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ROLE OF CHOLINERGIC STRUCTURES AT DIFFERENT LEVELS IN RAPID ADAPTATION OF THE PANCREAS TO FOOD QUALITY IN ONTOGENY

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The ability of the digestive glands to adapt the enzymic spectrum of their secretions to the character of the food stimulus is an important mechanism of efficient hydrolysis of the components of the food [1, 3]. The leading role in adaptation of synthesis and secretion of pancreatic enzymes is played by duodenal hormonal mechanisms [2, 6].

In the investigation described below the participation of cholinergic mechanisms of regulation in the formation of rapid enzymic adaptations of the pancreas in early postnatal ontogeny was studied.

EXPERIMENTAL METHOD

Rapid adaptation of the pancreatic enzyme spectrum to a predominantly protein (uncooked meat), fat (butter), and carbohydrate (bread) diet was studied in rats aged 23 days (the change to definitive feeding), 30 days (weaning), and 90 days (adult rats). The animals aged 30 and 90 days were starved beforehand for 14-16 h, and the rats aged 23 days were fed only on their mother's milk during the same period. For the next 30 min the rats were allowed free access (depending on the aim of the experiment) to meat, buffer, and bread and to the ordinary mixed animal house diet. Activity of lipase [5], and of a combination of proteases and amylase [4] was deterined in pancreatic homogenates 2 h after feeding. The same experiments were carried out after preliminary (30 min before feeding on the above-mentioned diets) intraperitoneal injection of the peripheral muscarinic acetylcholine receptor blocker atropine (1 mg/kg), the ganglion blocker benzohexonium (1 mg/kg), or the central muscarinic acetylcholine receptor blocker benactyzine (0.6 mg/kg). In control groups, activity of the pancreatic enzymes were studied in the fasting state. Animals of all groups had unrestricted access to water.

EXPERIMENTAL RSULTS

The experiments showed that at the time of switching to definitive feeding (at the age of 23 days) rapid specific adaptation to food stimuli with predominance of one particular component was absent in the intact rats. At that age, activity of proteases and lipase in intact rats on a protein diet was unchanged and amylase activity was depressed; on a carbohydrate and fat diet the pancreas reacted by an undifferentiated stimulation of synthesis of all enzymes, in the same way as in a mixed diet.

On the 30th day of life (Table 1) the response to food stimuli became more differentiated: protein induced an increase mainly in synthesis of proteases, but in response to fat or carbohydrate stimuli at this age there was an undifferentiated increase in hydrolase synthesis. On a mixed diet, amylase activity fell but activity of proteases and lipase increased.

In adult rats (aged 90 days) increased synthesis of proteases was observed after feeding on meat and of lipase after feeding on butter, i.e., adaptations of pancreatic enzymes to protein and fat stimuli took place.

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TABLE 1. Effect of Predominantly Protein (meat) Diet on Enzyme Activity in Pancreatic Homogenate from 30-Day-Old Rats (M ± m, n = 6)

Experimental conditions	Enzyme		
	amylase, g/min/g	protease complex, μmoles/min/g	lipase, conventional units/min/g
Fasting state (control)	84,3±6,2	305,5±15,6	3055,0±224,6
Fasting state preceded by			
atropine	45,6±3,6***	293,5±25,4	3055,0±265,0
benzohexonium	44,3±2,8***	207,2±22,6*	3142,8±315,4
benactyzine	38,0±4,2***	213,8±18,6	2950,0±319,2
Mixed diet	33,3±2,6***	475,9±34,2*	4265,0±392,0***
Mixed diet preceded by			
atropine	123,0±9,2*	463,8±25,7*	3290±251,4
benzohexonium	124,0±8,4*	415,6±16,7*	3738,3±386,4
benactyzine	116,3±5,5*	435,9±28,6*	3475,0±292,6
Meat	32,7±18,6***	447,7±33,4*	3265±182,4
Meat preceded by:			
atropine	119,7±9,8*	424,6±38,2*	3633,3±186,4
benzohexonium	126,9±10,4*	443,6±31,6	3896,7±122,5*
benactyzine	126,3±7,6*	413,3±40,5*	4106,7±286,4*

Note. *p < 0.05, **p < 0.01, ***p < 0.001) significant differences from control.

Bread, used as a stimulus rich in carbohydrates, did not induce any selective increase in amylase synthesis in the rats at any age.

Blockage of cholinergic structures at different levels on the 23rd day after birth modified synthesis of pancreatic enzymes in response to qualitatively different diets. Against the background of all the acetylcholine receptor blockers used, synthesis of amylase thus was depressed, both in the fasting state and after feeding on mixed, protein, fat, and carbohydrate diets. After protein feeding, lipase synthesis was stimulated.

Blockade of the cholinergic structures on the 30th day of life prevented the development of rapid specific adaptation to a protein diet: against the background of acetylcholine receptor blockers a nonspecific increase was observed in the synthesis of virtually all pancreatic enzymes, on all the diets used.

Against the background of acetylcholine receptor blockers specific adaptation to protein and fat stimuli did not occur in the adult (aged 90 days) rats; on all diets the pancreas responded by an undifferentiated, parallel increase in activity of the test enzymes.

Thus rapid adaptations of the pancreas to the quality of food are not inborn reactions. They are formed during individual development and consolidated during maturation of the acinar apparatus and of mechanisms, including cholinergic, controlling pancreatic synthesis and secretion. Blockage of cholinergic structures at different levels acts virtually identically on the response of the pancreas: against the background of all the acetylcholine blockers used, the pancreatic enzymes do not exhibit adaptation to food quality.

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