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THE EXOCRINE PANCREATIC FUNCTION IN CHICKEN (*Gallus gallus* L.) FED DIETS SUPPLEMENTED WITH DIFFERENT VEGETABLE OILS

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Abstract

The efficiency of different vegetable oils in poultry nutrition is still a matter of interest for the theory and practice; numerous studies in broilers have evidenced that different oils can significantly affect the productive performance and metabolism. However, the mechanism of the influence of different oils on the exocrine pancreatic function is understudied. In our study on fistulated chicken the innovative data are presented for the analysis of the effects of different dietary lipid sources on the secretion and enzymatic activities of pancreatic juice. The study was performed in 2019 on three laying hens (*Gallus gallus* L., cross Hisex White) with chronic fistulae of main pancreatic duct inserted by the method of Ts.Zh. Batoev (2001). The physiological trials were performed by the method of periods (7-10 days per period): during the control period the basic feed (commercial compound feed for layers PK-1) was supplemented with sunflower oil; during period 1 with soybean oil; during period 2 rapeseed oil; during period 3 flaxseed oil. The pancreatic juice and blood were sampled throughout these periods. The secretion rate of pancreatic juice and enzymatic activities in it (amylase, lipase, total proteases TP, alkaline phosphatase AP) were determined by standard methods. The activities of amylase, lipase, alanine (ALT) and aspartate (AST) transaminases in blood serum were determined on analyzer ChemWell 2900 (T) (Awareness Technology, USA) with corresponding reagent kits by Human GmbH, Germany; the activities of TP and AP and other biochemical indices in blood serum were determined on semi-automatic analyzer Sinnowa BS-3000P (SINNOWA Medical Science & Technology Co., China) with BAPNA as the substrate (TP) and corresponding reagent kits by DIAKON-VET, Russia (AP and all other indices). It was found that the activity of lipase in pancreatic juice can adjust to the dietary oil used. The significantly highest lipase activity was found with unrefined sunflower oil (21345±652.8 $\mu mol \cdot l^{-1} \cdot min^{-1}$, $p < 0.05$), together with the increases in the activity of amylase (9254±440.3 $mg \cdot ml^{-1} \cdot min^{-1}$, $p < 0.05$). The increases in lipolytic activity in the first few postprandial minutes (corresponding to complex-reflex phase of regulation of the pancreatic secretion) with sunflower and flaxseed oils evidenced that these oils are the most palatable for chicken while the increase in the activity of lipase in neurohumoral phase of regulation with rapeseed and soybean oils evidenced their higher nutritive value. The strong negative correlation ($r = -0.87$, $p < 0.05$) was also found between the activities of TP and AP in the pancreatic juice. The phosphatase-protease index, AP/TP ratio, is proposed as a significant physiological indicator of the adaptation of the digestive tract in poultry to the changes in diet composition. The most affected by oil type blood indices were the activities of TP, lipase, ALT, AST, and concentration of triglycerides. The dynamics of lipase activity in blood serum was similar to that in the pancreatic juice; the AP/TP ratio in serum was partially close to the values of this ratio in the pancreatic juice. The changes found in the exocrine pancreatic function in response to different dietary oils evidenced that the studies on the digestion should be continued for further optimization of the composition of commercial diets for poultry.

Keywords: exocrine pancreatic function, chickens, digestive enzymes in blood, sunflower oil, soybean oil, rapeseed oil, flaxseed oil

Issues of adaptation of the digestive glands of animals to different diets still remain discussible and relevant both for fundamental research and for the practice of poultry rearing. Experiments on birds established that gastric secretion and exocrine pancreatic function adapt to the chemical composition of food [1, 2]. In poultry farming, the use of vegetable oils in feeding is of considerable interest. Experiments on broilers [3, 4] indicate the advantage of soybean, camelina, and flaxseed oils compared to sunflower oils. Replacing sunflower oil with other oils, ensure an increase in live weight, a decrease in feed costs per unit of production, better meat quality and higher profitability. There is a viewpoint [5] that dietary sunflower oil improves poultry development and feed conversion compared to olive oil.

