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# The Effect of Sodium Tetraborate on Chromium-Induced Oxidative Damages in Rats Lung Tissue

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**The purpose of this research is to study the effect of sodium tetraborate on chromium-induced oxidative damage in lung tissue. The experiment was conducted on 60 «Wistar» male rats (170-190g.) which were divided into 6 groups. The first group is control; the second, third, fourth groups received potassium dichromate (K2Cr2O7) with drinking water at a dose of 700 mg/l for 21 days; the fifth and sixth groups of animals received orally a solution of sodium tetraborate (Na2B4O7) at a dose of 22.5 mg/kg and 225 mg/kg of body weight per day for 31 days. Animals of the third and fourth groups received orally Na2B4O7 at doses of 22.5 mg/kg and 225 mg/kg per day, respectively, for ten days before receiving K2Cr2O7, then for 21 days, co-administration of potassium dichromate. Introduction of K2Cr2O7 caused a change in the endopulmonary cytogram, significantly reduced the nonspecific mechanism of respiratory protection from external influences, increased the content of malonic dialdehyde ($p<0.05$) and same as previous. Co-administration of Na2B4O7 (22.5 mg/kg) with K2Cr2O7 improves the mucociliary index (anti-inflammatory effect - the effect of debridement), inhibits oxidative damage (oxidative stress) in the lung tissue (antioxidant effect) in comparison with the data of animals exposed to K2Cr2O7. The combined use of Na2B4O7 in a high dose with K2Cr2O7 did not show the expected positive effect. Oxidative stress in the lung tissue induced by K2Cr2O7 leads to changes in the endopulmonary cytogram, disturbances in the mucociliary index, the balance of prooxidants/antioxidants in the lung tissue, to an increase in the peroxidation of lipids and inhibition of the antioxidant system. Sodium tetraborate, depending on the dose (at a low dose of 22.5 mg/kg body weight), can protect lung tissue from chromium-induced oxidative damage. However, with the introduction of sodium tetraborate in a high dose with chromium, the expected positive effect is not observed.**

**Keywords:** Chromium-Induced Oxidative Damage; Potassium Dichromate; Respiratory Protection; Sodium Tetraborate.

According to the abundance and incidence respiratory diseases take 3rd place, leading to disability and death. Specialists connect this rise to an unfavorable environmental situation and addiction to bad habits. Ecopathogenic risk in the

Western region of the Republic of Kazakhstan is associated with geochemical features – a chrome-boron biogeochemical province, an oil and gas processing complex. The world's second richest chromite ore deposit (South-Kimpersaysk) is located in the Aktobe region, where a large concentration plant, factories of chromium compounds and chromium ferroalloys are concentrated. Among workers and the population living near the chrome industry, respiratory diseases take first place. There are two forms of chronic chromic intoxication: gastric and pulmonary. The latter form includes chronic bronchitis, chronic obstructive pulmonary disease, bronchial asthma[1].

In 2003, the USA Agency for Toxic Substances and Registration (ATSDR) published a list of 275 organic and inorganic substances hazardous to human and the environment. Among the 20 most dangerous compounds, chromium is in 17th place[2]. Chromium exists in the environment in three stable states — Cr0, Cr+3 and Cr+6, which have different toxicities and transport characteristics[3]. Chromium valence (Cr+3 or Cr+6) affects the degree of absorption: Cr+6 is adsorbed through the lungs and gastrointestinal tract more easily and more intensively Cr+3. The oxidation degree and solubility of chromium compounds determines their toxicity. Cr+3 are an important trace element for cells, potentiating the action of insulin[4] and it is used in many food additives[5]. Cr+6 are a major environmental toxin and pollutant emitted from cigarette smoke, car emissions and hazardous waste. Potassium dichromate (K2Cr2O7), which is the hexavalent form of Cr+6, it is widely used in the metalworking, leather, textile, chemical, paint and varnish, ceramic, match and pyrotechnic industries[6]. Due to the widespread use and inappropriate disposal of waste, the level of Cr+6 in water, soil and air leads to an increase in environmental pollution [7,8]. It is known that Cr+6 is the most toxic form because it has a high oxidation potential, high solubility and mobility through the membranes of living systems and in the environment[9], and easily passes into human and animal cells using nonspecific anion transporters (together phosphate anions which it is structurally suitable)[10,11].

