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ORIGINAL PAPER

The effect of sex on meat quality and the fatty acid profile of the longissimus lumborum muscle in growing-finishing pigs*

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Abstract

The aim of this study was to evaluate the effect of sex on meat quality and fatty acid (FA) composition in growing-finishing pigs. Meat samples were collected from gilts, surgically castrated males and immunocastrated males. Surgical castration was carried out at 5 days of age, whereas immunocastration was performed with two injections of Improvac administered 4 weeks apart, at 9 and 15 weeks of age. Pigs were fed complete diets containing 17% and 15% of total protein, respectively Pig Nutrient Requirement. Feed and water were available *ad libitum*. Pigs from each group were kept in separate pens, and they were slaughtered at BW of around 105 kg. The pigs were slaughtered according to the usual procedure in meat plants. Samples of the longissimus lumborum muscle (*musculus longissimus lumborum*, LL), approximately 10 cm thick, were collected from the right half-carcasses to determine the proximate chemical composition, physicochemical properties and sensory attributes of meat. The content of dry matter, total protein (Kjeldahl method), crude fat (Soxhlet extraction) and crude ash, and the FA profile of meat samples were determined. Fatty acids were separated by gas chromatography. Fatty acid methyl esters (FAMEs) were prepared according to the modified Peisker method. Fatty acids were identified by comparing their retention times with those of pure FAME standards (Sigma-Aldrich, St. Louis, Missouri, USA) and peaks in the analyzed samples. The relative content of FAs was expressed as the percentage of the total surface area of all FAs detected in each sample. Sex had no influence on the quality or processing suitability of pork, but it affected the intramuscular content, which is an important consideration for consumers.

Keywords: fatty acids, pigs, sex, meat quality

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INTRODUCTION

The primary goal in pig production systems is to produce high-quality pork. Pig producers consistently strive to improve production efficiency and profitability, as well as to adapt production systems to the binding rules and regulations, and increasing consumer expectations. To date, breeding progress has focused on improving fattening performance and carcass quality parameters (Żak et al. 2009). A modern sow can wean more than 33 piglets per year, the fattening period has been shortened to 150 days, average daily gain has reached 1 kg, the amount of feed consumed per 1 kg of body weight (BW) gain has been reduced to 2.4 kg, and carcass lean content has exceeded 60%. As a result, pork quality has deteriorated, which has not escaped the consumers' notice (Karpiesiuk et al. 2013, Żak et al. 2014). The literature also shows that such selection has very little or no effect on the development of quality traits. This is especially true for the development of intramuscular fat (IMF) in the meat. According to Mörlein (2005), the correlation between IMF and meat content is rG = -0.17 and between IMF and carcass fat weight is rG = 0.18. Even lower heritabilities between IMF and fat thickness were demonstrated in a study by Suzuki et al. (2005). It can be concluded that a higher intramuscular fat content, the quality trait that deviates most from the desired level, need not lead to a significant increase in carcass fat thickness and a decrease in carcass meat content when unidirectional selection for a higher IMF content is performed. It can also be assumed that the level of IMF content in pork is determined by a different set of genes than backfat thickness, so that independently performed selection for improvement of these two traits is possible. Feed offered to pigs must be safe for consumption by the animals and pork consumers (Okorski et al. 2017, 2022). Consumers are becoming more conscious of their food, including meat, choices (Karpiesiuk et al. 2016). They are looking for products from animal-friendly farming systems (non-GMO, antibiotic-free, pain-free) – Kozera et al. (2016), Karpiesiuk et al. (2019). Due to the increasing demands and expectations of consumers with regard to meat quality, new pig production systems have been developed to guarantee the production of high-quality pork. The most important systems include the Pork Quality System (PQS) and the Quality Assurance for Food Products (QAFP) System which has a multi-product nature. A wide range of food products available on the market are produced under the certified organic farming system. The production and certification of pork based on immunocastrated males provides another opportunity and alternative for consumers seeking high-quality meat produced with strict observance of animal welfare standards.

