

**Research Article****Physiological reaction of hemostasis in piglets to overheating**

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**ABSTRACT**

**Introduction:** Until now, pig breeding feels a serious need to continue obtaining additional knowledge on the physiology of pigs and piglets. It is of great interest to clarify aspects of the functioning of the body of piglets, taking into account the influence of environmental factors on it. A negative environmental impact can also have a very negative effect on the state of the hemostatic system. However, these changes are not evaluated in all cases.

**Objective:** to identify the dynamics of the activity of the hemostatic system in piglets who have experienced overheating.

**Material and methods:** A total of 42 pigs of the large white breed at the age of 2.5 months, which as a result of a malfunction of the air conditioning system during the summer period, overheated for 3 hours, were examined. The control group consisted of 32 healthy pigs in the standard conditions of the pigsty. In work hematologic and statistical methods of research are applied.

**Results:** In piglets subjected to overheating, increased activity of platelet aggregation was revealed spontaneous and stimulated. These piglets showed excessive activity of hemocoagulation and depression of fibrinolysis. There is no doubt that this adversely affects the hemorheology of their blood and can inhibit anabolism. It became clear that in the piglets that experienced overheating, there is an activation of the hemostasis system, which impairs the microcirculation processes and weakens their growth.

**Conclusion:** In this regard, there is a great need to search for options for correction in piglets that have experienced overheating of blood clotting activity and platelet aggregation properties.

**Key words:** Piglets, Overheating, Platelets, Hemostasis, Hemocoagulation.

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**INTRODUCTION**

In many countries of the world, pig farming is an economically very important branch of agriculture, which provides high-quality food for the population.<sup>1,2</sup> At present, pig breeding continues to experience a great need for new knowledge in the physiology of piglets of different ages.<sup>3,4</sup> In this regard, a detailed clarification of the subtle mechanisms of functioning of various organ systems in piglets in different environmental conditions<sup>5</sup>, which often have a negative effect on them<sup>6,7</sup>, is

becoming more important. Elucidation of the possible response of the body of pigs at any age to environmental impacts is required to continue improving the methods used to improve them, save livestock and increase their productivity, accelerate reproduction.<sup>8,9</sup> Provided that the obtained new physiological information about piglets is justified in practice, it should help create a solid scientific basis for the regulation of their functional state in any environmental conditions.<sup>10,11</sup> This will help to increase the

level of their meat productivity at low costs for their feeding and maintenance.<sup>12,13</sup>

An important problem of modern practical biology is the intensification of all processes in the pig industry due to the acceleration of growing healthy young stock with a high degree of its preservation in any environmental conditions as a result of the use of physiologically justified approaches to its feeding and maintenance.<sup>14</sup> It becomes clear that the parameters of his blood have a high significance in maintaining the optimum viability and productivity of animals at any stage of ontogenesis.<sup>15-18</sup> It has been proven that blood is a very labile marker of the dynamics of the functional state of the whole organism, which early reacts to any environmental effects.<sup>19,20</sup> Changes in the activity of various systems of the body, in metabolism, including against the background of external influences, are always reflected in blood counts. In addition, the blood can change its composition and hemostatic properties and itself regulate the functional state of the internal organs and the whole organism.<sup>21,22</sup>

To maintain homeostasis in piglets, optimum hemocirculation is of great importance, which strongly depends on the level of activity of the components of the hemostasis system. It is clear that the level of viability of tissues and the degree of development of their functional activity is largely determined by hemorheological parameters.<sup>23,24</sup> They, in turn, strongly depend on the activity of hemostasis.<sup>25</sup> In this regard, the level of hemostasis activity is able to determine the course of anabolism in the whole mammal and the realization of its productive potential.<sup>26,27</sup> Due to the high physiological significance and vulnerability of homeostasis, it is currently being studied in detail in animals under normal and unfavorable conditions.<sup>28,29</sup>

It was established earlier that with negative effects on a living organism, quite pronounced negative changes in hemostatic parameters often develop, which worsens the hemocirculation processes in small-caliber vessels.<sup>30,31</sup> Their condition in pigs of different ages at the optimum of the medium remains poorly

elucidated. Aspects of hemostatic dysfunctions with adverse environmental effects are even more poorly investigated.<sup>32</sup> At the same time, piglets are very vulnerable to metabolic disturbances and phenotypic disorders in manifestations of genetically determined viability indicators.<sup>33</sup> These include many physical, chemical and biological effects. Of particular interest is the effect on medium temperature fluctuations on piglets<sup>34</sup>, including in terms of the dynamics of the activity of the hemostasis system.

Objective: to determine the dynamics of the activity of the hemostatic system in piglets who have experienced short-term overheating.

