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STRESS-PROTECTIVE PROPERTIES OF THE 1,2,4-TRIAZOLE-3-THIOL DERIVATIVES COMPOUND UNDER ACUTE STRESS CONDITIONS OF LAYING HENS

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A new synthesized substance codenamed ASP-34 was used as the research object. The stress-protective properties were studied during prophylactic oral consumption of the compound under conditions of 4-hour acute heat and immobilization stress of laying hens in comparison to the control groups and the reference substance with proven stress-protective, hepatoprotective and immunostimulating effects «Cyanophor» (cyanocobalamin+butaphosphane).

In serum and liver homogenate, the content of markers of the antioxidant-prooxidant system was determined: the quantitative content of diene conjugates (DC), thiobarbituric acid reactants (TBA-reactants), as well as the activity of catalase and superoxide dismutase (SOD).

The results of the study demonstrate the presence of probable stress-protective properties of the 1,2,4-triazole-3-thiol derivative compound ASP-34 on the model of acute 4-hour heat and immobilization stress of laying hens. The test sample compound of the 1,2,4-triazole-3-thiol derivative ASP-34 in this study contributed to the restoration of the levels of TBA-reactants and DC (both in the serum and in the liver parenchyma) to the levels of similar indicators in negative control group ($p>0.05$ vs. NC). Moreover, there was also a tendency to increase the serum activity of SOD by 2.4 times ($p=0.09$) from the values of this indicator in the positive control group. According to the results of the biochemical study, it is clear that both of the tested agents in the indicated doses showed an antioxidant effect against the background of acute thermal and immobilization stress of chickens, but no significant difference between the activity of the two agents was noted.

The practical value of the obtained results is the confirmation of the stress-protective properties of the compound of the 1,2,4-triazole-3-thiol derivative ASP-34 on the model of acute 4-hour heat and immobilization stress of laying hens and the following recommendation for conducting tests in production conditions.

Key words: 1,2,4-triazole-3-thiol derivatives, stress-protective action, acute stress, antioxidant system, laying hens.

СТРЕС-ПРОТЕКТОРНІ ВЛАСТИВОСТІ СПОЛУКИ ПОХІДНИХ 1,2,4-ТРИАЗОЛ-3-ТІОЛУ ЗА УМОВ ГОСТРОГО СТРЕСУ У КУРЕЙ НЕСУЧОК

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В якості об'єкта досліджування використовували нову синтезовану речовину під шифром «АСП-34». Досліджували стреспротекторні властивості за профілактичного перорального задавання сполуки в умовах 4 годинного гострого теплового та іммобілізаційного стресу у курей несучок у порівнянні до груп контролю та референтного засобу з доведеними стрес-протекторним, гепатопротекторним та імуностимулюючим ефектами «Цианофор» (ціанокобаламін+бутафосфан).

В сироватці і гомогенаті печінки визначали вміст маркерів антиоксидантно-прооксидантної системи: кількісний вміст дієнових кон'югатів (ДК), реактантів тіобарбітурової кислоти (ТБК-реактанти), а також активність каталази та супероксиддисмутази (СОД).

Результати дослідження демонструють наявність вірогідних стрес-протекторних властивостей у сполуки похідної 1,2,4-триазол-3-тіолу під шифром «АСП-34» на моделі гострого 4 годинного теплового та іммобілізаційного стресу у курей несучок. Тестовий-зразок сполуки похідної 1,2,4-триазол-3-тіолу під шифром «АСП-34» в даному досліджені сприяв відновленню рівнів ТБК-реактантів і ДК (як в сироватці, так і в паренхімі печінки) до рівнів аналогічних показників в групі негативного контролю ($p>0,05$ проти НК). При цьому також відмічалася тенденція до збільшення сироваткової активності СОД в 2,4 рази ($p=0,09$) від значень даного показника в групі позитивного контролю. За результатами біохімічного дослідження очевидно, що обидва досліджуваних засоби в зазначених дозах виявляли антиоксидантний ефект на тлі гострого стресу теплового та іммобілізаційного у курей, проте вагомої різниці між активністю двох засобів не відмічалося.

Практичною цінність отриманих результатів є підтвердження стрес-протекторних властивостей у сполуки похідної 1,2,4-триазол-3-тіолу під шифром «АСП-34» на моделі гострого 4 годинного теплового та іммобілізаційного стресу у курей несучок та наступна рекомендація до проведення випробувань у виробних умовах.

