

Chronic experiments of dogs with fistulas in the proximal part of the duodenum some 10 to 12 cm caudally to the pyloric sphincter showed that during the greater part of the digestive process in dogs after eating bread the relative content of bread in the chyme remained stable even though the rate of evacuation from the stomach varied considerably. If the synchronized function of the stomach, duodenum, and digestive glands was disturbed by blocking the entero-gastric reflex, the density of the duodenal chyme was increased. The density of the duodenal contents remained constant only if the amount of bread in the stomach exceeded the threshold level (about 25 g). Constancy of the relative density of the duodenal contents is secured by co-ordination of the motor and secretory functions of the organ of the gastro-duodenal system.

There is strong evidence to show the relative constancy of the pH, osmotic pressure, and amino-acid concentration in the contents of the small intestine [1, 7, 8, 15, 18].

The purpose of this investigation was to determine whether the density of the chyme in the initial part of the small intestine remains constant when the stomach contains solid food.

EXPERIMENTAL METHOD

Three dogs with fistulas in the proximal part of the duodenum 10-12 cm caudally to the pyloric sphincter were used. The fasting dogs were fed with 25, 50, 100, 200, or 300 g of bread, carefully mixed with small balls made from special rubber with specific gravity 1.1 (i.e., close to the specific gravity of the contents of the gastrointestinal tract). The diameter of each ball did not exceed 1.5-2 mm, so that they passed

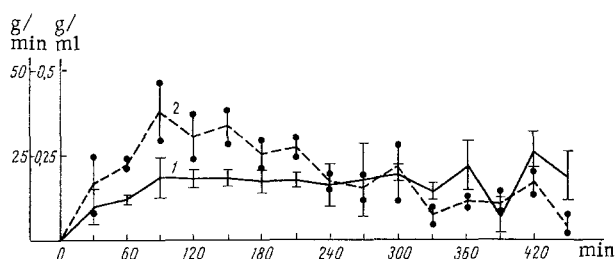


Fig. 1. Dynamics of evacuatory activity of the stomach and density of chyme in the duodenum after feeding a dog with 300 g of bread: 1) density of chyme; 2) evacuatory activity of stomach. Abscissa, time after feeding (in min), ordinate: left) rate of evacuation of bread (in g/min); right) quantity of bread in chyme (in g/ml). Short vertical lines represent confidence limits of means ($M \pm 2.5 m$).

without obstruction together with the chyme through the pyloric sphincter. To each 25 g bread 150 balls were added. Every 25 min the duodenal fistula was opened and the contents escaping from the duodenum collected in a special receiver. The volume of chyme, which was a mixture of food and digestive juices secreted was measured, and the number of balls in it was counted. The ratio between estimated quantity of bread and the total volume of chyme was a measure of the relative quantity of bread and chyme in the duodenum or, in other words, a measure of density of the chyme. The rate of evacuation from the stomach was calculated by using data for the quantity of bread leaving the stomach during a fixed time interval [6]. From the results obtained a graph was plotted with the time after taking the food along the abscissa (in min) and the density of the chyme in the duodenum and rate of evacuation of bread from the stomach, respectively, along the or-

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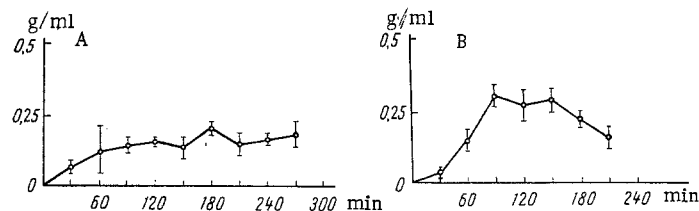


Fig. 2. Dynamics of density of chyme in duodenum after feedings dogs with 100 mg of bread: A) without blocking entero-gastric reflex; B) with blocking of entero-gastric reflex. Abscissa, time after feeding (in min); ordinate, quantity of bread in chyme (in g/ml). Short vertical lines represent confidence limits of means ($M \pm 2.5 m$).

ordinate. Each point was obtained by averaging the results of five to seven experiments. The results were analyzed statistically [16].

The secretory activity of the pancreas and activity of the biliary system in the initial period of digestion anticipated the evacuatory function of the stomach, and the density of the duodenal chyme was low (Fig. 1). By the end of the first hour after the dogs had eaten 200-300 g of bread, the density of the duodenal contents had risen to a stable level which was maintained during the next 3-4 h, despite the fact that the rate of evacuation from the stomach varied exponentially [6, 11, 17]. For example, during the fourth hour after eating 300 g of bread, 33.1% less bread was evacuated from the stomach than during the second hour. Meanwhile the density of the duodenal chyme at these times was practically identical (0.187 ± 0.030 and 0.171 ± 0.031 g bread/ml chyme). The density of the chyme in the duodenum may remain unchanged until the stomach is completely emptied. However, in some experiments in the final phase of digestion (when not more than 20-30 g of bread remained in the stomach) a temporary decrease or increase in the quantity of bread was observed in the chyme. These deviations were probably connected with the fact that at the end of digestion, but before the stomach has completely emptied, the next period of work or rest of the stomach may begin to develop [3, 4, 12], and this accelerates or retards its evacuatory activity, respectively.

Similar results were obtained by feeding the dogs with 50, 100, or 200 g of bread although the period during which the density of the chyme remained constant was shortened under these conditions. This period almost completely disappeared after feeding with 25 g bread.

These results show that the body maintains a stable composition of the chyme in the proximal part of the small intestine, which within certain limits is independent of the quantity of food in the stomach and the rate of its evacuation. This constancy is determined by two coordinated systems of reflexes. The first reflex is a link between mechanical and chemical stimulation of the stomach and duodenum and the secretory activity of the stomach, pancreas, and liver [9, 10], while the second is a link between mechanical and chemical stimulation of the stomach and duodenum and the motor-evacuatory activity of those organs [2, 4, 5, 9].

One of the most effective mechanisms regulating the evacuatory function of the stomach is the entero-gastric reflex [19, 20]. With constant drainage of the contents escaping from the duodenal fistula, the entero-gastric reflex largely ceased to influence the motor-evacuatory function of the stomach, and this led to a marked increase in the relative density of the chyme in the initial part of the small intestine (Fig. 2). Whereas the mean density during the stable phase was 0.158 ± 0.011 g bread/ml chyme, after blocking of the entero-gastric reflex it increased to 0.244 ± 0.028 g/ml ($P < 0.05$).

It can be concluded from these results that there is a certain threshold quantity of bread which effectively triggers the whole system ensuring constancy of composition of the chyme in the duodenum. The smallest of the doses of bread used (25 g) was evidently the threshold, for when it was fed to the dogs the relative density of the duodenal chyme in the different experiments varied within very wide limits. Characteristically, deviation of density from the stable level observed in the final phase of evacuation from the stomach also was more marked at a time when 20-30 g bread remained in the stomach.

In their general form the results of this investigation are further confirmation of Pavlov's principle [13] of coordination in the place and time of functional activity of the digestive organs, and they agree well with views regarding the "behavior" of visceral systems [14].

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