

ANALYSIS OF CHEMICAL COMPOSITION IN PORK LONGISSIMUS MUSCLE OF LATVIAN BREED PIGS

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Abstract

The aim of this study was to investigate the pork chemical composition (protein, intramuscular fat, cholesterol) and fatty acid composition (SFA, PUFA, MUFA) of the *longissimus dorsi* muscle of purebred Latvian White (Latvian Yorkshire) and crossbred Latvian Yorkshire and Landrace pigs selected from different herds. The average protein level in pork was 22.8 ± 0.21 g 100 g⁻¹ and average intramuscular fat (IMF) $5.6 \pm 0.62\%$. It was found that IMF in investigated meat samples was higher than the ideal level. The crossbred pigs produced meat with higher protein level ($p < 0.05$) and with less IMF ($p < 0.05$). The saturated fatty acid (SFA) range from 0.7 to 5.2 g 100 g⁻¹ and polyunsaturated fatty acid (PUFA) range from 0.1 to 1.2 g 100 g⁻¹. PUFA:SFA ratio of lean meat was 0.24 on average, which is less than the recommended minimum and did not exceed the value 0.4. The crossbred pigs meat contained significantly lower SFA with higher PUFA:SFA ratio ($p < 0.05$) compared to those of purebred pigs. Investigated pork samples contain higher level of omega-6 ($n-6$) and a small level of omega-3 ($n-3$) with evaluated $n-6:n-3$ ration 4:1 to 11:1. However, in our investigation were samples of pork in which the IMF was in the recommended range 2–3% and with higher protein and omega-3 level. In general, pork chemical and fatty acid composition depended on pigs genetic.

Keywords: pork, pork quality, intramuscular fat, cholesterol, fatty acid composition

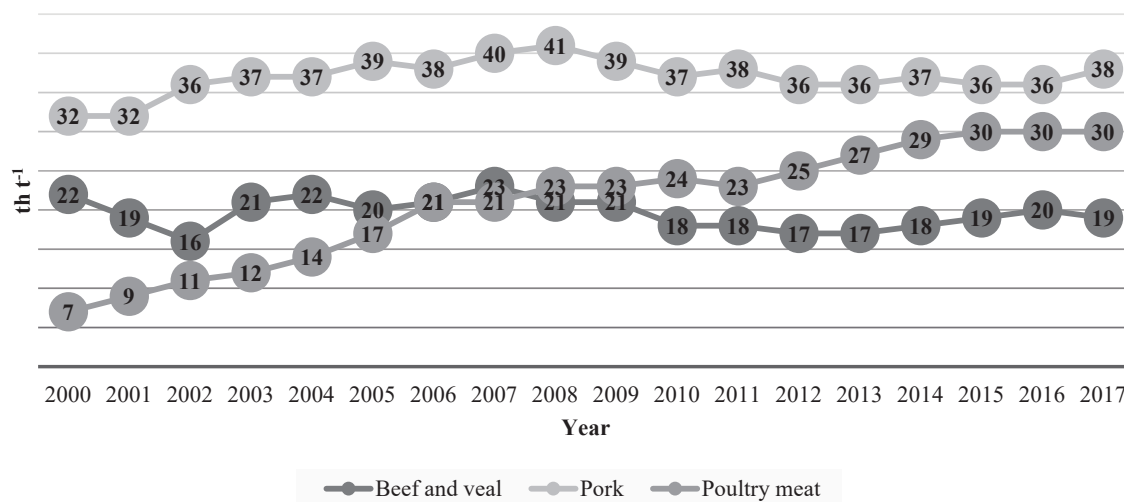
INTRODUCTION

The total meat production in Latvia has been increasing between 2000 and 2017 and ranged from 60,000 tonnes to 87,000 tonnes. The pork production during this period was higher to compare with beef and chicken production and was around half of all produced meat in Latvia. Pork production was more stable in a range from 32,000 tonnes to 41,000 tonnes per year (Fig. 1).

However, the meat production per capita is increasing from 26 kg in 2000 to 44 kg in 2016, of which pork production per capita is increasing from 13 kg to 18 kg. Pork is the most popular meat in Latvia.

Chemical composition varies depending on the pig's diets (Václavková *et al.*, 2011; Park *et al.*, 2012; Inserra *et al.*, 2015), physiological – sex, age (Lo Fiego *et al.*, 2010) and genetic factors (Cameron and Enser, 1991; Jukna *et al.*, 2007; Jukna *et al.*, 2013; Choil *et al.*, 2016).

Pork muscle tissue in average contains 70% to 75% moisture, 18% to 22% protein, 2% to 3% fat. In Large white (LW), crossbred of Landrace and LW, crossbred of Yorkshire and LW *m. longissimus dorsi* the content of moisture varied from 72 to 75%, protein from 23 to 24%, and fat from 1.6 to 1.9% (Jukna *et al.*, 2013).

