



Effect of ethylthiosulfanylate in combination with vitamin E on certain biochemical blood parameters and hematological indicators in rats under the influence of Cr(VI)

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BIK: Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Project administration; Writing — review & editing.

Declaration of Conflict of Interests:

None to declare.

Ethical approval:

A permission to conduct the research was obtained from the Committee on Bioethics of the Institute of Animal Biology NAAS (Protocol no. 124 from 20.12.2022, Lviv, Ukraine).

Acknowledgements:

None.



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The aim of our study was to investigate the effect of ethylthiosulfanylate, a representative of the class of thiosulfonate compounds, in combination with vitamin E on certain biochemical blood parameters, hematological indicators and total Chromium content in liver of rats exposed to Cr(VI). Laboratory rats were divided into 8 groups of 5 animals each. Animals of group I (intact control) were injected daily intraperitoneally with 150 μ l of physiological saline solution for 7 days. Rats of III/IV groups received intraperitoneal daily administration of $K_2Cr_2O_7$ (diluted in physiological saline solution at a dose of 2.5 mg Cr(VI)/kg) for 7/14 days. Animals of the II experimental group were injected daily intragastrically with 1000 μ l of sunflower oil for 14 days. Rats of V/VI experimental groups were administrated daily intragastrically with 1000 μ l of an oil solution of vitamin E (20 mg/kg)/ vitamin E (20 mg/kg) in combination with ethylthiosulfanylate (100 mg/kg) for 14 days. Animals of VII/VIII experimental groups were injected daily intragastrically with 1000 μ l of an oil solution of vitamin E (20 mg/kg) in combination with ethylthiosulfanylate (100 mg/kg) for 14 days, after which a 7-day/14-day period of intraperitoneal $K_2Cr_2O_7$ administration was performed. Exposure to Cr(VI) led to a decrease in the number of erythrocytes, leukocytes, content of hemoglobin, phospholipids, total protein against the background of the accumulation of total lipids, mono- and diglycerides, non-esterified fatty acids, and creatinine in blood of rats. Chromium concentration significantly increased in the liver of rats after administration of Cr(VI). The combined effect of vitamin E and ethylthiosulfanylate contributed to the partial compensation of Cr(VI)-induced disturbances of the number of leukocytes and content of total proteins, phospholipids, non-esterified fatty acids in blood of rats. Vitamin E and ethylthiosulfanylate pretreatment also contributed to the reduction of the percentage accumulation of Chromium in liver of rats injected with Cr(VI).

Key words: ethylthiosulfanylate, hexavalent chromium, hematological parameters, lipids, lipid classes, creatinine

Introduction

Cr(VI) is a common heavy metal and is classified as a global environmental pollutant that increases the risk

of several types of cancer and is increasingly recognized as a neurotoxicant [18]. The United States Environmental Protection Agency (USEPA) has included Cr(VI) as a priority pollutant due to its persistent toxic properties and

largely irreversible nature of adverse effects [39, 13]. However, Cr(VI) is an integral component in such technological processes as: paint production, leather tanning, magnetic tape production, hydrocarbon production (the role of a catalyst), metal processing, chromate production, stainless steel welding [3, 4]. Violation of production leads to uncontrolled emissions of Cr(VI) compounds into the environment. In particular, more than 20% of Cr compounds used in the process of industrial leather tanning are released in the form of wastewater and pollute the surrounding soils and water bodies with toxic Cr(VI), which in turn creates serious risks for poisoning of animals and human [28]. Cr(VI) compounds accumulate in cells of living organisms that inhabit polluted areas of ecosystems, and thus the toxic heavy metal is included in the food chain [38]. Cr(VI) from natural and industrial sources is mostly presented in the form of chromate and dichromate oxyanion (CrO_4^{2-} ; $\text{Cr}_2\text{O}_7^{2-}$), which easily penetrates the cell membrane. The main pathways of Cr(VI)-induced toxicity are the activation of oxidative stress mechanisms, damage to the DNA structure, epigenetic disorders, which in turn leads to cytotoxicity, cellular mutagenesis, carcinogenesis, apoptosis.

