



Effect of adding *Eruca sativa* in common carp on growth criteria, feed utilization and chemical composition

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Abstract

To examine the effects of adding seeds powder and rocket *Eruca sativa* leaves to the diets of common carp *Cyprinus carpio* L. fish with percentages of 1, 2, and 3% of the total diet (the first, second, and third treatments), as well as the addition of rocket leaf powder to the fourth, fifth, and sixth diets, respectively, While the control diet, was empty of these additions (the seventh diet). Each treatment was replicated three times. These diets were used to feed common carp for 56 days. According to the statistical analysis's research results, the fish fed the fourth diet significantly superior surpassed the control diet and all other experimental diets in terms of growth criteria represented by the final weight, total weight gain, daily growth rate, relative, specific growth rate, and in terms of feed utilization: feed conversion ratio, feeding efficiency ratio and protein efficiency ratio. Except for the sixth treatment, the fed fish outperformed all other experimental treatments, and the second and fourth treatments regarding retained protein and protein production value. Fish were fed as the fifth treatment, significantly superior to the control diet. These results in the highest percentage of dry matter and crude protein for the edible portion of the body. Feeding fish on the fourth treatment resulted in the lowest proportion of ether extract, much lower than all the experimental diets.

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Introduction

The common carp, *Cyprinus carpio* L., is the third-most important freshwater fish in the world and a member of the Cyprinidae family (1). Fish and aquaculture have outperformed beef production, which has grown by 1% over the past ten years, as well as sheep and poultry production, which has grown by 3-2% and 4.9%, respectively, to reach 30% with an annual growth rate of roughly 8.8% (2). The most crucial of these elements is feed, which must satisfy the fish's nutritional needs in addition to the environment's conditions and the fish's resistance to diseases and stress. As a result of the usage of pesticides and antibiotics during intensive fish farming, a

significant mortality rate of up to 50% of the farmed fish was experienced (3). However, the drawbacks of excessive use of these materials, as well as their negative effects on fish and the aquatic environment, have prompted many researchers to use safe materials, such as probiotics and medicinal herbs in various forms, that have no negative impact on the aquatic environment and do not inhibit fish growth and mortality (3-7). The leaves, oil, and seeds of the medicinal plant *Eruca sativa* have been used for a variety of therapeutic purposes since ancient times. It heals stomach and urinary diseases and enhances bile secretion, liver function, and digestion (8-11). This plant is notable for its high content of crude protein and fat, as well as its abundance in vitamins E, C, and K, carotenoids, minerals,

and secondary metabolic products such as glucosinolate, flavonoids, saponin, and alkaloids that have positive effects on promoting the health of the organism due to their antimicrobial activity and antioxidant properties (12). Essential fatty acids, particularly Omega 3 and Omega 6, as well as carotenoids and minerals are also present in this plant (13,14).

The current study aims to demonstrate the effects of adding each of the rocket seeds and leaves to the diets of common carp fish at three different levels on growth characteristics and the effectiveness of utilizing nutrients in the diet.

Materials and methods

Ethical approve

This work was approved by the first congress for the scientific committee to Department of Animal Production Techniques dated September 01, 2021.

Study location

The present study was carried out from November 20, 2021 to January 15, 2022 at the fish laboratory.

Fish

147 fingerlings of common carp, *Cyprinus carpio* L. were used, with an average weight of 32 g/fish, which were randomly distributed to 21 glass tanks with dimensions of

40*60*40 cm at a rate of seven fish/glass tank. The fish were acclimatized for three weeks before the feeding experiment to get used to the environment of the aquariums.

Characteristics of culture water

The temperature measurements were between 22 and 24°C, pH 7.2-7.5, and dissolved oxygen 4-4.9 mg/L, within the appropriate limits for fish growth (15).

Experimental diets

Fish were given one of seven experimental diets, three of which contained rocket seeds powder at levels of 1, 2 and 3% (first, second, and third treatments), while the fourth, fifth, and sixth treatments contained powdered Rocket leaves at levels of 1, 2 and 3%, and the seventh treatment (control) was free of both the seeds and leaves additives. Rocket leaves collected at autumn season 2021. The components of the experimental diets and the Rocket seeds and leaves used as feed supplements, as well as their chemical composition, are listed in tables 1 and 2. The feed was manufactured in the form of pellets with a diameter of 3 mm after grinding and mixing the ingredients well, drying, placing in plastic bags and storing them in the freezer until the start of the experiment. The fish were fed 3% of their live body weight three times a day, and the fish were weighed every two weeks to determine the weight gain and adjust the amount of feed provided to the fish.