Once inside the cell, Cr+6 is reduced to the reactive intermediates Cr+5, Cr+4 and Cr+3 by cellular enzymes or non-enzymatic reducing agents. This intracellular reduction is accompanied by the overproduction of reactive oxygen species (ROS), which causes oxidation of macromolecules, such as DNA, lipids, proteins, and induces oxidative damage to tissue cells such as the liver, pancreas, brain, heart, kidneys, lungs[10,12,13,14,16,17]. According to[17,18,19], hexavalent chromium induces protein oxidation, lipid peroxidation (LP) in animal organs, including in the lungs, through oxidative stress in tissue systems[17]. Therefore, the use of antioxidants can be considered as an alternative method for the correction of induced oxidative damage[20,21,22], because oxidative stress (OS) plays a decisive role in chromium-induced toxic disorders, physiological and biochemical dysfunctions.

Boron (B) is a conditionally essential element and it plays an important role in the health of people and animals. It is rapidly absorbed from the gastrointestinal tract into the blood and in physiological quantities affects a wide range of metabolic processes[23,24,25]. So, in the metabolism of minerals, boron affects viitamin D, enzymes, hormones, mineral metabolism, biochemical parameters and AFO[26,27,28,29]. Boron exhibits hepatoprotective and antigenotoxic effects[20], as well as antioxidant activity, inhibiting AFO, destroying various oxygen radicals[32,33,34]. The introduction of boron limits oxidative damage by increasing the body's antioxidant reserves, such as glutathione and its derivatives, or by inducing other neutralizing agents that react with ROS[35].

According to some of scientists[36,37,38,28,20,21], boron compounds that provide protective effects caused by oxidative stress during aluminum-induced hepatotoxicity, titanium, aluminum, caused by genotoxicity, thioacetamide-induced liver failure and cyclophosphamide-induced peroxide reactions of lipid formation and genotoxicity, chromium-induced hepato-, geno- and neutrotoxicity.

As far as we know, the protective effects of boron compounds (sodium tetraborate) with chromium induced oxidative effects on lung tissue have not been studied remain open.

## MATERIALS AND METHODS

The work was performed on 60 Wistar male rats weighing 170-190 g. The animals were kept in standard conditions in the vivarium of the Scientific and Practical Centre of the Non-

commercial Joint-Stock Organization West Kazakhstan Marat Ospanov Medical University (Aktobe, Republic of Kazakhstan) under natural light, standard temperature and food conditions with free access to food and water. The experiment was carried out in accordance with the European Convention for the protection of vertebrate animals used for experimental and other purposes (Strasbourg, 1986). The programmed of the experiment was discussed and approved by the ethics committee of the university (protocol #6 dated 09/17/2019).

Animals after 10 days acclimatization were randomly divided into 6 groups (group of 10 rats each): I – group is control; animals of groups II, III and IV received potassium dichromate with drinking water (K2Cr2O7 – LTP "Chemistry and Technology" Kazakhstan) at a dose of 700 mg/l for 3 weeks; rats of groups III and IV were also treated orally with a solution of borax (Na2B4?7 – "Farmak" Ukraine), respectively, at doses of 22.5 mg/kg and 225 mg/kg per day for 10 days before receiving K2Cr2O7 and for 21 days together with potassium dichromate (total 31 days); animals of groups V and VI received orally only borax solution at the rate of 22.5 mg/kg and 225 mg/kg body weight per day for 31 days.

