ENZYMATIC ADAPTATIONS OF THE GASTRIC GLANDS TO MEAT PROTEINS AND GLUTEN AT SIMULATED FEEDINGS

(UDC 612.322)

B. I. Sabsai and Yu. Ya. Kulik

Laboratory of Physiology and Pathology of Digestion (Head—Professor S. I. Filippovich), Institute of Normal and Pathological Physiology (Director—Member of the Academy of Medical Sciences of the USSSR, Professor V. V. Parin), Adademy of Medical Sciences of the USSR, Moscow
(Presented by Member of the Academy of Medical Sciences of the USSR, V. V. Parin)
Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 60, No. 9, pp. 27-30, September, 1965
Original article submitted April 2, 1964

The existence of specific enzymatic adaptability of the glands of the gastrointestinal tract to the nature of the food ingested was first established by the work of I. P. Pavlov and his associates [3]. The question of enzymatic adaptations of the digestive glands in prolonged, qualitatively differing systems of nutrition has been developed in the greatest detail in I. P. Razenkov's laboratory [4]. A number of important data permitting the detection of the fine mechanisms of the adaptive reactions of the digestive glands were subsequently obtained [9, 12, 31, etc.].

During the last few years, the coworkers of the Laboratory of Physiology and Pathloogy of Digestion have been studying the specific enzymatic adaptability of the digestive glands in the normal state and during operative intervention in the gastrointestinal tract [7, 10, 11, etc.].

Since the adaptation of the gastric glands to entering food may be expressed in a change not only in the amount of pepsin secreted, but also in the spectrum of proteolytic activity of the gastric juice with respect to proteins of various types [7, 9], it was of interest to study the nature and mechanisms of the enzymatic adaptations of the gastric glands during simulated feeding of meat, in dogs receiving mixed food with a predominance of vegetable proteins.

EXPERIMENTAL

The investigations were conducted in chronic experiments on eight dogs with gastric fistulas (one dog was additionally esophagotomized). The animals received mixed food, primarily vegetable. The daily diet of each animal included meat (200 g), cereal (400-500 g), bread (250 g), fish oil (10 g), yeast (8 g), and broth (to 2.5-3 liters). The experiments were begun after 1.5-4 months on the diet. Simulated feeding with meat was conducted for 2 min (100 g of meat in 25 pieces). The acidity of the gastric juice was determined by a titration method, and the pepsin concentration by the method of [6].

The enzymatic adaptations of the gastric glands to vegetable or animal proteins were judged according to the intensity of hydrolysis of gluten and muscular proteins and their ratio—the index G/M* [9]. The technique of the determination was described in detail previously [7]. The proteolytic activity of the gastric juice with respect to various substrates was expressed in pepsin units (p.u.) [6]. The pepsin concentration in the gastric juice was determined with a solution of serum after adjusting the pH to 1.8; the specific activity of the gastric juice with respect to gluten and muscle protein was determined with weighed samples of protein after adding natural gastric juice.

RESULTS

In the first series of experiments we studied the activity of samples of gastric juice (taken from the total volume obtained in the experiment), with respect to various protein substrates (Table 1).

*G/M = < ratio of hydrolysis of gluten to hydrolysis of muscle protein.

TABLE 1. Activity of Cleavage of Protein Substrates by Gastric Juice Obtained During Two-Minute Simulated Feeding with Meat (average values)*

Name of dog	Digestive activity with respect to			Index G/M
	serum	gluten	musc prot.	
Pirat	33	25	20	1,25
Egoza	29	21	19	1,11
Tsygan	36	31	23	1,33
Sedoi	29	20	20	1,00
Piket	43	35	40	0,90
Laska	36	26	21	1,30
Pestryanka	42	30	19	1,90
Lord (dog with gastric fistula and esophagotomy)	48	27	22	1,23
Average	37	27	23	1,25

*The determination was conducted with samples taken from the total volume of juice obtained during the experiment.

