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RESEARCH ARTICLE

The Effect of *Moringa oleifera* Leaves Powder Increasing the Productive Characteristics of Common Carp (*Cyprinus carpio* L.) Exposed to Chlorpyrifos

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ABSTRACT

Pesticides are a major global problem because of their effects on living organisms and their bodily functions. This study was conducted from August 25, 2022, to October 25, 2022. It aimed to know the toxic effects of Chlorpyrifos on common carp (*Cyprinus carpio* L.), and the potential of Moringa oleifera leaves to reduce this toxicity by evaluating their effect on growth performance in fish exposed to the pesticide. The LC50 for Chlorpyrifos has been estimated at 0.60 mg/L over 96 hours. Use 1/10 of the LC50 in the pesticide toxicity test treatment; Moringa leaf powder (MOL) was also added to the food (ready-made commercial feed granules) in three proportions: 5, 10, and 15 g/kg, in addition to using feed the control treatment. During the experiment, the fish weight rates (WR), weight gain (WG), daily weight rate (DGR), relative growth rate (RGR), and specific growth rate (SGR) were studied in the exposed fish to Moringa and/or Chlorpyrifos. The results indicated that all growth indicators studied decreased with exposure to Chlorpyrifos CPF. The study achieved significant results regarding the use of Moringa oleifera leaves in treatment, as treatment with leaf powder improved growth performance at 10 g/kg and 5 g/kg From MO respectively. Adding 15 g/kg of Moringa leaves also reduced growth performance. We concluded through the study that using moderate proportions of Moringa leaves has anti-toxic effects, and raising these proportions has negative effects due to an increase in anti-nutritional compounds. Therefore, we suggest that the active substances be extracted and used as additives for fish feed.

Keywords: Chlorpyrifos, Growth, Moringa, Pesticides, Toxic effect

Introduction

Pesticides are chemical compounds that eliminate or reduce pests, insects, and weeds.[1] Most pesticides affect the nervous system with slight changes in their mechanism of action.[2] Organophosphorus and organochlorine pesticides are the most widely used because of their high activity in control operations.[3] It represents more than 50% of the total use of pesticides around the world. Chlorpyrifos is an organophosphorus insecticide registered for the first time in the United States in 1965.[4] It is a widespread pesticide with a moderately toxic effect and is used to combat harmful pests. It affects crops and livestock, including rice, cotton, fruits, vegetables, and termites.[5] It is a widespread pesticide with a moderately toxic effect45, in addition to the many agricultural benefits of this pesticide. However, it is considered a severe threat to the environment due to its high stability, which leads to changes in environmental

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quality.[6] Its low solubility in water characterizes it due to the stability of hydrolysis and the lack of factors affecting the aqueous environment, However, it may physically, chemically, or biologically decompose in water after 8-53 days.[7,8]

The Moringa tree is a perennial, deciduous flowering plant that grows in various environmental conditions, as it can grow in arid lowland areas and humid highland areas.[9,10] It is rich in valuable medical, food, environmental, and industrial substances, as it has been used to treat many diseases and in water purification, fuel, and dyeing.[11] Moreover, this plant may contribute to climate protection due to its high ability to adapt to the environment in which It is grown,[12] and due to these benefits, it has been raised in many countries such as Pakistan, Nepal, the Philippines, Cambodia, the Arabian Peninsula, North and South America, the Caribbean islands, Egypt and Ghana, and it is also available in abundance in northern Iraq.[13]

Moringa is an important nutritional source due to its high content of amino acids, carotenoids, and vitamin C. In addition, it is rich in minerals such as calcium, copper, and magnesium. The leaves also contain abundant flavonoids, phenolic compounds, and phytosterols such as galactagogue.[14] Many researchers also found that moringa leaves contain vitamin A and vitamin C more than carrots and oranges. In addition, it concludes a higher percentage of calcium than that found in milk.[15] Moringa leaves have been long used as a feed supplement for animals. They can be given to animals, either fresh or dried. Moreover, they can be used as a substitute for traditional protein meals for monogastric and ruminant animals and aquatic species because they are rich in bioactive substances necessary for nutritional health.[16,17]

