The Impact of Replacing Fishmeal with Brewer's Yeast on Some Production Indicators of Cultured Catfish (*Silurus glanis*)

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□ ABSTRACT □

This study assessed the feasibility of using brewer's yeast (*Saccharomyces cerevisiae*) as a full substitute for fishmeal in the diet of catfish (*Silurus glanis*), with emphasis on growth, feed utilization, and water quality. Fifty fingerlings (initial weight: 47.5–50 g) were assigned to two dietary treatments: a control group fed a fishmeal-based diet and a test group receiving an isonitrogenous diet with total fishmeal replacement by brewer's yeast. Fish were fed twice daily at 3% of body weight over 90 days.
Final weight, weight gain, and daily growth rate did not differ significantly between groups. However, a numerically improved feed conversion ratio was observed in the yeast group. Brewer's yeast, rich in protein (~64%), amino acids, and B-vitamins, supported stable water parameters.
Results suggest that brewer's yeast can serve as a cost-effective and nutritionally viable protein alternative in catfish diets, possibly offering immunological benefits. Further investigation is needed to evaluate long-term impacts of partial inclusion levels.

Keywords: *Silurus glanis*, *Saccharomyces cerevisiae*, fishmeal, growth parameters.

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تأثير استبدال مسحوق السمك بخميرة البيرة على بعض المؤشرات الإنتاجية لسمك السلور *Silurus glanis* المستزرع

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□ ملخّص □

هدفت الدراسة إلى تقييم إمكانية استخدام خميرة البيرة *Saccharomyces cerevisiae* كبديل كلي لمسحوق السمك في علف سمك السلور *Silurus glanis* من حيث النمو وكفاءة العلف وجودة المياه. استخدمت 50 إصبعية بوزن أولي بين 47.5–50 غرام، قسمت إلى مجموعتين: الأولى تلقت علفًا تقليديًا يحتوي على مسحوق السمك، والثانية تلقت علفًا متساوي البروتين لكنه استُبدل فيه مسحوق السمك بخميرة البيرة بالكامل. استمرت التجربة 90 يومًا، مع تغذية مرتين يوميًا بنسبة 3% من وزن الجسم.

أظهرت النتائج تشابهًا في الوزن النهائي وزيادة الوزن ومعدل النمو اليومي بين المجموعتين، مع تحسن غير دال إحصائيًا في نسبة تحويل الغذاء لمصلحة خميرة البيرة . ساعدت خميرة البيرة، التي تحتوي على نحو 64% بروتين وأحماض أمينية وفيتامينات "ب"، في الحفاظ على استقرار جودة المياه.

تشير البيانات إلى أن خميرة البيرة يمكن اعتبارها بديلاً اقتصاديًا فعّالًا من حيث المحتوى البروتيني في علائق سمك السلور، وقد تلعب دورًا داعمًا في تعزيز الاستجابة المناعية. يُوصى بإجراء دراسات مستقبلية لتقييم آثار نسب مختلفة من الاستبدال على المدى الطويل.

الكلمات المفتاحية: *Silurus glanis*، *Saccharomyces cerevisiae*، مسحوق السمك، مؤشرات النمو.

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Introduction

Fish have long been a fundamental component of human diets, valued for their high nutritional value and ease of digestion. They are rich in protein, typically containing between 60% and 90% of dry weight, depending on the species and life stage [1]. With the increasing global demand for fish-derived proteins driven by population growth, aquaculture production is expected to expand significantly in the coming years. However, this expansion presents several challenges, particularly regarding feed availability and economic feasibility both of which are critical to the success of commercial fish farming operations.

According to the Food and Agriculture Organization (FAO), global fisheries and aquaculture production recently reached approximately 185.4 million tons, supplying an average of 20.7 kilograms of aquatic food per capita annually. This accounts for about 15% of the total global animal protein supply [2]. Notably, aquaculture itself has shown consistent growth, increasing by approximately 6.6% since 2020, and now provides over half of the fish consumed by humans worldwide [2].

Among freshwater fish species commonly used in aquaculture systems, the catfish (*Silurus glanis*) stands out due to its biological and economic importance. It exhibits a relatively fast growth rate, strong adaptability to changing environmental conditions, disease resistance, reproductive efficiency, and a favorable nutrient profile [3, 4, 5]. These characteristics make it a promising candidate for sustainable aquaculture development.

