

## The Application of Physical and Biological Stimulants in Livestock Breeding

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**Abstract:** In this study, we describe the experimental material on the study of the expediency of application of aeroionization in different livestock enterprises. It has been established that in the air of livestock houses the content of light negative ions is 5.6 times less than in the atmosphere and of heavy ones, on the contrary, it is 1.8 times more. The ion pollution coefficient is 10 times higher than in the atmosphere. The use of aeroionization increases the sanitary condition of the microclimate with the relative humidity reduced by 6.9-8.1%, carbon dioxide content by 0.03%, ammonia by 2.0 mg/m<sup>3</sup>, hydrogen sulfide by 1.0 mg/m<sup>3</sup>, the amount of dust and germs by 1.8 times. Under the influence of optimal concentrations of light negative ions, hematological factors, the level of natural resistance of animals, average daily live weight gain of piglets are improved by 13.1%, calves by 13.9% in relation to control animals. Combined application of aeroionization, “Erakond”, “Biotim” tissue preparations and “Sporovit” and “Lactobacterin” probiotics has a more significant stimulating effect on hematological factors, the level of natural resistance and the intensity of growth of animals than their separate application. Thus, the average daily gain increased by 15.8%, the indices of natural resistance improved: lysozyme activity of blood cell increased by 5.9%, bactericidal activity by 5.9%, phagocytic activity by 7.0%, complementary by 9.0%. Combined application of aeroionization, biological stimulants and probiotics is not only hygienically expedient but it is a highly effective measure with the pay back of 8.85/1 rub. of expenses.

**Key words:** Aeroionization, microclimate, biostimulants, probiotics, hematological, payback

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### INTRODUCTION

In the conditions of intensification of animal products production at high density of animal placement on relatively small areas, often with indoor breeding, the effect of microclimate of livestock houses on the health and productivity of animals is increasing. In this regard, there is a need for more careful regulation of all its parameters for the development and compliance with veterinary and sanitary measures (Mozzherin, 2000; Cepeleva *et al.*, 2012).

According to Chizhevskij (1989) along with the control of indices generally accepted in zoohygenic practice, it is necessary to pay attention to the electric charge of the air as the evolution of living organisms on

the Earth proceeded in ionized air and it is one of the important conditions for the normal development and maintenance of life.

Positive effects of aeroionization on the microclimate of livestock houses and animal organism were stipulated in the research of national and Foreign scientists (Mozzherin, 2000). However, according to Cepeleva *et al.* (2012) the modified technology of keeping and using animals at the present stage does not exclude further research in this direction.

At present, animals have a decrease in natural resistance and metabolic disorders caused by man-induced pollution of the environment, the growing impact of anthropogenic factors, technological and other stresses. One of the promising directions of scientific research to reduce the impact of man-induced and

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environmental load on the animal body, increasing natural resistance and the preservation of young animals is the use of biological stimulants and probiotics (Tagirov *et al.*, 2015; Li *et al.*, 2018; Perevozchikov *et al.*, 2017).

In the modern sense probiotics are microorganisms that are able to replace the pathogenic microflora in the intestines of animals and thereby regulate their immune system (Alekseev *et al.*, 2014; Balasubramanian *et al.*, 2018). In the studies by Foreign researchers (Hou *et al.*, 2015) it was found that probiotics could increase the intensity of animal growth and improve feed use. In addition, Balasubramanian *et al.* (2018) report a positive impact of probiotics on the quality of pig meat. A number of scientists note that when using various probiotic combinations they have a therapeutic effect in case of salmonellosis, colibacteriosis and other diseases (Barba-Vidal *et al.*, 2017; Li *et al.*, 2018, Perevozchikov *et al.*, 2017).

In recent years, probiotic supplements have appeared, their composition is close to the natural microbiocenosis of the intestines of animals and birds. Their use provides an anti-stress effect in case of unfavourable external factors such as air hyperthermia and transition to other feeding rations, close herding and other man-induced factors (Idoui, 2014; Kim *et al.*, 2018; Li *et al.*, 2018).

