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EVALUATION THE GROWTH PERFORMANCE AND FEED UTILIZATION OF CYPRINUS CARPIO FED ON MORINGA OLEIFERA LEAVES FLOATING ON WATER AS SUPPLEMENTED DIET

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ABSTRACT

The objective of the current study was to assess the effects of utilizing Moringa oleifera at various inclusion levels in fish meal-based diets for common carp fish. In contrast to control treatments without Moringa oleifera, leaves floated on water MOLW when was present in this experiment at doses of 2%, 4%, and 6%. Fish are fed twice daily at a 3 percent weight feeding ratio. We weigh the fish every two weeks up until the last week of the experiment (84 days). The T3 diet, which included 4% MOLW, had the highest rate of relative growth rate 99.65, significantly higher, at the probability level significantly ($P<0.05$) followed by the T4 diet, which contained 6% MOLW 88.79, the T2 diet, which contained 2% MOLW 70.08, and the control diet T1, which contained 0% MOLW, had the lowest value 25.54. Three variables in the T3 diet were statistically significant: daily growth rate 0.32g/day, feed conversion ratio 3.42, and specific growth rate 0.82. T3 treatment had the best protein efficiency ratio (0.86), followed by the T4, T2, and T1 treatments (0.81, 0.53, and 0.23 respectively). In of Protein productive value, T3 treatment attained the greatest value at 0.64, followed by T4, T2, and T1 at 0.58, 0.49, and 0.22, respectively. We conclude from the foregoing that the addition of moringa seeds in proportions of 2, 4 and 6 to the diet of common carp fish enhanced both the growth parameters and some other parameters of the experimental fish. But the bester level was 4%.

INTRODUCTION

Aquaculture is the fastest-growing, nutrient-producing, and food-delivery sector on Earth, supplying over 47% of the world's edible fish in 2014 (FAO, 2016). Historically, aquatic animals' sole source of nourishment was fishmeal (FM), a real ingredient in fish feed (Shahzad et al., 2022). First discovered by Linnaeus in 1758, the common carp (Cyprinus carpio) is a hardy fish that grows fast and can withstand adverse conditions. It belongs to the family Cyprinidae and order Cyprinidae, which has 7 subfamilies, 220 genera and nearly 20,000 known species (Yaqoob, 2021) .

According to Mizory, (2021), common carp is the second most common fish in Duhok city after C. carassius. Carp ponds stocked with more than two fish per square meter are not recommended, as according to Mizory et al., (2020) Stocking density has a significant effect on carp behavior. Due to the high concentration, carp start eating for a longer period of time. Fish, on the other hand, become more hostile when crowded. For carp cultured in Duhok, which achieves optimal development and feed conversion, slow growth can be restored by increasing dietary protein content (Mizory and Selivany, 2012).

The best sources of supplemental plant-derived protein for fish feed are plant-derived goods (Hussain et al., 2019 and Shahzad et al., 2020). According to numerous studies, fish should be replaced with a variety of plant-based sources of protein (Hussain et al., 2019). Fish prefers plant protein sources due to their constancy, affordability, absence of phosphorus, high protein content, and variety of amino acid profiles (Shahzad et al., 2022).

Words like "murunggai" or "muringa" in Malayalam come from the family name of the Moringa oleifera plant (Aiyelari and Adeyeye, 2022). Medicinal plants like moringa are used as nutritional supplements for aquatic animals because of their antioxidant content, which protects them from a range of disease conditions. It improves common carp fingerlings' development performance, feed digestion, blood reading accuracy, and immune response while also increasing their likelihood of survival (Abdallah et al., 2022).

Considered a possible substitute for fish meal, the leaves of the Moringa oleifera plant are rich in nutrients (Afuang et al., 2003). Another alternative plant protein source for fish feeds is Moringa oleifera, which is increasingly becoming popular since its leaves, flowers, and seeds may all be consumed. According to Trigo et al., (2022) and Makanjuola et al., (2014) the fresh M. oleifera leaves have a beneficial effect on animal feed because they encourage increased microbial activity, which improves the efficiency of using metabolizable energy, as well as increased efficiency of using energy from pastures.

The crude protein content of the extracted and un extracted Moringa leaves was 43.5 and 25.1%, respectively, indicating that both types of leaves are beneficial sources of protein for animals (Makkar and Becker, 1997; Puycha et al., 2003 and El-Badawi et al., 2023). Its leaves are nutritional and have high crude protein content (29.40%) by Padayachee and Baijnath.(2020)

This study was conducted due to the scarcity of studies related to the use of Moringa leaves on its use in common carp fish diets, as it is the most important, traded and consumed type of fish in the world. Hence the importance of highlighting the effect of adding this plant in common carp fish diets and its impact on some growth characteristics and weight gain for the fish.