Feed remains one of the most critical components in fish farming, often accounting for more than 50–60% of total production costs [7]. Of particular significance is dietary protein, which plays a crucial role in tissue synthesis, metabolic activity, and overall growth performance [8]. Fishmeal has traditionally been the primary protein source in aquafeeds due to its well-balanced amino acid composition [9]. However, growing limitations on fishmeal availability due to ecological concerns and rising demand—have prompted researchers to seek alternative protein sources that are both economically viable and nutritionally adequate. These alternatives include plant-based proteins, other animal-derived ingredients, and biomass derived from industrial by-products [6, 10].

While plant-based proteins offer certain advantages, their widespread use as complete replacements for fishmeal is often limited by deficiencies in essential amino acids and reduced palatability for some fish species [11]. In catfish, for example, optimal growth generally requires crude protein levels of around 40%, although the ideal range may vary between 35% and 50%, depending on developmental stage and feeding strategies [12].

One promising alternative showing encouraging results in numerous studies is *Saccharomyces cerevisiae*, commonly known as brewer’s yeast. With a protein content of 45%, low fat content (~1%), and a notable presence of essential amino acids such as lysine, methionine, and cysteine, it represents a potential substitute for traditional protein sources. Moreover, it contains B-complex vitamins and minerals that support physiological functions and immune responses [15, 16, 20]. Evidence suggests that replacing up to 50% of fishmeal with brewer’s yeast in fish diets does not negatively affect growth performance [13].

Several studies have also demonstrated the effectiveness of brewer’s yeast in stimulating appetite and enhancing growth across various fish species. For instance, Nile tilapia (*Oreochromis niloticus*) showed positive responses at substitution levels reaching up to 60%, while rainbow trout (*Oncorhynchus mykiss*) performed well with inclusion rates between 20% and 30%. Similar beneficial effects have been reported in Atlantic salmon (*Salmo salar*) and Arctic char (*Salvelinus alpinus*) [14, 17, 18, 19].

Beyond its nutritional benefits, brewer's yeast has been shown to positively influence immune function through immunonutrition. Research indicates that it can enhance immunity, improve overall health, and increase resistance to diseases [25,26]. Additionally, it supports digestive processes by producing enzymes such as amylase, peptidase, and cellulase, which aid in breaking down complex compounds and improving feed utilization [23].

Findings suggest that brewer's yeast serves not only as a nutritional substitute but also as a functional ingredient capable of boosting productivity and health within aquaculture systems. Furthermore, compared to fishmeal, it offers advantages in terms of cost and availability [22, 24, 27].

Based on these observations, this study was designed to determine whether a complete replacement of fishmeal with brewer's yeast is feasible in the diet of catfish (*S.glanis*), and to evaluate the impact of this substitution on key production parameters. The main objective is to help establish more sustainable and cost-effective feeding strategies for aquaculture operations.

Materials and Methods

The search was conducted on a private farm in the Al-Ghab area of the Hama countryside,45km from Hama Governorate,between July1and October1,2024 . A cohort of 70 *S. glanis* fingerlings was obtained from a local private fish farm. The initial average body mass of the fish ranged between 47.5 and 50 grams. Upon arrival, all individuals underwent an initial health assessment to ensure the absence of visible diseases or physical abnormalities. This was followed by a two-week acclimatization period conducted under controlled laboratory conditions before the start of the experimental feeding trial.

The experiment was carried out in a concrete pond measuring 6*6*1m. The pond was divided into two identical compartments, each assigned to one of the two dietary treatments. Throughout the experimental period, key environmental parameters—such as water temperature, dissolved oxygen concentration, and pH were regularly monitored and recorded. These values were 25°C, 6.5mg/L and 7.4 for Water Temperature Dissolved Oxygen and pH respectively, confirming that the rearing conditions remained within the acceptable ranges for this species.

Prior to placement in the experimental units, the fish were subjected to a freshwater bath containing a suitable concentration of sodium chloride (NaCl) to eliminate any potential external pathogens.

Following the acclimatization period of 14 days, 50 healthy fingerlings of similar size were randomly assigned to two experimental groups, with 25 fish placed in each pond compartment. Experimental diets were formulated based on predetermined specifications. Table 1 presents the percentage composition of each feed ingredient used for the two treatment groups. Additionally, Table 2 provides a detailed nutritional analysis of the feed components, including crude protein, fiber, ash, moisture content, fat content, and digestible energy levels.

