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EFFECT OF THE SEX OF FATTENING PIGS ON FATTENING VALUE, SLAUGHTER CHARACTERISTICS AND MEAT QUALITY

Wojciech Kozera[1], Weronika Gurzyńska[1], Rodian Pawłowski[2], Adam Okroski[3], Karolina Dobiesz[1], Urszula Czarnik[1], Agnieszka Pożarska[1], Michał Dąbrowski[4], Krzysztof Karpiesiuk[1]✉

[1]Department of Pig Breeding, Faculty of Animal Bioengineering, University of Warmia and Mazury in Olsztyn, Oczapowskiego 5, 10-719 Olsztyn, Poland
[2]Warmińsko-Mazurski Agricultural Advisory Center based in Olsztyn, ul. Jagiellońska 91, 10-365 Olsztyn, Poland
[3]Department of Entomology, Phytopathology and Molecular Diagnostics, University of Warmia and Mazury in Olsztyn, Pl. Łódzki 5, 10-727 Olsztyn, Poland
[4]Department of Veterinary Prevention and Feed Hygiene, Faculty of Veterinary Medicine, University of Warmia and Mazury in Olsztyn, Oczapowskiego 13, 10-718 Olsztyn, Poland

ABSTRACT

Meat quality depends on a number of factors, which can be divided into genetic and environmental. Gender can significantly alter the meat quality of fattening pigs. Porkers undergoing surgical castration have a higher fat content compared to gilts. The aim of the study is to compare the fattening and slaughter characteristics as well as the chemical composition of meat from gilts and surgically castrated males. The research material consisted of 113 fatteners: gilts (61 animals) and surgically castrated males (52 animals) from 12 litters of sows with elements of two native breeds (6 litters – Polish Large White and 6 litters – Polish Landrace), randomly selected from a group of 50 sows and crossbreed boar of the paternal breeds Pietrain x Duroc. The chemical composition of the *longissimus lumborum* muscle was analysed in the samples, the content of dry matter, total protein, crude fat and crude ash was taken into account. The color of the meat was determined in the CIE L*a*b* system on the cross-section of the taken samples of the *longissimus lumborum* muscle (LL). After slaughter, the pH_{45} of LL, carcass length and backfat thickness were also measured. The significance of differences between the mean physicochemical scores in the groups was analyzed using the one-way analysis of variance in the orthogonal system using Duncan's test. The results were statistically processed using Statistica PL 13.5. Surgically castrated males was characterized by a significantly higher daily gain compared to gilts. It was shown that the percentage of meat in the carcass was significantly higher in the gilts, which were also characterized by a lower fatness expressed in the average backfat thickness. Ultimately, it was found that the sex of the experimental animals did not differentiate the quality of the meat.

Key words: fattening pigs, sex, meat, chemical composition, quality

INTRODUCTION

One of the main components of the human diet is animal meat. Eating meat provides many important nutrients. The improvement in living standards in developing countries is increasing the demand for animal products. The most important meat consumed in Poland is pork. This is influenced, among other things, by the culinary habits and preferences of consumers. Although the consumption of poultry is increasing, the consumption of pork has remained at a similar level for years. The total consumption of meat and offal in our country in 2022 was 89.2 kg per capita, of which 46.3 kg per capita was pork [Statistical Yearbook of Agriculture 2023]. A similar trend has been observed in the pork market worldwide; pork is the most popular meat consumed by consumers. Pork consumption is expected to increase by up to 37% by 2050 [Davoudkhani et al. 2020].

✉ krzysztof.karpiesiuk@uwm.edu.pl

Pig farming is primarily about producing the best quality meat, which depends on the following factors, among others water binding capacity, acidity, colour, firmness and shelf life, external appearance, texture, palatability, i.e. taste and smell [Karpiesiuk et al. 2019]. Consumers evaluate the quality of meat at the time of purchase. The resulting product should have a high rating based on reliable methods for assessing meat quality. Such behaviour allows us to introduce an appropriate standardisation of meat, which translates into an increase in the competitiveness of products on foreign and domestic markets. Such a problem can be solved by selecting evaluation methods that best reflect a reliable description of meat quality and the relationship between different traits [Karpiesiuk et al. 2013, Zapotoczny et al. 2014].

