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Evaluation of coriander seed powder supplementation on body composition, growth performance, hematology, and serum biochemical indices in common carp (Cyprinus carpio) fingerlings

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Abstract

This study aimed to investigate the role of coriander seed powder (Coriandrum sativum) on growth indices, feed utilization, body composition, and haemato-biochemical parameters in common carp (Cyprinus carpio) fingerlings over 84 days. One hundred and forty-four common carp (25.24±0.05 g) were assigned into four groups fed with different diets, namely 0 (basal diet), 1%, 2%, and 4% of coriander seed powder (CSP). In the current study, C. carpio fed with dietary CSP revealed significant improvement in weight gain, final weight, specific growth rate, total feed intake, feed conversion efficiency, feed conversion ratio, protein intake, and protein efficiency ratio, in comparison to control fish fed after 84 days (P>0.05). It was also found that fish fed with 1%CSP-supplemented diet had the best growth performance and feed utilization. The crude protein of fish fed with CSP dietary treatments increased, and significant differences were only found in the fish fed with 1%CSP diet, in comparison to the control group. The CSP supplementation groups showed significant increases in hemoglobin, hematocrit, albumin, total protein, and globulin compared to the control group. Nevertheless, differential white blood cells, mean corpuscular hemoglobin concentration, cholesterols, and triglycerides were significantly reduced in the CSP dietary group in comparison to the control group. It was also found that CSP dietary treatment significantly increased lipase and amylase in comparison to the control group (P>0.05). However, the highest lipase and amylase levels were obtained at 1%CSP and 2%CSP dietary treatment groups, compared to the control basal diet. Based on the results, CSP supplementation could improve the overall health status and growth performance of common carp fingerlings.

Keywords: Body composition, Coriander seed powder, Cyprinus carpio, Growth performance, Hematology, Serum biochemical.

1. Introduction

Aquaculture, which involves farming aquatic animals and plants, remains the dominant method of producing aquatic food in Asia and worldwide, as stated by the FAO in 2019. Currently, more than 91% of global aquaculture production takes place in Asia, amounting to 102.9 million tonnes in 2017. These days, capture fisheries have been overtaken by the total global aquaculture production by over 18.32 million tonnes. Over 95% of global aquaculture production occurs in developing countries, in contrast to most terrestrial agricultural systems, where production is concentrated in developed countries [1, 2].

Several herbal plants are utilized as food additives and supplements in fish feed. Fish require a diet rich in vitamins, minerals, and other nutrients, many of which can be found in these plants. Spirulina, garlic, turmeric, ginger, aloe vera, and many others are all examples of common therapeutic plants. Thyme, moringa, and sumac are a few others. In aquaculture, medicinal herbs or phytogenics have been recognized as safe and effective supplements that play various roles [3, 4]. Extensive research has shown that medicinal herbs have the potential to replace antibiotics, providing an environmentally friendly approach to organic aquaculture. The effectiveness of medicinal herbs can be attributed to their rich content of active components, including tannins, phenolics, saponins, alkaloids, glycosides, flavonoids, terpenoids, and steroids [5]. Their valuable properties, which have gained researchers and farmers' attention, have been recognized as antibacterial agents, growth promoters, immunostimulants, and antioxidants [6].

Fish circulatory system and general health can be improved by supplementing feed additives which are rich in many nutrients that boost fish blood. Feeds and herbs, including spirulina, garlic, beetroot, aloe vera, and turmeric, have improved fish blood quality [7]. Various medicinal plant species and forms have been researched and recommended for aquaculture. For example, coriander (*Coriandrum sativum* L.), an herbal plant belonging to the Apiaceae family, is able to grow in multiple regions worldwide

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[8]. The most important components of coriander include essential oils and fatty oils, particularly Petroselinum acid, palmitic acid, oleic acid, and linoleic acid, [9]. Coriander, similar to other green vegetables, is a good source of, fiber, iron, minerals, and vitamins, especially vitamin A/β-carotene and vitamin C [10]. In terms of functionality, coriander seeds have demonstrated significant growth-promoting, antibacterial, immune-boosting, and antioxidative properties in various fish species, such as Catla (*Catla catla*) [11], beluga (*Huso huso*) [12], Nile tilapia (*Oreochromis niloticus* L.) [13], and rainbow trout (*Oncorhynchus mykiss*) [14]. However, limited data exists on coriander seed powder in fish diets, especially for common carp. As a result, this study was conducted to examine the 84-day effect of coriander seed powder on hematology, serum biochemical indices, growth performance, body composition, and feed utilization in common carp fingerlings.

2. Materials and Methods

2.1. Preparation of coriander seed powder (CSP) and diet

Coriander seeds were bought from a village around Duhok City, Iraq. The seeds were kept in plastic bags and moved to the laboratory. After being washed with distilled water, they were dried in a hot air oven at 60°C for 4 days. An electric grinder was used to grind the dried seeds into a fine powder, which was then sifted through a household sifter. The coriander seed powder (CSP) was kept in a plastic bag at room temperature until use.

