic variation in fat and intramuscular fat content, which can depend on the age at which the sample was taken. Therefore, the authors propose to develop selection criteria based on the final live weight. According to research of Cilla *et al*. (2006) on similar samples of pigs at 100 kg of LW, lean share ranging from 53.1% to 57.6% was determined. This is considerably lower than lean share determined in this study. Although bone growth slows down with animal entering the later life stage, skeleton still grows, but considerably slower. In the present study bones grew proportionally to body growth. Furugouri *et al*. (1981) reported that body weight gain is accompanied with proportional growth of bone length and diameter in pigs between 30 and 150 kg LW. This indicates that bone shape is formed in early stage of growth. Higher growth of bone length and diameter (Liu *et al*.. 1999) during time represents a physiological answer to their functions: walking, running and support to growing body weight. Kastelic *et al*. (1993) reported bone weight of 14 kg in sows aged 1000 days. Žgur *et al*. (1995) investigated influence of pig breed on bone percentage in carcasses. The authors found higher bone percentage in crosses with Duroc than in other genotypes.

Conclusion

Differences in tissue composition of pigs within a breed are markedly influenced by sex. In this study gilts had higher muscle tissue percentage in relation to distribution of the other tissues in carcasses. The highest muscle tissue growth is achieved between 83 and 167 days of life, after which it significantly decreases. At the end of fattening period muscle growth slows down; the time and the rate at which this occurs are dependent on sex and genetic structure of the animal. Significant accumulation of fat tissue starts at higher live weight, i.e. at the weight which is not economically important for meat industry. Analyses of different methods for growth and body composition assessment produce different results. For that reason constant investigation on growth and growth characteristics, especially in relation to pig leanness, is recommended.

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PROMJENE U SASTAVU TKIVA SVINJA TIJEKOM RASTA

Sažetak

Cilj ovog istraživanja bio je proučiti promjene u sastavu tkiva svinja tokom rasta. Istraživanje je provedeno na 60 svinja (30 kastrata i 30 nazimica) u dobnom intervalu između 49 i 215 dana. Kroz cijelo vrijeme istraživanja, svaka pojedina životinja vagana je svakih sedam dana. Svakih tri tjedna, odabrane su četiri prosječne životinje s obzirom na prosječnu tjelesnu masu skupine, te se obavljala disekcija. Glavni dijelovi trupova (but, plećka, leđa, rebra i vrat) su disekcijom bili secirani na mišiće, kosti, intramuskularnu mast (IMF) i potkožno masno tkiva s kožom. Najintenzivniji rast mišićnog tkiva primijećen je u interval između 83 i 167 dana starosti. Razlike u sastavu tkiva svinja unutar pasmine izrazito su pod utjecajem spola. Nazimice su imale veći postotak mišićnog tkiva u odnosu na distribuciju drugih tkiva u polovicama. Na kraju tova rast mišića se usporava; vrijeme i brzina po kojoj se događa taj proces ovise o spolu i genetskoj strukturi životinje. Značajna akumulacija masnog tkiva započinje kod većih težina životinja.

Ključne riječi: rast, svinje, sastav tkiva.

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