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STUDY OF THE EFFECT OF GINSENG EXTRACT ON METABOLIC PARAMETERS IN COMPULSIVE OVEREATING

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ABSTRACT

Being overweight in the modern world affects about 1.5 billion adults and about 20 million children under the age of 8. In the countries of the former Soviet Union, 35% to 50% of the population is overweight. One of the main causes of this pathology is compulsive overeating. The purpose of this scientific work is to study the effect of ginseng extract on the indicators of carbohydrate metabolism and lipid peroxidation during compulsive overeating in the example of laboratory rats. To experiment, laboratory adult healthy rats were divided into 3 groups: intact animals, animals with alloxan-induced diabetes mellitus, and animals with induced polyphagia. To assess the effect of ginseng extract, 3 similar groups were created. but the introduction of an alcoholic solution of ginseng (20 ml/kg) orally was added to their diet. It was found that ginseng extract has a partially stabilizing effect on metabolism not only in experimental alloxan diabetes but also caused by polyphagia. Such an effect of ginseng may be due to the presence in its composition of a special type of glycosides called eleutherosides, which can increase the permeability of cell membranes for glucose, a stimulating effect on the hexokinase reaction, providing an intensive intake of carbohydrates into the cell, a general stimulating effect of ginseng.

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Introduction

According to the latest estimates of the World Health Organization, approximately 1.5 billion adults and about 20 million children under the age of 8 are overweight in the modern world [1]. This problem, which initially faced the most acute health care in the United States and Great Britain, where about two-thirds of the population is overweight, is increasingly covering European countries. For example, in Cyprus, Malta, the Czech Republic, Finland, Germany, and Slovakia, more than 40% of the population is diagnosed with obesity. In the countries of the former Soviet Union, 35% to 50% of the population is overweight [2].

The causes of this pathology are very diverse, but unbalanced nutrition and overeating are the primary factors. In about 30-40% of cases, some kinds of eating disorders are registered in obese patients, among which compulsive overeating (polyphagia) is the most common. In turn, the main types of compulsive overeating are polyphagic stress response, premenstrual polyphagia, compulsive polyphagia, and nocturnal polyphagia [3]. The mechanisms of occurrence of food disorders are not fully established. It is believed that they may be associated with excessive secretion of neuropeptide Y in the funnel nucleus, damage to the ventromedial and paraventricular nuclei of the hypothalamus, and taking certain medications [4]. In some cases, polyphagia is the result of a low nutritional culture of the patient [5]. Such nutritional disorders are a very serious problem for the treatment of obesity since the nutrition of such patients is imperative and usually extends to foods with a high carbohydrate content, which is undesirable to consume in large quantities. Such patients have an increased risk of relapse after a successful weight loss course [6]. Thus, the issue of regulation of nutritional disorders, as well as the problem of correction of

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physiological and biochemical disorders caused by chronic overeating and unbalanced nutrition are of important scientific and practical interest. This interest is also reinforced by the fact that polyphagia and its accompanying obesity often lead to serious complications, including type 2 diabetes mellitus, diseases of the cardiovascular system and gallbladder [7].
In this regard, special attention is drawn to the possibility of using drugs belonging to the pharmacological group of adaptogens in the cases described above. It is known that these substances, when taken systematically, can not only increase the nonspecific resistance of the body to a wide range of harmful effects of physical, chemical, and biological nature but also provide regulation of nitrogen, carbohydrate, lipid, and protein metabolism, as well as contribute to reducing oxidative stress by increasing the activity of antioxidant systems in normal and pathologies of various etiologies [8].
Thus, the purpose of this work was to study the possibility of correcting carbohydrate metabolism disorders with ginseng extract, the intensity of the lipid peroxidation process, and the functioning of antioxidant protection in laboratory rats with experimental polyphagia.

