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ORIGINAL ARTICLE

Influence of farm conditions on sows' morphological blood indicators

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The article summarizes the influence of farm conditions on sows blood morphological parameters. Our research was carried out in the farms of Zolochiv and Starosambir districts of the Lviv region (Ukraine) and revealed strong violations of animals feeding, both in terms of nutrition, and on the macro- and microelement composition. In all the farms, there was practically no appropriate way to feeding sows from different physiological groups, which may further adversely affect the growth and development of the resulting offspring. The parameters of the microclimate in the premises were invested in the limits of permissible norms. The differences between farms were production process and pigs keeping. Animals of the Zolochiv region were not registered and had the opportunity to move freely, to nest before the farrowing, to satisfy their physiological needs for food search (to dig, to throw the bedding), without barriers to consume food and water. In the farm of the Starosambir district the sows were kept in individual fixing machines, they were restricted in movement, free choice of place for rest, manifestation of natural behavior, the ability to satisfy the instinct of nesting and show the instinct of caring for the offspring. Free holding of sows have a positive effect on the processes of hematopoiesis. The blood of these animals had more red blood cells and the hemoglobin concentration was higher. It was also proved that the most susceptible to the conditions of containment were farrowing sows from both farms, as evidenced by the morphological indices of blood. Thus, the number of erythrocytes, hemoglobin concentration, hematocrit magnitude and red blood indices in animals of this physiological group are recorded at the lower limit of the physiological norm.

Keywords: Sows; Physiological condition; Conditions of maintenance; Micro-climate; Feeding conditions; Morphological parameters of blood; Rate of erythrocyte sedimentation.

Introduction

Pig-breeding is one of the most profitable branches of animal husbandry, in Ukraine it has always been and will remain traditional, which provides the consumer with the necessary high-quality and relatively inexpensive food. Pig-breeding is constantly evolving and improving. In most cases it is either industrial intensive technology or small farms. However, current conditions of keeping and advanced technology in pig breeding usually do not take into account the biological needs and ethological features of this species of animals. The most reasonable assessment of the biological conformance of the conditions of maintenance to the requirements of the organism is its reproductive capacity throughout life (Demchuk & Kozenko, 2008; Hunchak et al., 2018; Khalak et al., 2020; Martyshuk et al., 2020). Due to the influence of the conditions of pigs keeping far from the natural needs, changes in their organism occur, which negatively affects both its functional state and the quality of products (Voloshchuk & Gryshchenko, 2014; Bogachyk et al., 2015). A considerable number of scientists, specialists of this particular branch believe that the search of morphological parameters and the chemical picture of blood is very important in the life of pigs. It is generally accepted that there is a close connection between some morphological, biochemical indicators of blood and productivity: pigs with more intense growth have an increase in the index of total protein, hemoglobin, the number of red blood cells. It was established the correlation between blood groups, activity of ALT and AST enzymes and pig growth energy (Malina et al., 2013; Zasuha et al., 2006; Krempa, 2018; Zhurenko et al., 2018). The search of the dynamics of interior features, combined with a variety of factors, both exogenous and endogenous, helps to obtain an objective assessment of the health of these animals.

Blood, like a liquid tissue, has direct contact with all organs and tissues of the body. Thanks to it, supplies to organs and tissues of vital substances and oxygen are carried out, derived from them waste products of exchange (Slivinska et al., 2018; 2019; Brygadyrenko et al., 2019; Lesyk et al., 2020; Mazur et al., 2020). While maintaining the stability of its composition, blood is a fairly labile system that quickly reflects the changes occurring in the body, both in normal and in pathology (Gutyj et al., 2017; 2018; 2019). Under unfavorable conditions of maintenance and action of environmental factors, there are changes in its morphological, immunological and biochemical composition, which serves as a diagnostic material for controlling changes in cellular and humoral immunity (Khariv et al., 2017; Holovakha et al., 2018; Shcherbatyy et al., 2019).

The purpose of our work was to search and analyze the influence of the conditions of keeping and operation of sows of different physiological groups of morphological indices of their blood.

