Agronomy Research **19**(2), 552–561, 2021
https://doi.org/10.15159/AR.21.039

Alleviation of technological stresses by a feed supplement

A.V. Miftakhutdinov, E.R. Saifulmulyukov* and E.A. Nogovitsina

South Ural State Agrarian University, 13 Gagarina street, RU457100 Troitsk, Chelyabinsk Region, Russia
*Correspondence: ernest_saif@mail.ru

Received: February 2nd, 2021; Accepted: April 10th, 2021; Published: April 17th, 2021

Abstract. Technological stresses affect the productivity of broiler-type chicken and are related directly to poultry farming intensification. Heat stress occurring in conditions of high density keeping, especially at high summer ambient temperatures, is very important. Stress factors influence the metabolic processes in poultry, while reducing the production parameters of operation and, by extension, the efficiency of broiler farming.
The objective of this research was to identify the efficiency of a feed supplement in alleviating technological stresses in poultry industry.
Use of supplement (the preparation contains succinic acid, L-carnitine, betaine, inorganic salts of zinc, manganese, copper and lithium) preserved the production performance of broiler-type chickens in the pre-slaughter period, by reducing the technological load on the poultry body, as it was indicated by an increase in the efficiency of fattening by 16.2 conditional units, meat yield by 1.4%, gross income by 49.2% and a decline in mortality rate by 1.5%. The data on production efficiency indicators of broiler feeding were obtained on a large sample - 6136 heads.

Key words: pre-slaughter period, technological stress, heat stress, poultry industry, broiler-type chicken, livability, growth, development, meat productivity, economic efficiency.

INTRODUCTION

Quick rearing and broiler fattening is usually associated with technological stress. The body is continuously under stress, since it responds to loading and transportation, deviations from the thermoneutral zone, the quality and quantity of feed, as well as changes in the social structure of the flock. Thus, it is essential to control stress originated from environmental factors in poultry. Feed supplements could serve as an alternative strategy of coping with these stressful treatments (Kavtarashvili & Kolokolnikova, 2010; Shatskikh & Molokanova, 2019; Shatskikh et al., 2020).

According to many authors, technological stresses in poultry industry result in decrease of body weight, livability rates and meat productivity, deterioration of meat quality, and thus- economic efficiency of poultry operation (Oliveira et al., 2018; Cândido et al., 2019). Notably, the greatest losses are observed in the pre-slaughter period (Jacobs et al., 2017b; Di Martino et al., 2017).

Catching stage causes a significant increase in production losses: the bird can be injured, therefore, the level of carcass defects rises and the death rate increases (Queiroz et al., 2015). It has been observed that the longer the bird remains in the hands of the catcher, the greater the chances of various types of injuries (Langkabel et al., 2015; Kittelsen et al., 2015a).

High ambient temperature during transportation is also a great stressor for poultry (Spurio et al., 2016). When the duration of transportation increases, the risk of coat contamination with poultry waste products increases, leading to a decrease in the sanitary condition of carcasses (Jacobs et al., 2017a).

Pre-slaughter period is very crucial and can contribute to great losses of birds. The mortality rate may depend on the immunity of poultry, method of catching, cage density, ambient temperature, conditions and duration of transportation, distance to the slaughter unit and conditions of pre-slaughter treatment (Grilli et al., 2015; Vieira et al., 2015; Jacobs et al., 2017b; Di Martino et al., 2017). The most frequent causes of broiler-type chicken death in the pre-slaughter period are the so-called 'sudden death syndrome' and injuries, including fractures and hepatorrhexis (Kittelsen et al., 2015b).

In view of this, the aim of this study was therefore to examine the effectiveness of a feed supplement in alleviating technological stresses in broilers.

MATERIALS AND METHODS

Research and production experiment was performed following the conditions of an industrial-type poultry plant, with Arbor Acres broiler-type chickens.

The applied feed supplementis protected by copyright (Miftakhutdinov et al., 2019), and included vitamin-like and mineral substances such as: succinic acid - 37.0–38.0%, L-carnitine - 5.0–6.0%, betaine - 14.0–15.0%, inorganic salts of zinc - 11.5–11.7%, manganese - 11.5–11.7%, copper - 2.6–2.8% and lithium - 16.5–16.7%.

