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OBTAINING COLLAGEN-BASED FEED CONCENTRATES AND STUDYING THEIR EFFECT ON FISH PRODUCTIVITY

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Abstract

This paper examines the performance of feed concentrates based on bovine skin collagen and their effect on fish feeding efficiency. Because of research, it was possible to obtain a protein concentrate containing up to 50 and 70%. When these concentrates are added to fish feed for 10%, it was observed that they have a positive effect on the growth of fish, and it was found that the concentrates have no side effects on the parenchymatous organs of fish.

Keywords: *collagen; protein; concentrate; polysaccharide; fish*

Introduction

Feeds derived from animal raw materials play a key role in providing essential amino acids to maintain high animal productivity and improve meat quality. Finding new sources of food is very important in increasing the food supply. The daily increase in the demand for meat products requires additional protein-rich forages for feeding livestock, fish, and chickens (Soloveva A.A., Zinina O.V., Rebezov M.B., Lakeeva M.L., Gavrilova E.V., 2013; Lähteinen T., Rinttilä T., Koort J.M. K., Kant R., Levonen K., Viljanen M.J., Björkroth J., Palva A., 2015).

Currently, much attention is being paid to obtaining protein hydrolysates and their rational use in the production of feed additives from low-value products obtained from the slaughtering and processing of livestock (Radjabov O.I., Gulyamov T., Turaev A.S., 2011; Radjabov O.I., Turaev A.S., Gulmanov I.D., Otajanov A. Yu., Azimova L.B., 2022; Mora L., Reig M., Toldrá F. 2014; Martínez-Alvarez O., Chamorro S., Brenes A., 2015).

The most promising raw material as protein hydrolysates in the production of food additives is collagen storage waste. In many production enterprises, the ways of rational use of waste products of animal products have not yet been solved. As a result, in addition to material losses, it causes environmental pollution. Therefore, research aimed at the production of high-quality feed proteins from animal processing waste is one of the most urgent problems (Djekic I., Tomasevic I. 2016; Veeruraj A., Arumugam M., Ajithkumar T., Balasubramanian T., 2015).

The main goal of the work is to obtain protein-rich feed concentrates based on chemically processed collagen from collagen-preserving raw materials and to determine their effectiveness.

Materials and Methods

To obtain collagen splits from cattle hides are used as raw materials. The raw cut of cattle hides was washed with running water, and crushed into pieces of 1x1 cm. Then alkali-salt treatment was carried out to soften and swell. The treatment was carried out for 24 hours with stirring. After treatment, the alkali-salt mixture was neutralized with a solution of hydrochloric acid, the spent reaction mixture was drained, and the raw materials were washed with running water until the pH of the medium was 7 ± 0.5. The washed raw materials were homogenized until a homogeneous collagen mass was obtained. To obtain a high-protein concentrate, the aqueous mass of collagen was mixed with chaff and cotton meal in a 1:1 mass ratio. The resulting mixture was dried and crushed.

Experiments to determine the effect of protein concentrates on fish productivity were divided into 5 groups of 75 carp of different weights in closed ponds, and their total and average weights were determined.

Table 1. *Weight indicators of fish in each pond, g*

№	Pool number				
	Pool № 1	Pool № 2	Pool № 3	Pool № 4	Pool № 5
1.	350 g	337 g	418 g	421 g	359 g
2.	365 g	395 g	383 g	405 g	365 g
3.	380 g	363 g	393 g	373 g	371 g
4.	400 g	412 g	397 g	411 g	428 g
5.	420 g	410 g	368 g	409 g	417 g
6.	330 g	338 g	430 g	329 g	419 g
7.	380 g	339 g	480 g	398 g	383 g
8.	363 g	393 g	397 g	373 g	319 g
9.	412 g	418 g	362 g	421 g	422 g
10.	437 g	407 g	397 g	417 g	427 g
11.	396 g	387 g	426 g	436 g	391 g
12.	318 g	398 g	418 g	418 g	358 g
13.	369 g	379 g	409 g	379 g	379 g
14.	426 g	466 g	396 g	416 g	431 g
15.	431 g	451 g	381 g	429 g	398 g
Average	385.13 g	392.87 g	403.67 g	401.73 g	391.13 g

The fish in each pool were fed the following fixed diets for 30 days: № 1-OE-1, № 2-OE-2, № 3-OE-3, № 4-OE-4. For comparison, “ALLER CLASSIC” mixed feed for carp from “Aller Aqua Polska” was used. The quantitative composition of the feed is presented in Table 2.