Compound feeds with rapeseed oil are not inferior in efficiency to those with sunflower oil [6]. According to some research, the positive effect of dietary rapeseed oil is expressed in an increase in the content of polyunsaturated fatty acids in the meat of broiler chickens [7]. Rapeseed oil is superior to palm oil as a source of lipids due to higher concentration of digestible fatty acids. In the meat of chickens fed with rapeseed oil, oleic acid predominated [8].

It is known [9] that digestion and absorption of various fats differ depending on a lipid composition. A correlation was shown between the lipid profile of blood serum and the composition of fatty acids supplied in diet and metabolized in the body. This allowed the authors to suggest that the lipid composition of the diet can modulate digestion and absorption in the gastrointestinal canal [9].

A comparative study on sheep have shown that dietary rapeseed and flaxseed oils affect the activity of pancreatic enzymes. The secretion of bile and pancreatic juice tended to increase in sheep fed rapeseed and flaxseed oil (69.5 and 68.5 ml/h, respectively) as compared to control (59.8 ml/h); lipase and trypsin activity was also higher compared to the control diet, 175 and 21.6 U/l and 179 and 23.2 U/l, respectively, vs. 128 and 13.1 U/l, respectively [10].

Thus, data on the effect of different vegetable oils on poultry productivity are controversial, and no information is available on the mechanisms of action of these nutrients on the digestive system.

This paper is the first to show for the first time that dietary unrefined sunflower oil, as compared to soybean, rapeseed or flaxseed oil, significantly increases the lipolytic and amylolytic activity of pancreatic juice, changes the phosphatase-protease index and blood plasma biochemical profile which is consistent with indicators of the secretory function of the pancreas.

The work aimed to examine effects of various vegetable oils on the secretory function of the pancreas and blood biochemical parameters in laying hens.

Materials and methods. Three 28-46-week old Hisex White chickens (*Gallus gallus domesticus* L.) were fistulated according to the method of C.Zh. Batoev and S.Ts. Batoeva [2, 11]. A 4-5 cm segment was cut out of the duodenum, into which the main pancreatic duct was transplanted with the implantation of two L-shaped fistulas. An external anastomosis was formed, allowing the return of pancreatic juice to the duodenum in the periods between feed trials. Chickens' feeding and keeping were in compliance with requirements for the cross [12] (the vivarium of FSC VNITIP RAS, 2019). Physiological experiment began in the morning on an empty stomach of birds after 14-16 hours of fasting. The chickens were placed in a special facility, in which they were kept for 3 hours. A microtube for collecting pancreatic juice was attached to the fistula from an isolated section via a special rubber adapter. In the first 30 minutes, the juice was collected after starvation, then the birds were given 30 g of compound feed and collection of the juice continued in every 30 minutes. The treatments were as follows: basal diet according to the norms for the cross (BD, compound feed PK-1, Russia) [12] + 2.6% soybean oil (experiment 1), BD + 2.6% rapeseed oil (experiment 2) and BD+ 2.6% linseed oil (experiment 3); BD + 2.6% sunflower oil (control). Feeding trials were designed in periods (7-10-day control period, 2-3-day transition period, 7-10-day test period). Each series of experiments was repeated thrice the least.

Amylase activity was determined by modified Smith-Roe assay for high amylolytic activity [2], proteolytic activity was quantified by hydrolysis of Hammerstein Grade Casein with colorimetry (λ = 450 nm) [2], lipase activity was measured using a semi-automatic biochemical analyzer Sinnowa BS3000P (SINNOWA Medical Science & Technology Co., Ltd, China) with a kit of diagnostic reagents for blood lipase quantification in animals (DIAKON-VET, Russia).

Blood (2-3 ml) was sampled from hen's axillary vein after fasting for 14 hours using sodium citrate as an anticoagulant and centrifuged at 5000 rpm for 5 min.

In the blood plasma, the activity of digestive enzymes trypsin, amylase and lipase was measured. Nα-benzoyl-DL-arginine-p-nitroanilide (BAPNA, ACROS ORGANICS, Switzerland) was a substrate for trypsin, the activity was determined with a Sinnowa BS3000P semi-automatic biochemical analyzer (China) by kinetic method [13]. To determine the activity of blood amylase and lipase, an automated biochemical analyzer Chem well 2900 (T) (USA) was used with the requisite reagent kit (Human GmbH, Germany).