Biologically active substances with antioxidant, detoxifying and cytoprotective properties are good candidates for the prevention and reduction of the negative effects of Cr(VI)-induced oxidative stress [29, 30, 36]. Ethylthiosulfanylate (ETS) belongs to the class of thiosulfonate compounds, which are synthetic analogues of natural biologically active organosulfur compounds isolated from garlic, onion, broccoli, cauliflower and sea urchin. Thiosulfonates are more stable than their natural counterparts, exhibit a wide range of biological properties and are characterized by low toxicity. Recent studies have shown that ETS is characterized by antioxidant, cytoprotective and hypolipidemic properties [23, 31]. Our previous studies established that 14-day exposure to ETS (100 mg/kg) contributed to only partial normalization of certain blood biochemical parameters of rats exposed to Cr(VI) [20]. Literature data report that the combined action of antioxidant compounds is often more effective in preventing Cr(VI)-induced disorders. In particular, vitamin E significantly complements the protective effect of Selenium, melatonin, atorvastatin under the conditions of Cr(VI)-induced toxicity [29, 30, 36]. Considering the good effectiveness of the combined application of vitamin E, it is important to evaluate the complex effect of ETS with the corresponding vitamin under the action of Cr(VI). The purpose of our work was to evaluate the specifics of the combined vitamin E and ETS action on certain biochemical blood parameters, hematological indicators and total Chromium content in liver of rats exposed to Cr(VI).

Materials and Methods

The research was conducted on male Wistar rats with mean body weight 135 ± 5 g. Laboratory rats were kept in normal vivarium conditions with 12/12 hours lighting cycle, room temperature (22°C), air humidity $50 \pm 20\%$, standard

feed and free access to drinking water. All manipulations with animals were conducted in accordance with European Convention "For the Protection of Vertebrate Animals Used for Experimental and Other Scientific Purposes" (Strasbourg, 1986) and laws of Ukraine "Common Ethical Principles for Animal Experiments" (Ukraine, 2001). The animals were divided into 8 groups of 5 animals each (1 control and 7 experimental groups):

group I (intact control): daily intraperitoneally administered physiological saline solution (150 μl) for 7 days;

group III/IV: daily intraperitoneally administered $\text{K}_2\text{Cr}_2\text{O}_7$ solute in 150 μl of physiological saline (in terms of 2.5 mg Cr(VI) per kg of body weight) for 7/14 days;

group II (oil control): daily intragastrically treatment with 1000 μl of sunflower oil ("Oleina", ISO 14024: DSTU 4492) during 14-day period by the next 7-day period of physiological saline solution (150 μl) administration;

group V: daily intragastrically treated with vitamin E solute in 1000 μl of sunflower oil (in terms of 20 mg of vitamin E per kg of body weight) during 14-day period by the next 7-day period of physiological saline solution (150 μl) administration;

group VI: daily intragastrically treated with vitamin E and ethylthiosulfanylate (ETS) solute in 1000 μl of sunflower oil (in terms of 20 mg of vitamin E and 100 mg of ETS per kg of body weight) during 14-day period by the next 7-day period of physiological saline solution (150 μl) administration;

group VII/VIII: daily intragastrically treated with vitamin E and ETS solute in 1000 μl of sunflower oil during 14-day period by the next 7-/14-day period of $\text{K}_2\text{Cr}_2\text{O}_7$ administration.

In our research we used organosulfur compound — ETS (ethylthiosulfanylate), which was synthesized at the department of technology of biologically active compounds, pharmacy and biotechnology of National University "Lviv Polytechnic" according to the method as described previously [26].

After the thiopental anesthesia rats were decapitated and then we collected blood and liver. The research material was whole blood, blood plasma and liver of rats. In whole blood we counted the number of erythrocytes, leukocytes and determined the hemoglobin content. In blood plasma we determined total lipids, proteins and creatinine level, as well as measured the percentage content of individual lipid classes. In liver tissue we measured the total Chromium content.

