

Effect of adding organic chromium and cinnamon on the growth performance and food utilization of common carp *Cyprinus carpio* L.

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ABSTRACT

The present study aimed to test the effect of adding organic chromium (chromium picolinate) and the impact of cinnamon (*Cinnamomum zeylanicum*) on the growth performance and feed efficiency of common carp (*Cyprinus carpio* L.).

105 fish were used with an average weight 32.21 ± 2 g/ fish they were kept in glass tanks, that were randomly distributed into five experimental treatments with three replicates for each treatment in an experiment that lasted for 56 days preceded by a three-week acclimatization period. Chromium picolinate was added at a quantity of 0.1 and 0.2 mg/kg feed to the second and third treatments, while cinnamon powder was added to the fourth and fifth treatments at a quantity of 1.5 and 2.0 g/kg feed, respectively, whereas the control diet excluded these additions (first treatment). The statistical analysis of growth characteristics and feed utilization indicated that fish administered chromium picolinate and cinnamon powder exhibited significantly enhanced ($P \leq 0.05$) outcomes compared to the control group in terms of final weight, total weight gain, relative growth, specific growth, feed conversion ratio, and feed efficiency ratio. The incorporation of chromium picolinate demonstrated a more pronounced effect compared to both cinnamon and the control treatment for retention protein, protein efficiency ratio, and protein production value. The incorporation of chromium and cinnamon powder markedly enhanced the crude protein percentage while reducing the fat percentage in the fish's edible section.

Keywords: Chromium picolinate, cinnamon, common carp, growth parameters, protein production value.

INTRODUCTION

Interest in medicinal plants has increased recently due to their active ingredients that play an important role in improving appetite, digestion, and absorption and improving the efficiency of food conversion. In light of this, recent scientific research has indicated the necessity of using medicinal plants in a scientific manner, considering them a safe source for the production of drugs and

medicines [39]. The plant can be used as a whole or its parts directly or after extracting its active ingredient using boiling methods, soaking in cold water, extracting its juice, cold extraction methods, solvent extraction, etc. Cinnamon is one of the medicinal plants that has received great attention, as there are two main types of it: Ceylon cinnamon (*Cinnamomum zeylanicum*) and Chinese cinnamon (*Cinnamomum cassia*) [27].

Ceylon cinnamon comprises 4% volatile oils, predominantly consisting of cinnamaldehyde. It possesses numerous biological functions, particularly in the pharmacological realm, functioning as an analgesic and lowering blood pressure and fever. It also comprises eugenol, a sedative; cinnamyl acetate; cinnamyl alcohol; methoxy cinnamaldehyde; cinnamic acid; diterpene compounds; tannins; and gelatinous substances [24,25], as well as polyphenol, which has insulin-like properties and possesses antibacterial and antifungal activities.[21] discovered that cinnamon powder enhanced the growth, feed efficiency, and health of common carp.

The current research aims to enhance fish growth and increase the utilization of energy sources in the feed, which come from carbohydrates and fats, so

MATERIALS AND METHOD

Experience location

This experiment was conducted in the Fish Laboratory of the Department of Animal Production Sciences at the College of

Experience fish

One hundred five common carp (*Cyprinus carpio* L.) with an average weight of 32.21 ± 2 g / fish were procured from a local fish farm for rearing and hatching in the Tajrian area, Al-Kuwayr district, Nineveh Governorate. The fish

Chromium is classified as one of the rare elements that have been widely used as feed additives, not only because it is an essential mineral element, but also because it has a positive effect in supporting growth and reducing fat percentage in various types of fish and its important effect in enhancing protein, carbohydrate, and fat metabolism in the body [6,19]. It is considered one of the metabolic enhancers due to its positive effect in supporting the action of insulin [36], in addition to being one of the strong antioxidants and a cholesterol reducer[16,38] .[4] showed that adding organic chromium (chromium picolinate) had a positive effect on enhancing growth parameters, food utilization, enhancing feed protein utilization, and reducing the percentage of fat in the body of common carp.

that the utilization of feed protein is directed towards building new protein tissues by adding two types of nutritional additives, which are organic chromium and cinnamon.

Agriculture and Forestry at the University of Mosul, which lasted for 56 days from 13/5/2024 to 7/8/2024.

were sterilized with 3% table salt for five minutes to eliminate any exterior parasites. The fish were allocated randomly across the five experimental treatments at a rate of 21 fish per treatment.