JMP Trial 14.1.0 software (https://www.jmp.com/en_us/home.html) was used for statistical processing, the mean values (*M*), standard deviations (±SD), and Pearson's (*r*) correlation coefficients were calculated. The significance of the differences was confirmed by the Student's *t*-test, the differences were deemed statistically significant at $p < 0.05$.

Results. In-deep insight of the exocrine function of the pancreas is associated with the experimental surgery methods developed by academician I.P. Pavlov [14]. In 1904 I.P. Pavlov was awarded the Nobel Prize for his "work on the physiology of digestion" which proposed a surgery method to isolate part of the stomach (ventricle) retaining the same innervation as the main stomach. This technique allows physiological phenomena to be studied on objects that are in a state of physiological norm. Another discovery of I.P. Pavlova is chronic experiments with surgically prepared animals with chronic fistulas or gastric pouches to abandon acute experiments by the end of which, as a rule, the animals died.

Fig. 1. Hisex White hens (*Gallus gallus domesticus* L.) with a chronic fistula of the pancreatic duct: feeding trial of the effects of vegetable oils on digestion (the vivarium of FSC VNITIP RAS, 2019).

The feeding trials we performed used chickens with a chronic fistula of the pancreatic duct [2], from which we obtained secretions during feeding test for 180 min, and the rest of the time, connecting the cannulas with a rubber adapter, send secretions to the intestine (Fig. 1). This method, in our opinion, is best suited for studying the effect of different vegetable oils on digestion. The pancreas is very sensitive to the diet composition, thence performing tests on a healthy organism allows researchers to more accurately trace adaptation to a new dietary ingredient and the most completely disclose its mechanisms.

Nowadays, one of the challenge of poultry farming is the need to replace some ingredients of the diet with cheaper components, however, little is known about their effect on the poultry body, and for some potential additives the problem is not studied at all. Along with protein sources [15], these components include vegetable oils.

We compared the effects of sunflower, soybean, rapeseed and unrefined linseed oils on the exocrine function of the chicken pancreas. The results show that the exocrine function of the laying hens adapts to each of the added vegetable oils (Table 1).

1. **Exocrine pancreatic function of Hisex White laying hens (*Gallus gallus domesticus* L.) fed basal diet** (BD) **supplemented with various vegetable oils** (M±SD, n = 9, the vivarium of FSC VNITIP RAS, 2019)

Parameter	Control	Test 1	Test 2	Test 3
Amount of pancreatic juice for 180 min of experiment, ml	3.5±0.13	3.8±0.13	3.5±0.14	3.4±0.16
Activity per 1 ml of pancreatic juice:				
amylase, mg/(m · min)	9254±440.3	6531±381.4*	6014±467.7*	7685±376.8*
lipase, μmol/(l · min)	21345±652.8	12347±594.8*	9048±486.4*	17264±1000.2*
proteases, mg/(ml · min)	391±16.0	400±14.2	401±18.4	415±23.5
Total activity for 180 min:				
amylase, mg/(m · min)	34878±2347.3	26210±1882.9*	23652±2424.2*	25847±1221.4*
lipase, μmol/(l · min)	78435±6174.7	49959±2787.3*	32370±2956.5*	58148±2882.9*
proteases, mg/(ml · min)	1475±79.8	1528±62.8	1386±49.3	1354±69.8
trypsin, U/l	5709±233.6	5840±204.4	5855±268.6	6059±343.1
alkaline phosphatase, U/l	5707±321.5	12159±566.0*	3961±188.1*	10791±423.6*
Index ALP/proteases	1.0	2.1	0.7	1.8

Note. Control — BD + 2.6 % sunflower oil, test 1 — BD + 2.6% soybean oil, test 2 — BD + 2.6% rapeseed oil, test 3 — BD + 2.6% linseed oil; ALP — alkaline phosphatase.
* Differences between the control and test periods are statistically significant at $p < 0.05$.

