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Effects of partial replacement of soybean meal by sesame seed cake on diet stability and growth performance of common carp (*Cyprinus carpio* L.)

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Abstract

This study was conducted under laboratory conditions to evaluate the effect of sesame seed (*Sesamum indicum*) cake (SSC) as a protein source by a partial replacement of soybean (Glycine max) meal (SBM) on diet stability and growth performance and some productive traits (final weight, total weight gain, specific growth rate, relative growth rate, feed conversion rates and condition factor) of common carp (*C. carpio*). The experiment consisted of ten treatments with two replications for each treatment, where SSC was used instead of SBM in three types of treatments: row, soaked and phytase enzyme addition in T1, T2 and T3 with three different substitution ratios 10%,20% and 30% in D1, D2 and D3 and treatment without SSC (control group) in T0D0. The results showed that the diet stability was unaffected by inclusion different levels of SSC, while results of growth performance showed that the replacement of 30% SSC instead of SBM with the addition of phytase enzyme improved significantly ($p \leq 0.05$) all growth parameters and some productive traits (final weight, total weight gain, specific growth rate, relative growth rate, feed conversion rates and condition factor), In addition, the results showed that the use of sesame seed cake in raw or soaked form does not negatively affect the growth parameters of the fish. Therefore, sesame seed cake can be used as a cheap source of protein in common carps *C. carpio* diets.

Key words: Sesame seed, Stability, growth performance.

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Introduction

Reducing the cost of fish feed is conceder one of the important and necessary steps to improving aquaculture. Preparing diet suits the needs of the fish and meets the growth requirements, and in a low costs are very important to achieving the success of fish projects [1]. The majority of traditional fish diets are plant or animal products and some by-products of factories the majority of these products are also consumed by humans [2]. The most common plant sours of protein used in fish diets is soybean meal, but consuming it by human or animal feed industries makes the sustainably of using soybean protein sources for fish feed difficult [3,4]. Sesame seeds (*Sesamum indicum*) can be used in the diets of some types of fish as a source of protein due to the ability of fish to digest its nutritional contents [5]. The quantity and quality nutrients contain in sesame seed cake is similar to nutrients contain in soybean meal and some other traditional legumes [6,7]. Many researchers substantiate that the sesame seeds cake is rich in protein and it can be used as feed ingredients in diets of some aquatic organisms [8]. This study aimed to evaluate using sesame seed cake as a one of the by-product that rich in protein, and available locally as a residue of oil production, and using it as a partial substitute of soybean meal in common carp diets.

Materials and methods

The experiment was conducted in fish laboratory of Animal Production Department/ College of Agriculture / Tikrit University, for 60 days from 6/3/2022 to 5/5/2022. Twenty glass tanks with dimensions of 40× 60 x 40 cm placed on stands made of iron consisting of three floors were used. The aquariums provided with sponge filters to filter the water, and an air pump to supply the necessary oxygen.

1- Experimental design

The experiment consisted of ten treatments with two replicates for each treatment. Sesame seed cake SSC was used instead of soybean meal SBM in three different treatments: row, soaked and phytase enzyme addition in T1, T2 and T3 with three different replacing ratios 10%,20% and 30% in D1, D2 and D3 and a treatment without addition of SSC as a control group (T0D0) as follows :

1- In T1D1, T1D2 and T1D3 used raw SSC, in a replacement rates 10% 20%and 30% instead of SBM.
2- In T2D1, T2D2 and T2D3 used soaked SSC, in a replacement rates 10% 20% and 30% instead of SBM .

3- In T3D1, T3D2 and T3D3 used SSC + phytase, in a replacement rates 10% 20% and 30% instead of SBM.

2- Experimental fish

300 common carp (*C. carpio*) were btained from one of the private farms, with an initial weight of 34.8±1.55 g. The fish were acclimatized for a week to the environmental conditions inside the laboratory, then the fish distributed in 20 glass tanks with 15 fish per tank .

3- Experimental diet:

Diets ingredients; soybean meal, wheat, corn, sunflower oil, wheat flour, protein concentrate and minerals and vitamins premix obtained from the local market.

3-1- Sesame seed cake preparation

3-1- 1- Preparing raw sesame seed cake

Raw sesame seed cake ground without any physical treatment or adding enzyme and mixed with the ingredients of the diet to be used in treatments T1D1, T1D2 and T1D3.

3-1-2- Preparing soaked sesame seed cake

Sesame seed cake was soaked in distilled water for (24) hours at a temperature between 45-65 °C then dried under the sun light and ground [9], then mixed with the ingredients of the diet to be used in treatments T2D1, T2D2 and T2D3.