Three experimental and one control diets were formulated using ingredients, as shown in Table 1. The diet contained 32% crude protein and 7% crude lipid. The basal formulations were then mixed with CSP as the inclusion of (control 0 CSP), (10 g/kg, 1%CSP), (20 g/kg, 2%CSP), (40 g/kg, 40%CSP). All ingredients were homogenized, mixed in a commercial food mixer, and added with hot water and oil to produce a stiff dough. Diet pellets were extruded using a cold press extruder (SUNRRY, model: SYMM12, China) with a 2-mm aperture die, air-dried at room temperature, and each diet was separately stored in a plastic pack until use.

2.2. Fish Husbandry

Common carp (*Cyprinus carpio* L.) fingerlings were attained from a private fish hatchery. The fish were transferred to a closed system in Erbil Kurdistan Region, Iraq. The experiment was performed in a closed system at an aquaculture unit, Grdarasha station, College of Agriculture Engineering Sciences, Salahaddin University, Erbil, Kurdistan Region, Iraq. The fish were stocked into 12 fiberglass tanks (200 L). The fish were acclimated to the closed system for 2 weeks and fed commercial diets (32% protein and 7% lipid). Each tank was supplied with flow-through aeration provided by an electrical aerator (ROYAL, Sub-

Table1. Formulation of experimental diets and proximate analysis of diets and coriander seed powder.

		Basic diet	Experimental diets		
Ingredients					
Soybean meal (g) [a]		570	570	570	570
Corn (g) [b]		130	130	130	130
Fishmeal (g) [c]		100	100	100	100
Soya oil (g) [d]		45	45	45	45
Wheat flour (g) [e]		100	90	80	60
Wheat bran (g) [f]		10	10	10	10
PREMIX (g) [g]		45	45	45	45
Coriander seed powder (CSP) (g) h		0	10	20	40
Feed Ratio formulation (g)		1000	1000	1000	1000
Proximate analysis					
	CSP				
Dry matter %	95.08	93.64	93.55	93.61	93.69
Crude protein %	15.41	30.27	30.10	30.00	29.97
Crude lipid %	13.18	6.91	6.68	5.90	5.62
Crude fiber %	30.56	2.81	3.41	3.46	3.59
Crude ash %	3.17	6.91	6.78	6.92	6.79
Metabolic Energy (kcal/kg)	2765	3286	3252	3208	3197

[a] Soybean was obtained from Kosar Local Company and originally sourced in BAF in Turkey and consists of (Dry mater=89%, MEn=2,230 kcal/kg, protein=44%, crude lipid=0.8%, crude fiber=7%, total phosphorus=0.65%). [b] Corn: (Dry matter=92%, MEn=1,525 kcal/kg, protein=19.2%, crude lipid=2.1%, crude fiber=14.4%, total phosphorus=0.65%). [c] Fish meal: (Dry matter =0%, protein=65%). [d] Soya oil. [e] Wheat flour: (Dry matter=87%, MEn=2,900 kcal/kg, protein=14.1%, crude lipid=2.5%, crude fiber=3%, total phosphorus=0.37%). [f] Wheat bran: (Dry matter=89%, MEn=1,300 kcal/kg, protein=15.7%, crude lipid=3% crude fiber=11%, total phosphorus=1.15%). [g] Vitamin Premix sourced in Kosar Company and originally sourced in BAF in Turkey and consists of Vitamin D3 (300,000 IU/kg), Vitamin A (200,0000 IU/kg), Vitamin K3 (1,600 mg/kg), Vitamin E (40,000 mg/kg), Vitamin C (150,000 mg/kg), Vitamin B6 (2,000 mg/kg), Vitamin B2 (3,000 mg/kg), Vitamin B1 (2,000 mg/kg), Pantothenic acid B5 (20,000 mg/kg), Niacin B3 (8,000 mg/kg), Folic acid (800 mg/kg), Cholin (45,000 mg/kg), Biotin (2,000 mg/kg). Mineral Premix consists of 1-trace minerals consisting of selenium (60 mg/kg), manganese (3,000 mg/kg), Cobalt (20 mg/kg), Iodine (200 mg/kg), Zinc (6,000 mg/kg), Copper (30,000 mg/kg)2- calcium carbonate 41% 3- salt 1g/kg limestone 14g/kg. [h] Coriander seed powder: bought from a village in Duhok, Kurdistan Region, Iraq

mersible water pump, QDX1.5-32-0.75F, China). All tanks were cleaned twice a week and a siphoning method was applied to remove the remaining uneaten food and faeces from the system. The number of 144 healthy fish were distributed into the fiberglass tanks in a random manner (12 fish, with the baseline weight of 25.24±0.05 g). Each diet was fed to a triplicate tank. Common carp fingerlings were fed on one of the experimental diets twice a day at a rate of 3% of live body weight for six days a week. Fish biomass was weighted weekly and the daily feeding of each experimental group was adjusted weekly. In order to maintain the water quality during the experimental period, water physiochemical parameters were measured daily as follows: Dissolved oxygen: 7.06±1.09 mg L-1, temperature: 22.59±1.66°C and pH: 8.13±0.35.

