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Issue Article

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# THE EFFECT OF γ-RADIATION ON THE HOMEOSTASIS OF DIGESTIVE ENZYMES

***Abstract**: This study investigates the impact of varying doses of γ-radiation on the homeostasis of digestive enzymes in laboratory rats. Emphasis is placed on key enzymes such as α-amylase, lipase, and pepsinogen. The experimental model utilizes controlled γ-irradiation (1–6 Gy) and subsequent evaluation of enzyme activity in blood serum over different time intervals (1–60 days). The results indicate that γ-radiation causes a dose-dependent reduction in enzyme activity, with more severe effects observed at higher doses, particularly 6 Gy.*
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## Introduction

### Relevance of the Issue

Recognition of the "endo-exocrine principle" (duocrinia) of digestive glands emphasizes the presence of digestive enzymes in the bloodstream. Once in the blood, these enzymes can exist in various states: as zymogens, activated or inactivated forms, bound or unbound to specific inhibitors, adsorbed or unadsorbed by plasma proteins and formed elements, or entirely free. The degree of these associations varies across different enzymes.

The entry of hydrolytic enzymes into the bloodstream is based on several mechanisms. One such mechanism is the absorption of enzymes from the small intestine into the blood. According to V. Varro, the appearance of digestive enzymes in the blood is also due to the apoptosis (destruction) of glandulocytes. Another mechanism involves secretion (incretion) of enzymes from the glands, whereby enzymes pass from the acini and small ducts into the interstitial space, from which they enter the blood and lymph. The ratio of these transport pathways depends on the functional state of the gland and intestine, permeability of histo-hematological barriers, ductal pressure, blood supply, and external stress factors. Among such stressors is radiation therapy, commonly used in medical practice to treat tumors.

In clinical diagnostics, enzymes synthesized by specific organs and cells can be detected in the blood. This category includes gastric proteases (pepsinogen), salivary α-amylase, pancreatic proteases (trypsin, chymotrypsin, elastase), lipase, and α-amylase.

### Objective

To study the effect of different doses of γ-radiation on the synthesis, transport into the blood, and recirculation (homeostasis) of digestive enzymes in the digestive glands.

### Materials and Methods

Experiments were conducted on white, non-breed male rats weighing 150–180 g. The rats were exposed to γ-quanta from Co60 using a "Terabalt-80" device. Irradiation field: 20×20 cm; focal distance: 75 cm; radiation dose rate: 0.85–0.86 Gy/min. Total absorbed doses: 1, 2, 4, and 6 Gy.

The irradiated rats were kept in standard cages and euthanized under anesthesia after 1, 3, 10, 20, 30, and 60 days. Blood was collected, and serum was analyzed for amylolytic, lipolytic activity, and pepsinogen levels. A control group of intact, untreated rats was used for comparison.

**Analysis of Results**

Over 100 years ago, C. Bernard and W. Cannon introduced the concept of homeostasis – the constancy of the internal environment. To maintain this, the body relies on the coordinated function of its systems (brain, nerves, heart, lungs, kidneys, spleen, etc.). Environmental changes disrupt this balance and put stress on the systems responsible for maintaining it. External factors such as radiation can alter glandular secretion, affecting enzyme concentrations in the blood.

**Amylolytic Activity**

Table 1 shows changes in serum amylolytic activity under γ-radiation.

In rats exposed to 1 Gy, amylolytic activity decreased significantly on days 10 and 20 compared to controls, then returned to baseline by day 30.

At 2 and 4 Gy, activity dropped immediately post-irradiation and remained below control levels through day 30. The 4 Gy group saw a 34% decrease from baseline, while the 2 Gy group showed wave-like variations from 3% to 11% below control.

By day 60, enzyme levels in both groups returned to normal.

At 6 Gy, activity dropped by 29% on day 1 and decreased steadily to a 78% reduction by day 30.

Pancreatic (P) and salivary (S) α-isoamylases contribute to blood amylase levels. These exist in species-specific ratios. In humans, their proportions are nearly equal. A significant portion of amylase in blood is bound to plasma proteins (e.g., 23% to albumins, 13% to globulins in dogs). The binding affinity affects availability, acting like a reservoir. In hypoamylasemia, this affinity increases, reducing renal excretion. In hyperamylasemia, binding decreases, and renal clearance rises.

**Lipolytic Activity**

Lipase primarily enters the bloodstream via secretion from the pancreas, although it is also produced by other glands, including the liver. Table 2 summarizes serum lipolytic activity:

At 2 Gy, activity decreased by 15% on days 3 and 10, by 23% on day 20, and returned to baseline by day 30.

At 4 Gy, activity dropped by 16% the next day, then decreased further (36% on day 3, 48% on day 10, 58% on day 20), with slight recovery by days 30 and 60, though not reaching control levels.

At 6 Gy, a sustained 20–25% reduction in activity was observed between observation points, reaching 85% below baseline by day 30.

**Pepsinogen Levels**

Pepsins are proteins that hydrolyze other proteins in acidic environments (pH 1.5–2.0). They are synthesized in the stomach's chief cells as inactive pepsinogen. In blood, pepsinogen originates from the stomach and enters saliva via secretion. This process is regulated according to physiological needs.

Table 3 shows changes in serum pepsinogen under radiation:

At 1 Gy, levels remained stable.

At 2 Gy, levels dropped by 11% on day 10, 16% on day 20, and recovered to within 8% of normal by day 30. By day 60, they returned to baseline.

At 4 Gy, similar but more intense and prolonged declines were observed, with no full recovery by day 60.

At 6 Gy, levels declined from day 1 and continued to drop throughout the study.

**Conclusions**

1. The reduction in enzyme activity in blood is dose-dependent. Higher doses of γ-radiation led to more significant decreases.

2. At 2 Gy, enzyme activity decreased but returned to baseline by day 60. At 4–6 Gy, activity did not normalize even by day 60, with 6 Gy causing the most severe decline.

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