3-1-3- Preparing sesame seed cake + Phytase

Powder type of phytase enzyme was purchased from Sunson Industry Group Company. It was packaged in 1 kg bags, 1 g of it contains 1200 FTU. According to previous studies, 500 FTU was used (which is equivalent to 0.42 g) per kg of diet [10].

Powder phytase enzyme was mixed with the ingredients of the diet in treatments T3D1, T3D2, and T3D3. The chemical comparison of SSC and SBM shows in table 1.

Table 1: Chemical compassion of sesame seed cake and soybean meal.

Proximate composition %	Ingredients	
	Sesame seed cake	Soybean meal
Moisture	8.5	9.20
Protein	44.2	46
Fat	8	7.40
Ash	7	5.66
Crude fiber	10	5.14
Nitrogen free extract[1]	22.3	26.6
Energy (MJ/kg)[2]	11.306	11.795

[1]Nitrogen free extract = 100 – (moisture + crude protein + crude fat + as). [2]Energy represented by MJ/kg dry matter = 0.012 Crude Protein + 0.031 x Fat + 0.005 x Crude Fiber + 0.014 x Dissolved Carbohydrates [11]

3-2- Diet formulation

Experimental diets ingredients mixed according to proportions shown in table 2, and 35% of water was added to the mixture to helping the formulation of the diet, then the pellets were dried under the sunlight and used it for fish feeding.

Table 2: Feed ingredients ratio used in the experimental diets

Treatments	Feed ingredients%							
	Sesame cake	Soybean meal	Wheat	Barley	Corn meal	Sunflower fat	Protein concentrate	Premix
T0D0	0	45	15	5	18	6	10	1
T1D1	4.7	40.5	15	5	17.8	6	10	1
T1D2	9.4	36	15	5	17.6	6	10	1
T1D3	14.5	31.5	15	5	17.4	6	10	1
T2D1	4.7	40.5	15	5	17.8	6	10	1
T2D2	9.4	36	15	5	17.6	6	10	1
T2D3	14.1	31.5	15	5	17.4	6	10	1
T3D1	4.7	40.5	15	5	17.8	6	10	1
T3D2	9.4	36	15	5	17.6	6	10	1
T3D3	14.1	31.5	15	5	17.4	6	10	1

P C = protein concentrate, V P= Vitamins premix

4- Water quality parameter .

The selected water quality parameters (dissolved oxygen concentration, temperature, salinity and pH) were monitored during the experimental period, using a water quality meter and the pH-measuring device type (DPH-2), The air conditioners inside the laboratory had a major role in regulating the temperature.

5 –Diet stability%

To find out the stability of the different diets used in the experiment, particular weights of each type of the diets were soaked in a constant volume of water at a laboratory temperature of 25 ℃. The crumbs were collected from the diet and dried, then the rate of diet stability was measured after: 15, 30, 60 and 90 minutes. The stability rate was measured according to the equation {12}

Stability % = Dry weight of the diet after soaking (g) / Dry weight of the diet before soaking (g) x 100

6- Growth parameters

The growth parameters were evaluated in 3 periods, after 20, 40 and 60 days, and the initial weights of the fish were measured at the start of the experiment to be used in measuring the different parameters of growth. Growth parameters was estimated based on [13[

Weight gain of the fish (g) (WG)

WG (g) = Final weight - initial weight

Relative growth rate (RGR%)

RGR%= (final weight - initial weight / initial weight) x 100

Specific growth rate (SGR%)

SGR%= {(ln final weight (g) - ln initial weight) / experiment period (day)} x 100

Food conversion ratio (FCR)

FCR = Weight of diet fed (g) / weight gain of fish (g)

Condition factor (CF)

CF = Weight (g) / cube of fish length (cm) ×100

7- Statistical analysis

The data were analyzed by the Statistical Analysis System (SAS), Mean and standard error (Mean± SE) for all parameters were calculated, and the significant differences between the means were compared using Duncan's test at a probability level of $P \leq 0.05$.

Results

1- Water quality parameters

The results of water quality parameters of the experimental aquariums water shown in table (3), they were relatively stable, with small fluctuations during the study period, and fish mortality was not observed during the experimental period.