Birds were allocated into 2 groups: group I – control ($n = 6{,}136$), group II – experimental ($n = 6136$). Poultry was kept in different units, with similar housing conditions. Broiler-type chickens of the experimental group received feed additive at a dose of 1,269 g L^{-1} ton of feed 5 days before slaughter, the poultry in the control group did not receive any additive in the diet. In the course of the experiment, the clinical status of birds, feeding and keeping conditions were checked. On day 38, broilers were slaughtered. Scheme of the experiment is shown in Table 1.

Table 1. The scheme of the experiment

Group	Heads quantity	Poultry feeding
I group – control	6,136	Main diet
II group – experimental	6,136	Main diet + feed additive 5 days before slaughter

Before slaughter, blood from the bird axillary vein was taken, into vacuum tubes with a coagulation activator. The sample size was 9 heads. The total protein was determined by the refractometric method, urea - by the urease phenol hypochlorite method, creatinine - by the Jaffe color reaction, total lipids - by the color reaction with the sulfophosphovanilic reagent, cholesterol - by the Ilk method, glucose - by the glucose oxidant method, calcium - by the Wilkinson complexometric method, phosphorus - by photometric method with ammonium molybdate.

Poultry growth and development were controlled by individual weighing on Roxell scales. On the basis of weighing, the absolute and average daily gain was calculated.

Broiler-type chicken meat productivity was determined by cutting carcasses and establishing their morphological composition.

Further analyses were conducted in the laboratory of the innovation research center of South Ural State Agrarian University. Production indicators of poultry feeding efficiency and the results of assessing the meat productivity of broiler-type chickens are presented by the poultry farm. Statistical processing of the results of biochemical blood tests and the distribution frequency of causes of mortality in poultry in groups was carried out using the STATISTICA 12 program. Economic efficiency was calculated in accordance with the methodology developed by N.A. Zhuravel and co-authors (Zhuravel et al., 2019).

RESULTS AND DISCUSSION

Biochemical blood tests findings were within the reference values (see Table 2).

In the blood serum of broiler-type chickens of the experimental group, at the level of significant differences, there was a decrease in urea concentration - end product of nitrogen metabolism by 22.54%. The data obtained indicate the maintenance of the protein level in the experimental group of poultry and increased protein utilization in the control.

In the experimental group, the tendency to total lipids content decrease by 6.12% indicated the mobilization of lipid metabolism for the development of adaptive mechanisms, while in the control group, the process of lipid accumulation by the body was observed.

A higher calcium content in the experimental group by 22.5% may indicate an increase in minerals absorption from feed, due to a general improvement in the metabolic functions of the body.

Table 2. Biochemical blood status of broile-type chickens ($X \pm S\bar{x}; n = 9$)

Indicator	Group	
	Control	Experimental
Total protein, g L^{-1}	33.70 ± 0.98	35.65 ± 1.07
Urea, mmol L^{-1}	2.56 ± 0.10	1.99 ± 0.13**
Creatinine, mmol L^{-1}	21.43 ± 1.06	23.88 ± 1.74
Total lipids, g L^{-1}	5.72 ± 0.16	5.37 ± 0.13*
Cholesterol, mmol L^{-1}	4.85 ± 0.14	4.74 ± 0.12
Glucose, mmol L	10.89 ± 0.44	10.12 ± 0.42
Calcium, mmol L^{-1}	2.50 ± 0.13	3.06 ± 0.10**
Phosphorus, mmol L^{-1}	2.17 ± 0.06	2.28 ± 0.12
Calcium-phosphorus ratio	1.15	1.34

Note, hereinafter: * – differences are significant at $P \leq 0.1$; ** – differences are significant at $P < 0.05$.

Average daily and absolute total wight gain, livability and the efficient coefficient are presented in Fig. 1.

Data on production efficiency indicators for broiler-type chickens feeding are presented in average values obtained on a large sample - 6,136 heads. Average daily gain of broiler-type chickens in the experimental group was higher by 0.7%. The absolute increase was 2.3% in comparison with the control group. Data obtained suggested a better feed conversion in the experimental group. Owing to higher indicators of live weight gain and poultry livability in the experimental group, the efficiency coefficient was higher by 16.2 conditional units. The control group was lower than the experimental group in all the studied production parameters: the use of the developed additive had a positive effect on the average daily gain and poultry livability, whereby an additional 288 kg of meat was obtained.

