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SEASONAL DEPENDENCE OF THE PRODUCTIVITY OF IRISH ORIGINS SOWS FROM THE TYPE OF MICROCLIMATE SYSTEMS IN THE FARROWING ROOM

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Abstract

The aim of the article was to compare the annual dynamics of reproductive qualities of Irish origin sows during keeping them in farrowing rooms with different valve and geothermal microclimate systems. It was found that the number of piglets at weaning, which were kept in geothermal microclimate systems, outnumbered peers kept under classical ventilation by 0.37 goals or 2.98% (p <0.05) in winter, by 0.63 goals or 5.08% (p <0.05) in spring, by 0.58 goals or 4.73% (p <0.05) in autumn and by weight of the nest of piglets when weaned by 3.92 kg or 5.85% (p <0.01) in winter months, by 5.90 kg or 8.44% (p <0.001) in spring months, by 4.13 kg or 6.35% (p <0.01) in summer months and by 4.37 kg or 652% (p <0.01) in autumn months. During the autumn, the predominance of pigs kept in the geothermal microclimate system was found over the analogues kept in the valve system in terms of preservation by 4.27% (p <0.05). In terms of absolute, average daily and relative growth of piglets growing in farrowing room with different ventilation had no significant difference during the year.

Key words**:** *sow, stillbirths piglet, type of ventilation, growth intensity, weight of one head, safety of piglets*

INTRODUCTION

More efficient pork production requires close control of all factors that may affect its productivity. The microclimate on pig farms is one of these factors, as a proper ventilation system will have a positive impact on animal welfare and farm profitability [4, 24].
Pigs are extremely sensitive to ambient temperature. When it is too cold and the pigs have to use the energy they get from the food to keep warm. This means that they will not grow as well as they could. Meanwhile, excess heat suppresses appetite and air quality deteriorates, making animals more susceptible to disease. To reach the peak state, pigs need the appropriate comfort temperature [8, 18].
The ideal humidity for a pigsty is 60% to 75% (RH). Too dry air can damage the mucous membranes of pigs' noses and increase the risk of infection. At the same time, excess moisture creates ideal conditions for the spread of pathogens in water droplets [9].
The main elements that create the microclimate in the room for farrowing sows are air temperature, relative humidity and air velocity, as well as the concentration of harmful gases and other pollutants. The building's lighting and sun exposure are also important [1, 13].

In an intensive pig farming system, a mechanical ventilation system seems to be key to providing a heat-neutral zone for sows and piglets, especially in the warm season [11, 27]. In countries with hotter climates, farrowing facilities with side canopies are more comfortable for keeping pigs [19, 23]. This type of building provides natural through ventilation. However, rising global temperatures are a matter of global concern and require new methods and additional technologies to improve the cooling of animals in summer. Heat stress conditions are a major factor influencing animal health and productivity, especially in modern genetic lines [5, 21].

There are various modifications of the microclimate system that can improve heat transfer in pigs. Some systems can cause a decrease in room temperature for farrowing or direct cooling of the skin of sows and piglets. Most microclimate systems use the effect of water evaporation: fogging, spraying, evaporating gaskets, drip cooling. Heat loss by pigs in the heat can also be improved by using methods that improve convection or conductive heat transfer. Breeding pig farms often used technologies based on increasing air velocity, such as zonal cooling and tunnel ventilation [2, 26]. In particular, for sows kept separately during pregnancy or lactation, increased conductive heat transfer using floor cooling technologies can also help mitigate the effects of heat stress [10, 22].

Changes in animal physiology, behavior, and productivity have been widely considered as indicators of animal welfare. They were often taken into account together with the monitoring of microclimate parameters, primarily temperature, humidity and gas composition [3, 6, 17].

It is known that during farrowing the number of live piglets decreased ($P < 0.05$) and stillbirths increased with increasing humidity of the pigsty ($P < 0.001$). There was also a decrease in the number of weaned piglets when humidity was increased during the weaning period ($P < 0.05$), but mortality before weaning was not affected ($P > 0.05$) [28].

An increase in farrowing room temperature can significantly increase the concentration of NH_3. Recent studies have shown that even minimal exposure to ammonia can be harmful. For example, pigs exposed to 50 parts per million of ammonia for four minutes only four times a day had reduced productivity and reduced live weight gain (37 to 90 kg) [20, 29]. In addition, ammonia can seriously affect respiratory health and slow down puberty, even at a low level of 20 parts per million [7].

