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EFFECT OF USING SUNFLOWER AND CANOLA OILS IN COMMON CARP (CYPRINUS CARPIO L.) DIETS ON GROWTH PARAMETERS, FEED UTILIZATION AND BODY COMPOSITION

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Abstract

The fish production industry has become one of the most important animal production projects, and fish industry suffer from feed costs, so this study aims to find accessible food additives that increase production or reduce costs. This was done by 126 fish of common carp (*Cyprinus carpio* L.) Average individual weight 42.72 g ± 2.28 g. and 254.78 g ± 2.95 g biomass weight. were randomly distributed to 21 aquaria, with seven treatments with three replicates, 6 fish per aquarium. Fish were fed 3% by weight of biomass, on a prepared diet with a protein content of 28%. It was divided into seven sections by treatments, T1 without addition, T2, T3and T4 adding sunflower oil 2, 4 and 6 g/kg, consecutively, T5, T6 and T7 adding canola oil 2, 4, and6 g/kg consecutively. The experiment period lasted 70 days, and weight data were taken every two weeks. Studied growth indicators (WG) Weight gain (DWG) Daily weight gain (RGR) Relative growth rate (SGR) Specific growth rate, feed utilization indicators Feed conversion rate (FCR), feed efficiency rate (FER), protein efficiency rate (PER). The fish body components were studied. The results showed a significant superiority ($p \leq 0.05$) of T5, T6 and T7 treatments over all treatments of growth indicators. Similarly for indices of food use, treatments T5, T6 and T7 significantly outperformed ($p \leq 0.05$) in all experimental treatments for FER and PER indices.

Keywords: Sunflower oil, Canola oil, Cyprinus carpio L., Growth parameters, Feed utilization, Body composition.

تأثير استعمال زيت زهرة الشمس وزيت الكانولا في علائق اسماك الكارب الشائع (*Cyprinus carpio L.*) على مؤشرات النمو، الاستفادة من العلف ومكونات الجسم

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الخلاصة

أصبحت صناعة الإنتاج السمكي من أهم مشاريع الإنتاج الحيواني، وتعاني صناعة الأسماك من تكاليف العلف، لذلك تهدف هذه الدراسة إلى إيجاد إضافات غذائية يمكن الوصول إليها تزيد الإنتاج أو تقلل التكاليف. جهزت 126 سمكة من الكارب الشائع (Cyprinus carpio L.)، متوسط الوزن الفردي 42.72 غم ± 2.28 غم. و254.78 غم ± 2.95 جم وزن الكتلة الحيوية. تم توزيعها عشوائيًا على 21 حوضًا، مع سبعة معاملات بثلاثة مكررات، و6 أسماك لكل حوض. تم تغذية الأسماك بنسبة 3٪ من وزن الكتلة الحيوية، على نظام غذائي مُجهز بمحتوى بروتيني بنسبة 28٪. تم تقسيمها إلى سبعة أقسام حسب المعاملات، T1 بدون إضافة، T2، T3 وT4 بإضافة زيت زهرة الشمس 2، 4 و6 غم. كغم$^{-1}$، على التوالي، T5، T6 وT7 بإضافة زيت الكانولا 2، 4 ، 6 غم. كغم$^{-1}$ على التوالي. استغرقت فترة التجربة 70 يومًا، وأخذت بيانات الوزن كل أسبوعين. مؤشرات النمو المدروسة (WG) اكتساب الوزن (DWG) اكتساب الوزن اليومي (RGR) معدل النمو النسبي (SGR) معدل النمو المحدد، مؤشرات استخدام العلف تمت دراسة معدل التحويل الغذائي (FCR)، ومعدل كفاءة التغذية (FER)، ومعدل كفاءة البروتين (PER). وذُرست مكونات جسم السمكة. أظهرت النتائج تفوقاً معنوياً ($p\leq$ 0.05) لمعاملات T5 وT6 وT7 على جميع معاملات مؤشرات النمو. وبالمثل بالنسبة لمؤشرات استخدام الغذاء، تفوقت المعاملات T5 وT6 وT7 بشكل ملحوظ ($p\leq$ 0.05) في جميع المعالجات التجريبية لمؤشرات FER وP E R.