The fish in each pool were fed three times a day and the water was completely recirculated.

Morphological study of parenchymal organs of fish. The material for histological examination was described macroscopically, pieces were cut out and placed in formalin fixative 10–15% for a day, then these pieces were washed in running water for several hours. Next, the pieces were passed through the battery with alcohol and chloroform; the battery consisted of 7 jars. The entire drum battery runs through within 24 hours. Then they were transferred to the “porridge”, which consists of chloroform + paraffin. We loaded it into a thermostat at 37 degrees for 1–2 hours, and then into a thermostat at 57 degrees for impregnation for 1 hour. Only after an hour, they were allowed to cool, and

harden, and then the paraffin block was cut out. The block was mounted on a wooden cube and cut into a thin layer using a microtome. The glasses were pre-prepared for cutting, smeared with protein, and pierced on an alcohol lamp, the cut materials were fixed on the glasses and stained with hematoxylin and eosin. After staining, they were fixed with balsam and covered with a coverslip. The finished histological preparations were viewed under a binocular microscope made in Germany LEIKA and photographed with a web camera of the NM-35 series.

Table 2. *Quantitative ratio of feed components, g,%*

№	Name	Content of products added to feed, g,%				
		OE-1	OE-2	OE-3	OE-4	OE-5
1.	Wheat	15	15	15	15	ALLER AQUA
2.	Wheat bran	9	9	9	9	POLSKA
3.	Soybean meal	15	15	15	–	
4.	Sunflower meal	15	15	15	15	“ALLER CLASSIC”
5.	Fish flour	–	–	10	–	
6.	Collagen-cotton meal	–	10	–	25	
7.	Collagen-chaff	10	–	–	–	
8.	Chicken meal	15	15	15	15	
9.	Bone flour	10	10	10	10	
10.	Corn	5	5	5	5	
11.	Sunflower oil	3	3	3	3	
12.	Tricalcium phosphate	2	2	2	2	
13.	Premix	1	1	1	1	
	Protein,%	28	30	33	38	30

Results and discussions

When chaff and cotton meal are introduced into the collagen mass, a homogeneous viscous-fluid composition is formed, where the collagen particles are destroyed to form a viscous continuous medium in which the components of the system are evenly distributed and no signs of physical incompatibility are observed. It should be noted here that polysaccharides affect the structure of collagen and as a result collagen dissolves, moreover, all this happens in an aqueous environment and during the dehydration process the mixture is released in the form of a powder. The indicators of collagen-based concentrates are presented in Table 3.

Table 3. *Nutrient concentrate based on collagen*

№	The composition of the concentrate				Moisture,%	Total protein content, g,%
	collagen aqueous mass, g	collagen, g	chaff, g	cotton meal, g		
1.	1200	160	160	–	12 ± 1	51 ± 2
2.	1200	160	–	160	11 ± 1	70 ± 2

Collagen is a protein substance obtained from animals. Collagen contains a common protein similar to fish meal. Currently, all intensive fish farms in our republic import fish-

meal from abroad. Taking this into account, the efficiency of feed concentrates developed based on collagen obtained by chemical treatment of cattle hides in the intensive cultivation of carp fish was studied.

Table 4 shows the changes in the mass of carp fish as a result of the 30-day experiment.