Breeding water quality

The water temperature in the glass tanks varied between 24 and 27°C, as recorded by a mercury thermometer affixed to each tank and regulated by a heater equipped with a thermostat of type RS-200W within each tank. Twenty to twenty-five percent of the water in the tank was siphoned and substituted daily with new water from the main tank to eliminate fish waste

Diet preparation

Fish were fed five balanced experimental diets in terms of metabolized energy and crude protein. Fish were fed three times daily for fifty-six days. Then the amount of food for the fish was changed according to the live weights that were measured every two weeks by 3% throughout the experiment period and at a rate of three meals per day; then the percentage of feed provided was increased to 4% after the third week and until the end of the research according to the weight gain that the fish achieved during the experiment period. Organic chromium (chromium picolinate Cr-pic) produced by the Canadian company Isura and manufactured in the form of tablets (500 micrograms/tablet) and cinnamon powder were added at different levels to the components of the experimental diets, the main components of which were ground using an electric grinder. Then, chromium

and dissolved metabolites. The dissolved oxygen concentration was quantified using a dissolved oxygen meter HD 3030, with values fluctuating between 4.7 and 4.9 mg/L throughout the experimental duration. The pH levels varied from 7.2 to 7.6, as measured by the Eutech Instruments pH meter, which is within the acceptable range for the reproduction and growth of warm-water fish [13].

and cinnamon powders were added to the components of each feed separately by dissolving the organic chromium in water and then added as a spray to the other ground feed components to ensure the homogeneity of these additives as much as possible, with frequent stirring of the mixture before the feed manufacturing process, while cinnamon powder was added directly to the feed components. Warm water was added to moisten the feed to suit its manufacture in the form of pellets. The feeds were dried in the laboratory with continuous stirring. Chromium was added to the control feed at a quantity of 0.1 and 0.2 mg/kg feed (the second and third treatments) and cinnamon powder at a rate of 1.5 and 2.0 of the feed (the third and fourth treatments), except for the control feed (the first treatment), which was free of chromium and cinnamon, as shown in (Table 1).

Table 1: Dietary ingredients and chemical composition (%DM) of the experimental diets containing different percentages of diets

Experimental diets Ingredients	Control T1	T2	T3	T4	T5
Protein concentrate*	12	12	12	12	12
Soybean meal	30	30	30	30	30
Wheat bran	19	19	19	19	19

Yellow corn	18.5	18.5	18.5	18.5	18.5
Local barley	20	20	20	20	20
Binder (Bentonite)	0.5	0.5	0.5	0.5	0.5
Vita.& Miner.Mix.	1	1	1	1	1
Food salt	0.5	0.5	0.5	0.5	0.5
Lime stone	0.5	0.5	0.5	0.5	0.5
Total	100	100	100	100	100
Organic Chromium(mg/kg)	-	1	2	-	-
Cinnamon powder(%)	-	-	-	1.5	2.0

* The protein concentrate has 37.50% crude protein, 3.50% crude fat, 1.14% crude fiber, 2.67% moisture, 37.31% ash, along with a blend of vitamins, salts, amino acids, and antioxidants. It is manufactured by the Dutch firm WAFI and is specifically formulated for carp fish.

Chemical composition of experimental diets

The primary chemical constituents of fish feeds and body components were analyzed in both the fish laboratory and the central laboratory at the College of Agriculture and Forestry,

University of Mosul, utilizing the standard methods established by the Association of Official Analytical Chemistry [8].

Table 2: Chemical composition (%) of the experimental diets .

Chemical composition	%
Dry matter	91.40
Moisture	8.60
Crude protein	27.08
Ether extract	9.35
Ash	7.79
NFE(Nitrogein Free Extract)	55.77
ME(MG/KG)**	14.35

* Based on the Smith's equation (1971): $Fat \times 33.5 + Protein \times 18.5 + NFE \times 13.8$.

Criteria used in evaluating growth performance and food utilization criteria

The impact of incorporating chromium picolinate and cinnamon powder into the experimental diets was assessed using growth parameters, specifically final weight, total weight gain, relative growth rate, and specific

growth rate. Criteria for feed utilization encompassed feed intake, feed conversion ratio, feed conversion efficiency, protein intake, protein deposition, protein efficiency ratio, and protein productive value [13].

Statistical analysis

version 25, and significant differences among the researched criteria rates were assessed using Duncan's multiple range test [12].

