

GROWTH RATE AND CARCASS QUALITY OF HYBRID FATTENERS DEPENDING ON THE AGE OF SLAUGHTER

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ABSTRACT

The aim of the study was to evaluate the effect of age on the fattening performance qualities and carcasses slaughter value. The assessment covered 99 crossbred pigs (Danish Landrace × Yorkshire × Duroc). The animals were subdivided into two groups with different slaughter age (159 and 169 days). The assessment covered fattening and post-slaughter characteristics. It has been proven that, at slaughter, younger crossbred pigs showed a higher growth rate than older pigs ($P < 0.01$). In addition, the former were fattened for a shorter period and consumed less feed across the entire fattening period as well as per 1 kg of gain. Carcasses of pigs older at slaughter were characterised by greater warm carcass weight and height of the loin muscle relative to group I carcasses ($P < 0.01$). Slaughter value of fatteners from both groups studied was very high, as each of the carcasses under assessment was classified under the most valuable categories S, E, and U.

Key words: pigs, age of slaughter, fattening and slaughter assessment

INTRODUCTION

A new form of production has been increasingly popular among small-scale pig producers in Poland since 2018. It is called contract fattening and it is advantageous for smaller farms as it improves production profitability. Contract fattening involves the rearing of pigs that have a high genetic potential, purchased e.g. in Denmark or Germany. Feed manufacturers supply piglets to farms, provide feed as well as veterinary and zootechnical care, and collect the fatteners to deliver them to meat establishments at the end of fattening; in exchange for that, farmers offer their livestock buildings and their own labour [Ziętara 2019].

Pig production profitability is shaped by a number of factors, i.e. feeding [Kasprowicz-Potocka et al. 2017, Vieira et al. 2021], fattening duration [Bocian et al. 2017, Ding et al. 2020, Sońta et al. 2020] or age at slaugh-

ter [Latorre et al. 2003, Virgili et al. 2003, Rudy and Znamirowska 2007, Borah et al. 2016, Ortiz et al. 2021, Chen et al. 2022]. However, one of the most important factors is the capacity to convert feed into body weight, which is determined by genetic potential of animals [Bojko and Rekiel 2014, Bocian et al. 2015, Domański and Więcek 2019].

Slaughter age is a crucial factor affecting fattening efficiency and it is dependent on the extent of animal genetic potential; according to some researchers, it is equal to approx. 140 to 180 days [Latorre et al. 2003, Kušec et al. 2008, Bosch et al. 2012, Tyra 2012, Bocian et al. 2015, Bocian et al. 2017, Ortiz et al. 2021,]. Shorter slaughter age lowers the cost of animal management, but results in lower technological and eating quality of the obtained material, limiting the production of high-quality sliced meats and matured hams [Latorre et al. 2003]. Pig slaughter older age is disadvantageous due to aggravated

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fattening characteristics, including higher feed consumption during fattening, extended duration of animal feeding [Rudy and Znamirowska 2007, Borah et al. 2016, Van den Broeke et al. 2020], and lowered slaughter value, i.e. greater fatness and lower meatiness of carcasses [Virgili et al. 2003, Bosch et al. 2012, Borah et al. 2016, Bocian et al. 2017]. This increase of fatness is observed up to a certain age, while older animals also have slightly higher amounts of fat deposited in the muscle tissue (intramuscular fat – IMF). The presence of IMF is very important as largely determines the taste of meat as well as its organoleptic and physicochemical characteristics [Bosch et al. 2012].

On the other hand, raised slaughter age has an advantageous effect leading to higher carcass slaughter value and greater loin eye area [Virgili et al. 2003] as well as better meat quality parameters [Latorre et al. 2003, Dominguez et al. 2015, Borah et al. 2016]. In a study by Kušec et al. [2008], optimal pig slaughter age and body weight were established on the basis of a body weight gain and muscle gain analysis. It has been calculated that intensively fed pigs require 140 days to reach 100 kg of body weight, whereas restrictively fed pigs achieve 120 kg of body weight at the age of 160 days.

