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INFLUENCE OF PRE-KILLING LIVING WEIGHT ON THE QUALITY OF CARCASES OF HYBRID PIGS IN THE CONDITIONS OF INDUSTRIAL PORK PRODUCTION IN UKRAINE

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Abstract

The optimal pre-slaughter live weight of pigs for fattening in the conditions of an industrial pig complex in Ukraine was determined and its influence on the quality of pig carcasses was investigated. For the study, 80 heads of young pigs were selected, of which 32 were pigs and 48 were boars. Boars were surgically castrated at the age of 2 days. During fattening, all animals had free access to food and water. Pigs were fattened in group pens for 20-25 heads on a completely slotted floor. Feeding was carried out with complete feed of own production in the wet type. When the animals reached the age of 170 days, depending on live weight, they were divided into 3 groups: Group I - 85-95 kg; Group II - 100-110 kg, Group III - 115-120 kg and slaughtered at the meat plant. The results of slaughter were used to determine the main slaughter characteristics of pigs in accordance with generally accepted methods. After measurement, the carcasses were cut into pieces and evaluated for the yield of lean pork by deboning. As a result of the study, it was found that with the increase of ante-mortem live weight, the carcass yield of carcasses also increased. In all weight groups, pigs outnumbered boars in slaughter yield. At the same time, pig carcasses lost more weight during cooling compared to castrates (0.2-0.4%). The carcasses of castrated animals had a thicker fat, measured at different points on the carcass (0.1 to 3.6 mm above the first thoracic vertebra and 0.8 to 3.3 mm above 6-7 thoracic vertebrae). Further analysis of the carcasses showed that the ratio of valuable parts of carcasses does not change significantly with increasing pre-slaughter live weight of animals. The mass fraction of tenderloin, neck, shoulder, loin and ham was higher in pig carcasses, while in castrates only the proportion of brisket was higher. In general, the weight of meat from the four main cuts in pigs was significantly higher than in castrates (group I - 58.4 against 52.2%; group II - 56.6 against 55.5%; group III - 58.3 against 56.6%). Analysis of the morphological composition of the carcasses showed an increase in meat content with increasing pre-slaughter live weight. In particular, in animals with a live weight of 115-120 kg, the proportion of meat in the carcass was 68.6 ± 0.34 in castrates and 71.0 ± 0.59% in pigs.

Key words**:** *pigs, castrates, pre-slaughter live weight, weight of valuable parts of carcass, meat yield*

INTRODUCTION

Pig farming has become widespread in the vast majority of countries around the world. Despite the process of unification of technological elements, which has been observed over the past 20-30 years, there are still some differences between countries in the technology of pork production. This is mainly due to traditional food preferences, however,

it is based on economic feasibility. This aspect concerns such elements as the organization of feeding and ration formation, the choice of breeds and breed combinations for fattening, as well as others. Among these factors, the intensity of fattening and, especially, the live weight of animals before slaughter are important.

It should be noted that in world practice there is no unambiguous answer to the question of the optimal live weight of animals before slaughter. European practice shows an approximate weight of live animals before slaughter 110-115 kg. However, in some countries, such as Ireland, pigs are slaughtered with a live weight of about 95 kg (MLC, 2003) [16], due to the traditional desire of the population to eat lean bacon. However, there is currently a change in consumer preferences and the associated increase in demand among processing companies for heavier carcasses (DARD, 2002) [6].

In other countries, such as Italy, the slaughter weight of pigs exceeds 150 kg. This is mainly due to the production of traditional dried meat, which is in demand in this country.

The weight of pigs slaughtered in Asian markets, in particular in South Korea and China, is about 90-110 kg (Kim at al., 2005) [14]. We point out that consumers in Asian countries prefer brisket and shoulder with a high fat content, but the breeds traditionally used in these countries are precocious and early salted. At the same time, with the development of industrial pig breeding in Asian countries and the breeding of the world's most common breeds, we can expect an increase in the pre-slaughter weight of pigs in these regions in the near future.

Pork producers in North America sell pigs of about the same weight as producers in Europe. However, there is a tendency to increase the live weight of animals before slaughter. Thus, in the United States since 1995, the average weight of pigs at slaughter has increased by 12-15%. If this trend continues, the average carcass weight in 2030 will be 104 kg, in 2040 - 111 kg, and in 2050 - 118 kg (Harsh at al., 2017) [11]. This constant growth is due to some factors, including genetic improvement of the original genotypes, improvement of feeding levels, the use of new feed additives and others. It is these factors that increase the efficiency of production in the fattening of heavy pigs.