كلمات مفتاحية: زيت زهرة الشمس، زيت الكانولا، Cyprinus carpio L.، عوامل النمو، استخدام العلف، تكوين الجسم.

Introduction

Fish farming projects are among the best investment projects in Iraq and clearly support food security (10), fish farmers face the challenges of feed costs, which constitute 65-76% of the production cost, the researchers worked to try to reduce this percentage by finding alternatives to the ingredients of the diets, through available

and low-cost food additives and testing their addition in part or as a substitute for one of the components of the diet (7).

Canola oil is available globally in abundance and at an affordable cost compared to other food oils (3), in addition, it contains essential fatty acids in ideal quantities in feeding aquatic animals (18), it was noted that the use of canola oil partially or completely in fish diets feeding of common carp gave significant results in growth indicators, liver health indicators, hepatosomatic index (HSI), economic index, survival rates and net lipid utilization (NLU) (12), we can use food non-protein sources such as carbohydrates and fats to balance energy, they can reduce the consumption of protein to produce energy for the fish, which can be deposited in the muscles of the body and increase the weight of the fish (1). As a result, the benefit of the protein intake in the diet will be increased and the final cost of breeding will be reduced. For this reason, determining lipid requirements is an effective step for producing a low-cost, high-efficiency diet for fish growth (19).

This study aims to discover the possibility of adding different levels of sunflower and canola oils in the diets of common carp, to find out its effect on growth indicators, feed utilization and body composition of the fish under experiment.

Material and Methods

The protocol and the treaty of Rome - legal analysis of animal welfare standards were observed during transportation, feeding and sampling, according to standard (2). The experiment was conducted in the fish laboratory of the / Department of Animal Production / College of Agriculture / University of Anbar / Iraq.

Aquaria and environmental conditions of fish: The experiment lasted 70 days for the period from 4/December/ 2021 to 26/April /2022. The water quality was monitored and the needed checks were carried out periodically in cooperation with Directorate of Environmental Protection and Improvement / Anbar. The water temperature in the experiment aquaria ranged from 23-25 degrees Celsius (The water temperature is controlled by heaters designed for this purpose Chinese made), and the dissolved oxygen concentration was 6.8-9.2 mg/Liter. Two Chinese-made (Hailea) compressors with a capacity of 50 watts were used to ensure sustainable air supply and the pH value ranged between 6.8- 7.3. For the duration of the experiment. The water quality was controlled by withdrawing water and waste daily by siphon method after eating the prescribed meal and partially replacing 25% of the water with the previously stored water.

Food and processing transactions: The fish was fed 3% of the weight of the biomass as a ration (balls with a diameter of 2-3 mm). From a certified diet, produced by the Kingdom of Saudi Arabia, Maram Company, with 28% raw protein.

It was divided into seven sections by the treatments T1 without addition, T2 adding sunflower oil 2g/kg ration, T3 adding sunflower oil 4g/kg ration, T4 add sunflower oil 6g/kg ration, T5 add canola oil 2g/kg ration, T6 add canola oil 4g/kg ration and T7 add canola oil 6g/kg ration. The additives were mixed by extruding the amount of oil

in the form of a spray on the scattered ration on the table and homogenizing it in a way that ensures distribution on all the ration granules. The feed was given two meals per day (9 am and 2 pm), the weights of fish were taken individually every two weeks and the weight of the provided feed was adjusted according to the new weights of the biomass until the end of the experiment.

Experiment design: A total 126 fish of close weight were selected to carry out the experiment and were housed in the aquaria designated for them, with a weight average of 42.72 g ± 2.28 g per fish, and an average weight of 254.78 g ± 2.95 g per each biomass in one aquarium, with 6 fish for each replicate with three replications for each treatment.

studied standards: In order to find out the results of the indicators required to complete the study, at the end of experiment, approximately 100 ppm of clove oil was used to euthanize the fish.

Growth indicators: were determined using the following equation, for each indicator, where W1 is the final weight, W0 is the initial weight and T is the time in days.

