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ANTIOXIDANT BALANCE AND DIHYDROGEN SULFIDE CONTENT IN THE SALIVARY GLANDS OF RATS UNDER CONDITIONS OF IMMOBILIZATION STRESS AND SO_2 DONOR ADMINISTRATION

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Background. *Sulfur dioxide (SO_2) is proposed as a novel gasotransmitter that is endogenously formed depending on the activity of aspartate aminotransferase, glutathione synthetase, and dihydrogen sulfide content. SO_2 and its donors can potentially have a corrective effect in reducing oxidative stress-induced injuries under conditions of adaptation syndrome. Salivary glands are highly sensitive to stressors, but SO_2 role in these organs under stress and general adaptation syndrome is largely unknown.* ***Objective.*** *The aim of our study was to determine the effect of the inorganic SO_2 donor on the prooxidant-antioxidant balance and dihydrogen sulfide content in the salivary glands of rats under conditions of immobilization stress.* ***Methods.*** *Experiments were performed on 24 white male Wistar rats divided into groups: intact; injected intraperitoneally with SO_2 donor $Na_2SO_3/NaHSO_3$ (0.54 mmol/kg/0.18 mmol/kg) daily; immobilized on their backs for 1 h daily; injected intraperitoneally with $Na_2SO_3/NaHSO_3$ daily 30 min before immobilization. Animals were withdrawn from the experiment on the 5th day, salivary glands were removed, homogenised, the supernatant was used for biochemical studies.* ***Results.*** *It was shown that the introduction of SO_2 donor against the background of the general adaptation syndrome modeling led to a decrease in the blood plasma content of corticosterone, mitigation of lipid peroxidation and oxidative damage of proteins, cystathionine β-synthase and cystathionine γ-lyase activation and dihydrogen sulfide content restoration in the salivary glands.* ***Conclusions.*** *It was concluded that correction of stress-induced changes in the salivary glands of rats with sulfur dioxide led to the prevention of the development of oxidative stress and the restoration of dihydrogen sulfide production from cystathionine β-synthase and cystathionine γ-lyase and an increase in the activity of aspartate aminotransferase.*

K e y w o r d s: sulfur dioxide, dihydrogen sulfide, salivary glands, general adaptation syndrome, oxidative stress.

General adaptation syndrome arises as a non-specific response of the body to internal or external factors of excessive force and is realized through a combination of physiological, emotional, cognitive and behavioral reactions. The impact of destabilizing factors on the body activates the hypothalamic-pituitary-adrenal axis and the sympathetic nervous system. Stimulation of the hypothalamus leads to the release of corticotropin, which stimulates the release of adrenocorticotropic hormone by the pituitary gland. This hormone acts on the adrenal gland, which produces increased levels of glucocorticoids, particularly cortisol. It is cortisol that triggers physiological reactions throughout the body as an adaptive response to stressors [1]. The scientific school of Professor Tarasenko L.M. established that the salivary glands are highly sensitive to stressors, which are manifested by the activation of lipid peroxidation processes and oxidative modification of proteins against the background of a decrease in antioxidant protection, as well as a decrease in the mass of the gland under conditions of

acute stress and an increase in the content of sulfide anions under conditions of water avoidance stress [2, 3]. Prolonged elevation of cortisol levels contributes to an imbalance in the homeostasis of immune functions and inflammatory processes, leading to excessive release of pro-inflammatory cytokines and increased catabolism, which causes a pro-oxidant-antioxidant imbalance and induces oxidative stress, which contributes to changes in lipids, proteins, carbohydrates, and DNA [4].

The development of oxidative stress under immobilization stress in the salivary glands is likely to lead to corresponding changes in the transsulfuration pathway, namely a decrease in the activity of cystathionine β-synthase (CBS, EC 4.2.1.22), cystathionine γ-lyase (CSE, EC 4.4.1.1) and 3-mercaptopyruvate sulfurtransferase (3-MST, EC 2.8.1.2) and depletion of biothiols under chronic stress conditions [5, 6]. However, under conditions of acute stress, or chronic but low-intensity stress, the activity of CSE and 3-MST may temporarily increase, leading to increased formation of dihydrogen sulfide (H_2S), which performs an antioxidant, membrane-stabilizing, anti-inflammatory and anti-apoptotic role, which generally contributes to the adaptation process [7, 8]. And this will lead to an increase in the oxidation of SO_2 to SO_3 and SO_4 as intermediates and final metabolites of H_2S oxidation [9].

