Enhancing Common Carp (*Cyprinus carpio*) Health Aspects and Performance with Garden Cress (*Lepidium sativum*) Seed Powder

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ABSTRACT

This study aimed to evaluate the effects of garden cress (*Lepidium sativum*) seed powder on the growth and physiological activity of common carp (*Cyprinus carpio*). Fish were fed diets containing 0 (control), 5, 10, or 15 g·kg^{-1} seed powder. Cress seed inclusion significantly influenced growth performance ($p<0.05$), with the 15 g·kg^{-1} group showing higher feed efficiency ratio (FER) and protein efficiency ratio (PER) than other treatments. The 5% g·kg^{-1} group showed significant increases in hemoglobin (HGB), hematocrit (HCT), platelet count, mean corpuscular volume (MCV), and white blood cell (WBC) count. Elevated alanine aminotransferase (ALT), and aspartate aminotransferase (AST) activities, granulocyte levels, and creatine kinase (CK) activity were observed in the 10 and 15 g·kg^{-1} groups. Conversely, lymphocyte, glucose, and monocyte levels were reduced in the 15 g·kg^{-1} group. Other biological indices, including condition factor (K), hepato-somatic index, splenosomatic index, kidney somatic index, gill somatic index, intestine weight index, red blood cell (RBC) count, cholesterol, triglycerides, albumin (ALB), and total proteins (TP), exhibited minimal variation. The findings suggest that 15 g·kg^{-1} dietary cress seed powder is optimal for enhancing the performance of common carp.

Keywords: Aquaculture nutrition, Blood biochemistry, Fish growth, Fish physiology, Hematological parameters

INTRODUCTION

Herbal and plant-derived feed additives are increasingly recognized as sustainable and health-promoting alternatives to synthetic chemicals in aquaculture. These natural supplements typically include a diverse array of bioactive compounds, such as antioxidants, essential fatty acids, polyphenols, flavonoids, and vitamins (Prajapati *et al*., 2018), which enhance metabolism, immune response, and growth regulation in fish. Current exploration of functional feed ingredients has become a matter of exploring underutilized herbs with established nutritional and medicinal value in humans and terrestrial animals: garden cress (*Lepidium sativum* L.) serves as a prime example.

Garden cress, a member of the Cruciferae family, has been valued for its nutraceutical properties, including antioxidant, anti-inflammatory, hypoglycemic, and immunomodulatory effects (Al-Jenoobi *et al*., 2014; Datta *et al*., 2011). The seeds are rich in essential amino acids, minerals (particularly potassium, iron, and calcium), and lipids, with up to 25% oil content. Of particular interest is its high level of alpha-linolenic acid, an omega-3 fatty acid that supports cell membrane integrity, anti-inflammatory function, and hormone

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regulation in both vertebrates and fish (Gokavi *et al*., 2004). In addition, phenolic compounds, tocopherols, and carotenoids confer strong antioxidant potential, which may help mitigate oxidative stress, a common problem in intensive aquaculture (Conforti *et al*., 2008; Zia-Ul-Haq *et al*., 2012).

Most research on garden cress has been conducted in mammalian systems, particularly rodents, showing safety and physiological tolerance (Datta *et al*., 2011), while its potential application in fish remains poorly studied. In aquaculture, oxidative stress, immunosuppression, and metabolic dysregulation are major challenges that negatively affect survival and productivity. Therefore, feed additives with natural antioxidative and anti-inflammatory effects are highly desirable. Common carp (*Cyprinus carpio*) is a widely farmed freshwater species of high economic value and serves as a reliable model for nutritional studies due to its omnivorous feeding behavior and well-established physiological parameters.

Previous aquaculture studies on other Brassicaceae plants, such as mustard seed, cabbage, and broccoli by-products, have shown improvements in growth performance, immune status, and feed efficiency in various fish species including rainbow trout (*Oncorhynchus mykiss*) and Nile tilapia (*Oreochromis niloticus*). However, garden cress remains largely untested in aquafeeds despite its similar phytochemical profile and functional potential (Alkahtani *et al*., 2020). Few studies have evaluated its effects on growth indices, hematological responses, antioxidant status, and general physiological health in fish.

This study aims to fill this knowledge gap by evaluating the dietary effects of garden cress seed powder on the growth performance, hematological parameters, and biological activity of common carp. The hypothesis is that incorporating garden cress seeds into the fish diet will enhance physiological performance due to their antioxidant and anti-inflammatory properties, as well as essential fatty acids and amino acids. By investigating these effects, the study offers insights into the feasibility of garden cress as a natural functional feed additive and contributes to the broader goal of promoting sustainable aquaculture practices through plant-based bioactives.

MATERIALS AND METHODS

Experimental fish

This experiment lasted 84 days and involved 84 common carp obtained from a commercial fish farm in Hilla, central Iraq. The average initial weight of the fish was 85.2 g. The fish were distributed into experimental plastic tanks, with each tank containing fish with mean total weight ranging from 306 and 309 g. Before the feeding trial, the fish underwent a 21-day acclimation period in the laboratory and were fed a commercial pellet diet.

Experimental system

Twelve plastic tanks (70 L each) were used for four dietary treatments with replicates. Continuous aeration was provided using Chinese air compressors (Hailea ACO–318). Replicates were assigned randomly to minimize variation among treatments. Uneaten feed and feces were removed daily by siphoning. Four treatments, each group with three replicates and seven fish per replicate (mean 21 fish for each treatment), were tested.

Feed preparation and feeding methods

Four dietary treatments were prepared: 0 (control), 5, 10, or 15 $g \cdot kg^{-1}$ seed powder. Ingredients commonly available in local markets were supplemented with the desired levels of powdered cress seeds to formulate the experimental diets. Pellets were prepared using a Kenwood Multi-processor, air-dried at room temperature for four days, and then crushed into small particles. Fish were fed twice daily (9:00 a.m. and 2:00 p.m.) at 3% of body weight. Every two weeks, fish in each tank were collectively weighed to adjust feeding amounts. The feeding trial lasted three months. The diets contained 30% crude protein, and 2.1% crude fat, sourced from ingredients such as barley, yellow corn, wheat, soybean, and fish meal as shown in Table 1 (NRC, 2011).

Table 1. Dietary ingredients and nutrient composition of experimental diets supplemented with 0–15% cress seed powder.

Ingredients %	0%	5%	10%	15%
Soybean meal	35	35	35	35
Yellow Corn	13	13	13	13
Barley	15	15	15	15
Wheat	20	20	20	20
Fish meal	15	15	15	15
Premix	2	2	2	2
Total	100	100+5 g	100+10 g	100+15 g
Chemical composition				
Dry Matter (%)	91.77	91.08	91.10	91.10
Crude Protein (%)	28.35	28.00	28.38	28.49
Crude Fiber (%)	3.74	3.77	3.86	3.89

Growth and feed consumption indicators

The collective weight of fish in each replicate was measured every two weeks. Feed allocation for each replicate was then adjusted according to these weight measurements. Growth parameters and other indices were estimated using the following formulas:

$$\text{Weight gain (WG, g)} = W_2 - W_1$$

where W_2 = final body weight (g) and W_1 = initial body weight (g);

$$\text{Daily weight gain (DWG, g·d}^{-1}) = \frac{\text{Weight gain}}{\text{Experimental period}} \times 100$$

where experimental period = 84 days;

$$\text{Relative growth rate (RGR,\%)} = \frac{\text{Weight gain}}{\text{Initial body weight}} \times 100$$

… (Brown, 1957);

$$\text{Specific growth rate (SGR,\%)} = \frac{\text{Ln } W_2 - \text{Ln } W_1}{\text{Experimental period}} \times 100$$

… (Abdulrahman *et al*., 2018);

$$\text{Feed conversion ratio (FCR)} = \frac{\text{Total feed intake (g)}}{\text{Total weight gain (g)}}$$

…….. (Utne, 1978);

$$\text{Feed efficiency ratio (FER)} = \frac{\text{Total weight gain (g)}}{\text{Total feed intake (g)}}$$

….. (Utne, 1978);

$$\text{Protein efficiency ratio (PER)} = \frac{\text{Total weight gain (g·fish}^{-1})}{\text{Protein intake (g·fish}^{-1})}$$

….. (Utne, 1978);

$$\text{Hepatosomatic index (HSI,\%)} = \frac{\text{Liver weight}}{\text{Body weight}} \times 100$$

..... (Hama *et al*., 2015);

$$\text{Gill somatic index (GSI,\%)} = \frac{\text{Gill weight}}{\text{Body weight}} \times 100$$

..... (Hama *et al*., 2015);

$$\text{Kidney somatic index (KSI,\%)} = \frac{\text{Kidney weight}}{\text{Body weight}} \times 100$$

..... (Abdulrahman *et al*., 2018);

$$\text{Splenosomatic index (SSI,\%)} = \frac{\text{Spleen weight}}{\text{Body weight}} \times 100$$

..... (Abdulrahman *et al*., 2018).