Weight Gain (W G) = W1 – W0 (gm)
Daily Weight Gain (DWG) = W1 – W0 / T (gm/day)
Relative Growth Rate (R G R) = W1 – W0 / W1 (%)
Specific Growth Rate (S G R) = ln W2 – ln W1 / T (%)

Feed utilization indicators: were determined using the following equation, where R is total dry weight of diet (gm), and P is total dry weight of protein (gm), It is derived from the weight of the dry food served × the proportion of protein in the food

Food Conversion Rate (FCR) = R (gm) / WG (gm)
Feed efficiency rate (FER) = WG (gm) / R (gm)
Protein efficiency rate (PER) = WG / P (gm)

The proximate body composition analysis: After euthanize the fish. The bodies of the fish were taken to the laboratory for the purpose of analysis and detection of the components.

Moisture content: Two samples were collected from each replicate (six fish per treatment) and the samples were dried at 60°C until a constant weight was achieved. Approximate composition calculated according to standard (4). methods sunflower and canola oils, (17).

protein content: Kjeldahl method which used for the Crude protein analysis was according to the Analytical Methods Committee, uses the method to determine nitrogen content, using 6.25 as the conversion factor to get crude protein from total nitrogen.

Fat content: 5 g of sample was completely extracted by wrapping in a filter paper in a Soxhlet apparatus,to obtain crude fat, petroleum ether was the extractant used. according to standard (4). methods.

Ash content: After drying the samples and calculating the moisture content, they were taken to a burning furnace 550 Celsius for 4-8 hours until the weight stabilized, at which point the sample was weighed. According to (4).

Statistical analysis: Statistical Analysis System was used to analyze the effect of different coefficients in the studied characteristics on a complete Randomize Design (CRD), and the significant differences between the averages were compared with 8, 21. Polynomial at the level of significance (P≤0.05), depending on the mathematical model.

$Yij = M + Ti + eij$

Results and Discussion

Aquaria water quality: The water temperature in the experiment aquaria ranged from 23-25 degrees Celsius, and the dissolved oxygen concentration was 6.8-9.2 mg. per Liter and the pH value ranged between 6.8- 7.3. For the duration of the experiment.

Discussion water quality: The levels of temperature, pH and dissolved oxygen levels of aquaria water for the current experiment were within the appropriate limits for the welfare of common carp fish in Iraq (13).

growth parameters: WG: The results of the current study showed the significant (p≤ 0.05) of the weight gain of the two treatments T5 (0.002 canola) and T7 (0.006 canola) over all treatments of the experiment, and recorded 484g and 495g. respectively and it did not differ significantly (p≤ 0.05) from the treatment of T6 (0.004 canola) which recorded 482g.

DWG, RGR and SGR for the other indicators were daily weight gain, relative growth rate and specific growth rate significantly superior (p≤ 0.05) canola oil addition treatments with their three levels: T5 0.002, T6 0.004 and T7 0.006. As shown in Table 1.

Table 1 Effect of using sunflower and canola oils in common carp diets on growth parameters.

Criteria	Control T1	Add sunflower oil			Add canola oil		
		T2 0.002	T3 0.004	T4 0.006	T5 0.002	T6 0.004	T7 0.006
I W gm	254 *±0.375	253 ±3.25	255 ±0.075	253 ±1.99	254 ±2.14	254 ±3.03	254 ±0.590
F W gm	428 ±10.2 b	431 ±27.3 b	412 ±18.1 b	431 ±2.78 b	484 ±4.65 A	482 ±12.5 ab	495 ±6.58 a
W G gm	174 ±9.86 b	178 ±24.1 b	157 ±18.0 b	178 ±4.77 b	230 ±2.51 a	228 ±15.2 a	241 ±7.17 a

D W G gm/day	2.485 ±0.141 b	2.542 ±0.345 b	2.242 ±0.258 b	2.528 ±0.068 b	3.285 ±0.035 a	3.257 ±0.217 a	0.102 442 ± a
R G R %	0.674 ±0.141 b	0.703 ±0.345 b	1.012 ±0.258 b	0.703 ±0.068 b	0.905 ±0.035 a	0.897 ±0.217 a	0.948 ±0.102 a
S G R %	0.0072 ±0.0002 c	0.0076 ±0.0007 bc	0.0067 ±0.0006 c	0.0076 ±0.0002 bc	0.0092 ±0.00 a	0.0091 ±0.0006 ab	0.0095 ±0.0002 a

*** Values represent mean ± standard error.**
a, b, c: the different letters within the same row indicate the presence of significant differences between the treatments at the level of significance (P≤0.05).

