# EFFECT OF DIFFERENT DIETARY LEVELS OF FISH OIL ON COMMON CARP (*Cyprinus carpio*) GROWTH

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**ABSTRACT**

**This study aimed to investigate the impact of fish oil levels on the growth performance, feed efficiency, and body composition of common carp. The study divided 56 common carp into four treatment groups and fed diets containing different levels of fish oil over 56 days. Results showed significant differences in growth performance and feed efficiency between the treatments. The T3 (1.5% fish oil) and T4 (2% fish oil) groups showed the highest weight gain and most efficient feed conversion ratio, suggesting that 1.5% fish oil may support growth outcomes like those with 2% fish oil. Body composition analyses revealed favorable protein-to-fat ratios, suggesting improved nutrient retention and lean growth with reduced fish oil levels. These findings suggest that common carp can achieve satisfactory growth and feed efficiency with lower levels of fish oil, providing a more sustainable alternative to high-fish-oil diets.**

**Keywords: feed conversion ratio, aquaculture, feed efficiency, body composition ,specific growth rate**



# تأثيرإستعمال مستويات غذائية مختلفة من زيت السمك في نمو أسماك الكارب الشائع (*Cyprinus carpio*)

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**المستخلص**

**هدفت هذه الدراسة الى تقييم تأثير مستويات متباينة من زيت السمك في أداء النمو، كفاءة التغذية، وتركيب جسم أسماك الكارب الشائع، تم تقسيم 56 سمكة كارب إلى أربع مجموعات معاملات، حيث تم تغذيتها بعلائق تحتوي على مستويات مختلفة من زيت السمك (0.5%، 1%، 1.5%، و2%) لمدة 56 يومًا. أظهرت النتائج فروقًا معنوية في معدلات النمو وكفاءة تحويل العلف بين المعاملات. سجلت المعاملات التي تلقت 1.5 % (T3) و2 % (T4) من زيت السمك أعلى زيادة في الوزن وأفضل كفاءة في تحويل العلف، مما يشير إلى أن نسبة 1.5% من زيت السمك قد تكون كافية لتحقيق نتائج نمو مماثلة لتلك التي توفرها نسبة 2 % .كشفت تحليلات مكونات الجسم عن تحسن في نسب البروتين إلى الدهون، مما يدل على زيادة احتباس العناصر الغذائية ونمو العضلات مع إنخفاض مستويات زيت السمك. أوضحت هذه النتائج أن أسماك الكارب الشائع يمكنها تحقيق نمو وكفاءة تغذية مُرضية باستخدام مستويات أقل من زيت السمك، مما يوفر بديلًا أكثر استدامة مقارنة بالوجبات عالية المحتوى من زيت السمك.**

**الكلمات المفتاحية: نسبة التحويل الغذائي، الاستزراع المائي، كفاءة التغذية، مكونات الجسم، معدل النمو النوعي.**



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## INTRODUCTION

Aquaculture has become a vital industry for meeting the global demand for high-quality fish protein, as wild fisheries approach their sustainable limits (1). Fish farming sector is the fastest growing in production and maintaining global food security for more than decades due to its rapid development and intensive fish farming system are viewed as the main sources of food stead of commercial fisheries (22, 25). According to the Food and Agriculture Organization (FAO), fish and fishery products production continues to rise and is expected to reach approximately 8 million tons by 2050. Common carp (*Cyprinus carpio*) is one of the most widely cultured freshwater fish species due to its adaptability to various aquaculture systems, nutritional value, and significant economic importance (2, 3, 7, 23). Improving dietary formulations is crucial in aquaculture to support fish growth (1, 6, 24). Lipids are essential components to fish feeds, providing necessary energy sources and playing a vital role in cellular processes, hormone production, and immune responses (4, 11, 15). Fish oil is a key ingredient in aquaculture feeds due to its rich content of omega-3 fatty acids, particularly EPA (eicosapentaenoic acid) and DHA (docosahexaenoic acid), which play a significant role in enhancing growth, improving immune function, and supporting reproductive success in fish (15). EPA and DHA maintain cell membrane integrity and metabolic balance, which are essential for optimal growth and health (13). Studies have shown that fish oil in fish diets can significantly improve growth rates and feed conversion ratios (FCR) in various aquaculture species by enhancing nutrient absorption and metabolic efficiency (20). However, reliance on fish oil poses sustainability challenges (17). The overexploitation of wild fish stocks for fish oil production has raised concerns about its environmental impact in aquaculture feeds (21). This has driven the industry and researchers to explore alternative lipid sources or determine the minimum adequate levels of fish oil necessary to maintain fish growth and health while reducing dependence on this resource (10). Common carp are known for their adaptability to different feed formulations, and there is potential to reduce fish oil content without negatively affecting growth and health outcomes (19). The current study investigates the effect of different fish oil levels on Common Carp's growth performance, feed efficiency, and body composition. The study aimed to determine the minimum fish oil level that supports optimal growth and feed efficiency. Additionally, it seeks to provide insights into the broader implications of reducing fish oil usage in aquaculture, contributing to more sustainable fish farming practices.