1: Meat production in Latvia 2000–2017 (th t⁻¹)Source: Central Statistical Bureau of Latvia, <http://www.csb.gov.lv/en>

Pork is not only the source of the protein and minerals but as well provide the fatty acids for the human diet. Meat contains saturated, monounsaturated and polyunsaturated fatty acids. Polyunsaturated fatty acids (PUFA) are major flavour precursors of the meat (Wood *et al.*, 2004). Moreover, nutritionists recommend for a consumer to increase PUFA and decrease saturated fatty acids (SFA) in the diet. Meat with higher PUFA:SFA ratio and a high proportion of *n*-3 PUFA is beneficial from the nutritional point of view (Wood and Enser, 2017).

The aim of the study is to investigate the pork chemical composition (protein, intramuscular fat, cholesterol) and fatty acid composition (SFA, PUFA, MUFA) of the *m. longissimus dorsi* of Latvian local and commercial pig breeds.

MATERIALS AND METHODS

During the investigation 30 pork samples of ten purebred Latvian White (Latvian Yorkshire) and twenty crossbred Latvian Yorkshire and Landrace pigs were collected and analysed. The pigs were slaughtered with a live weight 100–120 kg. The average pigs carcass weight was 83.7 ± 2.22 kg with average carcass weight income 67.4 ± 1.06%. After slaughtered, from the right side of the carcasses, 0.5 kg of the *m. longissimus dorsi* were obtained between 5th and 10th rib. Each sample was placed in a plastic tube without contact between samples.

The pork technological quality was analysed during the 24 hours post mortem in fresh samples at Latvia University of Life Sciences and Technologies (LLU) laboratory. Crude protein

content was determined using the Kjeldahl method (ISO 937:1978), with Kjeltex 2100 (FOSS, Sweden), and a conversion coefficient 6.25 to convert the total nitrogen to crude protein was used (Januškevičienė *et al.*, 2012). Intramuscular fat defined by the ISO 1443:1973 standards. For the fat content determination was used SoxCap™ 2047 in combination with Soxtec extraction equipment (FOSS, Sweden). All analyses were done twice.

The samples used for the analysis of the fatty acids were frozen at -18 °C before sending to the laboratory. The Fatty acid composition of samples were analysed in J.S. Hamilton Poland S.A. laboratory¹ according to methods PN-EN ISO 12966-1:2015-01 and PN-EN ISO 12966-2:2011². As well in Hamilton laboratory hydroxyproline by PN-ISO 3496:2000, tryptophan by PB-136/HPLC (ed. I of 06.02.2012) and cholesterol by gas chromatography method (PB-75/GC ed. I of 20.01.2009) were analysed.

For the data analysis purebred and crossbred pigs pork samples were divided into three groups: 1st group Latvian White (Latvian Yorkshire) pigs pork samples; 2nd group Latvian Yorkshire and Landrace (50%:50%) and 3rd group Latvian Yorkshire and Landrace (25%:75%) crossbred pigs pork samples. 10 samples were included into each group.

Data analysis was processed using R software (R Core Team, 2017). The investigated groups influence to the pork chemical and fatty acid composition of the intramuscular fat of *m. longissimus dorsi* was analysed by one way ANOVA on the significant levels $p < 0.05$, 0.01 and 0.001. The Bonferroni test was applied to compare

1 www.hamilton.com.pl2 <https://hamilton.com.pl/wp-content/uploads/2017/12/FOOD-analytical-services.pdf>

the differences in chemical composition traits among the different genotypes. Data in the tables below is reported as means \pm Standard Error of means. The differences between means were tested at significant level $p < 0.05$.

RESULTS AND DISCUSSION

Analysis of the Chemical Composition of *M. Longissimus Dorsi*

The results show that the average protein level in pork was 23.4 ± 0.22 g 100 g⁻¹ and the average intramuscular fat (IMF) $4.6 \pm 0.51\%$. IMF is higher than the ideal level, which is considered as 2–3% and fresh meat with IMF over 3.5% can be rejected by consumer (Fernandez *et al.*, 1999), because is associated with the sensory evaluation of the meat.

The average values of the chemical composition of the *m. longissimus dorsi* of investigated groups are given in Tab. I. There are significant differences between the investigated groups in protein and IMF level. The 3rd group compare to the group 1 and the group 2 produced meat with higher protein level (24.5 ± 0.23 g 100 g⁻¹; $p < 0.05$) and at the same time meat was with less IMF ($2.7 \pm 0.47\%$, $p < 0.05$). The IMF level in the 3rd group is in recommended range (2–3%). A negative correlation was found between pork protein content and IMF ($r_{xy} = -0.53379$; $p < 0.05$). In several investigations (Daszkiewicz *et al.*, 2005; Zymantiene *et al.*, 2008) were reported the samples with higher protein are characterized with lower fat content.

