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Morphometric Features of the Development of the Parotid Salivary Gland of Rabbits in Conditions of Nutrition with Dispersed Food

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Abstract---*Recent studies have drawn attention to the fact that a change in the physical properties of food through its preliminary grinding (dispersion) affects the morphogenesis of the alimentary canal wall. The muscular and mucous membranes of the esophagus, jejunum and colon, as well as the stomach undergo structural transformations. Meanwhile, it has been shown that the parotid salivary gland is sensitive to the physical properties of food and the presence of the act of chewing. A positive correlation was found between the amount of stimulated saliva produced during chewing, an increase in the size of parotid salivary gland cells and its weight, as well as body mass index.*
Keywords---*acinus, dispersed food, morphogenesis, morphometry, ontogenesis, parotid salivary gland*.

Introduction

The studies of the last decade have convincingly demonstrated a significant change in the structure of nutrition not only of humans, but also of domestic animals, as well as agricultural and laboratory animals. The consumption of quickly eaten, finely ground and pasty food, which does not require long chewing and reduces the total time of eating, disrupts the assimilation of biologically valuable substances, which contributes to a decrease in the adaptive-compensatory capabilities of the body and the development of pathological processes. The detected changes were interpreted by the authors as a consequence of inhibition of the physiological reflex process of saliva synthesis. A number of studies have shown a change in the number of receptors on the serocyte membrane for neurotransmitters in the salivary glands of adult rats on a liquid milk diet, as well as a change in the enzymatic activity of saliva, a decrease in the total mass of the glands. At the same time, the results of the study by W.H. Wilbom and S.A. Schneyer indicate that the maintenance of 180-day-old rats for two weeks on a liquid diet does not affect the morphological features of the intercalated and striated ducts. Research P.N. Baer, T.N. Tarpley showed that keeping rats on a liquid diet from the 13th to the 365th day of postnatal ontogenesis does not cause any morphological

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changes in the cellular structures of the salivary glands. Switching liquid-fed animals to a diet of cellulose and solid food has also had mixed results. Given this phenomenon, as well as the inconsistency of the results obtained in previous studies, the scientific task of studying the influence of the physical properties of food on the structural and functional parameters of the parotid salivary glands remains relevant. The aim of the study was to establish the features of postnatal morphogenesis of the parotid salivary gland in rabbits based on the morphometry of its structural elements during prolonged feeding with dispersed food (Babaeva & Shubnikova, 1979; Denisov, 2011; Kim et al., 2022; Avtandilov, 1990).

Materials and Methods

Experimental studies were carried out on 10 Californian rabbits. On the 45th day after birth, the animals were randomly divided into control and experimental groups. Animals of the control group were kept under normal vivarium conditions on natural food for rodents. Animals of the I experimental group from the 45th to the 80th day of the experiment were fed with dispersed food of the same composition (grain mixture crushed in a mechanical mill, vegetables and minced meat processed by means of a fine grater). The material was taken at the age of 45, 60, and 80 days of development. Description, comparative morphological analysis and morphometry of the structures of the parotid salivary glands were carried out on histological preparations stained with hematoxylin-eosin. Morphometric studies included the determination of: cross-sectional area of acini, lumens and walls of intralobular (intercalary and striated) ducts, nuclei and cytoplasm of serocytes and epitheliocytes of intralobular ducts (μm2); the number of cells in the cross-sectional area of the acini, as well as in the wall of the intralobular ducts on their transverse sections; nuclear-cytoplasmic ratio of serocytes and epitheliocytes of intralobular ducts. The cross-sectional area of the cytoplasm of a serocyte/epitheliocyte was determined by the formula: S/N, where S is the cross-sectional area of the cytoplasm of the acinus/duct, N is the number of nuclei per cross-sectional area of the acinus. The weight of the animals, the individual amount of food consumed in grams, the length of the body, small and large intestines in centimeters were also determined (Tastanova et al., 2020; Avtandilov, 1976; Bailey, 1948).

