Patterns of changes in the activity of enzymes in the tissues of the jejunum in piglets in different phases of the postnatal period

M G Terentyeva*, R N Ivanova, G A Larionov and N V Mardaryeva

Federal State Budgetary Educational Institution of Higher Education, Chuvash State Agricultural Academy, 29 Karl Marx Street, Cheboksary 428003, Russian Federation

*E-mail: maiya-7777@mail.ru

Abstract. This paper describes the patterns of changes in the activity of transferases, phosphatases and α-amylase in the tissues of the jejunum in piglets in the colostrum, colostric-dairy, first, second and third dairy, dairy-vegetable, first and second plant phases of nutrition in the early postnatal period systemogenesis. Age-related changes in the activity of aspartate aminotransferase, alanine aminotransferase, γ-glutamyltransferase, α-amylase, alkaline and acid phosphatase in the tissues of the proximal, medial and distal parts of the jejunum in purebred piglets of large white breed grown in the conditions of the pig complex of OJSC "Vurnarsky meat-processing plant" in the Vurnarsky district of the Chuvash Republic were determined. The activity of enzymes is determined by the spectrophotometric method in the scientific laboratory of the FSBEI HE Chuvash State Agricultural Academy. The most pronounced changes in the activity of enzymes in the tissues of the jejunum, associated with changes in the main external food factor - the composition and quantity of feed components, are detected during the first four months of life of the piglets.

1. Introduction

The nature and intensity of postnatal changes in enzyme systems, which are indicators of the structural and chemical improvement of the tissues of internal organs, in each individual organ of the digestive system, or even in part of the organ of piglets, have their own specific features [1-7]. The development and structural and functional age-related changes in the tissues of the digestive organs in growing piglets are due to the genetic characteristics of pigs and precede changes in the composition and quantity of incoming feed, that is, the feeding phase of piglets.

In the postnatal period of development of the digestive system in pigs, in which the main, decisive factor in the structural and chemical development of the digestive organs is the feed components, we have identified the following feeding phases for piglets: colostrum, colostrum-milk (or the first transition phase), the first phase of the milk supply, the second phase of the milk supply and the third phase of the milk supply, the phase of the milk-definitive nutrition (or the second transition phase), the first phase of the definitive nutrition and the second phase of the definitive nutrition [8].

In the colostrum phase, the structure and functions of the digestive system are formed and prepared to ensure digestion and absorption of colostrum components into the blood. This phase lasts from the moment of birth to 5 days of the age of pigs. In the colostrum-milk phase, which lasts from 5 to 7 days of piglet life, the composition of the sow colostrum changes significantly: it reduces the content of
proteins, fats, increases the proportion of carbohydrates, water, minerals. Subsequently, during the transition to the first phase of dairy nutrition, from 8 to 14 days of piglet life, the structures of the digestive organs are reformed to the needs of digestion of new modified milk composition. In the second phase of dairy food, from 15 to 21 days of life, piglets begin to receive top dressing in the form of prestarter, which causes the formation of such structures in the digestive organs, which allow you to successfully assimilate and additional nutrients from the feed. In the third phase of milk nutrition, from 22 to 28 days of piglets' life, the amount of prestarter taken increases and in this regard, the structures involved in the processes of digestion and absorption of additional nutritional components of the feed are transformed. In the pig-breeding enterprise where research works were carried out, weaning of pigs was carried out from 29 days of age. Therefore, this age period, the piglets began the second transition, or milk definitive phase power supply, when the piglets weaned from 29 to 60 days age are transferred to complete feed. In the first phase of the definitive diet, from 61 to 120 days of age, in the pig complex in the main diet begin to add feed additives and significantly increase the amount of the main diet, which leads to increased activity of not only the digestive organs, but also all organs and systems of the body of pigs. In the second phase of the definitive nutrition, from 121 to 180 days of age of piglets, stabilized components and amount of feed, finally formed the structure and function of the digestive organs, and they become able to within the physiological norm of the reaction to digest and absorb a variety of food, having a wide range of functional systems.

The purpose of the research is to identify changes in the activity of aspartate aminotransferase (AsAT), alanine aminotransferase (AlAT), γ-glutamyltransferase (GGT), α-amylase, alkaline (ALP) and acid phosphatase (ACP) in the tissues of the jejunum of the small intestine in pigs in different postnatal phases. The study of phase changes in the activity of these enzymes allows us to judge about asynchronous age-related changes in the intensity of metabolic processes in the tissues of the jejunum in growing piglets. The activity of transferases reflects the intensity of protein metabolism in tissues, the level of α-amylase reflects the activity of amylolytic processes that provide the necessary energy to tissue of cells, the activity of phosphatases reflects the rate of exchange of organophosphorus compounds inside tissue cells [9-13].