MATERIALS AND METHODS

Study site:

The study carried out during November 2021 and January 2022. Hundreds of Cyprinus carpio with average weight 25 ± 0.50 gm get from Kirkuk Governorate Fish Hatchery and transported to the fish laboratory at the Department of Animal Production in the College of Agricultural Engineering Sciences at the University of Duhok, Summel Campus.

Physico-chemical parameters of water:

Using a dissolved oxygen meter and multimeter, all physico-chemical characteristics of aquarium water, including temperature, pH, total dissolved solids (TDS), and dissolved oxygen (DO), were measured every two weeks.

Feeding trial:

Four treatments were applied to 12 plastic fish tanks, each measuring 60.96 by 55.88 by 40.64 cm (3 replicates per treatment). The water was also changed daily at a rate of 30% in order to preserve its quality. For 84 days, fish were fed twice daily at 6:30–8:30 am and 2:30–4:30 pm, with 3% of their body weight in food for all experimental time. The performance of the fish's growth was continuously monitored by weighing them every two weeks.

Fish feed formulation:

Four separate experimental meals with a 33% crude protein content were produced using varying amounts of M. oleifera meal inclusion together with other nutrients from soybean meal, fish meal, wheat, sunflower meal, and premix (Table 1). The fish that received these diets are shown as T1, T2, T3, and T4, respectively. MOLW was added to each diet in levels of 0% (control), 2%, 4%, and 6%. Leaf meals could be the most affordable alternative protein and energy source for making fish feed in this situation (Maiti et al., 2019). According to Arsalan et al., (2016), the inclusion of M. oleifera leaf meal (MOLM) in diets at low levels has been shown to improve fish growth, nutrient utilization, and physiological and biochemical responses.

Table (1): Composition (%) of control & MOLW diets experimental diets provided to carp, Source (Jobling, 2012).

Ingredients	(T1) Control	T2	T3	T4
Fish meal	15	15	15	15
Corn	13	13	13	13
Soybean meal	30	30	30	30
Barley	17	17	17	17
Wheat	23	23	23	23
Premix	2	2	2	2
MOLW	0	2	4	6

Chemical analysis of the diets and the Edible portion of the fish:

Nutrient Ingredients: The main chemical components were estimated in the central laboratory at the College of Agricultural Engineering Science at Duhok University based on the standard methods that (Aiyelari and Adeyeye, 2022) explained as the followings:

- Moisture (%) = (Weight of the sample before drying - Weight of the sample after drying) / Weight of the sample before drying × 100.
- Dry matter (%) = 100 - % Moisture.
- Ash (%) = Weight of the sample before burning - Weight of the sample after burning Sample weight before burning ×100.
- Ether extract = (weight of the sample before extraction - weight of the sample after extraction) / Sample weight before extraction ×100.
- Crude protein: The crude protein was estimated by three phases using a micro calcium nitrogen estimator.

- Nitrogen-free extract: NFE (%) = 100 - (% moisture + % extract ether + % ash + % crude protein).

Growth performance :

- Relative growth rate (RGR%) = [(final weight-initial weight)/initial weight] ×100.
- Daily weight gain (DGR%) = Final Weight – Initial Weight/ time (days).
- Specific growth rate (SGR%) = (ln final weight-ln initial weight)/time (days) ×100.

Feed Utilization:

- Feed efficiency ratio (FER %) = Total feed fed (g)/ Total wet weight gain (g).
- Feed conversion ratio (FCR %) = weight gain (g) / feed intake (g).
- Protein efficiency ratio (PER %) = Total wet weight gain (g/fish)/ Amount of protein fed (g/fish).
- Protein productive value (PPV %) = Final body weight (g) × final body protein (%) -Initial body weight (g) × initial body protein (%) /Protein ingredients (g).
- Fat efficiency ratio (Fat ER%) = (final weight(g) - initial weight (g))/diet fat%.

Proximate chemical analysis:

Proximate chemical analysis of the materials, feeds, and fish was carried out in accordance with the Association of Official Analytical Chemists regulations (Horwitz, 2010). The samples were heated to 550°C for six hours in a muffle furnace built by Thermolyne Corporation, Dubuque, Iowa, USA, to assess the samples' ash content, and then were dried in a hot-air oven at 60°C for 48 hours to test their moisture content. After acid digestion, the crude protein content was measured using the Kjeltec TM 8400 fully automated analyzer and the N 6.25 Kjeldahl procedure. Fat and fiber were discovered using the chemical techniques.