As can be seen from the data cited in Table 1, the pepsin concentration in the gastric juice obtained from simulated feeding with meat was high. As a rule, the activity of gluten cleavage was higher than that of cleavage of muscle proteins. In view of this, the G/M index in all the dogs, with the exception of two, was greater than 1.0. In one dog (Sedoi) it was equal to 1.0, and in another (Piket) it was equal to 0.90.

Consequently, all the juice obtained during the experiment with a two-minute simulated feeding with meat possessed more pronounced ability to hydrolyze vegetable proteins, which should be expected after prolonged maintenance of the animal on feed with a predominant content of vegetable proteins.

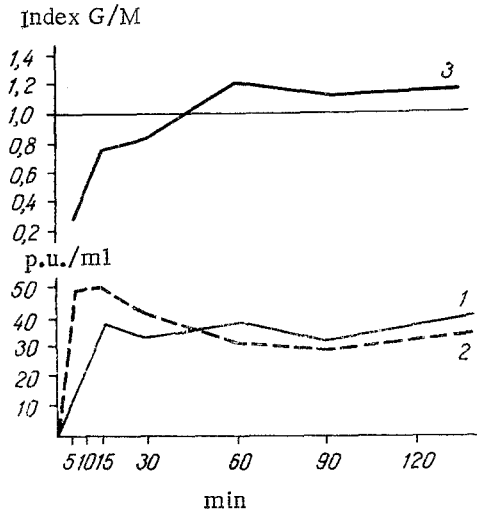
For a more detailed study of this question, we conducted two series of experiments on six dogs, in which we made a parallel investigation of the activity of the gastric juice with respect to gluten and meat protein on juice taken during various periods after the simulated feeding (after 5, 10, 15, 30, 45, 60, 120, and 210 min), as well as on samples from all the juice obtained in the experiment (Table 2).

The investigations showed that at the beginning of the period of secretion, gastric juice that cleaves meat protein considerably more actively than gluten is secreted. The duration of the secretion of gastric juice with a predominance of activity with respect to muscle protein varied with the individual, usually comprising 20-45 min. During this period, the proteolytic activity of the gastric juice with respect to meat protein gradually decreased, and that with respect to gluten increased. The index G/M increased and was established at the characteristic level for the given animal. The dynamics of the changes in the

TABLE 2. Activity of Cleavage of Gluten and Muscle Protein by Gastric Juice of Dogs During Simulated Feeding with Meat (average values)

Name of dog	Time of collection of sample of gastric juice from beginning of secretion (in min)									Activity of samples taken from total volume of juice in expt.
	5	10	15	30	45	60	90	120	210	
Pirat	29:37 / 0,78	—	31:40 / 0,77	27:24 / 1,12	—	21:15 / 1,40	—	21:17 / 1,23	—	25:20 / 1,25
Egoza	29:40 / 0,72	—	24:27 / 0,89	29:26 / 1,12	—	22:15 / 1,46	19:16 / 1,19	—	—	21:19 / 1,11
Tsygan	24:33 / 0,73	—	37:44 / 0,82	33:25 / 1,32	—	28:19 / 1,47	26:21 / 1,24	—	—	31:23 / 1,33
Sedoi	13:49 / 0,26	—	37:50 / 0,74	34:41 / 0,82	—	37:31 / 1,19	31:28 / 1,11	—	39:33 / 1,18	20:20 / 1,00
Piket	44:54 / 0,83	39:62 / 0,62	37:53 / 0,69	49:58 / 0,84	42:60 / 0,70	38:41 / 0,93	29:31 / 0,94	52:40 / 1,30	—	35:40 / 0,90
Lord	11:34 / 0,32	17:27 / 0,63	14:28 / 0,50	22:23 / 0,96	—	25:17 / 1,47	30:24 / 1,25	—	—	27:22 / 1,23

Note. In the numerator: first number to the left—activity of gastric juice with respect to gluten; number to the right—with respect to muscle proteins (in pepsin units per ml); in denominator—index G/M.



