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RECIRCULATION AND ADAPTATION OF PANCREATIC HYDROLYTIC ENZYMES SECRETION AND ENZYMATIC HOMEOSTASIS UNDER Γ-IRRADIATION

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Natural radiation exposure occurs for every person. Human activities involving the use of radiation and radioactive substances result in additional exposure alongside natural background radiation [1,2,3]. Medical applications of radiation contribute the largest and increasing share to anthropogenic exposure [4,5].

It is known that the digestive system is one of the most sensitive to radiation [6]; however, the pancreas is considered a relatively radioresistant organ, since even at doses causing acute radiation sickness (700–1000 R), it does not exhibit significant morphological changes [7]. The glands of the digestive tract secrete into their ducts, organ cavities, lymphatic and blood circulation, producing secretions, recretions, and excretions. A significant portion of the secreted hydrolytic enzymes is absorbed from the small intestine into the lymphatic and circulating blood. In the plasma, enzymes exist freely or bound to its proteins, formed elements, capillary endothelium, and inhibitors. Enzymes are recreted by glandular cells into the chyme, repeatedly participating in the hydrolysis of nutrients and secretions—that is, they recirculate within the organism.

Hydrolases possess properties of signaling molecules and exert regulatory and modulatory effects on the secretion and recretion of enzymes, on the organization of chyme adapted to nutrient composition, and on gastrointestinal motility. In acute enzymatic adaptation of digestive gland secretion, a significant role is played by the morphofunctional organization of digestive secretory-transport modules. Each module contains specialized sensory, afferent, and efferent elements, and within the gland itself, specialized microregions and a system of secretory ducts with micro-reservoir and valve apparatus. The pancreas maintains enzymatic homeostasis through enzyme incretion into and recretion from the blood [8].

This underlines the necessity of a comparative study on the effects of different doses of γ-rays on pancreatic enzyme secretion and enzymatic homeostasis.

Materials and Methods

Experiments were conducted on white, male, outbred laboratory rats weighing 180–200 g. Total γ-irradiation of the rats was performed using a ^60Co source in the “Luch” setup, with an irradiation field size of 20 × 20 cm and a skin-to-focus distance of 75 cm. The dose rate ranged from 0.85 to 0.86 Gy/min. Absorbed doses were 1, 2, 4, and 6 Gy. Enzyme activity in pancreatic tissue homogenates and blood serum was measured on days 1, 3, 7, 10, 20, 30, 45, and 60 post-irradiation. Control values were obtained from intact rats that were not subjected to any interventions.

Discussion of Results

The results obtained showed that in the pancreatic tissue homogenate of rats, amylolytic activity was the highest, at **1460 ± 56.0 U/g**. This enzyme, synthesized by acinar cells, hydrolyzes α-1,4-glycosidic bonds in polysaccharides. The hydrolysis of polysaccharides, initiated in the stomach

by salivary carbohydrases, continues actively with pancreatic α-amylase and is completed by several intestinal disaccharidases.

The next highest activity in the pancreatic homogenate was that of total proteases, **230.0 ± 6.1 U/g**. Proteolytic enzymes are synthesized and secreted by acinar cells in an inactive zymogen form as trypsinogens, chymotrypsinogens, procarboxypeptidases, and proelastases.

Lipase activity in the pancreatic tissue homogenate of rats was significantly lower than that of the previous enzymes, measuring **70.1 ± 3.1 U/g**. This enzyme is synthesized and secreted by acinar cells in an active form. Pancreatic lipase is the primary, essentially the sole lipolytic enzyme responsible for hydrolyzing dietary triglycerides, which constitute 90% of dietary fats consumed by humans.

Analysis of blood enzymes in rats showed that amylase activity was relatively high (**560.0 ± 11.0 U/mL**), while lipolytic activity was much lower (**16.0 ± 0.2 U/mL**) compared to amylolytic activity. The same pattern of enzyme activity observed in the pancreas was reflected in the blood.

After γ-irradiation at doses of 1, 2, and 4 Gy, amylolytic activity in pancreatic tissue decreased by day 3 (Table 1). On days 7 and 10, the reduction reached its maximum, with enzyme activity 20–40% lower than control values. By day 60 post-irradiation at 1 and 2 Gy, pancreatic amylase activity returned to baseline levels.

With increasing γ-irradiation doses, changes in pancreatic amylase activity were more pronounced. At 4 Gy, amylase activity decreased and remained suppressed until day 60. At 6 Gy, amylase activity sharply dropped by 28% within one day post-irradiation. By day 3, partial recovery was observed (13% below control), but subsequent days showed progressive decline, reaching 70% below control by day 30.

These findings are consistent with V.S. Tkachishin [9], who reported dose-dependent changes in enzyme activity after irradiation.

The reduction in pancreatic enzyme secretion may result from weakened stimulatory influences at the generation level, impaired neural signal transmission through the meta-sympathetic ganglion chains of the gland [10,11,12], and suppression of neurohumoral regulation. This manifests as imbalance between adrenergic and cholinergic mediation in the gastrointestinal tract, predominance of destructive processes, impaired microcirculation, and hormonal and mediator imbalances [13]. Reduced enzyme activity may also be due to disrupted enzyme protein synthesis.

Pancreatic enzymes are transported into the blood through multiple mechanisms: from the lumen of the small intestine, from damaged acinar cells, from the ductal lumen of the gland, and via enzyme incretion by pancreatic acinar cells [10]. The relative contribution of these pathways may vary depending on the functional state of the pancreas and small intestine, permeability of histohematological barriers, glandular blood supply, and possibly other factors.