Counting of erythrocytes and leukocytes number was performed by use of the Goryaev's chamber and at low microscope magnification (lens — 8x, eyepiece — 10x or 15x) with covered diaphragm or lowered condenser (in the dark field of view) [37]. To represent the number of erythrocytes and leukocytes per liter, the unit of measurement was given in $10^{12}/\text{L}$ and g/L respectively (SI units).

Determination of hemoglobin concentration was performed by hemoglobin-cyanide method [37]. The optical density of the obtained hemoglobin-cyanide solution was determined spectrophotometrically at λ 540 nm against

the transforming solution (NaHCO₃ — 1 g; K₃Fe(CN)₆ — 0.2 g; KCN or NaCN — 0.05 g; distilled water in order to obtain a total volume of 1 L). The hemoglobin content was expressed in g/L (SI units).

Blood plasma lipids were extracted according to Folch's method with the addition of a chloroform-methanol mixture in a ratio of 2:1 (v/v) [10]. To purify the lipid extract, a 0.74 M KCl solution was added. Determination of the content of total lipids was carried out by the gravimetric method by weighing the dry residue [17].

Determination of the percentage content of individual lipid classes was carried out according to the method of thin-layer chromatography on silica gel in the presence of a solvent complex of hexane — diethyl ether — glacial acetic acid in a ratio 70: 30: 1 (v/v/v). The plates with silica gel were processed using the crystalline iodine vapor [17]. The processed plates underwent scanning using an HP Scanjet G2710 (China). The lipid classes were quantitatively analyzed and counted from obtained scans by using the TotalLab TL120 (Nonlinear Dynamics Ltd., UK). The results were then expressed as a percentage of the total lipids pool.

Total protein plasma level was determined by the Lowry Method [25] using the biochemical kit Simko LTD (Lviv, Ukraine) and expressed in g/L (SI units).

Determination of creatinine level was performed at biochemical analyzer Humalyzer 2000 (Human; automatic type) by using the biochemical kit Creatinine liquicolor (10051) (Wiesbaden, Germany). The creatinine content was expressed in μmol/L (SI units).

Determination of Chromium content in liver tissues was performed by the method of atomic absorption spectrophotometry, which is based on absorption of electromagnetic radiation by free atoms in an unexcited state [37]. Liver tissue sample with a weight of 5 g was mineralized by the method of dry ashing in a muffle furnace stove according to GOST 286-87-85. Determination of the Chromium content was carried out after acid extraction (3N HCl) of sample. The Chromium content was expressed in mg/kg of tissue weight.

Statistical processing of data was carried out by the ANOVA method (with Tukey's *post hoc* test) and only P values ≤0.05 were statistically significant. All numerical values of indicators were presented as mean values (M) ± standard error (S.E.M.).

Results and Discussion

The main task of our work was to evaluate the potentially protective effects of vitamin E in combination with ETS against Cr(VI)-induced toxicity. As a result of research was established the multidirectional effect of the studied compounds on some hematological and biochemical parameters of rat blood.

We observed a statistically significant decrease of hemoglobin content, erythrocytes and leukocytes count after Cr(VI) intoxication in blood of animals of group III by 19, 16 and 19% and in group IV by 31, 25 and 35%

Table 1. Indicators of hematological parameters of rat blood (M±S.E.M., n=5)

Groups of animals	Hemoglobin, g/L	Erythrocytes, 10 ¹² /L	Leukocytes, g/L
I — control	126.61±7.86	8.16±0.29	9.67±0.27
II — oil	123.35±5.73	8.32±0.3	9.92±0.30
III — Cr(VI) 7 days	102.43±2.88*	6.89±0.26*	7.89±0.38*
IV — Cr(VI) 14 days	87.41±2.45*	6.11±0.20*	6.27±0.17*
V — vitamin E	121.28±7.12	8.55±0.36	9.85±0.22
VI — vitamin E + ETS	121.75±5.78	8.83±0.41	9.71±0.26
VII — vitamin E + ETS + Cr 7 days	123.31±5.08	8.28±0.44	8.97±0.32
VIII — vitamin E + ETS + Cr 14 days	112.25±4.46	7.87±0.38	8.29±0.33*#

Note. Here and in the following tables: the statistically significant difference II, III, IV, V, VI, VII, VIII groups compared to the group I (control) is: * (P<0.001–0.05); the statistically significant difference V, VI, VII, VIII groups compared to the group II is: # (P<0.001–0.05).

compared to the group I (intact control) (table 1). This indicates about Cr(VI)-induced suppression of hemoglobin biosynthesis [35] and inhibition of erythrocyte and leukocyte differentiation processes by damaging hematopoietic stem cells of the bone marrow [12].

