Electron-microscopic study of enterocytes of intestinal crypts of the small intestine of a hybrid of a yak (BOS MUTUS) with a cow of a black-and-white Holstein breed

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Abstract. In this work, an electron microscopic study of the structural features of enterocytes of intestinal crypts of the small intestine of hybrids obtained by crossing a yak and a cow of a black-and-white Holstein breed in comparison with the original species was carried out. The study indicated the similarity of the structure in the hybrids of all studied variants of crosses and the original species of borderless and goblet enterocytes of intestinal crypts of the duodenum and jejunum. The infinite enterocytes of the intestinal crypts of the hybrids had a well-developed smooth and granular endoplasmic reticulum, as well as many free ribosomes. The Golgi complex of crypt enterocytes in its development varied greatly, mitochondria were small, most often round in shape. Secretory granules had different electron density, more often moderate, matrix - average electron density. The cells of the Brunner glands were conical in shape with rounded apical ends, a well-developed Golgi complex, a smooth and rough endoplasmic reticulum, which formed extensive dilated lumens containing fine-grained material. The mitochondria were found to be predominantly rounded. Secretory granules completely filled the apical end of the cell and had a low electron density.

1. Introduction
The increase in production volumes and the expansion of the range of meat products that meet the modern requirements of nutritional science sets the task of not only improving their quality and hygienic safety, but also finding the rational use of new reserves of meat raw materials. From this point of view, nomadic animal husbandry is the most profitable, which in the conditions of the Baikal region provides a maximum of high-quality raw materials with minimal labor and financial resources [1-3].

The creation of more highly productive breeds of livestock with a higher immunobiological resistance to diseases, with a high adaptive ability to grazing conditions can be solved by creating hybrid forms of cattle, which are a source of meat raw materials of high biological value for humans in comparison with traditional beef [4-12].

Scientific works on the study of the meat quality of yaks have shown that it is not inferior to traditional raw materials (beef, horse meat), even slightly higher in nutritional value, and besides, yak meat is an environmentally friendly product [2; 4; 10].

The yak-cattle hybrid is known as the hainak. Also, like the yak, he has high vitality and endurance. The hybridization of yak and cattle has been known for a long time and was recorded in ancient historical documents. Hybridization between the two studied species occurs in two directions:
in one case, the yak is crossed with a bull of cattle, in the other, a cow with a yak as a producer. Male yaks are more likely than cattle bulls to try to care for females of a different species. This is apparently due to the year-round sexual activity of male yaks [6; 11; 13].

Successful breeding of yak and domestic cow hybrids, their maintenance and prevention of gastrointestinal diseases are possible only under the condition of a comprehensive study of the species characteristics of the animal organism and their adaptive variability. In particular, to obtain the maximum yield from hybrid species, optimal functioning of their digestive apparatus, especially the intestines, is required. In particular, the small intestine, having various functions (secretory, motor-evacuation, hydrolytic, absorption, endocrine and immune), affects the entire body of the animal.

The morphometric parameters of the intestine are subject to changes with varying degrees of intensity and depend on many factors [7; 14]. Despite this, in the literature available to us, there are isolated works devoted to the morphofunctional characteristics of the gastrointestinal tract of cattle hybrids [5; 8] and the morphology of the small intestine of the yak in ontogenesis [9]. This served as the basis for studying the structural features of the small intestine of hybrids obtained by crossing a yak and a cow of a black-and-white Holstein breed in comparison with the original species.

The aim of the research is to conduct an electron microscopic study of the structural features of enterocytes of intestinal crypts of the small intestine of hybrids obtained by crossing a yak and a cow of a black-and-white Holstein breed in comparison with the original species in order to use the results obtained in further work on the creation of new forms of productive livestock.

2. Materials and methods
The material for the research was the intestines of 21 heads of sexually mature animals (3 heads of a yak, 7 heads of a black-and-white Holsteinized cow, 5 heads of F₁ hybrids and 3 heads of F₂ hybrids containing ¾ the blood of a black-and-white Holsteinized cow and ¼ a yak, 3 heads F₂ hybrids containing ¾ yak blood and ¼ blood of a black-and-white Holsteinized cow). Live weight, weight and length of intestinal and intestinal sections in general were determined in animals.

