Regulation of Proteolytic Activity of Pepsin in Mice by Rotating Electromagnetic Field

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In experiments on Wistar rats we studied the effect of low-frequency electromagnetic field rotating in either right-handed or a left-handed sense on proteolytic activity of pepsin. The right-handed rotating field increased, while left-handed rotating field decreased pepsin activity. Possible mechanisms of these changes in pepsin activity are discussed.

Key Words: *rotating electromagnetic field; pepsin; proteolytic activity; chirality*

Rotating magnetic field (RMF) produces an informational and phenomenological effect on the whole organism. The effect of electromagnetic fields (EMF) on living organisms depends on polarization of constituting biological molecules (chirality) [2]. Proteolytic activity of pepsin was measured under the influence of magnetic field rotating in a right-handed or a left-handed sense (*D*- and *L*-chirality). The molecular structure of pepsin is characterized by *D*-spatial symmetry (right-handed sense).

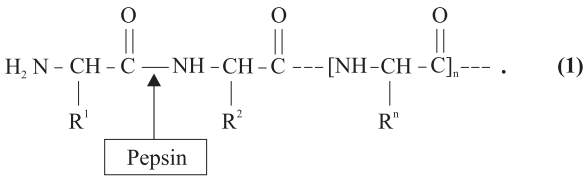
Inactive proenzyme pepsinogen is synthesized in chief cells of the gastric mucosa and secreted into the stomach. Pepsinogen is also present in other biological fluids (blood, urine, sperm, and cerebrospinal fluid). Pepsinogen biomolecule of has a molecular weight of 42,500 and is stable at pH 6-7 [1].

The terminal (inactive) part of pepsinogen contains 6 peptides with a molecular weight of 3100. The active site can be unblocked only in an acid medium. An inhibitor of the active site undergoes dissociation at pH<5.4 and is digested with active pepsin at pH 3.5-4.0. Pepsinogen is characterized by autocatalytic activation.

Secretion of pepsinogen is stimulated by cholinergic fibers, vagus nerve, sympathetic fibers terminating in β-adrenoceptors, gastrin, histamine, secretin, and cholecystokinin. The enzymes secretin and cholecystokinin directly stimulate pepsinogen synthesis.

It can be hypothesized that RMF stimulates pepsinogen secretion by the following mechanisms: increase in Ca^{2+} transport in cells, stimulation of Na^+/K^+-ATPase, stimulation of intracellular transport of zymogene granules, activation of membrane phospholipase, increased release of zymogene granules from cells, and activation of cGMP and cAMP.

Gastrin acts as a stimulator of parietal cells. Gastrin-mediated stimulation is followed by the release of considerable amounts of gastric juice with high acidity. The enzyme gastrin is produced in the gastric mucosa. This polypeptide exists in 2 forms containing 34 and 17 amino acids. "Short" gastrin is most potent in stimulating parietal cells. This compound increases the rate of HCl secretion by 8 times. In view of biochemical specificity, pepsin hydrolyzes only peptide bonds and is specific to optical configuration of amino acid residues on either side of the hydrolyzed bond:



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MATERIALS AND METHODS

Experiments were performed on adult male Wistar rats aging 6-8 months. RMF was generated on an authorized device.

Gastrostomy was performed 48 h before the experiment to provide direct sampling of the gastric juice. The animals were intraperitoneally narcotized with ketamine in a dose of 0.1 ml per 10 g body weight. A butterfly catheter for intravenous infusion was used as a gastrostomic tube. To prevent removal of a catheter by the rat, its proximal end was fixed on the back surface of the neck. This procedure allowed us to obtain gastric juice samples.

Gastrostomy involved upper median laparotomy. A purse-string serous-muscular suture was placed on the anterior surface of the gastric fundus. The end of the gastrostomic tube was introduced into the stomach cavity through a central cut in the suture. The purse-string suture was tightened. A serous-muscular suture was placed to fix the tube.

Each of the two series included 5 tests. *D*-RMF and *L*-RMF were applied in series I and II, respectively. Digestive activity of pepsin was measured in fasting animals. Samples of the gastric juice obtained immediately before the start of the study served as the control. The rats were placed in a chamber and exposed to RMF for 15 min. Gastric juice was sampled immediately after treatment. Enzyme production was assayed by the unified methods of Tugolukov and Anison—Mirskoi with modifications of Chernikov.

RESULTS

Measurements of pepsin proteolytic activity in series I showed that the enzyme from control animals digests 0.027-0.04 mg blood plasma proteins. The amount of pepsin-digested proteins after exposure to *D*-RMF increased to 0.04-0.08 mg (Table 1).

D-RMF increased proteolytic activity of pepsin in relation to standard hemoglobin (Table 1).

Series II showed that pepsin from control animals digests 0.045-0.06 mg blood plasma. Treatment reduced enzyme activity to 0.04-0.05 mg blood plasma (Table 2).

Measurements of pepsin proteolytic activity in relation to standard hemoglobin revealed similar changes in digestive activity of the enzyme (Table 2).

We analyzed possible mechanisms for the change in pepsin activity caused by RMF. Conversion of pepsinogen into pepsin is evoked by RMF, does not depend on H^+ concentration or pH, and can result from molecular chain break **(1)**:

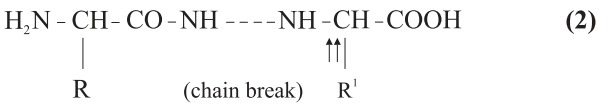
TABLE 1. Proteolytic Activity of Pepsin after Exposure to *D*-RMF

Sample, No.	Tugolukov method		Anison—Mirskoi method with modifications of Chernikov		
	control	experiment	blank sample	control	experiment
1	0.045	0.05	0.2	0.8	0.9
2	0.027	0.04	0.2	0.6	0.85
3	0.04	0.08	0.2	0.1	1.3
4	0.03	0.04	0.25	0.6	1.5
5	0.03	0.05	0.2	1.2	1.9
Mean value	0.032	0.053	0.21	0.66	1.29

Note. Spread (significant spread for several samples, presence of pronounced tendency) is associated with a change in position of the animal's body and natural variability of a physiologically normal level.

TABLE 2. Proteolytic Activity of Pepsin after Exposure to *L*-RMF

Sample, No.	Tugolukov method		Anison—Mirskoi method with modifications of Chernikov		
	control	experiment	blank sample	control	experiment
1	0.06	0.05	0.2	0.8	0.7
2	0.045	0.04	0.2	0.85	0.5
3	0.045	0.04	0.18	0.58	0.52
4	0.05	0.045	0.2	0.75	0.7
5	0.05	0.045	0.21	0.8	0.75
Mean value	0.05	0.044	0.19	0.75	0.63



(2)

Physicochemically, break of bonds in **(2)** can be associated with higher degree of twisting in biological molecules.

Our results indicate that exposure of biological systems to RMF is a new and highly efficient method of magnetic therapy. *In vivo* activation of pepsin under the influence of right-handed RMF and inhibition of the enzyme upon exposure to left-handed RMF can be used for the therapy of patients with gastroenterological disorders (*e.g.*, ulcers of the stomach and duodenum).

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