Material and Methods

The research was performed in the farms of Zolochiv and Starosambir districts (Lviv region, Ukraine) during the summer and

transitional periods. In both farms we and analyzed the conditions for the maintenance of the blank, piglets and suckling (sucking) sows, microclimatic indices and level and mode of feeding. Blood was taken from animals before feeding from the ear vessels, following the rules of asepsis and antiseptics. In blood we determined the number of erythrocytes, hemoglobin content, hematocrit size according to generally accepted methods, we also calculated the indices of red blood (average red blood cells, color index) and the rate of erythrocyte sedimentation (Vlizlo et al., 2012).

Results and Discussion

The animals from Zolochiv farm gained over 100 kg for 240 days. Blank sow, both firstborn and sows of the main breed are kept in groups of 3-4 animals, in small sections. After insemination and confirmation of fertility, they are transferred into individual brick sections, where they are all the period of fertility and lactation. In these sections, the sows are provided with a clean and soft litter, which is systematically replaced, births and rearing of young animals before weaning at 28 days of age (single-phase retention) occur here. In such retention, sows have the opportunity to move freely in the section, to show their natural instincts: search for food (digging, dropping of litter, research and manipulation), nesting before the farrowing and caring for offspring, consume food and water as needed. Year-round farrowing, the frequency of which on average from one sow is 2.3 times a year is practicing at the farm.

The indicators of the microclimate indoors, where the sows were kept, mostly depended on the season. In summer, the air temperature was 23.7°C, with a relative humidity of 50.6% and, in fact, a complete lack of airspeed, only 0.07 m/s. In autumn, the room temperature was dropped to 10.2°C, with an increase in relative humidity to 82.04%, and an increase in air velocity to 0.11 m/s. In the presence of suckling piglets in the section local heating was used. Unfortunately, the ammonia content in the air was higher than the upper limit of 6 mg/m^3 in summer and 3.33 mg/m^3 in the transition period, indicating a violation of sanitary standards, which had a significant effect on the body of sows.

The conditions of sows feeding of this household want to be better. The feed is given twice a day, at the rate of 2.5 kg per day for blank sow, farrowing – 3 kg and a suckling – 5 kg. After analyzing the nutrition of ration for various physiological groups of sows, they found that they are not balanced, both in terms of nutrition and mineral and vitamin content. Thus, the blank sows received 4.7% of feed units more than they needed, while the exchange energy was provided only by 88.2% of the need, digested protein – by 74.4%, fiber – by 37.4%, calcium and phosphorus – by 14.2% and 31.3% respectively, and carotene by only 1%. A similar situation with the provision of micronutrients and vitamins, which was 50% of the need.

In the period of fertility, the feeding conditions were somewhat improved. The supply of fodder units made 131.6% and the exchange energy – 111.5%, while the digestible protein – 81.1%; cellulose – 58.4%; calcium and phosphorus – by 1.7 and 36.1% of the need, at full absence of carotene. Farrowing sows were only provided by trace minerals and vitamins by 60-65%.

In lactating sows, the diet was not balanced by any indicator. These animals were provided with fodder units only by 97.2% of the need; exchange energy – by 82.2%; digestible protein – by 65,5%; cellulose – by 69.2%; calcium and phosphorus – by 14.4% and 34.7%. It should be noted that in the main ration of this physiological group of animals there is carotene, though in small numbers, only 6.2% of the need. Availability of micronutrients and vitamins again amounted to 60-65% of the need. To reduce the negative influence of the feed factor on the farm, an additive feed mixture "Sano" (trace elements and vitamins) is used at a rate of 30 kg per tons of feed, for blank and farrowing sows and 50 kg – for lactated.

In the farm of Staryj Sambir region, an intensive pig breeding technology is practiced, and the pigs gained 120-130 kg for 225-230 days. Blank sows, both the firstborn and sows of the main breeding stock are kept in sections of 5-6 heads, and the farrowing pig and lactated – in individual machines with the fixation of the animal. Individual machines are provided with a benign litter.

The farm practices year-round farrowing, the frequency of which in average from one sow is 2.3 times a year.

The parameters of the microclimate in the premises, as well as in the previous economy, depended on the season. In summer, the air temperature was 23.07°C, with a relative humidity of 46.54%. In the transition period, the air temperature dropped to 13.44°C, and the relative humidity increased only by 11%.