In pig production systems, male piglets are surgically castrated to improve meat quality by eliminating boar taint and reducing aggressive and sexual behaviors (Čandek-Potokar et al. 2017, Kress et al. 2020). Boar taint is caused by high concentrations of androstenone and skatole in meat. How-

ever, surgical castration is painful, which raises concerns about this procedure and makes farmers turn to alternative methods. In some countries, the animal welfare debate has led to the ban on the surgical castration of piglets, and immunocastration or the production of entire male pigs have been introduced as alternatives (United Kingdom). The surgical castration of piglets was banned in 2009 in Norway, in 2010 in Switzerland, and in 2018 in Germany, Belgium, Dermark, the Netherlands, and Spain. Sweden banned piglet castration without the use of anesthesia in 2018. In the Netherlands, male piglets are castrated under general anesthesia using CO2. In the European Union, the surgical castration of male piglets without anesthesia is allowed up to 7 days of age. When older pigs need to be castrated, the procedure must be carried out under anesthetic and prolonged analgesia by a veterinarian (Council Directive 2008/120/EC 18 December 2018).

It should also be noted that surgically castrated piglets consume more feed and deposit more fat than intact boars, immunocastrated males, and gilts. According to Aluwé et al. (2015), surgically castrated males are characterized by higher fat thickness than gilts and, in particular, entire male pigs, which suggests that immunocastration may also affect lipid metabolism and carcass fat content. Analyses of pork quality have revealed that fatty acid (FA) composition may affect fat firmness and the oxidative stability of meat. The FA profile may be modified by diet, including the type and content of dietary fat (Świątkiewicz et al. 2021), and it is related to carcass fatness (Wood et al. 2008). Therefore, differences in body and carcass tissue composition between sex categories lead to differences in the FA profile. A meta-analysis study by Pauly et al. (2012) demonstrated that the concentrations of saturated fatty acids (SFAs) were lower, and the concentrations of polyunsaturated fatty acids (PUFAs) were higher in entire males than in castrates and immunocastrates. Changes induced by immunocastration may vary depending on the type of the deposited adipose tissue (Poklukar et al. 2021).

The aim of this study was to evaluate meat quality and the FA profile in gilts, surgically castrated males and immunocastrated (Improvac) males.

MATERIALS AND METHODS

Pigs were fed two complete diets (PT-1 and PT-2) during two-phase fattening. Their ingredients and chemical composition are presented in Table 1. Cereals were the main components of both diets. Supplemental protein sources were soybean meal and sunflower meal, and energy content was balanced by adding poultry fat. The diets were supplemented with minerals and amino acids. The ingredient composition of diets was consistent with the recommendations of Grela et al. (2009). The diets were formulated in accor-

dance with the Pig Nutrient Requirements (2014). A total of 30 samples of the longissimus lumborum muscle (musculus longissimus lumborum, LL), approximately 10 cm thick, were collected from the right half-carcasses of hybrid DanBred pigs (gilts, surgically castrated males, immunocastrated males, 10 samples per group) at the level of the 1st – 3rd lumbar vertebrae. Pigs of each group were kept in separate pens, and they were slaughtered at BW of around 105 kg. Surgical castration without anesthesia was carried out at 5 days of age, whereas immunocastration was performed with two injections of Improvac administered 6 weeks apart, at 9 and 15 weeks of age. During fattening, the animals were fed cereal-soybean-based diets formulated so as to meet their nutrient requirements (Table 1). The slaughter and carcass evaluation were carried out in accordance with the relevant meat industry regulations. The slaughter involved stunning followed by severing major blood vessels. Subsequently, the carcasses were scalded, depilated, eviscerated, closed longitudinally, and weighed.

Carcass lean content was classified according to the EUROP system using the SYDEL CGM (Lorient, France; Capteur Gras/Maigre) ultrasonic device operated by authorized and trained personnel. The CGM is a hand-held device equipped with an optical probe, which is used to determine the

Table 1

Ingredients and chemical composition of pig diets

Specification	Phase I	Phase II
Barley	36.48	21.48
Triticale	5.000	49.30
Wheat	15.00	7.000
Maize	12.00	5.000
Soybean meal (more than 46% protein)	16.50	6.000
Sunflower meal	5.000	4.000
Sugar beet pulp	3.000	1.200
Limestone	1.500	2.000
Rapeseed oil	3.000	1.500
NaCl	0.020	0.020
Supplementary feed mix	2.500	2.500
Chemical composition		
Dry matter	89.93	89.65
Crude ash	3.400	3.530
Crude protein	17.24	15.42
Crude fat	2.960	3.390
Crude fiber	2.880	3.910
Metabolizable energy, MJ*	13.28	13.15