In general, the growth rate of muscle tissue decreases after reaching a live weight of 90 kg, while the growth rate of adipose tissue increases linearly to a live weight of 150 kg (Gu at al., 1992) [10]. This pattern of muscle formation explains the decrease in the content of muscle tissue relative to fat in the carcasses with an increase in live weight from 95 to 130 kg. Therefore, prolonging the fattening period and increasing the fat content may lead to less efficient feed consumption. These features of heavier carcasses limit their use, which in turn forces producers to be careful in choosing the genotypes of pigs for fattening.

It should be noted that the different pre-slaughter weight of pigs causes differences in the composition of their carcasses. It is known that with increasing ante-mortem live weight of both castrates and pigs, the content of lean meat in the carcass decreases while the content of intermuscular fat does not change (Beattie at al., 1999) [2]. High slaughter weights mean lower unit costs in processing, but also improved meat quality, since the meat is more mature and the intramuscular fat content increases with increasing slaughter age (Hempler at al., 2009) [12].

In general, the main argument in favor of low carcass weight is the reduction of feed costs and lean meat, while the arguments of opponents are the desire to obtain products with high fat content. However, both want to engage in cost-effective production.

All the above applies to Ukraine, which currently uses different technologies of pork production in households and in industrial farms of different sizes.

krainian pork production in the absence of significant exports is in fact focused exclusively on the domestic market and the demand that is observed in it. The main factors that form the competitive advantage of each producer are the quality of pig carcasses, which is largely related to their weight. In

industrial production in Ukraine, pigs with a live weight of 100-110 kg are traditionally slaughtered, but given the global trend (Friedhelm, 2006) [8], local producers are studying the feasibility of increasing the pre-slaughter live weight of animals to 120 kg.

However, the increase in pre-slaughter weight of animals is associated with certain organizational issues and additional logistical workload, so it may not be appropriate in every case.

It is also known that the relationship between live weight before slaughter and the economic efficiency of fattening depends on the genotype, gender, specifics of feeding, animal health, the intensity of production processes and other factors. In order to determine the optimal pre-slaughter live weight of pigs for fattening in the industrial complex in Ukraine, these studies were conducted.

MATERIALS AND METHODS

The research was carried out in the conditions of the industrial complex of Globinsky Pig Complex LLC, Dnipropetrovsk region, Ukraine. At the birth of 20 F1 sows, a combination of Irish Yorkshire and Irish Landrace and boars of the Maxgro synthetic line, 80 heads of young pigs were selected, of which 32 were pigs and 48 were boars. Boars were surgically castrated at the age of 2 days. All animals were kept mixed and received a standard diet, according to the recommendations of the firm Hermitage (Hermitage). During fattening, all animals had free access to food and water.

Fattening of pigs was carried out in machines of 20-25 heads on a completely slotted floor with an area of 0.7 m^2 per 1 head. Feeding was carried out with complete feed of own production on wet type of feeding, according to the technology accepted on a complex.

When the animals reached the age of 170 days, depending on live weight, they were divided into 3 groups: Group I - 85-95 kg; Group II - 100-110 kg, Group III - 115-120 kg. The pigs were transported to the meat processing plant and slaughtered in accordance with the technology adopted at the enterprise (stunning in the gas chamber SCHALLER "BUTINA" - DK 4300), the carcasses were cooled first in a shock tunnel at -14 ^oC for 105 minutes and then for temperature 4 ^oC for 24 hours.

The results of slaughter were used to determine the main slaughter characteristics of pigs in accordance with generally accepted methods. The carcasses were weighed immediately after slaughter (steam carcass weight) and after 24 hours of aging and cooling (chilled carcass weight).

To determine the quality characteristics of the carcasses, the thickness of the fat and the thickness of the longest back muscle were measured. All measurements were performed on the left half carcass with a ruler (GOST 427-75) and an ultrasonic device Fat-o-Meat'er S71.

The thickness of the lard with a ruler was measured at 3 points, mm:

X1 – on the withers;

X2 – over 6-7 thoracic vertebrae;

X3 – on the buttocks, mm.

The measurement was performed at the level of 3-4 last ribs 6 cm away from the mid-back line, mm:

X4 – fat thickness;

M1 – the thickness of the longest muscle of the back (MLD).

After measurement, the carcasses were cut into pieces and evaluated for the yield of lean pork by deboning. The research results were processed using the application program Statistica v.10.

RESULTS AND DISCUSSIONS

As a result of the research, 80 pigs were slaughtered, including 48 castrates and 32 pigs. The distribution of castrates and pigs by groups was uneven: the first group 40% of castrates and 60% of pigs; the second group - 80% of castrates and 20% of pigs; the third group - 60% of castrates and 40% of pigs (Table 1).

Heavier pigs had more steam and chilled carcass and slaughter yield. This coincides with the results of other researchers, who note a linear increase in carcass weight and slaughter yield (Cisneros at al., 1996) [3], as

well as steam carcass weight and chilled carcass weight (Hugo at al., 2015) [12] with increasing pre-slaughter live weight.