Table 1: Experimental diets containing the powdered seeds and leaves of rocket in different proportions

Ingredients	Rocket seeds			Rocket leaves			Control (T7)
	1% (T1)	2% (T2)	3% (T3)	1% (T4)	2% (T5)	3% (T6)	
Animal protein	12	12	12	12	12	12	12
Soybean meal	30	30	30	30	30	30	30
Rocket seed powder	1	2	3	0	0	0	0
Rocket leaf powder	0	0	0	1	2	3	0
Wheat barn	19	19	19	19	19	19	19
Yellow corn	16.5	16.5	16.5	16.5	16.5	16.5	16.5
Local black barley	20	20	20	20	20	20	20
Bentonite (binder)	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Vitamins and minerals	1	1	1	1	1	1	1
Salt	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Limestone	0.5	0.5	0.5	0.5	0.5	0.5	0.5

Table 2: The chemical composition (%) of the experimental diets and dried rocket seeds and leaves

Parameters	Control	Parameters	Rocket seeds	Rocket leaves
Moisture	7.59	Moisture	0.86	0.90
Dry matter	92.41	Dry matter	99.14	99.10
Crude protein	25.60	Crude protein	18.21	22.41
Ether extract	6.34	Ether extract	12.11	1.23
Ash	5.67	Ash	6.20	6.23
Nitrogen free extract	54.86	Fibers	3	4
ME (MJ/Kg)	14.35	Nitrogen- free extracts	59.72	65.23

Growth criteria

The growth criteria, which included final weight, total weight gain, daily growth rate, relative and specific growth rate, were calculated on the criteria of feed conversion rate, feed efficiency ratio, protein efficiency rate, protein retention, and protein productive value based (15).

Chemical analysis

The primary nutrients in fish body and feed components were examined using standard methods (AOAC, Association of Official Analytical Chemists, 2000).

Statistical analysis

The data were analyzed using SPSS version 21 in a Complete Random Design (CRD), with One-way ANOVA using Duncan's multiple range test used to test for significant differences between the averages of the studied traits. Significant differences were measured at the level of $P \leq 0.05$.

Results

The statistical analysis's findings demonstrated that there were no significant variations in the primary weight between the various experimental treatments. The fish fed the fourth treatment, which contained 1% Rocket leaves, significantly outperformed the fish fed the control diet in terms of final weight criteria 64.97 versus 51.89 gm/fish, total weight gain criteria 32.86 versus 19.73 gm/fish, and daily growth rate 0.583 versus 0.346 gm/fish/day. Additionally, in terms of the aforementioned criteria, the fourth treatment was significantly superior compared to all other experimental treatments (Table 3).

The fish fed on the fourth treatment were significantly superior to control and all other experimental diets in the relative growth and specific growth rate criteria (Table 4). No significant differences were recorded between the different experimental treatments in the survival rate criterion, which means that adding *Eruca sativa* seeds and

leaves or water quality had no negative effect on fish (Table 4).

The results of the statistical analysis in table 5 clearly demonstrate that adding seeds powder and Rocket leaves in ratios of 1, 2, and 3% had no appreciable impact on the daily and total feed intake between the various experimental diets. The results of the statistical analysis revealed that the fish fed the fourth treatment significantly outperformed those fed a control diet in both the feed conversion ratio and feed efficiency ratio.

According to the findings of the statistical analysis of the protein intake criterion, there were no significant differences between the various treatments (Table 6) when compared to the other experimental treatments, the fish in the fourth treatment significantly outperformed them in terms of both the protein retention and efficiency ratio criterion. The protein productive value criterion, which expresses the ratio of the protein content in the diet to what is deposited in the body, is another crucial factor in feed evaluation. In comparison to the control diet, the first treatment, and the fifth, the inclusion of 2% rocket seeds in the second diet and in the fourth and sixth diets significantly increased the protein producing value.

The fish fed on the second, third, fourth and sixth treatments differed significantly from the control diet, while the fish fed on the fifth treatment had the highest dry matter in the edible portion of the fish. The percentage of ether extract decreased significantly in all treatments of the experiment compared to the control, and the lowest percentage obtained was for the fourth treatment. The results of the statistical analysis showed a significant increase in the proportion of crude protein when fed fish on the second, fifth, and sixth rations than on the control ration, as well as the fish fed on the first, third, and fourth rations shown in table 7, no significant differences were recorded in the ash average between the different experimental treatments.

