# Correction of malsorption in dogs with allergic enteropathy with signs of disorders of the hepatobiliary and gastrointestinal systems

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**Abstract.** Correction of malsorption in dogs suffering from allergic enteropathy with signs of disorders of the hepatobiliary and gastrointestinal systems should be implemented based on the results of assessing the absorption function of the intestine, taking into account the nature of metabolic disorders. The purpose of this publication is to test the optimal algorithm for correcting malnutrition in dogs against the background of allergic enteropathy. The subjects of the study were medium-sized dogs with allergic enteropathy with signs of disorders of the hepatobiliary and gastrointestinal systems. During the research, clinical studies, data from qualitative stool analysis and D-xylose test were used. The use of the three-stage functional complex of dietary supplements developed by us based on prebiotic and probiotic components "GI-HB-3.1" allows us to restore the process of absorption of fats (fat loss - 3.96±0.31 g / day) and proteins (protein loss in 2 days before the study - 4.48±0.37 g / day; protein loss during the study - 1.65±0.15 g / day) in the small intestine of animals of the experimental group 1. It has been proven that the use of the three-stage functional complex "GI-HB-3.1" helps reduce the recurrence of allergic enteropathy in dogs, increase the absorption of nutrient substrates and stabilize the function of the gastrointestinal tract.

## 1 Introduction

Malsorption is a process of impaired absorption of digested foods by the intestinal mucosa, causing a disorder of the nutritional status in animals, contributes to the disruption of the endoecological balance of the intestinal microbiota, and which negatively affects the quality of life of patients with gastrointestinal pathology [1, 2, 3]. The mechanism of development of these processes in allergic enteropathy in dogs is due to insufficient intake of nutrient substrates, the development of disorders of the immune system, as well as immaturity of enzyme systems and intestinal dysbiosis against the background of sensitisation of the body [4-7].

Thus, a multimodal algorithm for the correction of malsorption in dogs with allergic enteropathy with signs of disorders of the hepatobiliary and gastrointestinal systems should be aimed at maintaining an optimal level of food intake by organizing additional nutritional

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support with easily digestible amino acids and correcting the population composition of the intestinal microbiome [8 - 15].

In particular, new knowledge in the field of developing a comprehensive algorithm for correcting malsorption in dogs with allergic enteropathy with signs of disorders of the hepatobiliary and gastrointestinal systems is of scientific and practical interest.

The purpose of the research is to develop and test a multimodal algorithm for the correction of malsorption in dogs with allergic enteropathy with signs of disorders of the hepatobiliary and gastrointestinal systems. The objectives of the research were to study the clinical status of animals, conduct a qualitative analysis of feces and D-xylose test, study the effect of the functional complexes "GI-HB-3.1" and "GI-HB-3.2" on the level of intestinal absorption function in experimental dogs, study the therapeutic effectiveness of the developed complexes.

## 2 Methods and equipment

Scientific research was carried out during 2020-2022 at the Don State Agrarian University (Persianovsky village) and at the Bely Klyk veterinary clinic (Novocherkassk) as part of a project on scientific research topics included in the plans of scientific work of scientific organizations and educational organizations of higher education , carrying out scientific research at the expense of the federal budget "Development of a comprehensive algorithm for the diagnosis and correction of disorders of the hepatobiliary and gastrointestinal systems in dogs with symptoms of malnutrition" (state registration number 122030200112-4).

The subjects of the study were 30 medium-sized dogs (poodle, sheltie, miniature schnauzer) aged from six months to two years. In order to carry out the experiment and evaluate the influence of the functional complexes "GI-HB-3.1" and "GI-HB-3.2" on the nutritional status, 30 animals with allergic enteropathy with severe gastrointestinal syndrome and damage to the hepatobiliary system, weighing bodies from 18.0 0.9 kg, from which two experimental groups were formed - experimental 1st and experimental 2nd, and one control group. Groups were formed as animals arrived at the veterinary clinic.

The criteria for inclusion of animals in the experimental groups were the results of a clinical study, ultrasonographic and laboratory signs of blood (hypochromic anemia, hypoproteinemia, dysproteinemia, hyperfermentemia, hyponatremia, hypocalcemia, hyperimmunoglobulinemia E) and feces (unformed, pasty, with a pungent odor, with admixtures of undigested food and neutral fat).

Exclusion criteria were gastritis, gastroduodenitis, enteritis, pancreatitis and liver pathologies of various etiologies.

Life history (anamnesis vitae): annual vaccination, treatment against exo- and endoparasites 3 times a year. Feeding is regular, twice a day, with a moderate calorie content.