Results and Discussion

The period from the 45th to the 80th day is characterized by a decrease in the number of serocytes on the cross-sectional area of the acini in the animals of the experimental group in relation to the control animals. As a result, during this period, there is a slight decrease in the cross-sectional area of the acini of animals eating dispersed food, in relation to that of animals in the control group. The nuclear-cytoplasmic ratio of serocytes of 60-day-old animals of the experimental group is 18.09 ± 0.23%, while in animals of the control group its values reach 19.59 ± 0.24% ($p < 0.01$). However, later on (days 60–80), the values of the nuclear-cytoplasmic ratio of the animals of the first experimental group exceeded those of the animals of the control group ($p < 0.01$). The observed decrease in the size of acini in 45-day-old animals of the experimental group is due to a decrease in the area of the cytoplasm of serocytes both in relation to the corresponding group of 60-day-old animals and 80-day-old control animals ($p < 0.01$, Table 1). The decrease in the size of the acini of the parotid salivary gland is due to the feeding of pre-ground food and, as a result, a reduction in the duration of the act of chewing (Eisbruch et al., 1999; Scott, 1977; Stimec et al., 2006). Irritation of oral cavity receptors during chewing is the main mechanism in regulating the synthesis of saliva proteins. The time spent in the oral cavity of pre-ground food is reduced, which leads to inhibition of the physiological reflex process of secretion synthesis by the parotid salivary gland. As a result, there is a decrease in the volume of acini, which is due to a decrease in the volume of serocytes. Nevertheless, by the 80th day, the cross-sectional area of acini and cytoplasm of serocytes, as well as their number on the cross-sectional area of acini in animals of the experimental group, reach the values of control animals (Table 1). At the same time, in 80-day-old animals of the experimental group, the nuclear-cytoplasmic ratio of serocytes was statistically significantly lower than in 80-day-old control animals (Table 1). In the period from the 45th to the 80th day, feeding with dispersed food does not have a significant effect on the morphometric parameters of the structures of the intralobular ducts (Tucker, 2007; Proctor & Carpenter, 2007; Bohuslavizki et al., 1999). However, in the 80-day-old animals of the experimental group, the cross-sectional area of the lumen of the intralobular ducts was significantly inferior to that in the animals of the control group (Table 2, $p < 0.01$). Subsequently (days 60–80), there is a slowdown in the growth of the area of the cytoplasm of the epithelial cells of the intralobular ducts of the animals of the experimental group, as a result of which the cross-sectional area of their walls is inferior to that of the animals of the control group ($p < 0.01$). The nuclear-cytoplasmic ratio of epithelial cells of intralobular ducts in 80-day-old animals of the experimental group exceeds that of 80-day-old control animals ($p < 0.01$). After the transfer of animals from feeding on dispersed food to

feeding on non-dispersed food, the area of acini in 60-day-old animals of the experimental group exceeded those of 60-day-old animals in the control and experimental groups ($p < 0.01$). Hypertrophy of the acini in the animals of the experimental group is due to an increase in the cross-sectional area of the nuclei and cytoplasm of serocytes (see Table 1). At the same time, the nuclear-cytoplasmic ratio of serocytes of animals of the experimental group decreases. Subsequently, statistically significant differences in the cross-sectional area of acini between 80-day-old animals of all experimental groups are lost. The nuclear-cytoplasmic ratio of serocytes of 80-day-old animals of the experimental group is less than the corresponding indicator of control animals ($p < 0.01$).

Table 1
Morphometric parameters of acini of the parotid salivary gland of control and experimental animals in different periods of postnatal development

Age (days), group		Area of serocyte nuclei (MKM2)	Sectional area of the cytoplasm of serocytes (MKM2)	serocytes	The number of serocytes on a section of acinus	Sectional area of acini (мкм2)
45	Control	12,27 ± 0,08X	71,36 ± 0,75X	22,69 ± 0,43X	6,22 ± 0,07	466,98 ± 6,76
	Experience	12,18 ± 0,06*	70,52 ± 0,76X	20,08 ± 0,32*	3,96 ± 0,05*	243,94 ± 3,43X
60	Control	10,57 ± 0,07X	64,00 ± 0,78X	17,58 ± 0,19X	6,35 ± 0,06	362,81 ± 6,66X
	Experience	10,09 ± 0,05*	84,82 ± 0,96X	18,43 ± 0,18X*	6,07 ± 0,08*	371,18 ± 6,66X
80	Control	10,07 ± 0,07X	86,09 ± 0,98X	18,52 ± 0,22	6,59 ± 0,09	448,66 ± 6,18X
	Experience	12,99 ± 0,09	86,97 ± 0,91X*	19,47 ± 0,27X*	8,76 ± 0,08X	609,09 ± 6,64X*

