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OXIDATIVE STRESS OF PIGS UNDER THE CONDITIONS OF INDUSTRIAL PRODUCTION

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ABSTRACT

Under modern conditions, especially under conditions of unfavorable ecological load, intensive development of swine rearing has a negative effect on animals' adaptive abilities. Adaptive resources of organisms of productive animals determine some measures taken regarding various factors, including technogenesis. Thus, the necessity of the research on the correction of oxidative stress of productive animals is becoming essential. In order to balance the process of lipid peroxidation when feeding pigs, a multi-component complex of organic nature was used. The content of malondialdehyde in blood serum and the content of amino acids in longissimus was determined. In organisms of pigs, at the cellular and tissue levels, the accumulation of toxic products of lipid peroxidation and the complete absence or low level of positive dynamics in decreasing the level of the oxidative load was stated. Under the conditions of oxidative stress, there were changes in organisms of pigs regarding the composition of amino acids.

Disciplinary: Animal Sciences, Biosciences/Biotechnology.

1. INTRODUCTION

Rearing of agricultural animals under the conditions of modern man-made civilization inevitably results in constant stress situations. The negative effect of environmental factors, such as contamination of air, water, soil and feedstuff with xenobiotics of man-made origin, as well as radiation, triggers increased production of free radicals [2, 3, 6, 8]. Accumulation of active damaging agents (prooxidants, ROI, and free radicals) and metabolic disorders cause damage to cells and lead to various pathologies that do not allow the complete realization of the biological potential of productive animals.

On the molecular-cellular level, oxidative stress (OS) is characterized by activation of the process

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of lipid peroxidation that results in morphofunctional changes in biomembranes. Products of free-radical lipid peroxidation (LP) trigger an oxidative modification of proteins and nucleinic acids that leads to the deregulation of the energy production process in an organism. Under physiological conditions, the antioxidative activity of an organism makes it possible to minimize and balance the negative effect of OS. However, OS progression causes depletion of resources of the antioxidative system. It happens mostly as a result of oxidative modification of the components of the antioxidative system, affected by both free radicals and toxic products of lipid peroxidation. For evaluation of LP quantification of malondialdehyde (MDA) in biological material, such as blood serum, mucosa cells, synovial fluid and so on, it is most often used. An increase in the concentration of MDA is taken as a diagnostic marker used for early diagnosis of metabolic disorders in the organism [1, 5, 7].

Under the conditions of industrial technologies of breeding agricultural animals [9], oxidative stress does not have any clinical manifestation. For this reason, neither timely preventive measures or correction of disorders are taken. OS effect on the amino acid profile of porcine muscles and the possibility to monitor the process of free-radical oxidation in an organism makes the present research essential and important.

This research focuses on the amino acid profile of porcine muscles under the conditions of oxidative stress and evaluates the possibility of its correction by means of food additive containing anti-oxidant elements.

2. MATERIALS AND METHOD

Dynamics of the MDA level in leucocytal cells and blood serum of fattening pigs was studied under the conditions of research and production experiment. Blood of animals was taken from ear's marginal vein on 1st, 30th and 60th days of research. Quantification of MDA in biological material was done according to standard methods. Amino acid profile was identified in the homogenate of longissimus according to 17 parameters.

The possibility of correction of LP was evaluated by means of the use of a multicomponent complex of organic nature with antioxidant elements. Two groups of landrace breed of pigs were formed on the principle of analogues (n=80). The animals from the control (C) and experimental (E) groups were kept under the usual conditions of the pig-breeding farm. The pigs from the experimental group were given the multicomponent complex of organic nature (pyridoxine, niacin, ascorbic acid, magnesium citrate, a complex of calcium and methionine hydroxy analog (MHA), lysine) fed for 14 days.

The authenticity of the results was proved using mathematical statistic techniques with averaging and standard deviation calculation by means of unpaired t-test. The results were considered to be verified by $P<0.05$. Processing of the obtained data was done using Microsoft Excel®.