## MATERIALS AND METHODS

The studies were conducted in strict accordance with the ethical principles established by the European Convention for the Protection of Vertebrate Animals used for experimental and other scientific purposes (adopted in Strasbourg on March 18, 1986 and confirmed in Strasbourg on June 15, 2006).

The work was performed on 42 healthy piglets of the large white breed at the age of 2.5 months, kept in the farms of the Samara region of Russia. The animals were taken into the study on the day of the accidental onset of the emergency shutdown of the air conditioning system in the pigsty during the summer period after they were in an environment with an elevated temperature of 10 ° C for 3 hours. These animals formed the experimental group. The control group was formed by 32 pigs, not exposed to negative environmental influences and completely healthy. The diet of all animals taken under observation was standard.

The amount of fibrinogen in the blood was evaluated in all animals using a modified Claus method. The amount of plasminogen was recorded in them using the kinetic method on an FP-901 device (LabSystems, Finland) using a chromogenic substrate (Dade Behring, Germany). The amount of soluble fibrin-monomer complexes was ascertained using a visual method using reagents manufactured by Tekhnolog-Standart (Russia). The magnitude of the activated partial thromboplastin time was

determined on a HumaClotcoagulometer (HUMAN GmbH, Germany), using a HemoStataPTT-EL reagent kit. Registration of the level of international normalized relations was performed according to the method of Quick. The level of ability to aggregate platelets was assessed by a turbidimetric method using a two-channel laser analyzer of platelet aggregation (Biola, Russia) and a 0.5  $\mu\text{M}$  solution of adenosine diphosphate (ADP) as an aggregation inducer.

Statistical processing of digital results obtained in the study was carried out by Student's t-criterion.

## RESULTS

When assessing the activity of hemostasis of the examined piglets who experienced overheating, a significant activation of the platelet activity and coagulation system functional capabilities were revealed while weakening the activity of the fibrinolytic system (Table).

**Table.** Parameters of hemostasis in piglets taken in the study

Indicators	Experienced group, n=42	Control group, n=32
Level of international normalized attitude	1.13 $\pm$ 0.13*	1.22 $\pm$ 0.09
The value of activated partial thromboplastin time, seconds	30.6 $\pm$ 0.82**	37.1 $\pm$ 0.69
Fibrinogen level, g/l	3.3 $\pm$ 0.31**	2.5 $\pm$ 0.23
The amount of soluble fibrin-monomer complexes, mg/dl	3.2 $\pm$ 0.24*	2.6 $\pm$ 0.82
Plasminogen activity, %	86.3 $\pm$ 0.32*	94.0 $\pm$ 0.57
The level of spontaneous aggregation of platelets, units	1.23 $\pm$ 0.10**	1.01 $\pm$ 0.10
Platelet aggregation activity of 0.5 $\mu\text{M}$ ADP, units	2.42 $\pm$ 0.16**	2.00 $\pm$ 0.21

**Legend:** the statistical significance of differences in performance in the experimental group and the control group \* -  $p < 0.05$ , \*\* -  $p < 0.01$ .

A significant reduction in the value of activated partial thromboplastin time (by 21.2%), a decrease in the value of the parameter of the international normalized ratio (7.9%) and a

decrease in plasma plasminogen concentration (8.9%), an excessive amount of fibrinogen (32, 0%) and an increase in the level of soluble fibrin-monomeric complexes (23.1%). At the same time, piglets who experienced an episode of overheating showed increased spontaneous (by 21.8%) and platelet aggregation that occurred during stimulation (by 21.0%).

## DISCUSSION

At present, pig breeding has a great need for continuing to increase the amount of information in the field of the physiology of pigs and piglets.<sup>35,36</sup> A detailed analysis of various aspects of the work of their organs, especially under the influence of various environmental factors on animals, is very important.<sup>37</sup> A long-term purposeful study of physiological moments in the process of their body's vital activity is extremely necessary for the practice of pig breeding. Their use will contribute to the improvement of options for exposure to piglets in order to increase their level of productivity, maximize the conservation of livestock and recovery at any age.<sup>38,39</sup>

However, long-term observations on the physiology of pigs did not provide sufficient knowledge of important aspects of the physiology of blood in pigs. Therefore, there is an urgent need to continue to assess the functioning of the blood system and its connection with the functioning of the body of piglets in different adverse environmental conditions.<sup>40</sup>

To a large extent, genetically determined ontogenesis is able to change the intensity of its course under the influence of environmental factors.<sup>41</sup> This effect is associated with the development of piglets on the background of external negative influences of the course of work of all their body systems, changes in blood parameters and hemocirculation process in tissues.<sup>42</sup> Of great importance in this are the violation of the processes flowing in the capillaries. Their biological significance is great and is associated with the provision of cell metabolism with nutrients and gases.<sup>43</sup> This determines the development in the body of all major physiological processes in close

relationship with the mechanisms controlling the parameters of the blood as a whole and its plasma. Their condition is considered to be an important factor in maintaining homeostasis in productive animals.<sup>44,45</sup>

