UDC 612.15:54.063

[1,a]S.T. Tuleuhanov, N.T. [1, b]Ablayhanova, [1, c]S.A. Sharipova,
[2,d]B.K. Dinistanova, [2,e]Z.A. Mansurov

[1] Department of biophysics and biomedicine, Faculty of Biology and Biotechnology,
al-Farabi Kazakh National University, Almaty, Kazakhstan
[2]Institute of Combustion Problems, sl-Farabi Kazakh National University, Almaty, Kazakhstan

Effect of the nanostructured carbon sorbent «Ingo-2» and cadmium chloride on limfodynamic and composition of lymph

Abstract

The effect of cadmium ions and nanostructured carbon sorbent on limfodynamic and composition of lymph was stadies. The experiments showed that prolonged poisoning of rats with cadmium chloride (*per os*) causes changes of biochemical composition and physic-chemical parameters of lymph and blood plasma. The accumulation was marked by of cadmium ions in the lymph nodes, where their concentration is increased 5-7 times of the original level. Using n nanostructured carbon sorbent «Ingo-2» reduces substantially negative effect of cadmium on limfodynamic and indicators of lymph.

Keywords: nanostructured carbon sorbent , composition of lymph, limfodynamic, cadmium chloride, cadmium intoxication.

Introduction

One of the priorities is the creation of nanocomposite systems. Much attention is paid to the synthesis of carbon nanomaterials for various purposes, especially the highly effective and affordable carbon-containing sorbents

The role of sorption materials in medicine is significant.

Thanks to the joint development of biologists, chemists, engineers there appeared independent of imports, non-invasive School health treatment technology using sorbents that bind to the surface and the toxic products of deducing them from the body naturally.

Among the large variety of adverse environmental factors of the environment that affect the body, occupy a special place heavy metals, especially cadmium [1-3].

Cadmium enters the body of animals and human beings by binding with proteins to form stable compounds and has a long-term nature of the toxic effects on the nervous system, reproductive function and development of the organism [4-5].

The search of substances that contribute to the removal of cadmium from the body continues. Our attention was attracted by the carbon nanostructured sorbent «Ingo-2»,which was developed in the Institute of Combustion Problems "at the execution of Al-Farabi Kazakh National University (Almaty, Kazakhstan) , based on vegetable raw materials because of their sorption and biological effects that are studied in detail by us previously and have no toxicity [6-8].

This sorbent meets the following requirements: a high degree of chemical purity, high sorption capacity with respect to the substance being removed, the inertia with respect to the formed elements of blood, the absence of dust (separation of ultrafine particles).

At the heart of waste plant material – rice husks used method of carbonization.

Rice husk is selected as the feedstock due to its chemical composition, allowing obtaining a result of processing material with physiological compatibility with blood and able to absorb toxins.

In addition, the rice husk is an environmentally friendly product available – waste processing plant in Kazakhstan, having an initial high porosity [9].

The micrographs of carbonized samples are

*E-mail: Sultan.Tuleuhanov@kaznu.kz

 Printed in Kazakhstan

presented in Fig. 1. According to the results from our physicochemical investigations, the obtained carbon sorbent has a highly porous structure with numerous cells.

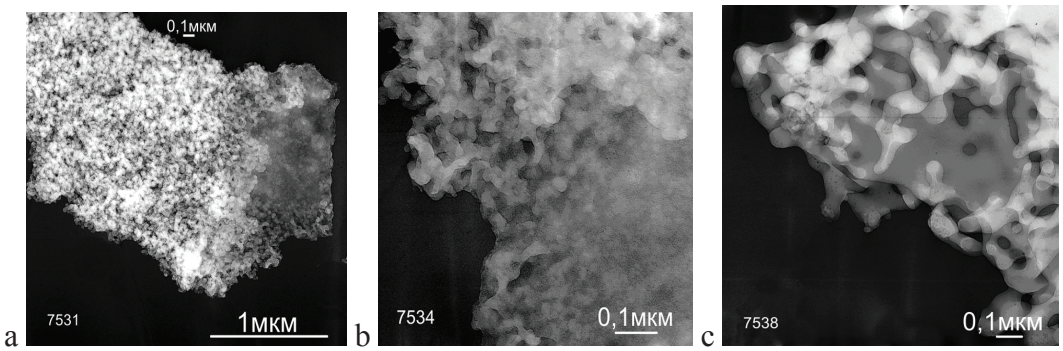

Figure 1 – Electron micrograph of the surface of particles samples carbonized at 700-850^{0}C

The purpose of this study is to study the composition of lymph limfodynamic with moderate intoxication of rats by cadmium chloride and ways of detoxifying the body by using nanostructured carbon sorbent «Ingo-2».