Discussion growth parameters: (17). indicated that the presence of the appropriate essential fatty acids in the ideal quantity and quality controls the diet of fish in the aquatic environment. The presence of similarity to some extent in the quality of unsaturated fatty acids and in quantities appropriate to the needs of fish in canola oil with fish oil (15). This may be caused the weight gain of fish that were fed at different levels to add canola oil to their diet, and their different percentages (0.002, 0.004 and 0.006), The rest of the indicators depend relatively mainly on the weight gain that occurs according to their equations.

feed utilization: FCR: The results for the food conversion rate trait showed no significant differences (P≤0.05) between all the experimental treatments.
FER: As for the feed efficiency ratio, all canola oil treatments T5, 6T and T7 significantly (P≤0.05) outperformed all experimental treatments and scored 41.0%, 40.5% and 43.1%, respectively.
PER: As for the feed efficiency ratio, all canola oil treatments T5, 6T and T7 significantly (P≤0.05) outperformed all experimental treatments and scored 41.0%, 40.5% and 43.1%, respectively.

Table 2. Effect of using sunflower and canola oils in common carp diets on feed utilization.

Criteria	Control T1	Add sunflower oil			Add canola oil		
		T2 0.002	**T3 0.004**	**T4 0.006**	**T5 0.002**	**T6 0.004**	**T7 0.006**
F C R	3.28 *±0.190 A	2.84 ±0.765 a	3.62 ±0.425 a	± 3.13 0.085 a	2.43 ±0.030 A	2.45 ±0.165 a	2.31 ±0.065 A
F C E	30.5 ±1.76 B	31.9 ±4.32 b	28.1 ±3.44 b	± 31.8 0.855 b	41.0 ±0.450 a	40.8 ±2.72 a	43.1 ±1.28 A
P E R	108 ±6.29 B	114 ±15.4 b	99.7 ±11.5 b	± 113 3.04 b	146 ±1.83 a	145 ±10.2 a	154 ±4.70 A

*** Values represent mean ± standard error.**
a, b, c: the different letters within the same row indicate the presence of significant differences between the treatments at the level of significance (P≤0.05).

Discussion feed utilization: Food Conversion Rate (FCR): (8) indicated that the optimal dietary protein level improves the digestive and absorption capacity of protein, and the abundance of fats in the diet is used as an energy source, providing protein for maintenance and muscle formation and (9). The results of our current study may agree with the researchers theory above. The results gave an increase in the

indicators of growth and feed utilization, and they did not differ significantly in the food conversion rate.

Feed efficiency rate (FER) and Protein efficiency rate (PER): Canola oil, when used partially or completely in fish diets, raises and improves growth performance rates and improves feed utilization rates economically (12). and it contains the appropriate dietary linolenic / linoleic acid ratios affecting growth performance and the formation of sex steroids for common carp (5). Perhaps this is what happened to our current study of the superiority of canola oil additives.

body composition: Moisture: The results showed the significant (P≤0.05) in the body moisture percentage of fish for the control treatment 1T, which was fed with the ready-made ration without additives, and the second treatment 2T, adding 2g/kg2 over all the experimental treatments, and it recorded 77.6% and 77.2%, respectively.

Protein: The results of the protein ratio showed a significant (P≤0.05) superiority for each of the two treatments of adding sunflower oil 4g/kg 3T and 6g/kg 4T, and it scored 16.6% and 16.7%, respectively. And the two treatments of adding canola oil 4g/kg 6T and 6g/kg 7T to all treatments were 17.1% and 17.4%, respectively.

Fats: As for the percentage of body fat in fish, it was significantly (P≤0.05) superior to the treatment 7T 6g/kg canola oil, which scored 3.52%, and did not differ significantly from the treatment, canola oil 4g/kg 6T, which recorded 3.18%, as shown in Table 3.