It should be noted that, there are few works on the combined application of aeroionization and probiotics. In view of this, the aim of the research was scientific and practical substantiation of the expediency of combined application of aero-ionization, biological stimulants and probiotics for optimizing the microclimate, activating the natural resistance and growth rate of animals.

## **MATERIALS AND METHODS**

The experimental part of the research was carried out at "Roschinsky" state pig-breeding farm (Sterlitamasky District, Republic of Bashkortostan), "Aurgazinsky pig-breeding farm" JSC (Aurgazinsky District, Republic of Bashkortostan), agricultural producer's co-operative "Demen" (Tatyshlinsky District, Republic of Bashkortostan). To create the optimal concentration of light negative ions in a large pig-breeding farm designed for breeding 54000 pigs, high voltage generator АИИ-70 was used (apparatus for cable insulation testing). Capacity of the apparatus and monoblocness of the building allowed to connect all parts of the reproduction department by the antenna type electrodes thus making it possible to conduct aeroionization sessions simultaneously for the whole stock of the department.

Aeroionization sessions were held twice a day for 30 min within a month. The concentration of air ions was 250-400 thousand in 1 cm<sup>3</sup> of air depending on the age of pigs.

For the formation of an artificial background in the calf house, "Elion-132" air ionizer was used. Sessions of aeroionization for calves were carried out twice a day for 45 min during a month. The concentration of light negative ions in the livestock house was within 250-300 thousand in 1 cm<sup>3</sup> of air. The number of air ions was determined by SAI TSU-70 (air ions counter of Tartu State University) and Sapphire-3M counters.

At the same time, "Eracond"-biological stimulant of plant origin -and a tissue preparation obtained from cattle spleen and manufactured by the original technique developed at the Department of Infectious Diseases, Zoohygiene and Veterinary-Sanitary Expertise of Bashkir State Agrarian University (Patent Number 2153343) were used in the experiment. "Eracond" was given to the calves with colostrum and milk in the form of 10% solution at the rate of 2.5 mL/kg for 10 days followed by a 10 days break. "Bioslim" was given at the dose of 0.1 mL/kg of live weight for a month.

"Sporovit" and "Lactobacterin" were given with colostrum and milk, 1 mL/10 kg of live weight and 2 mL/10 kg of live weight, respectively, twice a day for 5 days in succession with a 7 days break.

The experiment was carried out in three times repetition by the method of groups and analogues. In carrying out the research, we used modern methods generally accepted in veterinary and zoo-hygienic practice. The temperature and air humidity were measured by Avgust psychrometer, the speed of movement and the cooling ability of the air were determined by a catathermometer, the concentration of carbon dioxide by Hess method, ammonia and hydrogen sulfide by UG-2 universal gas analyzer. Microbial content and dust contamination of air were determined by Yu. A. Krotov modified device of Kuznecov *et al.*

Animals were weighed every day and blood was taken to control their general condition. The number of erythrocytes, hemoglobin and leukocytes was determined by conventional methods using MEC-6400 analyzer. Total protein in blood serum was determined by IRF-22 refractometer, protein fractions-using CFC-2 concentration photoelectric chromatometer. Indices of natural resistance, the level of gas-energy exchange and metabolism were determined by methods generally accepted in veterinary practice. Statistical processing of the experimental data was carried out using a statistical analysis package for Microsoft Excel.

**RESULTS AND DISCUSSION**

Determination of the natural air-ion spectrum was carried out in the comparative aspect in free atmosphere and air of the studied livestock houses in different seasons of the year. Studies have shown that, the natural aeroionic background of “Roschinskiy” production areas of the reproduction department differs from the atmospheric by spectrum and the number of ions and has a definite trend. This is most pronounced in relation to light air ions, their number inside the house has always been 1.5-2 times less than in the free atmosphere, especially in Winter. The highest concentration of light air ions was recorded in Summer. The ion pollution coefficient-predominance of heavy ions over light ions, amounted to 121.7 in Winter, 76.3 in Summer in the air basin of the industrial territory of the farm, the ion pollution coefficient was at the level of 39.2 and 42.4. It should be noted that in those periods of the year when the interior microclimate was more in keeping with zoohygieneal requirements, a more favourable aeroionic background was observed. Similar trend is observed in the study of aeroionic spectrum of other animal-breeding farms, the results are presented in Table 1.