We did not find statistically significant changes of hemoglobin level and erythrocytes number under the combined effect of vitamin E and ETS followed by Cr(VI) intoxication (experimental groups VII, VIII). The combined effect of vitamin E and ETS followed by Cr(VI) administration for 14 days led to decrease of leukocytes count in the blood of rats of group VIII by 16% compared to the group II. However, the percentage decrease of leukocytes number in blood of rats of group VIII (16%) compared with the group II was twice lower than the percentage decrease of leukocyte counts in blood of animals of group IV (35%) compared to the group I. Literature sources report that antioxidant and cytoprotective effects of vitamin E contributes to the prevention of Cr(VI)-induced decrease in the number of leukocytes [7].

Cr(VI) administration during 7-day and 14-day periods led to significant accumulation of the total lipids content in blood of rats by 38 and 44% relative to the group I (fig. 1).

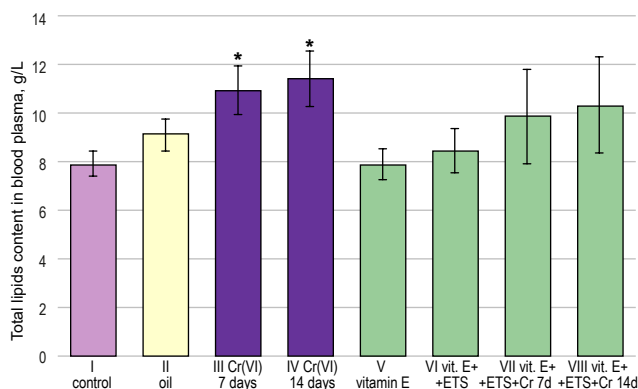


Fig. 1. Total lipids content in blood plasma of rats (M±m, n=5)
Note. * — P<0.05, the statistically significant difference II, III, IV, V, VI, VII, VIII groups compared to the group I (control).

Table 2. Indicators of the percentage content of individual lipid classes in blood of rats (M±S.E.M., n=5)

Groups of animals	Class of lipids, %	Phospho-lipids	Mono- and diglycerides	Non-esterified fatty acids	Non-esterified cholesterol	Triglycerides	Esterified cholesterol
I — control		32.33±1.61	9.78±0.95	13.39±1.75	12.94±0.57	17.81±1.07	13.75±3.42
II — oil		32.75±1.15	10.17±1.16	13.02±0.58	12.99±0.29	18.52±1.69	12.57±2.69
III — Cr(VI) 7 days		26.04±1.60*	12.94±0.16*	16.27±0.60	12.23±0.20	17.33±0.66	16.19±0.25
IV — Cr(VI) 14 days		23.00±2.31*	12.67±0.50*	17.82±0.53*	11.39±0.29	17.57±2.68	17.56±3.87
V — vitamin E		33.61±1.12	10.38±0.66	11.73±0.76	12.73±1.86	17.39±1.42	14.16±1.28
VI — vitamin E + ETS		38.46±1.28#	11.48±0.56	10.29±0.83#	11.23±0.84	16.56±1.10	11.98±1.94
VII — vitamin E + ETS + Cr 7 days		32.47±1.82	11.81±0.44	10.84±0.78	14.96±1.51	16.84±1.09	13.08±0.90
VIII — vitamin E + ETS + Cr 14 days		38.68±1.42**	11.46±0.34	10.26±0.35#	12.68±0.47	15.60±3.23	11.33±2.17

The cause of hyperlipidemia by Cr(VI)-intoxicated rats may be SREBP-1 protein hyperexpression by the next accumulation of lipids, cholesterol, and triglycerides in blood and tissues [21]. Exposure to vitamin E in particular (group V) and in combination with ETS (groups VI, VII, VIII) did not cause statistically significant changes of total lipid level in blood of rats.