Statistical analysis :

The results of body composition, growth and were analyzed using one-way analysis of variance (ANOVA) using statistical software SAS version 9.1.

RESULTS AND DISCUSSION

According to the analysis of the MOL meal's proximate composition shown in Table 2, the leaf meal contains 13.97% Moisture content, 29.70% crude protein, 3.40% Ether extract, 9.02% Ash, and 43.91% total nitrogen free extract. These values fall within the range that has been reported; however, the variance between this investigation and the prior study may be due to the different environmental factors, sample preparation techniques, analytical procedures, and Moringa oleifera species that were employed. It is important to note that the usage of moringa, either as a supplement or a feed replacement, is gaining popularity because to the minerals and vitamins it contains, which are generally good for enhancing the quality of reproduction and acting as a growth stimulant in animals. The addition of Moringa oleifera to animal diets has been shown to improve growth and reproductive performance (Aiyelari and Adeyeye, 2022).

Table (2): Proximate composition of *Moringa oleifera* leaf meal used for diets formulation.

Nutrients	**%**
Moisture content	13.97 ± 0.42
Crude protein	29.70 ± 0.26
Ether extract	3.40 ± 0.12
Ash	9.02 ± 0.36
NFE	43.91 ± 0.52

These results above were deal with Aiyelari and Adeyeye, (2022) study who showed that that the leaf meal contain 26.20% crude protein, 7.04% crude fat, 8, and 44.14% total nitrogen free extract. The chemical composition values showed the advantages of MOL powders as a food source, supporting their direct application to human nutrition or the production of nutritionally meals for animals (Amabye and Gebrehiwot, 2015).

Table (3): Chemical diet composition by different levels of *M. oleifera* Leaf floating on water

MOLW	Moisture %	Crude Protein %	Ether Extract%	Ash %	NFE %	ME (MJ/Kg)
T1	6.84 ±0.012[a]	27.62 ±0.123[c]	3.13 ±0.021[a]	3.4 ±0.011[d]	59.01	14.38
T2	6.5 ±0.035[b]	29.7 ±0.242[a]	2.82 ±0.018[b]	8.0 ±0.023[b]	52.98	13.83
T3	4.88 ±0.026[d]	29.7 ±0.198[a]	2.5 ±0.016[c]	7.5 ±0.042[c]	55.42	14.06
T4	4.91 ±0.029[c]	27.96 ±0.268[b]	2.5 ±0.024[b]	8.5 ±0.038[a]	56.13	13.83

Means within different letters within grouping differ significantly.

Gradually after diet preparation at this study, table 3, the highest level of protein was records for T3 treatment, this mean that the present study is in agreement with the values reported with standard of (Amabye and Gebrehiwot, 2015).

Table (4): Chemical body composition of carp fed by different levels of *M. oleifera*

MOLW	Moisture %	Crude Protein %	Ether Extract%	Ash %	Organic Matter %	Dry Matter %
T1	12.22 ±0.213[b]	27.98 ±0.014[d]	2.77 ±0.123[b]	7.4 ±0.029[a]	80.38 ±0.023[d]	87.78 ±0.012[c]
T2	7.49 ±0.031[c]	31.82 ±0.028[c]	4.706 ±0.033[a]	6 ±0.289[b]	86.51 ±0.052[b]	92.51 ±0.030[b]
T3	7.24 ±0.021[d]	38.99 ±0.042[a]	4.71 ±0.051[a]	5 ±0.245[c]	87.76 ±0.235[a]	92.76 ±0.121[a]
T4	12.85 ±0.003[a]	35.87 ±0.028[b]	4.71 ±0.424[a]	6 ±0.212[b]	81.15 ±0.225[c]	87.15 ±0.007[d]

Means within different letters within grouping differ significantly.

Table 4 demonstrates that the crude protein for common carp fed on T3 treatment was reported at 38.99, which was greater than that for other treatments (T4, 35.87, T2, and T2, 31.82), as well as T1, 27.98. The approximate composition of the bodies of common carp fish fed T3 varied significantly more with the different feed additions (P< 0.05) than with other treatments.

Table (5): Weekly increasing by using *M. oleifera* leaves Adding to water inaquarium.