Materials and Methods

The work was performed on mongrel white rats weighing 200-250 g, contained on a standard diet. All experiments were carried out following the ethical standards of animal treatment, as well as the rules for carrying out work using laboratory animals in scientific research [9].
During the research, all animals were divided into 6 experimental groups:
Group 1: intact animals (control 1).
Group 2: an experimental model of alloxan-induced diabetes mellitus (100 mg of alloxan/kg once intraperitoneally). Slaughter – 7 days after administration.
Group 3: polyphagia ("restaurant diet"). The duration of the diet is 7 days. This diet contained 25% fat and 30% easily digestible carbohydrates. The average energy consumption of rats on this diet is 108 kcal per day. The composition of the diet included for 1 rat/day: white bread – 5 g, chocolate biscuits – 5 g, cheese crackers – 5.5 g, potato chips – 5 g, low–fat cottage cheese - 10 g, regular meals of the standard diet. The above products in crushed form were provided to rats as a permanent choice.
Group 4: administration of an alcoholic solution of ginseng to intact animals orally for 7 days at 20 ml (control 2).
Group 5: administration of an alcoholic solution of ginseng (20 ml/kg orally) to rats with alloxan-induced experimental diabetes. The duration of administration is 7 days.
Group 6: administration of an alcoholic solution of ginseng orally by 20 ml for 7 days to rats on a "restaurant diet".

After the specified time, the rats were killed by decapitation and the activity of amylase, the content of pyruvate, glucose, and urea in the blood serum were measured. The α-amylase activity was determined by the Karavey method [10]. The determination of pyruvic acid in the blood was carried out by the modified Umbright method [10], the determination of blood urea by the urease method [10], and the determination of glucose by the antron method [10]. In all experimental series, the content of secondary products of lipid peroxidation and the activity of enzymes of the antioxidant system were determined in liver homogenates. The amount of malonic dialdehyde was determined in reaction with thiobarbituric acid [11], catalase activity was determined spectrophotometrically by hydrogen peroxide loss [12], superoxide dismutase activity was determined by quercetin oxidation reaction [13]. The protein content was determined by the biuretic method [10].

Results and Discussion

At the initial tap, the effect of a high-calorie diet with a predominance of easily digestible carbohydrates on the recorded indicators of carbohydrate metabolism was investigated. It was found that a seven-day unbalanced diet has a pronounced negative effect on the carbohydrate metabolism of experimental animals. Thus, the activity of pancreatic α-amylase in the blood of animals increased by almost 2 times compared with the control series, there was a significant (+71% to the control) increase in the content of pyruvic acid, the blood glucose level exceeded the control values by 2.74 times. At the same time, there was a decrease in urea concentration by 78.8% compared to the control, which may indicate a decrease in the intensity of nitrogen metabolism **(Table 1)**. Under the same experimental conditions, catalase activity was inhibited by 52%, and superoxide dismutase activity by 45%. The amount of malondialdehyde increased by 28% **(Table 2)**.
The resulting changes are probably associated with oxidative stress developing during polyphagia [14].

Table 1. Values of indicators of carbohydrate metabolism in the blood serum of rats, depending on the series of the experiment

Group of animals	Indicators of carbohydrate metabolism			
	Pyruvic acid content, mg (X±Sx)	**α-amylase activity, g starch /l.h.(X± Sx)**	**Urea concentration, mmol/l (X±Sx)**	**Glucose concentration, mmol/l (X±Sx)**
Group 1 (Control 1)	0.7±0.09 (100%)	117.8±3.6 (100%)	4.53±0.49 (100%)	128.1±19.8 (100%)
Group 2	0.8±0.06 (114.3%)	148.5±4.2 (126.1%)	9.75±0.44 (215.2%)	374.2±19.8 (292.1%)

Group 3	1.21±0.1 (172.9%)	213.8±3.4 (181.5%)	3.62±0.21 (79.9%)	348.2±34.5 (271.8%)
Group 4 (Control 2)	0.92±0.07 (131.4%)	126.4±4.6 (107.3%)	4.4±0.62 (97.1%)	117.2±12.4 (91.5%)
Group 5	0.91±0.12 (130%)	168.4±3.6 (143%)	2.3±0.14 (50.8%)	108.4±18.4 (84.6%)
Group 6	1.12±0.16 (160%)	188.6±4.3 (160.1%)	2.6±0.32 (57.4%)	246.2±26.7 (192.2%)

Table 2. Changes in lipid peroxidation and antioxidant system parameters in rat liver homogenate depending on the experiment series

Group of animals	**Indicators of carbohydrate metabolism**		
	Catalase activity, mmol/mg protein min (X±Sx)	**Superoxide dismutase activity, cu/mg of protein (X±Sx)**	**Content of thiobarbituric acid - active products, nmol/mg of protein (X±Sx)**
Group 1 (Control 1)	16.8±3.9 (100%)	0.82±0.16 (100%)	0.59±0.04 (100%)
Group 2	8.6±2.3 (51.2%)	0.21±0.1 (25.6%)	0.72±0.06 (122.0%)
Group 3	7.8±1.9 (46.4%)	0.48±0.25 (58.5%)	0.79±0.03 (133.9%)
Group 4 (Control 2)	18.6±1.2 (110.7%)	0.72±0.09 (87.8%)	0.65±0.04 (110.2%)
Group 5	9.8±1.1 (58.3%)	0.38±0.12 (46.3%)	0.64±0.09 (108.5%)
Group 6	10.4±1.4 (61.9%)	0.52±0.08 (63.4%)	0.72±0.08 (122.0%)