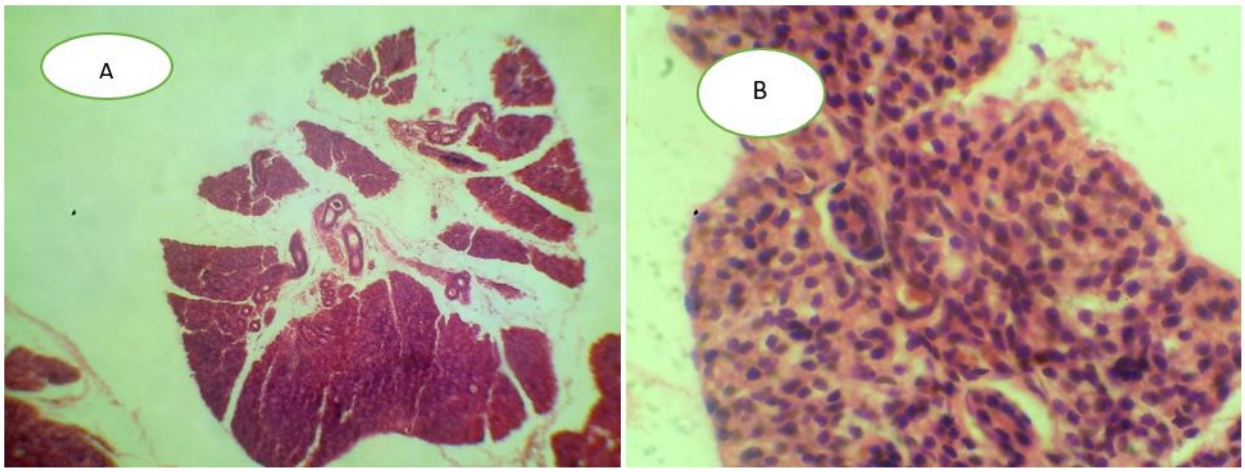

Figure 1. The structure of the parotid glands of rabbits of the control (A)and experimental (B) groups

Due to the increase in the number of epithelial cells in the walls of the intercalary ducts in the period from the 60th to the 80th day, the cross-sectional area of the walls of the ducts of the animals of the experimental group exceeds that of the animals ($p < 0.01$). The cross-sectional area of the walls of the striated ducts, as well as the cross-sectional area of the nuclei and cytoplasm of the epitheliocytes of the 60-day-old animals of the experimental group, is greater than that of the control animals ($p < 0.01$). Subsequently, the cross-sectional area of the walls and the diameter of the intralobular ducts of the animals of the experimental group are inferior to the corresponding indicators of the 80-day-old control animals. The nuclear-cytoplasmic ratio and the cross-sectional area of the cytoplasm of the epitheliocytes of the intralobular ducts of the animals of the experimental group is inferior to the corresponding indicators of the animals of the control group (Mitsui et al., 1997; Hakim et al., 2002; Menegaz & Ravosa, 2017). To determine the balance of morphological and functional relationships, reflected in the linear correlations of the values of the studied parameters, we carried out a correlation analysis of the anatomical and morphometric parameters of the animals of the control and experimental groups. The number of correlations according to Fisher's criterion in animals of the control group significantly exceeds those of animals and experimental groups in the entire period of postnatal ontogenesis studied ($p < 0.05$). Significant differences in the structure of correlations between the animals of the

control and experimental groups are found only in the early stages of postnatal ontogenesis. The transfer of animals from the diet of dispersed food to the usual diet leads to a decrease in the number of correlations compared to animals in the control and experimental groups, which indicates morphofunctional changes due to changes in the physical properties of the food consumed (Evans et al., 1996; Darmadi et al., 2017; Sulistyaningsih, 2016).

Conclusion

In the morphogenesis of the acini of the parotid salivary gland in rabbits that feed on dispersed food for a long time, two stages of the dynamics of changes in their morphometric parameters, uneven in duration, are distinguished: the first stage (45–80 days) is characterized by an increase in the nuclear-cytoplasmic ratio of serocytes and a decrease in the size of acini; the second stage is characterized by an increase in the size of acini and a decrease in the nuclear-cytoplasmic ratio of serocytes. In the period from the 45th to the 80th day, feeding with dispersed food does not have a significant effect on the morphometric parameters of the structures of the intralobular ducts. Subsequently (days 60–800), their values decrease. The transfer of animals fed on dispersed food for a long time to normal food on the 120th day of development is accompanied by an increase in the values of the morphometric parameters of the secretory end sections of the parotid salivary glands to the control level. Morphometric parameters of intralobular excretory ducts increase, but remain statistically significantly lower compared to control animals.

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