Ключові слова: похідні 1,2,4-триазол-3-тіолу, стрес-протекторна дія, гострий стрес, антиоксидантна система, кури несучки.

Introduction. The economic transformations that began in our country a few years ago affected all branches of the agricultural industry, not bypassing even the most stable and prosperous ones like poultry farming. In the process of reforming agriculture in Ukraine, there was a reduction in the number of animals and poultry, as well as their

productivity. As a result, only 60-70% of the population's needs for livestock and poultry products are met.

In connection with the importation of poultry from abroad, diseases that had not previously been encountered in our country were registered. The fate of Ukrainian poultry farming worries both practitioners and scientists. There is a constant search for a way out of the crisis. The ultimate goal is the efficient use of all reserves and the profitability of poultry farming.

In industrial poultry production, progress is closely related to the improvement of existing and the development of new methods of regulating the conditions of the external environment, taking into account the peculiarities of the biology of chickens, using the achievements of genetics and selection in the creation of highly productive breeds, crosses and lines with high and stable resistance to infectious diseases under strict compliance with the rules of veterinary protection of poultry health and adaptability to industrial technology.

Scientists are constantly working on improving standards, developing resource-saving technologies, the implementation of which will allow farms to increase the profitability of production.

The task of fully providing the population with poultry products is of great importance. The most important condition for increasing the production of these dietary food products is the intensification of production based on the use of techniques aimed at increasing productivity in poultry farming. Together with the increase of the fodder base and the improvement of the technology of keeping chickens, it is crucial to use various substances that accelerate growth and contribute to the preservation of its vitality and productivity when the poultry is affected by adverse factors.

The intensification of production in the poultry industry increases the load on the chicken's body, technological processes, veterinary treatments, poor-quality feed are stress factors for the chicken’s body in the conditions of poultry enterprises. The demand for stress-protective agents under conditions of profitability in the poultry industry is relevant.

Industrial poultry farming is the most sensitive branch of agriculture to heat stress. First of all, this is related to the peculiarities of the chicken's body. Sensitivity to high temperatures is facilitated by the dense covering of the skin with feathers, the absence of sweat glands, as well as the high density of stocking. More and more often, the summer months of the year are associated in Ukraine with abnormally high temperatures and droughts. In animal husbandry and poultry, losses from such weather conditions can reach enormous scales.

Under the influence of high temperature in the poultry house (35–40 °C), the body temperature of the chicken rises by 0.5–1 °C, which leads to an increase in water consumption by 2–3 times. Further increase in the temperature in the poultry house and, accordingly, the body temperature by 1.5–2 °C, leads to the death of the chicken. In addition, an excessively high temperature of the environment triggers a whole complex of negative reactions in the body in the form of oxidative stress: the balance in the chicken's body between the production of free radicals and the level of antioxidants that neutralize them is disturbed. Under normal conditions, the number of free radicals is about 5% of the total number of metabolites. In the event of stress, particularly thermal stress, their level increases sharply, and the functional capabilities of the body as a whole decrease rapidly.

Heat stress is accompanied by a decrease in poultry productivity. The level of feed consumption falls and, accordingly, increases and egg production decrease, feed

conversion, protein and shell quality deteriorate, mortality and culling of chickens increases. In other words, the economic efficiency of production deteriorates.

Accordingly, in the prevention of heat stress, it is important to comply with technological veterinary and sanitary requirements for keeping poultry, which relate to the arrangement of premises for keeping poultry (improvement of ventilation, water supply, etc.).

In addition, feed or medicinal supplements that provide energy balance in the chicken's body, protect against dehydration, and support the body in the fight against oxidative stress have a positive effect. Means of foreign production are high-cost, therefore, the creation and research of the effectiveness of stress-protective means of domestic production is an urgent issue.

Organic compounds containing nitrogen atoms represent a large group of chemical structures of both natural and synthetic origin that can exhibit a wide range of biological activity. In this regard, the 1,2,4-triazole system, a five-membered nitrogen-containing heterocycle, has attracted active scientific attention (Shcherbyna, R., 2019). Therefore, compounds that contain a 1,2,4-triazole cycle in their structure are among the most promising objects of pharmacological research.

1,2,4-triazole derivatives are widely used in pharmaceutical and medicinal chemistry as well as in organic synthesis (Gao, F., Wang, T., Xiao, J. & Huang, G, 2019). For example, such drugs as fluconazole, bevacizumab (Avestim), tripuzol-neo, itraconazole, thiotriazoline and many other substances containing a 1,2,4-triazole cycle have been used in clinical and veterinary practice.