The choice of the type of boron and chromium compounds, doses and methods of administration, the duration is justified according to the literature [16,39,22]. Euthanasia of animals in all groups was carried out at the end of the experimental period by cervical instant decapitation under light ether anesthesia. The removed lungs were washed with physiological saline at the rate of 100 ml per 1.0 g. of tissue to obtain bronchoalveolar flushing (BAF). The obtained BAF was centrifuged and the precipitate was stored until analysis, if necessary, in a refrigerator (-8°C). The washed lungs were homogenized and centrifuged. Tubes with homogenates were in ice throughout the study. The supernatant was used in the experiment. If necessary, the obtained supernatants were kept at –80°C and used for biochemical analyzes.

Cytological study of bronchoalveolar flushing of the lungs. The resulting bronchoalveolar flushing was centrifuged at 200 g for 10 minutes to obtain a precipitate. A smear was prepared from BAW sediment and subjected to Romanovsky – Giemsa staining. 500 cells were found in stained smears and the ratio of individual cells was expressed – neutrophils (NPh), lymphocytes, epithelial cells and alveolar macrophages (AMPh) of BAW in percent, i.e. the endopulmonary cytogram was counted. The mucociliary index (clearance) was determined by the formula: where NPh is the number of neutrophils, AMP is the content of alveolar macrophages in 100 cells (%). Mucociliary index or clearance is a non-specific mechanism for protecting the respiratory system from environmental influences. Its violation is a characteristic feature of respiratory diseases. The study of BAW cells, depending on the severity of the changes, makes it possible to assess the adaptive state of the body, the effectiveness of the treatment / correction. The development of the bio effect in dynamics, taking into account the respiratory function of the lungs, reflects the indicators of AMPh and neutrophilic leukocytes. BAW cell indices, as a criterion of the chemical load on homeostasis, reveal early changes at the cellular level before the occurrence of prepathology.

**Biochemical Studies**

The content of malondialdehyde (MDA), a marker of the intensity of lipid peroxidation (LP) in lung tissues, was determined spectrophotometrically using the method of Draper and Hadley[40]. The essence of the method: at high temperature in an acidic medium, MDA reacts with 2-thiobarbururic acid, forming a colored complex with an absorption maximum at 532 nm. The molar extinction coefficient is 1.56 · 10-5cm. M-1· MDA level expressed as nmol/mg protein (nmol / mg Pt.)

**Antioxidant Status of the Lungs**

Catalase activity (CAT) was measured in accordance with the method[41]. The reaction was started by adding 2.0 ml of hydrogen peroxide to 10 µl of the supernatant and was stopped after 10 minutes by adding 1.0 ml of 4% ammonium molybdate. The absorption of the sample was measured at 410 nm. Activity was expressed in µmol H2O2 degraded/ min/mg protein (µmol/min/mg Pt – µmoles H2O2 degraded/min/mg protein).

Superoxide dismutase (SOD) activity was evaluated by the Beauchamp and Fridovich method[42]. The method is based on recording changes in the rate of reduction of nitro blue tetrazolium (NBT) in the presence of reduced nicotinamide adenine dinucleotide and phenazine metasulfate. The optical density was measured at

560 nm. The unit of SOD activity was taken as the amount of enzyme necessary to inhibit NBT recovery by 50% and the activity was expressed in units of mg protein (U/mg Pt)

Glutathione peroxidase (GPx) activity was measured by the Flohe and Gunzler methods[44]. The enzyme activity is expressed as nmoles of the oxidized amount of reduced glutathione (GSH) – nmoles of GSH/min / mg protein (PT).

The level of glutathione in the lungs was determined by the Ellman method[44] as modified by Jollow *et al*[45] based on the formation of yellow staining when DTNB (5.5-dithiobis 2-nitrobenzoic acid) is added to the sample containing SH groups. Extinction was measured at 412 nm. The amount was expressed in μmol/mg protein.

Protein content was determined according to the Lowry *et al* method[46] using bovine serum albumin as a standard.