Table 3: Effect of rocket seeds and leaves in the final weight, total weight gain and daily growth rate of common carp

Treatments	Mean \pm SE			
	Initial weight (g)	Final weight (g)	Total weight growth (g)	Average daily growth (g)
Rocket seeds 1% (T1)	32.21 \pm 0.08 a	57.75 \pm 1.10 c	25.54 \pm 1.10 c	0.450 \pm 0.200 c
Rocket seeds 2% (T2)	32.30 \pm 0.08 a	61.49 \pm 0.65 b	29.19 \pm 0.66 b	0.520 \pm 0.011 b
Rocket seeds 3% (T3)	32.16 \pm 0.06 a	58.28 \pm 0.77 c	26.12 \pm 0.80 c	0.460 \pm 0.015 c
Rocket leaves 1% (T4)	32.11 \pm 0.04 a	64.97 \pm 0.77 a	32.86 \pm 0.81 a	0.583 \pm 0.014 a
Rocket leaves 2% (T5)	32.18 \pm 0.02 a	53.96 \pm 0.21 d	21.78 \pm 0.23 d	0.386 \pm 0.003 d
Rocket leaves 3% (T6)	32.18 \pm 0.06 a	58.20 \pm 0.68 c	26.01 \pm 0.63 c	0.460 \pm 0.011 c
Control (T7)	32.16 \pm 0.02 a	51.89 \pm 0.84 d	19.73 \pm 0.82 d	0.346 \pm 0.014 d

Different letters in the column indicate the presence of significant differences ($P \leq 0.05$).

Table 4: Effect of adding rocket seeds and leaves on the RGR, SGR and SR of common carp fish

Treatments	Mean \pm SE		
	Relative Growth Rate	Specific Growth Rate	Survival Rate
Rocket seeds 1% (T1)	79.30 \pm 3.45 c	1.03 \pm 0.03c	100
Rocket seeds 2% (T2)	90.37 \pm 2.12 b	1.14 \pm 0.02b	100
Rocket seeds 3% (T3)	81.21 \pm 2.60c	1.03 \pm 0.03 c	100
Rocket leaves 1% (T4)	102.31 \pm 2.66 a	1.25 \pm 0.02a	100
Rocket leaves 2% (T5)	67.66 \pm 0.74 d	0.91 \pm 0.00d	100
Rocket leaves 3% (T6)	80.81 \pm 1.85c	1.00 \pm 0.00c	100
Control (T7)	61.34 \pm 2.52 d	0.86 \pm 0.04d	100

Different letters in the column indicate the presence of significant differences ($P \leq 0.05$).

Table 5: The effect of adding rocket seeds and leaves on the TFI, DFI, FCR and FER for common carp

Treatments	Mean \pm SE			
	Total feed intake (g)	Daily feed intake (g)	FCR	FER
Rocket seeds 1% (T1)	64.80 \pm 1.25a	1.34 \pm 0.02a	2.53 \pm 0.06c	39.38 \pm 1.04c
Rocket seeds 2% (T2)	65.63 \pm 1.75a	1.36 \pm 0.03a	2.24 \pm 0.05d	44.50 \pm 1.04b
Rocket seeds 3% (T3)	62.69 \pm 2.85a	1.30 \pm 0.05a	2.39 \pm 0.03cd	41.71 \pm 0.64bc
Rocket leaves 1% (T4)	66.03 \pm 1.41a	1.37 \pm 0.02a	2.00 \pm 0.05e	49.78 \pm 1.28a
Rocket leaves 2% (T5)	63.92 \pm 1.65a	1.32 \pm 0.03a	2.93 \pm 0.10b	34.12 \pm 1.21d
Rocket leaves 3% (T6)	63.62 \pm 2.61a	1.32 \pm 0.05a	2.44 \pm 0.06cd	40.96 \pm 1.19c
Control (T7)	65.09 \pm 1.07a	1.35 \pm 0.02a	3.30 \pm 0.08a	30.29 \pm 0.77e

Different letters in the column indicate the presence of significant differences ($P \leq 0.05$).