Table 1. Slaughter characteristics of animals of different groups

Indicators	Group I (85-95 kg)		Group II (100-110 kg)		Group III (115-120 kg)	
	castrates, n=12	pigs, n=18	castrates, n=24	pigs, n=6	castrates, n=12	pigs, n=8
Live weight, kg	88.2±1.4	86.4±0.8	102.4±0.8	104.5±1.5	114.5±0.9	116.9±0.8
Weight of steam carcass, kg	64.9±1.2	64.3±0.7	75.8±0.8	78.4±1.2	86.1±0.7	89.1±0.9[1]
Slaughter yield,%	73.6±0.4	74.4±0.4	74.0±0.3	75.0±0.4[1]	75.2±0.5	76.2±0.6
Weight of chilled carcass, kg	63.5±1.3	62.6±0.8	74.3±0.8	76.6±1.2	84.1±0.7	86.9±0.9[1]
Losses after cooling,%	2.2±0.1	2.6±0.4	1.9±0.1	2.3±0.3	2.3±0.1	2.5±0.2

Note: [1] - $P < 0.05$; Source: Own calculations.

In each weight category, except for the first group, pig carcasses were heavier. The best slaughter yield was obtained when slaughtering pigs in all weight categories, but a significant difference ($P \leq 0.05$) was obtained only in the second group. Similar data were obtained by other researchers (Čobanović at al., 2016, Gispert at al., 2010, Czyżak-Runowska at al., 2015) [4, 9, 5]. However, some research results deny the existence of a link between the sex of the animal and individual indicators of carcass quality (Oliveira at al., 2015) [18].

It should be noted that during cooling more carcasses of pigs lost weight compared to castrates. For the first and second groups, the difference was 0.4%, for the third - 0.2%. In similar studies by other authors, it was found that castrates during cooling in the first 24 hours also lost less weight than pigs (2.09 and 3.17%, respectively) (Cisneros at al., 1996) [3].

The thickness of the fat at the measurement points increased with increasing ante-mortem live weight (Table 2).

Table 2. Thickness of the fat and the longest muscle of the back

Indicators	Group I (85-95 kg)		Group II (100-110 kg)		Group III (115-120 kg)	
	castrates, n=12	pigs, n=18	castrates, n=24	pigs, n=6	castrates, n=12	pigs, n=8
X_1, mm	37.7±1.5	36.4±0.9	42.3±0.8	42.2±3.5	49.0±2.3	45.4±2.5
X_2, mm	21.1±1.2	20.1±1.1	25.6±0.5	24.8±1.8	30.4±1.6	27.1±1.4
X_3, mm	17.3±1.6	14.6±1.2	18.4±0.8	16.3±1.6	20.6±0.8	17.8±1.8
X_4, mm	16.5±1.0	15.7±0.8	18.8±0.6	22.0±1.2[1]	20.8±1.2	22.9±2.5
M_1, mm	47.0±1.4	46.6±1.5	46.9±1.2	47.8±2.2	53.0±1.3	51.6±2.2

Note: [1] - $P < 0.05$; Source: Own calculations.

The results obtained are confirmed by studies by (Oliveira at al. 2015) [18], which also showed an increase in the thickness of the fat with increasing carcass weight.

Castrated animals had a greater thickness of lard at three measuring points. They predominated pig carcasses from 0.1 to 3.6 mm in fat thickness over the first thoracic vertebra; from 0.8 to 3.3 mm - over 6/7 thoracic vertebrae; from 2.1 to 2.8 - above the buttocks. This trend has been observed by other researchers (Bahelka at al., 2007, Tischendorf at al., 2002) [1, 20]. At the same time, (Mohrmann at al., 2006) [17] found no significant differences between the genders.

However, the measurements made by the Fat-o-Meat'er S71 give slightly different information. Thus, pigs had a smaller fat thickness only in the first group, in the other two they were worse than castrates by 3.2 mm (group II) and 2.1 mm (group III). In terms of MLD thickness, castrates predominated in the first and third groups, by 0.4 and 1.4 mm, respectively.

It is obvious that despite the increase in the absolute mass of valuable parts of the carcass with increasing pre-slaughter live weight, their ratio (%) does not change significantly (Table 3).