2. Materials and methods
For research, purebred piglets of large white breed at the age of 1, 7, 14, 21, 28, 60, 120 and 180 days were used, five heads at each age, grown in conditions of the pig farm of Vurnarsky Meat Processing Plant OJSC, Vurnarsky district of the Chuvash Republic. In the work, boar pigs were used from a daily for two weeks of age, neutered at the age of 11-13 days. Weaning of pigs was carried out at the age of four weeks. In the pig complex dry concentrate type of feeding using feedings in the form of prestarters and protein-vitamin-mineral supplements.

Piglets euthanasia and all manipulations were performed with the "Rules of work with the use of experimental animals" [14]. The intestines of the small intestine were removed from the abdominal cavity, cleaned of the contents, washed with cold saline, divided into parts, and samples of their tissues were frozen in liquid nitrogen for further studies.

In the scientific laboratory of the FSBEI HE Chuvash State Agricultural Academy in the homogenates of jejunal tissues by spectrophotometric method (UV-1800) and using the reagent kit of JSC Vital Development Corporation St. Petersburg, enzyme activities were determined in accordance with the methods.

The activity of the enzymes AsAT and AlAT was determined by the method of Reitman and Frenkel. The principle of the method is photometric measurement of the content of pyruvate or oxaloacetate in the sample, based on their reaction with 2,4-dinitrophenylhydrazine, since they are formed as a result of transamination under the action of AsAT or AlAT. The amount of pyruvate or oxaloacetate formed per unit time is proportional to the activity of the enzyme.

The principle of the method for determining the activity of GGT is that, that γ-glutamyltransferase catalyzes the transfer of the γ-glutamyl group from the synthetic substrate L-γ-glutamyl-3-carboxy-4-nitroanilide to glycylglycine with the release of 5-amino-2-nitrobenzoate in the reaction medium. The
rate of formation of the colored reaction product of 5-amino-2-nitrobenzoate is determined by increasing the optical density of the reaction medium at a wavelength of 405 nm and is proportional to the activity of γ-glutamyl transferase.

The activity of α-amylase was measured by the method of Karavei. The principle of the method is to measure the intensity of the color reduction of the iodine-starch complex, as a result of the destruction of starch under the influence of α-amylase. The intensity of complex color reduction per unit time is proportional to the activity of the enzyme.

The level of Acid Phosphatase, Alkaline Phosphatase was determined by the Bessey-Lowry-Brock method.

The method is based on photometric measurement of the amount of p-nitrophenol formed per unit time, obtained as a result of the action of Acid Phosphatase or Alkaline Phosphatase on p-nitrophenyl phosphate and a proportional activity of the enzyme.

The calculation of the activity of enzymes was carried out according to the calibration schedule.

The degree of reliability of differences in mean values was determined using student's criterion. The significance levels p<0.05, p<0.01 and p<0.001 were separated for the reliability of judgments.

3. Results and discussion

After birth, during the first four days of life, pigs eat colostrum, being in the colostrum phase of nutrition. The structures and functions of food functional systems of the colostrum phase are genetically programmed to provide newborn piglets with the assimilation of colostrum components. According to our data (table 1), in this phase of feeding in one-day pigs, compared with other groups, in the tissues of different parts of the jejunum, the activity of the studied enzymes is not the same.

Table 1. Changes in enzyme activity in the tissues of the jejunum in piglets in different phases of postnatal ontogenesis.