Fish are viewed as an important part of aquatic ecosystems. In addition to its high economic importance and its vital role in the structure of the food net and the flow of nutrientsnutrients.[18,19] They are essential sources of cheap animal protein and are distinguished from other types of animal protein by containing all essential amino acids. It is considered an important food source for people in many countries due to its high content of vitamins, magnesium, and iron and its high percentage of important nutrients and mineral components, including calcium, phosphorus, and iodine.[20,21] Many carp species are farmed with the common carp being the most economically important. It is popular in aquaculture for several traits, including its feeding habits and rapid growth rate.[22]

Common carp is farmed on a large scale by fish farmers around the world. The demand for this type of fish has increased, and the number of common carp farms worldwide has doubled.[23,24] Common carp comprise an essential part of global fish production, constituting about 8.5% of it, and are spread in 91 out of 120 countries. Li et al.[25] indicated that this species is widespread in Asia and North America. In 2020, the World Food and Agriculture Organization considered common carp to be the fourth most important freshwater fish species and the most aquacultured species in many European countries, as it constitutes about 80% of their fish production. Annual production in China in 2021 reached about 2.83 billion kilograms, representing 10.73% of the total freshwater fish production, while in 2023, it became the most diverse and widespread commercial fish species among freshwater fish in China.[25–27] More than 66 fish species live in Iraqi waters out of 10,000 freshwater fish classified globally, the most diverse and widespread of which is the common carp, which belongs to the Cyprinidae family, which constitutes 72% of Iraqi freshwater fish and according to statistics from the Arab Organization for Agricultural Development, carp fish rank first in fish farming in Iraq.[26,28,29]

About three billion kilograms of pesticides are used annually around the world. Only 1% of this huge amount is used effectively to control insect pests on target plants. At the same time, excess quantities penetrate various environments, including aquatic ones, affecting non-target organisms that reach them.[30] Chlorpyrifos is a pesticide absorbed mainly through the digestive, skin, and respiratory systems.[4] This pesticide reaches the nervous system of insects and works to inhibit the activity of Acetyl Choline Esterase (AChE).[31,32] Absorption of chlorpyrifos pesticide through the skin is less critical than oral absorption or inhalation, but it is a pathway. It is essential in the path of chemical toxicity.[33] There is also much evidence of its accumulation and its metabolites in the skin, which leads to harmful effects in the long term.[34] Chlorpyrifos accumulates in the fish's body, making it vulnerable to many noticeable effects. It may cause disturbances in breathing, feeding, growth, and the ability to reproduce. It may cause damage to the respiratory and nervous systems, which leads to the disruption of metabolic activities in the body that need oxygen to release energy, which reduces the ability of fish to digest food, thus disrupting growth.[35] Pesticide poisoning of the environment is considered one of Iraq's most critical problems due to its extreme toxicity and high stability due to its slow decomposition and broad impact on non-target species, including fish.[36]

Water pollution with pesticides in Iraq has reached high levels due to the random discharge of water from homes and hospitals, in addition to the surplus water

Fig. 1. Ingredients added to fish-feeding systems.
a- Moringa leaves powder. b- Chlorpyrifos pesticide. c- Threads of feed dough.

from irrigating agricultural lands, which are loaded with pesticide residues used in them, and the lack of effective strategies to treat water and limit this random use of pesticides.[37,38] Since fish growth is one of the indicators of their health, the current article aimed to try to reduce the toxic effects of Chlorpyrifos using Moringa leaf powder by evaluating some growth indicators in these fish.

Materials and methods

Collection and acclimatization

Employed Fish were in this investigation with an average of 49.29±0.44 g. we collected Ninety fish from local Fish farms in Babylon Governorate. Following a 24-hour waiting period, the fish were randomly placed in dechlorinated water-filled glass tanks with constant aeration, The source of the water was water tanks in the laboratory that were filled with tap water and left for 72 hours to get rid of chlorine a temperature of 25±2.4 °C, and a pH of 7.5±0.5. The 14-day adaptation to laboratory conditions included 12/12-hour light /dark cycles. The fish were fed commercial pelleted feeds twice daily at 3% of body weight during the adaptation period.[39] During the acclimation stage, the fish are monitored regularly, and dead or unhealthy fish are discarded.

