CHANGES IN THE NUMBER OF Ec CELLS IN THE SMALL INTESTINE AND PLASMA SEROTONIN LEVEL IN FOOD DEPRIVED RATS

T. M. Solomatina, M. N. Volgarev,
L. S. Bassalyk, and N. V. Gromova

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An important role in the maintenance of homeostasis and also in the development of certain pathological processes is played by biogenic amines, one of which is serotonin. This biologically active substance has many different functions [2], among which may be distinguished its effect on regulation of carbohydrate metabolism, its ability to stimulate insulin secretion and to affect the blood sugar level, and its property of inhibiting food consumption, and to exert other influences [6].

According to one report [11], 95% of all the serotonin in the body is synthesized by Ec (enterochromaffin) cells in the mucosa of the gastrointestinal tract (GIT) [11], belonging to the APUD system [12]. There is evidence that under certain dietary conditions the number of Ec cells may vary considerably [7], although the functional state of these apudocytes during total food deprivation for a long time has virtually not yet been studied, so that it is impossible to assess the role of Ec cells in disturbances arising in the GIT during food deprivation.

Food deprivation is a state of long-term stress during which the body may go over to endogenous nutrition, utilizing substances which are components of organs and tissues in metabolism [4, 10].

The aim of this investigation was to study correlation between changes in the number of Ec cells in the mucosa of the small intestine and the blood serotonin level in rats deprived of food for different periods.

EXPERIMENTAL METHOD

The mucosa of the small intestine of rats kept on an ordinary diet composed of natural products (control) and of rats deprived of food, but allowed water (experiment), served as the test material for the study of Ec cells.

Animals of the experimental group were decapitated on the 1st, 3rd, and 7th days after total food deprivation, and animals of the control group were decapitated at the same times, 1 h after the last meal. The control and experimental groups consisted altogether of 30 animals. Blood was taken from these same rats at decapitation in order to determine its serotonin level. Pieces of the proximal part of the small intestine were fixed in 10% neutral formalin solution and embedded in paraffin wax. To detect Ec cells the argentaffin method of Masson was used, in Fontana's modification [3]. The total number of argentaffin cells in 100 villi and in 100 crypts of the mucosa of the small intestine was counted in sections. Blood was mixed with concentated perchloric acid to obtain a perchloric extract. The serotonin level was determined by extraction of the compound from the sample with butanol, followed by analysis of the extract on a fluorescent spectrometer by the method in [13] in the modification in [8]. The results were subjected to statistical analysis by Student's method (Table 1).

EXPERIMENTAL RESULTS

Analysis of the argentaffin reaction showed that the number of Ec cells in the mucosa of the small intestine of intact animals (control) was 28.8 ± 1.3 per 100 villi and 100 crypts (Fig. 1). The intensity of the argentaffin

Laboratory of Alimentary Pathology and Morphology, with Electron Microscopy Group, Institute of Nutrition, Academy of Medical Sciences of the USSR. Laboratory of Clinical Biochemistry, All-Union Oncologic Scientific Center, Academy of Medical Sciences of the USSR, Moscow. (Presented by Academician of the Academy of Medical Sciences of the USSR D. S. Sarkis.) Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 100, No. 8, pp. 162-164, August, 1985. Original article submitted December 21, 1984.

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TABLE 1. Number of Ec cells in Musoca of Small Intestine and Blood Serotonin Level in Rats Deprived of Food for Various Times (M±m)

Parameters studied	Period of food deprivation			
	1 (control)	24 h	72 h	7 days
Ec cells (per 100 villi and 100 crypts)	28,8±1,3	74,5±3,1**	26,9±1,0*	44,8±1,4**
Serotonin level, μg/ml	0,14±0,01	0,26±0,02***	0,24±0,03**	0,12±0,01*

Legend. *P < 0.05, **P < 0.05, ***P < 0.01, ****P < 0.001 compared with control.

reaction in the cells was moderate. In animals deprived of food for 24 h the number of Ec cells rose to 74.5± 3.1 per 100 villi and 100 crypts, and the intensity of the argentaffin reaction was usually high in both villi and crypts.