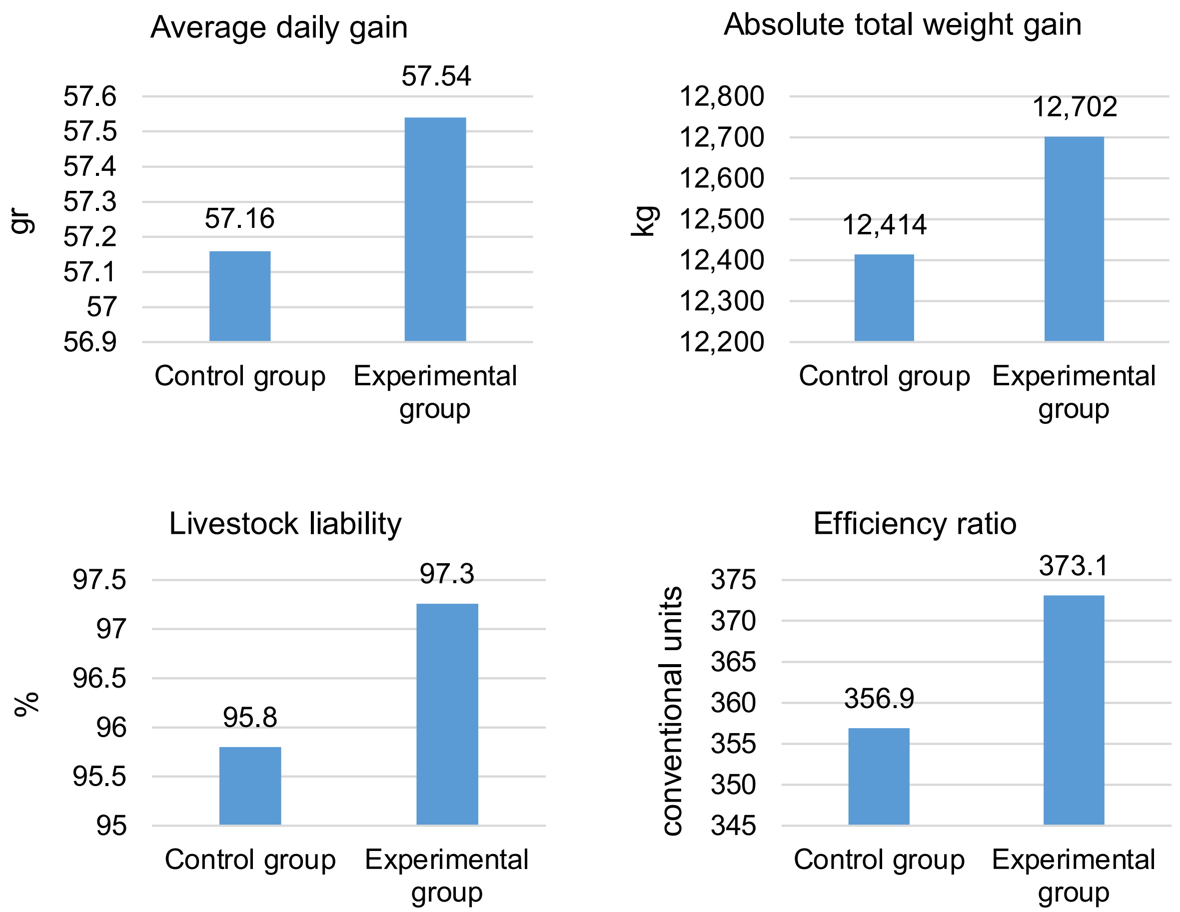

Figure 1. Production indicators of the efficiency of broiler-type chickens ' fattening (*n* = 6,136).

A living body continuously adapts to changing environmental conditions and maintains the necessary level of homeostasis. The trigger for the development of adaptation is the nervous system in connection with the endocrine system. Started flood of internal reactions is marked by the mobilization of energy and plastic resources of the body, owing to which the formation of an adequate response to the stressor occurs. Nevertheless, the physiological body reserves are progressively depleted, especially when the effect of stress factors does not stop or is reinforced by the appearance of new ones. Disorders of homeostasis are followed by changes in metabolism, dysfunction of organs and their systems. If the changes are nonreversible, it can lead to high mortality rates (Kavtarashvili & Kolokolnikova, 2010).

In the birds of the control group that experienced a high stress load at the peak of their productivity, a reduction in the average daily gain owing to the utilization of the body's resources for the development of adaptive mechanisms was observed, whereas in the experimental group feed additive components were consumed in response to the stress impact. Lithium salts by interfering the conductivity of the nerve fiber (Egbert & Ploeger, 1974) may have contributed to the sparing use of body reserves. The antioxidant properties of the components protected the cells from oxidative stress, which is the basis of free radical damage to tissues and organs (Olukosi et al., 2019).

