

# CARBON ORAL SORBENTS FOR THE ECOLOGICAL CONTROL OF THE INTERNAL MEDIA OF AN ORGANISM

Vladimir Strelko, Nikolai Kartel  
*Institute for Sorption and Problems of Endoecology,  
National Academy of Sciences of Ukraine*

Corresponding author e-mail address: [dstrelko@ispe.kiev.ua](mailto:dstrelko@ispe.kiev.ua)

The global environmental pollution, causing chronic contamination of an organism, is the reason of the increased sick rate and mortality, premature growing old, progressing decline of vital forces. According to experts the WOH near 80 % of diseases are caused by ecologically adverse factors and this now gives a reason to consider the ecological model of modern medicine as one of the basic models.

Development and application of the ecological friendly technologies in transport, industry and energy production require long time and huge finance investment. Therefore, positive influence on the human health is a matter of not near future.

In the present report it is developing representations that medical enterosorbents on the basis of granulated active carbons allow already today to put and solve tasks of the ecological control of the internal media of an organism, i.e. to prevent accumulation of ecotoxicants and to provide their fast evacuation from biological fluids of human and animals.

Enterosorbents (oral sorbents) on a basis of spherically granulated synthetic ( $d = 0.3-0.6$  mm) and fruit stones (irregular granules  $d = 0.3-2$  mm) carbons, and also the activated carbon fibers represent high purity and high porous materials with controllable surface chemistry. In some cases in a superficial layer of such carbons there are set amounts and types of heteroatoms nitrogen and oxygen, as well as acid groups of phenol and carboxyl types (oxidized carbons), in which the protons are replaced by useful microelements ( $K^+$ ,  $Mg^{2+}$ ,  $Zn^{2+}$ ,  $Cu^{2+}$ , etc.). In Table 1 technical names and porometric characteristics of carbon enterosorbents are submitted.

These materials have been developed in the Institute for Sorption and Problems of Endoecology, the National Academy of Sciences of Ukraine (Kiev), and clinical tests last 10-15 years have shown their high efficiency, as powerful detoxifying means of an organism and correction of the internal media at preventive maintenance (prophylaxis) and therapy of ecologically dependent diseases and pathological states [1-3]. So, these medical sorbents are effective at therapy of acute and chronic poisonings by pesticides, phosphorus organic compounds, salts of heavy metals; at prophylaxis and treatment of allergies, caused by remedy reception or some types of foodstuff, and also at a pollen allergy. At last, they provide radiation protection at external ray injuries and at

penetration of radionuclides in the internal media of an organism. Moreover, periodic application of enterosorbents during 2-3 weeks allows carrying out the correction of lipid, cholesterol, nitrogenous and electrolyte exchange on the phone of adverse ecological changes of biochemical parameters of an organism.

Table 1. The volume of adsorption pores on benzene ( $W_s$ ) and the specific surface area on argon ( $S_{sp}$ ) of some carbon adsorbents.

Adsorbent	$W_s, \text{cm}^3/\text{g}$	$S_{sp}, \text{m}^2/\text{g}$
Medical charcoal ("carbolen")	0.30	780
Synthetic carbon SCN	0.80	1910
Synthetic carbon SCS	1.10	2250
Fruit stones carbon KAU ("carbovit")	0,45	1710
Oxidized synthetic carbon SCNo	0,65	1430
Active fiber carbon UVM	0,54	1250

To demonstrate this on the Fig.1 the diagram of influence of synthetic enterosorbent SCN reception on the content (in mkg/l) of DDT pesticide isomers in blood of people is submitted. It is well visible that even microquantities of initial ecotoxicants in an organism can be appreciably lowered due to a 10-day's rate of enterosorption (3 times per day, on 1 spoon of adsorbent, 1 hour prior to meal).