Table 6: Effect of adding rocket seeds and leaves in different proportions on the protein intake parameters, protein efficiency ratio, precipitated protein and protein production value of common carp

Treatments	Mean \pm SE			
	Protein intake	Protein Efficiency %	Precipitated protein	Protein production
Rocket seeds 1% (T1)	16.58 \pm 0.32a	1.53 \pm 0.03c	4.37 \pm 0.19d	26.31 \pm 0.68d
Rocket seeds 2% (T2)	16.79 \pm 0.44a	1.73 \pm 0.04b	6.37 \pm 0.17a	38.05 \pm 1.89a
Rocket seeds 3% (T3)	16.04 \pm 0.73a	1.62 \pm 0.02bc	5.46 \pm 0.14bc	34.10 \pm 1.08bc
Rocket leaves 1% (T4)	16.90 \pm 0.36a	1.90 \pm 0.06a	6.44 \pm 0.08a	38.17 \pm 0.76a
Rocket leaves 2% (T5)	16.35 \pm 0.42a	1.32 \pm 0.04d	5.16 \pm 0.05c	31.58 \pm 0.86c
Rocket leaves 3% (T6)	16.28 \pm 0.66a	1.59 \pm 0.04c	5.73 \pm 0.15b	35.25 \pm 0.97ab
Control (T7)	16.66 \pm 0.27a	1.18 \pm 0.03e	3.88 \pm 0.13e	23.29 \pm 0.41d

Different letters in the column indicate the presence of significant differences ($P \leq 0.05$).

Table 7: Effect of adding rocket seeds and leaves on the chemical composition of the edible portion in common carp

Treatments	Mean \pm SE			
	Dry matter	Ether extract	Crude protein	Ash
Rocket seeds 1% (T1)	25.97 \pm 0.44cd	8.29 \pm 0.01c	16.63 \pm 0.10d	3.76 \pm 0.15a
Rocket seeds 2% (T2)	27.69 \pm 0.35ab	7.95 \pm 0.00d	18.90 \pm 0.32a	3.19 \pm 0.40a
Rocket seeds 3% (T3)	27.11 \pm 0.15b	8.81 \pm 0.01b	18.34 \pm 0.15b	4.02 \pm 0.10a
Rocket leaves 1% (T4)	26.7 \pm 0.36bc	7.67 \pm 0.14e	17.96 \pm 0.09bc	3.80 \pm 0.26a
Rocket leaves 2% (T5)	28.21 \pm 0.25a	8.90 \pm 0.01b	19.26 \pm 0.15a	3.74 \pm 0.11a
Rocket leaves 3% (T6)	27.46 \pm 0.16ab	8.4 \pm 0.01c	18.83 \pm 0.06a	3.53 \pm 0.22a
Control (T7)	25.71 \pm 0.00d	9.68 \pm 0.02a	17.55 \pm 0.04c	3.80 \pm 0.20a

Different letters in the row indicate the presence of significant differences ($P \leq 0.05$).

Discussion

The moral superiority in growth parameters in the recent study is due to the rocket is enriched with protein and containing a relatively large number of vitamins B₁, B₂, C, A, pro-vitamin, folic acid, glucosinolates, and minerals, including iodine, iron, calcium, and sulfur, which give rocket its distinctive aroma as well as its nutritional benefits (16). Furthermore, glucosinolates the main active compounds of rocket, are hydrolyzed by myrosinases into various hydrolysis products with a variety of growth-promoting biological activities (17), resulting in improved nutrient digestibility and a growth-stimulating effect (3,18). The high content of copper in Rocket is also necessary for the activity of copper superoxide dismutase (SOD), which has the characteristics of removing toxic compounds from the body, such as the activity of macrophages.

Additionally, rocket leaves have higher concentrations of vitamins a and c than rocket seeds, which are strong antioxidants that resist free radicals and are essential for stimulating growth (19). By increasing levels of anti-pathogenic lysozyme and SOD, inhibiting the conversion of unsaturated fatty acids to cholesterol esters, and boosting levels of anti-pathogenic lysozyme, vitamin c enhances growth performance and feed utilization in fingerling common carp (20). These results are in agreement with the findings of Khalil (21) that the addition of Rocket enhanced the growth of *Oreochromis niloticus*.

The addition rocket seeds and leaves to the diets of experimental fish has improved the utilization of feed components, which is due to stimulating the activity of digestive enzymes that contribute to increasing the metabolic activity of feed, where the plant acts as a drug. The performance of fish has improved depending on the feed conversion factor and the rate of feeding efficiency. Additionally, it improves liver functions and raises the hepatic antioxidant glutathione (GSH), which shields cells from free radical damage, as well as inhibiting potential pathogens in the digestive system. The results showed that Rocket has anti-bacterial activity, including *Listeria monocytogenes* by boosting the secretion of digestive enzymes like lipase, protease, and amylase, which provides a positive environment for the digestive tract, this helps to promote the presence of beneficial microorganisms, increase their activity, and create a healthy environment for their work (22). This has a positive impact on the digestion and absorption of nutrients (23-26). The results of this study agree with Khalil (21), Nile tilapia's feed conversion ratio and feed efficiency ratio both increased as a result of the addition of rocket. When using rocket seeds in place of soybean meal, Sayed (27) found no significant differences in the feed intake criterion.