Table (3) Water quality parameters in the experimental aquariums

Water quality parameter	Value
Temperature (°C)	19.5±0.76
Dissolved oxygen (mg.l-l)	6.20±1.24
Ph	7.45±0.55
Salinity ppt	0.35±0,02

2- Diets stability%

Figure (1) shows the results of diet stability, it showed that the stability percentage of the diets at 15 minutes ranged between 94.3 - 94.9%, while the highest percentage was observed in T2D3 that contain 30% soaked SSC with a percentage 94.9% and the lowest percentage was noted in T1D1 that contain 10% raw SSC and T3D1 that contain 10% SSC + phytase with the value 94.3% for each, while the stability of the control diet T0D0 was 94, 5%. However, the results of diet stability after 30 minutes were ranged between 93.8-93.3%, the highest percentage of diet stability 93.8%, was observed in the treatment T2D3 that contain 30% soaked SSC, followed by T1D3 which containing 30% raw SSM, while the lowest percentage was observed in T1D1 which contain 10% raw SSC and control group T0D0 with rates 93.3% of each.

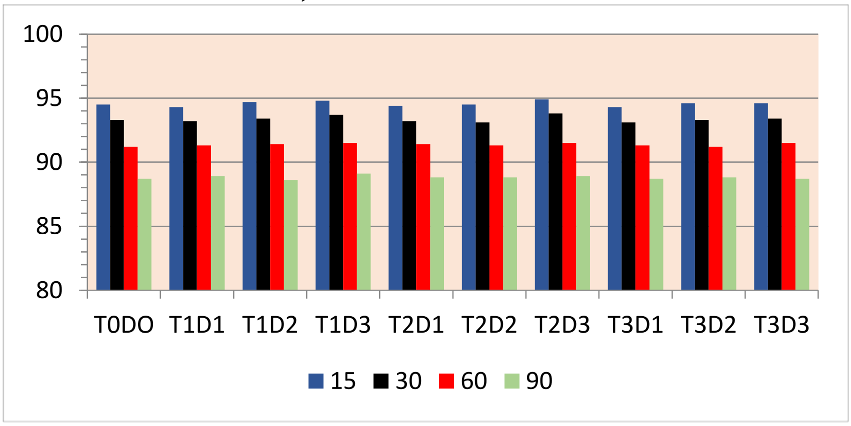

Figure (1) Diets stability % at 15, 30, 60 and 90 minutes

The results of diet stability after 60 minutes were ranged between 91.5-91.1%, and the highest percentage of diet stability was observed in T2D3 that contain 30% soaked

SSC with a rate 91.5%, followed by the two treatments contain 20% soaked SSC in T2D2 and 10% soaked SSC in T2D1 with a rate of 91.4% of each, while the lowest percentage of diet stability 91.1% was recorded in T3D3 that contain 30% SSC with addition of phytase, while the percentage of diet stability in control group T0D0 was 91,2%

As well as, the results of diet stability after 90 minutes were ranged between 89.1-88.5%, when the highest percentage 89.1.5% was recorded in T2D3 which contain 30% soaked SSC, followed by T2D2 with a rate 88.9%, while the lowest percentage 88.5% was observed in T3D3 that containing 30% SSC with phytase, while the percentage in the control group T0D0 was 88.7%.

3- growth performance

3-1- Final weight and total weight gain.

The results of final weight and the total weight gain (Table 4) indicated that the significant difference ($p \le 0.05$) in final weight and total weight gain between the treatments started from the first period (20 days), where treatments T3D3 T3D1 and T3D2 had a significant ($p \le 0.05$) superiority in the final weight with values 40.8. ,40,73 and 40,67 g respectively, compared to control group T0D0 40.47 g. This significant difference continued in the same manner even after 40 days, but at the end of the experiment (after 60 days) the results showed that the T3D3 was significantly ($p \le 0.05$) superior compared to all treatments, reaching the highest value of final weight 67.05 g, followed by T3D2 and T3D1 with a value 66.13 and 65.67 g respectively, while the lowest value of final weight at the end of the experiment was observed in the control group with a value 64.57 g. Similarly, the results of total weight gain confirmed that the T3D3 was significantly ($p \le 0.05$) superior compared to all treatments at 20, 40 and 60 days with values 6.40, 11.83 and 14.42 g respectively, while the lowest value of total weight gain at the end of the experiment was observed in the control group with a value 13.5 g.