In experimental rats, γ-irradiation caused dose-dependent reductions in blood amylase activity (Table 2). With increasing radiation dose, the decrease in amylolytic activity was more pronounced: 1 Gy (2.5–8% below control), 2 Gy (3–16%), 4 Gy (5–12%), and 6 Gy (50–84%).

Dose-dependent changes were also observed for lipase activity in both pancreatic tissue and blood.

At 1 and 2 Gy, lipolytic activity in pancreatic tissue and blood remained at baseline levels (Tables 3 and 4), indicating that these doses do not affect pancreatic lipase secretion or its incretion into the blood. At 4 Gy, pancreatic tissue lipase activity dropped by approximately half on the day after irradiation and became three times lower than baseline by day 10. By day 60, lipase activity in the pancreas remained significantly below control levels. At 6 Gy, tissue lipase activity decreased threefold by the day after irradiation and fourfold by days 20–30. Similar changes were observed in blood lipase activity at 4 and 6 Gy.

Total proteolytic activity in pancreatic tissue also depended on γ-irradiation dose. At 1 Gy, total protease activity decreased by 18% on day 10 and returned to baseline by day 20; at days 30 and 45 it was reduced again, returning to control levels by day 60. At 2 Gy, activity initially decreased by 37% but gradually recovered by day 45. At 4 Gy, proteolytic activity decreased by 13% the day after irradiation and remained roughly four times lower than baseline between days 20 and 60. At 6 Gy, protease activity decreased by 30% the day after irradiation and continued to decline, reaching 50% of control by day 30.

Conclusions

The rat pancreas contains enzymes that hydrolyze virtually all macronutrients—proteins, lipids, and carbohydrates. Their relative abundance in pancreatic tissue is unequal: amylolytic enzymes predominate, followed by proteolytic enzymes, with lipolytic enzymes being the least abundant. Amylase and lipase levels in the blood are much lower than in pancreatic tissue.

γ-Irradiation causes dose-dependent reductions in the synthesis of pancreatic enzymes (amylase, lipase, and proteases) and in their incretion (amylase and lipase) into the blood.

Literature:

1. Карпов А.Б., Тахауов Р.М., Урут В.В. Роль ионизирующего излучения в развитии гомеостатического дисбаланса. // Бюллетень Сибирской медицины: научно-практический журнал.- 2005, -№2. -С.82-87.
2. Петрова Г.В. Заболеваемость злокачественными новообразованиями на территориях, пострадавших вследствие аварии на ЧАЭС(1981-2006г). //Медицинская радиология и радиационная безопасность.-М., 2009. -№1. -С.16-18.
3. Токарская З.Б., Хохряков В.Ф. О факторах риска злокачественных опухолей среди работников ПО «Маяк» //Медицинская радиология и радиоцонная безопастность.-М., 2010.-№2.-С.-32.
4. Бушмаков А.Ю., Баранов А.Е., Надежина И.М. Три случая острого радиационного поражения человека от внешнего гамма- излучения. // Бюллетень Сибирской медицины: научно - практический журнал. -2005, -т. 4, №2. -С.133-140.
5. Отчеты НКДАР ООН по действию атомной радиации генеральной ассамблее. // Медицинская радиология и радиационная безопасность. – Москва, 2010.- №1.- С.28-47.
6. Бабаджанова Ш.А., Шамсутдинова М.И., Мусаева И.Б. Патология системы пищеварения у лиц, подвергшихся воздействию малодозного облучения. / Современные подходы диагностике и лечению заболеваний кроветворной системы. Актуальные

проблемы транс физиологии: сборник научных трудов научно-практической конференции с международным участием. - Ташкент, 2006. -С. 68.
7. Суринов Б.П., Шеянов Г.Г. Структурное-функциональное состояние поджелудочной железы и некоторые её гидролазы при облучении. //Радиобиология.-М.,1979.-№1. -С.60-65.
8. Коротько Г.Ф. Секреция поджелудочной железы. – Краснодар: Кубанский гос.мед.университет, 2017. – 312с.
9. Ткачишин В.С. Ретроспективная оценка дозы облучения организма по активности аланинаминотрансферазы и аспартат – аминотрансферазы. //Медицинская радиология и радиоцонная безопастность.-М., 1997.- №6. -С.43.
10. Коротько Г.Ф. Эндосекреция ферментов в модуляции деятельности пищеварительного тракта //Рос. журнал гастроэнтерол. гепатол. колопроктология. -2007.-№5.-С.97-104.
11. Telbisz A., Kovics AL, Somosy Z. Influence of X-ray on the autophagic-lysosomal system in rat pancreatic acini // Micron. -2002.- v.33,№2.-P.143-151.
12. Yamaguchi K., Nakamura K., Kimura M., Yakakota K., Noshiro H., Chijiiwa K., Tanaka M. Intra operative radiation enkances decline of pancreatic exocrine function after pancreatic head resection. //Radiat Res. -2000 . –v.45,№6.-P. 1084-1090.
13. Ершов А.В., Шербак Н.П. Изменения иннервации желудка крыс при хроническом воздействии ионизирующего излучения в малых дозах. //Научно- теоретический медицинский журнал. Морфология. -Санкт- Петербург, 2000. -т. 117, №3. -С.45.