The velocity of the air space was 0.12 m/s during the period of search. We revealed that the concentration of ammonia in all periods did not exceed the limit and amounted to 18.13 mg/m^3 in summer and 17.33 mg/m^3 in the transition period, indicating compliance with hygiene and sanitary standards in the economy.

We also registered that rations for various physiological groups of sows were unbalanced. No blank or farrowing or lactated sows did not receive 100% of the required nutrients. Accordingly, the provision of feed units was 85.6%; 93.55% and 76.14% of the need. A similar pattern we determined with exchange energy. The ensurance of blank sows was 86.58%; farrowing 95.55% and lactated 90.58%. The digestible protein of a blank sow were provided on 71.71%, farrowing - by 87.52% and lactating 77.53%. Calcium and phosphorus the main ration contained within the range of 14-17%, in the complete absence of carotene. The trace elements and vitamins of the sow of this farm were provided only within the limits of 30-90% of the need. Similarly to the Zolochiv district, the farm also uses an auxiliary feed mixture (vitamin-mineral premix for sows and buds), at a rate of 30 kg per ton of feed for blank and 35 kg for farrowing and lactated sows. Accordingly, the consumption of food by blank sow is 2.5 kg; farrowing – 2.6 kg, and lactating – 5.6 kg of feed per day.

During the entire period of fertility and during lactation, the sow is fixed in the machine. An animal can only stand, lie, have free access to water and feed, but cannot show its natural instincts of digging, food search and breeding, which is genetically enclosed. The pigs are weaned the same way as in the previous farm in 28 days, using three-phase retention, after which the sow is transported to the office for the blank sows.

Studying dynamics of morphological parameters of blood of sows during reproductive period, which are kept on farms with different technology, was found that in the blood of sows of the economy of Zolochiv district, the number of red blood cells was closer to the lower boundary of the physiological norm. The smallest number of animals in the first half of fertility was 6.54 T/l, which is 0.11 T/l less than the indices of blank sows. In the second half of fertility, the number of red blood cells in the sows increased by 0.12 T/l and amounted to 6.66 T/l. In lactating sows, this indices were the same as in the blank.

In all physiological periods, the concentration of hemoglobin was less than the lower limit of physiological norm. In blank sows this figure was lower by 10.13 g/l (Table 1).

Table 1. Dynamics of sows blood morphological parameters blood during reproductive cycle (Zolochiv farm).

Indexes		Blank sows	First half fertility sows	Second half fertility sows	Lactating sows
Erythrocytes, T/l		6.65 ± 0.21	6.54 ± 0.27	6.66 ± 0.48	6.65 ± 0.40
Hemoglobin, g/l		79.87 ± 6.58	49.54 ± 1.88	58.84 ± 5.09	81.97 ± 7.74
Hematocrit,%		38.06 ± 1,14	33.71 ± 0.82	33.35 ± 1.39	37.00 ± 0.92
KP, pg		36.74 ± 3.87	24.48 ± 1.43	27.1 ± 2.96	38.08 ± 4.08
AEV, мкм^3		74.79 ± 12.58	52.31 ± 2.88	51.41 ± 3.55	57.53 ± 3.75
ESR, мм	15 min.	1.16 ± 0.16	0.87 ± 0.19	1.66 ± 0.21	1.02 ± 1.95
	30 min.	2.25 ± 0.26	2.05 ± 0.41	3.57 ± 0.48	1.75 ± 0.25
	45 min.	2.88 ± 0.28	16.27 ± 2.53	11.06 ± 2.12	2.62 ± 0.33
	60 min.	5.62 ± 0.98	31.14 ± 7.02	20.14 ± 3.08	4.53 ± 0.50
	24 hours	50.0 ± 4.13	52.71 ± 3.14	47.42 ± 7.00	41.93 ± 3.33