Pigs with high production potential show this ability much longer, i.e. until an older age [Grela and Skomial 2020]. Pigs showing high genetic potential deposit large quantities of protein in their bodies [Bikker et al. 1994, Oresanya et al. 2008, Zhou et al. 2015]. Animals with a higher capacity to deposit protein have higher meatiness, lower carcass fatness, and low feed consumption per 1 kg of gain [Rudy and Znamirowska 2007, Bocian et al. 2015, Wang et al. 2018, Tyra et al. 2020]. It should be emphasized that in order to improve the slaughter efficiency with the optimal fattening length, and to maintain the high quality of pork, it is extremely important to determine the optimal slaughter weight of hybrid fatteners [Maiorano et al. 2007]. Common examples of commercial hybrid lines of pigs offered in Poland are Naïma (Choice Genetics) and DanBred (DanBred International). The breeds imported from Denmark, for the improvement of slaughter pigs, are characterised both by a high meatiness and good quality of raw and processed meat. DanBred hybrid is a maternal line created by crossing of Danish Landrace (L) and Danish Yorkshire (Y) [Zybert et al. 2022]. In the current conditions of the market economy, the age of fattening pigs on the day of slaughter plays a fundamental role, as it directly translates into the profitability of production [Szulc et al. 2022]. Therefore, this research provides information that may turn out to be very important, as many producers tend to fatten with the use of DanBred hybrids. This is due to, *inter alia*, the fact that DanBred porkers, compared to native breeds, are characterized by a faster growth rate and a higher lean meat content in the carcass [Kušec et al. 2022].

The aim of this study was to evaluate the relationship between slaughter age and fattening performance as well as carcass slaughter value of hybrid pigs reared in deep litter with straw.

MATERIAL AND METHODS

No individual approval of an ethics committee was required for this study. Pigs belonged to a farm and were fed by the farm owner. The studies were a part of a routine production cycle in the swine production sector. The experimental animals were slaughtered in a registered meat processing plant. In the next stage, the carcasses were analyzed. The major research goal was to analyze the fattening value and carcass quality [EU 2010].

Animals and diets

The study was carried out in one of the farms in the Kuyavian and Pomeranian region in Poland. It covered 99 crossbred pigs (Danish Landrace × Yorkshire × Duroc), 45 of them being females and 44 castrated males, all purchased in Denmark. The animals were being kept in two group pens, with ca. 50 animals per pen (1 m² per animal), in deep litter, in compliance with well-being requirements, with unlimited access to water.

Pigs body weight at the beginning of fattening was approximately 37 kg and the duration of pigs fattening period was from 85 to 95 days. The fatteners were being fed complete feeds in a 2-phase feeding regime according to the norms for pig feeding [Bocian et al. 2015]. The nutritional value of 1 kg of the complete feed was: I fattening period, 12.97 MJ · kg⁻¹ and 162 g of crude protein, Lysine 10.9 g; II fattening period, 13.14 MJ · kg⁻¹ and 151 g of crude protein, Lysine 9.0 g. Fattening of the animals had started at a body weight of approximately 37 kg and was continued until an average body weight of 114 kg was reached. Feed consumption and individual animal growth rate was monitored during the entire fattening period.

Upon fattening completion, the animals were transported to slaughterhouse, were allowed to rest with free access to water. An electric stunning method was applied to the pigs. Next they were slaughtered in compliance with applicable standards and provisions [Journal of Laws 2004].

Fattening value and carcass quality

The animals were weighed at the beginning and at the end of the fattening period, which made it possible to determine the size of the weight gain for the entire fattening period. The knowledge of the duration of fattening allowed for estimating the average daily gain (ADG) (ADG = Total weight gain / Fattening days) of the studied fatteners. What is more, the average feed consump-

tion per animal during fattening was calculated (feed consumption of all animals / number of animals) as well as feed conversion ratio (FCR) (FCR = Feed intake / Weight gain). The evaluation of the carcass quality also included the measurement of the hot carcass weight and the slaughter efficiency was made. Backfat thickness was also measured in five places on the carcass (above the shoulder, behind the last rib and above the I, II, III sacral vertebrae). Furthermore, the depth of the *Longissimus thoracis et lumborum* muscle behind the last rib on the carcass was estimated. Determination of meatiness of each carcass was assessed using the ULTRA-FOM 300 device. It allowed for an assignment carcasses to the quality classes in the SEUROP system [EU 2013].

Statistical analysis

The obtained results were compared and analysed in two groups formed according to fatterer slaughter age. Group I consisted of animals with a slaughter age of 159 days (n = 49), group II consisted of fatteners with a slaughter age of 169 days (n = 50). Arithmetic mean and standard deviation were calculated. Significance of differences between group I and II was verified using Student's *t*-test. Pearson's coefficients of linear correlation of age at slaughter with fattening and slaughter characteristics were estimated. The statistical calculations were performed using the Statistica 13.3 software [Statistica 2019].