Table 4. *Mass changes in carp fish after 30 days*

№	Experimental pools and feed type (OE)				
	Pool № 1 OE-1	Pool № 2 OE-2	Pool № 3 OE-3	Pool № 4 OE-4	Pool № 5 OE-5
1.	557 g	631 g	678 g	463 g	572 g
2.	545 g	655 g	589 g	511 g	637 g
3.	680 g	573 g	693 g	424 g	563 g
4.	619 g	621 g	637 g	542 g	626 g
5.	628 g	617 g	588 g	492 g	587 g
6.	539 g	558 g	638 g	561 g	671 g
7.	587 g	579 g	690 g	523 g	602 g
8.	567 g	593 g	597 g	413 g	563 g
9.	652 g	658 g	662 g	543 g	631 g
10.	637 g	627 g	593 g	514 g	614 g
11.	594 g	587 g	723 g	458 g	636 g
12.	518 g	498 g	684 g	537 g	688 g
13.	467 g	579 g	657 g	484 g	579 g
14.	526 g	667 g	691 g	514 g	616 g
15.	611 g	689 g	675 g	423 g	624 g
Average	581.8 g	608.8 g	653 g	493.47 g	613.93 g

It was found that replacing collagen-chaff and collagen-cotton meal samples with a 10% equivalent amount of fishmeal in the feed did not cause negative changes in fish growth. However, when fishmeal and soybean meal were replaced by collagen-cotton meal (total 25%) in the feed, the total protein content increased and the fish growth slowed due to energy imbalance.

A comparative analysis of mass change in fish after 30 days of experiment is shown in Table 5.

Table 5. *Comparative analysis of changes in fish mass in experiments*

Indicators	Pool № 1 OE-1	Pool № 2 OE-2	Pool № 3 OE-3	Pool № 4 OE-4	Pool № 5 OE-5
Average mass before the experiment, g	385.13	392.87	403.67	401.73	391.13
Average mass after the experiment, g	581.8	608.8	653	493.47	613.9
Mass ratio	1.51	1.54	1.61	1.22	1.56
The amount of total protein in the feed,%	28	30	33	38	30

As can be seen from the results of the experiment presented in Table 5, the mass of the fish increased in all the conducted experiments for 30 days. The highest fish mass

was observed in experiment № 3, where 10% fishmeal was used in the feed, but the total protein content in this experiment was 33%. Experiments conducted with collagen-cotton meal in experiment № 2 and "ALLER AQUA POLSKA" feed in experiment № 5 showed almost the same indicator, fish productivity increased by 1.54 and 1.56 times, respectively. Also, based on physiological experiments in fish farming, it was found that good results can be achieved when collagen-based protein concentrates are included in the diet in an amount of up to 10%.

Histological examination of the parenchymal organs of fish from all groups revealed no significant changes. In the liver, slight fatty degeneration was observed in hepatocytes mainly in groups 1 and 3, hyperemia and vascular congestion in groups 4 and 5, the lobular structure and beam structure were preserved in all groups. In the spleen, hypoplasia of the white and in some areas of the red pulp was noted, as well as a sharp expansion of the lumen of blood vessels with congestion in one case. In the kidney, there are straight and convoluted tubules with clear contours, the basement membrane is preserved, the nuclei in the epithelium are arranged in a single row, the glomeruli are equal in size, and capillary loops are without signs of pathology. In the first group, a cystic-changed atrophic glomerulus was detected in the field of view. Heart – the fibrous structure of the muscle tissue is preserved, the transverse striation is determined, and the nuclei have a central location with clear contours. In isolated cases, slight fatty degeneration and congestion of the vessels of the intermuscular layers are noted.

According to the results of the histological study of the parenchymatous organs of fish, the structural and functional structure of the parenchymatous organs was preserved after using the nutrient concentrate, and no signs of pathological changes were detected. Some of the identified dystrophic changes and blockage of blood vessels have a common pathological feature, which does not depend on the use of protein concentrate, as it is present in all experimental groups.

Conclusion

High-protein concentrates based on collagen-chaff and collagen-cotton meal with a high content of total protein (50 and 70%) were obtained. Testing high-protein concentrates on fish showed that when using collagen-cotton meal concentrate, after 30 days of feeding, the weight of fish increases by 1.5 times and corresponds to imported feed. Histological studies of the parenchymal organs of fish after using the protein concentrate showed that the structural and functional structure of the parenchymal organs was preserved and no signs of pathological changes were identified.

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