Fish feed

Fish were fed Commercial Feed Granules (CFG) during acclimation and study tests. Grains (wheat and corn), fishmeal, soybeans, fish oil, amino acids, monosodium phosphate, vitamins, mineral salts, antioxidants, and antioxidants are all included in this diet. Anti Rancid. Feed for the experimental treatments was also made by Moringa leaves were

Table 1. The ingredients used in the feed.

Produced feed	CFG Ratio	MOL Ratio
MOL 1	99.50%	0.50%
MOL 2	99.00%	1.00%
MOL 3	98.50%	1.50%

collected and washed well, to get rid of dust and materials stuck to them, and to exclude bad leaves. The leaves were dried in the shade for 10 days, and crushed using an electric grinder to obtain a fine powder from the leaves. The powder was sieved to get rid of the remains of the veins and parts that affect the Quality of manufactured feed Fig. 1-a, quantities of used commercial feed were also crushed and turned into powder. Feed for the experimental treatments was made by adding certain percentages of both Moringa leaf powder and commercial feed powder, as shown in Table 1.

Two powders were mixed well in all manufactured feeds to ensure homogeneity. Water was added gradually with continuous mixing until the mixture reached the desired consistency. After that, the resulting dough was placed in an electric meat grinder machine, to form threads of feed dough. These threads were dried and broken manually to form a pellet with a length of 5-10 mm and a diameter of 3 mm, after ensuring its complete dryness, it was stored in plastic boxes until used Fig. 1-b.Chlorpyrifos was obtained from the pesticide CHLORSON 48% EC (containing 480 g/L of Chlorpyrifos) by Menakshi Agro Chemicals in Telangana State - India, from the local market in Anbar/Al-Anbar Fig. 1-c, and it was diluted to suit what is added by Iraqi farmers according to Sharia law: -

$$C_1 V_1 = C_2 V_2$$

Concentration experiment for half of the animals (LC_{50})

After adaptation and feeding for 14 days. Concentration experiment for 50% of the fish (LC_{50}). Five reliable concentrations have been determined on:[40–42] (0.15, 0.30, 0.45, 0.60, and 0.75 mg/L), and after 96 hours, it was found through the experiment that the value of LC_{50} is (0.60 mg/L).

Study design

The fish were distributed into five treatments, each containing 18 fish. Each treatment was divided into three glass aquariums, with six fish per aquarium. The pesticide Chlorpyrifos was used by taking 1/10 of the LC_{50} (0.06 mg/L).[43] Commercial fodder and pre-manufactured fodder were also used by adding Moringa leaves powder MOL. The fish from the control treatment and one of the pesticide treatments were fed with commercial feed. In contrast, three treatments were fed with manufactured feed for 7 weeks (one week as an adaptation without adding the pesticide and 6 weeks with exposure to the pesticide) according to the proportions specified to test the effectiveness of moringa in the treatment. The experiment groups are as follows:

- **First Treatment** (T1): Use commercial feed only (negative control).
- **Second Treatment** (T2): Add CPF only with commercial etiquette (Positive control).
- **Third Treatment** (T3): Use manufactured feed MOL 1 + CPF.
- **Fourth Treatment** (T4): Use of manufactured feed MOL 2 + CPF.
- **Fifth Treatment** (T5): Use manufactured feed MOL 3 + CPF.

Growth performance

The growth study was conducted for 60 days, from August 25 to October 23, 2022. The fish were fed both produced and commercial feed, and some treatments included exposure to Chlorpyrifos. The air pumps are shut off for half an hour while the fish are fed by adding the floating feed in the glass aquariums, and these pumps are restarted once the meal is eaten. The fish were weighed five times during the experiment: once at the beginning and four more times every two weeks. A sensitive scale was used to evaluate the fish after they had been removed from the ponds and dried with a cloth. The relative growth rate (RGR), the specific growth rate (SGR), the daily weight gain rate (DGR), and the total weight gain rate (WG) were all calculated. To determine the growth performances, the mathematical equations[44,45] supplied were used: -

Weight gain (W.G).