Treatments	T1	T2	T3	T4
W0- IW (g/fish)	25.01 ± 0.48^{a}	25.64 ± 0.64^{a}	25.63 ± 0.44^{a}	25.39 ± 0.33^{a}
W2 (g/fish)	26.02 ± 0.21^{d}	29.79 ± 0.42^{c}	28.52 ± 0.24^{a}	27.59 ± 0.37^{b}
W4 (g/fish)	27.21 ± 0.45^{d}	27.75 ± 0.72^{c}	31.30 ± 0.49^{b}	28.05 ± 0.63^{ab}
W6 (g/fish)	27.76 ± 0.91^{c}	31.33 ± 0.42^{b}	33.24 ± 0.28^{a}	31.50 ± 0.44^{b}
W8 (g/fish)	29.22 ± 0.53^{d}	34.34 ± 0.55^{c}	38 ± 0.46^{a}	35.06 ± 0.56^{b}
W10 (g/fish)	30.13 ± 0.54^{d}	37.22 ± 0.34^{c}	41.04 ± 0.49^{a}	38.83 ± 0.79^{b}
W12-FW (g/fish)	31.40 ± 0.24^{d}	43.60 ± 3.79^{c}	51.14 ± 0.66^{a}	47.92 ± 0.35^{b}
TFI (g/fish)	5.39 ± 0.09^{d}	6.80 ± 1.32^{c}	7.47 ± 0.08^{a}	7.03 ± 0.83^{b}

Different superscripts in a row indicate significant differences (P<0.05). W0-W12: weight increasing by weeks (g/fish), IW: initial weight, FW: final weight, TFI: total food intake (g/fish).

Table (5) shows that there is a slight significant difference, at the probability level significantly (P<0.05) between the experimental treatments with regard to the initial weights, and this means that there is good consistency between the fish of the experimental groups and the absence of a clear dispersion among them. The results in table (5) also indicate the superiority of fish fed on diet T3. The weekly increment for carp feeds on moringa corresponds to the third treatment T3, which was significantly higher at 51.14g/fish compared to 47.92g/fish; 43.60g/fish and 31.40g/fish for T4, T2, and T1, respectively. On the other hand, while the total food intake was greater at T3 treatment which was 7.47g/fish than that of T4, T2, and T1, which were, respectively, 7.03g/fish, 6.8g/fish, and 5.39g/fish.

Table (6): Effect of feed supplements in common carp *Cyprinus carpio* L. growth traits Treatments.

Treatments	T1	T2	T3	T4
TWG (g/fish)	6.39 ± 0.16^{d}	17.97 ± 0.03^{c}	25.51 ± 0.21^{a}	22.54 ± 0.11^{b}
DGR (g/fish/day)	0.07 ± 0.007^{c}	0.22 ± 0.001^{b}	0.32 ± 0.003^{a}	0.25 ± 0.001^{b}
SGR%	0.27 ± 0.011^{c}	0.63 ± 0.009^{b}	0.82 ± 0.021^{a}	0.76 ± 0.018^{b}
RGR%	25.54 ± 0.59^{d}	70.08 ± 1.74^{c}	99.56 ± 1.58^{a}	88.8 ± 1.85^{b}

Different superscripts in a row indicate significant differences (P<0.05). TWG: total weight gain, DGR: daily growth rate, SGR: specific growth rate, RGR: relative growth rate.

According to the results of the above table (6), the highest weight gain (TWG g/fish) was recorded for T3 at 25.51g/fish and was significantly higher, at the probability level significantly (P<0.05) compared to those belonging to the other experimental groups before it dramatically decreased to 22.54 g/fish, 17.97 g/fish, and 6.39 g/fish for other treatments T4, T2, and T1 (control), respectively. In terms of final weight gain, daily growth rate, specific growth rate, and relative growth rate, all of which were significantly higher (P< 0.05) at the T3 treatment compared with the other treatments of diets.

The maximum daily growth rate (DGR g/fish/day) was recorded for T3 at 0.32g/day, and it steadily decreased to control treatment T1 which was reached only 0.07 g/day, respectively, at the probability level significantly (P<0.05). While both other treatments showed a numerical increase without any significant variation, reached 0.25, 0.22, and for T4 and T2.

Regarding the specific growth rate (SGR %), treatment T3 performed exceptionally well and achieved 0.82%, and then severely decreased to reach 0.07 % for control treatment T1, respectively, at the probability level significantly (P<0.05). But also, the second T2 and fourth T4 parameters were reached 0.76% and 0.63%, respectively although there's numerical different than the others.