2.3. Growth performance and feed utilization

At the end of the feeding trial, the growth and feed utilization were calculated by total feed intake (TFI), specific growth rate (SGR %), weight gain (WG), feed conversion efficiency (FCE), feed conversion ratio (FCR), protein intake (PI), protein efficiency ratio (PER), and survival rate (SR). Calculations were conducted as follows:

WG (g/fish) = FBW-IBW;

SGR% = [ln FBW−ln IBW]/t×100, where FBW is final body weight (g); IBW is initial body weight (g); ln = natural logarithmic; t = time in days.

FCR = TFI/WG, where TFI is total feed intake (g);

FCE = 100 [Live WG (g)/TFI (g);

PER =WG/PI (g);

SR = 100% (final number of fish)/(initial number of fish).

2.4. Proximate composition analysis

Analyses for test diets and fish samples (nine fish per treatment) were performed according to AOAC (2010) standard methods. All samples were analyzed in triplicate. The material was dried in a fan-assisted oven at 105°C until constant weight was reached; following that, moisture content was determined. Crude protein (N×6.25) was performed by the automated Kjeldhal method after acid digestion (Kjeldahltherm microsystem 40, C. Gerhardt GmbH, KG, Germany). By using petroleum ether (1356, Parr Instrument Company, IL, USA), a soxhlet gravimetric method was employed to determine lipid content. The assessment of ash level in the samples was achieved through incineration in a muffle furnace at 550°C for 24 h. All analyses were conducted at the Barash Feed Company Laboratory Department in Erbil, Kurdistan Region, Iraq.

2.5. Hematological and biochemical parameters

Fish underwent a 24-hour starvation period before sampling at the end of the experiment. Three common carp fingerlings from each tank (nine per treatment) were randomly selected and anesthetized with clove powder (200 ppm). Blood samples were collected from the caudal vein using a sterile 3ml hypodermic syringe. The blood sample was divided, with one portion transferred to a heparinized vial to evaluate its hematology, and the other portion placed into vials (without heparin) and allowed to clot. All samples were carefully transferred into a Vacuette k3EDTA container placed on ice. Serum biochemistry analysis involved separating the serum by centrifuging the blood samples at 3,000 rpm for 5 min. The collected blood samples were examined for various parameters, including leukocyte count (differential white blood cell [WBC]), erythrocyte parameters consisting of hemoglobin (HGB), red blood cell count (RBC), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), and hematocrit (HCT). These parameters were measured using an automatic hematology analyzer BC-2800 (Fish Laboratory, Department of Fish Resources and Aquatic Animals, College of Agricultural Engineering Sciences, Salahaddin University, Erbil Kurdistan Region, Iraq). The following serum biochemical indices were measured: globulin (Glob), serum total protein (TP), cholesterol (CHO), albumin (ALB), triglycerides (TG), low-density lipoprotein (LDL), very low-density lipoprotein (VLDL), high-density lipoprotein (HDL), and lipase and amylase enzymes.

2.6. Statistical analysis

All data were tested for normality and homogeneity of variance using the Shapiro-Wilk test. The data obtained in the trial were analyzed in SPSS26 software using a one-way ANOVA test. Therefore, means and stander deviation were calculated. Duncan's test was used to determine significant differences at 0.05 levels among the various parameters.

3. Results

3.1. Growth performance

The feed utilization, growth performance, and survival rate of common carp fed with CSP dietary are presented in Table 2. A significant improvement was observed in the final body weight (FBW), weight gain (WG), SGR,

Table 2. Growth performance and feed utilization of common carp (*Cyprinus carpio* L.) fingerlings fed with a control diet or a supplemented diet of coriander seed powder (CSP) for 12 weeks.

Parameters	Control	CSP 1%	CSP 2%	CSP 4%
IBW	25.16±0.9	25.29±0.8	25.17±0.8	25.30±0.8
FBW	46.06±0.5^{c}	54.9±1.6^{a}	49.8±0.5^{b}	49.6±0.3^{b}
WG	21.00±0.4^{c}	29.6±1.5^{a}	24.6±0.6^{b}	24.2±0.3^{b}
SGR	0.72±0.01^{c}	0.92±0.3^{a}	0.81±0.02^{b}	0.80±0.01^{b}
TFI	883.20±9.8^{b}	943.80±7.7^{a}	890.64±5.7^{b}	898.62±13.1^{b}
FCR	3.51±0.03 ^{a}	2.8±0.04^{c}	3.02±0.07^{b}	3.1±0.03^{b}
FCE	28.53±0.27^{c}	35.57±0.52^{a}	33.12±0.72^{b}	32.35±0.34^{b}
PI	267.3±3.0^{b}	284.1±2.3^{a}	267.2±1.7 ^{b}	269.3±3.9^{b}
PER	0.94±0.01^{c}	1.18±0.02^{a}	1.10±0.02^{b}	1.08±0.01^{b}