The total weight gain of fish for any given period can be calculated using the following equation:

$$Weight\ Gain\,(W.G)\,(g) = Final\ weight\,(g) - Initial\ weight\,(g)$$

Daily growth rate(D.G.R).

The daily growth rate of fish during a specific period is calculated using the following equation:

$$Daily\ Growth\ Rate\,(D.G.R)\,(g) = \frac{Final\ weight\,(g) - Initial\ weight\,(g)}{t}$$

Relative growth rate(R.G.R).

The relative average rate is calculated by:-

$$Relative\ Growth\ Rate\,(S.G.R) = \frac{Final\ weight\,(g) - Initial\ weight\,(g)}{t} \times 100$$

Specific growth rate(S.G.R).

To determine the specific growth rate, we used the following equation:

$$Specific\ Growth\ Rate\,(S.G.R) = \frac{Ln_{Final\ weight\,(g)} - Ln_{Initial\ weight\,(g)}}{t} \times 100$$

Where (t) represents the period between the two weights

(Ln) represents the natural logarithm

Statistical analysis

Using the SPSS program, version 26.0, the data was statistically analyzed.. The arithmetic mean and standard deviation of the variables were calculated. The significant differences between the means were estimated using the One-Way ANOVA test at the probability level of 0.05. The significant differences between the means were also tested using the least significant difference(LSD).[46]

Results and discussion

Results

Weight rate

The average weights of common carp under the various research conditions are shown in

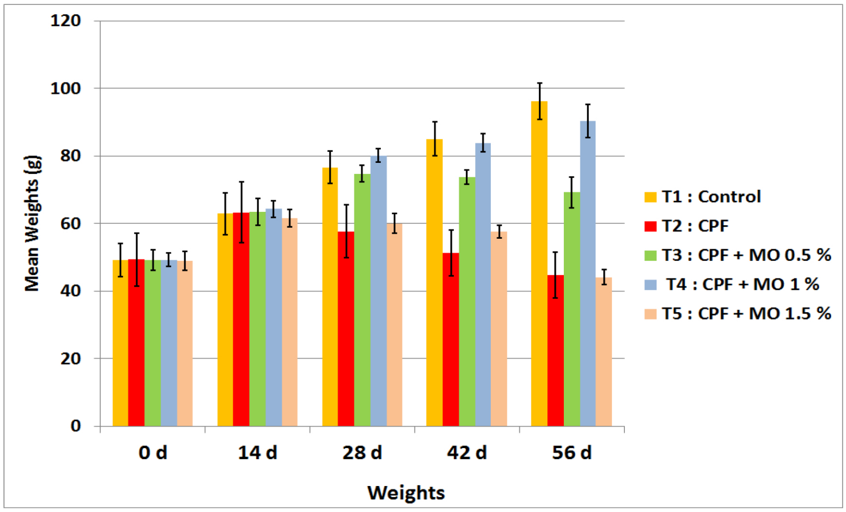

Fig. 2. Values of fish weights (Mean + SD).

Fig. 2 conducting study according to the statistical analysis at $P \leq 0.05$, the consequences of the second treatment, T2, were significantly lower than those of the first treatment, T1; the third treatment, T3, was followed by the fourth treatment, T4, which had the highest significant increase —as opposed to the second treatment, T2, the outcomes of the fifth treatment, T5, varied amongst the various weights without any discernible difference. The current results showed that the fish in the second treatment, T2, recorded the lowest average weight at the end of the experiment, which amounted to 53.22±4.71 g. The highest weight rate in the treatment treatments was in the fish of the fourth treatment, T4, with a weight rate of 73.59±3.59 g, followed by the third treatment, T3, with a weight rate of 66.06±3.94 g, compared to the second treatment, T2.