3. RESULTS OF RESEARCH

Analysis of the results of biochemical research has shown that in 80% cases MDA level in the homogenate of white blood cells of pigs was 1.53 ± 0.11 mcIU/l in blood leukocytes, and 1.75 ± 0.23 mcIU/l in blood serum. 20% of pigs had an MDA level of 0.81±0.02 mcIU/l in blood leukocytes and 1.51±0.10 mcIU/l in blood serum. The obtained results proved the fact that the animals' blood had excess content of LP products. For the entire period of the experiment, the MDA level in the

biological material under research did not undergo any significant changes ($p \geq 0.05$). However, the number of pigs with identified excess content of LP products increased by up to 93,8%. MDA level in the homogenate of their white blood cells was 1.51 ± 0.17 mcIU/l and in blood serum - 1.78 ± 0.19 mcIU/l. 6.4% of the animals had the parameters of 1.17 ± 0.29 mcIU/l and 1.47 ± 0.21 mcIU/l respectively. The results of the comparison between the obtained data and figures of MDA level described by other researchers make it possible to state that the pigs under research had long-term oxidative stress [6].

Research on the amino acid composition of samples of the longissimus of the pigs from the control group has shown the following. The content of the total amount of amino acids in samples of the animals under research was 23.3% less than standard parameters for landrace breed. Totally according to 17 parameters the content was 14883.7±102.2 mg/100 g, whereas the performance standard is 19413mg/100g [4]. No significant differences between the experiment data and performance standards of the content of lysine, methionine, and threonine in the porcine longissimus were not stated ($p \geq 0.05$). However, a significant reduction of the content of 5 irreplaceable amino acids (valine, isoleucine, leucine, tryptophan, and phenylalanine ($p \leq 0.05$) was stated. Changes in the amino acid composition of longissimus were stated in 77.5% of samples under research. In 22.5% of cases, changes in amino acid composition were minimal. However, it is necessary to note that protein full-value (tryptophan/oxyproline) of all the samples under research was 3.28±0.14, whereas the performance standard is 5.7-6.0 [4].

Table 1: Amino acid composition of the porcine longissimus under the conditions of oxidative stress (mg/100 g).

№	Parameters	Performance standard [4]	Parameter among the pigs from "Control" group (n=40)	Parameter among the pigs from "Experimental" group (n=40)
Irreplaceable amino acids		**8270**	**5479.0±97.3**	**5094.8±85.4**
Including:				
1	Valine	1060	679.1±22.7	497.3±19.5
2	Isoleucine	1000	463.0±11.9	547.6±17.3
3	Leucine	1590	684.2±19.3	751.6±23.4
4	Lysine	2010	1549.8±102.9	1386.7±95.9
5	Methionine	490	559.0±15.1	504.3±18.7
6	Threonine	970	852.6±20.2	776.4±19.5
7	Tryptophan	260	126.5±24.9	122.3±18.8
8	Phenylalanine	870	567.9±14.5	509.2±16.4
Non-essential amino acids		**11143**	**9404.7±104.8**	**8621.1±99.1**
Including:				
9	Alanine	1130	1040.6±82.4	875.6±57.6
10	Arginine	1420	1037.0±63.9	914.6±40.3
11	Asparagine acid	2050	1676.7±70.1	1734.4±53.9
12	Histidine	920	831.8±19.7	644.3±14.5
13	Glycine	860	707.5±13.9	657.3±17.2
14	Glutamine acid	3190	2895.0±103.8	2638.3±107.3
43	Oxyproline		38.3±5.4	60.7±9.8
820	Serine		644.4±17.6	601.3±11.6
17	Tyrosine	710	536.2±12.5	495.7±14.1
Total number of amino acids		**19413**	**14883.7±102.2**	**13715.9±107.5**

The possibility of correction of the negative effect of oxidative stress on an organism was researched on the pigs from the experimental group. As an antioxidant preparation, a feed additive containing organic substances, such as niacin, vitamin D_3, vitamin B_6, vitamin C, lysine, magnesium

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citrate, MHAn (methionine hydroxy analog), was used.