Data in the same row with different subscripts are significantly different (P≤0.05). Data are presented as mean ± SE.

and PER (P<0.05) in common carp fed with 1%, 2%, and 4%CSP compared to the control. The best FBW, WG, SGR, and PER were recorded in the carp fed with 1%CSP-supplemented diets. The TFI and PI gradually increased in carp fed on CSP dietary, and significant differences were only detected in 1%CSP-fed carp. The FCR was significantly better (P<0.05) in fish receiving diets supplemented with CSP, in comparison to the control. The best FCR was noticed in the 1%CSP-fed fish. The survival rate was 100% in *C. carpio* during the whole experimental period (P<0.05).

3.2. Proximate composition of fish

Table 3 tabulated the information related to the proximate composition of whole-body fish. The diets supplemented with 1% and 4%CSP significantly increased crude protein content (P<0.05) in comparison to the control and 2%CSP groups. A significant increase was observed in crude lipid content (P<0.05) in the 2%CSP-fed fish compared to their counterparts in the 1%CSP groups. However, the ash, moisture, and energy content were not significantly affected by CSP-supplemented diets (P<0.05).

3.3. Hematological parameters

Blood indices of the fish fed with dietary supplemented with CSP are tabulated in Table 4. Fish on a CSP-supplemented diet exhibited significantly lower WBC count and MCHC values than the control-fed fish (P<0.05). The fish fed with dietary treatments achieved significantly higher HCT compared to the control fish. The HGB levels of fish in the 2% and 4%CSP fed groups significantly rose when compared to the control group. Only the 1%CSP-supplemented diets showed a significantly higher RBC count (P<0.05) compared to the control group. However, MCH decreased significantly in 1%CSP dietary treatment and increased significantly in 2% and 4%CSP dietary treatments compared to the control diet (P<0.05). The MCV was significantly higher (P<0.05) in the fish fed with 4%CSP dietary treatment than in the fish fed with control and other dietary treatments.

3.4. Biochemical parameters

Serum biochemical indices of common carp fed with experimental diets are presented in Table 5. The TP, Glob, and ALB increased significantly (P<0.05) with an increase in the level of CSP-supplemented diets compared to the

Table 3. Whole body composition of common carp (*Cyprinus carpio* L.) fingerlings fed with a control diet or a supplemented diet of coriander seed powder (CSP) for 12 weeks.

Parameters	Control	CSP 1%	CSP 2%	CSP 4%
Moisture	76.64±0.45	78.31±0.34	77.81±0.22	78.51±1.57
Protein *	51.23±0.41^{c}	54.81±0.58^{a}	51.29±0.34^{c}	53.49±0.13^{b}
Lipid *	35.21±1.23^{ab}	31.24±1.38^{b}	35.71±1.03^{a}	33.22±1.21^{ab}
Ash *	8.36±0.33	8.96±0.69	8.59±0.34	10.26±1.19
Energy (kcal/kg)	4860.0±15.6	4641.3±79.9	4867.0±39.0	4690.0±99.1

Dry matter bases. Data in the same row with different subscripts are significantly different (P≤0.05). Data are presented as mean ± SE.

Table 4. Hematological parameters of common carp fingerlings fed with a control diet or a supplemented diet of coriander seed powder (CSP) for 12 weeks.

Parameters	Control	CSP 1%	CSP 2%	CSP 4%
WBC (×10^{9}/L)	84.95±2.3^{a}	61.9±4.0^{b}	68.5±2.2^{b}	31.2±1.96^{c}
RBC (×10^{12}/L)	0.8±0.14^{bc}	1.2±0.04^{a}	0.9±0.02^{b}	0.8±0.03^{c}
HCT (%)	17.2±0.1^{d}	22.7±0.7^{c}	28.4±0.5^{a}	25.9±0.7^{b}
HGB (g/L)	10.9±0.3^{b}	10.8±0.9^{b}	13.1±0.4^{a}	12.5±0.3^{a}
MCH (P g)	135.3±2.7^{b}	92.4±5.5^{c}	151.0±5.8^{ab}	164.6±6.6^{a}
MCHC (g/L)	63.0±1.99^{a}	47.0±3.1^{b}	46.2±1.1^{b}	48.4±0.6^{b}
MCV (f L)	209.7±2.2^{bc}	166.5±29.5^{c}	274.9±48.8^{ab}	332.6±7.9^{a}

Data in the same row with different subscripts are significantly different (P≤0.05). Data are presented as mean ± SE.

Table 5. Serum biochemical parameters of common carp fingerlings fed with a control diet or a supplemented diet of coriander seed powder (CSP) for 12 weeks.