Complete blood count

At the end of the trial, five fish were randomly selected from each experimental group. The weight and length of each fish were recorded individually. Blood samples were obtained by cutting the caudal veins, and collected into small plastic vials containing heparin as an anticoagulant (Al-Koye, 2013). The samples were kept refrigerated until analysis. A fully automatic hematology analyzer (BC-2800, USA) was used to perform the complete blood count (CBC). The parameters measured included hemoglobin (HGB, $g \cdot L^{-1}$), platelets (PLT, $10^9 \cdot L^{-1}$ cells), mean corpuscular hemoglobin (MCH, pg), mean corpuscular hemoglobin concentration (MCHC, $g \cdot dL^{-1}$), and erythrocyte count (RBCs, $10^{12} \cdot L^{-1}$ cells). In addition, the proportions of lymphocytes, monocytes, and granulocytes were determined.

Biochemical parameters

The blood tests measured ALT, AST, total protein (TP), albumin (ALB, $g \cdot dL^{-1}$), glucose ($mmol \cdot L^{-1}$), and creatine kinase (CK, $U \cdot L^{-1}$). The lipid profile included cholesterol, triglycerides, low-density lipoprotein (LDL), and high-density lipoprotein (HDL) ($mmol \cdot L^{-1}$). An ACCENT 200 hematological analyzer (Poland) was used for these tests, and the corresponding enzymatic kits were applied according to the manufacturer's instructions to determine enzyme levels.

Statistical analysis

The experiment followed a completely randomized design (CRD) and data were analyzed by one-way ANOVA using the general linear models (GLM) procedure of XLSTAT 2016 (Version 02. 28451). Duncan's multiple range test was applied to compare treatment means at a significance level of $p<0.05$.

RESULTS

Effects of cress seed supplementation on growth

The initial body weights of common carp did not differ significantly among treatments ($p \geq 0.05$) (Figure 1a). However, final weight, weight gain, daily growth rate, and relative growth rate were significantly affected by dietary cress seed powder supplementation ($p<0.05$). Fish fed diets containing 15 $g \cdot kg^{-1}$ cress seed powder (T4) showed the highest final weight, weight gain, and relative growth rate, followed by those in T3 and T2, while the control group (T1) had the lowest values (Figures 1b–1d, 1f). Specific growth rate (SGR) did not differ significantly among treatments ($p \geq 0.05$) (Figure 1e).

Effects of cress seed supplementation on feed utilization

Feed conversion ratio (FCR) was significantly reduced in all groups fed cress seed powder compared with the control ($p<0.05$), with the lowest FCR observed in T3 (10 $g \cdot kg^{-1}$) and T4 (15 $g \cdot kg^{-1}$) (Figure 2a). Feed efficiency ratio (FER) and protein efficiency ratio (PER) increased significantly with dietary cress supplementation ($p<0.05$). The highest FER and PER values were recorded in T4, followed by T3, while the control group (T1) showed the lowest values (Figures 2b–2c).

Effects of cress seed supplementation on biological indicators

No significant differences were observed in condition factor (K) (Figures 3a). However, dietary supplementation with cress seed powder

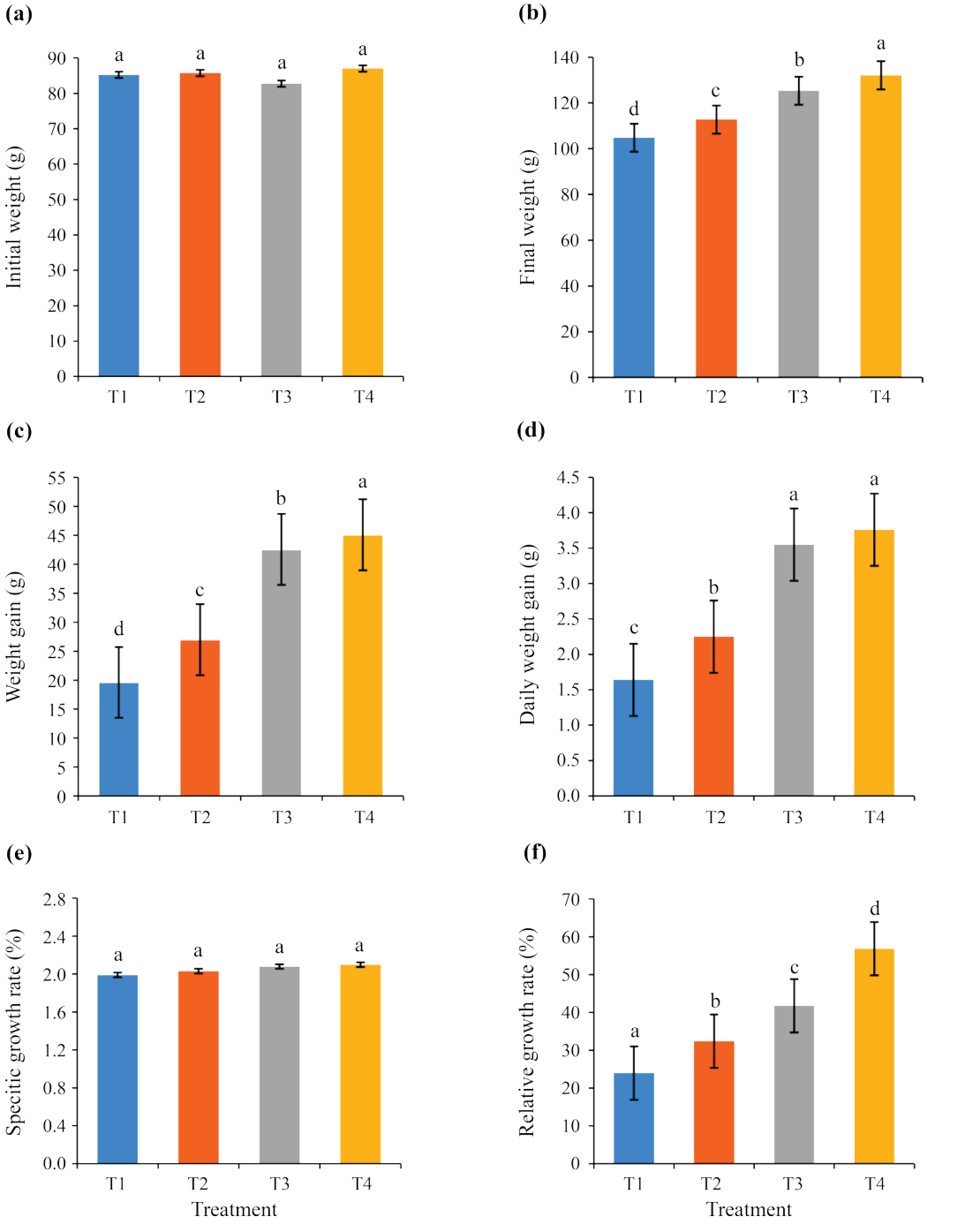

Figure 1. Effects of dietary cress (*Lepidium sativum*) seed powder on growth performance of common carp: initial weight (a), final weight (b), weight gain (c), daily weight gain (d), specific growth rate (SGR) (e), and relative growth rate (RGR) (f). Columns represent mean values, and error bars indicate standard deviations. Different letters above the bars denote significant differences ($p<0.05$). Treatment groups are shown by color: blue = T1 (control), orange = T2 (5 g·kg^{-1}) cress, grey = T3 (10 g·kg^{-1}) cress, and yellow = T4 15 g·kg^{-1}) cress.

significantly increased the intestine length index compared with the control (Figure 3c). Significant differences in the intestine weight index were observed among the experimental groups. The T3 group showed the lowest value, which was significantly lower than those recorded in T1, T2, and T4 (Figures 3b). In contrast, the intestine length index relative to fish length showed no consistent differences, except for T4, which was lower than the control (Figure 3d).

