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DEVELOPMENT OF A COMPOUND FEED FORMULATION FOR CYPRINID FISH BASED ON LOCAL RAW MATERIALS

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Abstract

This study investigates the development of a compound feed formulation for cyprinid fish based on a mixture of pumpkin seed cake meal and saffron leaf powder. The aim of the research was to evaluate the effects of this plant-based additive on the nutritional value of compound feeds, growth performance, and physiological status of cyprinid fish, as well as to assess the potential of locally available raw materials for replacing imported compound feeds and optimizing key feeding technology parameters. Experimental studies examined the chemical composition of pumpkin seed cake and saffron leaves, including the content of proteins, lipids, fiber, vitamins, mineral elements, and antioxidant compounds. A comparative assessment of growth performance indicators, feed conversion ratio, and overall physiological condition of fish was conducted following the inclusion of the mixture in compound feed formulations. The results demonstrated that the use of the investigated plant additive improves nutrient digestibility and feed utilization efficiency, and exerts a positive effect on fish resistance to stress factors. The findings indicate the feasibility of incorporating a mixture of pumpkin seed cake meal and saffron leaf powder into the technology of compound feed production for cyprinid fish in order to enhance biological value and reduce feed production costs.

Keywords: *mixture of pumpkin seed cake meal and saffron leaves, lactobacterin, moisture content, crude protein, fat, fiber, ash*

Introduction

According to official data, fish production in the Syrdarya region in 2025 amounted to 11,184.1 thousand tons, while the actual demand was 10,000 thousand tons. By 2026, the demand of the domestic aquaculture sector for compound feeds is expected to reach 25 million tons due to the expanding involvement of small and medium-sized farms, as well as the growth of production in certain aquacul-

ture subsectors. Feed costs remain the primary expenditure in industrial aquaculture; therefore, improving feed efficiency is a crucial prerequisite for ensuring the competitiveness and sustainable development of the sector (Abrosimova, N. A., Abrosimov, S. S., & Saenko, E. M., 2005).

The efficiency of livestock development plays a decisive role in shaping the national economy and ensuring food security. In-

sufficient provision of animals, poultry, and fish with balanced feeds, feed additives, and sources of biologically active substances remains a major constraint on the sustainable and prospective development of aquaculture. The use of imported therapeutic and preventive products increases the cost of livestock production and reduces its profitability. As a result, scientific research aimed at identifying and utilizing domestic resources capable of meeting the needs of the livestock sector for organically derived biologically active additives has become particularly significant (Bagrov, A. M., & Gamygin, E. A., 2006).

To compensate for deficient nutrients in fish diets, various natural and synthetic additives are actively incorporated into feeds. Vitamin-mineral, therapeutic, and preventive premixes are used to enhance feed safety, integrity, and digestibility. The main components of these premixes are often non-natural products of microbiological synthesis, such as antibiotics, hormones, enzymes, antioxidants, and similar substances (GOST 10385–2014. (2014); Grigoriev, S. S., & Sedova, N. A., 2008).

Aller AQUA is a global leader in the production and supply of feeds for fish farming. The composition of their feed includes poultry meal, fish meal, rapeseed oil, soybean, triticale, sunflower protein, wheat, feather meal, and a vitamin-mineral premix. The cost of imported feeds is significantly inflated due to customs duties, transportation, intermediary services, and other factors, which does little to support the development of domestic aquaculture. This situation has led to increased interest in current trends, innovations, and advanced technologies in feed production.

The aim of this study was to develop a formulation for production compound feed for cyprinid fish using locally available raw materials to replace imported feeds, as well as to determine the key parameters of feeding technology. The feed for cyprinid fish includes lactobacterin as part of the feed formulation (Sattarov, K. K., & Xazratkulov, J. Z., 2025).

Materials and methods

The experimental study was conducted from April 2025 to January 2026 in the laboratory of the Scientific Center of the Department of Food Technology at Gulistan State Univer-

sity. The subjects of the study were juvenile cyprinid fish. To develop a production compound feed formulation for cyprinid fish, the chemical composition of a mixture of pumpkin seed cake meal and saffron leaf powder was analyzed, with the scientific rationale based on widely accepted methods. The nutrient content of both the raw materials and the finished product was determined according to standard zootechnical feed analysis procedures using unified methods, including dry matter, crude protein, crude fat, crude fiber, nitrogen-free extractives, ash, calcium, and phosphorus. The nutritional value of the production compound feed containing the mixture of pumpkin seed cake meal and saffron leaf powder was evaluated using aquaculture-biological, hematological, and biochemical indicators of fish commonly accepted in biological studies. Key parameters for the controlled feeding of cyprinid fish with the production compound feed were developed within a standard mass accumulation model, taking into account the live weight of the cultured aquatic organisms, ambient water temperature, as well as feeding regime factors such as pellet size, feed application conditions, and methods for comprehensive monitoring of feeding efficiency.

For the feed trials, samples of 0.5 kg each were collected from the experimental compound feed (Compound Feed No. 1) and the control compound feed (Compound Feed No. 2) in accordance with the regulatory standards for testing methods (Table 1).