Chronic hypoxia, depression, loss of appetite, weight gain, weakness, and increased susceptibility to infection may occur in piggeries with too high a CO_2 content and oxygen deficiency over a long period of time [12, 31, 32].

Hydrogen sulfide emissions from livestock systems affect not only pig productivity but also local and regional air quality [30]. The results showed that the effect of hydrogen sulfide reduced the average daily gain, average daily feed intake and increased the incidence of diarrhea in piglets. Hydrogen sulfide can increase the number and diversity of intestinal microorganisms. Hydrogen sulfide disrupts growth productivity and destroys the balance of microbial bacteria in weaned pigs [6].

Recent studies have shown that the content of H_2S in the pigsty increases the severity of respiratory distress and lung pathology associated with influenza A-type pathogens in pigs [25].

In our previous studies, no patterns were found for the total number of piglets born, the number of piglets born alive, the weight of piglets born, the nest weight of piglets at birth and the number of piglets weaned from sows kept during suckling in farrowing rooms with valve ventilation and geothermal ventilation type. However, the effect of geothermal ventilation resulted in a significant excess of 6.83-8.37% of the weight of one piglet at weaning and 6.26-8.37% of the nest weight at weaning compared to the effect of valve-type ventilation [15]. We also found earlier that no significant difference between the indicators of absolute, average daily and relative growth of piglets kept under different microclimate maintenance systems during the year was found. This is due to the weak influence of the type of ventilation factor on the growth intensity in the range of 7.71-10.20% [16].

Thus, due to the differing views of scientists on the problem of the impact of the microclimate system on the reproductive qualities of sows and the intensity of growth of piglets before weaning, the study of this issue remains relevant today.

The aim of the article is to study the influence of geothermal and valve systems of the microclimate on the reproductive performance of Irish origin pigs in the farrowing rooms of industrial pig complex.

MATERIALS AND METHODS

In order to achieve the objectives of the study, a scientific experiment was set up on the basis of the pig industrial complex LLC "Globinsky Pig Complex", Globinsky district, Poltava region.

In the process of setting the tasks of the experiment, the object of research was determined by the influence of the ventilation system in the farrowing room on the reproductive characteristics of F_1 sows of the maternal line Hermitage Genetics. At the same time, the material for the experiment was generalized data on sows reproductive qualities collected during the calendar year separately for each season. The experimental sows were formed into two separate technological groups, after which they were inseminated with sperm of boars of the synthetic Maxgro line, according to the hybridization scheme of the mentioned pig complex.

The process of studying the reproductive qualities of pigs was based on statistical and analytical analysis of the results of farrowing of two groups of sows during 2019-2021. Sows and piglets were kept in identical farrowing rooms, which differed only in the technical characteristics of the microclimate systems. Sows with piglets of both groups were kept in the premises for farrowing of the breeder №1 LLC "Globinsky Pig Complex", equipped with ventilation equipment from Big Dutchman. The pigs of the I-control group were kept in farrowing rooms equipped with ventilation, where the inflow of air was carried out through supply valves located on both sides of the section. At the same time, pigs of the II-experimental group were kept in a farrowing room of similar planning, but with a different system of preparation and supply of air to the area of animal activity.

The farrowing room, which was equipped with a fairly common negative pressure microclimate system, equipped with air intake valves for air intake and exhaust roof fans for its release, was installed as a control in the experiment and pigs kept there are formed in the first control group (Fig. 1).

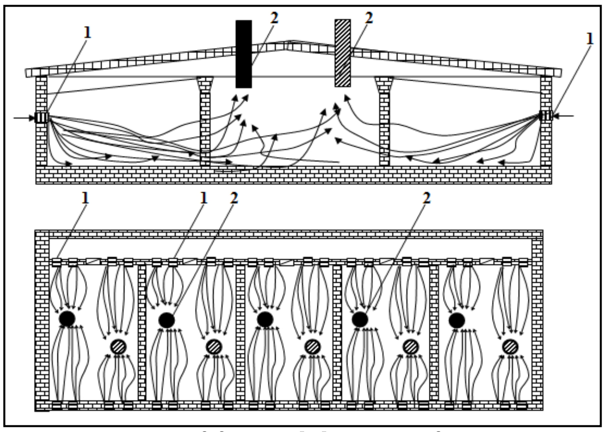

Fig. 1. Location of fans and direction of air movement in the section according to the valve system of microclimate in the farrowing room (I control group)
1 - supply valve; 2 - exhaust shaft.
Source: Own determination.