As can be seen from Table 1, the number of light ions was 5.6 times lower in the calf house than in the air. At the same time, it was found that the amount of heavy ions was 1.8 times higher than in the air of the surrounding area. The ion pollution coefficient in the calf house was practically 10 times higher than in the atmospheric air. All this points to the need for artificial aeroionization in livestock houses.

During the session of aeroionization of livestock houses relative humidity of air was significantly reduced by 6.9-8.1% in addition to that the content of harmful gas impurities decreased: carbon dioxide by 0.02-0.03%, ammonia by 2.0 mg/m<sup>3</sup>, hydrogen sulfide -by 1.0 mg/m<sup>3</sup> or 24.0%. The decrease of microorganisms and dust in the air of the house by 1.9 and 1.8 times is especially noticeable which shows the improvement of the sanitary state of the microclimate.

During the experiment, the overall development and growth of experimental animals were monitored. We noted that at the end of the experiment, under the influence of aeroionization sessions, the live weight of piglets exceeded that index of control animals by 13.1% (p<0.05). In the research of hematological factors, an increase in the number of erythrocytes by 6.5%, the level of hemoglobin in them by 5.8%, the number of leucocytes by 9.8% (p<0.05) was discovered. The biochemical parameters of blood serum have also changed. Thus, total calcium increased by 3.8%, inorganic phosphorus by 6.8%, total protein by 10.6%,  $\alpha$ -globulins-by 6.4%,  $\beta$ -globulins by 5.2%,  $\gamma$ -globulins by 10.7% (p<0.05).

Table 1: Comparative evaluation of the air ion spectrum in the calf house and in atmospheric air

| Index  | Place of research |                       |
|--|-------------------|-----------------------|
|  | Calf house        | Territory of the farm |
| Light positive ions, ion/cm <sup>3</sup> (n <sup>+</sup> ) | 190±18.4          | 1100.0±39.2           |
| Light negative ions, ion/cm <sup>3</sup> (n <sup>-</sup> ) | 160±19.02         | 850.0±22.5            |
| Unipolarity coefficient                                    | 1.18±0.015        | 1.29±0.011            |
| Heavy positive ions, ion/cm <sup>3</sup> (N <sup>+</sup> ) | 4200.0±89.1       | 2300.0±89.6           |
| Heavy negative ions, ion/cm <sup>3</sup> (N <sup>-</sup> ) | 3200.0±96.4       | 1850.0±45.6           |
| Unipolarity coefficient                                    | 1.31±0.011        | 1.24±0.015            |
| Ion pollution coefficient                                  | 21.14±2.12        | 2.12±0.89             |

It should be noted that no indices went beyond the physiological norm. Aeroionization sessions stimulate the natural resistance of pigs which is manifested in the increased lysozyme activity of blood serum by 9.97%, bactericidal by 4.57% and phagocytic by 15.88% in increasing cellular factors of protection of phagocyte number by 2.38 times, phagocyte index by 1.6 times and phagocytic capacity by 3.86 times (p<0.05).