Table 1. Regulatory standards for methods of feed nutritional value testing

Parameter Name	Standards and Regulations
Moisture content,%	GOST 13496.3–92
Crude protein content,%	GOST 13496.4–93
Crude fat content,%	GOST 13496.15–97
Crude fiber content,%	GOST 13496.2–91
Crude ash content,%	GOST 26226–95
Calcium content,%	GOST 26570–95
Phosphorus content,%	GOST 26657–97

For the development of a feed formulation using a mixture of pumpkin cake flour and saffron leaf powder, an existing carp feed

produced by Aller AQUA was taken as the basis. The nutritional value of the mixture of pumpkin cake flour and saffron leaf powder was evaluated based on the content of moisture, crude protein, fat, fiber, and ash. Studies were conducted to justify the formulation of carp feed using this mixture. A comparative analysis of the chemical composition of the feed containing the mixture of pumpkin cake flour and saffron leaf powder and the Aller AQUA feed demonstrated the high nutritional value of the developed feed for carp.

Results and discussion

The results of the laboratory analysis of the nutrient composition of the raw materials revealed significant variability in the content of proteins, fats, fiber, and energy value.

The nutritional value of the mixture of pumpkin cake flour and saffron leaf powder was assessed based on its chemical composition. The mass fractions of the main components are presented in Table 2.

Table 2. *Chemical composition of the mixture of pumpkin cake flour and saffron leaf powder*

Parameter Name	Actual value
Moisture content,%	8.55
Crude protein content,%	31.31
Crude fat content,%	20.45
Crude fiber content,%	29.69
Crude ash content,%	7.64
Calcium content,%	0.76
Phosphorus content,%	1.32

A comparative analysis of the physico-chemical and functional characteristics of the products revealed significant differences between the experimental samples produced using new technologies and the control samples from traditional production.

The high content of dry matter (91.45%) with a moisture content of 8.55% indicates the high nutritional value of the mixture of pumpkin cake flour and saffron leaf powder, as the valuable nutrients of the feed are concentrated in the dry portion of the flour.

As shown in Table 2, the percentage composition of the main components in the mixture of pumpkin cake flour and saffron leaf

powder indicates that the protein nutritional value, assessed by the mass fraction of crude protein (31.31%), is quite high and comparable to the protein content of soybean meal, feed yeast, and fish meal. This value approaches the recommended levels of crude protein in commercial feeds for carp. All of this suggests that the mixture of pumpkin cake flour and saffron leaf powder can be used as a source of plant-based protein in feed production.

Based on the mass fraction of crude fat (31.31%), it can be concluded that the mixture of pumpkin cake flour and saffron leaf powder meets the lipid nutritional requirements for carp feed. It should be noted that the plant origin of the studied product implies that the lipids in the mixture possess high biological value for carp.

The carbohydrate nutritional value of the mixture of pumpkin cake flour and saffron leaf powder is represented by the mass fraction of crude fiber (29.69%) and nitrogen-free extractives (6.17%). The high crude fiber content in the mixture limits its inclusion rate in the formulation of commercial feeds for carp. Considering the high crude fiber content, it is suggested that its proportion in carp feed should not exceed 5–6%.

The mineral nutritional value of the mixture, assessed by the crude ash content (7.64%), is relatively low. The crude ash composition revealed the presence of calcium (0.76%) and phosphorus (1.32%), which are essential for maintaining normal physiological functions in carp. A positive aspect is the absence of salt composed of sodium and chloride ions in the mixture of pumpkin cake flour and saffron leaf powder.

Thus, the results of the conducted studies demonstrate that the mixture of pumpkin cake flour and saffron leaf powder possesses high protein and lipid nutritional value.

Conclusions

The study demonstrated that the development of a new fish feed based on processed products of cucurbit crops is innovative, as commercial fish feeds currently rely predominantly on genetically modified soybean. The potential and prospects for the use of new plant-based components as constituents of fish feed were examined and confirmed.

One of the promising feed ingredients is the by-products of pumpkin seed processing – pumpkin cake and saffron leaves. These materials contain up to 30% crude protein and, in terms of amino acid composition, are comparable to peanut cake. Pumpkin cake is a high-energy feed that is environmentally safe and non-toxic for animals. It significantly surpasses similar products derived from sunflower, soybean, rapeseed, and mustard in amino acid composition and contains a wide range of naturally occurring bioactive compounds, including tocopherols, carotenoids, sterols, fatty and organic acids, sugars, vitamins B1, B2, B6, C, K, and resinous substances.

The calculated chemical composition of the mixture of pumpkin seed flour and saffron leaves (90:10) is characterized by a high content of crude protein (31.31%) and lipids (20.45%), as well as an increased proportion of dietary fiber (29.69%) and minerals (6.0%). The inclusion of saffron leaf powder

enriches the mixture with biologically active phenolic compounds and trace elements, enhancing its biological value and functional properties for use in carp feed formulations.

The results of the conducted studies allowed for the development of the main parameters of carp feeding technology using a commercial feed formulated with a mixture of pumpkin cake flour and saffron leaf powder. These parameters take into account the feeding rates of aquatic organisms depending on their body weight and water temperature, as well as the methods and schedules of feeding based on feed intake. Additionally, the pellet sizes of the feed were determined in accordance with the morphometric characteristics of the fish and the dimensions of their mouths. Based on the obtained results, the developed feed containing a mixture of pumpkin cake flour and saffron leaf powder can be recommended for industrial-scale production and use in commercial carp farming.

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