SO_2 has its own enzymatic pathway of formation in the body (Fig. 1). Cysteine dioxygenase oxidizes L-cysteine to form L-cysteine sulfinate, which is then transaminated to form β-sulfinylpyruvate, catalyzed by aspartate aminotransferase (AST, EC 2.6.1.1). The β-sulfinylpyruvate is then spontaneously broken down into SO_2 and pyruvate. Endogenous SO_2 is metabolized to sulfite, which is further oxidized to sulfate by sulfite oxidase and then excreted in the urine [10]. Another pathway for SO_2 biosynthesis may be its formation by NADPH oxidase in activated neutrophils from H_2S under conditions of oxidative stress. In addition, H_2S can first be oxidized to thiosulfate by sulfide oxidase and then converted to SO_2 by thiosulfate sulfur transferase or glutathione-dependent thiosulfate reductase [11].

SO_2 is proposed to play a role as a novel gasotransmitter involved in the control of blood pressure and vasorelaxation, cell proliferation, apoptosis, oxidative stress, inflammation, endoplasmic reticulum stress, collagen remodeling, ion channel function, and post-translational protein modification [11-14]. The role of SO_2 in the mechanisms of development of various diseases is no less important, and it has now been established to participate in the development of hypertension, atherosclerosis, vascular calcification, myocardial hypertrophy and damage, acute lung injury, colitis and neuronal damage [10]. Potentially, the use of SO_2 donors can have a significant corrective effect on metabolism under conditions of general adaptation syndrome, increasing the adaptive capabilities of the body.

The aim of the study was to determine the effect of the inorganic donor SO_2 on the prooxidant-antioxidant balance and dihydrogen sulfide content in the salivary glands of rats under conditions of immobilization stress.

Materials and Methods

The experimental study was conducted according to the ARRIVE (Animal Research: Report of In Vivo Experiments) 2.0 guidelines (Percie du Sert et al., 2020) and in accordance with the European Convention for the Protection of Vertebrate Animals used for Experimental and other Scientific Purposes (Strasbourg, 1986) The animals were kept in a vivarium accredited according to the "Standard Rules for the Arrangement, Equipment and Maintenance

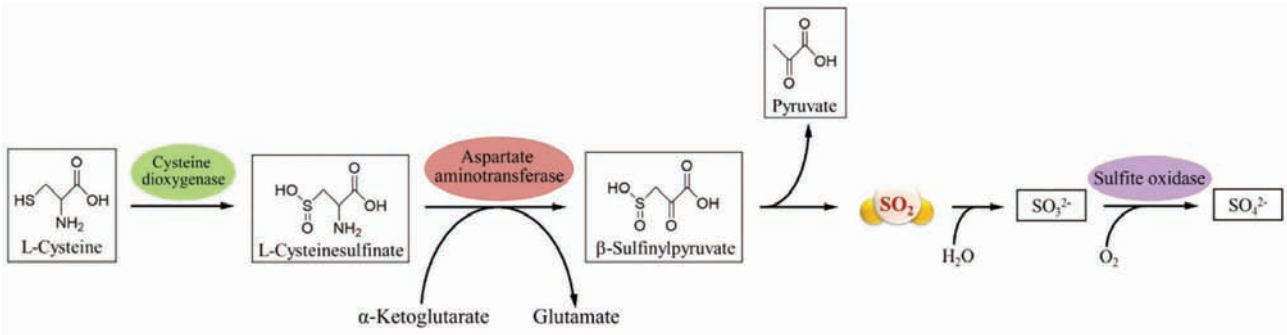

Fig. 1. Canonical enzymatic pathway of the formation of SO_2

of Experimental Biological Clinics (Vivarium)". The devices used in the studies were subject to metrological control. All experimental methods were approved by the Bioethical Commission of Poltava State Medical University (protocol No. 228 dated 20.06.2024).

The experiments were performed on 24 white, sexually mature male Wistar rats, weighing 210-295 g. Throughout the experiment, the animals were kept in a vivarium in accordance with the rules of animal hygiene and maintained on a 12/12 h light/dark cycle, at 26°C, with constant aeration, and a humidity of (43±2)%. Rats received ad libitum mixed grain-vegetable diet and water.

Groups. Group I – intact rats (n = 6). Group II (SO_2) – rats (n = 6) were daily injected intraperitoneally with the SO_2 donor Na_2SO_3/$NaHSO_3$ dissolved in distilled water (0.54 mmol/kg/0.18 mmol/kg) [15]. Group III (stress) – rats (n = 6) were daily immobilized on their backs for 1 h exposure for 5 days [16]. Group IV (stress+SO_2) – rats (n = 6) were administered intraperitoneally with the SO_2 donor Na_2SO_3/$NaHSO_3$ dissolved in distilled water (0.54 mmol/kg/0.18 mmol/kg) daily, 30 min before the immobilization stress simulation.