In our opinion, the study of structures with two bridged 1,2,4-triazole cycles belonging to different chemical classes may lead to the discovery of quite promising compounds that demonstrate versatility.

Taking into account previous studies, it can be stated that a large number of 1,2,4-triazole derivatives show a significant ability to inhibit the growth of pathogenic bacteria (Onkol, T., Doğruer, D. S., Uzun, L., Adak, S., Ozkan, S., & Sahin, M.F., 2008). In 2020, the antimicrobial activity of morpholine 2-(5-(3-fluorophenyl)-4-amino-1,2,4-triazol-3-yl)thio)acetate was evaluated in a rat model of experimental pancreatitis (Bigdan, O.A., Parchenko, V.V. & Kyrychko B.P., 2016). Furthermore, a research group from India studied the antimicrobial properties of new asymmetric bis-1,2,4-triazoles, demonstrating moderate bacteriostatic activity of the synthesized compounds against strains of *B. Subtilis, S. Aureus, E. Coli* and *P. Aeruginosa*. Feng Gao et al. showed (Gao, F., Wang, T., Xiao, J., & Huang, G., 2019) that the hybridization of the 1,2,4-triazole with other antibacterial pharmacophore groups can yield even more effective substances in this regard. The study conducted in China describes the recent results of targeted quinoline/quinone hybridization of 1,2,4-triazole, which holds promise for the treatment of infections caused by resistant bacterial strains (Zhang, J., Wang, S., Ba, Y., & Xu, Z., 2019).

Oxidative stress plays a crucial role in the development of a large group of diseases and pathologies, increasing with age (Cunha Lima, J.A.D., DE Farias Silva, J., Santos, C. S., Caiana, R.R.A., DE Moraes, M.M., DA Câmara, C.A.G., & Freitas, J.C.R., 2021). Accordingly, the discovery and development of protective agents against oxidative stress are of great interest. One possible approach to the development of new antioxidants involves the use of virtual screening through molecular docking with the enzyme superoxide dismutase (SOD) (Gurunanjappa et al. 2016, Kumar et al. 2016, Hatai & Banerjee 2019). SOD acts as an endogenous antioxidant defense system by converting hydrogen peroxide-derived superoxide radicals into water and oxygen to neutralize these species and thus prevent their damaging effects on cellular components

(Moloney & Cotter 2017; AL A, Kumar A, Singh V, Yadav B, Tiwari R, Chakraborty S & Dhama K. 2014.).

Among the classes of organic compounds that increase SOD activity, 1,2,3-triazoles stand out (Atapute P, Sanakal RD, Mulla SI & Kaliwal B., 2019, Zhang L et al. 2016.). 1,2,3-triazoles are heterocyclic compounds that are readily prepared by the Cu(I)-catalyzed azide-alkyne cycloaddition (CuAAC) reaction. These compounds serve as analogues of various biological functional groups that act as donors and acceptors of hydrogen bonds (Dheer D, Singh V & Shankar R. 2017., Agalave SG, Maujan SR & Pore VS. 2011., Santos CS, Oliveira RJ, Oliveira RN & Freitas JCR. 2020).

The purpose of this work was to determine the stress-protective properties of compounds of 1,2,4-triazole-3-thiol derivatives on the model of acute thermal and immobilization stress of laying hens.

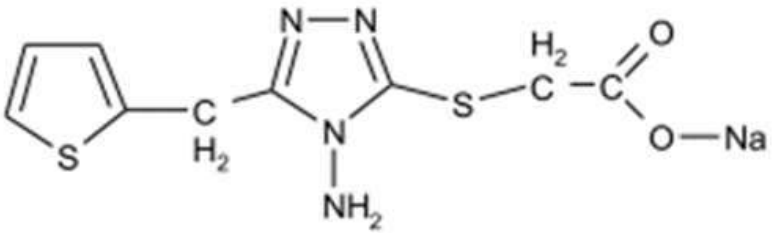
Materials and methods. The research was carried out on the basis of the "Veterinary Pharmacy" and "Innovative Technologies and Safety and Quality of Livestock Products" laboratories of the Department of Microbiology, Veterinary and Sanitary Examination, Animal Hygiene and Quality and Safety of Livestock Products of the Faculty of Veterinary Medicine of the Sumy National Agrarian University, Department of Toxicological and Inorganic Chemistry of Zaporizhzhya State University of the Medical and Pharmaceutical University, Educational and Scientific Institute of Applied Pharmacy of the National Academy of Sciences (Kharkiv).

