THE BREED INFLUENCE IN PORK QUALITY AND INTRAMUSCULAR FATTY ACID COMPOSITION

EDITA MESHKINYTE-KAUSHILIENE, VIGILIJUS JUKNA, ALMANTAS SHIMKUS,
JOLITA KLEMENTAVICHIUTE, NIJOLE PECHIULAITIENE, ALDONA SHIMKIENE
Lithuanian Health Sciences University, Veterinary Academy,
Laboratory of Meat Characteristics and Quality Assessment,
Tilžės 18, Kaunas LT-47181, Lithuania, tel. (8-37)36 34 14;

In the past decade a number of consumer driven changes have transformed industry approaches to pork production such as the desire for healthier and more nutritious pork products (**Mason et al**., 2005). Meat quality and its nutritional value depend on meat components ratio (**Culioli et. al**., 2003; **Jukna et. al.,** 2006).

Meat quality is assessed according to individual quality traits such as pH, color or intramuscular fat content. Meat color is an important quality attribute for the consumer (**Alonso V. et al.,** 1994; **Jukna et. al.,** 2010). Also, intramuscular fat in pork has been reported to positively influence juiciness, tenderness and flavor (**Wood,** 1993). Fat and fatty acids are important because of their effects on human health. In developed countries, fatty acid composition and the total amount of saturated fatty acids (SFA) have been identified as dietary risk factors **(Pascual et al.,** 2007). It is important to select production options which maximize both meat quality and healthiness in meat production (**Kouba et al**., 2003). Fatty acid (FA) composition is a major factor in the nutritional value of meat, with a high polyunsaturated fatty acid (PUFA) to saturated fatty acid (SFA) ratio of 0.4 or above considered suitable for human consumption (**Department of Health**, 1994).

Pigs have high levels of polyunsaturated fatty acids (PUFA), including the long chain (C20-22) PUFA (**Wood J.D et al**, 2008). The total fatty acid content of muscle (i.e. neutral lipid plus phospholipids fatty acids), termed marbling fat, has long been recognized as a factor in eating (**Wood J.D.**, 1990). Fatty acids are involved in various ‘‘technological’ aspects of meat quality. Because they have very different melting points, variation in fatty acid composition has an important effect on firmness or softness of the fat in meat. The ability of unsaturated fatty acids, especially those with more than two double bonds, to rapidly oxidize, is important in regulating the shelf life of meat (rancidity and color deterioration) (**Wood J.D. et al.,** 2003). Several factors can modify the composition of fat deposits, among them species, breed, anatomical location, sex and diet (**Lawrie,** 2006; **Nedeva et al**., 2009*).*

The aim of this research was to investigate whether meat quality and intramuscular fatty acid composition are affected by breed in pigs.

MATERIAL AND METHODS

Animals and muscle samples

The research of chemical characteristics of pork meat was carried out at the Laboratory of Meat Characteristics and Quality Assessment of the Lithuanian University of Health Sciences, Veterinary Academy. The samples of pork for analysis were taken from fifty Yorkshire (Y), Pietrain (P) Lithuanian White (LW), Lithuanian Large White (LLW) and Landrace (L) pig carcasses. Ten animals were chosen from each breed. Pigs were held

at the control Feeding Station of Pigs in Lithuania under standard feeding and keeping conditions. Pigs were slaughtered at the weight from 95 to 100 kg in the station. Slaughter and post-slaughter processing was carried out in accordance with the EU regulations binding in the meat industry. Samples were taken from dorsal loin muscle *m. longissimus dorsi.* All the studies were performed 48 hours after slaughter.