Animals were withdrawn from the experiment on the 5th day by taking blood from the right ventricle of the heart under thiopental anesthesia. The object of research was the salivary glands. For biochemical research, 10% homogenate was used, which was prepared according to the following protocol. Salivary glands were minced and placed in a Petri dish. The tissue was homogenized in 10 mM Tris (2-amino-2-hydroxymethyl-propane-1,3-diol)-HCl buffer, pH 7.4 (1 g of tissue per 9 ml of medium) for 30-40 s. The supernatant was used for biochemical studies. All manipulations were carried out at 0° to +4°C (in an ice bath).

Biochemical research methods. The content of corticosterone was determined in rat blood plasma [17]. 0.1 ml of blood plasma was taken for analysis. Then 2 ml of Reagent 1 (100 mg of ammonium tetramethylhydroxide pentahydrate in 5 ml of distilled water) was added. Then 2 ml of reagent 2 (100 mg of nitroblue tetrazolium chloride in 50 ml of methyl alcohol) was added. The mixture was incubated for 10 min at room temperature. Afterwards, it was centrifuged at 3000 rpm for 10 min. The supernatant was transferred to a new row of centrifuge tubes and absorption was measured at 510 nm in a 10 mm cuvette against the control sample (containing all reagents, but instead of blood plasma, distilled water was used).

Catalase activity in rat salivary gland homogenate was determined by the color of the products formed as a result of the reaction of hydrogen peroxide with ammonium molybdate. The calculation was performed based on the amount of hydrogen peroxide catabolized in the presence of 0.1 ml of 10% salivary gland homogenate containing catalase per unit of time [18].

To determine the activity of superoxide dismutase (SOD), we used the reaction of adrenaline autoxidation in an alkaline medium with the formation of superoxide, by comparing the rate of adrenaline autoxidation in the presence of 0.1 ml of 10% salivary gland homogenate and without it. SOD activity was calculated in conventional units (u.u., 1 unit indicates a 50% reduction in reaction rate) [18].

The production of superoxide anion radical was determined by the reaction of the latter with nitroblue tetrazolium dihydrochloride (DNST), which leads to the conversion of DNST, yellow in color, to diformazan, blue in color. The maximum absorption of diformazan in chloroform at a wavelength of 500-570 nm [19].

Free malondialdehyde (MDA) was estimated by a specific reaction with 1-methyl-2-phenylindole in a mixture of methanol and acetonitrile to form a chromogen (carbocyanine dye) with maximum light absorption at a wavelength of 586 nm [20].

The content of oxidatively modified proteins (OMP) was determined spectrophotometrically. The principle of the method is that 2,4-dinitrophenylhydrazine reacts with the carbonyl groups of oxidized proteins to form dinitrophenylhydrazones. The formation of dinitrophenylhydrazones was recorded at a wavelength of 540 nm [21].

Concentration of sulfide anion (calculated as H_2S concentration). H_2S specifically reacts with N-N-dimethyl-para-phenylenediamine in the presence of Fe^{3+} ions and excess of hydrochloric acid to form a red-pink chromogen with a maximum light absorption at a wavelength of 667 nm [21].

The content of sulfites (SO_3^{2-}) was determined by the concentration of the colored reaction product formed by the interaction of SO_3^{2-} with o-phthaldialdehyde in the presence of ammonium chloride [22].

The content of biological thiols was determined by the color product of the reaction of biological thiol groups (-SH) of cysteine (Cys) and reduced glutathione (GSH) with 3,3′,5,5′-tetramethylbenzidine (TMB) in the presence of silver ions (Ag^+) [23].

To determine the activities of cystathionine β-synthase (CBS) and cystathionine γ-lyase (CSE), the total substrate-induced increase in the amount of hydrogen sulfide was determined upon the introduction of excess L-cysteine. Under the influence of CSE, hydrogen sulfide and pyruvate are formed in equimolar concentrations. Therefore, the difference between the concentration of hydrogen sulfide and pyruvate formed will correspond to the activity of CBS, and the amount of pyruvate formed will reflect the activity of CSE.

CSE activity was determined by the increase in pyruvate concentration after incubation of 0.2 ml of 10% tissue homogenate with 0.3 ml of 1% L-cysteine hydrochloride solution and 3.5 ml of Tris buffer (pH 7.4; M = 0.2). Dilution factor K = 20. Incubation was carried out at a temperature of 37°C for 60 min. Then 0.1 ml of the solution was taken after incubation and 0.4 ml of 2,4-dinitrophenylhydrazine solution (1 mmol/l) was added. Incubation was carried out at room temperature for 20 min. 4 ml of sodium hydroxide solution (4 mol/l) was added. Incubation was carried out at room temperature for 10 min. The absorbance (A) was determined against distilled water at a wavelength of 510 nm in a cuvette with an optical path length of 10 mm. The calculation of cystathionine γ-lyase activity was carried out according to the formula: A×121 μmol/g×K(20)/t(60 min) or A1×40.333 μmol/min per g [24].