**Statistical Analysis**

Statistical processing was performed using the Statistica 10 software package from StatSoft, Inc. USA. The results of the study were processed by the methods of parametric and non-parametric statistics, and presented in the form M ± SD, where M is the arithmetic mean, SD-standard deviation. For comparison of groups the Mann-Whitney U-test and t-student test was used. In all statistical analysis procedures, the significance level was taken $p < 0.05$.

## RESULTS AND DISCUSSION

Analysis of the experimental data of endopulmonary cytograms (table 1) shows that in animals that received only Cr+6 – group "chromium", there is an increase in the number of neutrophilic leukocytes (7.2 times) and a significant decrease ($p<0.05$) in the number of alveolar macrophages, which ultimately leads to a nine-fold increase in the ratio of neutrophils to alveolar macrophages (MCC = NF/AMP); the number of lymphocytes and epithelial cells increases by 1.5 and 4.4 times, respectively, compared with the data of the control group (group 1). As can be seen from the data presented in table 1 in animals exposed to sodium tetraborate in low and high doses and potassium dichromate (group 3-4), a decrease in the content of AMP by 5.5% ($p>0.05$) and 18% ($p<0.05$), respectively, against the background of a significant increase ($p<0.05$) of all studied – determined BAW cells, with the except of the number of lymphocytes in animals of group 3. The introduction of sodium tetraborate in doses of 22.5 mg/kg and 225 mg/kg body weight with chromium led to a noticeable decrease in MCI by 5 and 40%, respectively, the number of lymphocytes by 32 and 6%, respectively, epithelial cells by 50 and 24%, respectively, neutrophils 58 and 36%, respectively, and an increase in the number of AMPs by 19% ($p <0.05$) and 4% ($p> 0.05$), respectively, in comparison with the data of rats of the chromium group (group 2).

It should be noted that sodium tetraborate in a high dose with chromium, in comparison with the data of animals with a low dose of Na2B4O7 with chromium, led to a significantly increased level of neutrophils (+52%), lymphocytes (+39%), epithelial cells (+51%) and a decrease the amount of AMP (-13%, $p>0.05$); MDI increased by 73% ($p<0.05$). In conditions of isolated (or separate) administration of Na2B4O7 at low and high doses, in contrast to the combined use of tetraborate with Cr+6, cytological shifts in the ALS cell composition were not recorded, with the exception of the number of neutrophils compared to the control. The level of neutrophils significantly decreased in animals that received sodium tetraborate in a low dose (22.5 mg/kg body weight), which naturally led to a significant decrease in the MCI value ($p <0.05$).

**Assessment of MDA**

When administered only drinking water with Cr (VI) orally, a significant ($p <0.05$) increase in the level of MDA in lung tissues (+ 60%) is observed in comparison with the control. The combined administration of Na2B4?7 in a low dose with chromium led to a significant ($p <0.05$) decrease in the amount of MDA (-25.5%) in comparison with the data of the chromium group. Whereas, in a high dose with chromium, the desired effect was not observed (- 15%, $p>0.05$). It should be noted in the latter case, i.e. in animals of group 4, the MDA level was significantly higher than the control data (+ 36%, $p <0.05$) and rats of group 3 (+15%, $p <0.05$), i.e. animals exposed to sodium tetraborate in a low dose of Cr+ 6. Isolated oral administration of Na2B4?7 in a low dose was accompanied by a decrease in the level of MDA (-20%, $p> 0.05$), in a high, on the contrary, increase

(+ 16%, p> 0.05) compared with the control data. The amount of MDA in animals of these 2 groups (groups 5 and 6) differed significantly (+ 45%, p <0.05) when compared with each other.