* Calculated value – WinPasze

thickness of the loin muscle and the fat layer by measuring light reflection. Measurements of backfat thickness and the longissimus dorsi muscle were used to calculate the meat content of pig carcasses based on the following regression equation:

$$LMCCGM = 59.42 + 0.1322M2 - 0.6275T2,$$

T2 – thickness of backfat between the 3rd and the 4th rib, 6 cm from the line of carcass partition; M2 – thickness of the LL muscle, 6 cm from the line of carcass partition, which is measured within 45 min after stunning. The carcasses were cold stored at a temp. of 2-4°C for 24 h. Samples of the LL muscle were collected from the right side of each carcass (10 per group), at the level of the 1st – 3rd lumbar vertebrae. The samples were packaged in polyethylene bags and transported to the laboratory in isothermal containers with ice.

Meat quality

Proximate chemical composition and collagen content

Meat samples were assayed for the content of dry matter, total protein (Kjeldahl method), crude fat (Soxhlet extraction without hydrolysis), crude ash (AOAC 2007) and hydroxyproline which was converted into collagen content using a conversion factor of 7.25 (PN-ISO 3496:2000).

Fatty acid profile

Fat was extracted by the Soxhlet method (AOAC 2007). Fatty acids were separated and determined by gas chromatography in a gas chromatograph (CP-3800, Varian, Walnut Creek, California, USA). Fatty acid methyl esters (FAMEs) were prepared according to the modified Peisker method (methanol: chloroform:concentrated sulfuric acid, 100:100:1, v/v) – Żegarska et al. (1991). The resulting FAMEs were stored in sealed tubes and were analyzed by gas chromatography-flame ionization detection (GC-FID; column: 50 m × 0.25 mm × 0.25 µm). The temperature of the GC injection port was set to 225°C in split mode (split ratio 50:1) with helium as the carrier gas at a constant flow rate of 1.2 mL min^{-1}. Detector temp. was 250°C and column temp. was 200°C. Fatty acids were identified by comparing their retention times with those of pure FAME standards (Sigma-Aldrich, St. Louis, Missouri, USA) and peaks in the analyzed samples. The relative content of FAs was expressed as the percentage of the total surface area of all FAs detected in each sample.

pH value

The pH value of muscle tissue was measured in the (LL) muscle at the level of the 1st – 3rd lumbar vertebrae, 45 min after bleeding (pH_{45}) and after 24 h of carcass chilling (pH_{24}), with the use of the WTW 3310 pH meter and

a combination electrode (WTW-Wissenschaftlich-Technische Werkstaetten GmbH, Weilheim, Germany) calibrated with the same standard solutions of pH 4.01 and 7.00 at 20°C. Their adjustment was additionally tested at the beginning and during the measurements on a regular basis.

Color measurements

The fresh-cut surface of the LL muscle at the level of the 1st – 3rd lumbar vertebrae was scanned 15 min after bloom. The surface color of meat samples was determined with a spectrophotometer (MiniScan XE Plus, Hunter Lab, an aperture of 31.8 mm, 10° observer, illuminant D65). The instrument was calibrated prior to sampling using a white and black tile. The investigated parameters were measured at a wavelength range of 400 to 700 nm with the resolution of 10 nm. Color parameters were described according to the L*a*b* standard, and average spectral distributions at selected measurement points were processed statistically. Instrumental color measurements were taken in ten different locations and averaged to represent the value for each sample.

Sensory analysis

The sensory attributes of pork were evaluated in samples deprived of fat and external connective tissues. The specimens for sensory analysis were cut against the grain into cubes of approximately 50 g. Meat cubes were cooked in 6.2 g kg^{-1} NaCl solution (2:1 solution-to-meat ratio) at 96°C until the temp. inside the sample reached 75°C. All samples were placed in covered containers and coded. They were evaluated at room temp. (20°C) on a 5-point grading scale. The following quality attributes were assessed: aroma, juiciness, tenderness, and palatability. The sensory evaluation was performed by five trained panelists with higher-than-average sensory sensitivity (Baryłko-Pikielna et al. 1964).

Statistical analysis

The results were processed statistically by one-way analysis of variance (ANOVA) for orthogonal designs. The significance of differences between group means was determined by Duncan's test at $P \leq 0.05$ and $P \leq 0.01$. Linear regression coefficients were calculated to determine the strength of the relationships between SFAs and monounsaturated fatty acids (MUFAs); SFAs and hypocholesterolemic acids (DFAs); SFAs and hypercholesterolemic acids (OFAs); PUFAs and DFAs; PUFAs and OFAs; DFAs and OFAs in the LL muscle. The correlations between individual FA groups in the LL muscle were determined by calculating Pearson's correlation coefficients. The calculations were performed using Statistica PL software ver. 13.3.

