APPLICATION OF NEW HYBRID ENTEROSORBENTS DERIVED BASED ON PECTIN

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Abstract

The study of integrative activity of the brain showed that groups of animals treated with pectin and PC/TS had a positive effect of pectin and its compounds on the function of the higher nervous activity. This is due to physical and chemical properties of the low methoxylated pectin, which include pectin that we obtained from sugar beet pulp.

Key words: *hybrid, enterosorbents, pectin, sugar beet pulp*

INTRODUCTION

Medicinal products created from natural raw materials have a number of advantages over synthetic: human or animal easily absorbs them; generally do not have side effects; very rarely toxic. The juices of berries, fruits and roots contain polysaccharides and similar substances that give significant amounts of galacturonic acid during hydrolysis. These substances are also known as pectin substances. The molecule of pectin is based on polygalacturonic or pectic acid, which is a chain of galacturonic acid residues [1, 2].

In general, the polysaccharides have the ability to reduce the excitability of the nervous system. They are used for neurasthenia and cardiospasm, insomnia, hysteria. Polysaccharides have the properties of anticoagulants and can reduce blood pressure. Polygalacturonic or pectic acid in a complex with other polysaccharides is part of many drug substances with nootropic action, restoring the higher brain functions - memory, learning, attention, mental performance. This is due to the improvement in metabolism that allows brain cells to endure different kinds of intoxication and lack of oxygen. And also due to the improvement of blood circulation in small blood vessels of the brain - the microcirculation process [3].

Complexing ability of pectin (PC) is based on its ability to form insoluble complex compounds with heavy metals and radionuclides. According to WHO recommendations, this property defines the pectin as a preventive tool in the polluted territories. Solutions of the pectin interacting with metal salts, form stable compounds - metal pectinates, which are not absorbed in the intestine. Complexing or chelating properties of pectins are due to the presence in the molecule the polymer of carboxyl and hydroxyl groups of the galacturonic acid. In addition to the formation of stable complexes with metals, pectin with physical properties of a hydrophilic colloid has a high sorption capacity. In our project pectin was obtained by extraction from sugar beet pulp. To compare the complexing effect of pectin we investigated the effect of the known sorbents - tagansorbent (TS), polyethylene glycol (PEG), and their complexes with pectin – PEG/PC, TS/PC.

METHODS

Experimental studies carried out in accordance with the rules of maintenance and care of laboratory rodents and rabbits, outlined in the book "Guide to the maintenance and care of laboratory animals" (Eurasian Council for Standardization, Metrology and Certification, Minsk, 2014).

Biological material for the research were 72 white laboratory rats weighing 180-200 grams. A total six groups of animals, 12 adult rats in each group. The test samples were given orally in the morning for 14 days - PC, TS and PEG at 10 mg of enterosorbent in 1 ml of water for animal weight of 200 g, PEG

/ TS and PC / TS - 5mg of each sorbent for rat under conditions *in vivo*, *per os*. Preventive daily dose of enterosorbents is from 4 to 16 grams per day.

1st group of animals took PEG, 2nd group – TS, group number 3 – PC, group number 4 - PEG / TS, 5th group of rats took the PC / TS and group number 6 was a control group of animals - daily orally took 1 mL of plain water.

Methods of assessing the behavioral responses of rats.

To identify the effect of new hybrid enterosorbents on the main functions of the brain - the processes of excitation and inhibition in the cerebral cortex, emotional behavior – there were studied animal behavior before and after administration of pectin compounds with adsorbents in the tests "Open field" and " Elevated plus maze ".

Open field test (OFT) allows exploring the innate features of orienting-exploratory behavior and resistance to stress by Hall [4]. In the OFT there were evaluated: 1) the orienting-investigative reaction (OIR) by the number of crossed squares in the perimeter, by the number of looking into the hole, according to the number of standing up (vertical motor activity, VMA); 2) emotional reaction - the number of crossed squares in the middle of the field, the time spent in the central squares (T_C); strong expression of passive fear was judged by the frequency of grooming and amount of the boluse.