RESULTS AND DISCUSSION

The statistical analysis results in Table (3) revealed no significant variations ($P \geq 0.05$) in the starting weight standard of the fish, which varied from 32.19 to 32.25 g/fish. The results recorded in this table (3) show that feeding common carp on the second diet containing 0.1 chromium picolinate and the fourth and fifth diets containing cinnamon powder in an amount of 1.5 and 2.0 mg/kg had a significant effect ($P \geq 0.05$) on the final weight standard of the fish, which reached 64.57, 63.83, 66.34 g/fish, respectively, compared to the control diet (59.22 g/fish). This positive effect of food additives was observed when adding both organic chromium and cinnamon powder at the levels mentioned above, which had positive effects on total weight gain and relative and specific growth rate. The best values were obtained for the total weight gain criterion when feeding fish on diets containing organic chromium and cinnamon powder, represented by the second, third, fourth, and fifth diets, which reached 32.38, 30.51, 31.59, and 34.09 gm/fish, respectively. The result of the relative growth rate on the second, fourth, and fifth diets outperformed and reached 100.57, 94.73, 97.98, 105.71% compared to control group (83.97%). The second, fourth, and fifth treatments significantly increased ($P \leq 0.01$) compared to the control group 1.07 in the specific growth criterion, which reached 1.23, 1.18, 1.21, 1.27 respectively.

These positive results obtained may be due to the action of organic chromium in doubling the insulin signal, enhancing the flow of

The data were statistically analyzed utilizing a completely randomized design (CRD) with the Statistical Package for Social Science [35]

glucose in the blood and the rate of glucose metabolism in the blood, thus increasing the utilization of dietary carbohydrates more efficiently as a primary source of energy, which enables the metabolism process to retain dietary protein more efficiently for the purpose of body growth [38]. This significant superiority of growth parameters recorded for cinnamon treatments is due to its content of cinnamaldehyde, polyphenols, and flavonoids, which exhibit antioxidant activity and metabolic improvement effects [30]. The addition of cinnamon has a positive effect on enhancing growth performance, immunity, and food utilization, which is reflected in increasing growth. The results align with the findings of [33, 30] about Asian catfish, and [2] concerning Nile tilapia *Oreochromis niloticus*, as well as [37] for common carp, [10] for catfish, and [22] for common carp. While [11, 9] did not obtain a significant difference for common carp when using cinnamon leaves (*Cinnamomum burmannii*), this result agrees with [4] who stated that the highest final weight was obtained when adding organic chromium as feed additives to common carp feed, and it gave the highest final weight while

[26, 31, 32] demonstrated that the inclusion of organic chromium in Nile tilapia diets had no significant effect. Additional investigations demonstrated a notable disparity in the specific growth rate criterion of fish subjected to experimental diets using cinnamon, as evidenced by [30, 10, 2, 28].

Table 3: The effect of organic chromium picolinate and Cinnamon on parameters of relative

Criteria Treatment diets	Initial Weight (gm/ fish)	Final Weight (gm/fish)	Total Weight gain (gm/fish)	Relative Growth Rate (RGR%)	Specific Growth Rate (SGR)
T1(control)	32.19±0.02a	59.22±1.38b	27.03±1.39b	83.97±4.37b	1.07±0.04b
T2(0.1 ch- p)mg/kg	32.19±0.05a	64.57±1.74a	32.38±1.70a	100.57±5.14a	1.23±0.05a
T3(0.2 ch- p)mg/kg	32.21±0.03a	62.72±0.38ab	30.51±0.40ab	94.73±1.30ab	1.18±0.01ab
T4(1.5% Cinnamon)	32.24±0.05a	63.83±0.55a	31.59±0.60a	97.98±2.00a	1.21±0.02a
T5(2% Cinnamon)	32.25±0.02a	66.34±1.97a	34.09±1.97a	105.71±6.08a	1.27±0.05a

growth rate, specific growth rate, carp fish (Means± SE)

Significant differences are present when there are different letters in a column at $P \leq 0.05$.

Food intake, feed conversion ratio and feed efficiency ratio

The results of the statistical analysis listed in Table (4) showed that there were no significant differences ($p \leq 0.05$) in the total food intake criterion, which reached to 80.41, 81.67, 81.20, 83.30, 82.89 g/fish. The addition of organic chromium at a quantity of 0.1 and 0.2 mg/kg feed to the second and third treatments and cinnamon powder at rates of 1.5 and 2% to the fourth and fifth treatments had a significant effect ($p \geq 0.05$) on the feed conversion ratio criterion, which reached values of 2.53, 2.66, 2.63, and 2.44, respectively, in comparison to the control group (2.98). The second and fifth treatments significantly above the control group regarding feed conversion efficiency ratio, with values of 39.61%, 41.17%, 33.58% respectively. The favorable outcomes may be ascribed to organic chromium, a trace mineral that significantly contributes to the utilization of feed components and enhances insulin activity, alongside its primary function in fat and protein metabolism [14,16].