RESULTS AND DISCUSSION

Chemical composition and quality of meat (*longissimus lumborum muscle*)

The results of a physicochemical analysis of meat from the experimental pigs are presented in Table 2. No significant differences in carcass lean content (%) and cold carcass weight were noted between sex groups. Dry matter content was highly significantly higher in meat from immunocastrated males than in meat from gilts. Fat content was highly significantly lower in meat from gilts than in meat from immunocastrated males. This is due to the fact that from a physiological perspective, immunocastrated pigs resemble entire males until shortly after the second dose of the vaccine, and later they behave like barrows (Dunshea et al. 2013). Intramuscular fat increases

Table 2

Physicochemical analysis of the longissimus lumborum muscle

Parameter	Gilts	Male pigs castrated surgically before 7 days of age	Male pigs immunocastrated with improvac
Carcass lean content (%)	59.18 2.16	59.38 1.65	60.47 2.22
Cold carcass weight (kg)	81.56 4.82	81.93 3.68	80.41 4.16
Dry matter (%)	25.46^{B} 0.55	26.34 1.08	27.06^{A} 1.22
Protein (%)	22.48 0.39	22.78 0.36	22.47 0.43
Crude fat (%) (intramuscular fat – IMF)	2.210^{b} 0.60	3.016 1.47	3.337^{a} 1.00
Crude ash, %	1.125^{Aa} 0.01	1.078^{B} 0.03	1.093^{b} 0.03
pH_{45}	6.01 0.21	6.07 0.23	6.04 0.14
pH_{24}	5.41 0.19	5.32 0.08	5.40 0.17
L	58.69^{A} 3.63	51.89^{Bb} 3.09	55.60^{a} 3.77
A	5.46^{B} 1.21	4.56^{b} 1.36	6.88^{Aa} 1.46
B	13.74^{c} 0.84	12.43^{bd} 0.64	14.45^{a} 1.07

a, *b* – means in the same row with different letters differ significantly ($P<0.05$).
A, *B* – means in the same row with different letters differ significantly ($P<0.01$).

the firmness of the carcass. Increasing intramuscular fat is very important, as it is related with sensory quality parameters, consumer preference and processing value (Jankowiak *et al*. 2019). The evaluated carcasses did not contain PSE or partially PSE meat, and active acidity (pH45) ranged from 5.73 to 6.40. All values were within the normal acidity range according the classification proposed by Pośpiech (2000). The average values of this parameter (Table 2) were similar to those reported by Karpiesiuk et al. (2013), and somewhat higher than those observed by Lisiak et al. (2014). pH_{24} is measured to detect DFD meat. There was no effect of sex on pH_{24}. However, in all sex groups, pH_{24} was relatively low, below 5.5. Meat acidity did not differ across sex groups. Our findings in relation to low muscle pH of < 5.5 at 24 h post-slaughter, support previous observations (Channon et al. 2016) in that the ultimate pH (measured at > 24 h post- slaughter) of loin and silverside muscles from Australian pigs appears to be declining. It may be that genetic selection programs may be resulting in a change in muscle fibre composition toward an increase in type IIß muscle fibres, causing lower pH values to be attained due to a higher glycogen concentrations available for lactic acid production post-slaughter (Channon et al. 2018).

Meat color is an important criterion of meat quality, which significantly influences consumer preferences. It is also highly correlated with other quality attributes of meat (Myung-Hwa et al. 2013). Meat from surgically castrated males was darkest in color, and the noted difference was highly significant relative to meat from gilts. Meat from immunocastrated males was characterized by an intermediate value of parameter L*, with a significant difference relative to meat from gilts. The contribution of redness (a*) was highest in meat from immunocastrated males and lowest in meat from gilts, and the observed difference was highly significant. The contribution of redness (a*) was significantly lower in meat from surgically castrated males than in meat from immunocastrated pigs. The values of color parameter b* differed significantly across groups, and the contribution of yellowness was highest in group 3 (immunocastrated males) and lowest in group 2 (surgically castrated males). Fresh pork should be reddish pink in color. A dark color could result in shorter shelf life and increased bacterial growth, while a pale pinkish gray color could be undesirable for consumers (Trevisan, Brum 2020).