Weight gain and daily growth rate

Weight gain (WG) and daily growth rate (DGR) differences were statistically significant at $P \leq 0.05$, as shown in Figs. 3 and 4. in the second treatment, T2. These results were recorded for the assigned treatment in T2 and were significant. The Weight gain (WG) -4.64±3.84 g with a daily growth rate (DGR) of -0.08±0.07 g at the first treatment T1. It also includes a significant difference in Weight gain WG and daily DGR in the third treatment, T3, and the fourth treatment, T4. The results showed that the fourth treatment, T4, may record the largest significant increase in Weight gain WG, 41.07±3.46 g, with daily growth rate DGR of 0.72±0.06 g, the third treatment, T3. The Weight gain WG was 19.97±2.33 g, and daily growth rate DGR was 0.35±0.04 g. At the same time, the fifth treatment, T5, chose a non-significant adjustment in the rate of decrease of Weight gain WG and daily growth rate DGR -4.99±3.53 g and -0.09±0.06 g on the right—comparison with the second treatment, T2.

Relative & specific growth rate

It is evident from Figs. 5 and 6 that there is a fluctuation in the results of relative rates and specific rates of growth between the experimental treatments. The second treatment, T2, recorded the lowest RGR of -8.66±6.51 and an SGR of -0.16±0.12 compared to the first treatment, T1, which recorded an RGR of 96.31±13.68 and an SGR of 1.18±0.13. Compared to the second treatment, T2, the statistical results showed a significant increase in relative growth rate and special growth rate for the fourth treatment, T4 and the third, T3, respectively. The fourth treatment, T4, recorded the highest relative growth rate and special growth rate of 84.84±15.61 and 1.07±0.14, respectively, followed by the third treatment, T3, which recorded 41.36±8.95 and 0.61±0.11. In contrast, the fifth treatment, T5, recorded a slight, non-significant decrease at $P \leq 0.05$ in both the relative growth rate, which reached -9.47±6.49, and the specific growth rate, which earned -0.18±0.12.

Discussion

Although the effectiveness of the immune system of fish and the ability of the liver to remove toxins, in addition to the role of intestinal microbes in breaking down pollutants and converting them into less toxic compounds, the indiscriminate use of many pesticides, including chlorpyrifos CPF, can weaken the immune system on the one hand and

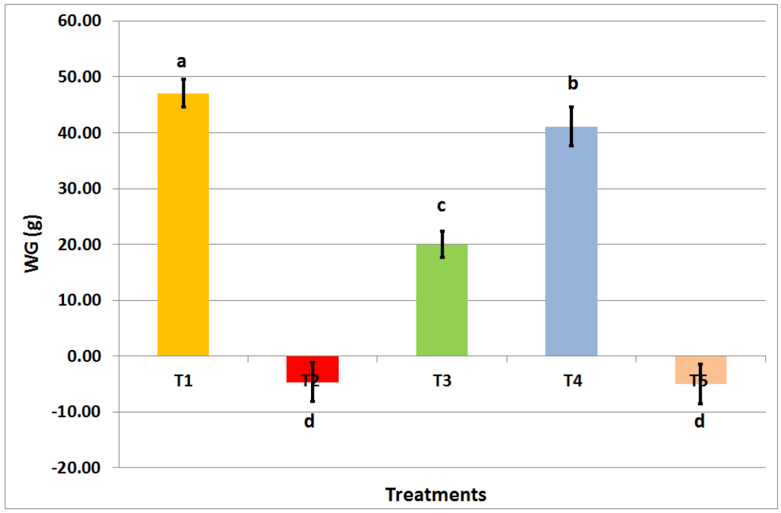

Fig. 3. Values of weight gain (Mean + SD) of *C. carpio*.
a, b, c and d the different letters indicate significant differences at ($P < 0.05$) between the different groups.