History of the disease (anamnesis morbi): the first signs of the disease were recorded 4-5 days before contacting the veterinary clinic, and the presence of signs of pruritis, dry skin, tachycardia, tachycardia, low-grade fever and moderate asthenia was recorded. No appetite, diarrhea, severe repeated vomiting, dehydration. Food allergies to pork, eggs. There is no lactose intolerance, lactase deficiency, congenital galactosemia, glucose-galactose malabsorption syndrome.

Lactose intolerance, lactase deficiency, congenital galactosemia, and glucose-galactose malabsorption syndrome were not established in the experimental animals.

To study the nature of malabsorption in sick animals, a qualitative analysis of feces was carried out using the methods of fat excretion and Kjedahl combustion, and the D-xylose test was used to assess absorption in the small intestine and the integrity of its mucous membrane. The method of fat excretion in feces consisted of giving the animals a diet containing 100.0 g of fat, which was prescribed 2 days before the start of the study and during the collection

of feces. The feces were collected for 3 days, then the fat content in it was determined using standard methods. The absorption of total protein and protein nitrogen was assessed by the Kjedahl combustion method. For this purpose, sick dogs were given 120.0 g of protein two days before the experiment and during the study. To conduct the D-xylose test, sick dogs were given 5.0 g of D-xylose orally, and after two and five hours the urine was collected and the D-xylose content was determined using the Roe and Rice method.

Dogs in the experimental groups were prescribed a basic treatment regimen for allergic enteropathy [16].

Dogs of the experimental 1st group were given a three-stage functional complex "GI-HB-3.1" from the 3rd day of therapy, for 10 days [17].

Animals of the experimental 2nd group were prescribed orally, starting from the 3rd day of correction, a three-stage functional complex "GI-HB-3.2". The difference from the three-stage functional complex "GI-HB-3.1" [17] was a change in the formulation of the 1st phase of "enterosorption": Clinoptilolite zeolite - 3,000 g (zeolite: KlinoDetox, Slovakia), Saccharomyces boulardii CNCM I-745 lyophilisate - 150,000 mg ; fennel extract – 30,000 mg. The total dose of phase 1 was 3.180 g per animal.

In the formulation of phase 2 "hepato- and enteroprotection", the dosage of a number of components was changed: milk thistle dry extract – 44.00 mg; chamomile flower extract – 0.520 g; N-acetylcysteine – 220.00 mg; horse chestnut extract – 55.00 mg. The total dose of phase 2 was 6.295 g per animal. The three-stage functional complex was taken for 10 days.

In order to maintain the intestinal microbiota, animals in the control group were prescribed the drug FortyFlora (Purina, ProPlan, Switzerland), 1 sachet, orally, the course of use was 30 days.

The processing of the research results was carried out by the method of variational statistics using an integrated system for complex statistical analysis and data processing in the Windows STATISTICA system, using the Student's criterion according to the rules of variational statistics.

## 3 Results

As a result of clinical studies of experimental dogs, symptoms of moderate weakness of the body, anorexia, pruritis and dry skin were identified. In all dogs of the experimental 1 st group and the control group, seven animals from the 2 nd group, repeated vomiting was recorded (every 5-6 hours), lasting for 3 days, in 7 three dogs of the experimental 2 nd group, double vomiting was noted. The act of defecation in sick dogs was frequent, the feces were of a liquid consistency and had a pungent odor. The body temperature in dogs from group 1 was $39.50\pm0.200^0$ C, the respiratory rate was 39.10 ± 1.40 respiratory movements/minute, the pulse was 133.00±5.00 beats/minute, but in animals from the 2 nd group, the indicated indicators were respectively $39.30\pm0.400^0$ C, 40.70±1.90 respiratory movements / minute and 136.00±4.50 beats/minute, in the control group these indicators were $39.80\pm0.300^0$ C, 38.50±2.00 respiratory movements/minute and 135.50±3.00 beats/minute.

In dogs suffering from allergic enteropathy with signs of disorders of the hepatobiliary and gastrointestinal systems and malsorption phenomena, a disorder of the absorption function of the small intestine was observed, which was accompanied by a violation of fat absorption (fat loss - 6.01±0.52 g / day and 5.85±0.46 g / day, and 5.96±0.30 g / day) and proteins (protein loss 2 days before the study - 7.45±0.40 g / day and 7.30±0.67g / day, and 7.41±0.50 g / day; protein losses during the study - 2.51±0.18 g / day and 2.58±0.21g / day, and 2.46±0.10 g / day) (Table 1, Table 2, Table 3).At the same time, the absorption capacity of the jejunum and the distal part ofthe small intestine in experimental animals was within the reference values (excretion of D-xylose after 2 hours - 0.84±0.20 g / l and 0.79±0.15 g / l, and 0.80±0.16 g / l; excretion of D-xylose after 5 hours - 1.48±0.14 g / l and 1.46± 0.30 g