The obtained results (see Table 1) showed that different dietary vegetable oils do not change significantly the amount of pancreatic juice in the laying hens. The lipolytic activity is the greatest in the control period when using sunflower oil. Replacement of sunflower oil with soybean oil leads to a 42.2% decrease ($p < 0.05$) in the lipase activity. Rapeseed oil reduces the lipase activity by 57.6% compared to control ($p < 0.05$), linseed oil by 19.1% ($p < 0.05$). Consequently, the lipase activity is adapted to the dietary vegetable oil used. The amylase activity also changes depending on the type of oil, with the highest level for sunflower oil. Soybean oil decreases amylolytic activity per 1 ml of pancreatic juice by 31.6% compared to control ($p < 0.05$), rapeseed oil by 35.1% ($p < 0.05$), linseed oil by 17.0% ($p < 0.05$). Note synchronous changes of amylolytic and lipolytic activity when a certain oil is added to the feed. The lowest amylase and lipase activities occur in response to rapeseed oil, then soybean, linseed and sunflower oil are ranked with a sequential increase. There is no unambiguous answer to the question why rapeseed oil has such a low stimulation towards pancreatic enzymes, but, apparently, this is due to the presence of a large number of unsaturated fatty acids (Table 2), and mainly oleic acid. For rapeseed oil, the quantitative ratio of the unsaturated + polyunsaturated fatty acids to saturated fatty acids is 11:1, whereas it is 8:1 for sunflower oil, 5:1 for soybean oil, and 9:1 for linseed oil (see Table 2).

2. **Fatty acid composition of vegetable oils used in the feeding trial** (the vivarium of FSC VNITIP RAS, 2019)

Fatty acid	Sunflower	Soybean	Rapeseed	Flaxseed
Oil	0.01	0.01	0.01	0.01
Caprylic	0.02	–	–	–
Capric	–	–	0.01	–
Lauric	–	–	0.01	–
Tridecanoic	–	0.02	–	–
Myristic	0.06	0.06	0.05	0.03
Pentadecane	0.03	0.03	0.04	0.04

Continued Table 2

Palmitic	6.24	11.14	4.73	5.68
Palmitoleic	0.08	0.09	0.10	0.02
Heptadecanoic (margarine)	0.03	0.07	0.04	0.05
Margarolevaya	0.02	0.05	0.05	0.03
Stearic	3.70	3.90	2.13	4.14
Oleinovaya	31.06	29.41	66.50	14.44
Elaidinic	0.61	1.03	–	–
Linoleic	56.81	47.79	17.62	16.99
α-Linolenic	0.04	5.08	6.57	58.14
Arachinic	0.26	0.45	0.62	0.15
Eicosenic (gondoinic)	0.20	0.34	1.00	0.06
Eicozoic	–	0.03	0.08	0.03
Arachidonic	–	–	–	0.04
Behenic	0.65	0.38	0.29	0.08
Tetracosan (lignocerol)	0.20	0.13	0.09	0.07
Nervonic	–	–	0.06	–
Total saturated fatty acids	11.18	16.21	8.10	10.28
Total unsaturated fatty acids	31.97	30.92	67.71	14.55
Polyunsaturated fatty acids:				
total	56.85	52.87	24.19	75.17
ω-3	0.04	5.08	6.57	58.14
ω-6	56.81	47.79	17.62	17.03

N o t e. The assay was carried out according to GOST 30418 "Vegetable oils. Method for determination of fatty acid composition" at the Testing laboratory center VNIIPP (Rzhavki, Moscow Province). The values for acid peaks are indicated as a percentage of the total peak area of all fatty acids. Dashes indicate the absence of the corresponding fatty acid.

The tests have shown that the proteolytic activity of the pancreatic juice does not change significantly upon replacing dietary vegetable oils. The activity of alkaline phosphatase adapts to various oils, as a result, the phosphatase-protease ratio (ALP/protease index) increases 2.1-fold when replacing sunflower oil with soybean oil, and 1.8-fold for linseed oil. For rapeseed oil, the index is almost as much as for the control period, comprising 0.7. The ALP/protease index was calculated because in our previous work we revealed strong inverse correlation between these indicators ($r = -0.87$; $p < 0.05$) [16].