The level of total substrate-induced H_2S production (V) was determined after incubation of 0.2 ml of 10% tissue homogenate with 0.3 ml of 1% L-cysteine hydrochloride solution and 3.5 ml of Tris buffer (pH 7.4; M = 0.2). Dilution factor K = 20. Incubation was performed at 37°C for 60 min. H_2S content was determined as described above [21]. Then, 0.2 ml of the solution was taken after incubation and 0.2 ml of the sulfide anion reagent was added. Incubated at room temperature for 15 min. 5 ml of 1 M hydrochloric acid solution was added. The absorbance (A) was determined against distilled water at a wavelength of 667 nm in a cuvette with an optical path length of 10 mm. The calculation of V was carried out according to the formula: A×78.603 μmol/g×K(20)/t(60 min) or A1×26.201 μmol/min per g.

CBS activity was determined by the formula: V – CSE, μmol/min per g.

The activity of aspartate aminotransferase (AST) in 10% salivary gland homogenate was determined using a diagnostic kit manufactured by NPP "Filisit-Diahnostyka".

Mathematical and statistical research methods. Statistical analysis of biochemical results was performed using pairwise comparison with the nonparametric Mann-Whitney test. All statistical calculations were performed in Microsoft Office Excel and its Real Statistics 2019 extension. The difference was considered statistically significant at $P < 0.05$.

Results

Under conditions of immobilization of rats on their backs for 1 h daily for 5 days, the content of corticosterone in the blood serum increased by 1.25 times compared to the intact group of rats (Fig. 2) ($P < 0.05$). Intraperitoneal administration of the inorganic donor of SO_2 to rats led to a 1.41-fold decrease in corticosterone content in the blood plasma of rats, and administration of the inorganic donor of SO_2 30 min before immobilization stress modeling resulted in a 1.71-fold decrease compared to the intact group of rats ($P < 0.05$). Correction of stress syndrome with an SO_2 donor led to a 2.15-fold decrease in corticosterone content in the blood plasma of rats compared to the group of animals with stress syndrome without correction ($P < 0.05$).

Intraperitoneal administration of a SO_2 donor solution for 5 days led to an increase in the production of superoxide anion radical in the salivary glands of rats by 1.28 times, the content of OMP by 1.18 times, sulfide anions by 1.35 times, sulfite anions by 1.29 times, and AST activity by 1.19 times compared to the intact group of rats (Fig. 3, *C*, *E*; Fig. 4, *A*, *B*, *F*) ($P < 0.05$).

Modeling immobilization stress according to G. Selye led to an increase in catalase activity in the salivary glands of rats by 1.12 times, SOD by 1.39 times, superoxide anion radical production by 1.74 times, MDA content by 1.61 times and OMP by 1.6 times compared to the intact group of rats (Fig. 3, *A*, *B*, *C*, *D*, *E*) ($P < 0.05$), which indicates the development of oxidative and carbonyl stress against the background of adaptive activation of the catalase-superoxide dismutase link of antioxidant defense in the salivary glands of rats. Modeling of the general adaptation syndrome led to a decrease in CBS activity in the salivary glands of rats by 1.73 times and CSE by 1.22 times, which was accompanied by a decrease in sulfide content by 1.62 times and an increase in AST activity by 1.29 times and sulfite content by 1.12 times compared to the intact group of rats (Fig. 4, *D*, *E*, *F*) ($P < 0.05$).

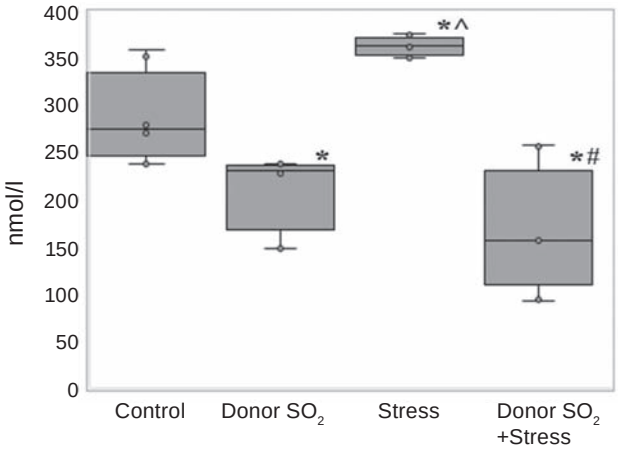

*Fig. 2. Corticosterone content in the blood serum of rats under the conditions of the introduction of an inorganic SO_2 donor against the background of modeling of the general adaptation syndrome, M±SE. *P < 0.05 compared with the intact group of rats; ^P < 0.05 compared with the group of rats that were introduced with the SO_2 donor; #P < 0.05 compared with the group of rats that were simulated with the stress syndrome*