The study was aimed at studying the stress-protective properties of a new synthesized substance under the code ASP-34 on poultry in conditions of acute immobilization and heat stress.

The substance was synthesized by the authors' team of the Department of Natural Sciences for Foreign Students and Toxicological Chemistry of ZSMFU (Zaporizhzhia): Yevgeny Knysh, Oleksandr Ivanovych Panasenko, Andriy Andriyovych Safonov. (Patent of Ukraine UA 112619 C2 "Sodium 2-((4-amino-5-(thiophen-2-ylmethyl)-4h-1,2,4-triazol-3-yl)thio)acetate, which provides actoprotective activity") (Fig. 1).

The formula of the invention

Sodium 2-((4-amino-5-(thiophen-2-ylmethyl)-4h-1,2,4-triazol-3-yl)thio) acetate:



which exhibits actoprotective activity

Fig. 1. **Formula of the invention Sodium 2-((4-amino-5-(thiophen-2-ylmethyl)-4h-1,2,4-triazol-3-yl)thio) acetate**

The study of stress-protective properties was carried out on 28 laying hens of the Dekalb White cross, aged 430 days, which were kept under standard conditions (temperature 25-28 °C, relative humidity 60±10%, 8:16 hour day-night cycle, with free access to water and food) on the basis of the Sumy National Agrarian University vivarium. All stages of the research were carried out in accordance with Directive

2010/63/EU of the European Parliament and the Council of the EU dated September 22, 2010 "On the protection of animals used for scientific purposes" (Protocol of the Bioethics Commission No. 6 dated June 8, 2021) (Guide for the care and use of laboratory animals, 2011, Directive 2010/63/EU).

For the study, the chickens were randomized according to the indicator of minimization of differences in average body weight into 4 experimental groups (7 heads in each):

1. Negative control (NC) – chickens that were not subjected to immobilization stress (group I);

2. Reference group (RG) – chickens that received a reference sample under the immobilization stress (group II);

3. Positive control (PC) – chickens that were subjected to immobilization stress without the use of any means (group III);

4. Experimental group (EG) – chickens that received a test sample under the immobilization stress (group IV).

A new synthesized substance codenamed ASP-34 was used as the research object. Taking into account the results of previous studies, a dose of 100 mg/kg was chosen in this experiment, which has already demonstrated the presence of actoprotective properties. The drug with proven stress-protective, hepatoprotective and immunostimulating effects "Cyanophor" (cyanocobalamin+butaphosphan) was used as a comparison drug in the recommended dose according to the instructions (1 ml/head).

The studied substances were given orally (by the method of individual drinking) in the form of a suspension with purified water. Substances were given daily for 10 days in appropriate doses on an empty stomach from 9:00 a.m. to 10:00 a.m.

On the 10th day, 1 hour after the last consumption of the substances, simulation of thermal and immobilization 4-hour stress with withdrawal of food and water was carried out. For this, chickens from 3 groups (except the negative control group) were kept in tight boxes (without access to water and feed) for 4 hours from 7:00 to 11:00. The temperature in the boxes at the beginning of the test was 26^{o}C, after 20 minutes it rose to 31^{o}C, after 4 hours it was 32-33^{o}C.

39 hours after the end of the thermal and immobilization 4-hour stress, the poultry was slaughtered in accordance with the principles of humanity by the method of decapitation. The period before slaughter was determined by the period of manifestation of changes at the stress-reaction stage. Whole blood was collected during decapitation. Blood serum was obtained by centrifugation at 1500 g for 10 minutes on an Eppendorf 5702R refrigerated centrifuge (Eppendorf, Germany). All received serum samples were stored at -20^{o} C.

An autopsy of the chicken was carried out in order to record pathological and anatomical signs, and liver samples were taken for biochemical research.

In serum and liver homogenate, the content of markers of the antioxidant-prooxidant system was determined: the quantitative content of diene conjugates (DC), thiobarbituric acid reactants (TBA-reactants), as well as the activity of catalase and superoxide dismutase (SOD). Verification of the results of biochemical studies (absorption) was carried out by photometric methods on a KFK-3 photoelectrocolorimeter and a SF-46 spectrophotometer.

Quantitative DC content in samples of biological material was determined photometrically by a routine method after extraction with heptane at a wavelength of 233 nm (Katerji, M., Filippova, M., & Duerksen-Hughes, P., 2019; Facundo H. T. F., Brandt C. T., Owen J. S., Lima V.L.M., 2004).