Table (4) Means ±SE) of final weight (g) and total weight gain (g) of common carp (*C. carpio*) feed on different experimental diets

Treatments	Final weight (g)			Weight gain (g)		
	20 day	40 day	60 day	20 day	40 day	60 day
T0D0	40.47±0.44 b	51.07±0.45 b	64.57±0.48 e	6.10± 0.06 b	10.60±0.17 c	13.5± 0.10 b
T1D1	40.67±0.41 ab	51.20±0.50 b	64.76±0.66 de	6.14±0.07 b	10.53±0.40 c	13.56±0.29 b
T1D2	40.53±1.33 b	51.07±0.19 b	64.67±0.48 de	6.13±0.07 b	10.54±0.30 c	13.6±0.27 b
T1D3	40.67±0.18 ab	51.17±0.35 b	64.80±0.21 de	6.20±0.12 b	10.50±0.31 c	13.63±0.57 b
T2D1	40.5±0.23 b	51.03±2.43 b	64.63±0.24 de	6.13±0.09 b	10.53±0.20 c	13.6±0.31 b
T2D2	40.47±1.22 b	51.00±0.25 b	64.77±0.38 de	6.17±0.09 b	10.53±0.35 c	13.76±0.12 ab
T2D3	40.53±1.15 b	51.20±0.15 b	65.03±0.41 d	6.20±0.06 b	10.67±0.23 c	13.83±0.08 ab
T3D1	40.73±0.87 a	51.63±0.39 ab	65.67±0.33 c	6.23±0.09 ab	10.90±0.12 bc	14.03±0.12 ab
T3D2	40.67±0.67 ab	52.00±0.07 ab	66.13±0.29 b	6.23±0.12 ab	11.33±0.33 ab	14.13±0.05 ab
T3D3	40.8± 1.91 a	52.63±0.41 a	67.05±0.27 a	6.40± 0.06 a	11.83±0.25 a	14.42±0.15 a

a-e Within a column, means with a same letter are not significantly different ($P > 0.05$).

3-2- Relative growth rate %RGR and the specific growth rate %SGR.

The results of the RGR% after 20 days of rearing (table 5) showed a significant differences ($p \le 0.05$) in treatments T3D3, T3D2, T3D1 and T2D3 with values 18.61, 18.10, 18.07 and 18.6% respectively compared with the rest of the treatments, while, treatment T3D3 showed a clear significant difference ($p \le 0.05$) at 40 and 60 days with values 28.99 and 27.39% respectively, while the lowest percentage of RGR at the end of the experiment (60 days) was observed in control group T0D0 with a value 26.43%. Likewise, the results of the specific growth rate SGR% (Table 5), showed that the T3D3 was significantly superior ($p \le 0.05$) with a value 4.03% compared to the rest of the treatments, However, after 40 and 60 days each of treatments T3D3 and T3D2 were significantly superior (p≤0.05) compared to the control group, where the value of SGR% in T3D3 and T3D2 were 5.36 and 5.27% respectively after 40 days, and 5.79 and 5.75% after 60 days .

Table (5) (Means ±SE) error of relative growth rate RGR% and the specific growth rate SGR% of common carp (*C. carpio*) Feed on different experimental diets.

Treatments	RGR%			SGR%		
	20 day	40 day	60 day	20 day	40 day	60 day
T0D0	17.75±0.08 b	26.19±0.53 cd	26.43±0.53 c	3.93±0.02 b	5.13±0.14 c	5.65±0.14 c
T1D1	17.78±0.40 b	25.89±0.66 d	26.48±0.66 c	3.94±0.02 b	5.11±0.27 c	5.66±0.27 c
T1D2	17.83±0.30 b	26.00±0.50 cd	26.63±0.50 c	3.94±0.02 b	5.11±0.33 c	5.67±0.33 c
T1D3	17.99±0.31 ab	25.82±0.32 cd	26.63±0.32 c	3.96±0.04 b	5.11±0.67 c	5.67±0.67 c
T2D1	17.85±0.29 b	26.00±0.35 cd	27.01±0.35 b	3.94±0.03 b	5.09±0.09 c	5.68±0.09 c
T2D2	17.98±0.25 ab	26.02±0.06 cd	27.02±0.06 b	3.95±0.03 b	5.12±0.09 c	5.68±0.09 c
T2D3	18.06±0.12 a	26.32±0.32 cd	27.18±0.32 ab	3.96±0.02 b	5.14±0.76 c	5.70±0.76 c
T3D1	18.07±0.24 a	26.76±0.55 bc	27.16±0.55 ab	3.97±0.03 b	5.19±0.22 bc	5.74±0.22 bc
T3D2	18.10±0.40 a	27.86±0.34 ab	27.17±0.34 ab	3.97±0.04 b	5.27±0.12 ab	5.75±0.12 ab
T3D3	18.61±0.29 a	28.99±0.36 a	27.39±0.36 a	4.03±0.02 a	5.36±0.06 a	5.79±0.06 a

a-d Within a column, means with a same letter are not significantly different (P > 0.05).

