



THE EFFECT OF NUTRITION ON THE FORMATION OF THE SECRETION AND HOMEOSTASIS OF PANCREATIC AMYLASE AND LIPASE ENZYMES IN POSTNATAL ONTOGENESIS OF RATS

Mullajonova Nigorakhon Mahmudovna

Andijan State Medical Institute

Assistant, Department of Medical Biology and Histology

Andijan State Medical Institute

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Abstract: The experiments were carried out in white, non-breeding, male rats of different ages (15 days, 1 month, 1.5 months, 2 Months, 3 months and 4 months). Rats in the control group were fed a diet consisting of protein, fat, carbon dioxide. Experimental rats were also fed additional protein (egg white) to these feeds. Rats fed with protein-rich nutrients increased the synthesis of enzymes (amylase, lipase) that we have learned in the gland tissue, and the secretory activity of the glands accelerated its formation in postnatal ontogenesis, as well as their absorption into the blood, which in turn ensures an improvement in the recirculation of these enzymes in the body, and the glands

The digestive glands produce a wide range of hydrolytic enzymes that depolymerize food nutrients absorbed into the blood and lymph to monomers for use in the body's energetic and plastic processes. Enzyme secretion is a key element of the digestive and trophic functions of the gastrointestinal tract [8].

Enzymes synthesized by the digestive glands perform not only a hydrolytic function, but also participate in other processes: they enter the blood, are absorbed into its components and the endothelium of blood vessels, and are also reabsorbed into the secretion of the digestive glands and provide autoregulation of their secretory activity [5, 6]. The multifunctionality of enzymes is manifested in their ability to support metabolic flows and provide a link between non-specific biochemical processes [7].

The stability of the level of hydrolytic enzymes in the blood is achieved by a balanced increase, excretion, interaction with inhibitors and proteolysis, which prevents significant deviations towards hypo- or hyperfermentemia [2].

S.S. Rothman and co-authors showed that the pancreas is not able to synthesize the entire volume of postprandial secreted enzymes (25-50% of the total set). The synthesis of one molecule of amylase takes 3 minutes, 0.67 mg of enzyme is formed per hour in 1 g of tissue. Energy expenditure covers only 4-15% of the synthesis. Recirculation of enzymes from the intestine to the blood and their reuse reduces the need for synthesis, as does the enterohepatic circulation of bile acids, where only 10-12% of the secreted volume is synthesized [5, 9].



Changes in the activity of digestive enzymes depend on the development of the digestive system and nutrition. Enzymatic activity in childhood is associated with the formation of organs, in adults with metabolic stability, and in the elderly with involution, including a decrease in pancreatic function.

The purpose of the study: To study the effect of nutrition on the secretion and homeostasis of pancreatic amylase and lipase enzymes in rats of different ages during postnatal ontogenesis.

Animal experiments: The experiments were performed on white, unbred, male rats of different ages in the institute vivarium. The rats were taken into control at birth. The rats in the control group were fed with a diet consisting of protein, fat, and carbohydrates. The diet of the experimental rats was the same as the control group, but they were also fed with additional protein (egg white). After reaching a certain age (15 days, 1 month, 1.5 months, 2 months, 3 months, and 4 months), the control and experimental rats were decapitated under anesthesia and the pancreas was removed from them. The blood released during decapitation was collected. The pancreas was mixed with physiological solution in a ratio of 1:10 to prepare a homogenate. Amylolytic and lipolytic activity in the gland tissue filtrate and blood serum was determined by the colorimetric method.

The results obtained in rats in each group were compared with the indicators of rats of the same group at the age of 15 days, and the formation of the activity of these enzymes in the pancreas and blood during postnatal ontogenesis was analyzed.

The results obtained in experimental rats were compared with the indicators of the control group, and the effect of protein-rich feeding on the formation of the activity of these enzymes in the pancreas and blood during postnatal ontogenesis was studied.

The results obtained were analyzed. Age-related changes in amylolytic and lipolytic activity in pancreatic tissue and blood serum of rats of different ages are reflected in Table 1.

Table 1

Index of hydrolytic enzymes in pancreatic homogenate and serum of rats of different ages fed with mixed feed

(M±m) (control group)

The age of rats	Pancreatic homogenate		Blood serum	
	Amylase	Lipase	Amylase	Lipase
15 days	143,3±12,8	59,0±6,8	30,4±2,6	28,2±1,6
1 month old	280,2±25,0*	150,2±18,3*	49,3±2,3*	27,1±2,0
1,5 month old	284,2±16,7*	146,8±10,2*	51,2±4,8*	31,0±1,5



2 months old	527,0±3,7*	184,3±4,1*	70,6±11,2*	43,4±6,6
3 months old	909,0±48,9*	202,5±13,0*	86,7±3,3*	53,3±0,5*
4 months old	1405,8±127,5*	262,5±16,1*	96,1±3,0*	68,2±1,4*

Note: * The level of confidence in the difference in enzyme activity between rats of different ages from the 15-day-old rat.

Changes in the activity of digestive enzymes (α -amylase, lipase) in the body depend on physiological processes such as growth and development of the digestive tract, formation of the control process, metabolic shifts, and the influence of the external environment. Enzyme activity in young organisms depends on the formation of organs, and in mature organisms - on metabolic stability.