Meat quality measurements

Common accepted methods were used for experiment. pH values were measured with pH-meter Inolab 3 with a contact electrode SenTix Sp according to ISO standard **ISO 2917:1999***,* color intensity with Minolta ChromaMeter 410, measuring values of L* for lightness, a* – for redness and b* – for yellowness. Protein was determinate according to Kjeldal method (**LST ISO 937:2000**). Cooking loss values were determinate by Schilling method (1966). Fat content analysis was performed by Soxhlet method (**AOAC International**, 2007), dry matter - according **LST ISO 1442:2000.**

Fatty acids analysis

Fatty acid content of the samples was determined by gas chromatography using a flame ionization detector. Samples were prepared according **LST EN ISO 12966-2:2011** and analyzed according **LST EN ISO 15304:2003/AC: 2005** methodology. The methyl esters from fatty acids (FAMES) were formed using a KOH solution in methanol. The FAMES were analysed in a gas chromatograph Shimadzu GC - 17A, with a capillary column BPX – 70, 120 m, using nitrogen as the carrier gas. Fatty acid composition was quantified using "Supelco 37 Component FAME Mix" as the internal standard.

ISO 2917:1999 Meat and meat products measurement of pH. (Reference method.)

LST ISO 937:2000 Meat and meat products. Determination of nitrogen content (Reference method)

LST ISO 1442:2000 Meat and meat products. Determination of moisture content. (Reference method)

LST EN ISO 12966-2:2011 Animal and vegetable fats and oils - Gas chromatography of fatty acid methyl esters - Part 2: Preparation of methyl esters of fatty acids (ISO 12966-2:2011)

LST EN ISO 15304:2003/AC:2005 Animal and vegetable fats and oils - Determination of the content of trans fatty acid isomers of vegetable fats and oils - Gas chromatographic method (ISO 15304:2002/Cor.1:2003)

Statistical analysis

The R statistical package version 2.0.1. (Gentlemen, Ihaka, 1997) was used to estimate data. Differences were considered significant if $P \leq 0.05$.

RESULTS AND DISCUSSION

Meat quality

The characteristics of *longissimus dorsi* muscle from all pigs are shown in Table 1. The differences in pH values among the breeds were not statistically significant, although LW had the highest value. Those results agree with **Ačaitė S.** (2005) who found that pH of LW had the highest value between LW, LLW, J and L breeds. The lightness of Yorkshire pigs was higher than other breeds. The redness was higher in LW pigs and the yellowness of Landrace pigs was higher than that in other breeds. Intramuscular fat content values in *m. longissimus dorsi* from different breed varied from 1.78 to 2.97% (Table 1).

Pietrain pigs had the highest value of fat; it was 1.19% more than in Yorkshire pigs. The meat drip loss is important technological indicator that specifies meat suitability for making of special products and influence of commodity pork quality (**Jukna et al**., 2007). Differences in meat drip loss in Yorkshire and Lithuanian Large White breeds were the biggest (2.92%) ($P < 0.01$). The Warner–Bratzler shear force was significantly ($p < 0.001$) influenced by genotype; LW pigs had the highest value of shear force and Y pigs had the lowest.

Intramuscular fatty acid composition

Differences between breeds were significant ($P < 0.01$) (Table 2) when comparing concentrations of most individual fatty acids in the intramuscular

Table 1. **Chemical composition and physical characteristics of *longissimus dorsi* from different Lithuanian pig breeds**

Indexes/Breed	LW	LLW	L	Y	P
Dry matter, %	26.40±1.24	26.74±1.10	26.38±0.82	26.26±0.89	26.76±1.06
pH	5.54±0.07	5.45±0.07	5.43±0.04	5.51±0.04	5.50±0.02
Lightness L^*	55.98±3.50	61.25±3.51	58.11±1.03	61.60±3.25	58.24±2.92
Redness a^*	15.43±1.94	13.08±1.93	15.07±0.93	14,49±1,05	15.16±0.94
Yellowness b*	8.47±1.07	8.67±2.34	6.92±1.01	8.31±1.68	8.43±1.93
Drip loss, %	4.69±1.78	3.91±1.36	6.33±3.99	4.30±1.66	6.83±3.84
Cooking loss, %	26.09±2.77	27.01±1.36	28.01±1.48	26.44±0.64	25.63±2.05
Shear force, g/cm^2	2.32±0.74	1.80±0.52	1.87±0.59	1.81±0.63	2.09±0.45
Fat, %	1.88±0.49	1.88±0.31	2.02±0.91	1.78±0.54	2.97±0.98
Ash, %	1.15±0.06	1.01±0.08	1.12±0.08	1.01±0.04	1.03±0.10
Protein, %	23.37±0.97	23.85±1.00	23.23±1.60	23.48±0.97	22.73±1.05