| Age, day | 1   | 7   | 14  | 21  | 28  | 60  | 120 | 180 |
|----------|-----|-----|-----|-----|-----|-----|-----|-----|
| AAT µmol/g*h |     |     |     |     |     |     |     |     |
| Proximal | 30.9±1.01 | 52.5±3.16 | 18.8±1.37 | 21.8±1.65 | 19.8±0.93 | 27.2±1.11 | 29.6±1.44 | 49.1±2.33 |
| Medial   | 23.5±2.14 | 43.4±1.96 | 14.1±1.02 | 9.8±0.31  | 9.1±0.58  | 18.3±0.93 | 22.8±2.40 | 49.6±2.99 |
| Distal   | 8.4±0.34  | 15.8±1.24 | 12.7±0.33 | 14.6±0.88 | 11.9±0.77 | 16.5±1.13 | 18.3±2.21 | 46.7±1.66 |
| AsAT µmol/g*h |     |     |     |     |     |     |     |     |
| Proximal | 28.1±2.17 | 18.5±1.16 | 11.7±0.63 | 12.5±1.03 | 14.8±0.69 | 20.8±1.69 | 21.2±1.02 | 38.6±2.37 |
| Medial   | 27.6±1.97 | 25.9±2.32 | 12.6±0.34 | 12.8±0.61 | 13.3±0.66 | 32.6±2.94 | 28.9±1.51 | 36.8±2.09 |
| Distal   | 20.3±1.22 | 17.8±0.99 | 18.8±1.30 | 22.2±1.44 | 21.7±2.02 | 22.5±1.36 | 20.7±0.73 | 36.1±2.17 |
| γ-Glutamyltransferase µmol / g * h |     |     |     |     |     |     |     |     |
| Proximal | 294.8±5.23 | 399.4±8.77 | 383.1±7.67 | 228.5±5.51 | 361.9±8.89 | 390.1±5.77 | 277.2±4.11 | 498.0±8.02 |
| Medial   | 416.1±11.34 | 386.8±8.17 | 368.3±5.67 | 288.9±4.76 | 269.5±5.03 | 364.2±4.09 | 340.5±9.45 | 364.3±6.22 |
| Distal   | 124.3±3.67 | 115.7±4.09 | 222.1±5.01 | 280.3±4.94 | 305.4±5.56 | 432.7±10.22 | 467.8±9.91 | 658.1±14.05 |
| α-Amylase mg/(s*h) |     |     |     |     |     |     |     |     |
| Proximal | 0.239± 8 | 0.241± 8 | 0.297± 8 | 0.351± 8 | 0.356± 8 | 0.186± 8 | 0.314± 8 | 0.332± 8 |
| Medial   | 0.012± 8 | 0.009± 8 | 0.016± 8 | 0.012± 8 | 0.019± 8 | 0.013± 8 | 0.019± 8 | 0.027± 8 |
| Distal   | 0.110± 8 | 0.122± 8 | 0.316± 8 | 0.396± 8 | 0.392± 8 | 0.202± 8 | 0.291± 8 | 0.314± 8 |
| ALP µmol/g*h |     |     |     |     |     |     |     |     |
| Proximal | 348.9±12.4 | 331.4±17.6 | 186.4±9.6 | 139.7±7.7 | 36.4±2.8 | 194.6±11.5 | 230.3±12.5 | 253.2±13.8 |
| Medial   | 322.7±15.6 | 337.3±13.9 | 169.7±7.9 | 66.2±5.6  | 34.7±3.1  | 240.8±9.1  | 259.3±10.4 | 287.9±14.9 |
| Distal   | 279.1±11.2 | 270.6±10.4 | 174.8±8.3 | 78.8±4.5  | 85.1±6.8  | 221.2±10.7 | 234.8±13.9 | 216.3±11.4 |
| ACP µmol/g*h |     |     |     |     |     |     |     |     |
| Proximal | 3.6±0.16  | 3.5±0.11  | 17.4±1.7  | 27.9±2.1  | 25.9±1.6  | 3.4±0.19  | 3.6±0.21  | 4.7±0.16  |
| Medial   | 4.2±0.12  | 3.9±0.16  | 18.7±1.3  | 24.2±1.6  | 22.6±2.5  | 4.6±0.13  | 5.6±0.24  | 5.9±0.23  |
| Distal   | 4.6±0.18  | 3.4±0.13  | 21.7±2.2  | 22.7±2.7  | 25.1±1.9  | 4.3±0.14  | 4.8±0.17  | 5.8±0.22  |
In the tissues of the proximal part of the jejunum, the aspartate aminotransferase activity is 30.9±1.01, α-aminophosphatase activity is 28.1±2.17, and alkaline phosphatase activity is 348.9±12.4. The activity of γ-glutamyl transpeptidase (µmol/g*h) is 294.8±5.23, α-amylase (mg/(s*h)) is 0.239±0.012, and ACP activity is 3.6±0.16. In these tissues, the activity of α-amylase is relatively high. In the tissues of the proximal part of the jejunum, the aspartate aminotransferase activity is 23.5±2.14, α-aminophosphatase activity is 27.6±1.97, GGT activity is 416.1±11.34, and alkaline phosphatase activity is 322.7±15.6. The activity of α-amylase is 0.110±0.008, and ACP activity is 4.2±0.12. In the tissues of the proximal part of the jejunum, the activity of α-amylase is relatively low. In the tissues of the distal part of the jejunum, the activity of α-amylase is relatively low. In the tissues of the proximal part of the jejunum, the activity of α-amylase is relatively low. In the tissues of the distal part of the jejunum, in the colostrum phase of the feeding of pigs, compared with other phases of feeding, a relatively high activity of only ALP appears. In the tissues of the distal part of the jejunum, in the proximal part of the jejunum, in the tissues of the proximal part of the jejunum, the activity of α-amylase is relatively low.