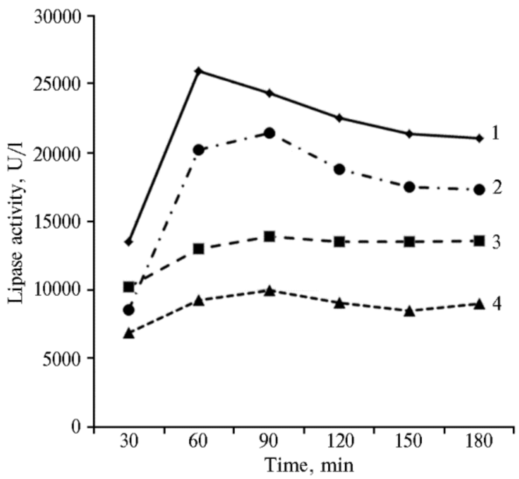

Fig. 2. Dynamics of changing lipase activity in pancreatic juice of Hisex White laying hens (*Gallus gallus domesticus* L.) fed basal diet (BD) **supplemented with various vegetable oils**: 1 — sunflower oil, 2 — linseed oil, 3 — soybean oil, 4 — rapeseed oil; basal level corresponds to the value at the 30th minute (prior to feeding) (M±SD, $n = 9$, the vivarium of FSC VNITIP RAS, 2019).

Chemical composition of oils was consistent with that reported, where it is indicated that rapeseed oil has the highest oleic acid content among fatty acids [17]. It is known [18] that the ω-6 to ω-3 acid ratio affects fat deposition in broilers. The optimal ω-6 to ω-3 ratio of 3:1 is typical for rapeseed oil, sunflower oil has a very high ratio of 1420:1, the ratio for soybean oil is 9:1, while linseed oil, on the contrary, contains a 5-fold excess of ω-3 acids over to ω-6 acids.

For a better insight into the effects of vegetable oils on exocrine pancreatic function, the dynamics of lipase activity should be evaluated after feed intake (Fig. 2). The tests showed that the basal activity was the lowest for rapeseed oil. That is, the oil obtained from cold-pressed rapeseed does not have a strong stimulating effect on the exocrine pancreatic function. The feed containing rapeseed oil increases the enzyme secretion

1.4-fold during the postprandial phase for 60 minutes, and then the activity remains approximately at the same level until the end of the test (180 minutes). The curve showing the dynamics of lipase activity when soybean oil is used in feed looks similar. It is possible that such a response of the exocrine pancreatic function is due to oil emulsions formed in the alimentary canal, since in ducks, for example, the type of fat and emulsifiers has a positive effect on lipid metabolism [19].

In contrast to these graphs, linseed oil caused a sharp increase in lipase activity during the complex reflex phase of pancreatic regulation. The activity of the enzyme during the first 60 minutes after feeding increases 2.5 times, decreasing further 1.2 times in the neurochemical phase as compared to the maximum level. The observed effect, apparently, is due to the fact that linseed oil has a bitter taste and smells like fish oil (fish meal). This causes a reflex response of the feeding center in the brain to impulses generated by receptors in the oral cavity, which contributes to increased appetite. In 60 minutes after feeding, when the contents of the stomach enter the intestine in small portions, a more detailed discrimination of the quality of nutrients occurs, and the duodenum reacts by releasing hormones (secretin, cholecystokinin) more restrainedly than the oral cavity receptors.

The curve of lipase release in response to the consumption of sunflower oil has a sharp rise in the first 30 min of the postprandial phase, when the enzyme activity increases 1.9 times compared to the basal level ($p < 0.05$). Then a decline in lipase activity is observed, which is apparently due to the presence of a lipase inhibitor in sunflower oil [20] and no stimulating effect in the neurochemical regulation of pancreatic secretion.

Blood biochemistry reflects the metabolic state of an animal [21]; therefore, it is unlikely that changes in the exocrine pancreatic function of laying hens would not affect the blood biochemical parameters (Table 3).