Effects of cress seed supplementation on health indices

As seen in Figure 4, dietary cress seed powder had a significant effect on the health indices of common carp, including hepatosomatic and splenosomatic indices. A notable reduction was observed across the treatments. However, the kidney somatic and gill somatic indices did not differ significantly among treatments ($p>0.05$).

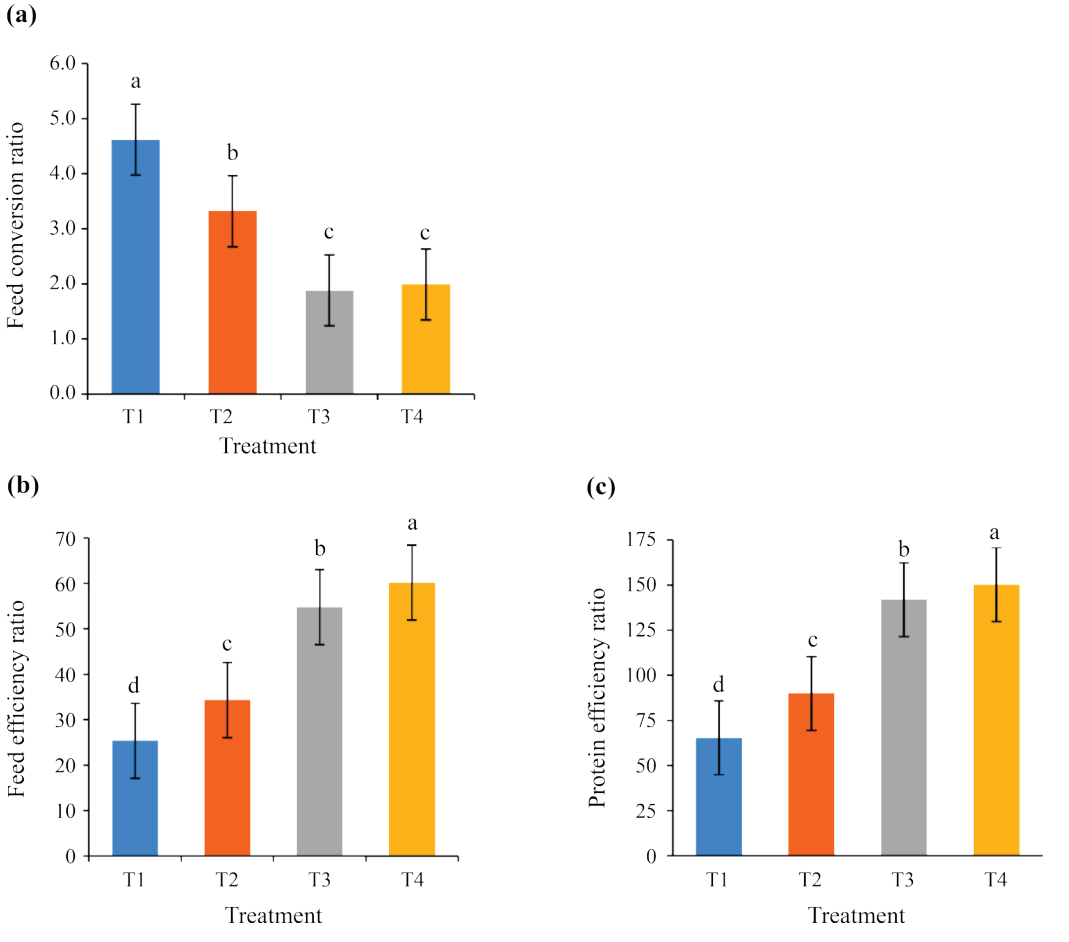

Figure 2. Effects of dietary cress (*Lepidium sativum*) seed powder on feed utilization of common carp: feed conversion ratio (a), feed efficiency ratio (b), and protein efficiency ratio (c). Columns represent mean values, and error bars indicate standard deviations. Different letters above the bars denote significant differences ($p<0.05$). Treatment groups are shown by color: blue = T1 (control), orange = T2 (5 g·kg^{-1}) cress, grey = T3 (10 g·kg^{-1}) cress, and yellow = T4 15 g·kg^{-1}) cress.

Effects of cress seed supplementation on blood parameters

As shown in Figure 5, RBC did not differ significantly among treatments (Figure 5a). Hemoglobin (HGB), hematocrit (HCT), and platelet levels were significantly higher in fish fed with 5 g·kg^{-1} cress seed powder (T2) compared with the control ($p<0.05$) (Figures 5b, 5e, 5g). In contrast, mean corpuscular hemoglobin (MCH) and mean corpuscular hemoglobin concentration (MCHC) were significantly higher in the control group than in the supplemented groups (Figures 5c–5d). Mean corpuscular volume (MCV) was significantly greater in T3 and T4 compared with T1 and T2 (Figure 5f).

