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THE USE OF SPECIALIZED FEEDS WITH A GRAIN PILE OF WHEAT IN THE EARLY STAGES OF RIPENESS
AND PROBIOTIC ADDITIVES IN THE DIET OF JUVENILE CARP

Research article

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Abstract

The feed industry plays an important role in the development of the agribusiness complex of Russia, in particular livestock and fish farming. Its development is strategically important for ensuring food security of the country. The article presents the results of a study of the effect of a new feed on the fish-farming and biological indicators of carp. It includes a new feed component from the grain heap of early ripeness phases of wheat and a probiotic feed additive *Bacillus amyloliquefaciens* B-1895. Early ripeness phases of wheat grain have an increased content of protein, amino acids, vitamins and minerals, so its use in the formulation of feed as a complete or partial replacement for feed grain with low quality characteristics is an urgent area of research. The results of the study proved the positive effect of the grain heap of early ripening wheat and the probiotic feed additive *Bacillus amyloliquefaciens* B-1895 on the weight gain of fish and its survival: a 50% more intensive weight gain was observed, the survival rate was 95%, which is 4% higher than the control.

Keywords: compound feed, carp cultivation, probiotic, wheat grain.

ПРИМЕНЕНИЕ СПЕЦИАЛИЗИРОВАННЫХ КОРМОВ С ЗЕРНОВЫМ ВОРОХОМ ПШЕНИЦЫ РАННИХ
ФАЗ СПЕЛОСТИ И ПРОБИОТИЧЕСКОЙ ДОБАВКОЙ В РАЦИОНЕ МОЛОДИ КАРПА

Научная статья

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Аннотация

Комбикормовая промышленность играет важную роль в развитии агропромышленного комплекса России, в частности животноводства и рыбководства. Ее развитие является стратегически важным для обеспечения продовольственной безопасности страны. В статье представлены результаты исследования влияния нового комбикорма на рыбоводно-биологические показатели карпа. В его состав входит новый кормовой компонент из зернового вороха пшеницы ранних фаз спелости и пробиотическая кормовая добавка *Bacillus amyloliquefaciens* B-1895. Зерно пшеницы ранних фаз спелости имеет повышенное содержание белка, аминокислот, витаминов и минеральных веществ, поэтому его использование в рецептуре комбикормов в качестве полной или частичной замены фуражного зерна, обладающего низкими качественными характеристиками, является актуальным направлением исследования. Результаты исследования доказали положительное влияние зернового вороха пшеницы ранних фаз спелости и пробиотической кормовой добавки *Bacillus amyloliquefaciens* B-1895 на прирост массы рыбы и ее выживаемость: наблюдается на 50% более интенсивный прирост массы, выживаемость составила 95%, что выше в сравнении с контролем на 4%.

Ключевые слова: комбикорм, выращивание карпа, пробиотик, зерно пшеницы.

Introduction

For successful and intensive fish farming in industrial conditions, inexpensive high-quality compound feeds are required, which are easily digestible by the fish organism at each stage of individual development and balanced according to the nutritional needs of each specific fish species (specialized). Compound feeds should have a positive effect on the quality of meat of aquaculture objects [1], [2]. The feeds should contain a balanced set of nutrients (proteins, fats, carbohydrates, vitamins, minerals). In addition, they should be environmentally friendly and fully satisfy the needs of fish at a certain stage of the life cycle. Due to the withdrawal of imported feeds from the Russian market – products from Holland, Denmark, France,

Spain, which led to complete dependence on the exchange rate, high prices, dependence on the introduction of sanctions, there was a need to develop domestic specialized feeds with high-value feed additives and feed components.

Aquaculture feeds differ from feeds for warm-blooded animals by their high protein content [3]. In compound feeds for various species of animals, birds and fish, fodder (forage) wheat, which has a low protein content and, accordingly, amino acids, is most often used as a plant raw material. It has been proven [4], [5], [6] that waxy wheat grain has an increased content of protein (by 0.1-1.0% [5]), amino acids (in total, 5% higher) [4], vitamins (Provitamin A) and minerals (selenium, iron) [6] compared to fully ripe grain. Therefore, such grain can be used in compound feeds for fish as a feed component as an additional source of protein, vitamins and minerals. The growth of carp fish species and their assimilation of essential amino acids can vary greatly depending on the selected compound feed and its balance in amino acid composition necessary to meet the fish's need for nutrients. To improve digestibility and improve the intestinal microflora of fish, probiotic preparations are used [7], [8], [9], [10]. The probiotic feed additive *Bacillus amyloliquefaciens* B-1895 [10], developed in a specialized laboratory, has proven its effectiveness in comparison with existing probiotic preparations [7], [8], [9]. It was obtained by solid-phase fermentation of soybeans with *Bacillus amyloliquefaciens* B-1895 bacteria. The bacterial content in the preparation is 4 10¹⁰ CFU/g. Live cells of probiotic bacteria, their enzymes and metabolites have a positive effect on resistance to infectious diseases, survival and productivity of fish [10].