3. Biochemical parameters Биохимические показатели крови у кур-несушек (*Gallus gallus domesticus* L.) породы Hisex White при добавлении в базовый рацион разных растительных масел (*M*±SD, *n* = 10; виварий ФНЦ ВНИТИП РАН, 2019 год)

Parameter	Basal diet + 2.6% oil			
	sunflower	soybean	rapeseed	linseed
Trypsin, U/l	89±11.3	164±20.3*	167±11.5*	84±7.0
Amylase, U/l	336±51.3	319±29.5	341±30.1	394±27.6
Lipase, U/l	43±2.3	25±1.1*	22±1.4*	37±2.0
ALT, U/l	18±5.3	8±0.9*	7±0.9*	5±0.9*
AST, U/l	129±6.0	153±7.2*	140±9.2	145±14.1
De Ritis ratio	7.2	19.1	20.0	29.0
Total protein, g/l	35±1.3	40±1.9	39±1.3	34±0.7
Triglycerides, mmol/l	2.3±0.30	5.3±0.64*	4.9±0.36*	2.8±0.17
Cholesterol, mmol/l	1.9±0.16	2.4±0.21	2.2±0.22	2.2±0.16
Alkaline phosphatase, U/l	2056±253.5	3040±439.5	2514±638.5	2701±178.1
Index ALP/trypsin	23.1	18.5	15.0	32.1

N o t e. ALT — alanine aminotransferase, AST — aspartate aminotransferase, ALP — alkaline phosphatase.
* Differences between the control and test periods are statistically significant at $p < 0.05$.

The blood trypsin activity was maximum for soybean and rapeseed oils, exceeding the control level (for sunflower oil) by 84.3 and 87.6%, respectively ($p < 0.05$) and corresponded to the control in the case of linseed oil treatment. It should be noted that the trypsin activity when using soybean and rapeseed oil is at the upper limit of the physiological norm for laying hens [13], which may be caused by anti-nutritional factors (trypsin inhibitor) in these oils [20]. We did not note significant differences in the blood amylase activity of the hens. The blood lipase activity was is the highest upon treatment with sunflower oil, which is consistent with the state of exocrine pancreatic function responding to the sunflower oil consumption. The activity of lipase decreased by 41.9% ($p < 0.05$) for soybean oil, by

48.8% ($p < 0.05$) for rapeseed oil, and by 14.0% ($p < 0.05$) for linseed oil. That is, the change in the blood lipase activity follows the dynamics of the enzyme activity in pancreatic juice. Conjugated modulation of the activity of duodenal lipase and blood lipase was observed when bile acids were added to broiler diet [22], which is consistent with our findings. The activity of aminotransferases also indicates the dependance on the dietary lipid component (see Table 3). The most critical increase in the de Ritis ratio value calculated as the aspartate transaminase (AST) levels divided by alanine transaminase (ALT) levels occurs when BD was supplemented with linseed oil.

The activity of blood alkaline phosphatase in the hens did not differ significantly in different test periods, although there was a tendency to an increase in the indicator when using soybean oil. An increase in the activity of alkaline phosphatase occurs as a result of general systemic response which is accompanied by violation of oxidative phosphorylation in organs and tissues and changed permeability of cell membranes [23].

Soybean and rapeseed oils markedly increase the concentration of blood triglycerides, which indicates a high availability of these fats. So, soybean oil increases the amount of blood lipids by 130.0%, and rapeseed oil by 113.0% compared to sunflower oil. In poultry, the lymphatic system is practically undeveloped; therefore, fat absorption occurs through the portal vein of the liver. It is characteristic that during the absorption and transport of fat, there is no change in its fatty acid composition. Therefore, there is a great similarity between the fat that is fed and deposited in the body. Triglycerides can also be synthesized from glucose during the absorption of carbohydrates. Thus, the final body fat in birds will consist of feed fats, endogenous fats from glucose, and fats obtained as a result of beta-oxidation of higher fatty acids when unsaturated acids are reduced to saturated ones [24].