Parameters	Control	CSP 1%	CSP 2%	CSP 4%
TP (mg/dL)	3.1±0.01^{d}	3.6±0.02^{c}	4.1±0.2^{b}	4.4±0.01^{a}
Glob (g/dL)	1.1±0.01^{d}	1.3±0.01^{c}	1.6±0.01^{b}	1.7±0.02^{a}
ALB (g/dL)	2.02±0.01^{d}	2.30±0.01^{c}	2.50±0.0^{b}	2.70±0.02^{a}
TG (mg/dL)	307.3±3.6^{a}	266.0±11.1^{b}	247.8±6.4^{b}	262.5±8.9^{b}
CHO (mg/dL)	118.0±1.1^{a}	90.3±1.3^{b}	95.5±3.2^{b}	93.5±1.9^{b}
HDL (mg/dL)	27.95±0.6^{b}	32.20±1.2^{a}	30.40±0.8^{ab}	30.20±1.1^{ab}
LDL (mg/dL)	19.6±1.3^{a}	16.1±0.6^{b}	16.9±0.1^{ab}	14.7±0.8^{b}
VLDL (mg/dL)	50.0±3.6	49.0±4.5	57.2±3.3	51.7±3.7
Lipase	33.6±1.0^{d}	63.5±1.6^{a}	53.4±0.9^{b}	44.9±0.5^{c}
Amylase	59.2±0.5^{c}	68.7±0.7^{b}	73.5±1.7^{a}	60.8±1.1^{c}

Data in the same row with different subscripts are significantly different (P≤0.05). Data are presented as mean ± SE.

control diet. Increasing levels of CSP in the diet of fish led to a significant decrease in TG and CHO compared to the control fish. The HDL was found at the highest level in the fish fed with 1%CSP which was significantly different compared to the fish fed in other dietary treatment groups. The lipase and amylase levels were significantly higher in CSP-fed fish than in the control fish. No significant differences were found in the level of VLDL among the experimental treatments.

4. Discussion

Farming practices have negative implications on the health and survival of aquatic animals [15]. Numerous studies in the literature have revealed the potential functionality of medicinal plants and herbs to enhance fish performance and health [16]. Coriander is among the suitable herbal supplements recommended for aquatic animals, including fish [17]. The aromatic properties of coriander are linked to its original use as a food flavor enhancer. However, because of its antioxidant and antibacterial properties, it appeared as a significant medicinal plant over time [18]. This versatile herb is rich in carbohydrates, fibers, proteins, minerals (e.g., phosphorus, calcium, and iron), and vitamins (e.g., A, C, and K). The findings of this study were indicative of an improvement in the growth performance indices and feed utilization of common carp fingerlings fed with a CSP diet for 12 weeks. The findings of the present research are consistent with those of a study conducted by Farsani *et al.* [14], demonstrating that rainbow trout receiving a diet of coriander had boosted growth performance and WG. The rise in growth performance can be attributed to decreased FCR and enhanced PER under the conditions of their study. Similarly, Ashry *et al.* [19] found that the European seabass *(Dicentrarchus labrax*) fed with different levels (0, 5, 10, and 20 g/kg) of CSP for 150 days had significantly promoted growth performance, survival rate, and feed utilization. Raissy *et al.* [20] adopted the same approach to optimize a 1% inclusion of a mixture of herbal extracts, including common mallow, oak acorn, and coriander. Although the mean WG was higher for the 0.5% and 1.0% coriander treatments compared to the control, the difference was only significant for the 0.5% treatment. In contrast to our study, they reported that no significant differences were observed between fish fed with 1% and 1.5% coriander extract-based diets and the control group ($P>0.05$). Nevertheless, fish fed with 1% to 2% coriander diets had lower growth performance, which could be attributed to the severe flavor that coriander added to the diet at higher inclusion levels. This flavor most likely reduces palatability and consequently feed intake [21]. Coriander supplementation improves growth outcomes in several fish species, including Nile tilapia and rainbow trout [13, 22]. Coriander supplementation in fish diets has the potential to improve the integrity of the intestinal mucosal barrier, which is important in protecting against pathogen infiltration and ensuring gut well-being [14]. Evidence suggests that CSP can be an effective dietary supplement for common carp fingerlings, promoting growth, health, and well-being.

No significant differences in moisture content, ash content, and metabolic energy were observed with the CSP dietary treatments in the present study. Despite an increase in protein content with CSP dietary supplementation, only the fish fed 1% and 4% CSP diets exhibited significant differences. Significant differences were also found in lipid content in 2%CSP-fed fish than in 1%CSP-fed fish, while no significant effect was reported among other dietary treatments. The findings of a study conducted by Ashry *et al.* [19] demonstrated no significant differences in body moisture content and ash content ($P<0.05$), which was in agreement with the results of our study. However, the findings of protein content and lipid content were not consistent with their study. In contrast to our study, Al-Shakarchi and Mohammad [23] reported a significant reduction in the lipid contents of fish that were fed with different portions of CSP. A slight increase was observed in the protein contents in fish fed with various dietary levels of CSP without any significant changes.