On the 3rd day of food deprivation there were 26.9±1.0 Ec cells per 100 villi and 100 crypts. An argentaffin reaction of average intensity was mainly found in the cells. By the 7th day of food deprivation the number of Ec cells per 100 villi and 100 crypts in the mucosa of the small intestine had fallen to 44.8±1.4. The intensity of the reaction was high in cells of the villi, and average in the crypt cells.

The spectrofluorometric investigation showed (Fig. 2) that the plasma serotonin level in rats of the control group was 0.140±0.01 μg/ml. In rats of the experimental group, after 24 h of food deprivation the plasma serotonin level was 0.260±0.02 μg/ml, after 3 days of food deprivation it was 0.240±0.03 μg/ml, and after 7 days of food deprivation 0.120±0.01 μg/ml.

The investigation thus showed that a more than twofold increase in the number of Ec cells in the mucosa of the small intestine in animals after 24 h of food deprivation compared with the control, and the increase in intensity of the argentaffin reaction corresponded to increased synthesis of serotonin and its release into the blood stream. On the 3rd day of food deprivation the number of cells and the intensity of the argentaffin reaction were reduced, but the plasma serotonin level showed no significant change at these times. On the 7th day of food deprivation the number of Ec cells and the intensity of the argentaffin reaction rose again, but the serotonin level fell below the corresponding values in the control animals.

The results show that the number of Ec cells detectable in the mucosa of the small intestine changes in a fluctuating manner depending on the time elapsing after food deprivation of the animals. The first peak of the increase in their number was observed after 24 h, the second, lower peak, on the 7th day. The same pattern also was observed with changes in the intensity of the histochemical reaction, which was strong in many cells during these periods.

Changes in the plasma serotonin level do not coincide with changes in the number of Ec cells at all times of food deprivation.

It can be tentatively suggested that 24 h after the beginning of food deprivation one cause of the rise of the blood serotonin level was the absence of the inhibitory effect of food on the serotonin concentration [14]. An increase in the serotonin concentration during food deprivation was observed also in the gastric and duodenal wall of rats, and there was a parallel fall in the concentration of tryptophan (a precursor of serotonin) in the number of Ec cells on the 3rd day of food deprivation could be due not to a true decrease in their number, but to their becoming less detectable by histochemical methods in view of the deficient serotonin concentration in the cytoplasm. This last fact could be due to a decrease in activity of serotonin synthesis, but its massive release into the blood stream is more likely. This could be the reason why there was only a very small decrease in the blood serotonin level at this period, in association with a decrease in the number of detectable Ec cells and in the intensity of the argentaffin reaction. On the 7th day of food deprivation disparity between the increase in the number of Ec cells and the intensity of their argentaffin reaction, on the one hand, and the fall in the plasma serotonin level, on the other hand, was seen particularly clearly. This phenomenon can be explained as follows. Ec cells are known [5] to synthesize several hormones besides serotonin: melatonin, motilin, substance P and, possibly, catecholamines also. The opposite trends of the

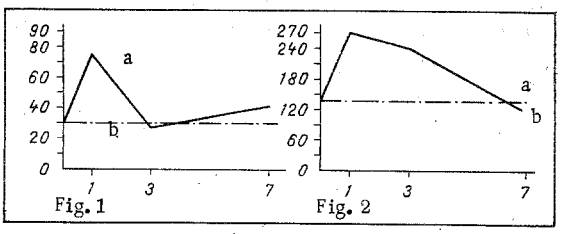

Fig. 1. Number of Ec cells in mucosa of small intestine of normal (a) and food-deprived (b) rats. Abscissa, time of experiment (in days); ordinate, number of Ec cells.

Fig. 2. Plasma serotonin level of normal (a) and food-deprived (b) rats. Abscissa, time of experiment (in days); ordinate, serotonin level (in mg/ml).

changes in the parameters studied on the 7th day of food deprivation was evidently due either to a disturbance of the mechanism of serotonin release and of its accumulation in the cells, or to a switch in the Ec cells from synthesis of serotonin to synthesis of another hormone, most probably melatonin, for serotonin is a precursor of melatonin. However, further investigations in this direction are required to solve this problem.

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