Materials and methods

In this work 43 albino rats, each of average weight 200-250 gm. Rats were kept under standard conditions along the experimental period, 12/12 h light-dark regimen. Food and water were supplied daily *ad libitum*.

All animals were housed according to the ethic rules in compliance with institutional guidelines. There were formed, four groups of rats: group 1, control (10 rats), Group 2, which received cadmium chloride *per os* at a dose (1.5 mg / kg) in drinking water for 30 days (12 rats), the third group – the rats were treated with cadmium chloride, water and optionally nanostructured carbon sorbent «Ingo-2» at a dose of 0,5 g / kg (10 rats) and Group 4 – rats, which, along with cadmium chloride was prepared by nanoenterosorbent «Ingo-2» at a dose of 1 g / kg (11 rats).

After 30 days of the impacts of rats they were taken to an acute experience. In anesthetized rats (sodium thiopental, injected intraperitoneally with 30-40 mg / kg).

There was recorded blood pressure in the tail artery using strain gauge monitor surgical MX-01 and measured the lymph flow from the intestinal lymph duct through a graded microcannula.

We took samples of blood and lymph and lymph nodes of animals'for examination. Isolated (cervical and mesenteric) nodes were placed on the installation consisting thermostatically controlled chamber and the vacuum tube 6MH1S recording device.

Nutrient solution served as the oxygenated Krebs solution at a temperature of + 370°C.

The contractile responses to the call of lymph nodes used vasoactive substances: epinephrine, acetylcholine and histamine in concentrations of 10^{-9}M – 10^{-3}M.

Measured in the blood and lymph through the viscometer viscosity in the blood plasma and lymph were measured osmotic pressure on osmometer OMTSK-01, the total protein content in the SF-18 spectrophotometer micro method using amidochernogo, dry matter – by weighing the sample.

Plasma volume was determined by hematocrit, blood clotting time by Sukharev's method, the concentration of sodium ions, potassium and chloride in blood plasma using ion-selective method for the analyzer Vitros DT 60.

The content of cadmium ions in the blood and lymph node tissue in rats was determined by emission spectral analysis on the atomic absorption spectrophotometer SFAA S3 [10-12].

All data were expressed as mean of ± SE and statistical analysis was made using the Statistical Package for Social Sciences (SPSS 11.0 software and Microsoft Excel 2010).

For tests, analysis of differences between groups consisted on a one-way analysis of variance (ANOVA) with repeated measures, followed by post-hoc comparisons (LSD test).

Differences were considered statistically significant at $p< 0.05$ and marked as (*), highly significant

at p< 0.01 and marked as (**), and very highly significant at p< 0.001 and marked as (***) [13].

Results and discussion

Indicators of lymph flow, blood pressure, and composition of lymph and blood plasma of intact rats (group 1) are presented in Table 1.

After the rats intoxicated by cadmium chloride for 30 days (2-group) There was revealed an increase of cervical and mesenteric lymph nodes and the linear dimensions of 2-3 times, puffiness and swelling them.

There was a decrease in lymph flow from the intestinal lymphatic vessels by 22%, decrease in blood pressure (BP) by 10%.

Found to decrease the viscosity and solids of blood plasma and lymph of rats after exposure of cadmium ions.

There was a slight increase in the volume of blood plasma (according to the hematocrit), and a significant decrease in total protein in blood plasma and lymph (Table 1). These data indicate a decrease in the exchange function of the lymphatic system.

After cadmium intoxication in rats. There were revealed changes in the ionic composition of blood plasma (Table 1).

The concentration of potassium ions in plasma decreased by 42% compared with control rats (6.03 0.12 mmol / l in the control and 3.5 0.2 mmol / L after receiving cadmium chloride).

The level of sodium and chloride ions in the plasma was increased significantly after cadmium intoxication in rats, however, these fluctuations were within physiological limits.

The content of cadmium ions in the blood and tissues of animals after poisoning by cadmium chloride increased sharply. In blood, its concentration is increased from 0,05 ± 0,001 in control to 0,24 ± 0,03 mg / kg (P <0.001) after cadmium chloride for 30 days (group 2). In the cervical and mesenteric lymph nodes of the level of cadmium was higher.

These data indicate an increase in the ion content of cadmium in blood and tissues by 5-7 times from the initial values after chronic poisoning with sodium chloride. The accumulation of cadmium ions in the lymph nodes leads to a reduction of transport and drainage of lymph tissue.

As it is evident from the data obtained after cadmium intoxication in rats the total protein content in plasma and lymph decreased and plasma portion of blood increased.

The simultaneous decrease in the viscosity of blood and lymph testifies to their dilution. These findings suggest a decrease in lymph after the administration processes of cadmium ions, and animals as a consequence of reduction in lymph flow.