RESULTS

Results for fattening performance of Danish crossbred pigs in relation to slaughter age have been presented in Table 1. At the start of fattening, body weight was balanced but at the end, fatteners from group II weighed ca. 5.5 kg more than animals from group I. In addition, total gains were 4.55 kg higher in group II compared to group I

($P < 0.01$). In comparison with group II fatteners, group I fatteners were being fattened for a 10 days shorter period and showed higher growth rates ($P < 0.01$). Group I showed lower feed consumption across the entire fattening period as well as per 1 kg of gain than group II.

Table 2 includes results for slaughter performance of the pigs. Hot carcass weight was higher in group II when compared to pig carcasses from group I ($P < 0.01$). Depth of the loin muscle proved to be higher in group II relative to group I ($P < 0.01$). Slaughter yield, backfat thickness, and carcass meat content were balanced across both groups. The categories under the SEUROP scheme set by the EU legislation (33) who have the highest price in the market are S (Superior), E (Excellent) and U (Very good). Each carcass (100%) in this study was classified under one of these three categories. For both groups, the largest percentage were carcasses classified as class E. Group II had a higher percentage of carcasses in class S than group I. Class S refers to carcasses with lean meat content of 60% or higher. Coefficients of phenotypic correlations between slaughter age and fattening and slaughter characteristics are contained in Table 3. Age at slaughter was significantly and positively correlated with body weight at the end of fattening, warm carcass weight, and depth of the loin muscle ($P < 0.01$). On the other hand, a negative correlation was shown between age at slaughter and average daily gains ($P < 0.01$).

DISCUSSION

Currently, a lot of attention is paid to shortening of the fattening duration in order to increase the profitability of growing pigs. Age at slaughter will affect not only the fattening and slaughter parameters, but also the profitability of fattening, which nowadays is the leading factor in maintaining pigs. Extending the fattening period results in higher direct and indirect production costs, e.g. higher energy consumption, longer room occupancy

Table 1. Results of fattening pigs depending on the age of slaughter

Trait	Age of slaughter		Average
	Group		
	I 159 days	II 169 days	
Number, n	49	50	99
Body weight, kg			
– at the beginning of fattening	36.56 ± 4.19	37.50 ± 3.89	37.03 ± 4.05
– at the end of fattening	108.82 ^A ± 7.28	114.30 ^B ± 5.65	111.58 ± 7.04
Total weight gain, kg	72.25 ^A ± 4.17	76.80 ^B ± 4.13	74.55 ± 4.72
Fattening period, days	85	95	90
Average daily gain, g	850 ^A ± 49.00	808 ^B ± 43.00	829 ± 50.00
Feed consumption per animal throughout the fattening period, kg	209	236	222.5
Feed conversion ratio, kg · kg ⁻¹	2.89	3.07	2.98

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

Table 2. The carcass characteristics depending on the age of slaughter.

Trait	Age of slaughter		Average
	Group		
	I 159 days	II 169 days	
Hot carcass weight, kg	85.64 ^A ± 5.50	90.22 ^B ± 5.16	87.95 ± 5.78
Carcass yield, %	78.73 ± 1.51	78.9 ± 1.37	78.82 ± 1.43
Backfat thickness, mm	15.26 ± 3.44	15.11 ± 3.65	15.18 ± 3.53
Loin muscle depth, mm	66.59 ^A ± 7.66	71.19 ^B ± 6.59	68.92 ± 7.47
Carcass meat content, %	58.03 ± 2.32	58.56 ± 2.27	58.3 ± 2.30
SEUROP carcass classification system			
Class S, n/%	10 / 10.10	15 / 15.15	25 / 25.25
Class e, n/%	33 / 33.34	31 / 31.31	64 / 64.65
Class U, n/%	6 / 6.06	4 / 4.04	10 / 10.10

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

Table 3. Phenotypic correlation coefficient between age of slaughter and fattening and slaughter traits

Specification	Age of slaughter, days
Body weight at the beginning of fattening, kg	0.116
Body weight at the end of fattening, kg	0.392**
Average daily gain, g	-0.413**
Hot carcass weight, kg	0.397**
Backfat thickness, mm	-0.022
Loin muscle depth, mm	0.309**
Carcass meat content, %	0.115

** Significance at P < 0.01.

and higher workload [Meul et al. 2007]. In many cases, cost-effectiveness, and increased fatness of older animals as well as significantly lower proportion of lean meat, can result in the shorter period of fattening [Senčić et al. 2005]. Taking into consideration the use of the fast-growing breeds of pigs, some researchers indicate that it should be associated with intensive fattening while using their efficiency. Therefore, the slaughter of such animals should take place earlier, when their fattening and slaughter characteristics reach the highest values [Rauw et al. 2020].