Table (1) Composition of the Experimental Diets (%)

Feed Ingredient	Compartment 1 (%)	Compartment 2 (%)
Soybean meal	5	5
Wheat bran	35	35
Corn	20	20
Fishmeal	40	-
Brewer's yeast	-	40

Table (2) Nutritional Content of Feed Ingredients

Feed Ingredient	Protein (%)	Fiber (%)	Ash (%)	Moisture (%)	Fat (%)	Energy (MJ/kg)
Fishmeal	65.00	0.48	10.35	14.95	2.13	7.30
Soybean meal	48.00	2.05	2.95	7.35	28.61	8.69
Corn	9.76	4.15	4.40	10.05	5.36	66.28
Wheat bran	17.10	11.30	6.90	13.00	3.00	2.67
Brewer's yeast	64.45	-	4.95	9.65	3.00	17.95

The feeding trial lasted 12 weeks, during which the fish were fed twice daily at a rate equivalent to 3% of their estimated body weight. This amount was periodically adjusted according to observed growth progression.
Growth performance was assessed by measuring individual body weights using a digital scale with a precision of ±5 grams. Several performance indices were calculated to evaluate the effects of the dietary treatments:

- Final Average Weight (g) = Total weight of fish (g) / Number of fish
- Weight Gain (g) = Final weight – Initial weight
- Weight Gain (%) = (Final weight – Initial weight) / Initial weight × 100
- Daily Growth Rate (g/day) = (Final weight – Initial weight) / Number of experimental days
- Survival Rate (%) = (Number of surviving fish / Number of initial fish) × 100
- Feed Conversion Ratio (FCR) = Total feed consumed (g) / Total weight gain (g)

At the end of the experiment, a random sample of six fish from each group was collected for detailed evaluation of growth-related parameters.

Results and Discussions

At the end of the 90-day feeding trial, six fish from each experimental group were randomly selected to assess growth performance and other key parameters. Statistical analysis revealed no significant differences ($p > 0.05$) between the two dietary treatments across most measured variables, indicating comparable performance in both groups.
Fish in compartment 1, which received the fishmeal-based diet, had an average final weight of 239.72 ± 17.47 g per individual, while those in compartment 2, fed a brewer's yeast-based diet, reached an average final weight of 238.36 ± 18.72 g ($p = 0.958$). Although not statistically significant, compartment 2 showed a slightly higher average weight gain of 58.14 ± 5.004 g per fish compared to 55.64 ± 4.041 g per fish in compartment 1. corresponding to an average weight gain of 47.16% and 45.04%, respectively ($p = 0.699$).
In terms of daily growth rate (DGR), fish in compartment 2 exhibited an average of 3.87 ± 0.33 g/day, while those in compartment 1 averaged 3.71 ± 0.27 g/day ($p = 0.699$). This minor difference aligns with the trend observed in overall weight gain.
Regarding feed utilization efficiency, the feed conversion ratio (FCR) was 2.52 ± 0.37 for compartment 2 compared to 3.37 ± 0.94 for compartment 1. While this suggests a potential improvement in feed efficiency when brewer's yeast is used as the protein source, the difference was not statistically significant ($p = 0.406$).
Water quality parameters remained stable throughout the experiment in both ponds, indicating that the dietary substitution did not have any adverse effects on the aquatic environment.
The main growth performance metrics obtained during the study are summarized in table 3:

Table (3) Fish Growth Performance Parameters During the Experiment

Experimental Groups Number of selected fish (from 25 fish per compartment)	compartment 1 6	compartment 2 6
Initial average weight (g)	47.5	47.5
Final weight (g)		
Minimum	89	94
Maximum	452	492
Average	239.72 ± 17.47	238.36 ± 18.72
Weight gain (g)		
Minimum	6	9
Maximum	91	109
Average	55.64 ± 4.041	58.14 ± 5.004
Weight gain (%)		
Minimum	2.19	5.88
Maximum	123.16	154.74
Average	45.04 ± 5.54	47.16 ± 6.94
Daily Growth Rate (g/day)		
Minimum	0.40	0.60
Maximum	6.10	7.30
Average	3.71 ± 0.27	3.87 ± 0.33
Feed Conversion Ratio (FCR)		
Minimum	0.37	0.29
Maximum	31.05	11.60
Average	3.37 ± 0.94	2.52 ± 0.37

These results suggest that complete replacement of fishmeal with brewer’s yeast does not significantly affect growth performance in *S. glanis* under the current experimental conditions.

One possible explanation for the comparable performance between the two dietary treatments lies in the nutritional composition of both ingredients. Both fishmeal and brewer’s yeast are rich in protein and contain essential amino acids such as lysine and methionine, which are crucial for optimal growth and metabolic function [15, 16]. In addition, brewer’s yeast includes biologically active components like beta-glucans, which are believed to support immune responses and aid in the more efficient uptake of nutrients [28].