Sensory evaluation

The results of a sensory evaluation of meat in different sex groups of pigs are presented in Table 3. Meat from entire male pigs is characterized by unacceptable levels of boar taint, i.e. undesirable sensory attributes. In the present study, the results of sensory analysis did not differ across sex groups. Meat samples collected from all groups received similar scores for the intensity and desirability of taste and aroma. Meat from immunocas-

Table 3

Sensory evaluation of the longissimus lumborum muscle

Parameter		Gilts	Male pigs castrated surgically before 7 days of age	Male pigs immunocastrated with improvac
Aroma	intensity	4.00 0.97	3.75 1.03	4.25 0.86
	desirability	4.10 0.99	4.45 0.95	4.10 0.74
Taste	intensity	4.05 0.86	3.60 0.39	3.65 0.47
	desirability	4.25 1.03	4.20 0.91	3.75 0.35
Tenderness		3.45^{b} 0.55	3.30^{b} 0.82	4.05^{a} 0.76
Juiciness		3.95^{a} 0.68	3.50 0.41	3.25^{b} 0.59

a, *b* – means in the same row with different letters differ significantly ($P<0.05$).

trated males scored highest for tenderness, and the noted difference was significant ($p\leq0.05$) relative to meat from gilts and surgically castrated males. The opposite was observed in juiciness evaluation. The value of this parameter was significantly ($p\leq0.05$) higher in gilts than in immunocastrated males.

Fat acid composition of meat

The nutritional value and technological quality of pork are determined by the chemical composition of pig carcasses, in particular fat content and the FA profile since FAs not only deliver health benefits to humans, but are also important for the sensory properties of meat and meat products (Čandek-Potokar and Škrlep, 2012). Carcass fat content and FA composition may vary depending on animal species, sex, anatomical location, and diet. The proportions of individual Fas in fat extracted from the LL muscle of experimental pigs are presented in Table 4. In the group of SFAs, a significant ($p\leq0.05$) difference in the content of lauric acid (C12:0) was noted between gilts vs. immunocastrated and surgically castrated males. In this group, highly significant ($p\leq0.01$) differences were also found in the levels of pentadecanoic acid (C15:0), margaric acid (C17:0) and arachidic aid (C20:0) between gilts and immunocastrated males vs. surgically castrated males, and in the concentration of stearic acid (C18:0) between surgically castrated males and gilts. In the group of MUFAs, the content of margaroleic acid (C 17:1) was highly significantly ($p\leq0.01$) higher in gilts than in surgically castrated males, and significantly ($p\leq0.05$) higher in immuno-

Table 4

Fatty acid profile of the longissimus lumborum muscle of pigs (g 100 g^{-1} total fatty acids) – means and standard errors

Specification	Gilts	Male pigs castrated surgically before 7 days of age	Male pigs immunocastrated with improvac
C 10:0	0.12	0.12	0.11
C 12:0	0.13^{a}	0.12^{b}	0.12^{b}
C 14:0	1.62	1.69	1.62
C 14:1	0.02	0.03	0.02
C 15:0	0.06^{A}	0.04^{B}	0.07^{A}
C 16:0	28.11	29.13	28.63
C 16:1	3.65	3.67	3.28
C 17:0	0.33^{A}	0.22^{B}	0.35^{A}
C 17:1	0.27^{A}	0.19^{Bb}	0.23^{a}
C 18:0	14.56^{B}	15.95^{A}	15.25
C 18:1 c9	38.93^{A}	40.05^{A}	36.64^{B}
C 18:2	9.22^{Aa}	6.24^{B}	10.90^{Ab}
C 18:3	0.49^{b}	0.42^{B}	0.58^{Aa}
C 20:0	0.21^{B}	0.26^{A}	0.20^{B}
C 20:1	0.76	0.82^{a}	0.74^{b}
C 20:2	0.41^{A}	0.26^{B}	0.44^{A}
C 20:4	0.97	0.78	0.77
C 22:0	0.13^{a}	0.03^{b}	0.05^{b}
SFAs	45.28^{b}	47.55^{a}	46.39
UFAs	54.72^{a}	52.45^{b}	53.61
MUFAs	43.63^{A}	44.76^{A}	40.92^{B}
PUFAs	11.09^{A}	7.69^{B}	12.70^{A}
n-3 PUFAs	0.49^{b}	0.42^{B}	0.58^{Aa}
n-6 PUFAs	10.61^{A}	7.27^{B}	12.12^{A}
DFAs=UFAs+C18:0	69.28	68.39	68.86
OFAs=C14:0+C16:0	30.72	31.61	31.14

a, *b*, *c*, *d* – means in the same row with different letters differ significantly ($P<0.05$).
A, *B*, *C*, *D* – means in the same row with different letters differ significantly ($P<0.01$).