The shortening of the fattening period is possible, especially with the use of hybrid animals, characterized by intensive growth and low-level feed consumption [Zmudzińska et al. 2020]. This decrease in time may be justified by the fact that longer fattening, and thus keeping animals to an older age, causes greater consumption of feed for weight gain, which is confirmed by the results of the research. On the other hand, older animals are often characterized by better meat quality, which is indicated both by the values of physicochemical traits assessed by apparatus and by sensory means [Ilavarasan and Abraham 2018].

In the present study, the pigs from both groups were characterised by low feed consumption during fattening and per 1 kg of gain. This indicates their high usefulness

and is a predictor of potentially high profitability of their production. More favourable results for fattening characteristics were achieved in group I, where the pigs were slaughtered 10 days earlier.

Similar results of fattening qualities of Danish cross-bred pigs have been reported by Polish researchers [Rudy and Znamirska 2007]. The biggest daily gains and the lowest feed consumption per 1 kg of gain were shown in pigs with the youngest age at slaughter (157 days), whereas the lowest parameters of fattening characteristics were attained in fatteners with the oldest age at slaughter (199 days) (P < 0.01).

A number of researchers are of the opinion that an older slaughter age of pigs results in decreased daily gains and increased feed consumption per 1 kg of gain [Latorre et al. 2003, Virgili et al. 2003, Tyra 2012, Borah et al. 2016, Bocian et al. 2017, Thölke and Wolf 2022]. In the case of non-castrated animals, attention should also be paid to the quality of the obtained slaughter material. The unfavorable effect of age on meat quality is typical for the meat of all males. This applies to those slaughtered at an old age, in which the level of skatole and androstenone is higher and identified as “boar taint” [Aluwé et al. 2011].

In some research slower growth of fattening pigs was observed, which resulted in an extended fattening period [Bocian et al. 2017]. However, no higher feed consump-

tion was found for the entire fattening period and no increase in pig body weight per 1 kg. Similar results on slower growth were observed [Tyra et al. 2020] while observing the even body weight of slaughtered pigs at different ages.

The obtained results for slaughter characteristics suggest that the slaughter age has a beneficial effect: higher warm carcass weights and greater height of the loin muscle have been observed. The research of Rudy and Znamirowska [2007] showed that fatteners slaughtered at an older age (199 days) had a larger eye area of the loin and at the same time, a greater fatness of the carcass, compared to younger animals (157 days). In a study [Migdał et al. 2020] carried out on PIC hybrid fatteners, an increase in carcass fatness of older animals was also observed, with a simultaneous decrease in meat content. In this case, the lower meat content was compensated by the obtained high values of physical and chemical properties of meat. On the other hand, in other studies [Lo Fiego et al. 2010] an increase in fat was observed only in hybrids of the white and Duroc breeds, while the remaining parameters of carcass and meat quality were at an even level in the groups differing in body weight on the day of slaughter.

Latorre et al. [2003] reported greater fatness of pork carcasses (slaughter age of 175 days), which positively influenced certain quality-related aspects of the material suitable for ham production. In studies by Virgili et al. [2003] on four-breed hybrids, improvement in the quality of meat was also observed in porkers kept until the age of eight months, while those fattened up to the age of 10 months showed suitability for the production of dry-cured hams. Similarly, more favourable values of meat quality traits in older fattening pigs were observed by other authors who conducted experiments on a native breed of pigs. They also indicated a higher content of omega-6 fatty acids and, very importantly, a much lower cholesterol content [Dominguez et al. 2015].

In many studies, it can be observed that fat is obtained in older fattening pigs (160 days versus 185, 210 or 220 days). The research in question concerns pigs of the Duroc breed, which, with age, also recorded an increasing content of fat in the *Longissimus lumborum muscle*. However, the growth of this muscle was intense until the age of 210 days, when it started to become thinner [Bosch et al. 2012]. Migdał et al. [2020], also indicated that pigs with higher body mass are more suitable for ham production. The same authors reported that the age of 150 days is the moment when the porkers' meat has more intramuscular fat and better technological values.