/ l, and 1.52±0.20 g / l).At the same time, the extreme elements of the variation series of the absorption function of the small intestine in dogs by groups were: fat loss (maxX - 6.53 g / day and 6.31 g / day, and 6.26 g / day; minX – 5.49 g / day and 5.39 g / day, and 5.66 g / day), protein loss 2 days before the study (maxX – 7.85 g / day and 7.97 g / day, and 7.91 g / day; minX – 7.05 g / day and 6.63 g / day, and 6.91 g / day), protein loss during the study (maxX – 2.69 g / day and 2.79 g / day, and 2.56 g / day; minX – 2.33 g / day and 2.37 g / day, and 2.36 g / day), excretion of D-xylose after 2 hours (maxX – 1.04g / l and 0.94 g / l, and 0.96 g / l; minX – 0.64 g / l and 0.64 g / l, and 0.64g / l), excretion of D-xylose after 5 hours (maxX – 1.62 g / l and 1.76 g /l, and 1.72 g / l; minX – 1.34 g / l and 1.16 g / l, and 1.32 g/ l).

**Table 1**. Dynamics of indicators of the absorption function of the small intestine during the correction of malabsorption in dogs of the 1st experimental group, patients with allergic enteropathy and signs of disorders of the hepatobiliary and gastrointestinal systems

| Indicators | Group of animals(n = 10) | | | | | |
|---|---|---|---|---|---|---|
| | Before the experiment | | | After the experiment | | |
| | X±Sx | maxX | minX | X±Sx | maxX | minX |
| Fat loss, g / day | 6.01±0.52 | 6.53 | 5.49 | 3.96±0.31** | 4.27 | 3.65 |
| Protein loss 2 days prior to study, g / day | 7.45±0.40 | 7.85 | 7.05 | 4.48±0.37*** | 4.85 | 4.11 |
| Protein loss during research, g / day | 2.51±0.18 | 2.69 | 2.33 | 1.65±0.15** | 1.80 | 1.50 |
| D-xylose excretion in 2 hours, g / l | 0.84±0.20 | 1.04 | 0.64 | 0.77±0.12 | 0.89 | 0.65 |
| D-xylose excretion in 5 hours, g / l | 1.48±0.14 | 1.62 | 1.34 | 1.30±0.10 | 1.40 | 1.20 |

Note: * P< 0.05; ** P< 0.01; *** P< 0.001 as compared to the indicator before the experiment

**Table 2.** Dynamics of indicators of the absorption function of the small intestine during the correction of malabsorption in dogs of the 2nd experimental group, patients with allergic enteropathy and signs of disorders of the hepatobiliary and gastrointestinal systems

| Indicators | Group of animals(n = 10) | | | | | |
|---|---|---|---|---|---|---|
| | Before the experiment | | | Before the experiment | | |
| | X±Sx | maxX | minX | X±Sx | maxX | minX |
| Fat loss, g / day | 5.85±0.46 | 6.31 | 5.39 | 4.10±0.35* | 4.45 | 3.75 |
| Protein loss 2 days prior to study, g / day | 7.30±0.67 | 7.97 | 6.63 | 4.69±0.42** | 5.11 | 4.27 |
| Protein loss during research, g / day | 2.58±0.21 | 2.79 | 2.37 | 1.81±0.10** | 1.91 | 1.71 |
| D-xylose excretion in 2 hours, g / l | 0.79±0.15 | 0.94 | 0.64 | 0.76±0.17 | 0.93 | 0.59 |
| D-xylose excretion in 5 hours, g / l | 1.46±0.30 | 1.76 | 1.16 | 1.38±0.19 | 1.57 | 1.19 |

Note: * P< 0.05; ** P< 0.01; *** P< 0.001 as compared to the indicator before the experiment

**Table 3.** Dynamics of indicators of the absorption function of the small intestine during the correction of malabsorption in dogs of the control group, patients with allergic enteropathy and signs of disorders of the hepatobiliary and gastrointestinal systems

| Indicators | Group of animals(n = 10) | | | | | |
|---|---|---|---|---|---|---|
| | Before the experiment | | | Before the experiment | | |
| | X±Sx | maxX | minX | X±Sx | maxX | minX |
| | 5,96±0,30 | 6,26 | 5,66 | 4,90±0,20* | 5,10 | 4,70 |
| Fat loss, g / day | 7,41±0,50 | 7,91 | 6,91 | 5,20±0,56* | 5,76 | 4,64 |
| Protein loss 2 days prior to study, g / day | 2,46±0,10 | 2,56 | 2,36 | 2,12±0,14 | 2,26 | 1,98 |
| Protein loss during research, g / day | 0,80±0,16 | 0,96 | 0,64 | 0,84±0,11 | 0,95 | 0,73 |
| D-xylose excretion in 2 hours, g / l | 1,52±0,20 | 1,72 | 1,32 | 1,48±0,30 | 1,78 | 1,18 |