These results are agree with the study conducted by [4] in these two criteria when using common carp, [23] for Indian carp, and [15] for snakehead fish, where these

researchers indicated that organic chromium has a positive effect in enhancing the action of insulin and thus the flow of glucose in the blood to the cells, which enabled the insulin hormone to enhance the transfer of glucose from the blood to living cells faster and then convert it into energy through the mitochondria, which enhances the tendency to use proteins for the purpose of building tissues and thus increases the growth of fish.

[1] indicated that the incorporation of cinnamon into tilapia diets improved the assimilation of dietary components, attributable to the elevated activity of digestive enzymes involved in food metabolism, including lipase, protease, innate immunity, amylase, and lysozyme. It also suppressed potential pathogens in the gastrointestinal tract, hence augmenting the population of good microbes and improving the activity of microbial enzymes that facilitate digestion. [18,29] found no significant impact of organic chromium supplementation on feed conversion metrics and feed efficiency ratios in Nile tilapia and trout, respectively.

Table 4 : The effect of organic chromium picolinate and Cinnamon on the feed conversion ratio, feed efficiency ratio, food consumed for common carp fish (Means \pm SE)

Criteria Treatment diets	Food intake (g/ fish)	Feed conversion ratio (FCR)	Feed efficiency ratio (%)
T1(control)	80.41 \pm 1.07a	2.98 \pm 0.12a	33.58 \pm 33.58b
T2(0.1 ch-p)mg/kg	81.67 \pm 1.58a	2.53 \pm 0.09b	39.61 \pm 1.46a
T3(0.2 ch-p)mg/kg	81.20 \pm 0.92a	2.66 \pm 0.02 b	37.57 \pm 0.20ab
T4(1.5% Cinnamon)	83.30 \pm 1.96a	2.63 \pm 0.01b	37.93 \pm 0.19ab
T5(2% Cinnamon)	82.89 \pm 1.09a	2.44 \pm 0.15b	41.17 \pm 2.73a

Significant differences are present when there are different letters in a column at $P \leq 0.05$.

Protein intake protein retention, protein production value, and protein efficiency ratio

The results of protein consumption in Table (5) showed a significant increased ($P \leq 0.05$) in fourth treatment, which amounted to 16.32 g/fish, compared to the control and other treatments. While the value of the fifth treatment decreased significantly in the amount of protein intake, which amounted to 15.79 g/fish, compared to the control feed (16.13 g/fish).

The addition of chromium picolinate and cinnamon in different proportions resulted in a significant increased ($P \leq 0.05$) in the retention protein which amounted to 8.34, 8.19, 7.67, 7.09 respectively compared to control group 6.04 (Table 5). The results we obtained in our current study for the retention protein standard differed from what [30] reached, as they did not notice any significant differences between the control treatment and the treatments to which cinnamon leaf extract and powder were added in Asian catfish diets.

It is noted from Table (5) that the fish in the fourth treatment outperformed in the protein efficiency ratio criterion, which reached 2.15 compared to experimental group 1.88, 1.98, 1.73 and control group 1.95. This result agrees with [4] who concluded: that adding chromium picolinate to common carp diets led to a significant increased ($P \leq 0.05$) in

the retention protein and protein efficiency ratio criteria. While This result not agreed with [30] who concluded that adding cinnamon leaf extract and powder to Asian catfish diets did not induce any change in the retention protein and protein efficiency ratio criteria, also the result not agree with [21] who found there were no significant differences in the protein efficiency ratio criterion when added cinnamon to the common carp.

A significant increase was found in the protein production value shown in Table (4) in the second and third treatments when adding chromium picolinate, which recorded values of 52.72 and 51.13% compared to the control diet (38.45%). This concludes that the addition of chromium had the best effect on this criterion compared to the addition of cinnamon. Chromium picolinate is a low-toxic organic form of trivalent chromium (Cr^{+3}), it is the best essential element for obtaining optimal metabolism of carbohydrates, fats, proteins and nucleic acids [19,17]. These results agree with [4,3,21] When incorporating picolinate or cinnamon into common carp indicated a substantial rise in protein productive value.