For electron microscopic examination, samples of the mucous membrane of the duodenum and jejunum were taken from 15 heads of the studied animals (3 heads of a yak, 3 heads of a black-and-white Holsteinized cow, 3 heads of F₁ hybrids and 3 heads of F₂ hybrids containing ¾ blood of a black-and-white Holstein cow and ¼ yak, 3 heads of F₂ hybrids containing ¾ yak blood and ¼ black-and-white Holstein cow blood). Tissue samples were fixed in solutions of aldehydes and osmium tetroxide, followed by pouring an eponaraldite mixture. Ultrathin sections were made using a Leica EM UC 7 ultramicrotome. The obtained preparations were studied using a Philips XL 40 electron microscope.

3. Results and Discussion
Our studies have shown that the body weight of the yak averaged 358.5 ± 24.23 kg, that of the black-and-white Holsteinized cow 453.5 ± 25.17 kg, and of F₁ hybrids - 475.6 ± 22.45 kg , in F₂ hybrids containing ¾ blood of a black-and-white Holsteinized cow and ¼ of a yak - 436.5 ± 27.25 kg and in F₂ hybrids containing ¾ yak blood ¾ blood of a yak and ¼ blood of a black-and-white Holsteinized cow - 372.2 ± 27.23 kg.

Indicators of linear measurement of the entire intestine, and in particular its thin section, in F₁ and F₂ hybrids containing ¾ blood of the black-and-white Holsteinized breed, as well as purebred animals of the black-and-white Holsteinized breed were higher than in the yak (P≤0.05) , and in hybrids containing ¾ of the blood of a yak, did not differ much from the latter. The indicators of the development of the duodenum in all studied animals were quite similar.

Hybrids F₁ and F₂ containing ¾ blood of a black-and-white Holsteinized cow had higher jejunal mass as compared to a yak (P≤0.01) and differed little from the black-and-white Holsteinized breed. F₂ hybrids containing ¾ yak blood were inferior to the Black-and-White Holsteinized breed in terms of jejunum weight (g) (P≤0.05), and when compared with the yak, no statistically significant differences were found.
The thickness of the duodenal wall in the yak was the highest - 1976.0 ± 87.4 microns; in the black-and-white Holsteinized breed was 1857.4 ± 78.5 microns, and in F₁ hybrids - 1602.5 ± 85.7 microns, F₂ containing blood of the black-and-white Holsteinized breed - 1633.8 ± 92.5 microns, F₂ containing ¾ yak blood - 1823.7 ± 88.4 microns.

The thickness of the wall of the jejunum in the hybrids was greater (P≤0.05) than in the original species, and was 985.2 ± 76.4 μm in the yak, 1137.8 ± 102.7 μm in the black-and-white Holstein breed, and in hybrids F₁ - 1642.8 ± 137.8 μm, in F₂ hybrids containing ¾ blood of the black-and-white Holstein breed 1112.8 ± 122.8 μm, in F₂ hybrids containing ¾ yak blood 1407.2 ± 143.4 μm.

Electron-microscopic examination of borderless and goblet enterocytes of intestinal crypts of the duodenum and jejunum indicates the similarity of the structure in the hybrids of all studied variants of crosses and the original species. The infinite enterocytes of the intestinal crypts of the hybrids had a well-developed smooth and granular endoplasmic reticulum, as well as many free ribosomes. The Golgi complex of crypt enterocytes in its development varied greatly, mitochondria were small, most often round in shape. Secretory granules had different electron density, more often moderate, matrix - average electron density. The cells of the Brunner glands were conical in shape with rounded apical ends, a well-developed Golgi complex, a smooth and rough endoplasmic reticulum, which formed extensive dilated lumens containing fine-grained material. The mitochondria were found to be predominantly rounded. Secretory granules completely filled the apical end of the cell and had a low electron density.

4. Conclusion

В заключение описываются результаты проведенного исследования. The results of our studies of the electron-microscopic structure of the borderless and goblet enterocytes of the intestinal crypts of the duodenum and jejunum allow us to assume approximately equal opportunities for the course of digestive processes in the mucous membranes of the duodenum and jejunum of the studied animals, with a slightly higher absorption activity of the jejunum in F₁ hybrids.

Thus, the hybrids acquire a favorable basis for the digestion type characteristic of ruminants and a broader adaptive capacity of the gastrointestinal tract in comparison with the original species. The data obtained by us is recommended to be used as a morphological substantiation of digestion processes in the development of optimal conditions for keeping and feeding such hybrids and their use to create new forms of productive livestock.

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