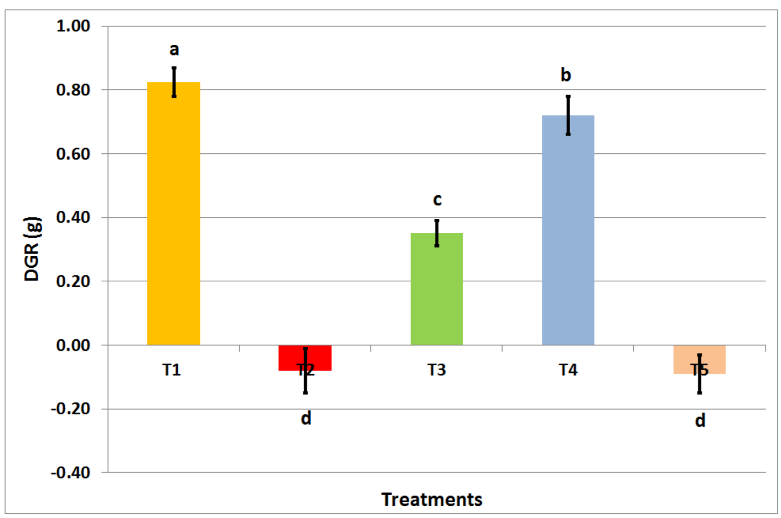

Fig. 4. Values of daily growth rate (Mean + SD) of *C. carpio*.
a, b, c and d the different letters indicate significant differences at ($P < 0.05$) between the different groups.

affect the digestive system on the other. Such include destroying the intestinal microbial community and increasing oxidative stress.[47–49] This is evident from the results in Figs. 2 to 6, which showed the presence of a decrease in weight rates, weight gain, daily weight rate, relative growth rate, and specific growth rate of fish from the second treatment exposed to Chlorpyrifos compared to the negative control treatment (first treatment), and this may be the reason for This decrease indicates the effects of this pesticide in damaging the nervous and respiratory systems of fish, which leads to the disruption of metabolic activities in the body, including the amount of oxygen that the fish must consume, causing a reduction in the fish's ability to digest food, and this, in turn, disrupts the growth rate of the fish.[40] The results of the current study were consistent with those obtained by Holzer et al.,[50] who indicated a decrease in the rates of weight, weight gain, daily weight, relative growth, and specific growth of Nile tilapia fish exposed to Chlorpyrifos. He explained his findings by pointing to the numerous ways this herbicide affected intestinal flora and the capacity of the digestive system to digest and absorb nutrition. By the present study's findings,, Liang et al. also demonstrated in 2019[51] that the toxic effects of Chlorpyrifos resulted in a weakening of epithelial barriers, which allowed lipopolysaccharide to pass through the body and cause some inflammation. Pesticide pollution, including Chlorpyrifos,

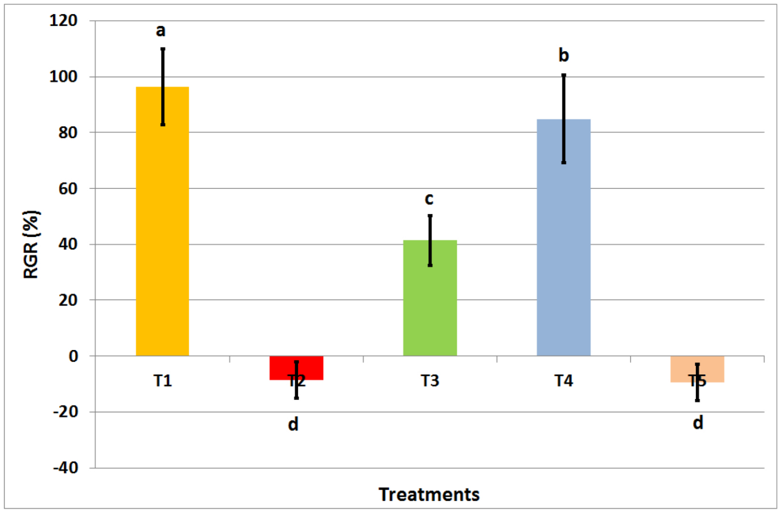

Fig. 5. Values of relative growth rate (Mean + SD) of *C. carpio*.
a, b, c and d the different letters indicate significant differences at (P < 0.05) between the different groups.