The introduction of the SO_2 donor Na_2SO_3/$NaHSO_3$ 30 min before the simulation of immobilization stress daily led to a decrease in catalase activity in the salivary glands of rats by 1.01 times, SOD by 1.12 times, superoxide anion radical production by 1.17 times, MDA content by 1.15 times, and OMP by 1.46 times compared to the group of rats in which the stress syndrome was simulated without correction (Fig. 3, *A*, *B*, *D*, *E*) ($P < 0.05$). Compared with the intact group of animals, catalase activity under the conditions of introduction of inorganic SO_2 donor against the background of immobilization stress in the salivary glands of rats is higher by 1.11 times, SOD by 1.23 times and production of superoxide anion radical by 1.49 times ($P < 0.05$). Introduction of SO_2 donor Na_2SO_3/$NaHSO_3$ against the background of immobilization stress led to an increase in CBS activity by 1.36 times, CSE by 1.34 times, AST by 1.08 times and sulfide content by 1.63 times in relation to the group of rats in which immobilization stress was simulated without correction (Fig. 4, *D*, *E*, *F*) ($P < 0.05$).

Discussion

Intraperitoneal administration of the SO_2 donor Na_2SO_3/$NaHSO_3$ (0.54 mmol/kg/0.18 mmol/kg) for 5 days leads to the development of protein-directed oxidative stress in the salivary glands of rats due to increased production of superoxide anion radical, however, we did not observe increased lipid peroxidation, which indicates the onset of oxidative stress development probably without a sufficient amount of hydroxyl radicals, which are the main reactive oxygen species (ROS) for lipoperoxidation. Protein oxidation is more sensitive to ROS than cell membrane phospholipids [25]. Such changes are consistent with experimental data from Qin G., et al. 2016 and Li S., et al. 2019, which found that at higher doses, sulfur dioxide reduces the membrane potential of cardiomyocyte mitochondria, cytochrome c oxidase (complex IV) activity, and ATP synthesis due to increased ROS production, leading to mitochondrial dysfunction [26, 27]. It is likely that mitochondrial electron transport chain dysfunction leads to decreased H_2S oxidation by sulfide quinone reductase (SQR), which is part of the sulfide oxidation unit (SOU) [28], resulting in increased sulfide levels in our studies. The initial development of oxidative stress leads to intermittent AST activation and increased sulfite levels in rat salivary glands.

Modeling immobilization stress in rats leads to activation of the superoxide dismutase-catalase link of the antioxidant system of the salivary glands of rats against the background of increased production of superoxide anion radical. However, activation of the antioxidant system is unable to compensate for the increase in ROS, which leads to the activation of lipid peroxidation and increased oxidative damage to proteins. Our data are consistent with the concept of oxidative stress development in the salivary glands of rats under chronic stress, as supported by the studies of Souza-Monteiro D., et al. 2025 and Keremi B., et al. 2017 [29, 30] and by our previous studies [31]. Changes in hydrogen sulfide metabolism are likely associated with inhibition of cbs gene transcription by cortisol through glucocorticoid receptors [32]. Decreased CBS and CSE activity enhances the development of oxidative stress due to mitochondrial dysfunction [33]. Such changes may be related to the transcription factor KLF4 (Kruppel-like factor 4), which is increased after stress or glucocorticoid treatment and suppresses the expression of CBS and CSE [34]. The decrease in endogenous hydrogen sulfide content, which is a consequence of the decrease in CBS and CSE activity, contributes to lipid peroxidation and oxidative damage to proteins, since endogenous H_2S acts as a cytoprotector and antioxidant. Increasing oxidative stress intensity