Research on dynamics of MDA level in the homogenate of leucocytes and blood serum of the experimental pigs have shown that a significant reduction of toxic OS products was identified only on the 30th day of research. Thus, the MDA level in the homogenate of leucocytes was 1.03±0.22 mcIU/l. in blood serum - 1.35±0.13 mcIU/l ($p \leq 0.05$). By the 60th day content of MDA was at the level of 1.52±0.14 mcIU/l and 1.77±0.25 mcIU/l respectively. The obtained results proved the antioxidant effect of food additive on porcine organisms. On the other side, they proved the fact that under the conditions of industrial complex antioxidant effect is short-termed (Figure 1).

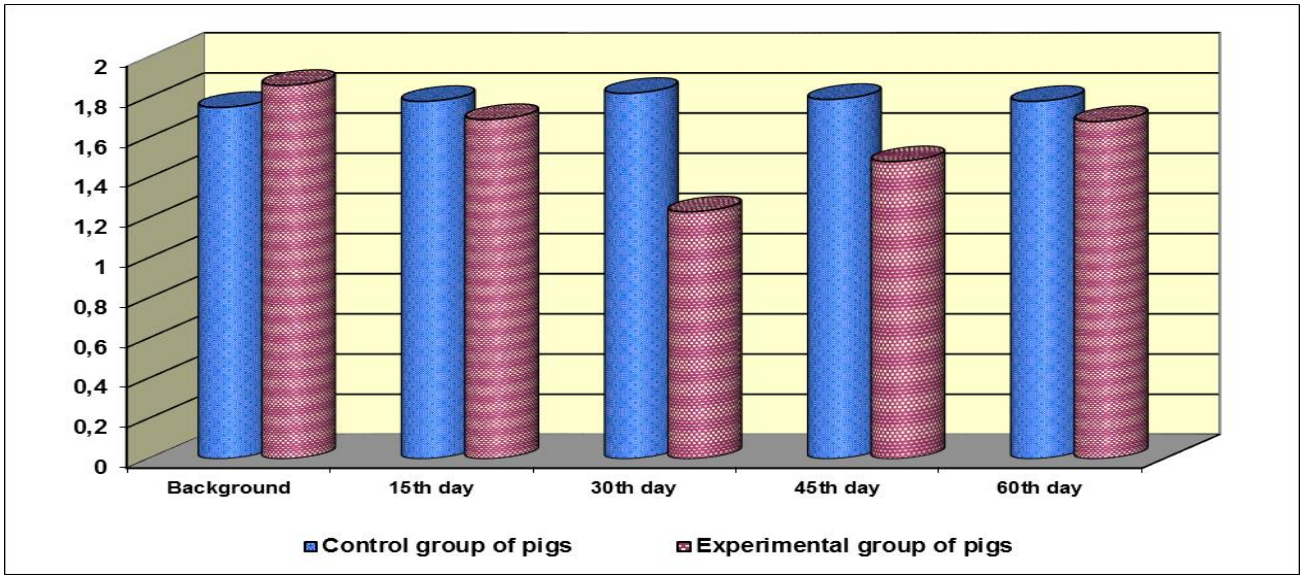

Figure 1: Dynamics of MDA level in white cells and blood serum of pigs (umol/l).

Amino acid composition of longissimus of the experimental pigs was compared with performance standards for landrace breed and parameters of the control group (Figure 2).