In the next series of experiments, rats received, along with cadmium chloride, sorbents: nanostructured carbon sorbent «Ingo-2» at a dose of 0,5 g / kg (third group of rats), and at a dose of 1,0 g / kg (Group 4), to detoxify the body and the rapid removal of cadmium ions from the body.

Obtained Data using nanostructured carbon sorbent «Ingo-2» against giving cadmium chloride is shown in Table 1.

In rats treated with an additional, except cadmium chloride also «Ingo-2», lymph flow rates were very close to control values and were more significant in 4 – the first group of rats.

The concentration of protein in lymph and blood plasma of third group rats receiving the drug nanoenterosorbent «Ingo-2» at a dose of 0,5 g / kg increased, but did not reach the control level (Table 1, Group 1).

In making nanoenterosorbent «Ingo-2» at a dose of 1,0 g / kg (third group) content of total protein in lymph and blood plasma were at a level typical of intact rats (Table 1, group 1).

Physical-chemical parameters were within the control of borders, slightly exceeding its level in intact rats (Table 1, the first group).

The concentration of protein in lymph and blood plasma of third group rats receiving the drug nanostructured carbon sorbent «Ingo-2» at a dose of 0,5 g / kg increased, but did not reach the control level (Table 1, Group 1).

In making nanostructured carbon sorbent «Ingo-2» at a dose of 1,0 g / kg (third group) content of total protein in lymph and blood plasma were at a level typical of intact rats (Table 1, group 1).

Physic-chemical parameters were within the control of borders, slightly exceeding its level in intact rats (Table 1, the first group).

Table 1 – Indicators of lymph flow and composition of lymph and blood plasma before and after the administration of cadmium chloride of rats and nanostructured carbon sorbent «Ingo-2»

Indicators	1 Group	2 Group	3 Group	4 Group
Blood pressure, mm Hg	100±7	92±4	100±4	104±5
Lymph flow, ml / min	0,0053±0,001	0,0042±0,001*	0,0045±0,001	0,0049±0,001
Osmotic pressure mOsm / l:				
In blood plasma	280±12	323±13*	295±10	285±11
In the lymph	275±20	295±12	278±13	274 ±10
Clotting time	250±24	190±20	248±12	246±17
Protein of Plasma,%	6,2 ± 0 ,5	4,5 ±0,03*	5,7 ± 0,03	5,8±0,05
Protein of lymph,%	4,3 ± 0,3	3,5 ±0,03*	3,9 ± 0,03	4,1± 0,2
Sodium, mmol / l	138 ± 1,41	141±1,18	140 ± 1,12	140±1,20
Potassium, mmol /	6,03 ± 0,12	3,5 ± ,2**	4,5 ±0,12*	5,8±0,18
Chloride, mmol	99,0 ± 1,73	102 ± 0,20	100 ± 0,48	100± 0,13
Hematocrit:				
The volume of red blood cells	48±2	43±3	46±2	47±2
Volume of plasma	52±3	57±4	54±3	53±2
The viscosity of blood	4,3±0,6	3,2±0,7*	3,8±0,7	4,0±0,5
The viscosity of the lymph	1,7± 0,04	1,2±0,02*	1,6±0,03	1,1± 0,02
The dry remain of plasma	4,8± 0,7	4,0±0,3*	4,4 ± 0,4	4,5± 0,4
The dry remain of lymph	3,3±0,4	2,7±0,3	3,1±0,2	3,1± 0,3

The content of cadmium ions in the blood and lymph node tissue sharply decreased in rats treated with nanoenterosorbent, significantly exceeding the above background (Fig. 2).

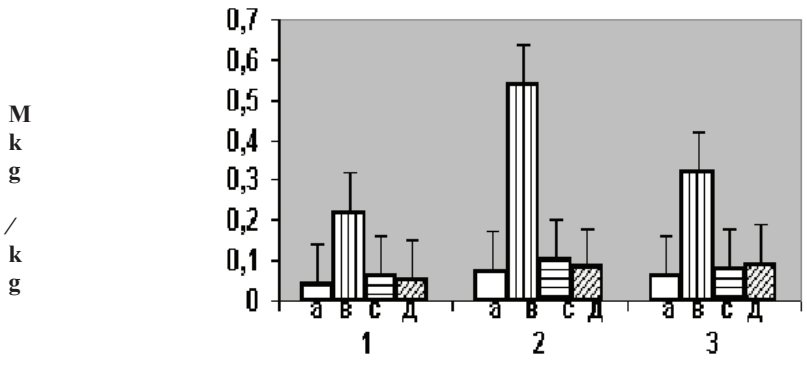

Figure 2 – The content of cadmium ions in the blood (1), mesenteric node (2), cervical lymph node (3) before and after giving 30-day cadmium chloride to rats per os alone and in combination with nanostructured carbon sorbents «Ingo-2». Note: the vertical axis – the concentration of cadmium ions in mg / kg, abtsiss axis – a group of animals in the form of columns: control (a), giving cadmium chloride (c), giving cadmium chloride and nanostructured carbon sorbent «Ingo-2»» at a dose of 0,5 g / kg (c), giving cadmium chloride and nanoenterosorbent «Ingo-2» at a dose of 1,0 g / kg (g).