3-3-Feed conversion rate and condition factor

The results of feed conversion rate (Table 6) showed that the treatment T3D3start reducing significantly (p≤0.05) the feed conversion rate from the first 20 days of fish rearing to reach 1.89 compared to control group which was 1.98, while after 40 days the feed conversion rate in treatments T3D3 and T3D2 with values 1.64 and 1.70 were significantly lower (p≤0.05) compared to control group T0D0 which was 1.80. However, after 60 day the feed conversion rate in treatments T3D3, T3D2 and T3D1 with values 1.79, 1.85 and 1.91 were significantly different compared to the control group T0D0 which was 2.05. In contrast, the results of condition factor showed that the treatment T3D3 significantly (p≤0.05) raised the condition factor value to reach 1,483 after 20 days and 1,583 after 40 days of rearing, while the control group was 1,471 after 20 days and 1,563 after 40 days. However, after 60 days, the results of condition factor showed that the treatments T3D3 and T3D2 were significantly (p≤0.05) increased the condition factor values to reach 1,783 and 1,778, respectively comparing with the control group which was 1,763.

Table (6) (Mans ±SE) of feed conversion coefficient and condition factor of common carp (C. carpio) Feed on different experimental diets.

Treatments	FCR			CF		
	20 day	40 day	60 day	20 day	40 day	60 day
T0D0	1.98±0.02 a	1.80±0.04 a	2.05±0.04 a	1.471±0.04 b	1.563±0.04 b	1.763±0.05 c
T1D1	1.97±0.12 ab	1.81±0.02 a	2.06±0.02 a	1.478±0.02 b	1.569±0.02 b	1.769±0.09 bc
T1D2	1.97±0.2 ab	1.81±0.18 a	2.06±0.18 a	1.473±0.21 b	1.564±0.21 b	1.764±0.12 c
T1D3	1.95±0.04 ab	1.82±0.33 a	2.07±0.33 a	1.478±0.01 b	1.568±0.01 b	1.768±0.22 bc
T2D1	1.97±0.33 ab	1.83±0.43 a	2.08±0.43 a	1.472±0.13 b	1.562±0.13 b	1.762±0.12 c
T2D2	1.96±0.03 ab	1.81±0.02 a	2.06±0.02 a	1.471±0.01 b	1.561±0.01 b	1.761±0.07 c
T2D3	1.95±0.02 ab	1.80±0.06 a	2.05±0.06 a	1.473±0.07 b	1.563±0.07 b	1.763±0.01 c
T3D1	1.94±0.03 ab	1.76±0.03 ab	1.91±0.03 b	1.481±0.02 ab	1.571±0.02 ab	1.771±0.33 bc
T3D2	1.94±0.04 ab	1.70±0.09 bc	1.85±0.09 b	1.478±0.00 b	1.578±0.00 ab	1.778±0.02 ab
T3D3	1.89±0.02 b	1.64±0.12 c	1.79±0.12 c	1.483±0.01 a	1.583±0.01 a	1.783±0.11 a

a-c Within a column, means with a same letter are not significantly different (P > 0.05).

Discussion

Through the results of the diet stability we concluded that the diets remained stable and coherent from the first 15-30 minutes of being placed in the water, and the percentage of loss during this period did not exceed 6.7% (as the lowest percentage of diet stability at 30 minutes was 93.3%), and this period is the ideal time that fits with common carp feeding, as [14] mentioned that the time it takes to consume the feed by fish is from 10 to 15 minutes. The good stability of the diets that used in this study may be due to using a wheat and wheat flour in the composition of the diet, this results agreed with what [15] said, that the good stability of the diets in water is due to the presence of cellulose and wheat flour as a binding agent. One of the raw materials used in the diets of this study was maize, which helps to gelatinizing the diets and increasing its cohesion [16]. The degree of diet stability is directly related to the degree of gelatinization during the formation of diets and the use of heat. Diets with high water stability allow for an extension the period of feeding and transiting time of nutrients in the intestine, and this may reduce feed consumption, but when the stability of the diet decreases, the possibility of nutrients being released into the water and its loss will be increased [17].

The results of growth parameters confirmed that the treatment T3D3 (which was replaced 30% of soybean meal by sesame seed cake with the addition of phytase enzyme) improved significantly ($p \leq 0.05$) all growth parameters (final weight, total weight gain, relative growth rate, specific growth rate, feed conversion rate and the condition factor) and it exceed all treatments including treatments with addition of phytase enzyme but the substitution percentages of sesame seed cake were lower (10% and 20%), this is evidence of the joint effect of adding the phytase enzyme and the percentage of sesame seed cake substitution and that indicating of the clear effect of the percentage of sesame seed cake to improving growth parameters. This effect is maybe due to the fact that sesame seeds cake containing a balanced composition of amino acids and health-promoting antioxidant bio-compounds such as lignans, primarily sesamin triglucoside and sesamin diglucoside [18] or the high content of calcium, phosphorus, potassium, and vitamins B3 and E [19], which promote the growth and development of organisms and regulate the health of organisms [20] ،