**Antioxidant System (AOS)**

The exposure to K2Cr2O7 led to a significant decrease in the activity of SAD, CAT, GPx and the content of GSH (-26.7%, -25%, -34% and 18%, respectively) in lung tissues compared to control data (table 2). With the simultaneous administration of boron (at low and high doses), chromium showed an increase in the activity of SOD (+17% and 34%, respectively, p<0.05), CAT (+17%, +38%, respectively) and GPx (+36% and +18%, respectively) in comparison with the data of the animals of the "chromium" group; GSH level at a low dose of boron with chromium increased (+14%, p <0.05), and at high, on the contrary, decreased (- 16.5%, p<0.05).

In conditions of isolated administration of Na2B4?7, only the CAT activity significantly increased in low and high doses (+17 and 25%, p<0.05, respectively), and in a low dose only the GSH content (+16%, p<0.05) compared to the control.

Cr+ 6 is characterized by a wide range of toxic disorders, physiological and physio-biochemical dysfunctions [47,48], which are accompanied by a number of clinical complications, including the development of bronchopulmonary pathology1. Chromium ions, being a transition metal, can stimulate free radical processes in living systems when Cr+ 6 is reduced to Cr+ 3, according to the Haber – Weiss and Fenton mechanisms[49,50], various radicals appear and excessive ROS generation disturbs the prooxidant/ antioxidant balance, "oxidative stress" develops[51], lipid peroxidation, protein oxidation are activated, the permeability of cell membranes changes, and intoxication develops with a violation of the biocatalytic systems of the body. Therefore, the development and search for drugs based on substances with antioxidant properties (effects) is necessary for the prevention (prevention), correction and treatment of chromium intoxication.

In the present study, the effect of Cr+6 on animals through drinking water led to a significant increase in the number of neutrophils in the endopulmonary cytogram and a decrease in the content of AMP, which was accompanied by an increase in the value of MCI (NF/AMP), the number of lymphocytes and epithelial cells increased compared to control data. These data are consistent with previously obtained results[52,53,54].

However, under the combined effects of borax (low and high doses) and potassium dichromate, there was a decrease in MCI (NF/ AMP), the number of lymphocytes, neutrophils, epithelial cells and an increase in the content of AMP in comparison with data from rats exposed only to Cr+6. Interestingly, joint treatment with brown led to a decrease in violation of the nonspecific mechanism of respiratory protection from the effects of Cr+6 (MPI = NF / AMP) – the mucociliary index (clearance) improves (anti-inflammatory effect), which is apparently associated with a decrease in expression (inhibition of production) IF – a, IL – ß and nuclear factor NFkB[29,55], leading to a decrease in lung tissue damage caused by Cr+6, suppressing the inflammatory response. It should be noted that a high dose of borax, in contrast to a low one, with the combined use of Cr+6 significantly worsens the MDI as a result of a significant difference in the numbers of neutrophils and AMP, i.e. at a high dose of Na2B4?7 with chromium, in comparison with the data of rats with a low dose of borax with chromium, an increase in MCI is observed (p<0.05). It should be emphasized that with isolated administration of sodium tetraborate in a low dose, a significant decrease in leukocyte neutrophils and MDI occurs (in a high dose, no changes in the endopulmonary cytogram are observed), which indicate the abatement of chromium-induced pulmonary inflammation due to a decrease in the accumulation of inflammatory cells due to inhibition of the synthesis of pro-inflammatory cytokinins[56,57,58].

The study showed that oral administration of K2Cr2O7 with drinking water at a dose of 700 mg/L caused a significant increase in the level of MDA, which determines the severity of oxidative stress (OS) in lung tissues and is consistent with previously obtained results [53,54,17]. Under conditions of exposure to sodium tetraborate in a low dose and chromium, a decrease in the level of MDA occurs, i.e. decrease in lipid peroxidation in lung tissues in comparison with the data of the chromium group. Therefore, Na2B4?7 in a low dose under conditions of combined exposure