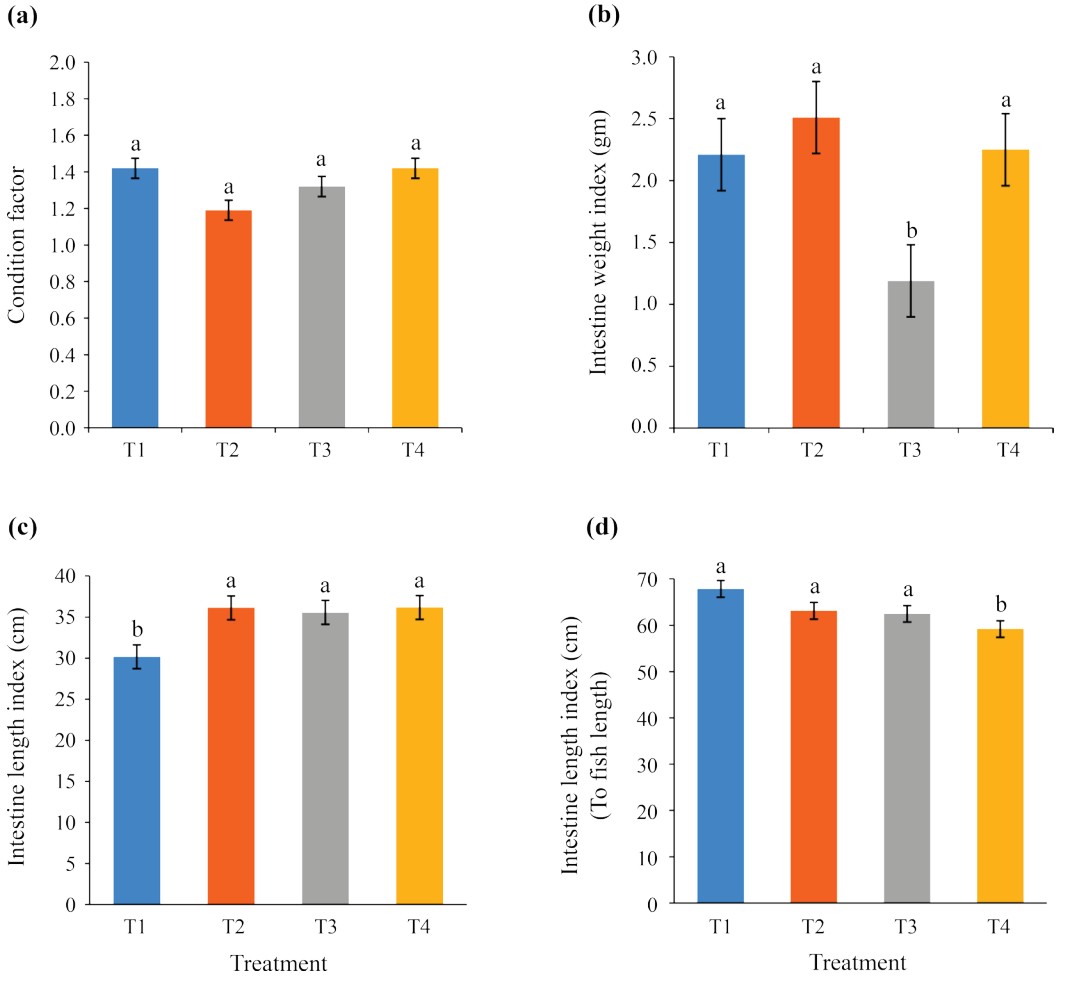

Figure 3. Effects of dietary cress (*Lepidium sativum*) seed powder on biological indicators of common carp: condition factor (K) (a), intestine weight index (b), intestine length index (c), and intestine length index (to fish length) (d). Columns represent mean values, and error bars indicate standard deviations. Different letters above the bars denote significant differences ($p<0.05$). Treatment groups are shown by color: blue = T1 (control), orange = T2 (5 g·kg^{-1}) cress, grey = T3 (10 g·kg^{-1}) cress, and yellow = T4 15 g·kg^{-1}) cress.

Effects of cress seed supplementation on leukocyte parameters

As shown in Figure 6, dietary cress seed powder significantly affected all measured leukocyte parameters ($p<0.05$). Total white blood cell (WBC) count was highest in fish fed 5% g·k^{-1} cress seed powder (T2), while T3 (10% g·k^{-1}) showed the lowest value (Figure 6a). Lymphocyte proportion was significantly elevated in T3 compared with the other treatments (Figure 6b). Monocyte levels were significantly higher in T3 and T4 (15% g·k^{-1}) compared with T1 and T2 (Figure 6c). Granulocyte proportion was greatest in T2, followed by T1, while T3 and T4 had significantly lower values (Figure 6d).

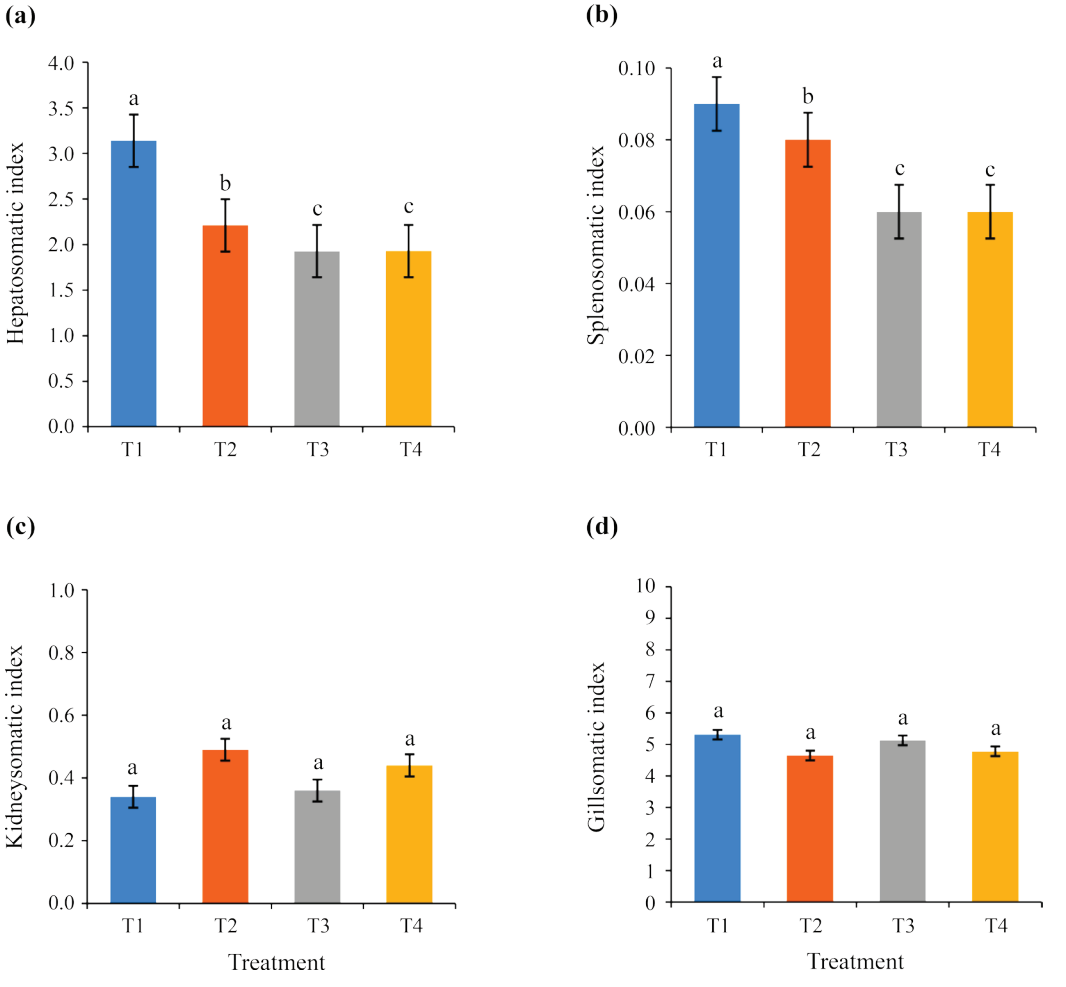

Figure 4. Effects of dietary cress (*Lepidium sativum*) seed powder on health indices of common carp: hepatosomatic index (a), splenosomatic index (b), kidney somatic index (c), and gill somatic index (d). Columns represent mean values, and error bars indicate standard deviations. Different letters above the bars denote significant differences ($p<0.05$). Treatment groups are shown by color: blue = T1 (control), orange = T2 (5 g·kg^{-1}) cress, grey = T3 (10 g·kg^{-1}) cress, and yellow = T4 15 g·kg^{-1}) cress.