Hematological indices are considered indicators of fish well-being and provide valuable insights into the assessment of fish health [24, 25]. The findings of this study reported the HCT, HGB, MCH, and MCV were significantly higher in *C. carpio* fed with 2% and 4%CSP, and RBC increased significantly in 1%CSP-fed fish. Similarly, Farsani *et al.* [14] found that coriander extract enhanced rainbow trout hematocrit, hemoglobin, RBCs, and WBCs. Das *et al.* [22] reported a significant improvement in Hgb, MCV, and MCH in red tilapia fed with a diet supplemented with 2% coriander oil for 60 days; however, no changes were observed in RBC, HCT, and MCHC, compared to fish fed on the control diet. This improvement in hematological indices may display that fish have a well-regulated metabolic and immunological status [26]. Another reason for a significant increase in hematological indices might be the presence of qualitative phytochemicals in coriander, such as flavonoids, steroids, alkaloids, saponins, and coumarin [27]. In the present study, differential WBC and MCHC were reduced significantly in the fish receiving a CSP-supplemented diet. In contrast to our study, Ashry *et al.* [19] found that European seabass fed with dietary treatments supplemented with CSP had significantly higher differential WBC than control-fed fish. Furthermore, Jimoh *et al.* [28] reported that African catfish hybrid fed with coriander-based diets enhanced differential WBC compared to those fed on the control diet. However, the MCHC in the fish fed with coriander-based diets decreased significantly compared to fish fed with the control diets, which was in line with our results.

A significantly higher TP, ALB, and Glob was observed in fish fed with CSP dietary treatments versus control diets in the current study. The findings of this research are in line with those of the study conducted by Ashry *et al.* [19], indicating that supplementation of diet with 0.5% and 1%CSP significantly increased TP and ALB than the control diet. Likewise, Jimoh *et al.* [28] showed that African catfish hybrid fed with dietary treatments of 0.5% and 1% coriander had significantly higher TP, ALB, and Glob levels in contrast to the fish fed with the control diet. Inconsistent with the findings of our study, Farsani *et al.* [14] demonstrated that supplementing rainbow trout diets with coriander seed extracts had no significant impact on the levels of TP, ALB, and Glob. Enhanced TP, ALB, and Glob levels in fish indicate improved health and immunological function [29, 30].

In our study, CHO, TG, and LDL levels decreased significantly, whereas HDL levels increased and the significant difference appeared only in 1%CSP supplementation compared to the control. The concentration of VLDL levels remained unaffected among dietary treatments with CSP and the control. The findings of our study were in agreement with those reported by Raissy *et al.* (20), demonstrating a similar trend of results when a combination of medicinal plant extracts containing coriander, oak acorn, and common mallow was used in carp diets, and the attributing the reduction to the extract of the medicinal plants. It is generally accepted that fish in better health would grow faster since they expend less energy on non-growth functions [31]. A similar observation was made by Bahrekazemi *et al.* [12] on beluga fed with coriander-supplemented diets. Some studies have suggested the inhibitory effect of plant extracts on the activity of cholesterol acyltransferase, an enzyme responsible for the production and biosynthesis of CHO and other lipoproteins [32].

In the present study, amylase and lipase significantly improved in fish fed with dietary treatment of CSP than those receiving an un-supplemented diet. The same results were found by Raissy *et al.* [20], reporting that enzyme change patterns were noted to be different between treatments with combined herb extracts (coriander, common mallow, and oak acorn). According to the mentioned study, amylase levels were highest in 5% and 3% CMO-supplemented diets, whereas lipase levels were maximum in diets supplemented with 1% and 3% CMO treatments, which may be attributed to different secretion thresholds in response to different dietary levels of CMO. This might be related to beneficial compounds of coriander that are high in minerals (e.g. Fe, Ca, Mg, Zn, and K), vitamins (predominantly vitamin A/β-carotene, β-cryptoxanthin, and vitamin C), fiber, which are required by fish bodies to perform specific physiological functions [28, 33]. It has also been found that the antibacterial properties of coriander inhibit the growth of pathogenic bacteria in fish intestines [18]. At the same time, the digestibility of aquafeed could improve along with the activity of digestive enzymes [16]. A number of factors may contribute to this, such as improved nutrient protection within the digestive system. It is possible that coriander plays a role in these positive outcomes by eliminating harmful microorganisms and bacteria in the intestines, improving cellular respiration and nutrient absorption, and increasing digestive enzyme levels.

5. Conclusion

The present investigation was carried out to assess the impact of dietary CSP on growth, whole proximate body composition, and haemato-biochemical indices in common carp fingerlings. It was revealed that dietary supplementation of CSP significantly enhanced growth performance, feed utilization, and crude protein in all CSP diet treatment groups, the best of which was found at the 1%CSP levels. It was noteworthy that dietary supplementation of CSP significantly improved hematological indices and serum biochemical parameters in all dietary CSP, particularly at the 4% levels. Further research is required to work on other factors, such as pathogen stress responses and environmental factors, which can help determine optimal levels of CSP. More attention should be paid to the global demand for countermeasures to combat antimicrobial resistance and reduce antibiotic use in animal production, including aquaculture. This research on carp provides evidence for the numerous benefits of CSP as a natural feed additive. The reduction of chemotherapeutic and antimicrobial medications in fish can be achieved through prophylactic nutritional strategies, offering long-term solutions.