castrated males than in surgically castrated males. Highly significant ($p\leq0.01$) differences were observed in the concentration of oleic acid (C18:1 c9) between gilts and surgically castrated males vs. immunocastrated males. The level of gadoleic acid (20:1 n11) was lowest in immunocastrated males, and the noted difference was significant ($p\leq0.05$) relative to surgically castrated males. In the group of PUFAs, a highly significant ($p\leq0.01$) diffe-

rence in the level of linoleic acid (C18:2) was found between gilts and surgically castrated males, and a significant ($p \leq 0.05$) difference in the concentration of this acid was observed between gilts and immunocastrated males. The level of α-linolenic acid was highly significantly ($p \leq 0.01$) lower in surgically castrated males and significantly ($p \leq 0.05$) lower in gilts than in immunocastrated males. Gilts and immunocastrated males were characterized by a highly significantly ($p \leq 0.01$) higher content of eicosadienoic acid (C20:2) than surgically castrated males. The proportion of SFAs was significantly ($p \leq 0.05$) lower in gilts than in surgically castrated males. The opposite trend was observed in the proportion of UFAs. Gilts and surgically castrated males were characterized by a more desirable and highly significantly ($p \leq 0.01$) higher proportion of MUFAs than immunocastrated males. The proportion of PUFAS was highly significantly ($p \leq 0.01$) higher in gilts and immunocastrated males than in surgically castrated males. Significant ($p \leq 0.05$) differences were noted between sex groups in the levels of *n*-3 and *n*-6 PUFAs, which were highest in immunocastrated males. Previous studies investigating the effect of sex on the FA composition of subcutaneous fat and the longissimus dorsi muscle also revealed that surgically castrated pigs had higher SFA content and lower PUFA content than gilts (Pauly et al. 2012, Mackay et al. 2013, Poklukar et al. 2021). Zomeño et al. (2023) analyzed the effects exerted by the BW and sex type of pigs and reported that the concentrations of SFAs and MUFAs were higher in surgically castrated males than in boars, gilts, and immunocastrated males. According to the cited authors, the above resulted from differences in the total content of palmitic acid (C16:0) and stearic acid (C18:0), and differences in the concentration of oleic acid (C18:1 n-9 cis), which are the predominant SFAs and MUFAs, respectively, in pig carcasses. Such a trend was also observed in the current study (Table 1). It is a well-known fact that the higher the MUFA content of meat, the higher its nutritional value in the human diet (WHO data cited by Warnants et al. 1996). Apart from genotype and sex, the FA profile in the muscles of growing-finishing pigs is also affected by the animal's diet, in particular the inclusion level and type of dietary fat (Karpiesiuk et al. 2013; Świątkiewicz et al. 2021). Czech et al. (2022) demonstrated that a liquid diet decreased the levels of androstenone and skatole, and improved FA composition in the LL muscle, backfat and perirenal fat. In a study by Lisiak et al. (2013), hybrid pigs were fed diets supplemented with various combinations of rapeseed oil, linseed oil, fish oil, meat fat and lard. The cited authors did not observe significant differences in the analyzed chemical and physicochemical parameters of carcasses or meat quality between groups. They found, however, that the type of dietary fat affected the UFA content of backfat and intramuscular from the LL muscle, which was lowest in pigs receiving rapeseed oil, fish oil and meat fat, and highest in the animals administered linseed oil.

Linear regression

A linear regression analysis revealed a negative relationship between the concentrations of MUFAs and SFAs in sex groups (Figure 1 *a*, *c*, *e*). An increase in the SFA content of meat samples was accompanied by a significant ($P \leq 0.05$) decrease in MUFA concentrations. The relationship between the concentrations of PUFAs and SFAs was positive in gilts, and negative in surgically castrated and immunocastrated males. The relationship between SFAs and UFAS was also analyzed, and it was confirmed in 100% in each sex type. Similar relationships between the concentrations of MUFAs and SFAs were observed by Karpiesiuk et al. (2023) who investigated guar meal protein as a substitute for genetically modified soybean meal in pig diets.