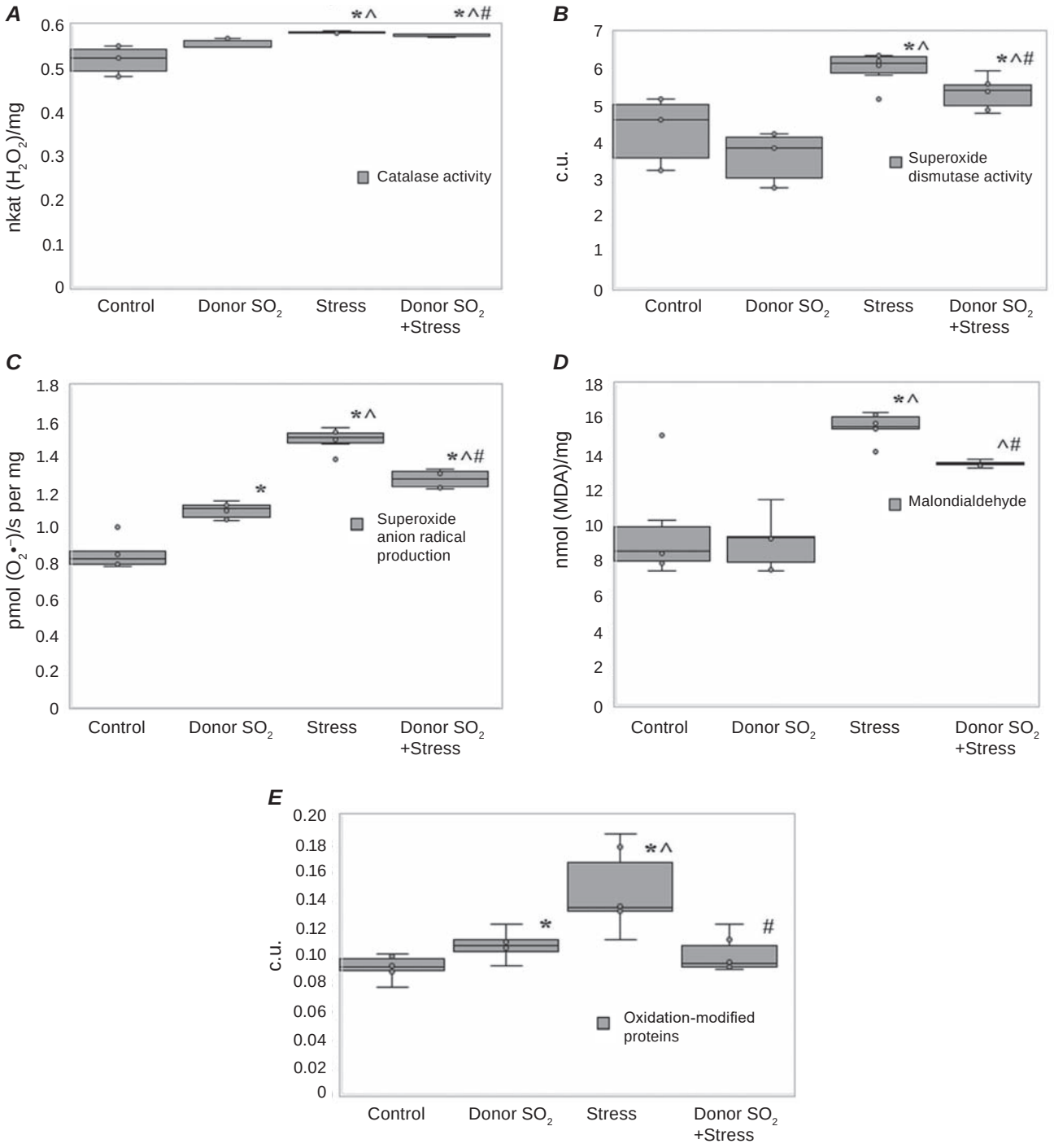

Fig. 3. Prooxidant-antioxidant balance in the salivary glands of rats under the conditions of introduction of inorganic donor SO_2 against the background of modeling of general adaptation syndrome, M±SE: ***A*** *– catalase activity;* ***B*** *– superoxide dismutase activity; C – superoxide anion radical production;* ***D*** *– malondialdehyde;* ***E*** *– oxidation-modified proteins. *P < 0.05 compared with the intact group of rats; ^P < 0.05 compared with the group of rats, which were introduced donor SO_2; #P < 0.05 compared with the group of rats, which were simulated stress syndrome*

