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EFFECT OF MUSCULAR EXERTION ON INVERTASE ACTIVITY OF THE SMALL INTESTINE

Sh. K. Kurbanov

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Invertase activity of the proximal, middle, and distal parts of the small intestine after muscular exertion lasting 2, 4, and 10 h (forced swimming in water at 35 ± 1°C) was studied in acute experiments on male albino rats. After swimming for 2 h the invertase activity in the first two parts of the intestine was sharply reduced and it returned to its initial level after 48-72 h. This decrease was much less marked in the distal portion. Swimming for both 4 and 10 h led to a slight increase in enzyme activity in all three parts of the intestine 24 h after the beginning of the experiments, followed by a decrease in the first two parts and a marked increase in the distal portior 48 h after the beginning of the experiment. It is suggested that these changes are brought about through the hypothalamic-pituitary-adrenal system in accordance with the principle of the general nonspecific adaptation syndrome.

KEY WORDS: *Contact digestion*; *invertase; muscular exertion.*

Intensive muscular exertion leads to considerable changes in metabolism [10], the hormonal status [12], and the motor-evacuatory, secretory, and absorptive activity of the gastrointestinal tract [2, 3, 7, 9, 11]. However, the state of the mechansims of contact digestion, which plays an important role in the digestion and absorption of the main components of the diet [6], has received extremely inadequate study under these conditions, with the result that difficulties exist in the solution of certain problems connected with the physiology of nutrition during muscular activity.

In the present investigation, in which an intestinal enzyme participating in the final stages of carbohydrate hydrolysis (invertase — E.C. 3.21.36) was used as the example, the effect of muscular exertion of varied duration on enzyme activity in different parts of the small intestine was studied.

EXPERIMENTAL METHOD

Experiments were carried out on 99 noninbred male albino rats weighing 100-120 g and kept on a standard diet. The animals were divided into three experimental (30 rats in each group) and one control (9 rats) group. The animals of the experimental groups were forced to swim in water at 35 ± 1°C for 2, 4, and 10 h, respectively, and then decapitated immediately or 4, 24, 48, and 72 h after swimming. The rats of the control group were kept under similar conditions but were not subjected to any special procedure. To determine enzyme activity homogenized preparations are obtained from the everted proximal, middle, and distal portions of the small intestine. These preparations were incubated in 1% sucrose at 37°C for 10 min. Enzyme activity was expressed in micromoles glucose formed per minute per gram wet weight of tissue [4]. Activity of the homogenate reflected the total reserves of enzymes, indirectly reflecting the rate of protein synthesis; surface activity of the intact portions of intestine characterized that fraction of the enzymes that was included in the composition of the membrane surface of the microvilli [6].