Significant differences between the groups were observed in amino acids of the proteins hydroxyproline (Hyd) ($p < 0.05$) and tryptophan (Trp) ($p < 0.001$), and in hydroxyproline:tryptophan (Hyd:Trp) ratio ($p < 0.001$). The 3rd group meat samples contain more Trp (0.28 ± 0.005 g 100 g⁻¹) with higher Trp:Hyd ratio (5.76 ± 0.63). The higher Trp:Hyd ratio determined biological value of the pork protein. However, proline and hydroxyproline

are the major amino acids in the collagen proteins and are the major extracellular components in connective tissues which are very important for pig growing (Guoyao *et al.*, 2011). The Tryptophan is only in muscle tissue. Our results of Trp:Hyd ratio compared with other research (6.82 ± 0.33) (Zymantiene *et al.*, 2008), are lower.

The differences in average cholesterol content between investigated groups was not significant, at the same time there was a tendency the cholesterol level was higher in the meat of the 1st group compare to the 2nd and the 3rd groups. The IMF and cholesterol parameters were higher in the 1st group meat samples. However, a higher IMF content in samples related with higher cholesterol level ($r_{xy} = 0.23$). According to the Jacyno *et al.* (2006) investigation, the meat of the fatteners (lean meat content 54.7–60%) contained by 9.5% less cholesterol.

The LW (LY) local breed pork samples were with higher IMF and lower protein content compare to the crossbred pigs. The intramuscular fat content has a positive effect on meat juiciness, hardness and flavour (Alonso *et al.*, 2009). Our results are the same as in the other research where the lowest amount of intramuscular fat in crossbred LWxL pig meat was found; it was by 0.17 percent lower than in LWxY and even by 0.28 percent lower than in LW pig breed meat. The intramuscular fat is the most variable component of the meat (Jukna *et al.*, 2007). The variation coefficients of fat were several times higher as those are in others meat ingredients; the highest variability of the traits was in LWxL crossbred and the lowest in LW pigs' meat (Jukna *et al.*, 2013).

Analysis of the Fatty Acid Composition of *M. Longissimus Dorsi*

In studied samples, the saturated fatty acids (SFA) range from 0.7 to 5.2 g 100 g⁻¹ and polyunsaturated fatty acids (PUFA) range from 0.1 to 1.2 g 100 g⁻¹. PUFA:SFA ratio of lean meat was 0.24 in average,

I: Chemical composition and amino acids of *m. longissimus dorsi* of investigated groups

Traits	LW (LY) Group 1	LY x L (50%:50%) Group 2	LY x L (25%:75%) Group 3	p-value
Protein, g 100 g ⁻¹	22.4 \pm 0.31 ^a	23.2 \pm 0.25 ^a	24.5 \pm 0.23 ^b	***
Hydroxyproline, %	0.08 \pm 0.01	0.08 \pm 0.01 ^a	0.05 \pm 0.01 ^b	*
Intramuscular fat, %	5.6 \pm 1.12 ^a	5.6 \pm 0.61 ^a	2.7 \pm 0.47 ^b	*
Tryptophan, g 100 g ⁻¹	0.24 \pm 0.01	0.26 \pm 0.00	0.28 \pm 0.01	***
Hydroxyproline: Tryptophan ratio	0.33 \pm 0.04 ^a	0.32 \pm 0.02 ^b	0.20 \pm 0.03 ^c	***
Tryptophan: Hydroxyproline ratio	3.31 \pm 0.38 ^a	3.30 \pm 0.24 ^a	5.76 \pm 0.63 ^b	*
Cholesterol, mg 100 g ⁻¹	62.4 \pm 2.92	57.3 \pm 3.05	58.1 \pm 4.28	NS

LW (LY) – Latvian White (Latvian Yorkshire), LY x L – Latvian Yorkshire x Landrace; NS – not significant ($p > 0.05$); Statistically significant * $p \leq 0.05$, ** $p \leq 0.01$, *** $p \leq 0.001$; ^{a,b} – means differences within a row statistically significant ($p \leq 0.05$)

II: Fatty acid composition of the intramuscular fat of *m. longissimus dorsi* of investigated groups