The operation of intake and exhaust elements of the control farrowing room was regulated by the software control module of the microclimate system, which performs general control of air movement and analyzes its temperature and gas parameters. It was equipped with automatic emergency stop sensors, light and sound warning devices to prevent abnormal ventilation. During the warm seasons of the year, the flow of outside air was directed directly to the area of activity of sows and piglets. And in the cold season, the outside air was directed first to the radiators of the heating system to first raise its temperature and then moved around the farrowing room. At the same time, heated and exhaust air was removed from the farrowing room by exhaust fans of roof shafts.

The farrowing room where the geothermal negative pressure microclimate system was installed has been established as experimental in the study and the pigs kept there were formed into the second experimental group (Fig. 2).

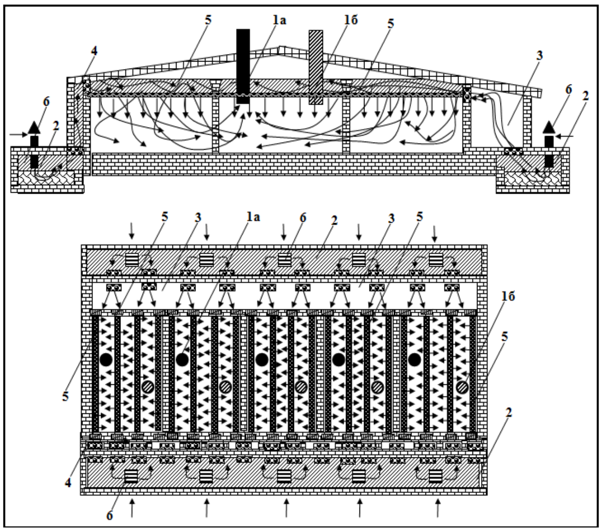

Fig. 2 Location of fans and direction of air movement under geothermal ventilation in the section of the farrowing room (II experimental group)
1a, 1b - exhaust shafts; 2 - underground tunnels; 3 - technological corridor; 4 - transverse air duct; 5 - under-ceiling supply air ducts; 6 - intake shafts.
Source: Own determination.

In contrast to the classical ventilation, equipped with supply valves, a negative pressure microclimate system with pre-treatment of air in underground external and subfloor tunnels and technological corridors of the section was used in the experimental room for farrowing.
The air was distributed through perforated air ducts located under the ceiling above the sow farrowing machines. Due to the vacuum created by the exhaust roof shafts, the outside air was drawn into the farrowing room through underground deep tunnels filled with stones.
Then the air moved through air ducts located on both sides of the room, going to the perforated channels-distributors, which are located above the individual pens for farrowing sows. Such a system was controlled by the Big Dutchman control module.
During the experiment, participants followed the rules of humane treatment of animals.

RESULTS AND DISCUSSIONS

Evaluation of the results of the study revealed that during the winter season there was no significant difference in such indicators of sow productivity as the number of piglets at birth, the number and proportion of stillborn piglets, the number of live piglets, the nest weight of piglets at birth, the weight of piglets at birth. However, it was found that the number of piglets at weaning, which were kept in geothermal microclimate systems, outnumbered peers kept under classical ventilation by 0.37 goals or 2.98% ($p < 0.05$) and by nest weight of piglets at weaning at 3.92 kg or 5.85% ($p < 0.01$). There was no statistically significant difference between the pigs of both groups in terms of safety, the weight of one head at weaning, the weight of the nest of piglets at weaning between the livestock of both groups (Table 1).