In pregnant sows, the concentration of hemoglobin in the blood was decreased, so in the first half of fertility to 49.54 g/l, which is 40.46 g/l less than the lower limit of the physiological norm, and in the second half hemoglobin concentration was increased slightly in comparison with the previous period (by 9.3 g/l), but it was still lower than the lower limit of the physiological norm at 31.16 g/l. In lactated sows, this indicator was the highest and amounted to 81.97 g/l, but it also did not reach the lower limit of physiological norm. Analyzing the dynamics of the hematocrit value of the blood of blank and farrowing sows, it should be noted that in all periods it was lower than the lower limit of physiological norm. The tendency of decrease in accordance with the term of fertility it was established: the hematocrit of blank sows was 38.06%, with the onset of the first half of fertility was decreased by 4.35% and 4.71% in the second half of fertility. However, with the beginning of lactation, it grew again and amounted to 37.0%, which is 1.06% less than in the blank sows.

Calculating the indices of red blood, the changes of color index and average volume of red blood cells were analyzed. It was installed that the highest value of the color index was in the blood of lactating sows and amounted to 38.08 pg, which is 1.34 pg more compared to the blank sows. With the beginning of the first and second half of fertility, this indicator was decreased significantly and corresponded to values that are 12.26 pg and 9.64 pg less than the indices of the blank sows, respectively. It is worth mentioning that the CI in all physiological periods significantly exceeded the upper limit of physiological norm, an average of 5.48-19.08 pg. The index of the ESR was mainly in the framework of the physiological norm. It was the highest in blood samples of the blank sows -74.79 μm^3, which is 6.79 μm^3 greater than the upper limit of the physiological norm. In sows in the first and second half of fertility, this indicator has significantly decreased, but was within the normal range. Its insignificant growth was observed in lactating sows, which is 57.53 μm^3.

The results of the research show that, in 15 minutes after the reaction, the blood glucose levels in all sows, with the exception of sows of the first half of fertility, were larger than 1 mm. After 30 minutes from the beginning of the search, the sows blood of the second half of fertility – 3.57 mm – reached the highest value, which is 1.82 mm more than that blood indices of lactating sows, which was the lowest among all investigated samples. ESR of blank and sows of the first half of fertility were in fact at the same level – 2 mm. After 45 minutes, the sows indices of the first and second half of the fertility were 16.27 mm and 11.06 mm respectively, whereas in the lactating and blank sows this reaction was slowed down. In 60 minutes after setting the reaction, the blood indices of the sows of the first half of fertility were 3.5 times, and the second half of the fertility 2.2 times were exceeded the upper limit of the physiological norm. In lactating sows, exactly as in the blank, the ESR was slowed down. After 24 hours, the ESR indicators in blank and sows of the first half of fertility were the highest and amounted to 50.0 mm and 52.71 mm, respectively. With the approaching the end of fertility and the beginning of lactation, this indicator, as compared to the sows of the first half of fertility, was decreased by 5.29 mm and 10.78 mm and corresponded to 47.42 mm and 41.93 mm, respectively.

We determined that the number of erythrocytes in the blood of sows of all physiological groups was within the limits of the physiological norm. Sows of the second half of fertility were exceptions, in which this figure was 1.66 g/l less than the lower limit of physiological norm. Regarding the concentration of hemoglobin, this indicator only in the blank and lactated sows was invested in the limit of physiological norm. In the farrowing sows, this indicator was significantly decreased, almost twice, and was lower than the lower limit of the physiological norm at 48.77 g/l. After farrowing, in the lactated sow, this indices was increased to 107.3 g/l.

The hematocrit value, which did not fit into the limits of the physiological norm and was 2.25 – 6.39%, was also lower than the lower limit. Only in sows of the second half of fertility this indices was closer to the upper limit of the physiological norm and amounted to 41.5%.

High values of CI that exceed the limits of the physiological norm are noted in the blood of sows of all physiological groups, except for the sows of the first half of fertility. The highest color index was observed in the blood of lactated sows of 40.40 pg, which is 4.06 pg more than the indicator of the blank sows, which makes 36.34 pg. In the farrowing sows the decrease of this indicator was recorded for 19.26 pg in the first half of fertility and 6.98 pg in the second half of fertility respectively.