Conflict of interests
The author has no conflicts with any step of the article preparation.

Consent for publications
The authors read and approved the final manuscript for publication.

Ethics approval and consent to participate
Not applicable.

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Availability of data and material
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References

1. Tacon AGJ (2020) Trends in global aquaculture and aquafeed production: 2000–2017. Rev Fish Sci Aquac 28 (1): 43–56.
2. FishStatJ FAO (2017) A tool for fishery statistics analysis. FAO Fish. Aquac. Dep. FIPS–Statistics Inf. Rome, Italy
3. Alagawany M, Farag MR, Abdelnour SA, Dawood MAO, Elnesr SS, Dhama K (2021) Curcumin and its different forms: A review on fish nutrition. 532 736030.
4. Pu H, Li X, Du Q, Cui H, Xu Y (2017) Research progress in the application of Chinese herbal medicines in aquaculture: a review. 3 (5): 731–737.
5. Caipang CMA, Suharman I, Avillanosa AL, Gonzales-Plasus MM (2021) Influence of phytogenic feed additives on the health status in the gut and disease resistance of cultured fish. In: IOP Conf. Ser. Earth Environ. Sci. IOP Publishing. p 12024.
6. Adel M, Dawood MAO, Gholamhosseini A, Sakhaie F, Banaee M (2021) Effect of the extract of lemon verbena (Aloysia citrodora) on the growth performance, digestive enzyme activities, and immune-related genes in Siberian sturgeon (Acipenser baerii). 541 736797.
7. Alamgir ANM, Alamgir ANM (2017) Classification of drugs, nutraceuticals, functional food, and cosmeceuticals; proteins, peptides, and enzymes as drugs. Ther Use Med Plants Their Extr Vol 1 Pharmacogn 125–175.
8. Lasram S, Zemni H, Hamdi Z, Chenenaoui S, Houissa H, Tounsi MS, et al. (2019) Antifungal and antiaflatoxinogenic activities of Carum carvi L., Coriandrum sativum L. seed essential oils and their major terpene component against Aspergillus flavus. Ind Crops Prod 134 11–18.
9. Coşkuner Y, Karababa E (2007) Physical properties of coriander seeds (Coriandrum sativum L.). J Food Eng 80 (2): 408–416.
10. Girenko MM (1982) Initial material and main directions of breeding of some uncommon species of vegetables. Biulleten'-Vsesoiuznyi Inst. Rastenievod.
11. Innocent BX (2011) Studies on the immouostimulant activity of Coriandrum sativum and resistance to Aeromonas hydrophila in Catla catla. J Appl Pharm Sci (Issue): 132–135.