Note: * P< 0.05; ** P< 0.01; *** P< 0.001 as compared to the indicator before the experiment

After correction of malsorption and functional disorders of the hepatobiliary and gastrointestinal systems in dogs of all groups, optimisation of the processes of absorption of the main nutrient substrates in the small intestine was noted. At the same time, dogs showed a significant decrease in fat loss with excrement to 3.96±0.31 g/day in the experimental 1st group, to 4.10±0.35 g /day in the experimental 2nd group and to 4.90±0.20 g/day in the control group, while the indicator of the experimental 1st group was lower than the same indicator of the experimental 2ndgroup by 3.41%, and the control group by 19.18% (Table 1, Table 2, Table 3).After the experiment, reliable optimization of protein absorption processes in the small intestine was recorded in animals of the experimental 1st and experimental 2nd groups, which was accompanied by a decrease in protein losses (protein losses 2 days before the study were 4.48±0.37 g/day and 4.69±0.42 g/ day; protein losses during the study were 1.65±0.15g/day and 1.81±0.10 g/day), whereas in the control group only the level of protein losses significantly changed 2 days before the study (5.20±0.56 g/day).Extreme elements of the variation series of the absorption function of the small intestine in dogs by groups were presented as follows: fat loss (maxX – 4.27 g/day and 4.45 g/day, and 5.10g/ day; minX – 3.65g/day and 3.75 g /day, and 4.70g / day), protein loss for 2 days before the study (maxX – 4.85g/day and 5.11g/day, and 5.76 g/day; minX – 4.11 g /day and 4.27 g /day, and 4.64 g / day), protein losses during the study (maxX – 1.80 g /day and 1.91g / day, and 2.26 g /day; minX – 1.50 g /day and 1.71 g / day, and 1.98 g / day), excretion of D-xylose after 2 hours (maxX – 0.89 g / l and 0.93 g /l, and 0.95 g / l; minX – 0.65 g / l and 0.59 g /l, and 0.73 g /l), excretion of D-xylose after 5 hours (maxX – 1.40 g /l and 1.57 g/l, and 1.78 g/l; minX – 1.20 g/l and 1.19 g/l, and 1.18 g/l).

After the experiment, the experimental animals showed a restoration of eating behavior and defecation, and the feces had a dense consistency. Body temperature, pulse and respiration values were within the reference interval. The dynamics of clinical changes in animals from the experimental 1st group were characterized by a gradual weakening of gastrointestinal syndrome and malsorption phenomena, starting from the 5th day of correction, and remission occurred on the 15th day of treatment, while in the experimental 2nd group there was an improvement in the clinical status of dogs was registered on the 7th day, and remission occurred only on the 18th day, and in the control group, similar changes were noted on the 12th day, and remission only on the 21th day.

## 4 Discussion

The development of malsorption in dogs with allergic enteropathy and signs of functional disorders of the hepatobiliary and gastrointestinal systems was accompanied by signs of tachycardia, tachypnea, subfebrile fever, moderate weakness of the body, eating disorders and defecation, pruritis, and skin dryness.

After the experiment, the complete disappearance of signs of malsorption and functional disorders of the hepatobiliary and gastrointestinal systems was recorded, which was manifested by the restoration of metabolic processes and the functional state of the gastrointestinal tract, and was characterized by a decrease in the loss of fat and protein with feces due to the influence of the components of a three-stage functional complex of dietary supplements "GI-HB-3.1". Thus, correction of malnutrition syndrome and functional disorders of the hepatobiliary and gastrointestinal systems in dogs with allergic enteropathy should be multimodal, based on additional nutritional support and implemented taking into account the nature of the markers of malnutrition.

## 5 Conclusion

Malnutrition syndrome in dogs with allergic enteropathy is characterized by impaired absorption function of the small intestine without disrupting the functional activity of the jejunum and distal intestine. Thus, the targeted strategy for diagnostic studies and correction for allergic enteropathy in dogs should be carried out taking into account the nature of nutritional disorders, which will increase the therapeutic effectiveness of the drugs used and limit the potential clinical harm of polypharmacy associated with the involvement of not only the gastrointestinal but hepatobiliary systems in the pathological process. The results obtained in this study confirm the fact that due to the use of phase 1 of the three-stage functional complex “GI-HB-3.1”, signs of diarrhea were eliminated and allergens were eliminated from the gastrointestinal tract. The combined influence of phases 1 and 2 allows you to optimize the functional activity of the liver and gastroenteral system. The components of phase 3 contribute to the restoration of the intestinal eubiome, limiting the processes of fermentation and decay, which gives grounds to talk about the restoration of the trophological status in animals.

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