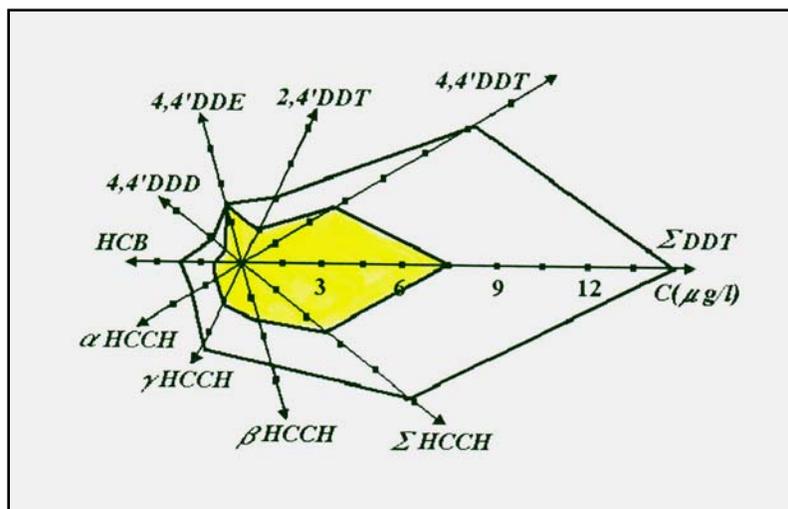


Figure 1. Influence of oral sorption with enterosorbents SCN on chlorine-containing pesticides removal from blood:  before treatment;  after treatment.

We have obtained the kinetic curves of mercury removal from an organism of intoxicated patient, testifying about more effective action of enterosorbents SCN on a basis of synthetic carbons in comparison with a typical carbonaceous antidote "carbolen" on a basis of powder medical charcoal. At this an antioxidant system of an organism is essentially improved; the content of -SH groups in blood plasma grows from 11 till 16.2 mMol/l, and serotonin - from 0.12 till 0.28 mMol/l.

As an example in Table 2 the typical data elucidated opportunities of enterosorption to correct lipid, cholesterol and electrolyte exchange of the patients living in a zone of ecological disaster (in industrial area) are also submitted. It is visible that high initial levels of lipids, triglycerides and cholesterol in blood are effectively reduced as a result of 2-week rate of enterosorption. Therapeutic effect is kept 2-3 months.

At last, it is necessary to note opportunities of enterosorption to carry out preventive maintenance of accumulation and the accelerated removal of radionuclides from an organism. These clinical researches were carried out during the first months after accident on the Chernobyl NPP in 1986.

Thus, it is necessary to note that as enterosorbent the mix of "basic" (initial) and partially oxidized carbons SCN was used. It is connected by that the "basic" carbon is anionite, and oxidized - cationite, showing the expressed selectivity in relation to heavy metals. Therefore the carbon mix should absorb from gastric and intestinal space both anionic, and cationic forms of radionuclides getting there with food or aerosol way, and also their complexes with organic biomolecules (products of a metabolism) by typical for carbons molecular adsorption.

In Table 3 the data, testifying that as a result of a fortnight rate enterosorption the general radioactivity of blood is reduced in ~7 times are submitted, and the greatest effect is achieved for radioisotopes  $^{140}\text{La}$ ,  $^{103,106}\text{Ru}$ ,  $^{131}\text{I}$ .

Table 2. Biochemical data of blood for patients with coronary insufficiency after 2-weeks course of therapy by enterosorbents SCN.

Parameter	Level before enterosorption	Level after enterosorption
Total serum protein, g/l	68.7±0.4	74.0±1.0
Total lipids, g/l	10.8±0.3	4.9±0.4
Triglycerides, g/l	5.74±0.20	1.34±0.05
Cholesterol, mM/l	8.20±0.12	5.80±0.28
Creatinine, μM/l	147±1	101±3
Bilirubin, mM/l	18.0±0.1	14.1±0.6
K <sup>+</sup> of serum, mM/l	4.20±0.03	4.76±0.13
K <sup>+</sup> of erythrocytes, mM/l	82.0±0.4	95.7±1.5
Mg <sup>2+</sup> of serum, mM/l	0.76±0.04	0.78±0.03

Table 3. Influence of prophylaxis oral sorption with enterosorbents SCN on radionuclides content in blood of persons worked in Chernobyl zone.