It is obvious that the course of ontogenesis is closely related to the dosed activation of the processes of adaptation to environmental parameters as a result of strengthening the work of many mechanisms in which hemostasis is of great importance. This greatly activates vital activity and maintains a high level of animal health.<sup>46</sup>

Being strictly genetically determined, hematological parameters can change the severity of their phenotypic manifestation in connection with influences from the external environment. In this regard, there is a high relevance of further in-depth elucidation of the main aspects of the functioning of the body during various negative environmental influences with the elucidation of the consequences of these effects.<sup>47</sup> Further studies on the physiology of piglets should create a reliable basis for continuing to improve approaches to their maintenance and feeding. Due to the generalization of information obtained in the course of these works and their subsequent application in practice, a significant intensification of pig breeding can be achieved.<sup>48</sup>

In earlier studies, it was possible to show on various types of active organisms that the hemostasis system strongly responds to many environmental influences of the damaging nature by the rapid development of dysfunctions and pathology.<sup>49</sup> It was also noticed that an increase in the activity of peroxidation processes of lipid molecules can very significantly affect the reactivity of the organism. It has been found that under these conditions the activity of most of the mechanisms of hemostasis increases and the rheological properties of the blood deteriorate.<sup>50</sup> With the development of these disorders, it is common to associate dysfunctions of microcirculation and metabolism.<sup>51</sup>

Despite the great importance of the mechanisms of hemostasis, their dynamics in piglets who

have experienced adverse environmental effects remain insufficiently clarified. There is no doubt that with the majority of negative changes in the environmental parameters of any productive animals, changes in hematological parameters almost always develop.<sup>52</sup>

In the work carried out, it was found that, due to overheating in piglets, there is an increase in functional readiness of hemostasis. The data obtained give reason to believe that this is associated in animals with the activation of hemocoagulation by two mechanisms. Obviously, this is due to the increased activity of most hemocoagulation factors. Apparently, for this reason, an excessive formation of thromboplastin and an increase in contact activation of factor XII occurs in piglets. The situation is also caused by an increase in the blood level of fibrinogen and the concentration of soluble fibrinogenic fragments in the blood of animals. These changes indicate the activation of its polymerization, which is inhibited by an insufficiently weakened fibrinolysis.<sup>53</sup>

Taking into account the literature, it is clear that a decrease in the antioxidant capacity of the organism<sup>54</sup> always leads to the growth of platelet spontaneous and activated aggregation by inducers. Apparently, the reason for this in animals is a decrease in the formation of cyclic adenosine monophosphate in platelets and the activation of the synthesis of thromboxane A<sub>2</sub>. Under these conditions, there is an increase in the formation of platelet aggregates in the blood.<sup>55</sup>

Modern researchers have an opinion about the strong connection of the somatic state of the animal organism with the activity of its hematological parameters.<sup>56</sup> In this work, a small fragment of early ontogenesis of piglets was observed, which does not allow one to draw general conclusions about the effect of short-term overheating on the further activity of hemostasis indicators.<sup>57</sup> However, the revealed disturbances in the hemostasis activity of these animals against the background of unfavorable external influences can be a stimulus for further research in this area and in connection with the activity of hemostasis with the growth of piglets.

**CONCLUSION**

At present, pig breeding has a great need for new knowledge on the physiology of pigs and piglets. This makes particularly relevant a detailed consideration of the age-related moments of the work of organs in piglets under the influence of various environmental factors on their bodies. It becomes clear that hematological indicators have a great importance in maintaining the optimum functioning, and therefore the maximum possible level of productivity of pigs in the period of their active growth. It is noticed that during the early ontogeny of pigs there is a large number of fluctuations in physiological parameters as a result of exposure to environmental factors. Of great biological importance for the growth of animals are the processes realized in their blood, which flows through the vessels of the smallest diameter. The biological significance of these processes is enormous due to their participation in the exchange of gases and substances. In this regard, the developmental changes in platelet aggregation and plasma protein composition must be considered as an important element in maintaining optimal homeostasis in pigs. In the study performed, it was established that, due to overheating, excessive hemostasis activity occurs in piglets. In these animals there is an increase in the level of activity of the coagulation system, a decrease in the activity of fibrinolysis and an increase in the functional readiness of platelets. This circumstance has a very negative effect on their hemocirculation processes in the vessels, which is very detrimental to the course of metabolic processes in their tissues and can often inhibit their growth.

**CONFLICT OF INTEREST**

No conflict of interest is declared.

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