In previous studies, we developed formulas for carp compound feed with the addition of a feed component from the grain heap of early ripeness phases of wheat and the probiotic feed additive *Bacillus amyloliquefaciens* B-1895 [11] and tested the resulting batches of compound feed on two-year-old carp in cages on a fish pond. The study involved comparing three formulas for compound feed: in the first test (formula 1), wheat was replaced with a feed component from the grain heap of early ripeness phases of wheat and, to improve the absorption of the feed components and increase the quality of aquaculture products, the probiotic feed additive *Bacillus amyloliquefaciens* B1895arm [9] was added; formula 2 differed from formula 1 only by the absence of the probiotic feed additive *Bacillus amyloliquefaciens* B1895arm; formula 3 served as a control. The results of the study showed that the compound feed made according to recipe 1 demonstrated a more intensive weight gain, increased survival by 3% compared to the control (98%) and decreased feed coefficient. The feed component from the grain heap of early ripeness wheat also proved its effectiveness – the survival rate was 96% compared to the control (95%), the feed coefficient was lower than in the control. Fry are more sensitive to the components of compound feed, so it is advisable to conduct studies to test compound feed with a feed component from the grain heap of wheat on juvenile carp. The purpose of the study is to determine the effectiveness of using a new feed component from the grain heap of early ripeness wheat with the probiotic feed additive *Bacillus amyloliquefaciens* B1895arm on juvenile carp.

Research methods and principles

The basic formula composition of carp fish feed for feeding in RAS conditions was determined: fish meal (20%), meat and bone meal (2%), blood meal (5%), full-fat soybeans (10%), sunflower cake (10%), corn gluten (3%), feed yeast (8%), feed component from early ripeness wheat grain heap (in the amount of 20% – as a replacement for wheat), phytase (3%), lysine (3%), threonine (3%), methionine (3%), carp premix (3%), fish oil (4%), linseed oil (3%). The feed was produced in the laboratory "Technological line for feed production" of the Don State Technical University. The process line consists of an extruder for processing raw materials of plant origin INEK-110 (manufactured by LLC PK PROMMASH, Stary Oskol, Russian Federation), which is used to increase digestibility and improve the organoleptic properties of the product; a pneumatic hammer mill DPM-5.5 (manufactured by LLC AgroPostavka, Nizhny Novgorod, Russian Federation) for grinding the extrudate; a horizontal mixer SG-1.5 (manufactured by LLC AgroPostavka, Nizhny Novgorod, Russian Federation) for mixing dry components of compound feed; a granulator ZLSP 150 (manufactured by LLC AgroPostavka, Nizhny Novgorod, Russian Federation). The resulting granulated compound feed was analyzed according to the quality indicators specified in GOST 10385-2014.

Various devices and equipment are used for a comprehensive assessment of the fish condition as a result of feed testing. Data analysis is carried out taking into account such parameters as hydrochemical analysis of water (in accordance with OST 15.372-87), fish weight and length. Some indicators can be obtained using portable devices – thermooximeters and portable water acidity and redox potential meters. The fish were kept in a system with circulating water supply, consisting of two pools, 2 × 2 × 0.7 m in size, equipped with a filtration, aeration, and oxygenation system. The stocking density in each pool was 200 pcs per 1 cubic meter. Weighing of a single feed rate and fish weight was carried out on AND electronic scales with a weighing accuracy of up to 0.01 g. An AZ Instrument 86031 thermooximeter was used to control the hydrochemical parameters of water. The level of dissolved oxygen, water temperature, and salinity were determined. The efficiency of the compound feed was assessed by the following indicators: absolute weight gain, average daily gain, average daily growth rate and mass accumulation coefficient [12], [13].