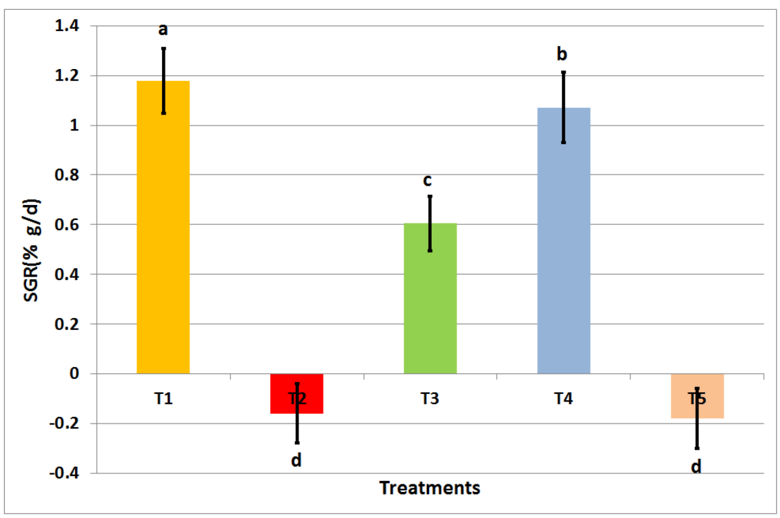

Fig. 6. Values of specific growth rate (Mean + SD) of *C. carpio*.
a, b, c and d the different letters indicate significant differences at (P < 0.05) between the different groups.

negatively affects Common carp. It may cause disturbances in physiological functions, which leads to the disruption of metabolic activities in the body. It may be due to the disruption of chlorpyrifos pesticide to metabolic processes and energy production pathways in the liver by inhibiting ATPase enzyme activity,[52] which reduces the digestibility of food and thus disrupts growth. However, the performance of the fish can be enhanced. Relieving these adverse effects of toxic substances through functional feeds.[35]

Aquaculture depends on the feed quality, including organic and inorganic materials and additives from various sources, including enzymes, fungi, yeasts, etc.[53] Herbal additives have gained popularity in aquaculture feed due to their low cost and lack of severe side effects on humans and the environment.[54] The results of the treatments with Moringa leaves powder MOL are shown in Figs. 2 to 6. Show that there is an improvement in the rates of weight rates, weight gain, daily weight rate, relative growth rate, and specific growth rate, in each of the fourth treatment, as the best treatment, followed by the third treatment. The reason for this may be due to the content of Moringa leaves powder of active compounds such as phenols, which have antioxidant, anti-inflammatory, and anti-microbial properties[55] because of their role in improving intestinal health through the analysis of these compounds by the intestinal microbes and their use in building Low molecular weight compounds can influence intestinal function.[56,57] Moringa is also rich in Isothiocyanates, which are essential plant chemicals because they play a significant role in removing toxic effects due to their antioxidant activity, and activating enzymes that decompose toxins, in addition to the anti-inflammatory functions that may occur due to the pesticide.[58] Due to its high efficiency as a biosorbent, it removes the toxic effects of pesticides and heavy metals by absorbing these substances.[59]

The results of this study were consistent with many studies in the field of herbs and medicinal plants, including the Moringa plant., and its ameliorative effects against toxic chemicals such as pesticides in fish and mammals.[60] Mansour et al. found in 2022[61] that feeding *Clarias gariepinus* exposed to Chlorpyrifos With *Carica papaya* extract led to an improvement in the physiological condition and a reduction in the toxic effects of the pesticide Chlorpyrifos; numerous studies have suggested that supplementing with dietary B-Gluten may help Nile tilapia and African catfish exposed to Chlorpyrifos grow more quickly by increasing the ability of intestinal bacteria to release digesting enzymes.[62] Meanwhile, Abd Rani et al.[63]; and Mondal & Rahaman 2020[64] indicated that the ability of Moringa to reduce the toxicity of Chlorpyrifos can be attributed to flavonoid activity and High antioxidant properties, in addition to the fact that these compounds are very effective in treating nerve disorders that the pesticide may cause because of their anti-cholinesterase properties. In addition to containing quercetin, kaempferol, and moringenin, which increase fish appetite and their ability to metabolize, they cause an increase in feed consumption and, thus, in weight. It also contains niaziridine, which increases the digestive system's absorption of minerals and vitamins.[65]