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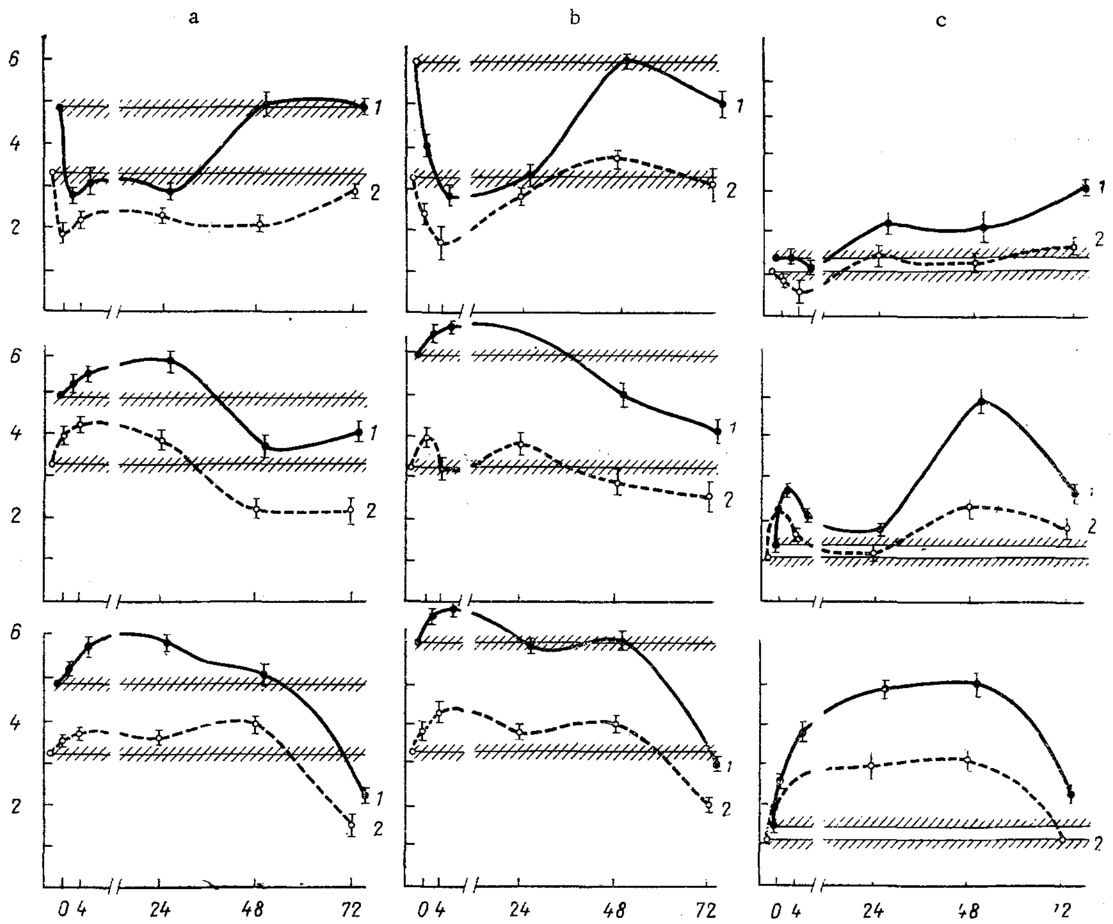

Fig. 1. Invertase activity of homogenized (1) and everted (2) segments of proximal (a), middle (b), and distal (c) portions of small intestine after muscular exertion for 2, 4, and 10 h (top, middle, and bottom rows, respectively). Abscissa, time after muscular exertion (in h); ordinate, enzyme activity (in μmoles/g tissue/min). Horizontal lines (with shading) indicate enzyme activity in control animals.

EXPERIMENTAL RESULTS AND DISCUSSION

As Fig. 1 shows, after the rats had swum for 2 h the invertase activity of the intestinal surface was fairly sharply reduced and it returned to its initial level 48-72 h later. This increase was less marked in the distal portion, which has the function of a reserve zone. Changes in enzyme activity of the homogenate were similar to those on the surface of the everted portions but were more marked in degree.

After the rats had swum for 4 h the pattern was rather different: Activity of the enzyme on the surface of the everted segments of the proximal, middle, and distal portions was very slightly increased or remained constant for 24 h after swimming, with a further gradual decrease in the proximal and middle portions and a small increase in the distal. The same pattern, with insignificant exceptions, also was observed with the homogenized segments.

After the rats had swum for 10 h the surface invertase activity was fairly constant during the first 48 h in the proximal portion of the intestine, it rose very slightly in the middle portion, and rose considerably in the distal portion. By the third day a tendency for it to decrease was observed. Changes in enzyme activity of the homogenates in the proximal and middle portions were the same as on the surface of the corresponding segments. However, activity of the enzyme in homogenates prepared from the distal portion was considerably increased; this increase, detectable immediately after the end of swimming, continued until the third day but had virtually disappeared by the end of observation, i.e., after 72 h.

The results thus show that the rates of formation of invertase and its incorporation into the cell membrane, judging from the enzyme activity of the homogenized and everted segments of small intestine, changed in different ways in different parts of the intestine after exposure to identical muscular loads, on the one hand, and in the same part of the intestine after exposure to different muscular loads, on the other hand.

These results are in agreement with those obtained by those workers who found, by a study of the effect of stressor factors such as heat, cold, injection of ACTH [5], acceleration, hypokinesia, inhalation of various gas mixtures [8], and immobilization [1] on intestinal function, that different parts of the small intestine respond in different ways to regulatory and harmful factors. Comparison of the results with those obtained by the workers cited above and certain others who have studied the functional state of the pituitary-adrenal systems during muscular work [12] suggests that changes in the activity of invertase and, perhaps, of other intestinal enzymes under the experimental conditions described above take place through the hypothalamic-pituitary-adrenal system in accordance with the principle of the general nonspecific adaptation syndrome.

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