In the experimental group, at the level of trends, there was a lower mortality rate from diseases such as pulmonary edema, intestinal atony, glandular stomach atony and enteritis (see Fig. 2).

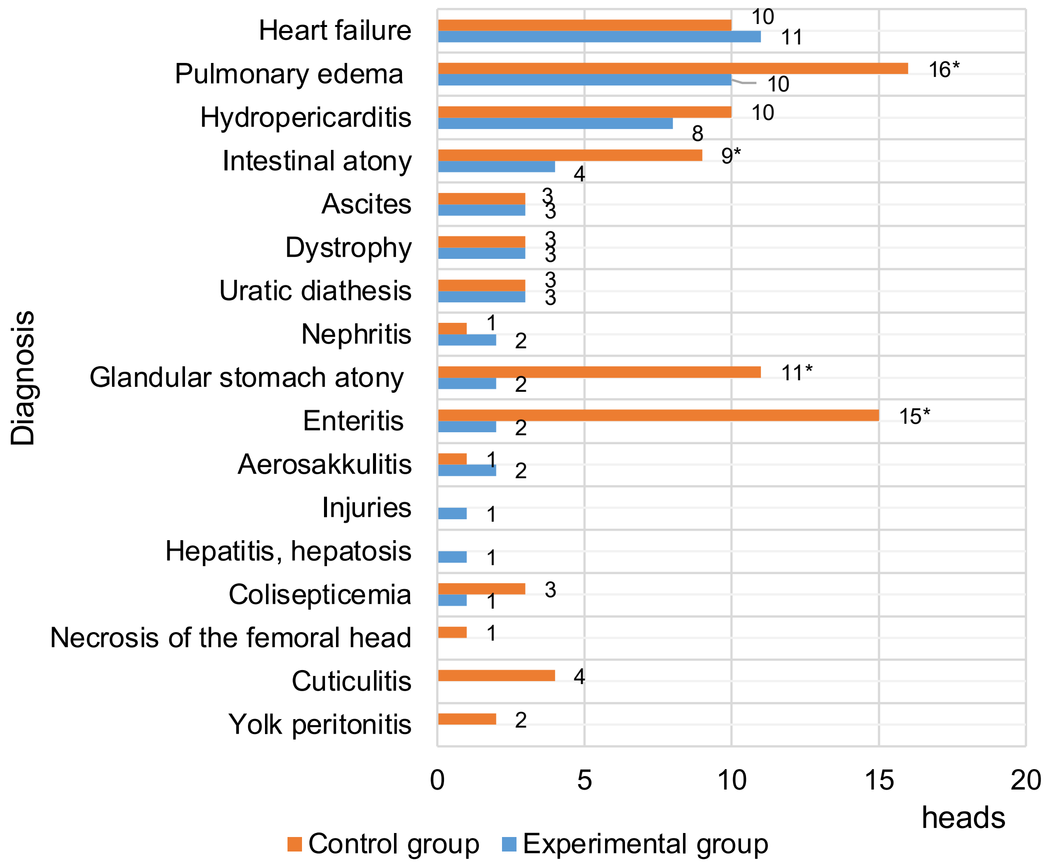

Figure 2. Chicken mortality causes in the experiment period.

Evaluating the reasons for poultry deaths, it was revealed that on day 33–35 in the experimental and control groups, the mortality rate did not exceed 0.1% of the total number of birds, according to the poultry farm requirements for this period. On the 36th day, within the limits of permissible values, there was an increase in the mortality rate of broiler-type chickens in the control group to 0.2%, in contrast to the experimental broiler-type chickens, where the mortality values remained at the same, lower level. By contrast, the mortality rate of broiler-type chickens in the experimental group remained the same. On the final day of fattening process, an increase in mortality rates was observed, with the lowest value of this indicator in the experimental group and the highest in the control group.

No infection episodes were reported during the period of broiler chickens' operation. The same dynamics and etiological factors of death of broiler-type chickens were found in the experimental and control groups. In the experimental group, there was a lower mortality of poultry by 1.5%, owing to higher liability at the final stage of fattening.

Pre-slaughter stage of poultry keeping is characterized by a complex of veterinary, sanitary and technological measures. Prior to slaughter, the poultry is subjected to starvation exposure, clinical examination, catching, loading, transportation, unloading, hanging on the conveyor line, stunning and bleeding. Due to physical impact, the birds could be injured at each stage. Scratches, dislocations, hematomas, hurts, bruises, and fractures appear. Injuries lead to an increase in the defective product level, and meat from stress-sensitive poultry can develop signs of PSE and DFD. By reducing the susceptibility of poultry to the effects of stressors and regulating adaptive mechanisms, a reduction in the number of broiler-type chickens ' injuries and carcass defects is accomplished, as well as an improvement in the meat quality (Miftakhutdinov et al., 2020).