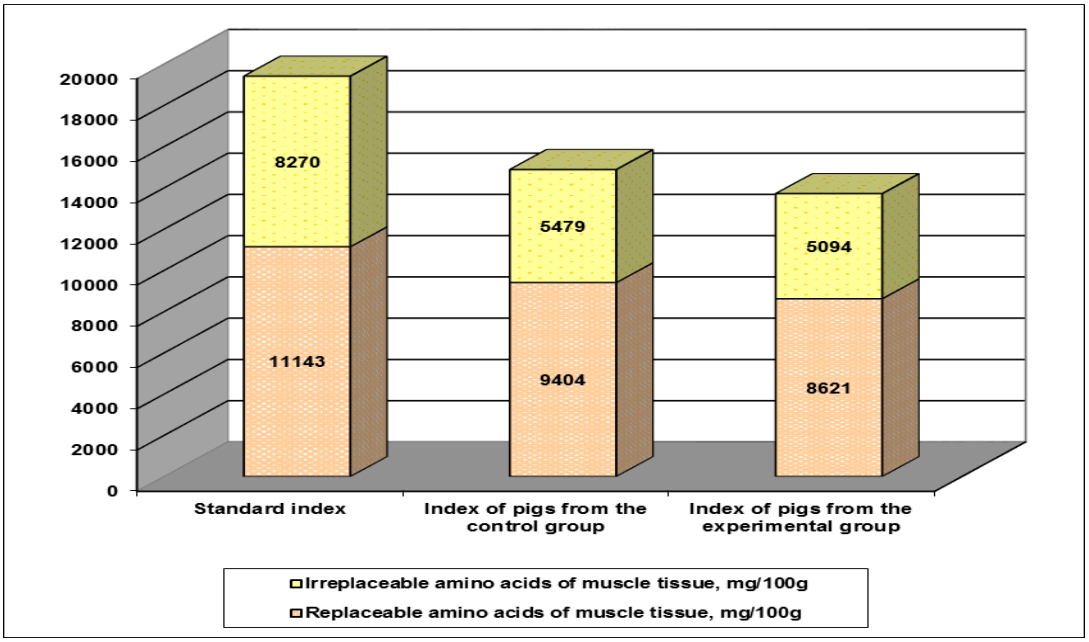

Figure 2: Indexes of the amino acid composition of longissimus of Landrace breed of pigs (mg/100g)

The samples of the experimental group showed disbalance in the number of irreplaceable amino acids, similar to the parameters of the animals from the control group. Content of valine, isoleucine, leucine, tryptophan. and phenylalanine in 100 g of muscle mass was also significantly (2.15-2.32

times) less ($p \leq 0.05$). Changes in the amino acid composition of longissimus were stated in 82.5% samples. Defining of protein full-value of samples of longissimus regarding the proportion tryptophan/oxyproline showed that the parameter. like in the control group. is less than the performance standard and is 3.20±0.17.

4. CONCLUSION

This research has shown that the conditions of industrial breeding technologies cause the oxidative stress of the pigs. In organisms of the animals, on cellular and tissue levels, accumulation of toxic LP products took place, whereas the dynamics of a reduced level of the oxidative load was absent or very low. Presumably, the animals were suffering from the depression of the antioxidant defense system. Under the conditions of oxidative stress, the amino acid composition of the pigs underwent significant changes in the group of "Irreplaceable amino acids", such as valine, isoleucine, leucine, tryptophan, and phenylalanine. Content of leucine and tryptophan reduced by more than twice. Changes in amino acid profile resulted in depreciation of the quality of pork, as a full-value food product.

Experimental research on evaluation of the possibility to use food additives with antioxidant effect has shown that, firstly, it is necessary to improve the formulation, considering species differences of agricultural animals and methods of animal management. Secondly, in order to achieve the significant antioxidant effect, the schedule of implementation of such food additives should be worked out in detail and compatible with animals' diet.

5. DATA AND MATERIALS AVAILABILITY

Relevant information is available by contacting the corresponding author.

6. CONFLICT OF INTEREST

The authors confirm that the given data do not have any conflict of interest.

7. ACKNOWLEDGEMENT

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