Thus, in the colostrum feeding phase of piglets in the early postnatal period of pig systemogenesis, judging by the level of enzymes in the tissues of the proximal and medial parts of the jejunum compared with subsequent phases of nutrition, a relatively high activity of protein metabolism with a predominance of transamination processes associated with the activity of alanine aminotransferase and asparaginate aminotransferase, as well as a high rate of transfer of α-glutamyl group from one peptide or amino acid. Also, relatively high intensity of hydrolysis of phosphoric acid esters with alkaline phosphatase is revealed. However, the activity of amylolytic processes, providing the necessary energy to the cells of tissues, and the rate of exchange of organophosphorus compounds carried out with the help of acid phosphatase in the tissues of all three studied parts of the jejunum, is relatively low.

During the first 5-7 days of life of the piglets, in the first transitional, colostrum-milk phase of the early postnatal period of systemogenesis, the composition of the incoming food in the jejunum significantly changes the amount of organic components decreases, the share of water increases. The newly formed food functional system changes the structure and function of the tissues of this intestine in growing pigs adapts the intestine to the assimilation of new components of food, which affects the activity of the enzymes in the tissues of the studied parts of this intestine. In the tissues of the proximal part of the jejunum in seven-day-old piglets, in the colostrum-lactic phase of nutrition, the activity of α-amylase (µmol/g*h) and GGT (µmol/g*h) in comparison with other groups of piglets, the highest, respectively, is determined at 52.5±3.16, which is higher than the colostrum phase by 1.7 times, p≤0.001 and 399.4±8.77–1.4 times, p≤0.001. The activity of AsAT (µmol/g*h) below the colostrum by 34.2%, p≤0.01, decreases to 18.5±1.16. The activity of α-amylase (mg/(s*h)), alkaline phosphatase (µmol/g*h), and ACP (µmol/g*h) in this short supply phase does not significantly change, it corresponds to the level of the colostrum phase. In the tissues of the medial part of the jejunum in seven-day-old piglets, in the milk-feeding phase, the activity of GGT increases by 1.8 times, p≤0.001, to 43.4±1.96. The activity of AsAT, GGT, and ACP in this phase of feeding piglets in the tissues of the medial part of the jejunum changes insignificantly. In the tissues of the distal part of the jejunum in seven-day-old piglets, in the milk-feeding phase, the activity of AsAT increases 1.9 times, p≤0.001, to 15.8±1.64. The activity of AsAT, GGT, and ACP is maintained at the level of the colostrum.
of the jejunum and the intensity of the exchange orthophosphoric monoethers with the participation of acid phosphatase in comparison with the previous phase is low, and with the participation of alkaline phosphatase, high. In the tissues of the distal part of the jejunum there is a relatively high activity of protein metabolism associated with the processes of amino acid transamination. The processes of transfer of the g-glutamyl group from one peptide to another peptide or an amino acid, the processes of hydrolysis of starch and glycogen with the participation of α-amylase and the intensity of the exchange of orthophosphoric monoethers with the participation of acid phosphatase are low compared to the previous phase, and with the participation of alkaline phosphatase are high.