The applied feed supplement appeared to mitigate the negative impact of stress factors on the meat productivity of broiler-type chickens (see Fig. 3).

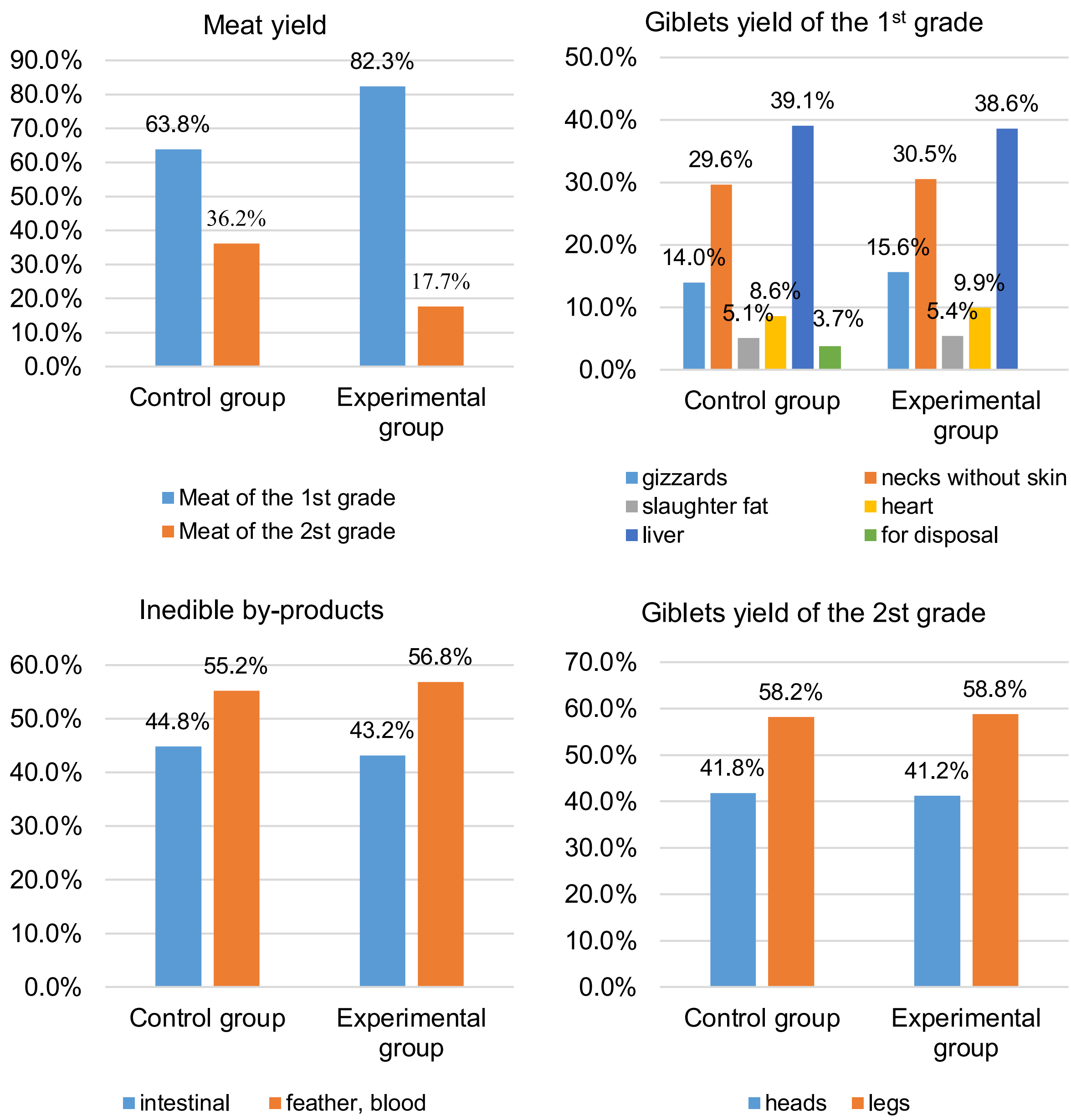

Figure 3. Meat productivity of broiler-type chickens ($n = 50$).