The production results of animals and the characteristics of the meat obtained from them depend on many factors, which can be categorised into genetic and environmental factors. The contribution of these two factors to the production and quality of meat varies. It is assumed that genetic factors have an influence of 30% and environmental factors of up to 70% [Monin et al. 1999]. The sex of the animals can change the quality of meat from fattening pigs. According to Aluwé et al. [2015], surgically castrated males barrows) have a higher fat content compared to gilts and especially compared to uncastrated pigs. It can therefore be assumed that immunological castration can also influence the fat metabolism and fat content of the carcasses. It is advisable to fatten gilts and surgically castrated malesseparately due to their different growth rates and feed intake. It is supposed that separate fattening of gilts and surgically castrated males can ultimately lead to better pork quality.

The aim of the study was to compare the fattening and slaughter characteristics as well as the chemical composition of the meat of gilts and surgically castrated males.

MATERIAL AND METHODS

The study material consisted of 113 fattening pigs (61 animals) and surgically castrated males (52 animals) from 12 litters of two native breeds (6 litters – Polish Large White and 6 litters – Polish Landrace) bred with a crossbred boar of the sire breeds Pietrain × Duroc (Table 1).

All experimental animals were fed ad libitum with complete mixtures adapted to their age and physiological condition in accordance with Polish pig feeding standards, and the feed consumption of the experimental animals was recorded throughout the study period. The animals were fed with two types of complete mixtures: PT-1 mixture for the first fattening period from 30–70 kg, PT-2 mixture for the second fattening period from 70 to 105 kg (Table 2).

The chemical composition of the feed mixtures is shown in Table 3. The total protein content was lower than recommended and was 12.02 g · MJ^{-1} and 10.0 g · MJ^{-1} compared to 12.8 g · MJ^{-1} and 11.05 g · MJ^{-1} for PT-1 and PT-2, respectively. However, the metabolic energy content in the mixtures used exceeded the recommended values and was 16.31% and 16.39% compared to 12.5–13.5 and 11.05 for PT-1 and PT-2, respectively. The amount of crude fat in the combined diets was 1.79% and 1.68%, which is a reasonable result considering the adopted values of the nutritional standards (2015) and does not exceed the maximum recommended value for pigs, which is 8–10%. The crude fibre content of 3.52% and 3.29% is within the permissible limit, whereby the nutritional standards stipulate a maximum value of 6% in 1 kg of total mixture for fattening pigs. This result proves a balanced feed ration and the right choice of ingredients for the feed in this technology group.

The production trial lasted from 30 kg to 105 kg body weight of the fattening pigs. Body weights were monitored throughout the trial and weighed every 2 weeks until the end of fattening. In addition, the animals' body weights were checked on the morning of the day they were sold to the meat plants. After fattening, the animals were slaughtered according to the procedures in place at the "Warmia" meat plant.

After slaughter and carcass cutting, a post-mortem evaluation of the carcasses was carried out according to the EUROP classification [EC 2008] using a SYDEL CGM 100 needle-optical camera.

The following measurements were also taken on the warm right carcass halves 45 minutes after bleeding: pH_{45} – the measurement was taken in the longisimus dorsi muscle behind the last rib using a previously calibrated pH metre WTW 3310; carcass length (from the front edge of the junction of the first rib with the sternum to the front edge of the pubic symphysis); fat thickness at 5 points on the carcass:

- at the thickest point above the shoulder blade;
- on the back behind the last rib;
- the so-called cross I – above the cephalic edge of the gluteus medius muscle (buttock muscle);
- the so-called cross II – in the centre of the gluteus medius muscle (m.g.m);
- the so-called cross III – over the caudal edge of the gluteus medius muscle (m.g.m);

In the meat plants, the pH value was determined after 24 hours on the chilled right half of the carcass using a WTW 3310 pH metre. To determine the chemical composition of the longissimus dorsi muscle and the meat quality, meat samples were taken after 24 hours of chilling at 2–4°C at the time of carcass cutting. The samples with a thickness of approximately 10 cm were taken from the right halfof the carcass, namely from the longissimus

Table 1. Number of animals per group

Specification	♀Polish Landrace × ♂ (♀ Pietrain × ♂ Duroc)		♀ Polish Large White × ♂ (♀ Pietrain × ♂ Duroc)	
Sex	♀	♂	♀	♂
Number of animals	34	28	27	24

Table 2. Component composition of the experimental mixture, %

Specification	1st stage of fattening	2nd stage of fattening
Wheat	55.00	45.00
Triticale	15.00	30.00
Wheat bran up to 9% fibre DM	8.00	11.00
Post-extraction soybean meal over 46% protein	6.00	3.00
Complementary feed	15.00	10.00
Oil	1.00	1.00