Table 3. Weight and proportion of valuable parts of the carcass

Indicators	Group I (85-95 kg)		Group II (100-110 kg)		Group III (115-120 kg)	
	castrates, n=12	pigs, n=18	castrates, n=24	pigs, n=6	castrates, n=12	pigs, n=8
Cutting, kg	0.9±0.02	0.9±0.02[2]	1.1±0.03	1.1±0.04	1.3±0.03	1.3±0.03[1]
%	1.5±0.03	1.6±0.03	1.4±0.03	1.5±0.05	1.5±0.03	1.5±0.04
Neck, kg	3.6±0.10	3.6±0.07	3.9±0.09	4.2±0.29	4.4±0.10	4.7±0.13
%	5.9±0.17	5.7±0.10	5.2±0.10	5.3±0.12	5.2±0.09	5.4±0.17
Shoulder, kg	7.4±0.19	7.3±0.17	8.7±0.13	9.4±0.22	10.4±0.20	11.2±0.36
%	11.9±0.15	11.7±0.19	11.5±0.11	12.1±0.11	12.3±0.22	12.7±0.30
Loin, kg	4.3±0.14	4.5±0.10	5.0±0.13	5.4±0.15	5.6±0.16	6.5±0.19
%	6.9±0.19	7.1±0.14	6.6±0.13	6.9±0.20	6.6±0.16	7.4±0.18
Belly, kg	5.1±0.12	4.9±0.11	5.9±0.10	5.8±0.18	7.0±0.14	7.0±0.16
%	8.2±0.13	7.9±0.19	7.9±0.12	7.4±0.13	8.3±0.16	7.9±0.14
Ham meat, kg	14.7±0.40	15.3±0.22	17.3±0.29	18.2±0.24	19.2±0.25	20.6±0.32
%	23.7±0.38	24.4±0.31	22.9±0.21	23.4±0.24	22.7±0.26	23.4±0.34

[1] – p<0,05; [2] – p<0,01; Source: Own calculations.

In particular, although the mass of the shoulder in castrates of group I was significantly less than the mass of the shoulder in castrates of group III (7.4±0.19 kg and 10.4±0.20 kg, respectively), its mass fraction did not actually change 11.9% and 12.3%). Such results are confirmed by other researchers (Martin at al., 1980) [15], who claim that the yield of valuable parts of the carcass is influenced more by breed and gender than the weight of animals before slaughter (Fortin, 1980) [7].

The weight of tenderloin, neck, shoulder, loin and ham was higher in pig carcasses. In the carcasses of castrates was only a large proportion of belly. These results are confirmed by other studies. In particular, it was found that pigs significantly outnumber castrates by muscle mass of the four main cuts (shoulder blades, loins, belly and ham) - 57.68 against 52.77%, respectively (Bahelka et al., 2007) [1]. The analysis of the morphological composition of the carcass showed a gradual increase in meat content with increasing pre-slaughter live weight (Table 4). The highest rates were obtained at the slaughter of pigs of group III (castrates 68.6%, pigs 71.0%). At the same time, in some studies (Hugo at al., 2015) [13], opposite results were obtained, which show that lighter pigs had a significantly higher content of lean meat compared to heavier ones.

Table 4. Total weight and proportion of meat, fat and bones

Indicators	Group I (85-95 kg)		Group II (100-110 kg)		Group III (115-120 kg)	
	castrates, n=12	pigs, n=18	castrates, n=24	pigs, n=6	castrates, n=12	pigs, n=8
Meat, kg	41.4±0.88	43.7±0.75	51.6±0.77	54.6±0.88[1]	58.2±0.57	62.5±0.97[3]
%	67.0±0.58	69.6±0.53[2]	68.5±0.35	70.1±0.26[3]	68.6±0.34	71.0±0.59[2]
Fat, kg	13.7±0.47	12.6±0.32	16.4±0.27	15.9±0.60	18.9±0.39	17.2±0.65[1]
%	22.2±0.59	20.1±0.44[1]	21.8±0.34	20.5±0.50[1]	22.3±0.40	19.6±0.67[2]
Bones, kg	6.7±0.10	6.4±0.09	7.3±0.09	7.3±0.14	7.8±0.14	8.3±0.13[1]
%	10.8±0.18	10.3±0.19[2]	9.7±0.11	9.4±0.28	9.2±0.19	9.4±0.16

[1] – p<0,05; [2] – p<0,01; [3] – p<0,001; Source: Own calculations.

A comparison of the carcasses of castrates and pigs shows a higher content of meat in the carcasses obtained from pigs at slaughter in all weight categories. Thus, the difference in group I was 2.6% (P <0.01), in group II - 1.6% (P <0.001), in group III - 2.4% (P <0.01). In the carcasses of all weight groups obtained from pigs, a lower fat content was found, which coincides with the results of other researchers (Povod at al., 2018) [19].

CONCLUSIONS

In terms of industrial production in Ukraine, it is advisable to slaughter animals of high weight (over 115 kg), which will increase the slaughter yield by 1.8% and 1.6% in pigs and neutered, respectively. It is important to consider the sex of the animals, as the carcasses of pigs had a higher yield of meat compared to the carcasses of castrates in all weight groups by 1.6-2.6%. As the ante-mortem mass of animals increases, the mass of valuable parts of the carcass increases, although their relative share in the carcass does not actually change.

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