Methodology "elevated plus maze" (EPM). “Elevated plus maze” is designed to study the behavior of rodents in variable stressful conditions (with the free choice of comfort) and allows evaluating: the level of anxiety of the animal (in the dark / light preferences, fear of heights, the expression and dynamic of “looking out” behavior; symptoms of neurological deficit; habituation. The elevated plus maze is a standard method for the study of stress and anxiety behavior in rats and mice. The maze is raised above the floor with two open and two closed sleeves. The experiments studied the behavioral conflict between the innate fear of rats to open spaces and natural exploratory behavior. It is believed that the choice of closed sleeve is caused by stress, while the open sleeve is selected by animal with low anxiety. Maze is painted in matt gray or light blue color to ensure the good contrast with light and dark animals [5].

RESULTS

Open field test. The research results showed a decrease in orienting-investigative reactions in the groups of animals treated with enterosorbents. Significant inhibition of motor activity was observed after administration of PEG and PEG / TS. Upon reception of pectin and PC / TS, animals activity decreased by 10-13% compared with controls (Table 1).

Table 1. Indicators of behavioral reactions (in absolute terms) in the Open Field test after receiving enterosorbents

Indicator	Group					
	control	TS	PC	PEG	PEG/TS	PC/TS
motive activity	48,44±5,31	44,70±0,69*	37,75±0,61*	35,26±0,80*	24,8±3,41*	39,73±1,10*
vertical bars	6,13±0,97	4,83±0,30*	4,58±0,52*	4,13±0,30*	2,15±0,70*	7,15±0,90*
T in c.sq.	3,00±0,10	0,13±0,05**	1,25±0,06**	0,93±0,33*	0	2,26±0,02*
Revers	2,19±0,29	2,38±0,14*	1,42±0,29*	1,80±0,13*	0,73±0,24*	1,41±0,18*
Grooming, sec.	4,42±0,26	4,63±0,67*	3,00±1,34*	7,28±0,71*	6,26±1,19*	0,33±0,09**
Bolus,pcs.	2,33±0,28	3,00±0,22*	2,30±0,11*	2,80±0,49*	4,13±0,33*	2,23±0,30*
Looking into holes, sec.	2,13±0,08	2,28±0,25*	2,17±0,46*	1,53±0,28*	0,67±0,18*	2,13±0,43

Note - Legend: * - p≤0,05, ** - p≤0,02 compared with controls. motive activity - the number of crossed horizontal squares, vertical bars -number of racks, T in c.sq. - time in the central squares. C - control, TS - group of rats, who took Tagansorbent, PC - pectin, PEG - polyethylene glycol, PEG / TS - polyethylene glycol with Tagansorbentom, PC / TS – pectin with Tagansorbentom.

This state of orienting-exploratory behavior showed a shift in the balance of the basic cortical processes in the brain - the dominance of inhibition or excitation after taking enterosorbents. It is likely that changes in metabolism in the body, caused by the influence of enterosorbents lead to a decrease in the excitation process, more pronounced under the influence of PEG / TC, and less under PC / TC. To identify the causes of such shift, the state of emotional sphere of the nervous system was analyzed. The time that animal spent in the central squares is regarded as a reflection of the fear response to the new factor - bright lighting. Overcoming this reaction shows the presence of strong cortical processes that characterize the strong type of higher nervous activity.

As can be seen from Table 1, in comparison with controls, the behavior of the animals treated with Tagansorbent, polyethylene glycol, PEG / TS revealed the presence of emotional stress - the residence time in the central squares did not exceed 22% of control values, the amount of boluses increased by 20- 60%, grooming time increased by 50-60%. At the same time, animals, taking pectin and PC / TS showed calmer behavior - mentioned visits to the central squares, reducing time of grooming, and amount of boluses, that showed the low level of emotional excitement.

Thus, the analysis of behavioral responses in the test "Open Field" showed that pectin compounds reduce emotional excitement during the action of the new environmental factors that are likely to be associated with the overall effect of polysaccharides in its composition.

To confirm the obtained data, we needed additional tests that determine the individual resistance to stress in rats and the maximum characterize the emotional behavior of animals. In this regard, in addition to OFT, resistance to stress in rats was evaluated in the test "Elevated plus maze" [5].

Elevated plus maze. The level of anxiety in the EPM was evaluated according to the number of entries into the open and closed sleeves for 5 minutes, the number of hanging on sleeves and time of grooming. The numerical value of the data shown in Table 2.

As shown in Table 2, the behavior of animals in the test EPM - number of visits to the open and closed sleeves, hanging on sleeves - after receiving such enterosorbents as TS, PEG and PEG / TS decreased both in open and in closed sleeves as compared with controls. It was 40-50% reduction in the number of visits to opened sleeves after PEG and PEG / TS, number of visits to closed sleeves increased respectively (Table 2).