The above material shows that moderate long-term cadmium intoxication of the animals has a negative impact on the state of environment of the body on limfodynamic and biochemical composition of blood and lymph. Decreased lymph flow and blood pressure, total protein, dry matter, lymph and blood viscosity, ion concentration in blood plasma.

The content of potassium ions in the blood plasma of rats after cadmium poisoning decreased dramatically, probably due to a violation of potassium reabsorption in the kidney. A small increase in the level of sodium and chloride in blood plasma resulted in water retention and an increase in the plasma of the blood, inhibited the excretion of cadmium ions from the body.

Application nanosorbents reduced sharply the negative effect of cadmium ions on the composition of lymph and limfodynamic. After giving nanostructured carbon sorbent «Ingo-2» at a dose of 1,0 g / kg physicochemical and biochemical parameters of blood plasma and lymph recovered better than when using «Ingo-2» at a dose of 0,5 g / kg, although the differences were not significant (Table 1).

The increase of lymph flow after giving nanostructured carbon sorbents «Ingo-2» accelerates the excretion of cadmium ions from the area of microcirculation. The concentration of cadmium ions in the blood and lymph nodes decreased to control values (Figure 1). Preparations nanostructured carbon sorbent «Ingo-2» adsorbing on the surface of cadmium ions, reducing the possibility of accumulation of these ions in the blood and body tissues.

Conclusion

Thus, moderate long-term poisoning of rats with cadmium ions inhibit limfodynamic, drainage, and tissue reduced number of physiol and chemical, biochemical indicators of lymph and blood plasma. The use of nanostructured carbon sorbents «Ingo-2» at a dose of 0,5 g / kg effectively reduces the negative effect of cadmium ions on the homeostasis of the organism. The results show the applicability of nanostructured carbon sorbents for the treatment of cadmium poisoning.

References

1 Levin E.N. General toxicology of metals. St. Petersburg: Nauka, 2002. – P. 240.

2 Oksengendler G. Poisons and body. St. Petersburg: Nauka, 2002. – P. 320.

3 Ershov Yu.A., Pletnev TV Mechanisms of toxic action of inorganic compounds. Moscow, 2005. – P. 272.

4 Nagymajtenyi L., Schluz H., Desi J. Behavioural and functional changes caused by cadmium in a free-generational study in rats // Hum. and Exp. Toxicol. – 1997. – V.16. № 12. – pp.691-699.

5 Kopp S.J., Fischer V.W., Erlanger M., Perry E.F. The influence of chronic low-level cadmium and or lead feeding on myocardial contractility related to phosphorylation of cardiac myofibrillar proteins // Toxicol. Appl. Pharmacol, 1980. V. 54. – pp. 48-56.

6 R. M. Mansurova, Physicochemical Principles of Synthesis of Carbon_Containing Compositions (XXI Vek, Almaty, 2001) [in Russian].

7 Z.A. Mansurov. Recent developments of the Institute of Combustion Problems in the field of nanomaterials // VI International Symposium on Physics and Chemistry of Carbon Materials / Nanoengineering, 2010, pp.11 -31 [in Russian].

8 Z. A. Mansurov and M. K. Gilmanov, "Nanostructural Carbon Sorbents for Different Functional Application" in Sorbents: Properties, Materials, and Applications, Ed. by P. Th. Willis (Nova Science Publ., New York, 2009), Ch. 7, P. 217.

9 A. R. Kerimkylova, B.B. Mansurova, M. K. Gilmanov and Z. A Mansurov. Nanoporous Carbon Sorbent for Molecular_Sieve Chromatography of Lipoprotein Complex // Russian journal of Physical, 2012, Vol. 86, No6. – pp. 1004-1007.

10 Clinical Biochemistry. / Ed. VA Tkachuk. – 2nd edition, revised. and enlarged. – Moscow. "GEOTAR-Med."2004. – P. 512.

11 Kamyshnikov VS Handbook of clinical and biochemical research and laboratory diagnosis. – Moscow: MEDPress-Inform, 2004. – P. 920.

12 Painter PC, Cope JY, Smith JL Reference information for the clinical laboratory. In. Burtis C.A., Ashwood E.R., eds. Tietz textbook of clinical chemistry. Philadelphia: WB Saunders company, 1999. – 1803.

13 Landue, S., Everitt, B.S.A Handbook of statistical Analyses using Spss // Chapman&Hall/CRC press LLC. London, 2004.