Traits	LW (LY) Group 1	LY x L (50%:50%) Group 2	LY x L (25%:75%) Group 3	p-value
SFA g 100 g ⁻¹	2.26 ±0.45 ^a	2.13 ±0.22	1.07 ±0.16 ^b	*
MUFA g 100 g ⁻¹	2.82 ±0.57 ^a	2.84 ±0.32 ^a	1.23 ±0.21 ^b	*
PUFA g 100 g ⁻¹	0.46 ±0.09	0.59 ±0.07	0.34 ±0.09	NS
Omega-3 (n-3) g 100 g ⁻¹	< 0.1	0.11 ±0.01	< 0.1	-
Omega-6 (n-6) g 100 g ⁻¹	0.44 ±0.09	0.49 ±0.06	0.31 ±0.08	NS
Omega (n-9) g 100 g ⁻¹	2.41 ±0.49 ^a	2.50 ±0.29 ^a	1.08 ±0.19 ^b	*
PUFA:MUFA ratio	0.17 ±0.02 ^a	0.21 ±0.01	0.25 ±0.03 ^b	*
PUFA:SFA ratio	0.21 ±0.02	0.28 ±0.01	0.28 ±0.04	NS
MUFA:SFA ratio	1.22 ±0.03	1.32 ±0.03 ^a	1.12 ±0.03 ^b	***

LW (LY) – Latvian White (Latvian Yorkshire), LY x L – Latvian Yorkshire x Landrace; NS – not significant ($p > 0.05$); Statistically significant * $p \leq 0.05$, ** $p \leq 0.01$, *** $p \leq 0.001$; ^{a,b} – means differences within a row statistically significant ($p \leq 0.05$); SFA – Saturated fatty acids, MUFA – Monounsaturated fatty acids, PUFA – Polyunsaturated fatty acids

which is less than recommended minimum 0.4 by World Health organisation (WHO) and in other authors' investigations. IMF has a lower polyunsaturated fatty acid (PUFA) content and a higher percentage of SFA, while monounsaturated fatty acid content (MUFA) is similar in IMF and back fat (Pena *et al.*, 2016).

The average values of the fatty acid composition of the intramuscular fat of the *m. longissimus dorsi* of investigated groups are given in Tab. II. The analysis shows that there was a significantly lower SFA and MUFA level ($p \leq 0.05$) in pork of the 3rd group, than it was in the 1st and the 2nd groups. There was not significant differences in PUFA level between investigated groups due to high variability within the groups. The SFA and MUFA level depends on the genetic, the crossbred pigs contained significantly lower SFA with higher PUFA:SFA ratio compared to those of purebred LW (LY) local pigs.

Dietetic value of meat depend on cholesterol and fatty acids level and as indicators of the healthfulness of fatty acid profiles are used PUFA:SFA and omega-6:omega-3 (*n-6:n-3*) ratios (Dugan, 2015). The average PUFA:SFA ratio of the lean meat was higher in the 2nd and 3rd (0.28) groups compare to the 1st group (0.21). In all groups PUFA:SFA ratio was not reached the recommended

minimum 0.4. In investigated samples the palmitic acid (C16:0) was the main component of SFA, oleic acid (C18:1cis-9) the main component of monounsaturated fatty acid (MUFA), and linoleic acid (C18:2 n-6) the main component of PUFA.

The pork contained higher level of omega-6 (*n-6*) and small level of omega-3 (*n-3*) (Tab. II) with evaluated *n-6:n-3* ration from 4:1 to 11:1, while nutritionist recommended a diet with 4:1 *n-6:n-3* ratio and diet with high level of omega-3 (Simopoulos, 2008).

In Lim *et al.* (2013) investigation in Yorkshire and Landrace crossbred pork samples PUFA:SFA ratio was in average 0.35 and an *n-6:n-3* ratio 9.75:1. Kasprzyk *et al.* (2015) have reported in Polish Landrace longissimus tissue PUFA:SFA ratio of 0.24 and an *n-6:n-3* ratio of 15.61:1. Choi *et al.* (2016) investigated fatty acid composition in longissimus muscles of Duroc, Landrace, Yorkshire pigs and crossbred (DLY) pigs and found the crossbred pigs contained significantly higher *poly-*, *n3-* and *n6-* unsaturated fatty acids compared to those of purebred pigs, including Duroc, Landrace, and Yorkshire pigs.

In our investigation, the fatty acid composition of crossbred pigs were lower with higher PUFA:SFA ratio compared to those of purebred pigs.

CONCLUSION

The study showed the chemical composition, fatty acid composition of *m. longissimus dorsi* depended on pigs genetic. Generally, the LYxLL crossbred pigs pork samples was with significantly higher protein content and lower IMF compare to the purebred LW (LY) breed. The fatty acid composition of crossbred LYxLL pigs was lower with higher PUFA:SFA ratio compared to those of purebred LW (LY) breed pigs. The IMF in the LYxLL crossbred pigs pork samples were in the recommended range (2–3%). PUFA:SFA ratio of pork was 0.24 in average and in investigated groups PUFA:SFA ratio did not reach the recommended minimum 0.4. However, there were pork samples in which the IMF was in range 2–3% and with higher level of omega-3.

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