

**ACTIVITY OF PANCREATIC AMYLASE AND SMALL
INTESTINE CARBOHYDRASES IN WHITE RATS WITH
DIFFERENT LEVELS OF STRESS REACTIVITY DEPENDING
ON THE PROTEIN CONTENT IN THE DIET**

**ACTIVITATEA AMILAZEI PANCREATICE ȘI A CARBOHIDRAZAZELOR
DIN INTESTINUL SUBȚIRE AL ȘOBOLANILOR ALBI CU DIFERITE
NIVELURI DE REACTIVITATE LA STRES, ÎN FUNCȚIE DE CONȚINUTUL
DE PROTEINE DIN DIETĂ**

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Sumar. În experimente pe șobolani masculi albi s-a depistat că cea mai mare activitate a α -amilazei pancreatice se observă la animalele cu un nivel ridicat de reactivitate constituțională la stres, iar cea mai scăzută - cu un nivel mediu de reactivitate constituțională la stres. În schimb, cea mai mare activitate a carbohidrazelor din intestinul subțire se observă la animalele cu un nivel mediu de reactivitate constituțională la stres și practic nu diferă între animalele cu niveluri scăzute și ridicate de reactivitate constituțională la stres. Activitatea enzimelor amilolitice ale pancreasului și intestinului subțire la șobolanii cu diferite niveluri de reactivitate constituțională la stres scade în principal pe măsură ce conținutul de proteine din alimentație crește, totuși, aceste modificări depind de tipul constituției, atingând valori maxime la animalele cu un nivel ridicat de reactivitate constituțională la stres. Rezultatele obținute demonstrează existența unei legături

între reactivitatea la stres determinată genetic a organismului și funcția digestivă a intestinului subțire și argumentează perspectivele cercetărilor ulterioare în această direcție.

Cuvinte-cheie: *enzime digestive, pancreas, intestin subțire, reactivitate constituțională la stres, dietă.*

INTRODUCTION

A number of studies have shown the relationship between a person's belonging to one or another basic type of phenotypic constitution and the expression of genes encoding metabolic enzymes, biochemical parameters of metabolism, peculiarities of eating behavior, the size of digestive organs, structural parameters of the intestine, the level of synthesis of certain intestinal hormones, predisposition to certain diseases of the digestive organs [1, 2, 3, 4, 5, 6]. At the same time, the constitutional features of the activity of digestive enzymes have been studied extremely insufficiently, and currently there are practically no generally accepted ideas about the features of digestion depending on the type of constitution. Individual studies have revealed differences in changes in the enzyme-secreting function of the stomach and pancreas in individuals of different somatotypes in response to stimulation of the digestive glands [7, 8], some structural and functional features of the intestine in model animals with different levels of stress reactivity corresponding to a certain type of constitution are shown [9 10, 11, 12, 13]. For the development of a sanogenic nutrition system, which provides, in particular, the individualization of the diet [14], and for solving the problems of an individual approach to the prevention and correction of disorders of digestive functions, it is important to identify the constitutional features of the functioning of the digestive system.

The aim of the work is to study the activity of pancreatic α -amylase and carbohydrases of the mucous membrane of the small intestine of white rats with different levels of constitutional stress reactivity depending on the protein content in the diet.

MATERIAL AND METHODS

It is known that each type of constitution has its own type of stress reactivity. This is the basis for the methodology of dividing experimental animals into types of constitution corresponding to a certain level of stress reactivity, which was used in this work. Rats were divided into three groups depending on the level of constitutional stress reactivity: 1 - high stress reactivity; 2 – medium stress reactivity; 3 – low stress reactivity. Constitutional stress reactivity was assessed using a set of behavioral tests and analysis of histopathological differences in the tissues of the stomach, thymus and adrenal glands in some animals of each group after immobilization stress. As behavioral tests, the most adequate models giving an objective assessment were used – the “forced swimming” method and the “water island” method.

The activity of α -amylase of the pancreas and the total activity of carbohydrases of the mucous membrane of the small intestine were determined in the homogenates of these organs using known biochemical methods.

Since carbohydrates in the diet play a key role as a substrate regulator of digestion of poly- and disaccharides, the contribution of dietary proteins can only be assessed using experimental diets with a constant carbohydrate content. In separate series of experiments, each of the three groups of rats with a certain level of constitutional stress reactivity (high, medium and low) was divided into 4 subgroups according to the protein content in the diet. The animals were kept on diets with different protein content for 2 months. Calculations were made in such a way that carbohydrates accounted for 50% of the total amount of energy consumed. In animals of 1 and 2 experimental subgroups proteins accounted for 15 and 18% of the total amount of energy consumed, respectively, and in animals of 3 and 4 subgroups - 32 and 40% (Table).