Table 1. Reproductive qualities of sows depending on the design features of the ventilation system during the winter season, n = 475

Indicators	Control group	Experimental group
The total number of piglets at birth, heads	15.37±1.03	15.51±0.33
Number of stillborn piglets, heads	0.90±0.22	1.12±0.19
Proportion of stillborn piglets,%	5.81±1.04	7.19±1.08
Number of piglets born alive, heads	14.46±0.83	14.39±0.18
The weight of the nest of piglets at birth, kg	18.70±1.03	18.47±0.25
Weight of piglets at birth, kg	1.29±0.01	1.28±0.01
Number of piglets at weaning, heads	12.41±0.09	12.78±0.14[1]
Preservation of piglets,%	85.82±2.40	88.85±1.68
Weight of 1 head at weaning, kg	5.40±0.21	5.55±0.21
The weight of the nest of piglets at weaning, kg	67.01±1.01	70.93±1.02[2]
Absolute gain, kg	4.11±0.21	4.27±0.21
Average daily gain, g	147±0.01	153±0.01
Relative increase,%	122.87±2.33	125.04±2.39

[1] – $P < 0.05$; [2] – $P < 0.01$; [3] – $P < 0.001$.
Source: Own calculation.

There was also no statistically significant difference in absolute, average daily and relative growth rates between piglets kept under different types of ventilation during the winter.

The study of reproductive qualities of Irish origin pigs in the spring season revealed no significant difference between animals kept in valve and geothermal microclimate systems in terms of number of piglets at birth, number of stillborn piglets, proportion of stillborn piglets, number of piglets born alive weight of piglets at birth, safety of piglets, weight of 1 head at weaning.

Table 2. Reproductive qualities of sows depending on the design features of the ventilation system during the spring season, n = 475

Indicators	Control group	Experimental group
The total number of piglets at birth, heads	15.30±0.36	15.27±0.31
Number of stillborn piglets, heads	1.27±0.35	1.00±0.67
Proportion of stillborn piglets,%	8.36±2.36	6.60±0.67
Number of piglets born alive, heads	14.04±0.55	14.26±0.33
The weight of the nest of piglets at birth, kg	18.71±0.43	19.00±0.09
Weight of piglets at birth, kg	1.33±0.03	1.33±0.03
Number of piglets at weaning, heads	12.40±0.19	13.03±0.21[1]
Preservation of piglets,%	88.31±3.33	91.37±0.98
Weight of 1 head at weaning, kg	5.64±0.37	5.82±0.20
The weight of the nest of piglets at weaning, kg	69.93±1.28	75.83±1.25[3]
Absolute gain, kg	4.31±0.11	4.49±0.09
Average daily gain, g	154±0.01	160±0.01
Relative increase,%	123.67±0.40	125.59±1.35

[1] – $P < 0.05$; [2] – $P < 0.01$; [3] – $P < 0.001$.
Source: Own calculation.

There was a significant advantage of pigs kept with the microclimate system of the experimental type over peers kept in farrowing rooms with the microclimate system of the valve type by the number of piglets at weaning at 0.63 goals or 5.08% (p <0.05) and the weight of the nest of piglets at weaning at 5.90 kg or 8.44% (p <0.001) (Table 2).

The difference in absolute, average daily and relative growth rates during the spring season was not statistically significant between piglets kept using different types of microclimate systems in the farrowing room.

Analysis of reproductive performance of pigs kept under different microclimate systems during the summer season showed that they had no significant differences between animals of both groups in number of piglets at birth, in number and proportion of stillborn piglets, in number of live piglets, in nest weight at birth, in the weight of piglets at birth, by number of piglets at weaning.

Table 3. Reproductive qualities of sows depending on the design features of the ventilation system during the summer season, n = 475

Indicators	Control group	Experimental group
The total number of piglets at birth, heads	15.56±1.06	15.32±0.74
Number of stillborn piglets, heads	1.07±0.35	0.86±0.08
Proportion of stillborn piglets,%	6.72±1.82	5.59±0.25
Number of piglets born alive, heads	14.49±0.71	14.46±0.66
The weight of the nest of piglets at birth, kg	18.8±1.57	18.66±1.00
Weight of piglets at birth, kg	1.3±0.05	1.29±0.01
Number of piglets at weaning, heads	12.32±0.77	12.83±0.75
Preservation of piglets,%	86.39±1.36	88.75±0.45
Weight of 1 head at weaning, kg	5.28±0.15	5.39±0.08
The weight of the nest of piglets at weaning, kg	65.04±1.17	69.17±1.28[2]
Absolute gain, kg	3.98±0.11	4.10±0.09
Average daily gain, g	0.142±0.01	0.146±0.01
Relative increase,%	120.97±0.40	122.75±1.35

[1] – $P < 0.05$; [2] – $P < 0.01$; [3] – $P < 0.001$.
Source: Own calculation.