## MATERIALS AND METHODS

**Experimental fish and setup:** This study was conducted on common carp. A total of 56 fish, with an average initial weight of 40 grams, were randomly distributed into four treatment groups based on their assigned diets:

T1 (0% fish oil)
T2 (1% fish oil)
T3 (1.5% fish oil)
T4 (2% fish oil)

The fish were placed in glass tanks equipped with aerators to maintain adequate oxygen levels, with two replicates per treatment (2 tanks per treatment), each containing 7 fish. The water temperature was maintained between 24 and 26°C, the optimal range for carp growth (9), and dissolved oxygen levels were kept above 6 mg/L to ensure sufficient respiratory function and avoid hypoxia (15). Water quality parameters such as pH were monitored due to their significant impact on fish health, growth, and feed efficiency (7). Tanks were cleaned daily by removing waste and replacing 25% of the water. Fish were weighed every 15 days over the 56-day experimental period.

**Experimental diet:** Four types of feed were formulated by sieving and mixing feed ingredients according to the composition of each diet(table 1), ensuring equal nitrogen content (30% protein) and caloric content to ensure that any differences in growth performance and body composition were due to fish oil levels and not variations in protein or energy intake (8). Protein was primarily sourced from animal-based ingredients such as fishmeal. Plant-based ingredients such as soybean, corn, barley, millet, and rice bran. provided essential carbohydrates and

additional protein (14). The composition of each diet was adjusted to maintain nutrient balance in line with the nutritional needs of common carp (14). Fish oil was the variable component in the diets, (Table 1) shows the specific composition of each diet, highlighting the variations in fish oil levels. This design allowed for a controlled investigation into the effect of fish oil on growth and nutrient utilization.

**Table 1. Composition of experimental diets (percentage basis)**

| Ingredient | T1 (0% Fish Oil) | T2 (1% Fish Oil) | T3 (1.5% Fish Oil) | T4 (2% Fish Oil) |
|---|---|---|---|---|
| Animal Protein | 25% | 25% | 25% | 25% |
| Corn | 12% | 12% | 12% | 12% |
| Rice Bran | 9% | 8% | 7.5% | 7% |
| Millet | 15% | 15% | 15% | 15% |
| Fish Oil | 0% | 1% | 1.5% | 2% |
| Soybean | 33% | 33% | 33% | 33% |
| Barley | 5% | 5% | 5% | 5% |
| Vitamins & Minerals | 1% | 1% | 1% | 1% |

Fish were individually weighed using a precision scale to ensure accurate growth tracking and to calculate feed quantities and growth, feed efficiency, and protein parameters, including:

Weight gain

Specific growth rate (SGR)

Feed conversion ratio (FCR)

Protein efficiency ratio (PER)

Protein intake (PI)

SGR was calculated using the formula:

Specific Growth Rate = [Natural Log of Final Weight – Natural Log of Initial Weight] x 100 / Time Period

Feed consumption was recorded daily, and FCR was calculated as:

Feed Conversion Ratio = Feed Intake (g/fish) / Weight Gain (g/fish)

PER was calculated to determine the effectiveness of dietary protein in contributing to weight gain, providing insights into the nutritional value of protein sources in each diet:

Protein Efficiency Ratio = Wet Weight Gain of Fish / Protein Intake

At the end of the 56-day period, a sample of fish from each group was sacrificed, and white and red muscles were collected for chemical composition analysis, including:

-Protein

-Fat

-Ash content

-Moisture

These analyses were conducted using standard biochemical procedures (7), allowing for comparisons of nutrient retention, particularly protein and fat levels, among the different treatments.

## RESULTS AND DISCUSSION

### Weight gain and growth performance

Different levels of fish oil in the diets significantly affected the growth performance of common carp. Fish in the T3 (1.5% fish oil) and T4 (2% fish oil) groups showed the highest weight gain, indicating that these lower fish oil levels can support effective growth outcomes. These results suggest that common carp can achieve similar growth using moderate to low levels of fish oil, reducing the need for high fish oil levels (12). These findings are constant with previous studies of alternative lipid sources, which have shown that, despite its benefits, fish oil may not be necessary in large quantities to support optimal growth if other energy and protein sources are adequately balanced in the diet (16).

**Table 2. Weight gain (grams) in common carp fed diets with different fish oil levels**

| Treatment | Initial Weight | Final Weight | Weight gain |
|---|---|---|---|
| T1 (0% Fish Oil) | 38.805 ±0.525 | 109.845 c±0.515 | 71.040 c±1.040 |
| T2 (1% Fish Oil) | 39.500 ±0.330 | 142.320 b±0.190 | 102.820 ± b±1.860 |
| T3 (1.5% Fish Oil) | 38.835 ±0.335 | 160.135 a±0.935 | 121.300 a±0.600± |
| T4 (2% Fish Oil) | 38.750 ±0.080 | 163.545 a±0.925 | 124.795 ± a±0.845 |

The T3 and T4 groups, which contained higher levels of fish oil, showed faster growth rates compared to the T1 and T2 groups. These results suggest that including fish oil at 1.5% and 2% levels provides additional growth benefits.These findings highlight the potential to reduce fish oil usage to 1.5% or 2% in common carp diets, which could contribute to sustainable and cost-effective aquaculture practices (19).