From a physiological perspective, *S. glanis* appears to exhibit a degree of dietary flexibility, allowing it to adapt efficiently to different protein sources particularly when the feed formulation is well-balanced in terms of amino acid profile and micronutrient content. The inclusion of supplemental amino acids, such as lysine or methionine, may have helped mitigate any potential nutritional deficiencies in the yeast-based diet, thereby contributing to the observed similar growth performance.

However, the effectiveness of brewer’s yeast as a substitute for fishmeal may vary depending on the fish species, the formulation of the diet, and the level of substitution. While many studies have reported promising results at moderate replacement levels [13, 14], others have documented negative effects on growth when yeast is used at higher concentrations or as a complete replacement [34].

Our results agree with those of Zhou *et al*, who found no significant improvements in growth or survival rates in largemouth bass (*Micropterus salmoides*) fed diets supplemented with hydrolyzed brewer’s yeast compared to fishmeal-based diets [29]. Similarly, Guo *et al*. demonstrated that brewer’s yeast could be included in shrimp diets at levels ranging from 180 to 240 g/kg without compromising biomass production or feed conversion efficiency [28].

Another relevant study by Hardy *et al*. investigated the effects of incorporating brewer’s yeast at 1% and 3% levels in diets for juvenile Nile tilapia and reported no significant differences in survival or overall health indicators during the trial period [29]. Likewise,

Rosal *et al*. showed that up to 50% of fishmeal could be replaced with brewer's yeast in diets for red drum (*Sciaenops ocellatus*) without negatively affecting growth performance [30]. Notably, Ozório *et al*. observed improved weight gain in Nile tilapia when diets contained up to 20% brewer's yeast, with optimal results achieved at an inclusion level of approximately 15% [34]. In addition, Omar *et al*. reported enhanced growth performance in common carp (*Cyprinus carpio*) when brewer's yeast was incorporated into the feed [31].
From an economic standpoint, brewer's yeast presents a viable alternative due to its availability and lower cost compared to fishmeal, the price of which has risen due to limited supply and increasing demand [33]. Hua *et al*. suggested that using brewer's yeast in aquafeeds could help reduce production costs without sacrificing product quality [36]. Moreover, substituting fishmeal with yeast-based ingredients may offer environmental benefits, such as reducing nitrogen and phosphorus emissions, although further empirical research is needed to confirm these advantages.
Nevertheless, some limitations should be considered. Krogdahl *et al*. noted that complete replacement of fishmeal with brewer's yeast might lead to challenges in certain fish species due to differences in amino acid profiles—particularly the lower arginine content in yeast compared to fishmeal [34]. Therefore, when brewer's yeast is used as the primary protein source, it is advisable to supplement the diet with limiting amino acids to ensure a nutritionally balanced feed.
In summary, the results of this study support the successful incorporation of brewer's yeast into aquafeeds, especially when used as part of a partial replacement strategy or combined with synthetic amino acid supplementation.

Conclusion

The results of this study suggest that completely replacing fishmeal with brewer's yeast (*Saccharomyces cerevisiae*) in the diet of catfish (*Silurus glanis*) did not lead to any significant negative effects on key growth indicators such as final body weight, total weight gain, or daily growth rate ($p > 0.05$). Although there were no major differences between the two feeding groups, the group fed the brewer's yeast-based diet showed a slight improvement in feed conversion ratio, which might point to some benefits under the experimental conditions used here.
Throughout the trial, water quality parameters remained stable in both ponds, suggesting that replacing fishmeal with yeast didn't have any harmful effects on the aquatic environment. Given that brewer's yeast contains around %64 protein and includes essential amino acids along with B-complex vitamins, it seems to be a promising alternative to fishmeal, especially when supplemented with certain amino acids or used as part of a partial replacement strategy.
These findings support the idea that brewer's yeast can serve as a cost-effective and sustainable protein source in aquafeeds for *Silurus glanis*, and possibly for other freshwater fish species as well. Its potential to improve immune function and enhance nutrient absorption makes it more than just a protein substitute — it could also act as a functional ingredient in fish diets.
Based on these outcomes, further studies are needed to explore different inclusion levels of brewer's yeast (less than 100%) to find the best balance between nutritional value and cost-effectiveness. Long-term trials should also be carried out to better understand how yeast-based diets affect the fish's overall physiology and immune system.
Finally, an environmental impact assessment is recommended to evaluate how replacing fishmeal with brewer's yeast affects nitrogen and phosphorus discharge in aquaculture

systems. This would help confirm its ecological sustainability and support its use in more environmentally friendly feeding programs.

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