It was found that sows that farrowed in a farrowing room with a geothermal type of microclimate system had a significantly higher nest weight of piglets at weaning by 4.13 kg or 6.35% (p <0.01) than their counterparts, which were placed in farrowing rooms with a valve type of ventilation (Table 3).

During the summer season, no statistically significant difference between the piglets of the control and experimental groups in terms of absolute, average daily and relative growth was found.

A study of sow productivity during the autumn months found that the type of microclimate system did not significantly affect such indicators as the number of piglets at birth, the number and proportion of stillborn piglets, the number of live piglets, the nest weight of piglets at birth, the weight of piglets at birth in pigs of both groups.

Table 4. Reproductive qualities of sows depending on the design features of the ventilation system during the autumn season, n = 475

Indicators	Control group	Experimental group
The total number of piglets at birth, heads	15.51±1.03	15.49±0.36
Number of stillborn piglets, heads	0.89±0.23	0.92±0.03
Proportion of stillborn piglets,%	5.66±1.16	5.97±0.19
Number of piglets born alive, heads	14.62±0.86	14.57±0.35
The weight of the nest of piglets at birth, kg	18.71±1.03	18.74±0.50
Weight of piglets at birth, kg	1.28±0.02	1.29±0.01
Number of piglets at weaning, heads	12.26±0.20	12.84±0.09[1]
Preservation of piglets,%	83.86±1.31	88.13±1.18[1]
Weight of 1 head at weaning, kg	5.47±0.24	5.56±0.13
The weight of the nest of piglets at weaning, kg	67.02±1.20	71.39±1.18[2]
Absolute gain, kg	4.19±0.25	4.27±0.13
Average daily gain, g	0.150±0.01	0.153±0.01
Relative increase,%	124.15±3.26	124.67±1.57

[1] – P < 0.05; [2] – P < 0.01; [3] – P <0.001.
Source: Own calculation.

However, it was found that sows of the experimental group outperformed analogues from the control group in terms of the number of piglets at weaning by 0.58 goals or 4.73% (p <0.05), according to the preservation indicator by 4.27% (p <0.05), according to the weight of the nest of piglets at weaning by 4.37 kg or 652% (p <0.01) (Table 4).

During the autumn season, no significant difference was found between the growth intensity of piglets kept under geothermal ventilation and valve ventilation in terms of absolute, average daily and relative growth.

The study of the annual dynamics of the total number of piglets revealed its tendency to increase from winter to autumn in the control group and to decrease during spring and summer in the experimental group (Fig. 3).

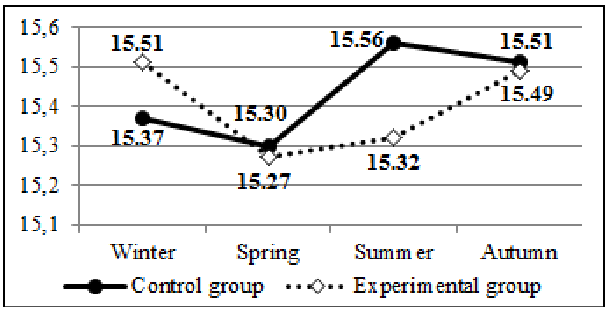

Fig. 3. Annual dynamics of the total number of piglets at birth
Source: Own determination.

Control of the annual dynamics of the number of piglets born alive showed that there was no significant difference between its seasonal indicators in pigs kept under valve ventilation and kept under geothermal ventilation (Fig. 4).

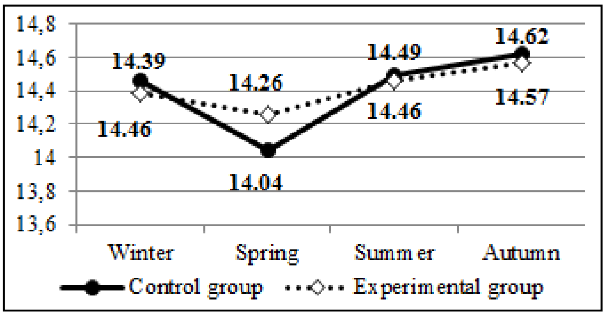

Fig. 4. Annual dynamics of the number of piglets born alive
Source: Own determination.