Table 2. Indicators of the level of anxiety during the test EPM after receiving enterosorbents

Indicator		Group					
		C	TS	PC	PEG	PEG/TS	PC/TS
Number of visits	O	2,23±0,16	1,73±0,24*	1,50±0,06*	1,26±0,18*	1,13±0,05*	2,33±0,24*
	C	2,13±0,16	1,86±0,21*	1,25±0,11*	1,55±0,16*	1,40±0,13*	2,06±0,26*
Time in the middle, sec	O	81,71±5,23	31,60±5,67*	152,66±13,65*	58,55±16,01*	39,33±9,11*	106,80±4,30*
	C	218,28±5,23	268,40±5,67*	147,33±13,65*	241,45±16,01*	260,66±9,11*	193,20±4,30*
grooming, sec	O	3,00±1,13	0,66±0,29*	0,83±0,37*	0	3,73±1,67*	0
	C	8,56±1,10	6,60±1,17*	6,50±1,67*	9,66±1,87*	6,46±0,96*	5,93±1,36*
Rack	O	0,85±0,16	0	0,25±0,06*	0,21±0,05*	0,06±0,02*	1,40±0,26*
	C	1,85±0,05	1,60±0,22*	1,16±0,19*	0,86±0,26*	1,13±0,23*	2,33±0,29*
Hangs		3,28±0,27	3,20±0,47*	4,33±0,26*	2,00±0,28*	2,33±0,05*	6,53±0,34*
Note –* - p≤0,05 compare with the controls.							

Groups of animals treated with pectin and PC / TS, had more frequent visits to open sleeves than to closed. The frequency of visits of both sleeves fluctuated at a level of control values in the animals treated with the PC / TS (Table 2).

Duration of hygiene procedures increased by 18.7% in the animals treated with TS, 74% - after PEG, 16% - after receiving PEG / TS. Rats who took pectin and PC / TS did not show so strong emotional excitement - grooming time in the open sleeves was minimal, and in closed - in line with the reference values (Table 2).

Grooming period - an indicator of hidden emotional tension of animals, increasing significantly in the closed sleeves is a natural poststress reaction of animals on enterosorbents and does not go beyond physiological norms of adaptation, but in a comparative perspective shows the presence of positive influence of pectin on basic cognitive processes in the brain of animals.

Thus, after oral treatment with enterosorbents TS, PEG and PEG / TC the activity of the animals in both tests decreased - less squares crossed, racks, open sleeves visits, hanging on sleeves and more time was spent on hygiene - grooming, boluses, reversers, which showed the moderate anxiety in these groups.

In groups of animals treated with pectin and PC / TS revealed a positive effect of pectin and its compounds on the integrative activity of the brain - a pronounced lack of emotional excitement and anxiety, a good motor and exploratory activity.

DISCUSSION

Enterosorption - a method based on binding and excretion from the body through the gastrointestinal tract the various pollutants for therapeutic or prophylactic purposes. Not all of the adsorbents can remove metabolites, products of intestinal microflora vital activity, including bacterial toxins, viruses, heavy metals from the body of the animal in the proper degree [6].

The number of high quality enterosorbent that able to carry out a general detoxification of body is insufficient. Tagansorbent and pectins are able to stop the manifestation and development of toxicosis caused by poisoning with heavy metal salts. Enterosorbents binding with various toxins in the gastrointestinal tract has a positive effect on cognitive functions, improves micro hemolymph circulation in the body and brain structures [7].

Tests showed that the use of pectic compounds improved the integrative processes in the brain, as this type of compounds contains a large amount of polysaccharides originating in cerebral blood flow.

Tagansorbent is not absorbed into the blood, so the effect of its impact associated with the gastrointestinal tract, total body detoxification. PEG has the ability to penetrate into the bloodstream, but the results of the research showed that its long-term use reduces stress factors resistance of the nervous system.

Thus, the study of the integrative activity of the brain showed that in the groups of animals treated with pectin and PC / TS it was revealed a positive effect of pectin and its compounds on the function of the higher nervous activity. Upon receiving the pure pectin and PC / TS there was a decrease in the level of emotional excitement and anxiety, a good motor and exploratory activity in treated animals. This behavior of the animals was due to the influence of pectin polysaccharides on brain structure and due to the sorbing effect of pollutants salts in the gastro-intestinal system.

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