Results of growth performance in this study are consistent with the results of [21], which found an increasing in final weight and improvement of feed conversion rate when used sesame seed cake in the diet of *Labeo rohita*, and also agreed with [22] results when found that the substitution of sesame seeds instead of soybean meal in the diet of catfish (*C. gariepinus*) increased the values of relative growth rate, feed conversion rate and survival rate. Similarly, [23] found that adding 20% sesame seed cake to rainbow trout (*Oncorhynchus mykiss*) diets leads to an increasing in weight gain, fish length, specific growth rate, protein conversion rate and feed conversion rate.

In addition, the results of growth performance in diets contain soaked sesame seed cake in the current study which had a non-significant effect, it agreed with the results of [24] when found that sterilization and fermentation led to improving the nutritional value of raw sesame seed cake in terms of crude protein and anti-nutrient compositions but did not had a significant effect on the growth parameters of male Nile tilapia *Oreochromis niloticus*

Adding phytase enzyme improved the growth parameters in this study, this improvement it due to the fact that most of the nutrients associated with phytase are not released when used as fish feed because of the fish guts do not contain phytase enzyme to breaks down these nutrients [25]. This result agreed with many researchers foundation when they mentioned that phytase improves the digestion of nutrients and fish growth, such as {26} when found that addition of phytase to *Labeo rohita* diet improved the growth performance, also [27] found that *Oreochromis niloticus* showed improvement in growth performance when fed on diet contain low percentage of fishmeal with addition of phytase. Similarly, {28] reported that the highest growth performance was observed in *Cirrhinus mrigala* fingerlings fed on diet supplemented with phytase at a rate of 1000 FTU/kg. In addition, {29] found that using phytase enzyme at the level of 500 FTU/kg in the diets containing soybean meal achieve optimal growth performance in common carp *C. carpio*.

Conclusion

Based on the results of current study can be concluded that the partial replacement of soybean meal by sesame seed cake in diets of common carp *C. carpio* has no negative effects on diet stability, However, replacing 30% SBM by SSC with adding phytase enzyme improves significantly ($p \leq 0.05$) all growth parameters (final weight, total weight gain, relative growth rate%, specific growth rate%, feed conversion rate and condition factor). While, sesame seed cake in raw or soaked form does not have negative affect on growth parameters of the fish. Therefore, sesame seed cake can be used as a cheap source of protein in common carp *C. carpio* diets.

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References

[1] Effiong, M. U.; Akpan, A. W. and Essien-Ibok, M. A. (2019). Effects of dietary protein levels on proximate, haematological and leukocyte compositions of *Clarias gariepinus*. Journal of Applied Sciences and Environmental Management, 23(11): 2065-2069.

[2] Socas-Rodríguez, B.; Álvarez-Rivera, G.; Valdés, A.; Ibáñez, E. and Cifuentes, A. (2021). Food by-products and food wastes: are they safe enough for their valorization?. Trends in Food Science and Technology, 114: 133-147.

[3] Jimoh, W. A.; Ayeloja, A. A.; Abubakar, M. I. O.; Yusuf, Y. O.; Shittu, M. O. and Abdulsalami, S. A. (2020). Toasted *Jatropha curcas* seed meal in Nile tilapia (*Oreochromis niloticus*) diet: Effect on growth, economic performance, haematology, serum biochemistry and liver histology. International Journal of Aquatic Biology, 8(2): 98-108.

[4] Arru, B.; Furesi, R.; Gasco, L.; Madau, F. A. and Pulina, P. (2019). The introduction of insect meal into fish diet: The first economic analysis on European sea bass farming. Sustainability,11(6): 90-97.

[5] Adeniyan, O. O.; Ibukun, E. O.; Ogunbolude, Y. and Eseigbe, M. I. (2013). Effect of boiling on the nutritional composition and antioxidant properties of beniseed (*Sesamum indicum* L.). Food Sci. Qual. Manage, 11: 557-568

[6] Vera, G.; Tatyana, S.; Elizaveta, P.; Aleksandra, D.; Larisa, P.; Aleksey, K.; Tamara, Y.; Natalya, K.; Andrey, P. and Nina, B. (2020). The diversity of fatty acid composition in traditional and rare oil crops cultivated in Russia. Biological Communications, 65: 68-81

[7] Saleh, N. E. (2020). Assessment of sesame meal as a soybean meal replacement in European sea bass (*Dicentrarchus labrax*) diets based on aspects of growth, amino acid profiles, haematology, intestinal and hepatic integrity and macroelement contents. Fish physiology and biochemistry, 46(3): 861-879

[8] Wasiu Adeyemi, J. (2022). Use of toasted sesame seed meal as a replacer of soybean meal in african catfish diets: effect on growth, nutrient utilization, body composition, haematology and histopathology of the liver. Journal of Applied Aquaculture, 34(4): 855-876 .