The increase in the intensity of piglet’s growth was due not to the large consumption of feed but to the better quality use of nutrients of the diet. Carrying out balance experiments showed that in the feedstock of the experimental group protein digestibility raised by 6.15%, fat by 6.57%, fiber by 5.04% (p<0.05). As compared with control animals, more nitrogen was deposited in the body of pigs having received the first sessions of aeroionization by 10.22%, calcium by 10.56% and phosphorus by 11.94% (p<0.05). At the same time, they were found to have an increase in the level of gas-energy exchange which resulted in an increase in oxygen consumption by 6.85%, the release of carbon dioxide by 23.6% and heat production by 9.17% (p<0.05). Under the influence of aeroionization the marketable quality of pig carcasses improved which manifested itself in slaughter yield by 1.4% due to an increase in meat by 1.6% and a decrease in fat by 1.5%. In the carcass of experimental animals the mass of internal organs and endocrine glands increased, the heart by 2.85%, lungs by 11.5%, liver by 1.17%, thyroid by 4.9%, pancreas by 1.4%, adrenal glands by 12.6% and the pituitary gland by 9.5% which indicates their best functional activity. This is confirmed by the study at histological and ultrastructural level, for example, activation of the endoplasmic reticulum, increase in the number of binucleated hepatocytes and raise in the amount of glycogen in hepatocytes was discovered in liver. The thickness of the glomerular zone in the adrenal glands increased by 23.67  $\mu$ m, the mesh zone by 28.01  $\mu$ m, the medulla zone by 1337.3  $\mu$ m as compared with control animals.

Table 2: Effect of combined application of aeroionization and “Erakond” and “Biostim” preparation on natural resistance of calves, n = 40

| Index (%)              | Animal groups |              |             |              |
|------------------------|---------------|--------------|-------------|--------------|
|                        | Eracond       |              | Biostim     |              |
|                        | Control       | Experimental | Control     | Experimental |
| Lysozyme activity      | 20.56±0.55**  | 23.62±0.32*  | 14.56±0.69* | 20.74**      |
| Bactericidal activity  | 36.34±0.32**  | 45.54±0.39   | 41.54±0.92  | 48.62±0.83** |
| Phagocytic activity    | 48.56±1.12**  | 55.92±0.98   | 49.96±0.95  | 58.42±1.05** |
| Complementary activity | 14.85±0.36    | 19.56*±0.32  | 17.92±0.59  | 22.62±0.96** |

\*p<0.05; \*\*p<0.01

Today, there are many methods to increase the productivity of animals. Among them, tissue biostimulants hold a prominent position. In this regard, we conducted an experimental work to determine the effect of “Erakond” preparation of plant origin and “Biostim” preparation of animal origin on the body of calves. It was found that the calves who received “Erakond” at the end of the experiment demonstrated the average daily gain increased by 6.8% compared to the control. In the group of calves who received sessions of aeroionization, it exceeded the index by 11.36% as compared to the calves of the control group. In the experimental group, the average daily gain increased by 15.9% compared to the control (p<0.05) when applying “Erakond” and aeroionization. There were changes in hematological factors in the form of an increase of erythrocytes by 7.49% under the influence of “Erakond”, by 8.46% under the influence of aeroionization and by 16.97% with the combined application of aeroionization and “Erakond”. The biochemical parameters of calves’ blood have also changed, so, the amount of calcium increased by 7.49%, phosphorus by 5.90%, total protein by 5.07% when using “Erakond” preparation. When using aeroionization calcium increased by 8.46%, phosphorus by 5.29%, total protein by 7.87% (p<0.05) relative to the control.

The favorable effect of “Erakond” on the natural resistance of the body of calves was registered. For instance, lysozyme activity of calves’ blood serum increased by 2.32%, bactericidal -by 2.26%, phagocytic by 3.86%, complementary by 2.89% in relation to control.

In the next series of experiments, the effect of “Biostim” preparation on the body of calves was monitored. At the same time, the average daily gain of calves increased by 13.9%, under the influence of aeroionization, the average daily gain increased by 8.2%, with a combined impact by 18.4% (p<0.05) relative to the control.

There have been changes in hematological parameters: due to “Biostim” action the number of red blood cells increased by 2.57%, hemoglobin by 1.21%, leucocytes by 15.87%. Under the integral effect of aeroionization and “Biostim” changes in calves’ bodies

were more pronounced. Thus, the number of red blood cells increased by 4.34%, hemoglobin by 4.94%, the number of white blood cells by 16.30% (p<0.05) compared to the control.