Table 3. Chemical composition of the experimental mixtures, %

Specification	1st stage of fattening	2nd stage of fattening
Dry matter, %	89.99	89.60
Crude ash, %	4.60	3.68
Total protein, %	19.61	16.42
Crude fat, %	1.79	1.68
Crude fibre, %	3.52	3.29
Metabolisable Energy, MJ · kg^{-1}	16.31	16.39

Table 4. Fattening performance of pigs

Specification	Sex	
	Gilts	Male pigs castrated surgically before 7 days of age
Average daily gain, kg 1st stage of fattening	0.782^{B} ±0.113	0.861^{A} ±0.121
Duration of the fattening period, days 1st stage of fattening	51	46
Average daily gain, kg 2nd stage of fattening	0.875^{B} ±0.133	0.958^{A} ±0.153
Duration of the fattening period, days 2nd stage of fattening, kg	44	41
Average daily gain, kg	0.830^{B} ±0.091	0.919^{A} ±0.091

Significance of differences: $^{A, B}$ $P < 0.01$.

dorsi lumborum muscle (LL.) at the level of 1–3 lumbar vertebra. The colour of the meat was determined in the CIE L*a*b* system using the MiniScan EZ spectrophotometer, HunterLab, model 4500L, on the cross-section of the samples taken from the longissimus dorsi muscleA D65 light source and a standard colourimetric observer with a field of view of 10° were used. The parameters tested were measured at λ = 400÷700 nm, with a resolution of 10 nm. The determination of colour in this system is used to evaluate the colour "space " and assess the magnitude of colour deviation in the spectrum, where L* – the brightness of the colour, a* – the proportion of red colour, b* – the proportion of yellow colour. The homogenized samples were tested for :

Table 5. Carcass evaluation and slaughter performance of the fattening pigs

Specification	Sex	
	Gilts	Male pigs castrated surgically before 7 days of age
Carcass weight, kg	82.98 ±6.610	84.28 ±5.975
Leanness, %	60.79^{A} ±1.724	58.98^{B} ±1.383
Carcass length, cm	82.29 ±2.626	82.25 ±2.821
Average backfat thickness, mm	15.63^{A} ±4.018	18.70^{B} ±4.061
Loin eye area, cm^2	59.89 ±8.16	58.94 ±8.15

Significance of differences: $^{A, B}$ $P < 0.01$

Table 6. Evaluation of meat quality parameters

Specification	Sex	
	Gilts	Male pigs castrated surgically before 7 days of age
pH_{45}	6.44 ±0.267	6.43 ±0.227
pH_{24}	5.86 ±0.203	5.81 ±0.139
L* – Brightness	56.73 ±3.502	57.76 ±3.054
a*– Red colour	6.92 ±1.338	7.05 ±1.103
b* – Yellow colour	14.58 ±1.184	14.92 ±1.030

Table 7. Chemical composition of meat of experimental pigs, %

Specification	Sex	
	Gilts	Male pigs castrated surgically before 7 days of age
Dry matter, %	25.99 ±0.597	25.96 ±0.794
Total protein, %	23.31 ±0.463	23.20 ±0.542
Crude fat, %	1.36 ±0.513	1.48 ±0.633
Ash, %	1.15 ±0.037	1.14 ±0.040

- dry matter – mass drying method at 105°C according to PN ISO 1442:2000 [PN-ISO 2000]
- total protein – Kjeldahl method according to PN 75/A-0401 [PN 1975]
- crude fat – Soxhlet method according to PN ISO1444:2000 [PN-ISO 2100]
- crude ash – by burning the sample at a temperature of 550°C according to PN-ISO 936:2000 [PN-ISO 2200]

The results obtained were statistically analysed. The significance of the differences between the mean values of physicochemical evaluation in the groups was analysed by means of one-way analysis of variance in an orthogonal system using the Duncan test. The results were statistically analysed using the Statistica PL 13.5 programme. Statistica PL 13.5.

RESULTS

The indicator used to describe the growth rate of the animals during the production period is the daily increase in body weight. Table 4 shows the results of the daily weight gain of fattening pigs in the individual fattening periods. Although there were no significant differences, a higher daily body weight gain was observed in surgically castrated males compared to gilts in both the first and second fattening periods.

Table 5 shows the results of the carcass evaluation of the fattening pigs studied. There were no statistically significant differences between the carcass weights of gilts and surgically castrated males. Gilts were characterised by a lower carcass weight. The average value of this parameter was 82.98 kg compared to surgically castrated males carcasses, which weighed 84.28 kg on average.