In the first phase of the milk feed, from 8 to 14 days of life, the piglets switch to maternal milk feed. At the same time, on the farm, at 8 days of age, the piglets are additionally fed to the prestarter according to the instructions for use. Under the conditions of the changed composition of the incoming food in the two-week-old piglets in the tissues of the proximal jejunum, the activity of AIAT (µmol/g*h) and AsAT (µmol/g*h) drops, respectively, by 64.2%, p≤0.001, to 18.8±0.49 and by 36.8%, p≤0.01, up to 11.7±0.63. The activity of GGT (µmol/g*h) and α-amylase in the first phase of the milk supply remains at the level of the previous phase. The activity of alkaline phosphatase (µmol/g*h) decreases significantly, by 43.8%, p≤0.001, to 186.4±9.6, and the activity of the ACP (µmol/g*h), on the contrary, increases 4.9 times, p≤0.001, to 17.4±1.7. In the first phase of dairy nutrition, in two-week-old piglets, in the tissues of the medial part of the jejunum, the activity of AIAT and AsAT, as well as in proximal tissues, decreases significantly, by 67.5%, p≤0.01, to 14.1±1.02 and by 51.4%, p≤0.001, up to 12.06±0.34. The activity of GGT in the first phase of milk nutrition in the tissues of the medial part remains at the level of the previous phase. α-Amylase (mg/(s*h)) activity significantly increases 2.6 times, p≤0.001, to 316.1±0.21, ALP activity decreases significantly, by 49.7%, p≤0.001, to 169.7±7.9, and ACP increases 4.8 times, p≤0.001, to 18.7±1.3. In the first phase of milk nutrition, in two-week-old piglets, in the tissues of the distal jejunum, the activity of AIAT, as well as in the tissues of other parts, decreases by 19.6%, p≤0.05, to 12.7±0.33. The activity of AsAT n α-amylase remains at the level of the transition phase. The activity of GGT and ACP significantly increases, respectively, by 1.9 times, p≤0.001, to 222.1±5.01 and 6.3 times, p≤0.001, to 21.7±2.2. The activity of alkaline phosphatase decreases significantly, by 35.4%, p≤0.001, up to 174.8±8.3.

Thus in the first phase of milk nutrition, in two-week piglets, in the tissues of the proximal part of the jejunum, relatively low activity of protein metabolism is revealed. However, the high rate of transfer of g-glutamyl group from one peptide to another peptide or amino acid remains. The rate of amylolytic processes involving α-amylase in comparison with the previous phase does not change. The intensity of the exchange of orthophosphoric monoethers, as in the tissues of other parts of the intestine increases. In the tissues of the medial part of the jejunum, the intensity of protein metabolism decreases, and the rate of transfer of g-glutamyl group from one peptide to another peptide or amino acid does not change. The rate of hydrolysis of starch and glycogen in the tissues of the medial jejunum is also maintained at the same level. The intensity of the exchange processes of orthophosphoric monoethers with alkaline phosphatase in comparison with the previous phase decreases, and with the participation of acid phosphatase increases. In the tissues of the distal part of the jejunum, the rate of proteolytic processes is low. The intensity of g-glutamyl group transfer from one peptide to another peptide or amino acid increases. The speed of the processes of hydrolysis of polysaccharides with the participation of the α-amylase does not change, the intensity of the exchange phosphonophoric monoethers with the participation of acid phosphatase in comparison with the previous phase increases, and with the participation of alkaline phosphatase – is reduced.

In the second phase of dairy feeding of piglets, from 15 to 21 daily age, the volume of incoming milk in the jejunum significantly increases. In terms of changes in the amount and composition of incoming food in three-week pigs, the character of phase age-related changes of AlAT (µmol/g*h) and AsAT (µmol/g*h) in the tissues of the proximal part of the jejunum, compared with the previous, first milk phase of the piglets, does not significantly change. The activity of GGT (µmol/g*h) during the next week of the life of the piglets in the tissues of the proximal part of the intestine drops significantly, by 50.4%, p≤0.001, to 228.5±5.51. The activity of α-amylase (mg/(s*h)) in this part of
the intestine will change insignificantly. The activity of alkaline phosphatase (µmol/g*h) decreases significantly, by 12.5%, p≤0.05, to 139.7±7.7. ACP (µmol/g*h) activity increases 1.7 times, p≤0.001, to 27.4±2.1. In the tissues of the medial part, the activity of AlAT, GGT and ALP decreases respectively by 30.5%, p≤0.01, to 9.8±0.31, by 37.9%, p≤0.001, to 288.9±4.76 and by 61.0%, p≤0.001, up to 66.2 ± 5.6. The activity of AsAT in this part of the jejunum in three-week-old piglets does not differ from the two-week-old piglets. The activity of α-amylase and ACP in this part of the intestine will change significantly, respectively, increases by 1.3 times, p≤0.05, to 0.396±0.017 and 1.3 times, p≤0.05, to 24.2 ±1.6. In the second phase of dairy nutrition, in three-week-old piglets, in the tissues of the distal jejunum, the activity of AlAT, AsAT and ACP is determined at the level of the first phase of the dairy diet. The activity of GGT and α-amylase in this part of the jejunum significantly increases, respectively, by 1.3 times, p≤0.001, to 280.3±4.94 and by 1.6 times, p≤0.001, to 0.294±0.011. The activity of alkaline phosphatase in the second phase of the milk supply in the tissues of the distal jejunum significantly, by 54.9%, p≤0.001, to 78.8±4.5, decreases.