It was also highlighted that the choice of breed fattened to an older age is key to the results obtained. In their research on Duroc × Landrace × Yorkshire porkers, Guo et al. [2022] observed that the pre-slaughter body weight, the warm carcass weight, the carcass length, the slaugh-

ter yield, the loin eye area, and the fat content of the carcass increased significantly. There was also an increase in certain values of the physicochemical properties of meat, which is not always favorable as far as the technological suitability of meat is concerned. In the study, an issue of this kind was an increase in the value of the b* yellow hue, drip loss, or thermal leakage [Guo et al. 2022]. On the other hand, a significant decrease was observed in the case of the meat pH measured immediately after slaughter, which may also indicate a higher probability of the occurrence of meat defects. These results differ significantly from those obtained from native-breed meat, often deliberately fattened to an older age [Virgili et al. 2003].

Carcasses of pigs currently fattened are characterized by high meatiness. This applies even more to Danish breeds and their hybrids. Most often they are classified into the two classes with the highest meatiness S and E. It is rare to observe the U class [Domański and Więcek 2019].

The obtained results concerning the meatiness of the studied fattening pigs allowed them to qualify for high classes in the SEUROPS System. A greater percentage of remarkably muscular and class S carcasses was observed among the older animals. A similar tendency was found by other authors, who indicated that, in the case of Danish high-yielding porkers, high meatiness was obtained at a higher body weight. Heavier porkers, with carcasses weighing over 95 kg, were characterized by the highest meat content and thus belong to the S class [Bojko and Rekiel 2014]. Many studies indicate, however, that as the body weight of fattening pigs increases and the fattening time lengthens, the carcasses become fatter [Virgili et al. 2003, Migdał et al. 2020]. Native breeds are considered suitable for keeping fattening pigs and slaughtering them at an older age, even though they usually have a significant increase in body fat. However, these animals, despite their greater fat content, constitute a slaughter raw material characterized by high technological and culinary suitability [Furman et al. 2010].

The significant correlations described in the present study suggest that average daily gains and feed consumption decrease with slight increases of slaughter age in pigs that yield high meat content. Nevertheless, these increases have a beneficial effect on carcass slaughter value. Correlations between the slaughter age of fattening pigs and their slaughter value were also observed while conducting research with Swedish Landrace pigs. In this case, negative correlations were found between the age of slaughter and the quality of the carcass. Moreover, it was found that the recorded higher body weight of animals is not economically justified [Radovic et al. 2007].

CONCLUSIONS

Raising the slaughter age of pigs with high genetic potential, such as Danish crossbreds, by 10 days resulted in their slower growth rate and higher feed consumption per 1 kg of gain. It also had an adverse effect on their fattening characteristics but a beneficial one on their slaughter value. In the group of pigs slaughtered at an older age, no increase in carcass fatness typical of older animals was found. This was confirmed, among others, by the occurrence of carcasses with outstanding meatiness, which in this group accounted for a greater percentage. The very intensively increasing growth rate of pigs and the slaughter value of carcasses require continuous research, and the effects of keeping pigs of various ages should still be observed.

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TEMPO WZROSTU I JAKOŚĆ TUSZY TUCZNIKÓW HYBRYDOWYCH W ZALEŻNOŚCI OD WIEKU W DNIU UBOJU

STRESZCZENIE

Celem badań była ocena wpływu wieku tuczników na cechy użytkowości tucznej i wartość rzeźną tusz. Oceną objęto 99 mieszańców (Danish Landrace × Yorkshire × Duroc). Zwierzęta podzielono na dwie grupy różniące się wiekiem w dniu uboju: grupa I – tuczniki ubite w wieku 159 dni, grupa II – w wieku 169 dni. Oceniono cechy tuczne: masę ciała początkową i końcową, dni tuczu, przyrosty całkowite i codzienne, spożycie paszy oraz cechy poubojowe: masę tuszy ciepłej, wydajność rzeźną, mięsność, grubość słoniny i wysokość mięśnia najdłuższego grzbietu. Stwierdzono, że młodsze tuczniki wykazywały wyższe tempo wzrostu niż starsze ($P < 0,01$). Ponadto, te pierwsze, były tuczone krócej i pobierały mniej paszy w całym okresie tuczu oraz w przeliczeniu na 1 kg przyrostu. Tusze tuczników starszych charakteryzowały się większą masą tuszy ciepłej i wysokością mięśnia najdłuższego grzbietu w stosunku do tusz grupy I ($P < 0,01$). Wartość rzeźna tuczników z obu badanych grup była wysoka, świadczy o tym zaliczenie ich do najcenniejszych kategorii S, E i U.

Słowa kluczowe: świnie, wiek uboju, cechy tuczne i poubojowe

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