Lithuanian White (LW), Lithuanian Large White (LLW), Landrace (L), Yorkshire (Y), Pietrain (P)

Table 2**. Saturated fatty acid composition of intramuscular fat of different breeds pig's meat**

Fatty acids	Breed				
	LW	LLW	L	Y	P
C10:0	0.00±0.00	0.00±0.00	0.00±0.00	0.11±0.02	0.10±0.01
C12:0	0.43±0.19	0.23±0.06	0.37±0.15	0.12±0.01	0.10±0.05
C13:0	0.21±0.05	0.21±0.02	0.21±0.11	0.00±0.00	0.00±0.00
C14:0	2.80±0.25	2.56±0.31	2.90±0.52	1.32±0.75	1.20±0.12
C15:0	0.60±0.17	0.90±0.25	1.01±0.32	0.00±0.00	1.00±0.23
C16:0	28.27±1.48	28.61±0.47	30.26±0.79	26.28±1.77	24.56±0.74
C17:0	1.23±0.27	1.10±0.08	0.93±0.21	0.23±0.07	0.34±0.06
C18:0	17.93±1.02	39.56±1.88	30.45±3.12	11.92±3.11	11.05±0.27
C20:0	0.53±0.13	0.85±0.40	0.88±0.24	0.10±0.06	0.10±0.04
C21:0	0.00±0.00	0.00±0.00	0.00±0.00	0.20±0.01	0.30±0.02
C22:0	0.14±0.03	0.00±0.00	0.00±0.00	0.21±0.02	0.20±0.07

Lithuanian White (LW), Lithuanian Large White (LLW), Landrace (L), Yorkshire (Y), Pietrain (P).

fat. The predominant saturated fatty acids (SFA) in meat were stearic acid (C18:0) and palmitic acid (C16:0). The proportion of palmitic acid was significantly ($P < 0.01$) lower in Yorkshire and Pietrain than in LW and Landrace. There were significant ($P < 0.05$) differences in the concentration of C14:0 Landrace and Pietrain breeds (1.75%).

The predominant monounsaturated fatty acid (MUFA) in meat was oleic acid (C18:1) (Table 3). Proportion of oleic acid was significantly ($P <0.01$) more in Yorkshire than in LLW; it was

Table 3. **Monounsaturated fatty acid composition of intramuscular fat of different breeds pig's meat**

Fatty acids	Breed				
	LW	LLW	L	Y	P
C 14:1	0.80±0.15	0.43±0,.2	0.34±0.12	0.00±0.00	0.20±0.12
C 15:1	0.30±0.10	1.23±0.10	0.90±0.13	0.67±0.02	0.56±0.11
C 16:1	0.71±0.22	3.40±0.48	4.62±0.51	3.67±0.29	3.21±0.53
C 17:1	0.62±0.05	0.38±0.25	0.20±0.11	0.31±0.08	0.30±0.04
C 18:1	37.35±4.01	15.98±3.32	21.87±1.32	48.70±1.98	50.48±2.16
C 22:1	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00
C 24:1	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.01±0.00

Lithuanian White (LW), Lithuanian Large White (LLW), Landrace (L), Yorkshire (Y), Pietrain (P).