The indicators of the average volume of erythrocytes had the same values in the blood samples of the blank and lactated sows and amounted to 46.93 μm^3. In the sows of the first half of fertility, the lowest level of this indicator was 44.56 μm^3, while in the blood of sows of the second half of fertility it was increased more than twice and reached the highest value of 106.5 μm^3, which is 59.57 μm^3 more than in blank or lactated sows. This was also 38.5 mkm^3 more than the upper limit of the physiological norm (Table 2).

Table 2. Dynamics of sows blood morphological parameters during reproductive cycle (Staryj Sambir farm).

Indices		Blank sows	First half fertility sows	Second half fertility sows	Lactating sows
Erythrocytes, T/l		7.94 ± 0.36	7.62 ± 0.62	4.34 ± 0.35	7.80 ± 0.33
Hemoglobin, g/l		94.53 ± 5.0	41.23 ± 0.77	41.02 ± 4.99	107.3 ± 4.62
Hematocrit,%		36.75 ± 0.75	32.61 ± 0.74	41.5 ± 1.02	36.06 ± 0.84
KP, pg		36.34 ± 2.90	17.08 ± 1.35	29.36 ± 4.22	40.40 ± 2.48
AEV, μm^3		46.93 ± 2.27	44.56 ± 2.78	106.5 ± 8.58	46.93 ± 2.73
ESR, mm	15 min.	0.96 ± 0.20	0.65 ± 0.23	1.71 ± 0.35	1.08 ± 0.20
	30 min.	1.83 ± 0.33	2.63 ± 0.82	3.87 ± 0.47	1.83 ± 0.28
	45 min.	2.40 ± 0.41	35.38 ± 9.30	8.25 ± 0.74	2.72 ± 0.18
	60 min.	3.68 ± 0.42	37.66 ± 9.01	30.25 ± 6.16	4.50 ± 0.43
	24 hours	43.56 ± 3.92	62.44 ± 2.45	73.25 ± 1.58	41.68 ± 3.11

Analyzing the dynamics of ESR, we registered the highest indicators in sows of the second half of fertility 15 minutes after the start of the reaction – 1.71 mm. The ESR of lactated sows decreased by 0.63 mm, and it did not reach 1 mm in the blank and first half fertility sows. The ESR of first and second half fertility sows accelerated with the blank and lactated sows after 30 min. The highest ESR values was registered in the sows of second half of fertility – 3.87 mm; this was by 1.4 mmm lower in sows of the first half of fertility. We observed a tendency to increase the rate of erythrocytes sedimentation in the blood of sows of the first half of fertility after 45 min. The highest values were determined in the blood of the blank sows one hour after the initial setting of the ESR response. In sows of the first half of fertility it was 4.2 times, and the second half – 3.3 times higher than the upper limit of physiological norms. In the blood of blank and lactated sows, the ESR was within the limits of the physiological norm (3.68 mm and 4.50 mm respectively). The growth trend was continued and the highest rates were registered in sows of the first and second half of fertility (62.44 to 73.25 mm), while in the blank and lactated sows the ESR were 43.56 and 41.68 mm, respectively after 24 hours.

Conclusion

Our data indicated significant violations in animals' farm keeping. The most susceptible were sows during fertility, both at Zolochiv and Staryj Sambir farms. The most significant influence on sows' blood morphological parameters had unsatisfactory feeding conditions, namely unbalanced diets, in terms of nutrition, vitamin and mineral composition. Adopted in these households conditions of detention, in this case occupied a secondary place. In Zolochiv farm, the animals had an opportunity to move freely in space, to nest before the birth of the offspring, to satisfy their physiological needs for food search (to dig, to throw the bedding), without barriers to consume food and water. These animals had the number of red blood cells and hemoglobin concentration somewhat higher than sows from Staryj Sambir farms, where the situation was somewhat different. Those sows were limited in movement, had no free choice of place for rest, had limitations with natural behavior and, being in a fixed condition, were unable to satisfy the nesting instinct. These restrictions together with incomplete feeding caused the discomfort conditions. We believed that the welfare requirements must be fully considered for the sows as they are recognized as "sensitive creatures" according to the Agreement on the activities of the European Union animals. We should also like to underline that according to the EU directive: "... farrowing sows to satisfy hunger needs and satisfy the need for chewing, in addition to energy feeds, it is necessary to provide appropriate quality of volumetric and high fiber, feed."

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