Table. The Content of Micronutrients (in % of the total amount of energy consumed) in Experimental Diets of Animals with Different Levels of Constitutional Stress Reactivity in the Study of the Effect of Protein on the Activity of Amylolytic Enzymes

Macronutrients	Subgroups of Animals			
	I	II	III	IV
Proteins	15	18	32	40
Fats	35	32	18	10
Carbohydrates	50	50	50	50

RESULTS AND DISCUSSION

Preliminary experiments to study the activity of amylolytic enzymes of the pancreas and small intestine, depending on belonging to a particular type of constitution in rats kept on a standard diet, showed that the activity of digestive enzymes differs significantly depending on the level of constitutional stress reactivity. It was found that the activity of α -amylase in pancreatic tissues in animals with an average level of constitutional stress reactivity (normosthenics) is significantly lower than in animals with a high level of constitutional stress reactivity (asthenics) (2-2.5 times), at the same time, in rats with a low level of constitutional stress reactivity (hypersthenics) the activity of this enzyme, although lower than that of asthenics, is significantly higher than that of normosthenics (by 1.2 – 1.5 times), which generally contradicts existing ideas (Kosolapov O.N., 1999, Nikolaev V.G., 2008), which are supported only by isolated results. Thus, according to the data obtained, the minimum activity of pancreatic α -amylase is observed in normosthenics and the maximum is observed in animals with a high level of constitutional stress reactivity. A completely different picture of the dependence of the activity of amylolytic enzymes on the type of constitution is observed in the mucous membrane of the small intestine. The maximum activity of carbohydrases of the mucous membrane of the small intestine is observed in normosthenics, and the minimum – in

animals with a high level of constitutional stress reactivity, while in hypersthenics the total activity of carbohydrases is slightly higher than in asthenics, which in both cases contradicts the data available in the literature. Perhaps this is due to the fact that the level of activity of carbohydrases enzyme systems of the small intestine depends more on the mechanism of substrate regulation compared to the apparatus of synthesis of pancreatic enzymes. These assumptions were verified by experiments on the study of the activity of amylolytic digestive enzymes in animals with different types of constitution, depending on the caloric structure of the diet.

According to the data obtained, the activity of pancreatic α -amylase in animals with a high level of constitutional stress reactivity did not significantly differ in groups of experimental animals 1 (233.33 ± 7.40 mmol/g $\square$ min) and 2 (228.14 ± 25.15 mmol/g $\square$ min), whose diets contained 15 and 18% protein by calories, respectively. However, it is significantly lower (by 1.8 times) in groups 3 (126.90 ± 8.83 mmol/g $\square$ min) and 4 (134.0 ± 6.43 mmol/g $\square$ min), whose animals were on diets with the highest amount of protein in the diet (32 and 40%), which may indicate on the inhibitory effect of an increase in animal protein in the diet by 1.5 times or more on the activity of pancreatic α -amylase. In animals with a normosthenic constitution, an increase in protein content in the diet also contributes to a decrease in the activity of pancreatic α -amylase, however, to a lesser extent compared with asthenics. In hypersthenics, the pancreatic α -amylase synthesis apparatus is most resistant to food factors, so the activity of this enzyme does not change significantly depending on the composition of the diet.

When studying the activity of glycolytic enzymes of the small intestine, it was found that in animals with a high and, to a lesser extent, an average level of constitutional stress reactivity, the total activity of small intestine carbohydrases progressively decreases as the protein content in the diet increases. Based on the fact that the carbohydrate content practically remains constant, it can be assumed that the essential value in this case is not the proportion of carbohydrates in the total composition of the diet, but the ratio of carbohydrates and proteins, and since it shifts in favor of proteins, the activity of carbohydrates decreases, and the activity of proteolytic enzymes increases (Strutinsky F.A., Septitchi V.A., 2017). The apparatus for synthesizing small intestine carbohydrases in animals with a low level of constitutional stress reactivity is apparently the most resistant to the action of food factors, therefore, the activity of these enzymes, as well as pancreatic α -amylase, does not change significantly depending on the composition of the diet.

Thus, the activity of amylolytic enzymes of the pancreas and small intestine depends on the level of constitutional stress reactivity of the body. Noticeable differences were found in the response of the enzyme systems of the pancreas and small intestine of animals with different levels of constitutional stress reactivity to changes in the structure of caloric intake, which to a certain extent shed light on the mechanisms of regulation and maintenance of the constitutional specificity of enzyme systems.

CONCLUSIONS

1. The activity of amylolytic enzymes of the pancreas and small intestine depends on the level of constitutional stress reactivity of the body. The highest activity of pancreatic α -amylase is observed in animals with a high level of constitutional stress reactivity, and the lowest in animals with an average level of constitutional stress reactivity. In contrast, the highest total activity of small intestine carbohydrases is observed in animals with an average level of constitutional stress reactivity, and it practically does not differ between animals with low and high levels of constitutional stress reactivity.

2. The activity of pancreatic α -amylase and small intestine carbohydrases in rats with different levels of constitutional stress reactivity mainly decreases with increasing protein content in the diet, however, these changes depend on the type of constitution, reaching maximum values in animals with a high level of constitutional stress reactivity and minimum values in animals with low the level of constitutional stress reactivity.

3. The obtained results demonstrate the existence of a connection between the genetically determined stress reactivity of the body and the digestive function of the small intestine and the prospects for further research in this direction.

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