Evaluation of the annual dynamics of piglet preservation revealed no statistically significant difference between its values during each season in the population of both experimental groups of pigs. We can note only the tendency to a slight increase in the spring in animals in both groups (Fig. 5).

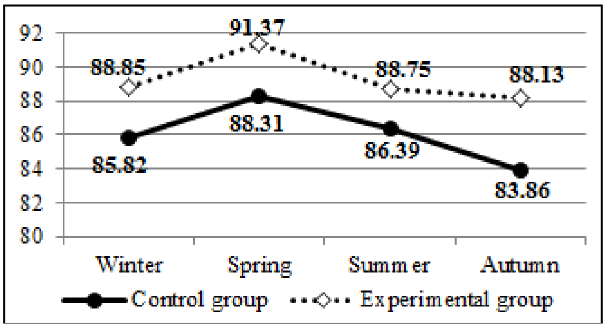

Fig. 5. Annual dynamics of piglets preservation
Source: Own determination.

After analyzing the annual dynamics of the number of weaned piglets, we found only a tendency to decrease during the season for sows kept under valve system of the microclimate, and for analogues kept under geothermal ventilation (Fig. 6).

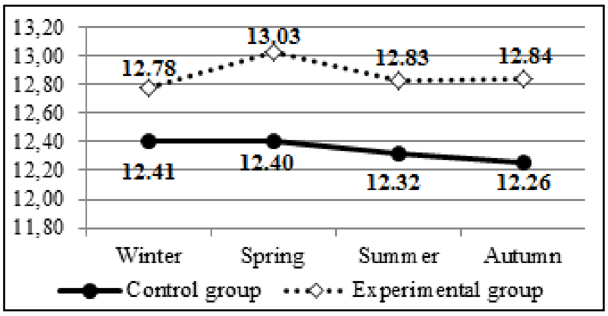

Fig. 6. Annual dynamics of the number of weaned piglets
Source: Own determination.

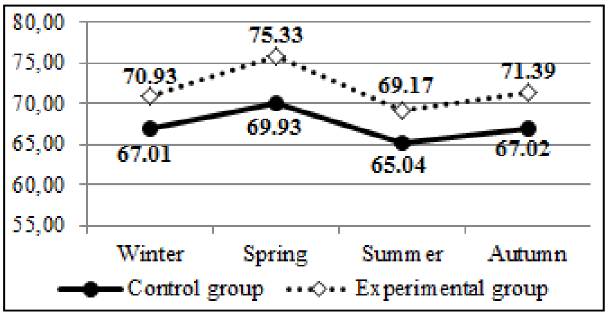

Fig. 7. Annual dynamics of the nest weight of piglets at weaning
Source: Own determination.

Analysis of the annual dynamics of the nest weight of piglets at weaning revealed the absence of a significant difference between its indicators during the year in piglets of the I-control group. At the same time, it was found that the nest weight of piglets was 4.90 kg or 6.91% ($p < 0.01$) higher than in winter, and there was no significant difference between the indicators of piglets of the II experimental group during other seasons (Fig. 7).

The study of the annual dynamics of the average weight of 1 head at weaning made it possible to establish the absence of a statistically significant difference between seasonal fluctuations of the indicator during the study period in piglets of both groups (Fig. 8).

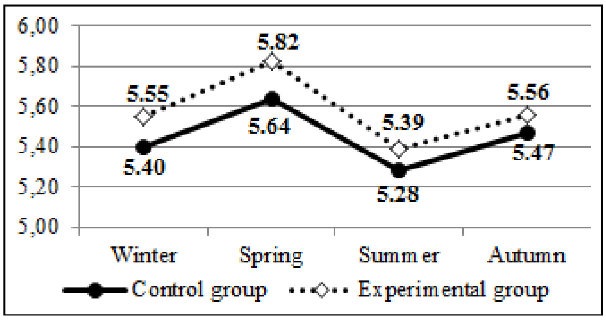

Fig. 8. Annual dynamics of the average weight of 1 head at weaning
Source: Own determination.