Thus, in the second lactic phase of feeding of piglets of the early postnatal period of pig systemogenesis, it was found that in the tissues of the proximal, medial and distal parts of the jejunum in three-week piglets, a relatively low intensity of protein metabolism is determined due to a drop in the rate of amino acid transamination processes due to the reduced activity of alanine aminotransferase and aspartate aminotransfer and due to the reduced rate of transfer of g-glutamyl group from one peptide to another peptide or amino acid. The intensity of amylolytic processes in the tissues of all three studied parts of the jejunum in the second phase of feeding piglets significantly increases. The rate of hydrolysis of phosphoric monoethers with the elimination of the phosphate group in tissues of the jejunum in the second phase of the dairy supply piglets with the participation of alkaline phosphatase is reduced, and acid phosphatase, conversely, increases.

In the third phase of dairy feeding of piglets, from 22 to 28 days old, when the volume of incoming milk to the jejunum continues to increase significantly, the incoming milk with prestarter components is significantly enriched; in the tissues of the proximal jejunum, the phase-related change in the activity of AlAT (µmol/g*h) and AsAT (µmol/g*h) is not determined. GGT (µmol/g*h) activity increases 1.6 times, p≤0.001, to 361.9±8.89. The activity of α-amylase (mg/(s*h)) in this phase compared with the previous one does not change significantly. The activity of alkaline phosphatase (µmol/g*h) significantly decreases by 74.0%, p≤0.001, to 36.4±2.8, and the ACP (µmol/g*h) – remains at the same level. In the third phase of milk feeding of piglets in the tissues of the medial part of the intestine, a significant phase age-related change in the activity of AlAT, AsAT, GGT and α-amylase is not detected. The activity of alkaline phosphatase significantly decreases by 47.6%, p≤0.001, and the activity of ACP does not change. In the third phase of the milk supply to the piglets in the tissues of the distal jejunum, no significant phase age-related change in the activity of AlAT, AsAT, GGT, α-amylase and ACP is detected.

Thus, in the third milk phase in the tissues of the proximal part of the jejunum in four-week piglets, the activity of protein metabolism enzymes associated with amino acid transamination processes is maintained at the level of the second phase of milk nutrition. The rate of transfer of gamma-glutamyl residue from gamma-glutamyl peptide to amino acid or other peptide increases. However, the intensity of the hydrolysis of polysaccharides with α-amylase does not change. The rate of hydrolysis of orthophosphoric monoethers with cleavage of phosphate group with alkaline phosphatase significantly reduced, and with the participation of ACP – do not change. In the tissues of the medial part of the jejunum, the rate of amino acid transamination remains at the level of the second phase of milk nutrition. A significant phase change in the rate of hydrolysis of polysaccharides with α-amylase in this part of the intestine does not occur. The rate of hydrolysis of orthophosphoric monoethers with phosphate group cleavage involving alkaline phosphatase is significantly reduced, and with the participation of ACP is maintained at the previous level. In the tissues of the distal part of the jejunum in four weekly piglets in the third phase of milk nutrition, the rate of amino acid transamination remains at the level of the second phase of milk nutrition in connection with the preservation of the activity of AlAT and AsAT without age-related changes. The intensity of protein metabolism that is
associated with the transfer of the gamma-glutamic groups of gamma-glutamic transferase with the age of the piglets is also not changed. Noticeable phase changes in the rate of hydrolysis of polysaccharides involving α-amylase in this part of the intestine are not determined. The rate of hydrolysis of orthophosphoric monoethers with phosphate group cleavage involving alkaline and acid phosphatases remains at the previous level.