Table 4. **Polyunsaturated fatty acid composition of intramuscular fat of different breeds pig's meat**

Fatty acids	Breed				
	LW	LLW	L	Y	P
C 18:2	1.17±0.26	6.01±0.22	2.10±0.71	6.00±0.43	6.91±1.09
C 18:3γ	0.21±0.08	0.64±0.06	0.10±0.04	0.32±0.03	0.21±0.01
C 18:3α	0.20±0.03	0,.7±0.12	0.32±0.15	0.90±0.25	1.10±0.07
C 20:2	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00
C 20:3 n3	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00
C 20:4 n6	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00
C 20:5 n3	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00
C 22:2	0.02±0.01	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00
C 22:6n3	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00

Lithuanian White (LW), Lithuanian Large White (LLW), Landrace (L), Yorkshire (Y), Pietrain (P).

more in 34.5%, also C14:1 wasn't found only in Yorkshire breed pigs.

Proportions of polyunsaturated fatty acid (PUFA), such as linoleic acid (C18:2) was significantly higher ($P < 0.001$) in the intramuscular fat of Pietrain compared with LW or Landrace (Table 4). Again, proportions of n_3 PUFA, such as α-linolenic (C18:3a) acid was higher in Pietrain and Yorkshire than in the other breeds ($P < 0.05$), those results agree with **St.Raj et al.** (2010) who found that Pietrain pigs had a higher ($P<0.001$) concentration of PUFA than the other breeds. Among PUFA, the concentrations of C18:2n−6 and C18:3n−3 acids were higher.

Monin et al. (2003) found that total lipids of Large White contained more saturated fatty acids, particularly C18:0 and less polyunsaturated fatty acids, particularly C18:2 and C18:3 than Pietrain. In our study we got the same results Large White contained more saturated fatty acids, particularly C18:0 and less C18:2, C18:3α than Pietrain, but however C18:3γ was very similar between Lithuanian Large White and Pietrain breeds.

Table 5. **Trans –fatty acid composition of intramuscular fat of different breeds pig's meat**

Fatty acids	Breed				
	LW	LLW	L	Y	P
C 18:1 trans	1.92±0.21	2.76±0.52	2.33±0.37	1.00±0.11	2.50±0.48
C 18:2 trans	0.32±0.01	0.22±0.06	0.11±0.08	0.06±0.02	0.35±0.13

Lithuanian White (LW), Lithuanian Large White (LLW), Landrace (L), Yorkshire (Y), Pietrain (P)

Table 6**. Omega – 3 fatty acid composition of intramuscular fat of different breeds pig's meat**

Fatty acids	Breed				
	LW	LLW	L	Y	P
C 18:3 ω3 (α-Linolenic)	0.20±0.03	0.27±0.12	0.32±0.15	0.90±0.25	1.10±0.07
C 20:3 ω3	0.10±0.03	0.12±0.02	0.16±0.04	0.09±0.01	0.15±0.03
C 22:6 ω3	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00

Lithuanian White (LW), Lithuanian Large White (LLW), Landrace (L), Yorkshire (Y), Pietrain (P)

The highest content of trans fatty acid isomer C18:1 were observed in LLW, its about 1.76% more than in Yorkshire pigs ($P < 0.01$) also the lowest content of C 18:2 isomer were in Yorkshire pigs meat.

The LLW pigs produced lipids with a higher content of C14:0, C16:0 and C18:0 and showed, consequently, a higher level of total saturated fatty acids ($P < 0.001$). The total content of PUFA was also significantly ($P < 0.01$) higher for LLW, but the highest content was in Pietrain pigs ($P < 0.01$). The total content of MUFA and PUFA was significantly higher for Pietrain pigs ($P < 0.001$), than in the other breeds.

The fatty acid ratios PUFA/SFA, which are related to human health, ratio decreased in the following order: Pietrain (0.26), Yorkshire (0.18), Large White (0.11), Lithuanian White (0.05) and Landrace (0.04). The PUFA/SFA ratio remained near 0.4 which is the limit recommended by **UK Department of Health** (1994).