In order to compare the body's response from carbohydrate, nitrogen metabolism, and lipid peroxidation processes to the production of easily digestible carbohydrates by animals, an experimental series was conducted with the introduction of alloxan (100 mg/kg), widely used for modeling diabetes mellitus in animals, to laboratory animals. According to the results presented in **Table 1**, the development of diabetes mellitus in rats was accompanied by an increase in blood glucose by 192.1%, α-amylase activity by 26.1%, urea concentration by 115.2%, as well as a tendency to increase the content of pyruvic acid in serum, which is in good agreement with the literature data [15]. Along with this, there was a significant decrease in the activity of the enzymatic antioxidant system. Thus, the decrease in catalase activity was 46.4% compared to the control, the activity of superoxide dismutase was 74.4%. These changes are associated with the ability of alloxan to destroy beta cells of pancreatic islets, disrupt intracellular calcium homeostasis, destabilize mitochondrial membranes, and stimulate redox reactions with the formation of peroxide and hydroxyl radicals [16].

The model of polyphagia used by us, created by an easily digestible diet, caused changes in the studied parameters in blood serum and liver homogenate comparable to those identified in the alloxan diabetes model, or surpassing them in some parameters. The comparison of the two models indicates diverse biochemical disorders caused by chronic overeating and an unbalanced diet.

The next stage of this work was devoted to the study of the effect of oral administration of a pharmaceutical preparation of ginseng extract (20 ml/rat) on the studied parameters of intact rats. It was found that daily oral administration of the ginseng preparation to rats for 7 days was not accompanied by a change in carbohydrate metabolism, except for a slight increase in the content of pyruvic acid in the blood (+31.4% to control). The activity of α-amylase, as well as the content of urea and glucose in the blood serum of rats, was at the level corresponding to the control. There were no statistically significant deviations either in the activity of the antioxidant system of the liver or in the content of thiobarbituric acid-active products **(Tables 1 and 2)**.

In the experiment, oral administration of ginseng to rats against the background of alloxan contributed to the stabilization of carbohydrate metabolism parameters **(Table 1)**. Thus, the concentration of glucose in the blood serum decreased by 3.2 times compared to a series of rats suffering from alloxan diabetes, and the concentration of urea – by 2.3 times. There was also a decrease in the content of secondary products of lipid peroxidation and an increase in catalase activity and superoxide dismutase activity **(Table 2)**.

At the next stage of our work, we turned to study the possibility of correcting various biochemical disorders by daily oral administration of ginseng tincture to rats on a "restaurant diet". It has been shown that in the presence of the adaptogen used, the activity of α-amylase in the blood of rats decreases by 20%, and the concentration of urea, as well as glucose, decreases by 1.4 times **(Table 1)**. The introduction of ginseng also changed the activity of the antioxidant system: catalase activity increased by 17%, and superoxide dismutase activity tended to increase compared with similar activity in rats on an unbalanced diet. There was also a decrease in the level of thiobarbituric acid-active products with spontaneous lipid peroxidation **(Table 2)**.

Thus, ginseng extract has a partially stabilizing effect on metabolism not only in experimental alloxan diabetes but also in the described variant of polyphagia. Such an effect of ginseng may be due to the presence of a special type of glycosides in its composition, which can increase the permeability of cell membranes for glucose, a stimulating effect on the hexokinase reaction, which provides an intensive intake of carbohydrates into the cell, a general stimulating effect of ginseng.

Conclusion

Summarizing the results of the work carried out, it can be concluded that the pharmaceutical preparation of ginseng root has a corrective effect on the indicators of carbohydrate and nitrogen metabolism, as well as on the activity of antioxidant defense enzymes and the accumulation of secondary products of lipid peroxidation in experimental animals on a high-calorie unbalanced carbohydrate diet.

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Ethics statement: The protocol for experiments with laboratory animals complied with the requirements of the European Convention for the Protection of Vertebrate Animals used for Experimental and other Scientific Purposes.

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