The meat content of the analysed carcasses was higher in the gilts group than in the surgically castrated males. The difference between the groups was 1.81%. The carcasses in the test groups were characterised by a similar length, which was 82.20 cm in the gilts and 82.25 cm in the surgically castrated males. The average backfat thickness from 5 measurements differed significantly between the groups and was 15.64 mm in the gilts and 18.70 mm in the surgically castrated males. The "eye" area of the tenderloin was similar in both groups, proving that there is no influence of sex on this indicator.

Table 6 shows the instrumental evaluation of the quality parameters of the *longissimus lumborum* muscle (LL. The results of active acidity for both sexes, measured 45 minutes and 24 hours after slaughter, were similar in each group and were pH_{45} 6.44 and pH_{24} 5.86 in gilts and pH_{45} 6.43 and pH_{24} 5.81 in surgically castrated males. The pH_{24} measurement allows us to conclude that no DFD meat was detected in the analysed carcasses. The group of surgically castrated males is characterised by a higher value of colour brightness, which is 57.76, compared to the gilts with the result L = 56.73.

The chemical composition of the *longissimus lumborum* muscle is shown in Table 7. Pork is a component of the human diet, thanks to which it enriches the diet with a high-quality source of protein. An element that has a significant influence and determines the value of meat is the content of complete protein. The total protein content between the groups of gilts and surgically castrated males was similar and was 23.31% and 23.20% respectively. The dry matter content did not differ between the groups analysed and was 25.99% in gilts and 25.96% in surgically castrated males. The meat of surgically castrated males had a higher fat content and was 1.48%, while the fat content of meat obtained from gilts was 1.36%. Similarly, surgically castrated males were characterised by a higher subcutaneous fat content.

The ash content in the chemical composition indicates the presence of minerals in the analysed meat samples. In the groups analysed, the content of this ingredient was comparable and amounted to 1.15% in gilts and 1.14% in surgically castrated males.

DISCUSSION

In the study by Knecht et al. [2009], the surgically castrated males reached an average higher body weight of 123.94 kg with a low coefficient of variation of 7.90%, while the gilts reached 120.34 kg with a CV = 8.34%. However, in the studies cited above, a significant difference in carcass weight was observed – the carcasses of surgically castrated males were 3 kg heavier than those of gilts. Similar to their own studies, Knecht et al. [2009] observed a higher proportion of meat in the carcass of gilts compared to surgically castrated males. This is a regularity that has been observed in many studies [Koczanowski et al. 1999, Karamucki et al. 2003, Kapelański et al. 2006, Daszkiewicz et al. 2011, Tuz et al. 2011]. The results obtained in this study are in agreement with the investigations of Eckert and Orzechowska [2002]. The gilts examined by them were characterised by thinner bakfat thickness compared to boars, and a greater height of the "eye" of the loin.

In the study by Kozera et al. [2023], no statistically significant differences were found in the percentage of meat in the carcass and in the cold weight of the carcass between the sex groups. The values obtained in our study are in agreement with the results of other authors [Blicharski et al. 2013], which allows the conclusion that the meat of the pigs studied fulfils the criteria for normal meat, i.e. the pH_{45} value at slaughter is above 6.3. Under the conditions of this experiment, it can be concluded that gender has no influence on the acidity of the meat. This was also found by Furman et al. [2007], who came to the same conclusion in their study. Lower pH_{24} values were found in studies by Kozera et al. [2023], ranging from 5.32 in meat from surgically castrated boars to 5.41 in meat from gilts. Colour is described by three physical properties: saturation, brightness and dominant wavelength. The brightness of meat is reflected in its physicochemical properties, which allow defects to become visible under industrial conditions. This property is also related to water absorption. The lighter the colour of the meat, the lower the water absorption index. This dependency results from the difficulty for the light to penetrate deeper layers of the meat, which is related to the structure of the raw material. This leads to a high surface reflection of light, which is reflected in the colour brightness [Karpiesiuk et al. 2013]. In terms of colour brightness, the samples tested exceed the values for German meat (normal quality), i.e. from 43 to 50 [Borzuta et al. 2018, Pospiech 2000]. The colour evaluation showed no significant differences between the groups of gilts and surgically castrated males. The comparison of the results allows the conclusion that the meat of surgically castrated males tends to have a lighter colour compared to the meat of gilts, which could be due to the higher fat content in the meat of surgically castrated males. The same observation was made in the study by Latorre et al. [2003], who linked the higher lightness ofsurgically castrated males meat to a higher proportion of intramuscular fat (IMF) compared to gilts. In the study by Kozera et al. [2023], the darker meat was obtained in pigs, although the intramuscular fat content in this group of animals was quite high and amounted to 3.016%. Sex influences the content of IMF in meat [Lampe et al. 2006]. The percentage of red colour (a*) in the *longissimus lumborum* muscle is higher in the pig group and was 7.05 in barrows and 6.92 in gilts. As for the percentage of yellow colour in the tested meat, similar results were obtained, which amounted to 14.92