In the second transitional, dairy-definitive phase of feeding piglets, from 29 to 60 days old, when animals are transferred to the basic diet with the addition of dairy products and protein, vitamin and mineral supplements, the quantity and quality of incoming ingredients with food in the digestive organs significantly changes. The forming food functional systems change the structure and functions of the digestive organs, which is expressed by a change in the activity of enzyme systems in their tissues, including the enzymes we are studying. In the tissues of the proximal jejunum, the activity of AIAT (µmol/g*h), AsAT (µmol/g*h) and ALP (µmol/g*h) significantly increases, respectively, 1.4 times, p≤0.01, to 27.2±1.11, 1.4 times, p≤0.05, to 20.8±1.69 and 5.3 times, p≤0.001, up to 194.6±11.5. GGT (µmol/g*h) activity is maintained at the level of the previous phase. The activity of α-amylase (mg/s*h) and ACP (µmol/g*h) significantly decreases, respectively by 33.8%, p≤0.001, to 0.186 ± 0.013 and by 86.9%, p≤0.001, to 3.4 ± 0.29. In the milk-definitive phase of feeding piglets in the tissues of the medial jejunum, the activity of AIAT, AsAT, GGT and ALP significantly increases, respectively, 2.0 times, α-amylase to 18.3±0.93, 2.4 times, p ≤0.001, up to 32.6±2.94, 1.4 times, p=0.001, up to 364.2±4.09 and 6.9 times, p≤0.001, up to 240.8 ± 9.1. The activity of α-amylase and ACP in the milk-definitive nutritional phase of piglets in the tissues of the medial part of the jejunum significantly decreases by 48.5%, p≤0.001, up to 0.202 ± 0.019 and by 79.7%, p≤0.001, to 4, 6 ± 0.13. In the tissues of the distal part of the intestine in the second transition phase, the activity of AIAT significantly increases in 1.4 times, p≤0.05, to 16.5±1.13. Significant changes in the level of AsAT in this part of the jejunum is not detected. The activity of GGT and alkaline phosphatase significantly increases, respectively, 1.4 times, p≤0.001, to 432.7±10.22 and 2.6 times, p≤0.001, to 221.2±10.7. The activity of α-amylase and ACP in the milk-definitive nutritional phase of piglets in the tissues of the medial part of the jejunum significantly decreases, respectively, by 37.6% p≤0.001, to 0.189±0.011 and by 82.9%, p≤0.001, to 4.3±0.14.

Thus, the obtained data in the milk-definitive phase of piglets nutrition indicate that in the tissues of the proximal part of the jejunum in two-month piglets the activity of proteolytic processes associated with the transamination of amino acids with the participation of alanine aminotransferase and aspartate aminotransferase increases. However, the rate of transfer of gamma-glutamyl residue from gamma-glutamyl peptide to amino acid or other peptide remains at the level of the previous phase. The rate of hydrolysis of polysaccharides under the action of α-amylase decreases, and the intensity of hydrolysis of orthophosphoric monoethers with alkaline phosphatase increases, and with acid phosphatase – decreases. In the tissues of the medial part of the jejunum in two-month piglets, proteolytic processes associated with the transamination of amino acids and the transfer of gamma-glutamyl residue from gamma-glutamyl peptide to amino acid or other peptide are accelerated. The intensity of hydrolysis of polysaccharides with α-amylase in this part of the intestine is lower than in the previous age. The rate of hydrolysis processes phosphoric monoethers with elimination of the phosphate group with the participation of acid phosphatase are significantly reduced, and with the participation of alkaline phosphatase is increased. In the tissues of the distal part of the intestine the activity of the processes in transamination amino acids related to alanine aminotransferase activity was significantly increased. These processes involving serum glutamic oxalacetic transaminase do not change. The rate of transfer of gamma-glutamyl residue from gamma-glutamyl peptide to amino acid or other peptide increases significantly. The rate of hydrolysis of polysaccharides under the action of α-amylase decreases, and the intensity of hydrolysis of orthophosphoric monoethers with alkaline phosphatase increases, and with acid phosphatase – decreases.

In the first definitive nutritional phase of piglets, from 60 to 120 days old, when piglets are transferred to the main diet with the addition of protein, vitamin and mineral supplements, the quantity and quality of the incoming components from food to the digestive organs changes significantly.
Forming food functional systems adapt the structure and functions of the digestive organs to the peculiarities of the incoming feed, which is expressed by a change in the activity of enzyme systems in their tissues, including the enzymes studied by us. In the tissues of the proximal jejunum in four-month-old piglets compared with the previous age, the level of ALAT (µmol/g*h) and AsAT (µmol/g*h) does not change. GGT (µmol/g*h) activity is significantly reduced, by 29.0%, p≤0.001, to 277.2±4.11. The activity of α-amylase (mg/(s*h)) is increased by 1.7 times, p≤0.001, to 0.314±0.019. Significant age-related changes in alkaline phosphatase (µmol/g*h) and ACP (µmol/g*h) in the tissues of the proximal jejunum in four-month-old piglets are not detected. In the tissues of the medial part of the jejunum in four-month-old piglets, the activity of ALAT, AsAT, GGT, ALP and ACP do not differ from the values of the previous phase. Only α-amylase activity during the first definitive phase significantly increases in 1.4 times, p≤0.01, to 0.291±0.016. In the tissues of the distal jejunum, as well as in the medial tissues, in the milky-definitive nutritional phase of the pigs, the activity of ALAT, AsAT, GGT, ALP and ACP is maintained at the level of the previous phase, and only the activity of α-amylase during the first definitive phase is significant increases by 1.7 times, p≤0.001, to 0.315±0.015.