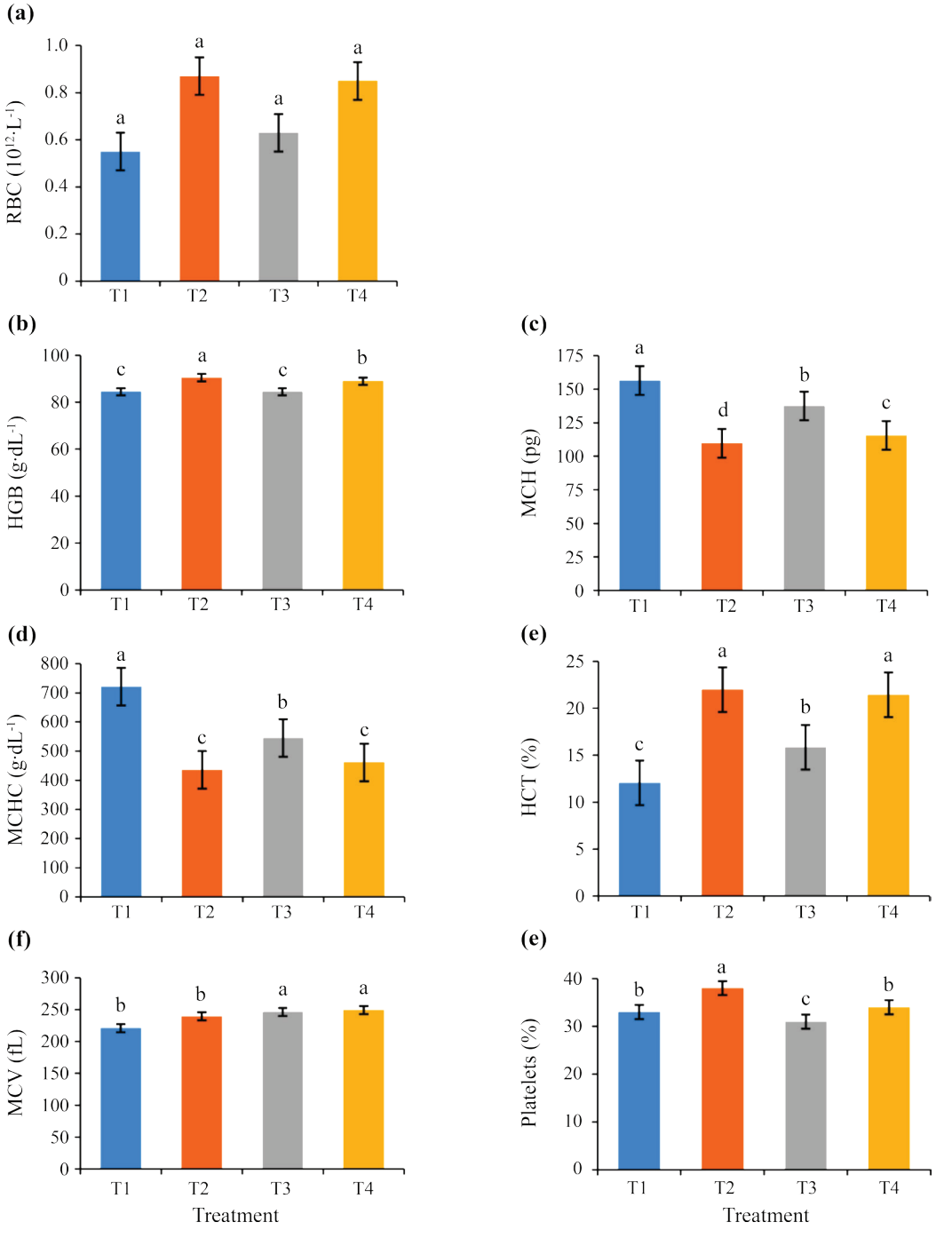

Figure 5. Effects of dietary cress (*Lepidium sativum*) seed powder on selected blood parameters: red blood cells (RBC) (a), hemoglobin (HGB) (b), mean corpuscular hemoglobin (MCH) (c), mean corpuscular hemoglobin concentration (MCHC) (d), hematocrit (HCT) (e), mean corpuscular volume (MCV) (f), and platelets (g). Columns represent mean values, and error bars indicate standard deviations. Different letters above the bars denote significant differences ($p<0.05$). Treatment groups are shown by color: blue = T1 (control), orange = T2 (5 g·kg^{-1}) cress, grey = T3 (10 g·kg^{-1}) cress, and yellow = T4 15 g·kg^{-1}) cress.

Effects of cress seed supplementation on blood lipids

As illustrated in Figure 7, dietary cress seed powder had no significant effect on cholesterol and triglyceride levels, although cholesterol tended to be highest in T3 (10% g·kg^{-1} cress seed) and triglycerides in T4 (15% g·kg^{-1}) (Figure 7a–7b). In contrast, low-density lipoprotein (LDL) levels were significantly elevated in T4 compared with the other groups (Figure 7c), while high-density lipoprotein (HDL) levels were significantly higher in T3 than in the remaining treatments (Figure 7d).

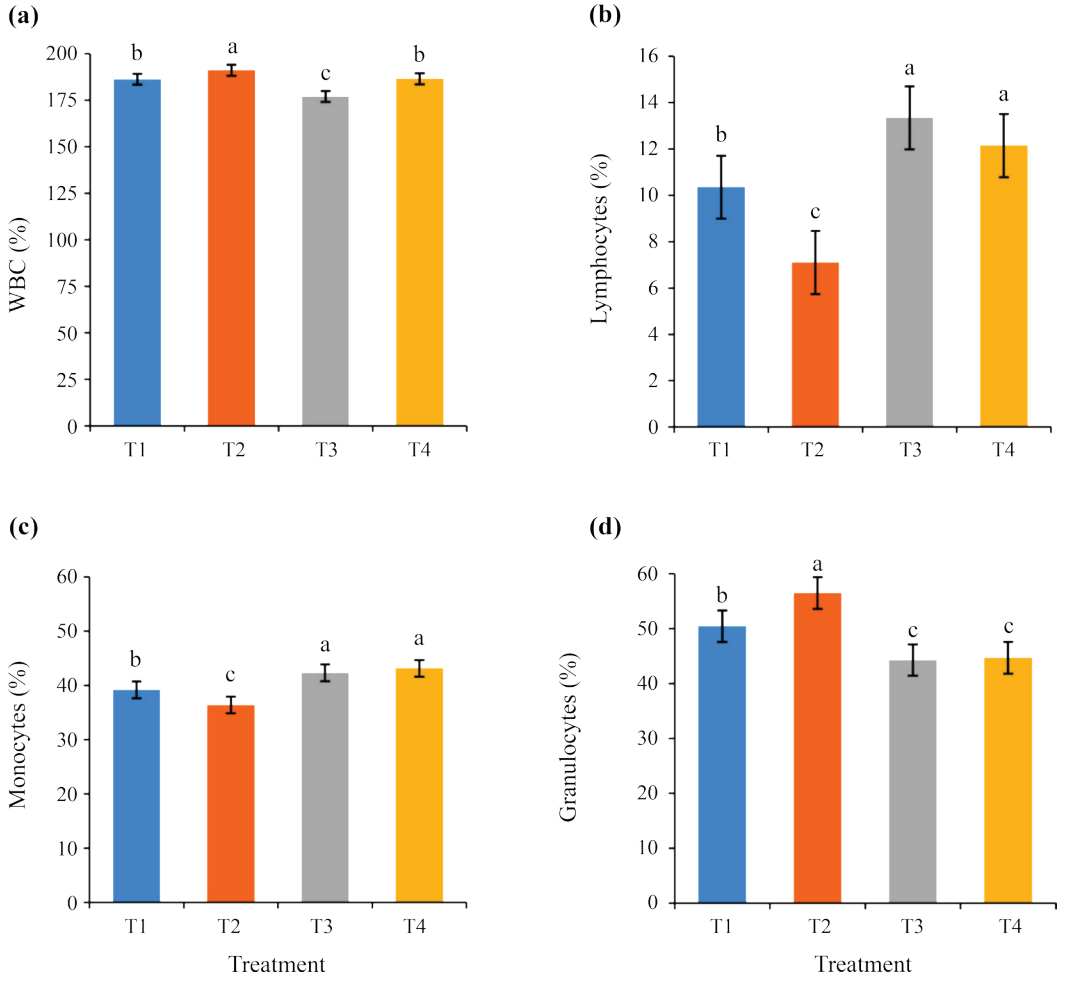

Figure 6. Effects of dietary cress (*Lepidium sativum*) seed powder on leukocyte parameters: WBC count (a), lymphocytes (b), monocytes (c), and granulocytes (d). Columns represent mean values, and error bars indicate standard deviations. Different letters above the bars denote significant differences ($p<0.05$). Treatment groups are shown by color: blue = T1 (control), orange = T2 (5 g·kg^{-1}) cress, grey = T3 (10 g·kg^{-1}) cress, and yellow = T4 15 g·kg^{-1}) cress.