Analysis of TBA-reactants was carried out according to a standard reaction with thiobarbituric acid, after protein precipitation with trichloroacetic acid, the optical density of the sample was measured against a control sample at 532 nm (Katerji, M., Filippova, M., & Duerksen-Hughes, P. , 2019; Borgesa A. C. P., Piassãoa J. F. G., 2018).

Catalase activity was determined by a generally accepted method based on the reaction of the formation of colored complexes of hydrogen peroxide and ammonium molybdate with an optimal absorption length of 410 nm (Korzhov V. I., Zhadan V. M., Polianska M. O., Opimakh S. H. & Ihnatieva, 2022; V. I. Nandi, A., Yan, L.J., Jana, C.K., & Das, N., 2019).

To determine the activity of SOD in samples of biological material, autooxidation of adrenaline at a wavelength of 347 nm was determined by dynamics every minute for 3 minutes; enzyme activity was expressed in conventional units, which corresponded to the percentage of inhibition (Kopanytsia, O.M., 2017).

The obtained results were expressed as arithmetic mean (M) and standard error of the mean (SEM). Comparisons between the studied groups were performed using parametric methods of analysis (ANOVA, post-hoc Tukey HSD test). The probability of differences was determined at the significance level of $P<0.05$. Statistical processing was carried out using the basic package of MS Exel 2007 and IBM SPSS Statistics 22 (Indrayan, A. & Malhotra, K. R., 2018).

Study of the influence of the 1,2,4-triazole-3-thiol derivative compound ASP-34 on the biochemical parameters of the antioxidant system of blood serum and liver tissues of laying hens under conditions of acute thermal and immobilization stress

Under the conditions of pathology in the chicken, the pro-/antioxidant system was predicted to be impaired, which was reflected in the imbalance of the serum and tissue content of lipid peroxidation products and the activity of antioxidant defence enzymes. The results of biochemical measurements are shown in Table 1.

Thus, in the blood plasma of animals of the positive control group, against the background of stress factors, there was a tendency to an increase in the content of TBA-reactants in the blood serum by 43.9% ($p=0.06$), a probable increase in the content of DC by 53.3%, and a probable decrease activity of SOD by 78.6% compared to similar indicators in the NC group. In turn, a statistically significant decrease in catalase activity by 19.4% and SOD by 55.4%, as well as an increase in the content of TBA-reactants by 134.9% and DC by 42.8% was observed in the homogenate of the liver of animals of the PC group ($p< 0.05$ against NC).

Against the background of the application of the reference agent to laying hens, there was a significant normalization of the content of TBA-reactants and DC in the blood plasma and the content of TBA-reactants in the homogenate of liver tissues, as well as a probable increase in the activity of SOD in the blood serum by 2.6 times and a decrease in the content of DC in the homogenate tissues by 18.1% ($p<0.05$ vs PC).

The test sample of the 1,2,4-triazole-3-thiol derivative compound ASP-34 in this study contributed to the restoration of the levels of TBA-reactants and DC (both in the serum and in the liver parenchyma) to the levels of similar indicators in negative control group ($p>0.05$ vs. NC). At the same time, there was also a tendency to increase the serum activity of SOD by 2.4 times ($p=0.09$) from the values of this indicator in the positive control group.

According to the results of the biochemical study, it is clear that both of the tested agents in the specified doses have an antioxidant effect on chickens under the acute thermal and immobilization stress, but no significant difference between the activity of the two agents was noted. Thus, it can be noted that the antioxidant effect of both agents

in the studied doses under conditions of acute stress of chickens is comparable (Table 1).

Table 1

The influence of ASP-34 on biochemical indicators of the antioxidant system of blood serum and liver tissues of chickens under conditions of acute stress (n=7, M±SEM)