The data on poultry meat productivity represent the results of anatomical cutting of 50 broiler-type chickens (from each group) and are obtained by summing the total weight of meat, by-products and inedible by-products.

In the experimental group of broiler-type chickens, there was an increase in the total yield of poultry meat by 1.4%, including grade 1 - by 18.5%, a decrease in the yield of by-products of categories 1 and 2 by 0.6 and 0, 9% respectively in relation to the control group.

This positive dynamics in the growth indicators of experimental poultry, livability and meat productivity has led to a reasonable increase in economic efficiency (see Fig. 4).

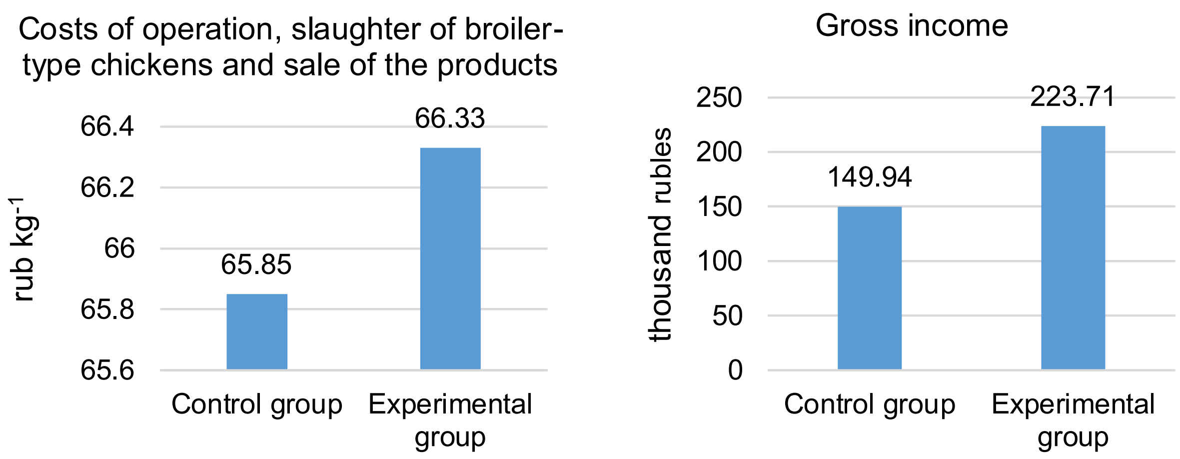

Figure 4. Economic efficiency of the supplement application.

Owing to additional costs for the purchase of components and preparation of feed, the costs of operation, slaughter and sale of products raised and exceeded the control indicator by 0.7% in the experimental group. Nevertheless, operation, livability of livestock, meat yield of the 1st grade enabled to increase the gross income from sales of the experimental group's products by 49.2% and to get additional profit in the amount of 73.77 thousand rubles.

Our research results are compatible with the ones of a number of authors (Fisinin et al., 2016; Kuzminova et al., 2018; Redka et al., 2018; Sobolev et al., 2019; Olukosi et al., 2019; Feng et al., 2020; Tufarelli et al., 2020).

Application of a complex lithium-containing pharmacological supplement had a positive effect on the livability of broiler-type chickens, which in the control group during the study period was lower by 1.24% than in the group where the supplement was used for stress prevention. It is explained by the fact that the components of the pharmacological supplement have adaptogenic properties, forming a mechanism for compensating the resource costs of the body for the development of adaptive processes under stress (Fisinin et al., 2016).

The use of the additive, containing succinic acid, for broiler-type chickens made it possible to achieve high preservation and growth in poultry live weight, by increasing the adaptive potential and optimizing the biochemical processes in the body. By the end of the experiment, the bird of the experimental group surpassed the control in terms of the total protein content in the blood by 9.7–12.2%, live weight - by 7.5%, viability - by 4.0% (Kuzminova et al., 2018).

The addition of lithium salts to the poultry diet increased the intensity of metabolic processes and contributed to higher productivity by increasing the deposition of nutrients in the body. At the same time, the average daily gain in poultry live weight in the experimental groups was higher than the control by 1.6–2.5%. (Sobolev et al., 2019).

Experiments on the influence of copper and zinc salts on metabolic processes showed an increase in the live weight of poultry (Olukosi et al., 2019). A meta-analysis of the evaluation also found a positive correlation between the intake of copper in the diet and the productivity of broilers (Feng et al., 2020). The use of a feed complex with zinc in its composition increased the protein content in the blood of the experimental group by 11.9–13.8% comparing to the control group. The authors determined an increase in the level of calcium and phosphorus in the blood, which they associate with better assimilation of these substances from feed (Redka et al., 2018).