Effects of cress seed supplementation on blood biochemical parameters

Figure 8 shows that glucose levels were significantly higher in all cress-supplemented groups compared with the control (Figure 8a). In contrast, alanine aminotransferase (ALT), aspartate aminotransferase (AST), and creatine kinase (CK) were significantly higher in the control group than in the supplemented treatments (Figures 8b–8c, 8e). No significant differences were detected in albumin (ALB) or total protein (TP) levels among treatments (Figures 8d, 8f).

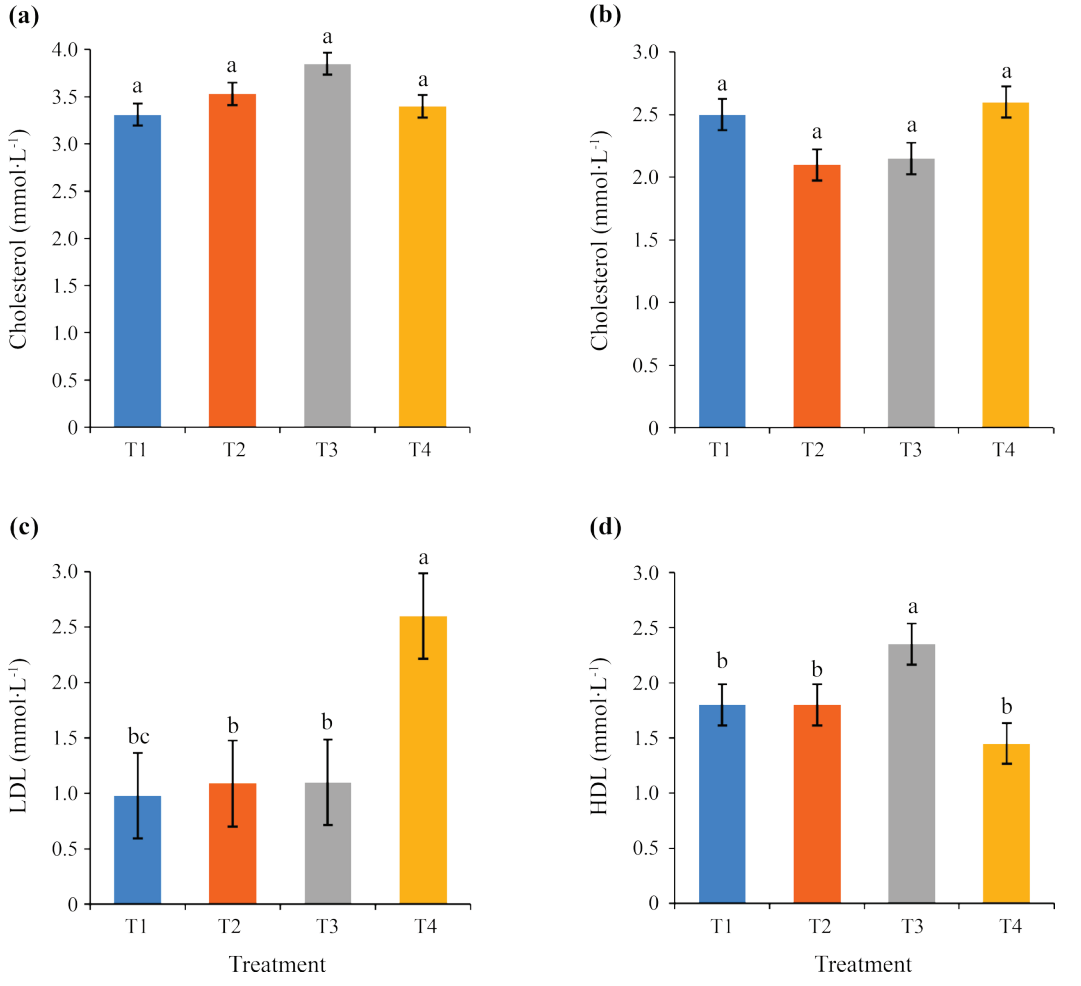

Figure 7. Effects of dietary cress (*Lepidium sativum*) seed powder on lipid profile; cholesterol (a), triglycerides (b), LDL (c), and HDL (d). Columns represent mean values, and error bars indicate standard deviations. Different letters above the bars denote significant differences ($p<0.05$). Treatment groups are shown by color: blue = T1 (control), orange = T2 (5 g·kg^{-1}) cress, grey = T3 (10 g·kg^{-1}) cress, and yellow = T4 15 g·kg^{-1}) cress.

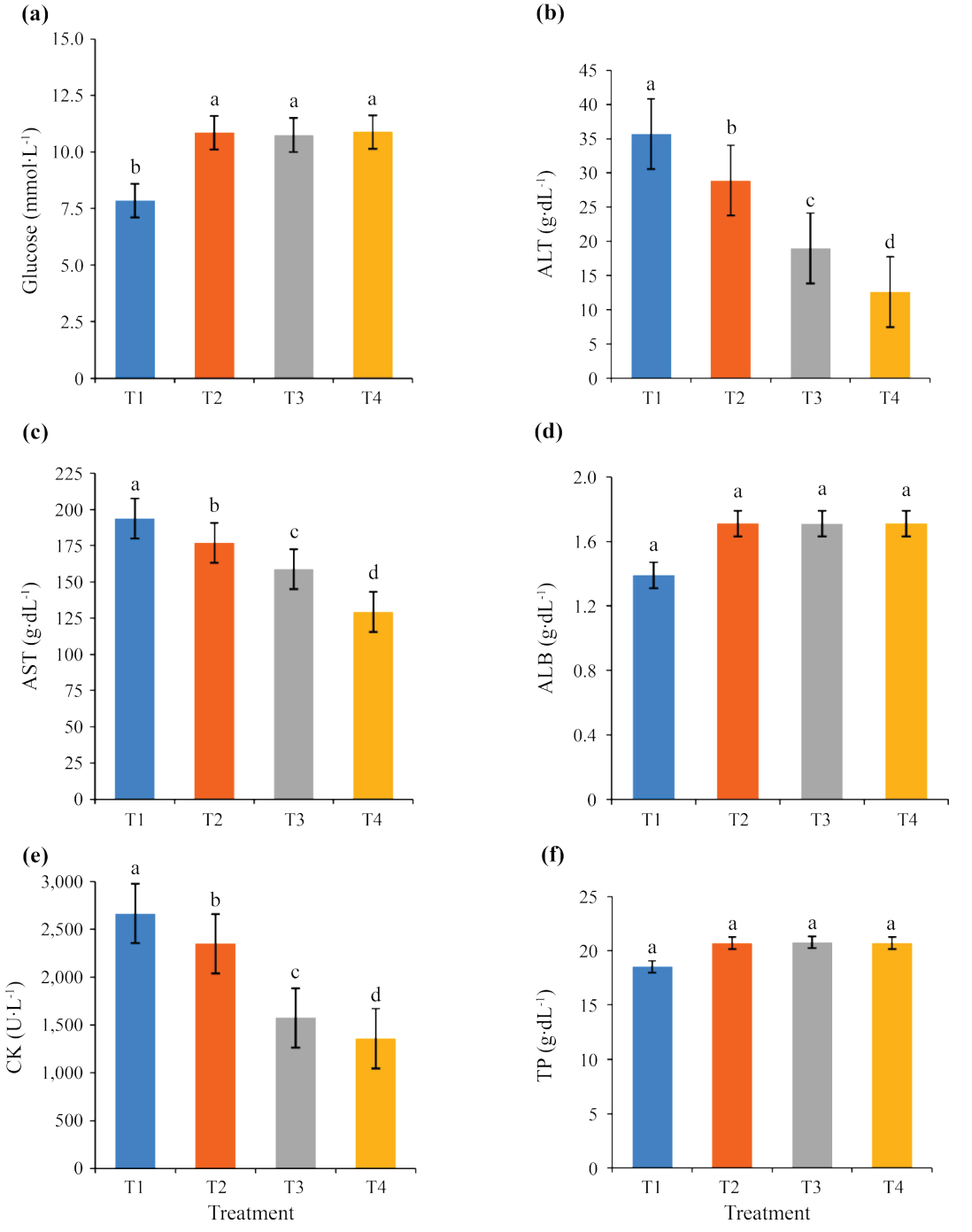

Figure 8. Effects of dietary cress (*Lepidium sativum*) seed powder on blood biochemical parameters of common carp: glucose (a), ALT (b), AST (c), ALB (d), CK (e), and TP (f). Columns represent mean values, and error bars indicate standard deviations. Different letters above the bars denote significant differences ($p<0.05$). Treatment groups are shown by color: blue = T1 (control), orange = T2 (5 g·kg^{-1}) cress, grey = T3 (10 g·kg^{-1}) cress, and yellow = T4 15 g·kg^{-1}) cress.