**Table 1.** The effect of $Na_2B_4O_7$ on the endopulmonary cytogram in chromium induced oxidative lung damage in rats

| Options | Groups | | | | | |
|---|---|---|---|---|---|---|
| | Control(I) | $K_2Cr_2O_2$(II) | $Na_2B_4O_7$ 22,5+ $K_2Cr_2O_2$(III) | $Na_2B_4O_7$ 225 + $K_2Cr_2O_2$(IV) | $Na_2B_4O_7$22,5(V) | $Na_2B_4O_7$225(VI) |
| Alveolar macrophages | 91.0±5.477 | 72.0±6.272[a] | 86.0±4.761[b] | 75.0±5.696[a]$_c$ | 92.3±7.646 | 89±8.485 |
| Lymphocytes | 4.55±1.863 | 7.0±3.197 | 4.75±1.867 | 6.6±2.212[a]$_c$ | 5.3±2.261 | 4.1±0.638[d] |
| Neutrophils | 3.5±0.650 | 25.2±5.069[a] | 10.5±3.764[a]$_b$ | 16.0±3.590[abc] | 2.5±0.474[a] | 3.6±0.406 |
| Epithelial cells | 1.5±0.941 | 6.6±0.419[a] | 3.3±0.485[a]$_b$ | 5.0±0.442[abc] | 0.9±0.408 | 1.3±0.778 |
| Mucociliary index | 3.82±0.53 | 34.68±4.14[a] | 12.03±3.78[a]$_b$ | 20.82±3.23[abc] | 2.72±0.34[a] | 4.06±0.21[d] |

Note: a - $p < 0.05$ in comparison with the data of animals of the control group; b - $p < 0.05$ compared with the data of rats of the «$K_2Cr_2O_2$» (II) group; c - $p < 0.05$ in comparison with the data of group 3 or a statistically significant difference between the data of animals of groups 3 and 4; d - $p < 0.05$ compared with the data of rats of group 5 or statistical significant difference between the data of animals of groups 5 and 6.

**Table 2.** The effect of $Na_2B_4O_7$ on chrominduced oxidative damage in lung tissue

| Options | Groups | | | | | |
|---|---|---|---|---|---|---|
| | Control(I) | $K_2Cr_2O_2$(II) | $Na_2B_4O_7$ 22,5 + $K_2Cr_2O_2$(III) | $Na_2B_4O_7$ 225 + $K_2Cr_2O_2$(IV) | $Na_2B_4O_7$22,5(V) | $Na_2B_4O_7$225(VI) |
| MDA | 2.5±0.867 | 4.0±1.018[a] | 2.98±0.349$_b$ | 3.4±0.374[abc] | 2.0±0.485 | 2.9±0.3496[d] |
| SOD | 72.0±13.548 | 53.0±8.313[a] | 62.0±9.452[a] | 71.0±6.583$_b$ | 70.0±10.360 | 81.0±8.2462 |
| CAT | 69.0±5.375 | 52.0±4.083[a] | 61.0±3.742[a]$_b$ | 69.0±7.288[bc] | 81.0±7.902[a] | 86.0±9.4516[a] |
| GPx | 16.0±3.742 | 11.0±3.496 | 15.0±4.0825 | 13.0±2.8674 | 21.0±4.761 | 18.0±3.496 |
| GSH | 6.1±0.960 | 5.0±0.639[a] | 5.7±0.316$_b$ | 4.2±0.320[abc] | 7.1±0.810[a] | 6.6±0.4082 |

Note: a - $p < 0.05$ compared with data from animals of the control group; b - $p < 0.05$ compared with the data of rats of the group "chromium" (II); c - $p < 0.05$ compared with data from animals of group 3 or a statistically significant difference between data from animals of groups 3 and 4; d - $p < 0.05$ compared with data from animals of group 5 or statistical significant difference between data from rats of groups 5 and 6.

to Cr+6 significantly protects the lungs from chrominduced oxidative damage, which indicates its radical cleansing activity and the mechanism of chain destruction. Whereas, in a high dose of borax, when co-administered with Cr+6, MDA increased in comparison not only with the data of rats subjected to sodium tetraborate in a low dose and Cr+6 (group 3), but also with control. In the scientific writing previous studies[20,21,22] detected that boron compounds (Na2B4?7) in low doses under conditions of chrominduced organ damage inhibits LPO and activates AOS in the liver, brain and heart tissues, while high, on the contrary, stimulates CPO lipids, i.e. boron compounds exhibit antioxidant in low doses, while in high, on the contrary, prooxidant properties.