The oldest animals we tested were 15-day-old rats, and their indicators were compared with those of other ages. The activity of the enzymes (amylase, lipase) studied in our experiments changed in pancreatic homogenate and blood serum as the rats aged. Amylolytic activity in the gland tissue increased almost twice in 1-month-old rats compared to 15-day-old rats, and the amylolytic activity of the pancreas in 1.5-month-old rats remained at the same level. The amylolytic activity in the pancreas tissue of 2-month-old rats increased by 3.5-4 times compared to 15-day-old rats. In 3-month-old rats, this indicator was 6.5 times, and the amylolytic activity of the pancreas in 4-month-old rats was almost 8 times higher than in 15-day-old rats.

This means that as the body ages, metabolic processes in it increase and a certain level of stability is achieved. As a result, the amylolytic activity of the pancreas is fully formed, that is, a sufficient amount of amylase enzyme is produced to fully cover the energy expenditure in the body.

Amylolytic activity in the blood is several times lower than this activity in pancreatic homogenate in rats of all ages, especially this difference is very large in mature rats. In the experiment under our observation, it was found that amylolytic activity in the blood of 1-1.5-month-old rats was 1.5 times higher than in 15-day-old rats, in 2-month-old rats this indicator was even higher - 2.5 times higher than in 15-day-old rats. Amylolytic activity in the blood of 3-4-month-old animals reached a level more than 3 times higher than in 15-day-old animals.

Amylolytic activity in the blood is mainly caused by pancreatic (P) and salivary (S) α -isoamylases. They have a species-specific quantitative ratio, and in human blood the ratio of these isoamylases is almost equal [4].

The second enzyme we studied was lipase, and its activity in the pancreas and blood is much lower than that of amylase, as can be seen from Table 1. We also observed that the formation of this enzyme in pancreatic tissue during postnatal ontogenesis also has a unique appearance. It was found that lipolytic activity in pancreatic tissue of rats aged 1-2 months



increased by 2.5-3 times compared to 15-day-old rats. In rats aged 3 months, this indicator increased by 3.5 times compared to 15-day-old rats, and in 4-month-old rats, this indicator increased by almost 4.5 times.

Lipolytic activity in the blood is much lower than in pancreatic tissue (Table 1), since lipase is secreted into the blood mainly from the pancreas [3], while lipase in human blood is a product of many glands, including the liver [1]. According to the results obtained in our experiments, lipase activity in the blood did not change in rats aged 15 days to 2 months. The formation of amylolytic activity in the blood was completed in rats aged 3-4 months, and its activity in the blood was found to be 2-2.5 times higher than in 15-day-old rats.

The second group of rats was fed a mixed (protein, fat, carbohydrate) diet supplemented with egg white. The results obtained in this group of experimental rats (Table 2) showed that the formation of amylolytic and lipolytic activities in the pancreatic tissue of rats fed with additional protein was observed to occur more rapidly in postnatal ontogenesis.

Table 2

Hydrolytic enzyme levels in pancreatic homogenate and serum of rats of different ages fed with additional egg white ($M \pm m$)

The age of rats	Pancreatic homogenate		Blood serum	
	Amylase	Lipase	Amylase	Lipase
15 days old	153,5 $\pm$ 12,7	64,0 $\pm$ 6,7	34,8 $\pm$ 2,6	19,3 $\pm$ 1,4
1 month old	381,3 $\pm$ 24,8*	203,2 $\pm$ 1,7*	80,0 $\pm$ 2,5*	50,7 $\pm$ 2,5*
2 months old	627,7 $\pm$ 31,4*	216,8 $\pm$ 3,8*	100,7 $\pm$ 2,6*	72,2 $\pm$ 2,7*
3 months old	935,2 $\pm$ 45,8*	220,2 $\pm$ 3,6*	107,5 $\pm$ 2,3*	74,8 $\pm$ 2,9*
4 months old	1510,0 $\pm$ 128,1*	272,0 $\pm$ 16,0*	122,3 $\pm$ 2,4*	78,0 $\pm$ 2,9*

Note: * The level of confidence in the difference in enzyme activity between rats of different ages from the 15-day-old rat.

The amylolytic and lipolytic activities in the glandular tissue and blood of the youngest 15-day-old experimental rats under our observation (Tables 1 and 2) are almost the same, only the lipolytic activity in the blood of animals fed with additional protein is 30% lower than the control group.



The activities of enzymes (amylase, lipase) in the pancreatic glandular tissue of 1-1.5-month-old experimental animals are 35-40% higher than in the control group, and in 2-month-old rats by 18-20%. The enzyme activities in the glandular tissue of 3-4-month-old rats are almost the same.

Thus, it can be concluded that the synthesis of the enzymes we studied (amylase, lipase) in the glandular tissue of rats fed with protein-rich food is enhanced and the formation of the secretory activity of the glands in postnatal ontogenesis is accelerated.

Our experiment showed that nutrition also has an effect on the activity of these enzymes in the blood. Amylolytic and lipolytic activities in the blood were higher by several tens of percent in rats of all ages (Tables 1-2) fed with additional protein starting from 1 month of age, especially this difference was more pronounced in lipolytic activity.

Therefore, it can be concluded that in experimental animals fed with additional protein, not only is the secretion of enzymes increased, but their uptake into the blood is also increased, which in turn improves the recirculation of these enzymes in the body and allows the glands to perform their functions without strain.

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