Periods of operation and fattening broiler-type chickens are associated with intensive protein synthesis. The additional introduction of L - carnitine into the poultry diet, which has a positive effect on the growth and development of broiler-type chickens, promotes this process with a high degree of confidence ($p < 0.05$) (Tufarelli et al., 2020).

CONCLUSION

Therefore, application of a stress-inducing supplement in the pre-slaughter period enables to maintain high production rates of poultry breeding and, thereby, increase the efficiency of poultry farming. Owing to this, the use of a stress-inducing supplement in the pre-slaughter period allows to enhance the efficiency of poultry farming. As a result of the removal of technological stresses from poultry body, with the help of feed additive, the intensity of the increase in live weight is maintained, the level of preservation and meat grade is increased.

COMPLIANCE WITH ETHICAL STANDARDS:
All applicable international, national, and/or institutional guidelines for the care and use of animals were followed.

REFERENCES

Cândido, M.G.L., Tinôco, I.F.F., Barbari, M., Freitas, L.C.S.R., dos Santos, T C., Andrade, R.R., Gates, R.S., Conti, L. & Rossi, G. 2019. Effect of environmental temperature during the of brooding period on growing period of pullets viscera and tibia. *Agronomy Research* **17**(2), 371–377.

Di Martino, G., Capello, K., Russo, E., Mazzucato, M., Mulatti, P., Ferre, N., Garbo, A., Brichese, M., Marangon, S. & Bonfanti, L. 2017. Factors associated with pre-slaughter mortality in turkeys and end of lay hens. *Animal* **11**(12), 2295–2300.

Egbert, J. & Ploeger, 1974. The effects of lithium on excitable cell membranes . On the mechanism of inhibition of the sodium pump of non-myelinated nerve fibres of the rat. *European Journal of Pharmacology*, **25**(3), 316–321.

Feng, C., Xie, B., Wuren, Q. & Gao, M.H. 2020. Meta-analysis of the correlation between dietary copper supply and broiler performance. *Plos One* **15**(5), 14.

Fisinin, V.I., Miftakhutdinov, A.V. & Anosov, D.E. 2016. Pharmacological prevention of stress during chicken debeaking. *Russian Agricultural Sciences* **42**(1), 97–100.

Grilli, C., Loschi, A.R., Rea, S., Stocchi, R., Leoni, L. & Conti, F. 2015. Welfare indicators during broiler slaughtering. *British Poultry Science* **56**(1), 1–5.

Jacobs, L., Delezie, E., Duchateau, L., Goethals, K. & Tuyttens, F.A.M. 2017a. Broiler chickens dead on arrival: associated risk factors and welfare indicators. *Poultry Science* **96**(2), 259–265.

Jacobs, L., Delezie, E., Duchateau, L., Goethals, K. & Tuyttens, F.A.M. 2017b. Impact of the separate pre-slaughter stages on broiler chicken welfare. *Poultry Science* **96**(2), 266–273.

Kavtarashvili, A. Sh. & Kolokolnikova, T.N. 2010. Physiology and productivity of the birds under stress (review). *Agricultural Biology* **4**, 25–37.

Kittelsen, K.E., Granquist, E.G., Kolbjornsen, O., Nafstad, O. & Moe, R.O. 2015a. A comparison of post-mortem findings in broilers dead-on-farm and broilers dead-on-arrival at the abattoir. *Poultry Science* **94**(11), 2622–2629.

Kittelsen, K. E., Granquist, E.G., Vasdal, G., Tolo, E. & Moe, R.O. 2015b. Effects of catching and transportation versus pre-slaughter handling at the abattoir on the prevalence of wing fractures in broilers. *Animal Welfare* **24**(4), 387–389.

Kuzminova, E.V., Semenenko, M.P., Zholobova, I.S. & Antipova, D.V. 2018. Scientific and Practical Aspects of the Application of a Biologically Active Adaptogenic Additive in Poultry Farming. *Research Journal of Pharmaceutical Biological and Chemical Sciences* **9**(5), 2303–2309.

Langkabel, N., Baumann, M.P.O., Feiler, A., Sanguankia, T.A. & Fries, R. 2015. Influence of two catching methods on the occurrence of lesions in broilers. *Poultry Science* **94**(8), 1735–1741.