The intensity of oxidative stress is characterized by significant changes in the activity of SOD, CAT, and GPx and the content of GSH in lung tissues. Thus, the use of Na2B4?7 in a low dose and chromium led to a significant ($p < 0.05$) decrease in MDA and an increase in the activity of SOD, CAT, GPx and GSH content in lung tissues in comparison with the data of animals of the second group and did not differ from the control data, for the exception of catalysis activity. High dose sodium tetraborate and chromium increased the amount of MDA in lung tissues compared with the third group and control. Moreover, despite an increase in the content of MDA, the activity of all studied AOS enzymes remained at the level of control data; however, the content of GSH in lung tissues was significantly reduced compared with the control data, groups 2 and 3. Enhanced LPO with depletion of GSH levels indicates that increased peroxidation may result from depletion of GSH reserves.

The use of tetraborate in a low dose showed normal levels of GSH, which could be caused by a boron-mediated decrease in LPO activity, due to its role as an acceptor (of as a scavenger of singlet molecular oxygen, superoxide) singlet molecular oxygen, superoxide and hydroxyl radical[34,59,28,60]. Antioxidant enzymes can inhibit the formation of free radicals and prevent their harmful effects on cells.

In the present study, the absence of reaction on the part of AOS enzymes under conditions of the use of Na2B4?7 at a high dose and chromium, despite an increase in MDA and a decrease in the amount of GSH, can be attributed as a factor leading to increased oxidative stress. An increase in the power of both the enzymatic and non-enzymatic (GSH) AOS units in the tissues of the lungs of animals treated with low-dose sodium tetraborate and Cr+6 compared to the chromium group indicates a decrease in chromium-induced OS due to the powerful antioxidant effect and can be part of a pulmonotropic sanitizing effect (mechanism) – the effect of boron sanitation (in a low dose of 22.5 mg/kg). It should be noted that in our study, under the conditions of isolated administration of Na2B4?7, only CAT activity increased in low and high doses, and the amount of GSH in lung tissues increased in low doses, which once again confirms the assumption that the role of boron compound as an antioxidant when used in low doses. Boron (its compounds) under these conditions exhibits an antioxidant property due to its affinity for hydroxyl groups and the ability to form dieters bridges between cishydroxyl-containing molecules[61]. Another mechanism that reduces the toxicity of chromium to cells should be sought in the activation of antioxidant enzymes34. The third mechanism is probably associated with the fact that boric acid in a low dose has a stabilizing effect on cell membranes[48]. The fourth, anti-inflammatory effect, characterized by a decrease in the expression of TNF-a, IL-l and NF kB[29,55], leading to a decrease in lung tissue damage, inhibiting the inflammatory response. And finally, the immunomodulatory effect of a boron compound refers to all parts of the immune system[62], leading to reorganization.

## CONCLUSION

Oxidative stress induced by Cr+6 in lung tissues may be responsible for changes in the endopulmonary cytogram, disturbance of the mucociliary index, balance of prooxidants / antioxidants in the lung tissue, enhancement of lipid peroxidation, and suppression of the activity of antioxidant enzymes and non-enzymatic AOS.

Sodium tetraborate (Na2B4?7), depending on the dose (at a low dose of 22.5 mg/kg body weight), can protect lung tissue from chromium induced oxidative damage. However, with the

introduction of a high dose of sodium tetraborate with chromium, the expected positive effect is not observed.

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