Proteolytic activity of gastric juice during simulated feeding with meat (dog Sedoi with gastric fistula). 1) Activity with respect to gluten; 2) activity with respect to muscle protein; 3) index G/M.

spectrum of proteolytic activity of the gastric glands are illustrated by the results of one of the experiments, conducted on the dog Sedoi (see figure). Analogous indices were obtained in the other five animals. At the same time, in samples taken from the entire volume of juice during the experiment, as has already been noted above, activity with respect to gluten predominated (see Tables 1 and 2).

The results of the investigations indicate that in spite of the pronounced adaptation of the gastric juice secreted to meat protein and the intensive secretion of juice during a period of 20-45 min, all the juice obtained in the experiment possesses greater activity in the digestion of gluten. This is explained by the fact that the amount of gastric juice with a predominance of activity with respect to muscle protein comprises only a small ($^1/_{10}$-$^1/_3$) portion of all the juice obtained in the experiment. Intensive secretion of juice with a predominance of activity with respect to gluten during the subsequent periods leads to an intensification of the cleavage of proteins of this type by the entire volume of juice in the experiment. The results of our investigations agree with the available literature data [9].

The mechanism of the observed changes in the spectrum of proteolytic activity consists of the following: in the case of "starter" secretion, the gastric juice secreted possesses the ability to cleave the proteins of the type of food that is taken into the organism at that time [9], since it is known that the first period of gastric secretion is determined to a considerable degree by reflex influences arising during eating and to a lesser degree by other mechanisms [1, 2, 5, 8, 14, etc.].

During the period of "successive" secretion to simulated feeding with meat, the adaptive properties of the gastric juice for meat are lost. This is evidently explained by the fact that in this case the specific enzymatic adaptation depends chiefly on the nature of the food diet. As a result, the distinctive adaptation of the gastric juice to meat protein, observed directly after simulated feeding with meat, is subsequently lost.

On the whole, the intensity of the digestion of vegetable and animal proteins by gastric juice in simulated feeding depends on the nature of the diet received by the animal over a prolonged period and on the amounts and ratios of various types of proteins in the food [4, 9].

The results obtained indicate a fine enzymatic adaptability of the gastric glands.

LITERATURE CITED

1. I. T. Kurtsin, Mechanoreceptors of the Stomach and Work of the Digestive Apparatus [in Russian], Moscow – Leningrad (1952),
2. I. P. Pavlov, and E. O. Shumova-Simanovskaya, Vrach, No. 41, (1890), p. 929.
3. I. P. Pavlov, Readings on the Work of the Main Digestive Glands [in Russian], Leningrad (1949).
4. I. P. Razenkov, Quality of Nutrition and the Functions of the Organism [in Russian], Moscow (1946).
5. I. P. Razenkov, New Data on the Physiology and Pathology of Digestion [in Russian], Moscow (1948).
6. B. I. Sabsai, Buyll. Éksper. Biol., No. 9 (1961), p. 117.
7. B. I. Sabsai, Buyll. Éksper. Biol., No. 5 (1965), p. 42.
8. A. S. Sanotskii, Stimulators of Secretion of Gastric Juice, Dissertation [in Russian], St. Petersburg (1892).
9. A. M. Ugolev, Digestion and its Adaptive Evolution [in Russian], Moscow (1961)
10. S. I. Filippovich, Adaptive Processes During Disturbances of the Activity of the Digestive System [in Russian], Moscow (1962).
11. S. I. Filippovich, et al., Compensatory Processes in the Digestive System After Resection of the Stomach and Small Intestine [in Russian], Moscow (1963).
12. L. S. Fomina and Z. M. Pavlova, In the book: Physiology and Pathology of the Digestive System [in Russian], Moscow (1963), p. 140.

13. G. K. Shlygin, Vopr. Pitaniya, No. 2 (1958), p. 3.
14. A. C. Ivy, Surgery, 10, (1941), p. 861.

All abbreviations of periodicals in the above bibliography are letter-by-letter transliterations of the abbreviations as given in the original Russian journal. *Some or all of this periodical literature may well be available in English translation.* A complete list of the cover-to-cover English translations appears at the back of this issue.