Miftakhutdinov, A.V., Velichko, O.A., Shabaldin, S.V., Sayfulmulyukov, E.R., Nogovitsina, E.A. & Grigorieva, M.A. 2019. Supplement for increasing meat productivity and meat quality of broiler-type chickens in conditions of technological stress. *Patent for an invention*. RU 2701656 C1. September 30, 2019. Application No. 018140306 as of November 14, 2018.

Miftakhutdinov, A.V., Sayfulmulyukov, E.R., Nogovitsina, E.A. & Miftakhutdinova, E.A. 2020. Quality and safety of broiler meat and the correction of pre-slaughter stress **34**(3), 71–74.

Oliveira, K.P., Ferreira, C.F.S., Tinoco, I.F.F., Andrade, R.R., Barbari, M. & Cruz, V.M.F., Baptista, F.J.F., Vieira, M.F.A., Conti, L. & Rossi, G. 2018. Productive performance of broilers at the final stage of breeding submitted to different levels of metabolizable energy in different thermal environments. *Agronomy Research* **16**(2), 556–563.

Olukosi, O.A., van Kuijk, S.J.A. & Han, Y.M. 2019. Sulfate and hydroxychloride trace minerals in poultry diets - comparative effects on egg production and quality in laying hens, and growth performance and oxidative stress response in broilers. *Poultry Science* **98**(10), 4961–4971.

Queiroz, M.L.d.V., Barbosa, Filho, J.A.D., Duarte, L.M., Brasil, D.d. & Gadelha, C.R.F. 2015. Environmental and Physiological Variables During the Catching of Broilers. *Brazilian Journal of Poultry Science Jan-Mar*. 2015 **17**(1), 37–43.

Redka, A.I., Bomko, V.S. & Babenko, S.P. 2018. Broiler chickens biochemical blood indicators by the zinc sulfate and zinc-mixed ligand complex feeding. *Nauchno-tekhnicheskiy byulleten' Instituta zhivotnovodstva Natsional'noy akademii agrarnykh nauk Ukrainy* **120**, 127–135.

Shatskikh, E.V. & Molokanova, O.V. 2019. Feed additive proteolytic action in the composition of feed for broiler chickens. *Agrarian Bulletin of the Urals* **8**(187), 50–54. doi: 10.32417/article_5d908d82c66c44.30527886

Shatskikh, E.V., Nufer, A.I. & Drozdova, L.I. 2020. Digestibility of dietary nutrients and morphohistological changes in the pancreas and duodenum of broiler chickens against the background of replacement of feed antibiotics with a complex phytobiotic drug. *Agrarian Bulletin of the Urals* **12**(203), 61–67. doi: 10.32417/1997-4868-2020-203-12-61-67.

Sobolev, O.I., Gutyj, B.V., Soboliev, S.V., Fesenko, V.F., Bilkevych, V.V., Babenko, O.I., Klopenko, N.I., Kachan, A.D., Kosior, L.T., Lastovska, I.O., Vered, P.I., Shulko, O.P., Onyshchenko, L.S. & Slobodeniuk, O. 2019. The influence of different doses of lithium additive in mixed feed on the balance of nitrogen in organism of goslings. *Ukrainian Journal of Ecology* **9**(2), 91–96.

Spurio, R.S., Soares, A.L., Carvalho, R.H., Silveira, V., Grespan, M., Oba, A. & Shimokomaki, M. 2016. Improving transport container design to reduce broiler chicken PSE (pale, soft, exudative) meat in Brazil. *Animal Science Journal* **87**(2), 277–283.

Tufarelli, V., Mehrzad-Gilmalek, H., Bouyeh, M., Qotbi, A., Amouei, H. & Seidavi, A., Paz, E. & Laudadio, V. 2020. Effect of Different Levels of L-carnitine and Excess Lysine-Methionine on Broiler Performance, Carcass Characteristics, Blood Constituents, Immunity and Triiodothyronine Hormone. *Agriculture-Basel* **10**(4), 8.

Vieira, F.M.C., Deniz, M., da Silva, I.J.O., Barbosa, J.A.D., Vieira, A.M.C. & Goncalves, F.S. 2015. Pre-slaughter losses of broilers: effect of time period of the day and lairage time in a subtropical climate. *Semina-Ciencias Agrarias* **36**(6), 3887–3895.

Zhuravel, N.A., Miftakhutdinov, A.V. & Suchanova, S.F. 2019. Economic assessment of stress prevention in broiler chickens in the pre-slaughter period. *IOP Conference Series: Earth and Environmental Science. The proceedings of the conference AgroCON-2019* **012056**.