Table 3 Effect of using sunflower and canola oils in common carp diets on body composition.

Criteria	Control T1	Add sunflower oil			Add canola oil		
		T2 0.002	T3 0.004	T4 0.006	T5 0.002	T6 0.004	T7 0.006
Moisture	77.6 ±*0.242 A	77.2 ±0.050 a	76.3 ±0.038 b	75.9 ±0.047 b	76.2 ±0.267 b	74.9 ±0.297 C	73.9 ±0.250 D
Protein	15.4 ±0.432 C	15.5 ±0.197 bc	16.6 ±0.170 a	16.7 ±0.165 a	16.5 ±0.307 ab	17.1 ±0.215 a	17.4 ±0.555 A
Fats	2.57 ±0.226 C	2.50 ±0.020 c	2.76 ±0.075 bc	2.65 ±0.070 bc	2.65 ±0.285 bc	3.18 ±0.069 ab	3.52 ±0.130 A
Ash	2.40 ±0.295 A	2.51 ±0.360 a	2.81 ±0.167 a	2.73 ±0.142 a	2.99 ±0.125 a	3.32 ±0.372 a	3.24 ±0.095 A

*** Values represent mean ± standard error.**
a, b, c: the different letters within the same row indicate the presence of significant differences between the treatments at the level of significance (P≤0.05).

Discussion body composition: Moisture: There is a clearly inverse relationship between moisture content and fat mass deposited in fish body cells, and fish use a lot of fat reserves as an energy source, especially during spawning and starvation activities (11). Long-chain omega-3 fatty acids (N-3) can be deposited in the body of fish and stored in the ventral muscle cells, for use in energy production (16). The low moisture ratios of the treatments of the current study may be due to the canola oil's

content of long-chain omega-3 fatty acids added to the diets, which led to the deposition of fats in the bodies of fish fed on the experimental diets, and the moisture levels of the bodies of fishes treated as control decreased.

Protein and Fat: Long-chain omega-3 (N-3) polyunsaturated fats are considered safe additives or alternatives when used in fish feed and affect the activities of enzymes related to oxidative stress and fat deposition on the whole body in a positive way (16). (6) indicated that the consumption of these oils into the diet of fish works to provide or reduce the digestion of protein to produce energy, and the surplus is deposited in their bodies and between the muscles. From the results of our current study, may be the proportion of protein in the tissues of the fish body increases when saturated fats similar to fatty acids are available in the diet, the saturated fats in the diets preserved the digested protein to be deposited in their bodies

Ash: represents minerals, salts and rare metal elements in addition to mineral sources, as silica can be found from plant food sources that absorb mono salicylic acid and insects (14). It may be that the percentage of ash does not differ between treatments as it is from abiotic solids, and the slight differences in ash may be attributed to the same fish.

Conclusions: A study was conducted to test the feasibility of using sunflower oil and canola oil in feeding common carp fish, by adding three levels of each (0.002, 0.004 and 0.006) to the diets for a period of 70 days under appropriate conditions. The results of adding sunflower oil (0.004 and 0.006) showed that protein was deposited in the fish body. While the addition of canola oil at an amount of (0.004 and 0.006) improved all growth indicators and improved feed utilization efficiency and protein utilization efficiency and led to an improvement in the deposition of protein and fat in the fish body. More research is required to obtain a significant reduction in the costs of the fish production industry by testing other alternatives that improve production performance without compromising on the overall health and welfare of the fish under cultivation.

References

1. Aminikhoei, Z., Choi, J., and Lee, S. M. (2015). Optimal dietary protein and lipid levels for growth of juvenile Israeli carp Cyprinus carpio. Fisheries and aquatic sciences, 18(3): 265-271.
2. Camm, T., and Bowles, D. (2000). Animal welfare and the treaty of Rome-legal analysis of the protocol on animal welfare and welfare standards in the European Union. Journal of Environmental Law, 12(2): 197-205.
3. Canola Council of Canada. (2007). Canadian Canola Industry, Market Statistics. http://www.canolacouncil org/canolaprices. htmL Canola Council of Canada, Winnipeg, Manitoba, Canada.
4. Cunniff, P., and Washington, D. (1997). Official methods of analysis of aoac international. The Journal of AOAC International, 80(6): 127A.