Thus, the results of the research in the first definitive phase power pigs indicate that in the tissues proximal, medial and distal parts of the jejunum from piglets four months of substantial changes in the processes of transamination, the transfer of gamma-glutamic balance gamma glutamic peptide to an amino acid or another peptide of the hydrolysis of phosphoric monoethers with the participation of alkaline and acidic phosphatase – does not occur. Only the activity of amylolytic processes involving α-amylase significantly increases.

During the next, in the second definitive phase of feeding of pigs, from 120 to 180 days of life in the early postnatal period of systemogenesis of pigs, in the tissues of the studied parts of the jejunum the level of enzymes of protein metabolism changes significantly. In the tissues of the proximal part, the activity of ALAT (µmol/g*h) increases by 1.7 times, p≤0.001, to 49.1±3.08, the activity of AsAT (µmol/g*h) – by 1.8 times, p≤0.001, to 38.6±2.37 and the activity of GGT (µmol/g*h) – 1.8 times, p≤0.001, up to 498.0±8.02. The activity of α-amylase (mg/(s*h)) in this part of the jejunum is stabilized from four months, the activity of alkaline phosphatase (µmol/g*h) and ACP (µmol/g*h) – from two months of age. In the tissues of the medial part of the jejunum, as in the proximal tissues, the level of amino acid transamination enzymes increases significantly: ALAT - 2.2 times, p≤0.001, up to 49.6±2.99 and AsAT activity - 1.3 times, p≤0.05, up to 36.8±2.09. GGT activity in the medial part of the jejunum is stabilized from two months of age. The activity of α-amylase in this part of the jejunum is stabilized from four months, the activity of alkaline phosphatase and ACP - from two months of age. In the tissues of the distal part of the jejunum, as in the tissues of other parts, the activity of ALAT increases by 2.6 times, p≤0.001, to 46.7±1.66, the activity of AsAT increases by 1.7 times, p≤0.001, to 36.1±2.17 and GGT activity 1.4 times, p≤0.001, up to 658.1±14.05. The activity of α-amylase in this part of the jejunum at a higher loss is stabilized from four months of age, the activity of ALP and ACP - from two months.

Thus, the results of studies in the second definitive phase of nutrition of the jejunum, in six-month piglets, indicate that the activity of proteolytic processes associated with the transamination of amino acids involving ALAT and AsAT and the transfer of gamma-glutamyl residue from gamma-glutamyl peptide to amino acid or another peptide in the tissues of all three studied parts of the jejunum increases. The rate of hydrolysis of polysaccharides under the action of α-amylase in the tissues of all three studied parts of the jejunum is stabilized from the age of four months of piglets. The intensity of hydrolysis of orthophosphoric monoethers with the participation of ALP and ACP in the tissues of the studied parts of the jejunum is stabilized from the age of two months.

Apparently, by the six-month age of pigs, judging by the phase changes in the activity of the studied enzymes of protein metabolism, structural and chemical improvement and structural and functional formation of the jejunum is not completed.
4. Conclusion
Thus, the stated results of our research indicate uneven and heterochronic age-related changes in the activity of enzyme systems in the tissues of each individual part of the jejunum in piglets. With a change in the quantity and quality of food supplied to them, phase changes in the activity of the transferases, phosphatases and amylases studied by us are revealed, indicating asynchronous age-related changes in the intensity of metabolic processes in the tissues of the digestive organs in growing pigs.

Analysis of the results shows that the most intense age-related changes in metabolic processes in the tissues of the jejunum in piglets are found between the dairy and first milk, between the first and second milk, between the third and milk-definitive, and between the first and second definitive phases. These gaps in piglet life may need to be called critical phases.

In the tissues of the jejunum, the activity of ALAT, AST, and GGT during the studied early postnatal systemogenesis is not stabilized. A-amylase activity in jejunal tissues is stabilized from the first definitive phase. The activity of alkaline phosphatase and ACP in the tissues of the jejunum is stabilized from the milk-definitive phase.

Thus, judging by the stabilization of the activity of the studied enzymes during the studied early postnatal systemogenesis, the structural and chemical formation of tissues and maturation of the food functional systems of the jejunum in pigs is not completed. That indicates the selective maturation of individual units of functional systems in accordance with the characteristics of animals [15-17].

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