Omega–3 fatty acids content are shown in Table 6. Proportions of omega – 3 fatty acid, such as C 18:3 ω3 (α-Linolenic) was significantly higher ($P < 0.01$) in the intramuscular fat of Pietrain pigs compared with LW (different was 0.9 %), C 20:3ω3 or was higher in Landrace pigs ($P < 0.05$). The total content of omega-3 fatty acids was the highest in Pietrain pigs.

CONCLUSIONS

In this study largest differences in meat quality parameters were in drip loss, shear force and fat content. The lowest drip loss (3.91%) was in LLW pigs, and the lowest shear force (1.80 kg/cm^2) was in LLW pigs. The bigest fat content (2.97%) was in Pietrain pigs.

The predominant fatty acids in meat were stearic acid (C18:0), palmitic acid (C16:0), oleic acid (C18:1), linoleic acid (C18:2). The LLW pigs produced lipids with a higher content of C14:0, C16:0 and C18:0 and showed, consequently, a higher level of total saturated fatty acids. The total content of MUFA and PUFA was significantly higher for Pietrain pigs ($p < 0.001$), than in the other breeds. The fatty acid ratios PUFA/SFA, the best was in Pietrain pigs (0.26).

We conclude that the differences among breeds are important in relation with fatty acid composition.

REFERENCES

1. Ačaitė S., 2005. Mėsos fizinių savybiu priklausomybė nuo kaiulių veislės. Magistro tezės. Lietuvos veterinarijos akademija, Kaunas.

2. Alonso V., María del Mar Campo, Español S., Roncalés, Beltrán J.A., 2009. Effect of cross-breeding and gender on meat quality and fatty acid composition. in pork. Meat Science 81, 209–217.

3. Culioli J., Berri C., Mourot J., 2003. Muscle foods: consumption, composition and quality. Sci. Aliments. Vol. 23, 13−34.

4. Department of Health, 1994. Nutritional aspects of cardiovascular disease. Report on Health and Social Subjects No. 46. London: Her Majesty's Stationery Office.

5. Gentlemen R., Ihaka R. Notes on R: A programming environment for data analysis and graphics. 1997. Department of statistics university of Auckland.

6. Josell Å., Gertrud von S., Tornberg E., 2004. Sensory and meat quality traits of pork in relation to post-slaughter treatment and *RN* genotype. Meat Science, V. 66, Issue 1, 113–124.

7. Jukna Č., Jukna V., Pečiulaitienė N., Kerzienė S. 2010 Influence of English Large White breed on fattening and meat characteristics and meat quality of Lithuanian White pigs. Vet Med Zoot., Vol. 51 (73), 17-22.

8. Jukna Č., Jukna V., Valaitienė V., Korsukovas A., 2007. Skirtingų rūšių gyvūnų mėsos kokybės palyginamasis įvertinimas. Veterinarija ir zootechnika, T. 37 (59), 24–27.

9. Jukna V., Jukna Č., Pečiulaitienė N. 2006. Genetic factors influence on pork quality. Vet Med Zoot., T.. 40 (62). P. 35−38.

10. Kouba M., Enser M., Whittington F. M., Nute G. R., Wood J. D., 2003.Effect of a high linolenic acid diet on lipogentic enzyme activities, fatty acid composition and meat quality in the growing pig. Journal of Animal Science, V. 81, 1967–1979.

11. Lawrie, R. A., 2006. The eating quality of meat. In R. A. Lawrie & D. Ledward (Eds.), Lawrie's meat science Abington, Cambridge, England: Wooodhead Publising Limited, V.7, 279–341.

12. Mason L. M., Hogan S. A., Lynch A., O'Sullivan K., Lawlor P. G., Kerry J. P., 2005. Effects of restricted feeding and antioxidant supplementation on pig performance and quality characteristics of Longissimus dorsi muscle from Landrace and Duroc pigs. Meat Science, 2005. V. 70, 307–317.