12. Bahrekazemi M, Eslami M, Nikbakhsh J (2022) The effect of dietary coriander supplementation on growth performance, biochemical responses, carcass proximate composition, and heavy metal accumulation in beluga, Huso huso. J Appl Aquac 34 (1): 23–42.
13. Ahmed SAA, Reda RM, ElHady M (2020) Immunomodulation by Coriandrum sativum seeds (Coriander) and its ameliorative effect on lead-induced immunotoxicity in Nile tilapia (Oreochromis niloticus L.). Aquac Res 51 (3): 1077–1088. doi: 10.1111/are.14454.
14. Naderi Farsani M, Hoseinifar SH, Rashidian G, Ghafari Farsani H, Ashouri G, Van Doan H (2019) Dietary effects of Coriandrum sativum extract on growth performance, physiological and innate immune responses and resistance of rainbow trout (Oncorhynchus mykiss) against Yersinia ruckeri. Fish Shellfish Immunol 91 233–240. doi: 10.1016/j.fsi.2019.05.031.
15. Kari ZA, Kabir MA, Dawood MAO, Razab MKAA, Ariff NSNA, Sarkar T, et al. (2022) Effect of fish meal substitution with fermented soy pulp on growth performance, digestive enzyme, amino acid profile, and immune-related gene expression of African catfish (Clarias gariepinus). 546 737418. doi: 10.1016/j.aquaculture.2021.737418.
16. Dawood MAO, Noreldin AE, Ali MAM, Sewilam H (2021) Menthol essential oil is a practical choice for intensifying the production of Nile tilapia (Oreochromis niloticus): Effects on the growth and health performances. 543 737027. doi: 10.1016/j.aquaculture.2021.737027.
17. Said AA, Reda RM, Abd El-Hady HM (2021) Overview of herbal biomedicines with special reference to coriander (Coriandrum sativum) as new alternative trend for the development of aquaculture. Egypt J Aquat Biol Fish 25 (2): 539–550. doi: 10.21608/ejabf.2021.165900.
18. Mandal S, Mandal M (2015) Coriander (Coriandrum sativum L.) essential oil: Chemistry and biological activity. Asian Pac J Trop Biomed 5 (6): 421–428.
19. Ashry AM, Habiba MM, Desouky MG, El-Zayat AM, Moonmanee T, Van Doan H, et al. (2022) The effects of coriander (Coriandrum sativum) seeds on the growth performance, growth hormone, antibacterial capacity, and immune response of European sea bass (Dicentrarchus labrax). Ann Anim Sci 22 (4): 1273–1280. doi: 10.2478/aoas-2022-0021.
20. Raissy M, Ghafarifarsani H, Hoseinifar SH, El-Haroun ER, Shahbazi Naserabad S, Van Doan H (2022) The effect of dietary combined herbs extracts (oak acorn, coriander, and common mallow) on growth, digestive enzymes, antioxidant and immune response, and resistance against Aeromonas hydrophila infection in common carp, Cyprinus carpio. 546 737287. doi: 10.1016/j.aquaculture.2021.737287.
21. Cardoso-Ugarte GA, Sosa-Morales ME (2022) Essential Oils from Herbs and Spices as Natural Antioxidants: Diversity of Promising Food Applications in the past Decade. Food Rev Int 38 (S1): 403–433. doi: 10.1080/87559129.2021.1872084.
22. Das S, Pradhan C, Pillai D (2023) Dietary coriander (Coriandrum sativum L) oil improves antioxidant and anti-inflammatory activity, innate immune responses and resistance to Aeromonas hydrophila in Nile tilapia (Oreochromis niloticus). Fish Shellfish Immunol 132 108486. doi: 10.1016/j.fsi.2022.108486.
23. Al-Shakarchi HH, A. Mohammad M (2021) Effects of Different Levels of Cinnamon and Coriander Powders on Growth Performance, Feed Utilization, Survival Rate and Body Chemical Composition of Common Carp Cyprinus Carpio L. Plant Arch 21 (Suppliment-1): 46–54. doi: 10.51470/plantarchives.2021.v21.s1.010.
24. Fazio F, Piccione G, Arfuso F, Faggio C (2015) Peripheral blood and head kidney haematopoietic tissue response to experimental blood loss in mullet (Mugil cephalus). Mar Biol Res 11 (2): 197–202. doi: 10.1080/17451000.2014.898850.
25. Burgos-Aceves MA, Cohen A, Smith Y, Faggio C (2018) MicroRNAs and their role on fish oxidative stress during xenobiotic environmental exposures. Ecotoxicol Environ Saf 148 995–1000. doi: 10.1016/j.ecoenv.2017.12.001.
26. Fazio F, Lanteri G, Saoca C, Iaria C, Piccione G, Orefice T, et al. (2020) Individual variability of blood parameters in striped bass Morone saxatilis: possible differences related to weight and length. Aquac Int 28 (4): 1665–1673. doi: 10.1007/s10499-020-00550-z.
27. Francis G, Makkar HPS, Becker K (2001) Antinutritional factors present in plant-derived alternate fish feed ingredients and their effects in fish. 199 (3–4): 197–227. doi: 10.1016/S0044-8486(01)00526-9.
28. Jimoh WA, Ayeloja AA, Yusuf OY, Abdulfatahi AA (2022) Physiological Responses of African Catfish Hybrid (Clarias gariepinus ♀ ×Heterobranchus bidorsalis ♂) to Dietary Coriander Supplementation. J Fish Environ 46 (3): 157–179.
29. Mohammadi G, Rashidian G, Hoseinifar SH, Naserabad SS, Doan H Van (2020) Ginger (Zingiber officinale) extract affects growth performance, body composition, haematology, serum and mucosal immune parameters in common carp (Cyprinus carpio). Fish Shellfish Immunol 99 267–273. doi: 10.1016/j.fsi.2020.01.032.
30. Mabrouk MM, Ashour M, Labena A, Zaki MAA, Abdelhamid AF, Gewaily MS, et al. (2022) Nanoparticles of Arthrospira platensis improves growth, antioxidative and immunological responses of Nile tilapia (Oreochromis niloticus) and its resistance to Aeromonas hydrophila. Aquac Res 53 (1): 125–135. doi: 10.1111/are.15558.
31. Esmaeili M (2021) Blood performance: a new formula for fish growth and health. Biology (Basel) 10 (12): 1236. doi: 10.3390/biology10121236.
32. Banaee M, Sureda A, Mirvaghefi AR, Rafei GR (2011) Effects of long-term silymarin oral supplementation on the blood biochemical profile of rainbow trout (Oncorhynchus mykiss). Fish Physiol Biochem 37 (4): 885–896. doi: 10.1007/s10695-011-9486-z.
33. Pereira R, Costa M, Velasco C, Cunha LM, Lima RC, Baião LF, et al. (2022) Comparative Analysis between Synthetic Vitamin E and Natural Antioxidant Sources from Tomato, Carrot and Coriander in Diets for Market-Sized Dicentrarchus labrax. 11 (4): 636. doi: 10.3390/antiox11040636.