Conclusion

The current study revealed that adding Chlorpyrifos at 0.06 mg/L led to an apparent decrease in weight, weight gain, and daily, relative, and specific growth rates. The significant effect of the pesticide on the nervous system and its direct effect on health, the digestive system, and the intestine's natural flora may cause these adverse effects of the pesticide. The study also revealed a significant improvement in growth performance when adding Moringa leaves powder to fish feed, as adding 10 g/kg gave the best results, and the leaves content of antioxidants and biologically active compounds may have the most significant role in reducing the toxic effects of Chlorpyrifos. It was also shown through the study that increasing the amount of addition to 15 g/kg of Moringa leaves resulted in negative results in the growth indicators studied. This may be due to the synergistic effect of pesticide toxins and anti-nutritional compounds in Moringa leaves, which decreased fish growth rates. Because of the availability and ease of obtaining Moringa leaves, adding moderate percentages can improve the feed's nutritional value and reduce its production costs.

Authors' declaration

- Conflicts of Interest: None.
- We hereby confirm that all the Figures and Tables in the manuscript are ours. Furthermore, any Figures and images, that are not ours, have been included with the necessary permission for republication, which is attached to the manuscript.
- No animal studies are present in the manuscript.
- No human studies are present in the manuscript.
- Ethical Clearance: The project was approved by the local ethical committee at the University of Anbar.

Authors' contribution statement

Three authors worked together to complete this project.. H.H.F., A.A.T., and H.S.A. designed the study, H.S.A. prepared the laboratory and experimental tools, and H.H.F. conducted the experiment, analyzed the data and wrote the article. The article has been previously reviewed and improved by A.A.T. and H.S.A.

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تأثير مسحوق أوراق نبات *Moringa oleifera* في زيادة الصفات الانتاجية لأسماك الكارب الشائع (*Cyprinus carpio* L) المعرض لمبيد الكلوربيريفوس

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المستخلص

تعد المبيدات الحشرية مشكلة عالمية كبيرة لما لها من تأثيرات على الكائنات الحية ووظائف اجسامها، أجريت هذه الدراسة في الفترة من 25 آب 2022 إلى 25 تشرين الأول 2022. وقد هدفت الى معرفة التأثيرات السامة للكلوربيريفوس CPF على سمك الكارب الشائع. وإمكانات اوراق نبات *Moringa oleifera* في تقليل هذه السمية من خلال تقييم تأثيرها على أداء النمو في الأسماك المعرضة للمبيد. تم تقدير التركيز المميت LC50 بـ 0.60 ملغم/لتر خلال 96 ساعة. تم استخدام 10/1 من LC50 في معاملات الدراسة؛ كما تم استخدام أوراق المورينجا أوليفيرا *M. oleifera* بثلاث نسب: 5 و10 و15 جم/كجم. تم خلال التجربة دراسة معدلات وزن الأسماك (WR)، معدل الزيادة الوزنية الكلية (WG)، معدل الزيادة الوزنية اليومية (DGR)، معدل النمو النسبي (RGR) ومعدل النمو النوعي (SGR).في الاسماك المعرضة للمورينجا اوليفيرا و/ أو مبيد الكلوربيريفوس CPF. أشارت النتائج إلى أن جميع مؤشرات النمو المدروسة تنخفض مع التعرض للكلوربيريفوس CPF. توصلت الدراسة إلى نتائج إيجابية فيما يتعلق باستخدام أوراق المورينجا أوليفيرا في العلاج، حيث أدت المعاملة بمسحوق الأوراق إلى تحسين أداء النمو عند 10 جرام/كجم و5 جرام/كجم. من MO على التوالي. كما أن إضافة 15 جم/كجم من أوراق المورينجا يقلل من أداء النمو. واستنتجنا من خلال الدراسة أن استخدام نسب معتدلة من اوراق المورينجا له تأثيرات مضادة للسموم ورفع هذه النسب له تأثيرات سلبية بسبب زيادة المركبات المضادة للتغذية لذا نقترح أن يتم استخلاص المواد الفعالة واستخدامها كمضافات لأعلاف الاسماك.

الكلمات المفتاحية: الكلوربيريفوس، النمو، المورينجا، المبيدات، التأثير السام.