PROTEOLYSIS OF SOME BLOOD PLASMA PROTEINS IN THE STOMACH IN EARLY ONTOGENY

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Milk proteins are known to be assimilated highly efficiently at an early age despite definite immaturity of the proteolytic system of protein digestion in the stomach [1, 2, 4]. In connection with the need to study digestion of milk protein substitutes in the neonatal stomach, the writers have undertaken a comparative investigation of proteolysis of substitutes containing fibrinogen, bovine serum albumin (BSA), and casecid as the protein component, experimentally at an early age. The process of clotting of milk proteins in the presence of rennin is similar to the process of clotting of fibrinogen in the presence of thrombin. There are data in the literature on the origin of milk proteins from blood proteins [5]. Homology is observed between the α-chain of fibrinogen and kappa-casein. The biological value of fibrinogen is quite high [7].

The aim of this investigation was to study digestion of rat milk protein (natural feeding) and substitutes containing fibrinogen BSA, and casecid as the protein component (artificial feeding) in the neonatal rat stomach.

EXPERIMENTAL METHOD

Experiments were carried out on rats fed artificially from the 15th through the 21st day of life on a milk substitute — a liquid diet adapted with respect to its principal parameters to the composition of rat milk, with a protein content of 10%. The composition of the diet and the feeding schedule were described previously [4]. The animals were divided into the following groups: 1) maternal natural feeding, 2, 3, and 4) artificial feeding of the animals from the 15th through the 21st day of life with milk substitute containing fibrinogen, BSA, or casecid as the protein component.

At the age of 21 days, and for 3 h after the normal period between feeds, the animals received a portion of diet, while animals of the control group were fed by their mothers for 30 min. The animals were killed 1 h after feeding. Protein was determined by Lowry's method [6].

The pH of the gastric contents, and their total proteolytic activity and pepsin activity also were determined [1]. Activity of acid phosphatase and cathepsin D was studied in the gastric mucosa [3]. The fractional composition of the gastric content was determined by gel-chromatography with Sephadex [1].

EXPERIMENTAL RESULTS

The switch to artificial feeding led to some acidification of the gastric contents. The pH of the gastric contents during natural feeding was 5.6, confirming previous observations [1]. Artificial feeding with milk substitute, with casecid as the protein component, caused acidification of the gastric content to pH 5.2. During artificial feeding with fibrinogen and BSA as the protein component of the milk substitute, the pH of the gastric content was shifted to 5.1.

The results of the study of proteolytic activity of the gastric contents at the pH of gastric chyme showed that with the switch from natural to artificial feeding proteolytic ac-

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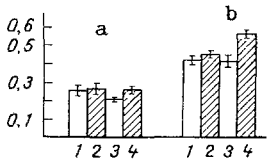

Fig. 1

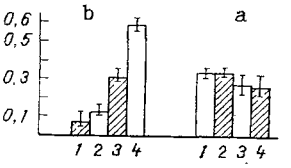

Fig. 2

Fig. 1. Proteolytic activity (a) and pepsin activity (b) of gastric contents (in relative units/mg protein/h) during natural feeding (1) and artificial feeding with casecid [2], fibrinogen (3), and BSA (4).

Fig. 2. Cathepsin activity (a) and acid phosphatase activity (b) in gastric mucosa (in relative units/mg protein/h) during natural (1) and artificial feeding with casecid (2), fibrinogen (3), and BSA (4).

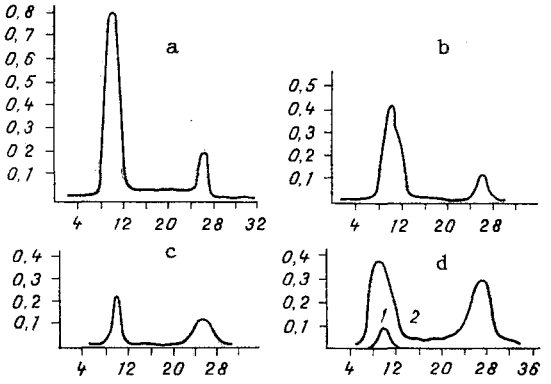

Fig. 3. Fractional composition of gastric contents during artificial feeding with casecid (a), fibrinogen (b), and BSA (c), during starvation for 24 h (d, 1) and during natural feeding (d, 2). Abscissa, nos. of fractions; ordinate, optical density at 260 nm (in relative units).

tivity remained virtually unchanged (Fig. 1a). Pepsin activity in the gastric contents was rather higher during artificial feeding of the animals in the postnatal period of development than during natural feeding (Fig. 1b). This very small increase in peptin activity, linked with adaptive changes in the enzyme-forming function of the stomach, was observed during artificial feeding with a substitute with BSA as the protein component, but it was not found when casecid and fibrinogen were used for artificial feeding of the animals during postnatal development (Fig. 1b). Incidentally, during both natural and artificial feeding, pepsin activity was almost twice as high at the optimal pH than at the pH which was observed in the gastric contents (Fig. 1a, b).

The study of cathepsin activity in the gastric mucosa showed that it was virtually unchanged by the switch from natural to artificial feeding (Fig. 2a). Acid phosphatase activity was virtually unchanged on the switch from natural feeding to feeding with casecid, but it rose considerably during feeding with a substitute containing fibrinogen and BSA as the protein component (Fig. 2b), evidence of adaptive changes in the enzyme-forming function of the stomach.

The study of the fractional composition of the gastric chyme showed that the principal fractions of the gastric contents during natural feeding are the protein fraction and the low-molecular-weight fraction. During artificial feeding with a substitute containing casecid as the protein component, besides the above-mentioned fractions, a fraction of "medium" peptide also was found. Proteolysis of fibrinogen in the stomach leads to the formation of protein, large peptide, and low-molecular-weight fractions. Artificial feeding with a substitute containing BSA as the protein component was characterized by intensive evacuation of protein from the stomach, whereas during natural feeding and artificial feeding with fibrinogen and casecid, slow evacuation of protein from the stomach was observed (Fig. 3).

The results of the study of the efficiency of utilization of blood plasma proteins and, in particular, of fibrinogen, showed that it is 66.8% for this protein, compared with 78.6%

for natural feeding. Consequently, the efficiency of utilization of this protein is quite high. We know from the literature [4] that casein has a closely similar efficiency of utilization (56.1%). The efficiency of utilization of BSA is very low [4], only just over half of that for casein and fibrinogen.

The comparative study of proteolysis of milk substitutes containing fibronogen, casecid, or BSA as the protein component showed that the efficiency of utilization of fibrinogen is quite high and close to that for casein. The results of investigation of the fractional composition of the gastric content of the animals show that evacuation of protein from the stomach takes place slowly in the case of natural feeding and artificial feeding with milk substitutes containing casecid and fibrinogen, whereas during artificial feeding with milk substitutes containing BSA, evacuation of protein takes place more rapidly. Pepsin activity in the gastric content is a little higher during artificial feeding with BSA as the protein component of the milk substitute, but is virtually unchanged when fibrinogen and casecid are used.

It can be concluded from these results that adaptive changes in gastric function depend on the quality of the protein.

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