The analysis of individual classes of blood plasma lipids showed that the 7-day and 14-day exposure to Cr(VI) led to a significant decrease in the content of phospholipids by 19 and 27%, respectively, compared to the group I (table 2). Cr(VI) induces activation of phospholipids hydrolysis due to stimulation of phospholipase A2 [24].

In turn, the combined effect of vitamin E and ETS in particular (VI group) and by the next 14-day exposure to Cr(VI) (VIII group) caused an increase in the content of blood phospholipids by 17 and 18%, respectively, compared to the indicators of group II. Corresponding changes may indicate the need for the use of appropriate lipids in the adaptive rearrangements of cell membranes under the action of ETS [31] or inhibition of phospholipid hydrolysis processes due to phospholipase A2 suppression by vitamin E [32].

It is known that the toxic effect of heavy metals and oxidative stress are accompanied by the inactivation of the enzymes monoacylglycerol lipase and diacylglycerol kinase, which in turn contributes to the accumulation of mono- and diglycerides due to inhibiting the processes of splitting and conversion of the latter [2, 11]. It was established that mono- and diglycerides level increased under the influence of Cr(VI) in blood plasma of animals of groups III and IV by 32 and 30%, respectively, compared to the group I (table 2). We did not register statistically significant changes in the content of mono- and diglycerides under the combined effect of vitamin E and ETS (VI, VII, VIII groups).

We observed an increase in the level of non-esterified fatty acids (NEFA) in blood plasma of rats exposed to Cr(VI) during 14 days by 33% compared to the group I, which may be a consequence of the inhibition of fatty acids β-oxidation processes under the conditions of Cr(VI)

intoxication [22]. However, the combined effect of vitamin E and ETS in particular (VI group) and by the next 14-day Cr(VI) exposure (VIII group) was accompanied by a significant decrease in the content of blood NEFA by 21% compared to the group II. Vitamin E and natural analogues of thiosulfonates contribute to the acceleration of the liver fatty acids breakdown [6, 14], which may be the reason for the decrease in the concentration of NEFA in rat blood.

As for the indicators of triglycerides, non-esterified and esterified cholesterol in blood of rats, no significant changes were found between all experimental groups.

Exposure to Cr(VI) for 14 days was accompanied by a decrease in the total protein content in blood plasma of rats by 28% compared to the indicators of group I (table 3), which may indicate Cr(VI)-induced damage to the filtering apparatus of kidneys with subsequent development of proteinuria [33]. Proteins are an important structural component of cells and at the same time are very sensitive to free radical damage. Literature data indicate that the decrease in blood total protein content under the conditions of Cr(VI) toxicity may be associated with nephrosis, as well as with a disruption of anabolic and catabolic balance of protein metabolism [8, 35].

The combined effect of vitamin E and ETS followed by the next 14-day exposure to Cr(VI) (group VIII) was also contribute to a decrease of blood total protein content by 12% compared to group II (table 3). However, the percentage

Table 3. Indicators of the total protein and creatinine content in blood of rats (M±S.E.M., n=5)

Groups of animals	Total protein, g/L	Creatinine, μmol/L
I — control	43.91±1.68	74.94±2.52
II — oil	44.28±0.71	74.70±2.26
III — Cr(VI) 7 days	36.97±3.50	134.41±2.82 *
IV — Cr(VI) 14 days	33.94±1.60 *	182.93±22.9 *
V — vitamin E	46.20±1.81	67.96±2.76
VI — vitamin E + ETS	45.46±1.44	71.64±2.03
VII — vitamin E + ETS + Cr 7 days	41.30±1.17	100.42±5.50
VIII — vitamin E + ETS + Cr 14 days	38.83±1.10 #	148.20±6.38 * #

decrease of total protein content in this case was twice lower than in blood of animals injected with Cr(VI) without vitamin E and ETS pretreatment (group IV). Vitamin E is an important natural antioxidant and provides protection of protein molecules due to the effective neutralization of reactive oxygen species (ROS) and free radicals [16]. Thiosulfonates and ETS in particular are also characterized by antiradical properties [23, 27]. It is possible that the radical scavenging and antioxidant properties of vitamin E and ETS may be the cause of attenuation of Cr(VI)-induced total protein content decreasing in blood of rats.