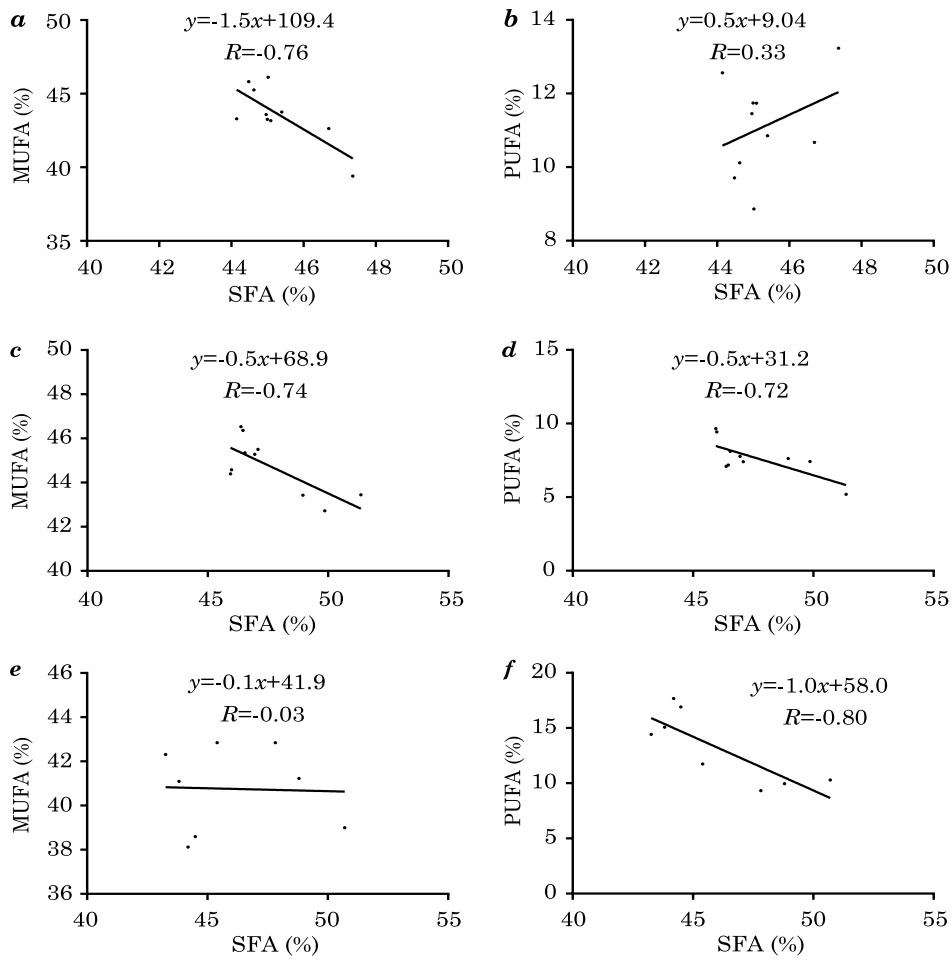

Fig. 1. Linear regression between the concentrations of MUFAs (%), SFAs (%), and PUFAs in the longissimus lumborum muscle: *a*, *b* – gilts, *c*, *d* – surgically castrated males, *e*, *f* – immunocastrated males

Similar relationships between the concentrations of MUFAs and SFAs were observed by Karpiesiuk et al. (2023) who investigated guar meal protein as a substitute for genetically modified soybean meal in pig diets.

CONCLUSIONS

Sex had no influence on the quality or processing suitability of pork, but it affected intramuscular fat content, which is an important consideration for consumers. Gilts and immunocastrated male piglets were characterized by higher concentrations of UFAs than surgically castrated male piglets. However, further research involving a higher number of animals is needed to confirm the observed relationships.

Author contributions

Conceptualization, K.K., W.K.; methodology, K.K., W.K.; validation, K.K. and W.K.; formal analysis, K.K.; investigation, K.K., W.K., A.O., P.F., A.C.; resources, K.K., W.K.; data curation, K.K. W.K., A.O., P.F.; writing – original draft preparation, K.K., W.K., P.F., A.O.; writing – review and editing, K.K.; visualization, K.K, W.K., A.O., P.F.; supervision, K.K.; project administration, W.K.; funding acquisition, K.K. and W.K. All authors have read and agreed to the published version of the manuscript.

Conflicts of interest

The authors declare no conflict of interest.

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