in pigs and 14.58 in gilts. The colour brightness in the study by Kozera et al. [2023] on the influence of sex on meat quality, the values of the colour parameter b* differed significantly in the individual groups, and the degree of yellowing was highest in group 3 (male animals that underwent immunocastration) and lowest in group 2 (male animals that underwent surgical castration). Fresh pork should have a reddish-pink colour. A dark colour can lead to a shorter shelf life and increased bacterial growth, while a pale pinkish-grey colour can be undesirable for the consumer [Trevisan and Brum 2020].

Seiquer et al. [2019] found similar values for protein content in the longissimus dorsi muscle in immunologically castrated males and surgically castrated males, but lower values in gilts. The fat content was significantly higher in all sex groups of animals in the studies cited, although it should be noted that the studies were carried out on primitive Iberian pigs. Barton-Gade [1987] also showed a higher intramuscular fat content in the surgically castrated males group in their study. Kozera et al. [2023], who investigated the influence of sex on meat quality, showed that the meat of immunologically castrated boars had a significantly higher dry matter content compared to gilts. Moreover, it was found that meat from gilts had a lower fat content compared to boars castrated with Improvac. The increase in intramuscular fat content is very important as it is related to sensory quality parameters, consumer preferences and processing value [Jankowiak et al. 2019].

CONCLUSIONS

1. Surgically castrated males were characterised by a significantly higher growth rate compared to gilts.
2. The percentage of meat in the carcass was significantly higher in gilts, which were also characterised by a lower backfat thickness.
3. The sex of the test animals had no influence on the meat quality of the test animals.

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WPŁYW PŁCI TUCZNIKÓW NA CECHY TUCZNE, RZEŹNE I JAKOŚĆ MIĘSA

STRESZCZENIE

Jakość mięsa zależny od wielu czynników, które można podzielić na genetyczne i środowiskowe. Płeć może istotnie wpłynąć na zmianę jakości mięsa tuczników. Tuczniki poddane kastracji chirurgicznej mają wyższą zawartość tłuszczu w porównaniu z loszkami. Celem pracy było porównanie cech tucznych, rzeźnych oraz składu chemicznego mięsa loszek i wieprzków. Materiał do badań stanowiło 113 tuczników: 61 loszek i 52 wieprzki ras matecznych (6 miotów – wielka biała polska i 6 miotów – polska biała zwisłoucha) krytych knurem mieszańcowym ras ojcowskich pietrain x duroc. Po uboju dokonano także pomiaru na półtuszy pH_{45}, długości tuszy i grubości słoniny. Analizowano skład chemiczny mięśnia najdłuższego grzbietu: zawartość suchej masy, białka ogólnego, tłuszczu surowego i popiołu surowego. Na przekroju poprzecznym mięśnia najdłuższego grzbietu określono barwę mięsa w układzie CIE L*a*b*. Istotność różnic między średnimi oceny fizykochemicznej w grupach analizowano wykorzystując jednoczynnikową analizę wariancji w układzie ortogonalnym z zastosowaniem testu Duncana. Wyniki opracowano statystycznie za pomocą programu Statistica. Wieprzki charakteryzowały się istotnie wyższymi przyrostami dziennymi w porównaniu do loszek. Wykazano, że procentowa zawartość mięsa w tuszy była istotnie wyższa u loszek, które jednocześnie charakteryzowały niższym otłuszczeniem tuszy. Ostatecznie stwierdzono, że płeć zwierząt doświadczalnych nie wpłynęła na zróżnicowanie jakości mięsa.

Słowa kluczowe: tuczniki, płeć, mięso, skład chemiczny, jakość

Wojciech Kozera https://orcid.org/0000-0001-8931-3190
Karolina Dobiesz https://orcid.org/0009-0001-6568-9473
Urszula Czarnik https://orcid.org/0000-0002-9065-2197
Michał Dąbrowski https://orcid.org/0000-0002-1445-5554
Krzysztof Karpiesiuk https://orcid.org/0000-0002-7334-5355