Table 5: The effect of organic chromium picolinate and Cinnamon on the protein intake, Protein retention, Protein efficiency and Protein Productive Value criteria of common carp ((Means \pm SE)

Criteria Treatment diets	Protein consumption (gm/fish)	Protein retention (gm/fish)	Protein efficiency ratio(PER)	Protein Productive Value(PPV)
T1(control)	16.13 \pm 0.09ab	6.04 \pm 0.02d	1.95 \pm 0.02b	38.45 \pm 0.73d
T2(0.1 ch-p.)mg/kg	15.83 \pm 0.16ab	8.34 \pm 0.10a	1.88 \pm 0.04c	52.72 \pm 0.87a
T3(0.2 ch-p.)mg/kg	16.03 \pm 0.15ab	8.19 \pm 0.03a	1.98 \pm 0.02b	51.13 \pm 0.54a
T4(1.5% Cinnamon)	16.32 \pm 0.12a	7.67 \pm 0.11b	2.15 \pm 0.02a	47.01 \pm 0.40b
T5(2% Cinnamon)	15.79 \pm 0.19b	7.09 \pm 0.07c	1.73 \pm 0.02d	44.90 \pm 0.43c

Significant differences are present when there are different letters in a column at $P \leq 0.05$.

Chemical composition of the edible portion of the fish

The result in table(6) indicated a significant decrease in the moisture percentage of experimental treatments 67.28,66.76,68.86,66.41 compared to the first treatment (control treatment) 74.36%, these result agreed with [4] who indicated a significant decrease in the common carp in the moisture percentage in the body of fish fed at different levels of chromium picolinate. While this study did not agree with [3]who did not obtain significant differences in the percentage of moisture in fish fed at different levels of Ceylon cinnamon in common carp. The addition of cinnamon and chromium picolinate led to a significant increase ($P \leq 0.05$) in the percentage of dry matter compared to the control feed, which amounted to 32.72, 33.24, 31.14, 30.59%, compared to control treatment 26.15.

These results are agreed with [4], who stated that adding organic chromium picolinate gave the highest dry matter value in common carp meat. They are also agreed with [5] who achieved analogous outcomes with common carp administered varying concentrations of cinnamon. The findings not agreed with [20, 3] who demonstrated no significant variations in

the effects of varying amounts of cinnamon on common carp feed.

Chromium picolinate have clearly appeared to have a positive effect in raising the percentage of crude protein in treatment T2 22.82% ,T3 (21.81%), T4(19.79%), T5(19.49%) compared to the control treatment (18.26%). It is clear from the above-mentioned table that the addition of chromium picolinate and cinnamon had a positive effect in raising the percentage of crude protein significantly compared to the control treatment. This study agreed with [4] and [20] ,who found that adding chromium picolinate and cinnamon to common carp fish feed led to an increase in the percentage of crude protein of the fish body. The result of this study did not agree with what was reach [20] that adding Chinese cinnamon powder to common carp fish feed did not increase crude protein in the fish bodies, [3] found no significant differences in crude protein levels in carp fish fed Ceylon cinnamon. Fish fed on the first, third, and fourth treatments had higher ash percentages (5.68, 5.06, 5.52%) than those fed on the second (4.30%) and fifth (4.05%) treatments. This contradicted [4] who found no significant differences in carp fish ash percentage after adding organic chromium and cinnamon powder.

Table 6: The effect of organic chromium picolinate and Cinnamon on chemical composition(%) of the edible portion of common carp fish ((Means \pm SE)

Criteria Treatment diets	Moisture	Dry matter	Ether extract	Crude protein	Ash
T1(control)	74.36 \pm 1.13a	26.15 \pm 1.13c	0.07 \pm 9.45a	18.26 \pm 0.23d	0.15 \pm 5.68a
T2(0.1 ch-p.)mg/kg	67.28 \pm 0.70b	32.72 \pm 0.70b	0.13 \pm 5.60d	22.82 \pm 0.14a	0.31 \pm 4.30b
T3(0.2 ch-p.)mg/kg	66.76 \pm 1.05b	33.24 \pm 1.05b	0.15 \pm 6.35c	21.81 \pm 0.18b	0.39 \pm 5.06a
T4(1.5% Cinnamon)	68.86 \pm 0.66b	31.14 \pm 0.66b	\pm 0.105.83d	19.79 \pm 0.19c	0.27 \pm 5.52a
T5(2% Cinnamon)	66.41 \pm 0.57b	30.59 \pm 0.57b	0.15 \pm 7.05b	19.49 \pm 0.09c	1.21 \pm 4.05b

Significant differences are present when there are different letters in a column at $P \leq 0.05$.

CONCLUSIONS

The results show that the feed additives represented by organic chromium and cinnamon have positive effects on

promoting growth, utilization of food and on supporting the nutritional value of the edible part of the fish body.

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