DISCUSSION

This study provides an experimental setup detailing the impact of cress seed powder on common carp performance and physiological activities by incorporating cress seed powder into the diet. The seeds contain 27% protein, 14–26% lipids (with 20–25% of the oil as linolenic acid), 35–54% carbohydrates, moisture, and 8% crude fiber, which are essential in fish diets (Zia-Ul-Haq *et al*., 2012). Additionally, the seeds are rich in essential phytochemicals including flavonoids, glucosinolates, alkaloids, saponins, sterols, sinapic acid, and tannins (Behrouzian *et al*., 2014). Cress seeds are considered a beneficial supplement for aquafeeds due to their antioxidant and antimicrobial properties; indeed, they are known to provide resistance against bacteria, viruses, and fungi (Chatoui *et al*., 2016). In the present study, cress seeds substantially improved the growth of common carp, particularly in terms of weight gain, daily growth rate, and relative growth rate.

Previous studies have reported that diets rich in medicinal plant compounds positively influence fish growth and physiology (Attalla, 2009). In particular, cress seeds have been identified as a useful aquafeed supplement due to their ability to combat oxidative stress and reduce inflammation (Abu-Khudir *et al*., 2023). Similarly, (Bilen *et al*. (2018) documented that supplementation with grass cress extract (1 and 2 $g \cdot kg^{-1}$ diet) improved immune responses and digestive enzyme activity in juvenile common carp.

In this study, FCR was significantly reduced in groups fed cress seed powder, especially at higher inclusion levels (≥ 10 $g \cdot kg^{-1}$), while feed efficiency ratio (FER) and protein efficiency ratio (PER) were significantly increased compared with the control. These findings are in line with El-Gendy *et al*. (2023), who reported that cress seed supplementation in rats significantly influenced FER, feed intake, and body weight gain. Similarly, Al-Rawe *et al*. (2022) found improved FCR when *Eruca sativa* was added to fish diet.

There were no significant differences in some biological parameters of common carp, such as condition factor, while intestine weight index, intestine length index was significantly enhanced with cress seed supplementation. Akl *et al*. (2021) also reported that cress seed powder significantly affected small intestine length and intestine length index in rats.

Health indices, including kidney somatic and gill somatic indices, were not significantly affected by dietary treatments, except for hepatosomatic and splenosomatic indices. For that reason, cress seeds are known to contribute to regulating liver enzymes and renal function owing to their rich content of amino acids, minerals, vitamins, and fatty acids (Abuelgasim *et al*., 2008). Their hepatoprotective effects have been linked to benzene and ç-tocopherol (Miyoshi *et al*., 2004; Nakamura *et al*., 2004), as well as phytosterols such as α-sitosterol and campesterol (Chen *et al*., 2020).

Hematological parameters were also influenced by cress seed supplementation. Significant changes were observed in HGB, HCT, MCH, MCHC, MCV, and platelet counts. These findings are consistent with El-Houseiny *et al*. (2024), who reported similar changes in Nile tilapia fed cress seeds, except for RBC, which was unaffected in their study. In the present study, cress seeds also significantly increased WBC count, lymphocytes, monocytes, and granulocytes, suggesting enhanced immune function and potential immune-restorative properties of cress seed powder (El-Houseiny *et al*., 2024).

Blood lipid parameters showed no significant differences in cholesterol and triglyceride levels, although cholesterol tended to be highest in T3 and triglyceride in T4. LDL levels were significantly higher in T4, while HDL was significantly elevated in T3. Similar to our results, Ramadan *et al*. (2021) demonstrated that increasing cress from 100 to 200 $mg \cdot kg^{-1}$ had no significant effect on LDL and HDL in rats.

Serum biochemical analysis further demonstrated that ALT, AST, and CK activities were significantly reduced in cress-fed groups compared with the control, indicating protective effects on liver function. In contrast, glucose levels were significantly elevated in all cress-fed groups, while ALB, and TP remained unchanged. These results are partly consistent with earlier findings by Abuelgasim *et al*. (2008) and El-Houseiny *et al*. (2024), who linked cress supplementation to improved liver enzyme profiles. In tilapia, Raish *et al*. (2016) and Abdelhamid and Soliman (2012) reported increases in TP and ALB with cress seed inclusion, though such effects were not observed in common carp in this study.

Overall, this study presents evidence that cress seed powder enhances growth performance, feed utilization, hematological parameters, and selected biochemical indices of common carp, while maintaining stable somatic indices. These findings support the use of plant-based supplements as alternatives to synthetic chemicals in aquaculture. However, further research is required to evaluate long-term effects, immune function, antioxidant enzyme activity, and gut microbiota modulation, which may provide deeper insights into the mechanisms underlying the observed improvements.

Despite the promising results of this study, several limitations should be acknowledged. Although different dietary doses of cress seed powder were examined, the long-term effects of supplementation remain unknown. In addition, this study predominantly focused on growth performance and basic physiological responses, while other important indicators, such as immune system function, antioxidant enzyme activity, and gut microbiota composition, were not assessed. These parameters could provide deeper insights into the mechanisms underlying the observed improvements. Future research should therefore address these aspects to better elucidate the broader impact of cress seed on the health of common carp.

CONCLUSIONS

This study demonstrated the beneficial effects of dietary cress seed powder on the health and performance of common carp. Supplementation at different concentrations significantly influenced physiological and hematological parameters, where treated groups performing better than the control. Notably, final weight, weight gain, DWG, SGR, RGR, FER, and PER were all significantly improved. Hematological indices, including, HGB, HCT, MCH, MCHC, MCV, and platelets, were also enhanced by seed supplementation. Among the test levels, 15 $g \cdot kg^{-1}$ diet was identified as the most effective concentration, suggesting its practical application in aquaculture. These findings support the potential of cress seed powder and other plant-based products as natural alternatives to synthetic additives. Further studies should explore their effects on additional aquatic species and broader physiological responses.

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LITERATURE CITED

Abdelhamid, A.M. and A.A.A. Soliman. 2012. Possibility of using medical plants in fish diets: III- cresson seeds. **Journal of Animal and Poultry Production** 3(6): 319–327. DOI: 10.21608/jappmu.2012.82796.

Abdulrahman, N.M., S.H. Abid, A.A. Khidir, B.B. Omer, D.B. HamaRasheed and L.H. BahaAlddin. 2018. Effect of adding microalgae *Chlorella* sp. on some biological parameters and proximate analysis of common carp *Cyprinus Carpio* L.. **Iranian Journal of Veterinary Medicine.** 12(3): 199–206. DOI: 10.22059/ijvm.2018.244747.1004856.

Abu-Khudir, R., G.M. Badr, H.I. Abd El-Moaty, *et al*. 2023. Garden cress seed oil abrogates testicular oxidative injury and NF-kB-mediated inflammation in diabetic mice. **International Journal of Molecular Sciences** 24(20): 15478. DOI: 10.3390/ijms242015478.