Cr(VI) stimulates the processes of protein catabolism and degradation, followed by the accumulation of urea and creatinine in blood plasma, which are the end products of amino acid metabolism [9]. The level of creatinine significantly increased in the blood plasma of rats after 7 and 14 days of Cr(VI) exposure by 79 and 144%, respectively, compared to the group I (table 3). Creatinine accumulation in this case may indicate a violation of renal filtration processes under the influence of Cr(VI) as a result of inflammation, fibrosis, renal tubular necrosis [33].

Creatinine content similarly increased after exposure to vitamin E and ETS by the subsequent 14-day Cr(VI) injection in blood of animals of group VIII by 98% compared to the group II. However, the percentage accumulation of creatinine in the blood of animals of group VIII (98%) compared to the II group was by 46% lower than the percentage increase of creatinine content in blood of rats of group IV (144%) compared to the indicators of group I. Vitamin E and organosulfur natural analogues of thiosulfonates are characterized by nephroprotective properties. These compounds reduce the intensity of lipids and proteins oxidation, ROS formation, reduced glutathione (GSH) depletion in kidneys under the conditions of oxidative stress, which in turn contributes to normalization of blood creatinine level [1, 15]. It is possible that the antioxidant properties of vitamin E and ETS may be the reason for the decrease in the intensity of creatinine accumulation in blood of rats injected with Cr(VI).

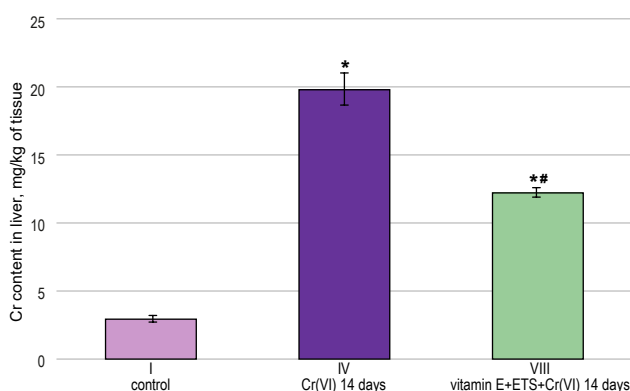


Fig. 2. Total Chromium content in liver of rats ($M \pm m$, $n=5$)
Note. * — $P < 0.05$, the statistically significant difference IV, VIII groups compared to the group I (control); # — $P < 0.001-0.05$, the statistically significant difference of group VIII compared to the group IV.

An important parameter that reflects the degree of Cr(VI) intoxication is the level of corresponding heavy metal accumulation in tissues and organs. The liver is one of the organs that intensively accumulates Cr(VI) from the blood circulatory system [40, 41]. Cr(VI) enters the liver cells through the capillary network and is accumulated by hepatocytes, which subsequently leads to hepatotoxicity, hyperplasia, fibrosis, necrosis and apoptosis [34]. Therefore, we determined the content of total Chromium in the liver of rats after 14-day exposure to Cr(VI) in order to assess the level of the corresponding heavy metal accumulation in the liver tissue of animals. It was established that exposure to Cr(VI) for 14 days (group IV) caused a significant increase in total Chromium content in liver of rats by 6.6 times compared to the control (fig. 2). Exposure to vitamin E in combination with ETS by the following 14-day injection of Cr(VI) was also accompanied with a significant increase in Chromium content by 4.1 times in the liver of rats compared to the control.

However, the percentage of Chromium accumulation in the liver tissue of rats of group VIII was by 38% lower compared to the group IV, which indicates a decrease in the percentage accumulation of Cr(VI) in the liver of rats pretreated with vitamin E and ETS. The literature data and our previous research report that exposure to vitamin E and ETS promotes the accumulation of GSH pool in liver of rats [14, 19]. Non-enzymatic antioxidant GSH reduces the intensity of Cr(VI) accumulation in liver by binding to the corresponding heavy metal with subsequent formation of biologically inert complexes [42]. GSH-Cr(VI) complexes are reduced to GSH-Cr(III), which are subsequently excreted from the body through the kidneys [5].