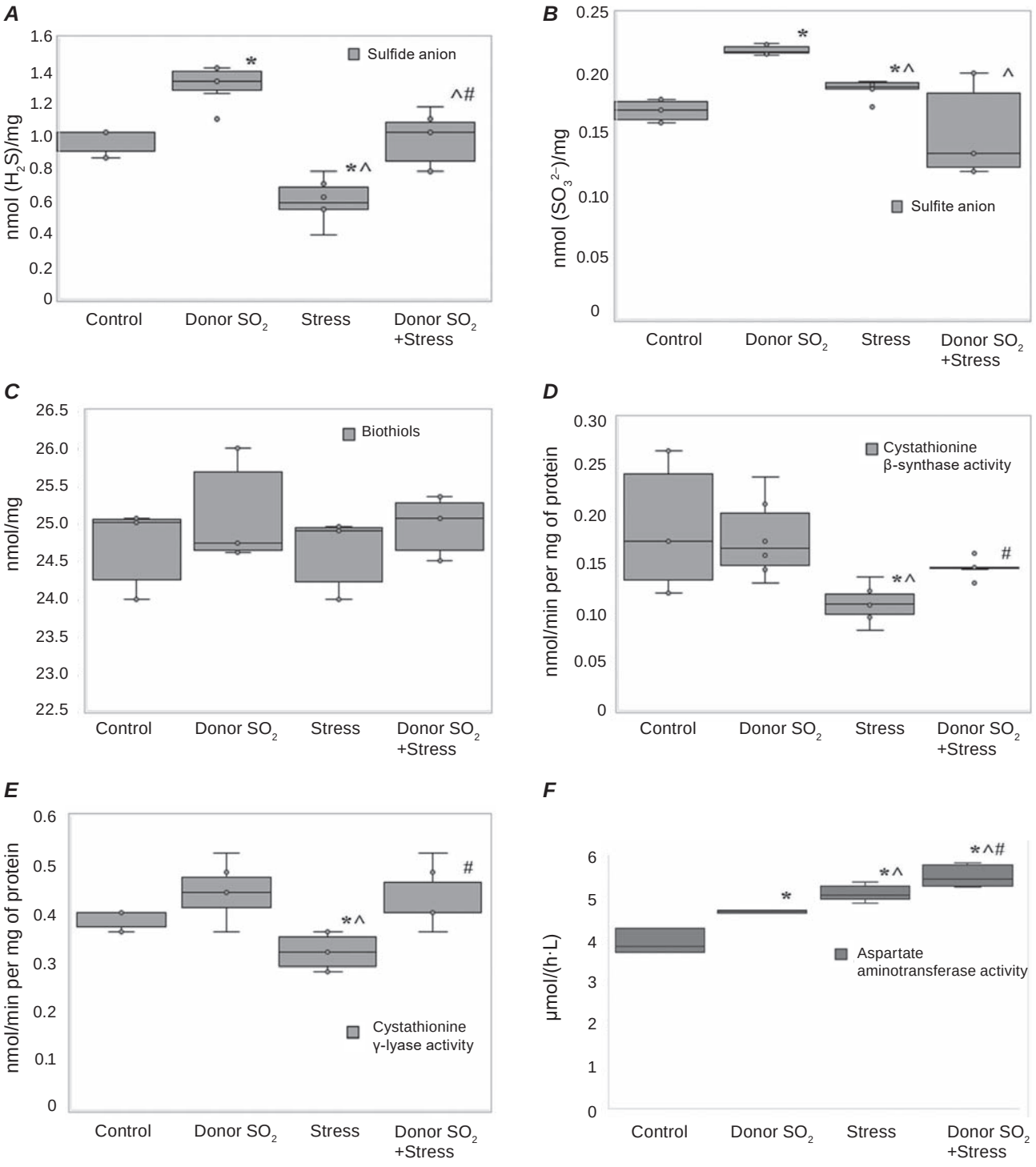

Fig. 4. Parameters of sulfur metabolism in the salivary glands of rats under the conditions of the introduction of an inorganic SO_2 donor against the background of modeling of the general adaptation syndrome, M±SE: ***A*** *– sulfide anion;* ***B*** *– sulfite anion;* ***C*** *– biothiols;* ***D*** *– cystathionine β-synthase activity;* ***E*** *– cystathionine γ-lyase activity;* ***F*** *– aspartate aminotransferase activity. *P < 0.05 compared with the intact group of rats; ^P < 0.05 compared with the group of rats that were introduced with the SO_2 donor; #P < 0.05 compared with the group of rats that were simulated with the stress syndrome*

increases AST activity, including through cytolysis and mitochondrial dysfunction, but a high redox potential likely reduces SO_3 content by rapidly transforming it to SO_4. It is also important to reduce the hydrogen sulfide level as the reduction in the activity of CBS and CSE reduces the amount of substrate for SO_3 formation.

According to the results of our studies, daily administration of the SO_2 donor Na_2SO_3/$NaHSO_3$ (0.54 mmol/kg/0.18 mmol/kg) 30 min before one-hour immobilization of rats on their backs for 5 days led to the prevention of the development of oxidative stress and a decrease in the production of superoxide anion radical in the salivary glands of rats. Such changes can be explained by the rapid conversion of SO_2 to SO_3 under conditions of high redox potential in the salivary glands of rats during stress syndrome modeling, which plays a cytoprotective role by maintaining the content of biothiols. According to Kimura Y., et. al. 2019 sulfite is a novel cytoprotective molecule against oxytocin by maintaining extracellular cysteine levels, leading to increased intracellular cysteine and glutathione (GSH), through the reaction of sulfite with cystine, which converts it to cysteine, which can be transported into neurons more efficiently than cystine and used for GSH production. [35]. Our data are consistent with those of Salari M., et. al. 2023, who found that SO_2 donors reduced MDA and corticosterone levels in depressed animals. According to these results, SO_2 reduced tissue damage and ultimately behavioral disorders induced by depression by reducing oxidative stress and inflammation [36]. According to our research, prolonged immobilization stress leads to depletion of the superoxide dismutase-catalase link of antioxidant defense and causes adaptive activation of AST to restore and maintain the level of biothiols (cysteine and GSH).