Indicators	I (NC)	II (RG)	III (PC)	IV (EG)
In blood serum				
Catalase, μmol/(min*l)	24.324± 2.605	18.530± 2.767	17.053± 1.204	19.723± 1.989
TBA-reactants, μmol/l	0.264± 0.026	0.244± 0.037 [c]	0.380± 0.031 [b. d]	0.251± 0.028 [c]
DC, μmol/l	0.287± 0.024 [c]	0.312± 0.008 [c]	0.440± 0.017 [a. b. d]	0.344± 0.024 [c]
SOD, d. unit (% inhibition)	29.429± 3.470 [b. c. d]	16.571± 2.277 [a. c]	6.286± 1.426 [a. b]	14.857± 2.293 [a]
In the liver homogenate				
Catalase, μmol/(min*l)	2.573± 0.104 [b. c. d]	2.086± 0.079 [a]	2.074± 0.106 [a]	2.173± 0.101 [a]
TBA-reactants, μmol/l	77.653± 10.924 [c]	101.096± 15.967 [c]	182.410± 23.466 [a. b. d]	93.769± 15.193 [c]
DC, μmol/l	79.251± 4.472 [b. c]	92.726± 3.735 [a. c]	113.180± 2.172 [a. b. d]	83.896± 2.934 [c]
SOD, d. unit (% inhibition)	17.286± 1.886 [c]	12.571± 2.959	7.714± 1.584 [a]	14.571± 2.308

Notes:
[a] *– the differences are probable relative to the NC group (p<0.05);*
[b] *– the differences are probable relative to the RG group (p<0.05);*
[c] *– the differences are probable relative to the PC group (p<0.05);*
[d] *– differences are probable relative to the EG group (p<0.05).*

Discussion. Scientists around the world are drawing attention to a wide range of pharmacological properties of 1,2,4-triazole-3-thiol derivatives. For example, Zahid H. Chohan and Muhammad Hanif from Bahauddin Zakaria University investigated the antibacterial and antifungal activity of 1,2,4-triazole derivatives and showed that divalent metal complexes can be more powerful antibacterial and antifungal drugs than the precursors of Schiff's bases (Chohan , Z.H., & Hanif, M., 2013).

Kumar, H., Javed, S. A., Khan, S. A., & Amir, M. (2008) synthesized a series of 1,3,4-oxadiazole/thiadiazole and 1,2,4-triazole derivatives of biphenyl-4-yloxyacetic acid with the aim of obtaining new compounds with potential anti-inflammatory activity, analgesic activity and less ulcerogenic potential. All compounds were evaluated for their anti-inflammatory activity using the carrageenan-induced rat paw edema test. Compounds with strong anti-inflammatory activity were further tested for their analgesic, ulcerogenic and antioxidant effects. Of all the compounds tested, compounds 3, 7, 17, and 20 demonstrated a significant reduction in rat paw edema induced by carrageenan treatment. These compounds showed significant analgesic effects and, at equimolar oral doses compared to flurbiprofen, were also non-gastrotoxic in rats. Compound 17

was evaluated as the lead compound, which has higher anti-inflammatory activity (81.81%) than the comparator (79.54%), low ulcerogenic potential and protective effect on lipid peroxidation.

Cunha Lima, J. A. D., DE Farias Silva, J., Santos, C. S., Caiana, R. R. A., DE Moraes, M. M., DA Câmara, C. A. G., & Freitas, J. C. R. (2021). obtained the compounds semisynthetically via Cu(I)-catalyzed azide-alkyne cycloaddition (CuAAC) reaction between ethyl 2-azidoacetate and terminal acetylenes obtained from the natural products carvacrol, eugenol, isovanillin, thymol, and vanillin. The products were obtained in 50 to 80% yield and characterized using several spectrographic methods. Antioxidant activity was investigated using 2,2-diphenyl-1-picrylhydrazyl (DPPH) and 2,2'-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid) (ABTS). The authors confirm that the products showed moderate antioxidant activity, with ethyl 2-(4-((4-formyl-2-methoxyphenoxy)methyl)-1H-1,2,3-triazol-1-yl)acetate showing the highest antioxidant capacity (EC 50 = 75.5 μg/ml) among the 1,4-disubstituted 1,2,3-triazoles formed. As a result, the formation of these compounds opens up new opportunities for the development of new antioxidants.

The results of our study also demonstrate the presence of probable stress-protective properties of the 1,2,4-triazole-3-thiol derivative ASP-34 in the model of acute thermal and immobilization stress of laying hens.

Conclusions

Under the conditions of acute thermal and immobilization stress of 4-hour stress of laying hens (which also caused oxidative stress), under the influence of the compound 1,2,4-triazole-3-thiol derivative ASP-34 a probable decrease in peroxide markers was determined oxidation of lipids in the serum and liver of poultry, which indicates the presence of mediated antioxidant and membrane-protective properties of the studied agent.

Prospects for further research include studying the effectiveness of the 1,2,4-triazole-3-thiol derivative ASP-34 under industrial conditions.

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Conflict of interest

There is none

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