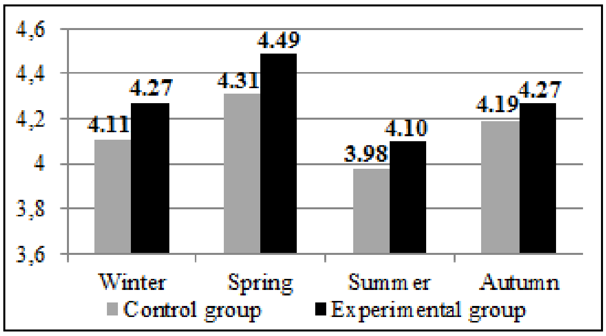

Fig. 9. Annual dynamics of absolute growth of piglets
Source: Own determination.

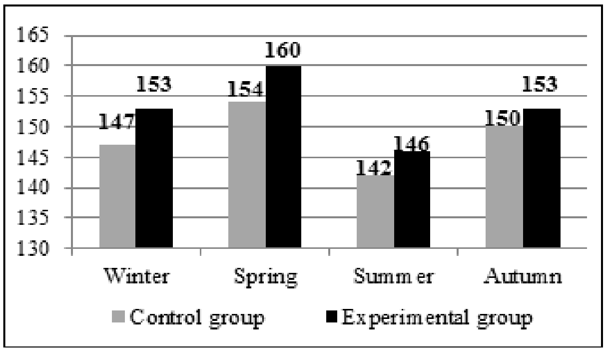

Fig. 10. Annual dynamics of average daily growth of piglets
Source: Own determination.

The study of the annual dynamics of absolute, average daily and relative growth showed that there was no significant difference between the seasonal values of both groups of pigs kept in the valve and pigs kept in experimental ventilation during the year (Fig. 9, 10, 11).

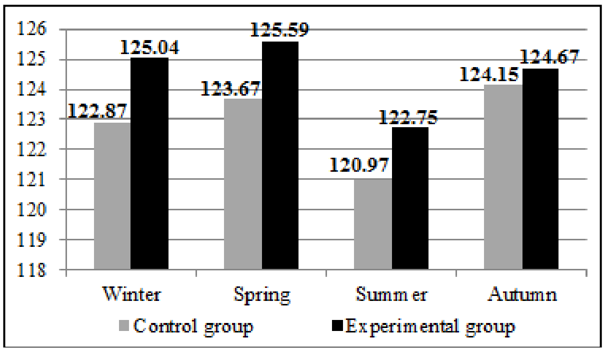

Fig. 11. Annual dynamics of relative growth of piglets
Source: Own determination.

Our studies did not coincide with other reports [29], which indicated an increase in the number of stillborn piglets with increasing humidity in the spring and autumn seasons in the survey premises (P <0.001). We did not find such a dependence and during the spring and autumn we did not notice a significant change in the number or proportion of stillborn piglets. We also did not observe a decrease in the number of weaned piglets during the usually wetter spring season during the weaning period, as noted in these scientific studies [29].

The results of our previous studies on the lack of influence of the type of ventilation on the growth rate of piglets was confirmed by the current experiment. We did not receive statistically significant confirmation that the type of ventilation affected the absolute, average daily and relative growth both in terms of groups and during individual seasons [16].

The results of the study did not coincide with our previous conclusions about the effect of geothermal ventilation on the growth of 6.83-8.37% of the weight of one piglet and 6.26-8.37% of the nest weight at weaning [17]. We found the effect of geothermal ventilation on other indicators of reproductive qualities of pigs, namely: to increase the number of piglets at weaning and to increase the nest weight of piglets at weaning in winter, spring and summer, and in autumn – in addition to increasing preservation.

We found the dependence of the nest weight of piglets when weaned from the ventilation system of the premises makes this figure higher when keeping pigs in the farrowing room with a geothermal ventilation system by 5.85-8.44%, which coincides with the another conclusions [14], which indicates an 11.00% excess of the nest weight of piglets for keeping using geothermal type of ventilation compared to the valve.

CONCLUSIONS

It was found that when keeping pigs in farrowing rooms equipped with geothermal type of microclimate system such indicators as the number of piglets at weaning and the nest weight of piglets at weaning were significantly higher than their counterparts kept in the valve system of microclimate in all seasons.

The annual dynamics of reproductive quality of pigs in both sows kept under valve ventilation and sows kept under the geothermal ventilation had no statistically significant seasonal differences.

The type of microclimate system did not affect the intensity of growth of piglets in terms of technological features of ventilation equipment or method of preparation and supply of air to the area of animals activity, nor in terms of seasons.

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