**Feed conversion ratio (FCR) and protein efficiency ratio (PER):** FCR is a critical indicator of feed efficiency, and the results of this study show that the T3 and T4 groups utilized feed most efficiently, with the T4 group (2% fish oil) recording the lowest FCR values, closely followed by the T3 group (1.5% fish oil). These values indicate that these levels improved feed conversion efficiency (8), which is reflected in protein utilization (Table 4). These results suggest that including fish oil at levels below 5% can maintain or improve feed conversion efficiency, consistent with previous research supporting low-fish-oil diets without compromising performance (13, 14).

**Table 3. Feed conversion ratio (FCR) in common carp**

| Treatment | FCR |
|---|---|
| T1 (0% Fish Oil) | 2.290 a±0.040 |
| T2 (1% Fish Oil) | 1.905 b±0.035 |
| T3 (1.5% Fish Oil) | 1.745 c±0.005 |
| T4 (2% Fish Oil) | 1.700 c±0.003 |

**Table 4. Protein efficiency ratio (PER) in common carp fed diets with different Fish oil levels**

| Treatment | PER |
|---|---|
| T1 (0% Fish Oil) | 1.500 c±0.030 |
| T2 (1% Fish Oil) | 1.660 b±0.030 |
| T3 (1.5% Fish Oil) | 1.865 a±0.005 |
| T4 (2% Fish Oil) | 1.905 a±0.025 |

**Body composition**

Body composition analysis at the end of the experiment revealed differences in moisture, protein, fat, and ash content among the treatment groups. The T3 and T4 groups showed higher protein and moisture levels and lower fat levels, suggesting that low-fish-oil diets may promote lean muscle growth compared to fat deposition (7). This finding is essential for consumer preferences, as less fatty fish are more marketable (15).

**Table 5. Body composition of common carp fed diets with different fish oil levels**

| Treatment | Moisture (%) | Protein (%) | Fat (%) | Ash (%) |
|---|---|---|---|---|
| T1 (0% Fish Oil) | 80.79 | 17.93 | 2.6 | 1.089 |
| T2 (1% Fish Oil) | 83.7 | 18.65 | 3.9 | 1.231 |
| T3 (1.5% Fish Oil) | 90.1 | 19.65 | 2.2 | 1.163 |
| T4 (2% Fish Oil) | 77.5 | 17.30 | 10.1 | 0.637 |

The T2 and T3 groups showed increased protein retention and moisture levels compared to the T1 (0% fish oil) and T4 (2% fish oil) groups, suggesting that diets with these fish oil levels may promote lean muscle growth rather than fat accumulation (7). This result is important from a consumer perspective, as less fatty fish are generally preferred in the market (15).Previous studies have shown that fish can adapt to low fish oil levels without compromising growth when provided with adequate energy and protein from alternative sources (15), (16). These findings align with the current study, as common carp demonstrated efficient nutrient utilization even at low fish oil levels, this could contribute to cost savings and environmental benefits by reducing reliance on fish oil—a limited and expensive resource (13). Previous studies have shown that fish can adapt to low fish oil levels without compromising growth when provided with adequate energy and protein from alternative sources (15), (16). These findings align with the current study, as common carp demonstrated efficient nutrient utilization even at low fish oil levels, this could contribute to cost savings and environmental benefits by reducing reliance on fish oil—a limited and expensive resource (13). This study demonstrates that common carp can maintain optimal growth performance, feed efficiency, and favorable body composition using low levels of fish oil in their diets. The T4 (2% fish oil) and T1 (0% fish oil) groups showed similar or even better growth than higher fish

oil levels, indicating that low fish oil supplementation is feasible without compromising growth or nutritional quality. These findings support previous research suggesting that alternative or low fish oil levels can meet the nutritional needs of cultured species when supplemented with balanced protein and energy sources (11, 16). Aquaculture operations can adopt low fish oil levels, such as 2% or 0%, in common carp diets without affecting growth or body composition, This adjustment could reduce costs and contribute to environmental sustainability. Fish oil provides essential omega-3 fatty acids, there is potential to use alternative sources ,which could offer similar nutritional benefits while reducing environmental impact (13).Expand research to other species, while common carp have shown adaptability to low fish oil levels, it would be beneficial to expand this research to other commercially cultured species to determine if similar benefits apply across a broader range of aquaculture (20). A comprehensive cost-benefit analysis and environmental impact assessment should be conducted to determine the full implications of reducing fish oil usage on industry profitability and sustainability.

**CONFLICT OF INTEREST**

The authors declare that they have no conflicts of interest.

**DECLARATION OF FUND**

The authors declare that they have not received a fund.

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