The indices of natural resistance changed when using “Biostim” in calves of the experimental group. In these circumstances, lysozyme activity increased by 3.26%, bactericidal activity by 4.26%, phagocytic activity by 3.12% in relation to control. The most positive effect was noted in the combined application of “Erakond” and “Biostim” (Table 2).

Analysis of Table 2 data shows that due to the integrated effect of aeroionization and “Erakond” lysozyme activity of calves’ blood serum increased by 3.06%, bactericidal activity by 9.2%, phagocytic by 7.36%, complementary by 4.71% (p<0.05). The combined application of aeroionization and “Biostim” had a positive effect. Thus, lysozyme activity increased by 6.18%, bactericidal activity by 7.08%, phagocytic by 8.46%, complementary by 4.70% in relation to the control.

Of particular interest are the studies on the effect of “Sporovit” and “Lactobacterin” probiotics and aeroionization on the body of calves. It was found that the average daily gain under the action of “Sporovit” increased by 8.75%, under the action of “Lactobacterin” by 7.95%, under combined application with aeroionization by 15.78%. The same trend is noted in the dynamics of natural resistance. The results are presented in Table 3.

As can be seen from Table 3, in the experimental group, under the impact of combined application of aeroionization and “Sporovit”, all indices raised as compared to the control group. In this connection, the lysozyme activity of blood serum increased by 5.85%, bactericidal activity by 5.93%, phagocytic activity by 7.0%, complementary activity by 9.0% (p<0.01).

The same trend was noted for the use of “Lactobacterin” probiotic while the lysozyme activity of calves’ blood serum increased by 4.21%, bactericidal by 8.29%, phagocytic by 6.07%, complementary by 8.36% (p<0.01) in relation to the control. It should be noted that, all these indices did not go beyond the physiological norm and indicate the activation of the protective forces of the body of calves.

Table 3: Effect of combined application of aeroionization and probiotics on the natural resistance of calves (%), n = 40

| Index (%)              | Animal group |              |               |              |
|------------------------|--------------|--------------|---------------|--------------|
|                        | Sporovit     |              | Lactobacterin |              |
|                        | Control      | Experimental | Control       | Experimental |
| Lysozyme activity,     | 16.95±0.38   | 22.80±0.32** | 18.60±0.36    | 21.81±0.38** |
| Bactericidal activity  | 36.42±0.32   | 45.35±0.42   | 36.60±0.34    | 44.89±0.42*  |
| Phagocytic activity    | 53.48±1.18   | 60.48±0.95** | 54.12±0.98    | 60.19±0.96** |
| Complementary activity | 14.95±0.38   | 23.95±0.48** | 14.72±0.22    | 23.08±0.26** |

\*p<0.05; \*\*p<0.01

Currently, a lot of work is being done to create optimal conditions for the maintenance and breeding of animals, to find ways and means aimed at increasing their natural resistance, preservation and getting high productivity. Among priority series of actions, certain attention is paid to the use of artificial aeroionization, the positive effect of which has been established in the experiments of many national scientists (Mozzherin, 2000; Cepeleva *et al.*, 2012; Chizhevskij, 1989).

During the experiments we studied the natural air-ion spectrum of the atmosphere and air of livestock houses. The greatest difference was found in the case of light air ions, their number in the livestock room was 5.6 times less than in the free atmosphere, especially in Winter, alongside with that it was found that the content of heavy ions was by 1.8 times higher than in the air of the surrounding area. The ion coefficient of air pollution in the calf house was 10 times higher than that of the atmospheric air. The data obtained in these experiments are in good agreement with the data received by the scientists of Bashkir *et al.* who studied the dynamics of aeroionic spectrum of atmosphere and indoor air.

To create artificial aeroionic spectrum in the experiments, we used electric ionizers. On a large pig-breeding farm, АИИ-70 apparatus and needle electrodes of antenna type were used. In the monobloc building it npermitted to connect all parts of the reproduction department by the electric circuit thus making it possible to conduct aeroionization sessions simultaneously for the whole stock of the department. This greatly simplifies aeroionization sessions and easily fits into the technology of the farm. During the sessions of aeroionization, significant changes in the main parameters of the microclimate were noted. For instance, relative air humidity was reduced by 6.9-8.1% which was due to the deposition of water vapor in the electric field as well as to the adsorption of water vapor by air ions.