Conclusions

Cr(VI) causes a violation of the homeostasis of hematological blood parameters due to a decrease of erythrocytes, leukocytes count and hemoglobin content after both periods of administration. The combined effect of vitamin E and ETS lowered the percentage decrease of leukocytes number in blood of animals.

The toxic effect of Cr(VI) led to an increase in the level of blood total lipids, mono- and diglycerides during both periods of administration and caused also blood NEFA accumulation after 14-day period of Cr(VI) action. In turn, phospholipids content decreased after both periods of Cr(VI) exposure in blood plasma of rats.

The combined effect of vitamin E and ETS partially compensated for 14-day Cr(VI)-induced disturbances of blood lipid parameters by preventing an increase of NEFA content and decrease of phospholipids level in blood of rats. In turn, vitamin E and ETS in particular contributed to accumulation of the content of phospholipid fraction and to reduction of NEFA level in blood plasma of rats.

Cr(VI) caused a decrease of total protein level and led to an increase of creatinine content in blood plasma of animals. The combined effect of vitamin E and ETS

attenuated the percentage accumulation of creatinine and lowered the percentage decrease of total protein in blood of rats under conditions of 14-day Cr(VI) toxicity.

The combined effect of vitamin E and ETS attenuated the percentage accumulation of Chromium in liver tissue of rats exposed to Cr(VI) during 14-day period.

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Вплив етилтіосульфанілату у поєднанні з вітаміном Е на окремі біохімічні параметри крові та гематологічні показники щурів за дії Cr(VI)

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Метою роботи було з'ясувати вплив етилтіосульфанілату, представника класу сполук тіосульфонатів, у поєднанні з вітаміном Е на стан окремих гематологічних показників, біохімічних параметрів крові та вміст Хрому у печінці щурів за впливу Cr(VI). Лабораторних щурів розділили на 8 груп по 5 тварин у кожній. Тваринам I групи (інтактний контроль) вводили 150 мкл фізіологічного розчину щоденно внутрішньоочеревинно впродовж 7-ми діб. Щури III/IV груп отримували внутрішньоочеревинне щоденне введення K₂Cr₂O₇ (розведений у фізіологічному розчині у дозі 2,5 мг Cr(VI)/кг) впродовж 7-ми/14-ти діб. Тваринам II дослідної групи вводили 1000 мкл соняшникової олії внутрішньошлунково щоденно протягом 14-ти діб. Щури V/VI дослідних груп отримували щоденне внутрішньошлункове введення 1000 мкл олійного розчину вітаміну Е (20 мг/кг)/вітаміну Е (20 мг/кг) у поєднанні з етилтіосульфанілатом (100 мг/кг) протягом 14-ти діб. Тваринам VII/VIII дослідних груп внутрішньошлунково щоденно вводили 1000 мкл олійного розчину вітаміну Е (20 мг/кг) у поєднанні з етилтіосульфанілатом (100 мг/кг) протягом 14-ти діб, після чого проводили 7-/14-добовий цикл внутрішньоочеревинного щоденного введення K₂Cr₂O₇. Вплив Cr(VI) призводив до зниження числа еритроцитів, лейкоцитів, вмісту гемоглобіну, фосфоліпідів, загального протеїну на фоні накопичення вмісту загальних ліпідів, моно- та диацилгліцеролів, неестерифікованих жирних кислот, креатиніну крові щурів. Концентрація Хрому значно зростала у печінці щурів після введення Cr(VI). Поєднаний ефект вітаміну Е та етилтіосульфанілату сприяв частковій стабілізації Cr(VI)-індукованого порушення кількості лейкоцитів, вмісту фосфоліпідів, неестерифікованих жирних кислот, загального протеїну у крові та зниженню відсоткового накопичення Хрому у печінці щурів, яким вводили Cr(VI).

Ключові слова: етилтіосульфанілат, хром шестивалентний, гематологічні показники, ліпіди, класи ліпідів, креатинін