The alkaline phosphatase/protease (trypsin) index (see Table 3) is consistent with the indicators characterizing the exocrine function of the pancreas (see Table 1) in that the lowest index was observed when using rapeseed oil. Data on the relationship between the activity of alkaline phosphatase in the intestine and blood were obtained by changing the components in the diet of broiler chickens [25]. Our tests have shown that the most efficient assimilation of feed protein occurs with the addition of rapeseed oil due to optimization of the function of digestive glands, the pancreas and liver. The results presented by us also confirm the "loaded" metabolism of the liver and pancreas when using linseed oil, in this case, the ALP/trypsin index increased to 32.1. Thence, the ratio of alkaline phosphatase to proteases is of diagnostic value and can serve as an indicator of the physiological state of the alimentary canal.

Thus, our findings have shown that various lipid components of the diet affect the metabolism of laying hens through changes in the function of the pancreas and the state of the gastrointestinal tract. The scholar literature reports on the effect of fats on glucose and lipid metabolism in pigs [26], on changes in the intestinal microbiota when replacing fats in the diet of sheep [27], on improving digestion, ruminal fermentation and rumen fatty acid profile in dairy cows under the influence of linseed oil [28]. It has been found that vegetable oils rich in polyunsaturated fatty acids improve productive and reproductive performance of dairy cows [29], rapeseed oil has a positive effect in diseases of the pancreas due to reduction of inflammation and oxidative stress [30]. There is evidence of an increase in pancreas and bile secretion with an increase in lipolytic and trypsin activity in sheep fed rapeseed and linseed oils [10]. However, we did not find information on the effect of different vegetable oils on the pancreas secretory function of the in birds. The results we obtained on surgically prepared hens give the first insight into the mechanism of action of various lipid feed additives on the secretion of pancreatic juice and its enzymatic activity. The experiments revealed that the index of alkaline phosphatase/protease reliably reflects the physiological state of the digestive tract during bird adaptation to feed ingredient. In addition, the tests allowed us juxtapose pancreatic secretion with the blood biochemical parameters for each vegetable oil added to the diet. As a result, we have established that the change in blood lipase activity occurs similarly to the enzyme activity in pancreatic juice.

Our data complement the information that aromatic compounds of rapeseed oil affect the taste of food [31]. In general, the results of the study are consistent with the notion that the quality of livestock products depends on the vegetable oil used in the diets. Thus, sunflower oil improves the fatty acid profile of milk and its oxidative stability in dairy cows [32], and in aquaculture, the addition of soy and linseed with different ω6-ω3 fatty acid ratios affects growth parameters, tissue composition, biosynthesis of fatty acids and expression of lipid genes in Atlantic salmon (*Salmo salar*) [33]. In laying hens, the size and quality of eggs and blood biochemical parameters depended on the used dietary oil, the fish oil, coconut and soybean oils [34], which is associated with the digestive function of the pancreas.

So, the study allows us to draw the following conclusions. In laying hens, the lipase activity is adapted to the dietary vegetable oil, and for unrefined sunflower oil, the activity is the highest. Amylase activity also changes with the use of different oils, and the highest level is also observed for sunflower oil. Analysis of the dynamics of pancreatic lipase activity in the postprandial period indicates that sunflower and linseed oils are leading in taste, since in the first 60 minutes after feed intake (the period corresponding to the complex reflex phase of pancreatic secretion regulation), enzymatic activity increases 1.9-2.5-fold compared to the basal level. Rapeseed and soybean oils markedly increase the activity of lipase in the neuro-humoral phase, which indicates their high nutritional value. The activity of trypsin, lipase, aminotransferases and the concentration of triglycerides are the most labile blood biochemical parameters when replacing vegetable oil in the diet. The activity of blood lipase upon a change in the feed lipid component follows the activity in the pancreatic juice, and the alkaline phosphatase/protease index partially follows the indicator values in the pancreatic juice. The relationship between the activity of proteases and alkaline phosphatase in pancreatic juice and blood has been established, which makes it possible to propose a phosphatase-protease index calculated from blood parameters as an estimate of the intestine physiological function in response to changes in the ingredient composition of the diet. The revealed changes in the secretory function of the pancreas upon the addition of various dietary vegetable oils prompt us to conduct further in-depth studies of digestion processes to determine the optimal ingredients in poultry feeding.

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