5. Davydov, D. M., Boev, A., and Gorbunov, S. (2021). Making the choice between bioelectrical impedance measures for body hydration status assessment. Scientific reports, 11(1): 1-13.
6. Dawood, M. A. (2021). Nutritional immunity of fish intestines: Important insights for sustainable aquaculture. Reviews in Aquaculture, 13(1): 642-663.
7. Maaruf, H. T., and Akbay, C. (2020). Economic Analysis of Fish Farming in The Northern Region of Iraq. Kahramanmaraş Sütçü İmam Universitesi Tarım Ve Doga Dergisi, 23(5): 1257-1269.
8. Ma, X., Wang, L., Xie, D., Tian, X., Zhang, Y., Wu, L., ... and Nie, G. (2020). Effect of dietary linolenic/linoleic acid ratios on growth performance, ovarian steroidogenesis, plasma sex steroid hormone, and tissue fatty acid accumulation in juvenile common carp, *Cyprinus carpio*. Aquaculture Reports, 18: 100452.
9. Ma, R., Liu, X., Meng, Y., Wu, J., Zhang, L., Han, B., ... and Li, C. (2019). Protein nutrition on sub-adult triploid rainbow trout (1): Dietary requirement and effect on anti-oxidative capacity, protein digestion and absorption. Aquaculture, 507: 428-434.
10. Mahmud, S. F. (2021). Opportunities and Challenges of Sustainable Agricultural Development in Iraq.
11. McClements, D. J., and Grossmann, L. (2021). The science of plant-based foods: Constructing next-generation meat, fish, milk, and egg analogs. Comprehensive Reviews in Food Science and Food Safety, 20(4): 4049-4100.
12. Minabi, K., Zakeri, M., Ghafleh Marammazi, J., Yavari, V., and Mousavi, S. M. (2015). Effects of dietary replacement of fish oil with canola oil in the diet of juvenile common carp, *Cyprinus carpio* on growth performance and feeding utilization of body and diet economic index. Journal of Fisheries, 68(1): 157-175.
13. Mohammed, A. J. (2019). Evaluation of The Validity of Agricultural Drainage Water for The Breeding of Common Carp Fish in Artificial ponds, Iraq. Plant Archives, 19(2): 403-406.
14. Nasef, A. M. (2021). Effect of Variation in Aquatic Environment Type on Biochemical Composition and Protein Quality in Some Fishes. Egyptian Academic Journal of Biological Sciences, B. Zoology, 13(2): 207-223.
15. Petrie, J. R., Zhou, X. R., Leonforte, A., McAllister, J., Shrestha, P., Kennedy, Y., ... and Singh, S. P. (2020). Development of a Brassica napus (Canola) crop containing fish oil-like levels of DHA in the seed oil. Frontiers in plant science, 11, 727.
16. Ruyter, B., Sissener, N. H., Østbye, T. K., Simon, C. J., Krasnov, A., Bou, M., ... and Berge, G. M. (2019). n-3 Canola oil effectively replaces fish oil as a new safe dietary source of DHA in feed for juvenile Atlantic salmon. British Journal of Nutrition, 122(12): 1329-1345.
17. Sikandar, M. A., Hassan, Z., Basit, A., Khan, R., and Ozdemir, F. A. (2020). Virtual analysis on proximate body composition of Labeo rohita and Cirrhinus mrigala. Turkish Journal of Agriculture-Food Science and Technology, 8(1): 105-109.

18. Steinberg, C. E., and Steinberg, C. E. (2022). Essential Fatty Acids— 'Fueling Versus Controlling'. Aquatic Animal Nutrition: Organic Macro-and Micro-Nutrients, 673-721.
19. Yin, K. S., Roos, N. A. C., Gnanou, J., and Caszo, B. (2022). Influence of Protein Diet on Weight Change in Obesity: A Systematic Review. Journal of Clinical and Diagnostic Research, 16(1): 1-6.