Abuelgasim, A.I., H. Nuha, A.J.R.J.o.A. Mohammed and V. Sciences. 2008. Hepatoprotective effect of *Lepidium sativum* against carbon tetrachloride induced damage in rats. **Research Journal of Animal and Veterinary Sciences** 3: 20–23.

Akl, E.M., F.S. Taha, S.S. Mohamed and R.S. Mohamed. 2021. Characterization of garden cress mucilage and its prophylactic effect against Indomethacin-Induced Enter-Colitis in rats. **Biointerface Research in Applied Chemistry** 11(6): 13911–13923. DOI: 10.33263/BRIAC116.1391113923.

Al-Jenoobi, F.I., A.A. Al-Thukair, M.A. Alam, F.A. Abbas, A.M. Al-Mohizea, K.M. Alkharfy and S.A. Al-Suwayeh. 2014. Effect of garden cress seeds powder and its alcoholic extract on the metabolic activity of CYP2D6 and CYP3A4. **Evidence-Based Complementary and Alternative Medicine** 2014(1): 634592. DOI: 10.1155/2014/634592.

Al-Koye, H. 2013. Effect of using *Spirulina* spp. instead of fishmeal on growth, blood picture and microbial load of common carp *Cyprinus carpio*. **Iraqi Journal of Veterinary Sciences** 1(33): 27–31.

Al-Rawe, S.D., M.A. Mohammad and A.A.B.A. Al-Farha. 2022. Effect of adding Eruca sativa in common carp on growth criteria, feed utilization and chemical composition. **Iraqi Journal of Veterinary Sciences** 36 (Supplement I): 107–113. DOI: 10.33899/ijvs.2022.135758.2514.

Alkahtani, J., M. Soliman Elshikh, K.S. Almaary, S. Ali, Z. Imtiyaz and S. Bilal Ahmad. 2020. Anti-bacterial, anti-scavenging and cytotoxic activity of garden cress polysaccharides. **Saudi Journal of Biological Sciences** 27(11): 2929–2935. DOI: 10.1016/j.sjbs.2020.08.014.

Attalla, R. 2009. Influence of some feed additives on growth rates and physiological measurements of blue tilapia (*Oreochromis aureus*). **Egypt Journal of Aquatic Research** 35: 231–241.

Behrouzian, F., S.M.A. Razavi and G.O. Phillips. 2014. Cress seed (*Lepidium sativum*) mucilage, an overview. **Bioactive Carbohydrates Dietary Fibre** 3: 17–28.

Bilen, S., O. Özkan, K. Alagöz and K.Y. Özdemir. 2018. Effect of dill (*Anethum graveolens*) and garden cress (*Lepidium sativum*) dietary supplementation on growth performance, digestive enzyme activities and immune responses of juvenile common carp (*Cyprinus carpio*). **Aquaculture** 495: 611–616. DOI: 10.1016/j.aquaculture.2018.06.037.

Brown, M. 1957. **Experimental studies on growth.** In: The Physiology of Fishes (ed. M. Brown), pp. 361–400. Academic Press, New York, USA.

Chatoui, K., A. Talbaoui, M. Aneb, Y. Bakri, H. Harhar and M.J. Tabyaoui. 2016. Phytochemical screening, antioxidant and antibacterial activity of *Lepidium sativum* seeds from Morocco. **Journal of Materials and Environmental Science** 7(8): 2938–2946.

Chen, Z., A. Wu, H. Jin and F. Liu. 2020. β-Sitosterol attenuates liver injury in a rat model of chronic alcohol intake. **Archives of Pharmacal Research** 43(11): 1197–1206. DOI: 10.1007/s12272–020–01271.

Conforti, F., G. Ioele, G.A. Statti, M. Marrelli, G. Ragno and F. Menichini. 2008. Antiproliferative activity against human tumor cell lines and toxicity test on Mediterranean dietary plants. **Food and Chemical Toxicology** 46(10): 3325–3332. DOI: 10.1016/j.fct.2008.08.004.

Datta, P., B. Diwakar, S. Viswanatha, K. Murthy and K. Naidu. 2011. Safety evaluation studies on garden cress (*Lepidium sativum* L.) seeds in Wistar rats. **International Journal of Applied Research in Natural Products** 4(1): 37–43.

El-Gendy, M.S., E.S. El-Gezawy, A.A. Saleh, R.A. Alhotan, M.A.A. Al-Badwi, E.O.S. Hussein, H.M. El-Tahan, I.H. Kim, S. Cho and S.M. Omar. 2023. Investigating the chemical composition of *Lepidium sativum* seeds and their ability to safeguard against monosodium glutamate-induced hepatic dysfunction. **Foods** 12(22): 4129. DOI: 10.3390/foods12224129.

El-Houseiny, W., A.E. El-Murr, N.A. Abd-Allah, *et al*. 2024. Dietary garden cress (*Lepidium sativum*) seeds mitigate the effect of aflatoxin B1 contamination on growth, antioxidant status, AFB1 residues, immune response, and tissue architecture of *Oreochromis niloticus*. **Aquaculture Reports** 36: 102040. DOI: 10.1016/j.aqrep.2024.102040.

Gokavi, S.S., N.G. Malleshi and M. Guo. 2004. Chemical composition of garden cress (*Lepidium sativum*) seeds and its fractions and use of bran as a functional ingredient. **Plant Foods for Human Nutrition** 59(3): 105–111. DOI: 10.1007/s11130-004–4308–4.

Hama, S.R., N.M. Abdulrahman and N.K. Wahab, 2015. Correlation between heavy metals in water and some health parameters. **International Journal of Plant, Animal and Environmental Sciences** 5(4): 257–260.

Miyoshi, N., S. Takabayashi, T. Osawa and Y. Nakamura. 2004. Benzyl isothiocyanate inhibits excessive superoxide generation in inflammatory leukocytes: implication for prevention against inflammation-related carcinogenesis. **Carcinogenesis** 25(4): 567–575. DOI: 10.1093/carcin/bgh051.

Nakamura, Y., N. Miyoshi, S. Takabayashi and T. Osawa. 2004. Benzyl isothiocyanate inhibits oxidative stress in mouse skin: Involvement of attenuation of leukocyte infiltration. **Biofactors** 21(1–4): 255–257. DOI: 10.1002/biof.552210149.

National Research Council (NRC). 2011. **Nutrient Requirements of Fish and Shrimp.** National Academies Press, Washington, D.C., USA. 392 pp.

Prajapati, M.R., P.H.J.J.o.P. Dave. 2018. Therapeutic and nutritional importance of garden cress seed. **Journal of Pharmacognosy and Phytochemistry** 7(5): 140–143.

Raish, M., A. Ahmad, K.M. Alkharfy, S.R. Ahamad, K. Mohsin, F.I. Al-Jenoobi, A.M. Al-Mohizea and M.A. Ansari. 2016. Hepatoprotective activity of *Lepidium sativum* seeds against D-galactosamine/lipopolysaccharide induced hepatotoxicity in animal model. **BMC Complement Altern Med** 16(1): 501. DOI: 10.1186/s12906–016–1483–4.

Ramadan, S., A.M. Hegab, Y.S. Al-Awthan, M.A. Al-Duais, A.A. Tayel and M.A. Al-Saman. 2021. Comparison of the efficiency of *Lepidium sativum*, *Ficus carica*, and *Punica granatum* methanolic extracts in relieving hyperglycemia and hyperlipidemia of streptozotocin-induced diabetic rats. **Journal Diabetes Resource** 2021: 6018835. DOI: 10.1155/2021/6018835.

Utne, F. 1978. Standard methods and terminology in finfish nutrition. **Hamburg** (2): 20–23.

Zia-Ul-Haq, M., S. Ahmad, L. Calani, T. Mazzeo, D. Del Rio, N. Pellegrini and V. De Feo. 2012. Compositional study and antioxidant potential of *Ipomoea hederacea* Jacq. and *Lepidium sativum* L. seeds. **Molecules** 17(9): 10306–10321.