[9] Greiner, R. and Konietzny, U. (1999). Improving enzymatic reduction of myo-inositol phosphates with inhibitory effects on mineral absorption in black beans (*Phaseolus vulgaris* var. preto). Journal of food processing and preservation, 23(3): 249–261.

[10] Sardar, P.; Randhawa, H. S.; Abid, M. and Prabhakar, S. K. (2007). Effect of dietary microbial phytase supplementation on growth performance, nutrient utilization, body compositions and haemato-biochemical profiles of *Cyprinus carpio* (L.) fingerlings fed soyprotein- based diet. Aquaculture Nutrition, 13(6):444–456.

[11] MAFF (1975). Ministry of Agriculture, Fisheries and Food department of Agriculture and Fisheries for Scotland Energy allowances and Feed systems for ruminants, Technical Bulletin, 33: First published.

[12] Misra, C.K.; Sahu, N.P. and Jain, K.K. (2002). Effect of extrusion processing and steam pelleting diets on pellet durability, water absorption and physical response of *Macrobrachium rosenbergii*. Asian-australasian Journal of Animal Sciences, 15(9): 1354-1358 .

]13] Kareem, Z. H.; Abdelhadi, Y. M.; Christianus, A.; Karim, M. and Romano, N. (2016). Effects of some dietary crude plant extracts on the growth and gonadal maturity of Nile tilapia (*Oreochromis niloticus*) and their resistance to *Streptococcus agalactiae* infection. Fish physiology and biochemistry, 42: 757-769 .

[14] Ighwela, K. A., Ahmad, A. B., & Abol-Munafi, A. B. (2013). Water stability and nutrient leaching of different levels of maltose formulated fish pellets. Global Veterinaria, 10 (6): 638-642.

[15] Orire, A.M., S.O. Sadiku and L.O. Tiamiyu, (2010) Evaluation of yam starch (*discorea rotundata*) as aquatic feed binder. Pakistan Journal of Nutrition, 9(7): 668-671.

[16] Jayaram, M.G. and H.P.C. Shetty, (1981). Formulation, processing and water stability of two new pelleted fish feeds. Aquaculture, 23: 355-359.

[17] Haetami, K., Junianto, J., Iskandar, I., Rostika, R., & Abun, A. (2017). Durability and water stability of pellet fish supplementation results pairing coconut oils and hazlenut oil. International Journal of Environment, Agriculture and Biotechnology, 2(3), 238800

[18] Melo, D.; Álvarez-Ortí, M.; Nunes, M. A.; Costa, A. S.; Machado, S.; Alves, R. C. and Oliveira, M. B. P. (2021). Whole or defatted sesame seeds (*Sesamum indicum* L.) The effect of cold pressing on oil and cake quality. Foods, 10(9): 108-118 .

[19] Wu, W. H. (2007). The contents of lignans in commercial sesame oils of Taiwan and their changes during heating. Food Chem, 104:341–344

[20] Wei, P.; Zhao, F.; Wang, Z.; Wang, Q.; Chai, X.; Hou, G. and Meng, Q. (2022). Sesame (*Sesamum indicum* L.): A Comprehensive Review of Nutritional Value, Phytochemical Composition, Health Benefits, Development of Food, and Industrial Applications. Nutrients, 14(19): 79-90 .

[21] Das, K. C.; Mohanty, S.; Nayak, S. K. and Swain, P. (2021). Evaluation of sesame oil cake based floating feed on growth performance and non-specific immune response of *Labeo rohita* (Hamilton, 1822). Indian Journal of Fisheries, 68(3): 70-76 .

[22] Yakubu, N.; Isah, M. C. and Musa, A. I. (2020). Nutritional Composition and Growth Performance of Fish Meal Supplemented with *Sesame indicum* (Beni Seed) in the Diets of *Clarias gariepinus*. Journal of Applied Sciences and Environmental Management, 24(5): 741-748.

[23] Emadi, H.; Mokhayer, B. and Faal, M. (2014). Alternative role of sesame seed replacing fish meal in the diet of rainbow trout (*Oncorhynchus mykiss*) fingerlings .Iranian Journal of Fisheries Sciences, 13(3): 509-521.