In studying the chemical composition of air professor Chizhevskij, originator of aeroionization, found that the content of harmful gases-carbon dioxide, hydrogen sulfide and ammonia -decreases during aeroionization. In his opinion, this is due to the dissociation of oxygen into atoms and the active capture of the electron from the

molecules of these gases which have a smaller ionization potential. Similar results were noted in the works by Mozzherin (2000) (Bashkir SAU). The effect of aeroionization is particularly pronounced against dust and germs. Their number decreased by 1.9-1.8 times. These changes were also registered by other researchers (Cepeleva *et al.*, 2012) who studied the effect of aeroionization on the microclimate of animal breeding areas.

Upon direct action of aeroionization on animals, a positive effect on metabolic processes occurring in their bodies was observed. Thus, at the optimal concentration of light negative aeroions, the live weight of piglets increased by 13.1% at the end of the experiment and calves by 13.9%. Hematological factors and the level of natural resistance were significantly improved.

When studying the effect of tissue preparations and probiotics, we noted their beneficial effect on growth rate, hematological factors, natural resistance of animals that is in good agreement with the results of Foreign researchers (Balasubramanian *et al.*, 2018; Barba-Vidal *et al.*, 2017; Hou *et al.*, 2015). Particular attention should be given to our investigations of the integrated application of aeroionization, biostimulants of plant and animal origin and probiotics with the use of a suspension of live bacteria of *Bacillus subtilis* “Sporovit” and *Lactobacillus* “Lactobacterin”. At the same time we noted a more pronounced effect on the increase in live weight by 15.78% in relation to the animals of the control group.

All indices of natural resistance also increased in relation to the control under the combined application. Thus, the lysozyme activity of blood serum significantly increased by 5.85%, bactericidal activity by 5.93%, phagocytic activity by 7.0%, complementary activity by 9% which indicates an increase in the body’s defenses. We did not find studies of the like nature in the available literature but the use of probiotics containing *Lactobacillus*, *Bacillus subtilis* and *Bifidobacterium* germs in their structure caused a change in the intensity of growth, improvement of hematological factors and of the level of natural resistance as noted by the majority of researchers (Alekseev *et al.*, 2014; Barba-Vidal *et al.*, 2017; Idoui, 2014).

Concluding the discussion of the results of the studies, we can state that the air-ion spectrum of the air in livestock houses is significantly inferior to the atmospheric content of light negative ions. The use of aeroionization has a positive effect on blood parameters, natural resistance of animals as well as on the main parameters of the microclimate. The combined use of aeroionization, biostimulants and probiotics is synergistic and has a more pronounced effect than their separate use.

### CONCLUSION

Among microclimatic factors, air-ion spectrum is an important index of the biological value of air in livestock houses. Under the influence of aeroionization in all seasons of the year, there is an improvement of the main indices of the microclimate, a decrease in relative humidity by 6.9%, carbon dioxide content by 0.03%, ammonia by 2.0 mg/m<sup>3</sup>, hydrogen sulfide-by 1.0 mg/m<sup>3</sup>. The most pronounced effect of aeroionization is on dust and microorganisms, the amount of dust decreased by 1.9 times, of germs by 1.8 times (p<0.05). The use of aeroionization sessions increases the growth rate of piglets by 13.1%, of calves by 13.9%. Hematological factors and the level of natural resistance are significantly increased.

Combined application of aeroionization, “Erakond” and “Biostim” preparations and “Sporovit” and “Lactobacterin” probiotics is synergistic that is expressed by the increase of young animals growth intensity by 15.39%, the improvement of hematological parameters and of the natural resistance level. The use of aeroionization and biological stimulants is not only hygienically expedient but it’s also a highly effective measure, the pay back being 8.85/1 rub. of expenses.

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