13. Monin G., Hortós M., Diaz I., Rock E., Garcia-Regueiro J. A., 2003. Lipolysis andlipid oxidation during chilled storage of meat from Large White and Pietrain pigs. Meat Science, V.64, 7–12.

14. Nedeva R., A. Apostolov, Y.Marchev, E. Kistanova, D. Kacheva, E. Shumkov, G. Borjaev (2009) Effect of the injective application of selenopyran on the productivity in growing gilts. Bulg.J.Agricultural Science, 15, 6, 604-609, 2009

15. Pascual J. V., Rafecas M., Canela M. A., Boatella J., Bou R., Barroeta A. C., 2007. Effect of increasing amounts of a linoleic-rich dietary fat on the fat composition of four pig breeds. Part II: Fatty acid composition in muscle and fat tissues. Food Chemistry, V. 100, 1639–1648.

16. Raj St., Skiba G., Weremko D., Fandrejewski H., Migdał W., Borowiec F., Poławska E., 2010. The relationship between the chemical composition of the carcass and the fatty acid composition of intramuscular fat and backfat of several pig breeds slaughtered at different weights. Meat Science, V. 86, 324–330.

17. Wood J. D., 1990. Consequences for meat quality of reducing carcass fatness. In J. DWood, & A. V. Fisher (Eds.), Reducing fat in meat animals. London, Elsevier Applied Science, 344–397.

18. Wood J. D., Richardson R. I., Nute G. R., Fisher A. V., Campo M. M., Kasapidou E., 2003. Effects of fatty acids on meat quality: A review. Meat Science, V. 66, 21–32.

19. Wood J.D., Enser M., Fisher A.V., Nute G.R., Sheard P.R., Richardson R.I., Hughes S.I., Whittington F.M., 2008. Fat deposition, fatty acid composition and meat quality: A review. Meat Science 78, 343–358.

THE BREED INFLUENCE IN PORK QUALITY AND INTRAMUSCULAR FATTY ACID COMPOSITION

E. Meškinytė-Kaušilienė, V. Jukna, A. Šimkus, J. Klementavičiūtė, N. Pečiulaitienė
Lithuanian Health Sciences University, Veterinary Academy, Laboratory of Meat Characteristics and Quality Assessment, Tilžės 18, Kaunas LT-47181, Lithuania, tel. (8-37)36 34 14

SUMMARY

The aim of this research was to investigate whether meat quality and intramuscular fatty acid composition are affected by breed in pigs. The samples of pork for analysis were taken from Yorkshire (Y), Pietrain (P) Lithuanian White (LW), Lithuanian Large White (LLW) and Landrace (L). Pork samples were removed from *m. Longissimus dorsi.* In this study largest differences in meat quality parameters were in drip loss, shear force and fat content. The lowest drip loss (3.91%) and the lowest shear force (1.80 kg/ cm^2) were in LLW pig's meat. The biggest fat content (2.97%) was in Pietrain pigs. Predominant fatty acids in meat were stearic acid (C18:0), palmitic acid (C16:0), oleic acid (C18:1), linoleic acid (C18:2). The LLW pigs produced lipids with a higher content of C14:0, C16:0 and C18:0 and showed, consequently, a higher level of total saturated fatty acids. Proportion of oleic acid (C18:1) was more in Yorkshire and Pietrain than in LLW. Proportions of polyunsaturated fatty acid (PUFA), such as linoleic acid (C18:2) was significantly higher ($p < 0.001$) in the intramuscular fat of Pietrain pigs compared with LW. The total content of MUFA and PUFA was significantly higher for Pietrain pigs ($p < 0.001$), than in the other breeds. The fatty acids ratios PUFA/SFA, the best was in Pietrain pigs (0.26). The results demonstrate differences in fatty acid compositions among breeds.

Key words: *breed; fatty acids; meat quality; pigs.*

Corresponding author: meskinyte@lva.lt