An important mechanism of protection against oxidative stress that occurs under conditions of general adaptation syndrome in the salivary glands of rats in our studies is the activation of CBS and CSE by the production of H_2S, which has a direct antioxidant effect and activates Keap1 through S-sulfhydration, which leads to dissociation of NRF2, and increased nuclear translocation and expression of antioxidant genes by binding to ARE sites of promoters [37]. The direct antioxidant effect of H_2S was established in the works of Predmore BL., et. al. 2012 and Nagy P., et. al. 2010, namely, it was proven that H_2S is able to remove ROS and reactive nitrogen species (RNS), including hypochlorous acid, hydrogen peroxide, lipid hydroperoxides, superoxide and peroxynitrite [38, 39], which may explain the decrease in the production of superoxide anion radical in our studies.

Limitations. The authors of the manuscript consciously acknowledge that the interpretation of the results is limited by species/model factors, housing conditions, and resource constraints. *In vivo* studies in sexually mature male Wistar rats under standardized conditions with a limited number of doses, mostly surrogate endpoints and a short observation period do not allow for definitive conclusions regarding long-term safety and clinical relevance.

Conclusions. Modeling immobilization stress for 5 days led to lipid peroxidation and damage to protein structures in the salivary glands of rats, with a decrease in the formation of dihydrogen sulfide and sulfites from cystathionine β-synthase and cystathionine γ-lyase and an increase in the activity of aspartate aminotransferase, probably for the recovery of biothiols.

Correction of the general adaptation syndrome in the salivary glands of rats exposed to sulfur dioxide prevented the development of oxidative stress, restored dihydrogen sulfide production from cystathionine β-synthase and cystathionine γ-lyase, and increased aspartate aminotransferase activity.

Author contributions. Conception and design of the study: AOM, KSN. Acquisition of data: AOM, VVP, AOP, AMC, KIB. Analysis and interpretation of data: AOM, VVP, AOP, AMC, KIB. Drafting the article: AOM, VVP, AOP, AMC, KIB. Critical revising: AOM, VVP, KSN. Final approval: AOM, KSN.

Conflict of interest. The authors have completed the Unified Conflicts of Interest form at http://ukr-biochemjournal.org/wp-content/uploads/2018/12/coi_disclosure.pdf and declare no conflict of interest.

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АНТИОКСИДАНТНИЙ БАЛАНС ТА ВМІСТ ДИГІДРОГЕН СУЛЬФІДУ В СЛИННИХ ЗАЛОЗАХ ЩУРІВ ЗА УМОВ ІММОБІЛІЗАЦІЙНОГО СТРЕСУ ТА ВВЕДЕННЯ ДОНОРА SO_2

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Вступ. Сульфур діоксид (SO_2) запропоновано як новий газотрансмітер, що ендогенно утворюється залежно від активності аспартатамінотрансферази, глутатіонсинтетази та вмісту дигідроген сульфіду. SO_2 та його донори потенційно можуть мати коригувальний ефект у зменшенні ушкоджень, спричинених оксидативним стресом, за умов загального адаптаційного синдрому. Слинні залози дуже чутливі до стресових факторів, але роль SO_2 у цих органах залишається недостатньо вивченою. **Мета.** Метою нашого дослідження було визначити вплив неорганічного донора SO_2 на прооксидантно-антиоксидантний баланс та вміст дигідроген сульфіду в слинних залозах щурів за умов іммобілізаційного стресу. **Методи.** Експерименти проводили на 24 білих щурах-самцях лінії Вістар, розділених на групи: інтактні тварини, яким щодня внутрішньоочеревинно вводили донор SO_2 Na_2SO_3/$NaHSO_3$ (0,54 ммоль/кг/0,18 ммоль/кг); тварини, яких іммобілізували у положенні на спині протягом 1 години щодня; тварини, яким щоденно внутрішньоочеревинно вводили Na_2SO_3/$NaHSO_3$ за 30 хв до іммобілізації. Тварин виводили з експерименту на 5-й день, слинні залози видаляли, гомогенізували, супернатант використовували для біохімічних досліджень. **Результати.** Показано, що введення донора SO_2 на тлі моделювання загального адаптаційного синдрому призводило до зниження вмісту кортикостерону в плазмі крові, до зменшення пероксидного окислення ліпідів та оксидативного ушкодження протеїнів, активації цистатіонін-β-синтази та цистатіонін-γ-ліази і до відновлення вмісту дигідроген сульфіду в слинних залозах. **Висновки.** Зроблено висновок, що корекція стрес-індукованих змін у слинних залозах щурів SO_2 запобігала розвитку оксидативного стресу, сприяла відновленню продукції дигідроген сульфіду від цистатіонін-β-синтази і цистатіонін-γ-ліази, а також підвищила активність аспартатамінотрансферази.

Ключові слова: сульфур діоксид, дигідроген сульфід, слинні залози, загальний адаптаційний синдром, оксидативний стрес.

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