The effective polyphenols present in *Eruca sativa* and many other medicinal plants may have contributed to the

improvement in the parameters of the protein efficiency ratio of protein, protein retention, and protein productive value as a result of the addition of Rocket seeds and leaves by enhancing the growth and utilization characteristics of feed. Along with possessing β -carotene, which inhibits diphenyl-1-picrylhydrazyl (DPPH) to a greater extent than 70%, rocket leaves also contain significant concentrations of vitamin c, which has a high efficacy of more than 90% in inhibiting free radicals DPPH. It is possible to make use of the properties of the rocket plant and its possible applications as a feed stock for biologically active compounds (28,29). The recent results agree with Khalil (21) in protein efficiency ratio and protein productive value.

The addition of Rocket seeds and leaves led to an improvement in the utilization of nutrients represented by high levels of crude protein and low-fat percentage due to the high content of free fatty acids in seeds and *Eruca sativa* leaves. This caused changes in many parameters of cholesterol metabolism, including its excretion outside the body with waste. The high vitamin c in Rocket prevents the transformation of unsaturated fatty acids into cholesterol esters and the high efficiency of transferring glucose to cells for use as a source of energy, and thus the process of fat formation is inhibited and its levels will decrease in the body (20,30). While the percentage of crude protein increased and the percentage of ash decreased, indicating an improvement in the content of the edible portion of the fish, this may be attributed to the high composition of protein and amino acids in the seeds powder and leaves of rocket, particularly the glutamic and glycine acids, as flavonoids play an important physiological role in regulating hormone levels, especially steroid hormones, growth hormone, and thyroid gland. As they improve thyroid function, flavonoids also have a positive impact on thyroid function (31,32). The present results agreed with Khalil (21) in raising the value of the protein efficiency and protein productive value significantly compared to the control in Nile tilapia.

Conclusions

The results of the current research showed that the addition of rocket leaf powder by 1% (the fourth treatment) worked to enhance growth and benefit from feed. The percentage of crude protein increased and the percentage of fat decreased significantly in the eaten part of the fish compared to the control diet.

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Conflict of interest

There is no conflict of interest.

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الخامسة والسادسة على التوالي، فيما خلت عليقة السيطرة من هذه الإضافات (العليقة السابعة). غذيت أسماك الكارب الشائع لمدة ٥٦ يوم على هذه العلائق. بينت نتائج التحليل الإحصائي تفوق الأسماك المغذاة على العليقة الرابعة معنوياً عن عليقة السيطرة وعن كافة العلائق التجريبية الأخرى في معايير النمو والتمثلة بالوزن النهائي والزيادة الوزنية الكلية ومعدل النمو اليومي ومعدل النمو النسبي والنوعي، ولمعايير الاستفادة من الغذاء التي شملت معدل التحويل الغذائي ونسبة كفاءة التغذية ومعدل كفاءة البروتين، فيما تفوقت الأسماك المغذاة على المعاملة الثانية والرابعة في معياري البروتين المترسب و القيمة المنتجة للبروتين (باستثناء المعاملة السادسة) عن معاملة السيطرة وكافة المعاملات التجريبية الأخرى. بلغت أعلى نسبة مئوية للمادة الجافة والبروتين الخام للجزء المأكول من الجسم عند تغذية الأسماك على المعاملة الخامسة والتي تفوقت معنوياً عن عليقة السيطرة. تم الحصول على أقل نسبة مئوية لمستخلص الإيثر عند تغذية الأسماك على المعاملة الرابعة والتي انخفضت معنوياً عن كافة العلائق التجريبية.

تأثير إضافة الجرجير في الكارب الشائع على معايير النمو والاستفادة من الغذاء والتركيب الكيميائي

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الخلاصة

نفذ البحث الحالي باستخدام سبع معاملات وبواقع ثلاث مكررات لكل منها، لبيان تأثير إضافة مسحوق حبوب الجرجير على صفات النمو والاستفادة من الغذاء إلى علائق أسماك الكارب الشائع وبنسب ١ و ٢ و ٣% من العليقة الكلية (المعاملة الأولى والثانية والثالثة)، فيما تم إضافة مسحوق أوراق الجرجير بنفس النسب أعلاه إلى العلائق الرابعة