Radionuclides	Activity of blood, nCi/l		Coefficient of decreasing
	Before enterosorption	2 weeks after enterosorption	
<sup>131</sup> I	52 ± 4	7 ± 1	7.4
<sup>103,106</sup> Ru	29 ± 2	7 ± 1	4.1
<sup>140</sup> La	518 ± 47	30 ± 4	17.3
<sup>134,137</sup> Cs	23 ± 2	12 ± 8	1.9
<sup>95</sup> Zr	22 ± 3	8 ± 1	2.8
<sup>95</sup> Nb	33 ± 3	17 ± 1	1.9
<sup>141,144</sup> Ce	57 ± 7	23 ± 2	2.5
TOTAL	734 ± 68	104 ± 18	7.1

In a case of preventive reception of enterosorbents at work (2 weeks) of personnel in zone polluted with radionuclides (aerosols) the degree of their accumulation in an organism is reduced in 7-8 times in comparison with the persons who were not accepting enterosorbents.

The important circumstance is also that application of enterosorbents allows to control in an organism not only a level of radionuclides, but radiotoxins - quinons, aldehydes, ketones, and, the most important, free radicals and peroxides of lipids. Factually the development of any types of ray pathology begins from radiolysis of water in an organism, appearance of highly active free radicals and, as consequence of this, - the mentioned highly toxic radiotoxins.

It is well known that «basic» carbons possess quite high catalytic activity in reactions of decomposition of peroxides, in particular hydrogen peroxides. Especially the nitrogen-containing carbons possess the best catalytic ability [4].

Therefore we have specially studied features of influence of nitrogen heteroatoms on catalytic activity of carbons in modeling reactions of H<sub>2</sub>O<sub>2</sub> decomposition. Controllable amounts of nitrogen are introduced into a carbon matrix by means of impregnation of preliminary oxidized carbons with melamine and following thermal treatment of them in vacuum at 800 °C.

It is shown that maximal catalytic activity belongs carbons containing 1.5-3 % N. It is also important to note that presence in a matrix of N-containing carbon of 3-4 % of oxygen of furan or pyrone types also improves the catalytic activity not only in reactions of decomposition of peroxides, but also in reactions of oxidation of harmful products of metabolism (creatinine, uric acid, aldehydes, etc.). In fact as a result of chronic ecointoxication the pathologic changes of metabolic pathways occur, and carbon enterosorbents actually incur in part a function of secretor bodies (liver, kidneys).

Differently, it is necessary to note that enterosorbents on basis of N- and O- containing active carbons show not only properties of adsorbents - catchers of ecotoxicants and harmful products of metabolism in a gastroenteric path, but also original carbon catalysts with high enzymatic activity, i.e. as enzymes of catalase (decomposition of  $H_2O_2$ ) and oxidase (oxidation of metabolites) types. Moreover, it was already spoken about use of oxidized carbons as enterosorbents. As they possess a mobile proton of superficial HO- and HOOC- groups, they should not only adsorb hepatic toxicant  $NH_3$ , but also work as enzymes of hydrolase type. And it is valid, special researches have shown that in the modeling experiences, simulating media of a gastroenteric path, enterosorbents on the basis of oxidized carbons SCN and KAU catalyze quite effective the hydrolysis of polysaccharides and fats of some type.

Thus, stated allows to conclude that on set of the marked properties the developed carbon enterosorbents are really unique means of ecological protection of an organism. Their clinical application at treatment of many thousand patients of a various structure including liquidators in the Chernobyl zone, invariable found out high medical effect. At this it is necessary to note once again three main mechanisms of curative action of enterosorbents:

- molecular adsorption of harmful and toxin substances from gastroenteric fluids (stomach and intestine juices, bill, etc);
- catalytic action in reactions of oxidation of harmful and toxic substances of molecular nature (like liver enzymes of oxidative type) and good activity in reactions of hydrolase type;
- radioprotection function caused by catalytic decomposition of lipid peroxides and other peroxides (like catalase); adsorption and catalytic conversion of radiotoxin's.

## References.

- [1] V.G.Nikolaev, V.V.Strelko. Hemosorption on Activated Carbons. –Kiev: Naukova dumka, 1979. –287 p.
- [2] Yu.P.Butylin, Yu.M.Sakun, V.V.Strelko et al. // *Physiol. J.*, 1986, 32(3).-P.314-318.
- [3] I.K.Dedenko, A.V.Starikov, V.V.Strelko. Efferent Methods in Treatment of Ray Injuries. –Kiev: Nora-print, 1996. – 410 p.
- [4] I.A.Tarkovskaya, S.S.Stavitskaya, V.V.Strelko. // *Ukrainian Chem. J.*, 1983, 49(1). – P.16-20.