[24] Olude, O.; George, F. and Alegbeleye, W. (2016). Utilization of autoclaved and fermented sesame (*Sesamum indicum* L.) seed meal in diets for Til-aqua natural male tilapia. Animal Nutrition, 2(4): 339-344.

[25] Fries, E. M, Oxford, J. H.; Godoy, A. C.; Hassamer, M. Z.; Corrêia, A. F.; Boscolo, W, R. and Signor, A. (2020). Phytase on the digestibility of plant protein feed for silver catfish, *Rhamdia voulezi*. Aquaculture, 528:735528

[26] Afzal, M, Sultana, N.; Hassan, A.; Shah, S. Z. H.; Fatima, M.; Hussain, S. M.; Bilal, M. and Hussain, M. (2019). Effectiveness of acidification and phytase pretreatment on growth performance, muscle proximate composition and nutrient digestibility of Rohu (*Labeo rohita*, Hamilton 1822) juveniles fed soybean meal based diet. Pakistan Journal of Zoology, 51(5): 1741-1750

[27] Li, X. Q.; Zhang, X. Q.; Kabir, C. M.A.; Zhang, Y. and Leng, X. J. (2019). Dietary phytase and protease improved growth and nutrient utilization in tilapia (*Oreochromis niloticus* × *Oreochromis aureus*) fed low phosphorus and fishmeal-free diets. Aquaculture Nutrition, 25(1): 46–55.

[28] Hussain, S. M.; Ahmad, N.; Javid, A.; Shahzad, M. M.; Hussain, M. and Arsalan, M. Z. (2018). Effects of phytase and citric acid supplemented corn gluten (30%) mealbased diets on the mineral digestibility of *Cirrhinus mrigala* fingerlings. Turkish Journal of Fisheries and Aquatic Sciences, 18(4): 501-507 .

[29] Sardar, P.; Randhawa, H. S.; Abid, M. and Prabhakar, S. K. (2007). Effect of dietary microbial phytase supplementation on growth performance, nutrient utilization, body compositions and haemato-biochemical profiles of *Cyprinus carpio* (L.) fingerlings fed soy protein- based diet. Aquaculture Nutrition 13(6): 444–456.

مجلة جامعة كركوك للعلوم الزراعية

تأثير الإحلال الجزئي لكيك بذور السمسم بدل مسحوق فول الصويا على ثباتية العلائق ومعايير النمو لأسماك الكارب الشائع (*Cyprinus carpio* L.)

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- البحث مستل من أطروحة دكتوراه للباحث الأول .

المستخلص

أجريت هذه الدراسة تحت ظروف المختبر لتقييم تأثير الإحلال الجزئي لكيك بذور السمسم (*Sesamum indicum*) (SSC) كمصدر للبروتين بدل مسحوق فول الصويا (*Glycine max*) (SBM) على ثباتية العلائق ومعايير النمو وبعض الصفات الإنتاجية (الوزن النهائي ،الزيادة الوزنية الكلية، معدل النمو النوعي، معدل النمو النسبي ،معامل التحويل الغذائي ومعامل الحالة) لأسماك الكارب الشائع (*C. carpio*). كونت التجربة من عشرة معاملات وبمكررين لكل معاملة، وتم فيها استخدام SSC بشكل: خام ، منقع ومضاف اليه أنزيم الفايتيز في T1, T2 و T3 على التوالي بدلاً من SBM بثلاث نسب إحلال مختلفة 10٪ و 20٪ و 30٪ في D1 , D2 و D3 على التوالي، ومعاملة بدون SSC (معاملة السيطرة) T0D0. النتائج أظهرت أن ثباتية العلائق لم تتأثر بإدراج النسب المختلفة من SSC، في حين ان نتائج معايير النمو أظهرت أن إحلال كيك بذور السمسم بنسبة 30% بدل مسحوق فول الصويا مع إضافة أنزيم الفايتيز حسنت بشكل معنوي ($p \leq 0.05$) جميع معايير النمو والصفات الإنتاجية (الوزن النهائي ، الزيادة الوزنية الكلية ، معدل النمو النسبي ، ومعدل النمو النوعي ، معامل التحويل الغذائي ومعامل الحالة)، وبين النتائج بان استخدام كيك بذور السمسم بشكل الخام مباشرة او منقع لا يؤثر سلبا على معايير النمو للأسماك، لذا يمكن أن تكون كيك بذور السمسم مصدرًا رخيصاً للبروتين في علائق الكارب الشائع (*C. carpio*).

الكلمات المفتاحية: بذور السمسم ، الثباتية ، معايير النمو.