The absolute increase in mass P is determined by the formula (1):

$$P = Mf - Mi \quad (1)$$

where Mf – final mass, g; Mi – initial mass, g.

The average daily increase in C is determined by the formula (2):

$$C = (Mf - Mi) / n \quad (2)$$

where n – number of days of feeding, days.

The average daily growth rate A is determined by the formula (3):

$$A = [(Mf / Mi)^{1/n}] - 1 * 100 \quad (3)$$

Mass accumulation coefficient Km is determined by the formula (4):

$$Km = (3((Mf)^1/3) - (Mi)^1/3)/n \quad (4)$$

To conduct the test, the fish were divided into 2 groups.:

test – compound feed with the addition of a component from the grain heap of early ripening wheat and the probiotic feed additive *Bacillus amyloliquefaciens* B1895arm in the amount of 0.15% of the total weight of the compound feed;

control – compound feed made according to the standard recipe described above.

The duration of the test was 45 days. The feeding rate was determined according to special feeding tables [14].

Main results

The results of the analysis of the obtained compound feed (control and test) showed compliance with the requirements for compound feed for carp GOST 10385-2014. The mass fraction of protein was 36.3%, the mass fraction of fat was 7.5%.

The water temperature in the pools fluctuated within 21-22.5°C, oxygen 7.5-8.9 mg/l. The hydrochemical parameters in the pools were within normal limits throughout the entire period.

The results of growing young carp on test feed are presented in Table 1.

Table 1 - Results of the test on growing juvenile carp in RAS

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| Indicators | Test | Control |
|--------------------------------------|------------|-----------|
| Initial mass, g | 4.32±0.19 | 4.30±0.15 |
| Final mass, g | 10.74±0.30 | 8.66±0.34 |
| Total increase, g | 6.42 | 4.36 |
| Average daily gain, g | 2.02 | 1.55 |
| Average daily growth rate, % | 0.16 | 0.11 |
| Mass accumulation coefficient, units | 0.07 | 0.03 |
| Survival, % | 95 | 91 |
| Duration of the test, days | 45 | 45 |

Discussion

The weight gain of the test fish group was significantly higher than that of the control fish, the total gain was 6.42 g (2.5-fold increase in weight from the initial) and 4.36 g (2-fold increase in weight from the initial), respectively. At the same time, the daily weight gain in the test was higher and was 0.16 g.

High survival was noted in the test and control variants, which was 95% and 91%, respectively. In the test, survival was 4% higher.

The obtained data are consistent with the previous research results [7], [8], [9], [11]: probiotic feed additives present in the test have a beneficial effect on fish weight gain and survival. However, in studies on two-year-old carp, survival was higher – 98% in the test and 95% in the control. These data are related to the fact that the greatest fish losses occur during incubation and growing of juveniles. In adulthood, when the carp's intestinal microflora and immunity are already formed, waste is significantly reduced.

In comparison with another study, where the preparation "Subtilis" [15], which includes the bacteria *Bacillus subtilis* and *Bacillus licheniformis*, was used as a probiotic feed additive, the survival rate was 92.3% in the test and 79.7% in the control. The studies were conducted on two-year-old carp.

Conclusion

Probiotic feed additives have a positive effect on the growth and development of fish, in particular carp. The use of a component from the grain heap of early ripeness phases of wheat in the compound feed enhances the effect when feeding juvenile carp. In the test, a 50% more intensive weight gain was observed, the survival rate was 95%, which is 4% higher than the control. In further studies, tests will be conducted to test compound feed with a feed component from the grain heap of early ripeness phases of wheat on valuable fish species (sturgeon, salmon). Also, the new feed component will be studied for various indicators in order to identify a positive effect on weight gain and survival of fish.

Финансирование

The work is carried out as part of the project "Development of personalized feeds of a new generation with plant and probiotic additives to increase the survival rate and improve the health of fish" (FZNE-2023-0003).

Конфликт интересов

Не указан.

Рецензия

Все статьи проходят рецензирование. Но рецензент или автор статьи предпочли не публиковать рецензию к этой статье в открытом доступе. Рецензия может быть предоставлена компетентным органам по запросу.

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Conflict of Interest

None declared.

Review

All articles are peer-reviewed. But the reviewer or the author of the article chose not to publish a review of this article in the public domain. The review can be provided to the competent authorities upon request.

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