While the relative growth rates (RGR %), significantly higher, at the probability level significantly (P<0.05) for the T3 (99.56 g), T4 (88.46 g), and T2 (70.08 g) groups outperformed the control group T1 (25.54 g), these results pertain to Zhang *et al.*, (2020).'s use of fermented moringa leaves (FMLs) as a partial replacement of fish meal at three FML diets (which replace 20%, 40%, and 60% of the fish meal in the baseline diet, F In contrast to the control group, the F20 and F40 groups significantly (P 0.05) increased final mean body weight (FBW), weight gain, according to Zhang *et al.*,(2020) 's results showed that, as compared to the control group, the F20 and F40 groups significantly (P<0.05) increased final mean body weight (FBW), weight gain rate (WGR), specific growth rate (SGR), feed efficiency (FE), and survival rate (SR).

Table (7): Effect of different ratios administered in common carp *Cyprinus carpio* L. on feed utilization.

Treatments	T1	T2	T3	T4
FCR%	$1.08{\pm}0.54^{c}$	$2.64{\pm}0.75^{ab}$	$3.42{\pm}1.07^{a}$	$3.21{\pm}0.56^{ab}$
FER%	$0.92{\pm}0.23^{a}$	$0.38{\pm}0.08^{b}$	$0.29{\pm}0.05^{d}$	$0.31{\pm}0.07^{c}$
PER %	$0.23{\pm}0.002^{d}$	$0.53{\pm}0.006^{c}$	$0.86{\pm}0.004^{a}$	$0.81{\pm}0.007^{b}$
PPV %	$0.22{\pm}0.004^{c}$	$0.49{\pm}0.005^{b}$	$0.64{\pm}0.008^{a}$	$0.58{\pm}0.005^{a}$
Fat ER%	$2.04{\pm}0.11^{d}$	$6.37{\pm}0.24^{c}$	$10.20{\pm}0.62^{a}$	$9.02{\pm}0.33^{b}$

Different superscripts in a row indicate significant differences (P<0.05). FCR: feed conversion ratio, FER: feed efficiency ratio, PER: protein efficiency ratio and PPV: protein productive value, Fat ER%: Fat efficiency ratio.

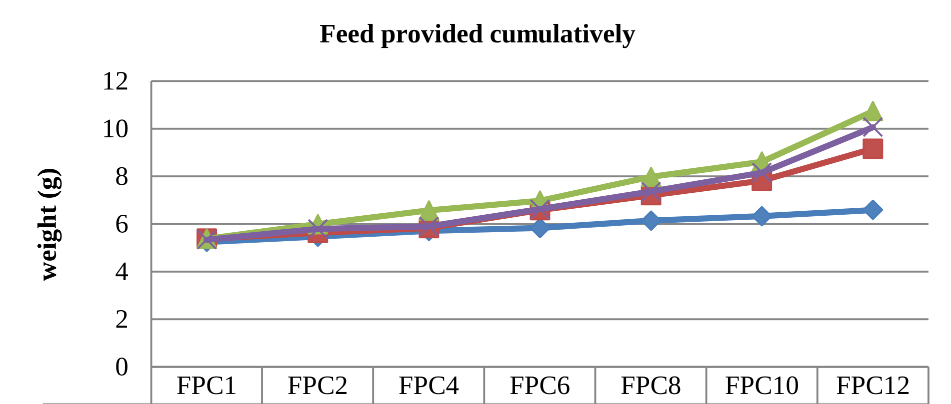
The very same pattern was seen for the feed and protein consumption measurements. Over the course of the trial, the feed conversion ratio (FCR %), calculated based on the supplemented feed, significantly varied between the treatments T3 and control treatment T1, at the probability level significantly (P<0.05), which were 3.42% and 1.08%, respectively, followed by just numerical differences without significant variation between T4 and T2, by 3.21% and 2.64%, correspondingly (table 7).

Contrary to these data, it was found that T1 recorded the greatest feed efficiency ratio (FER %), significantly higher, at the probability level significantly (P<0.05) for the control treatment T1 which was 0.92%, followed by 0.38%, 0.31%, and 0.29%, for other treatment T2, T4 and T3 respectively, indicating that fish that were cultured at the control treatment T1 without adding moringa were consuming more feed than other treatments with different levels of moringa as a result.

Protein, which must be taken continually in huge amounts throughout life, makes up a substantial portion of animal bodies. The primary objective of fish culture is the efficient conversion of protein from diet to protein for tissue. This article refers to Effendi *et al.*, study's (2022), which claim that a medical plant can hasten the growth of farmed fish. Due to the increased production of digestive enzymes, fisheries were able to thrive and grow. Additionally, the T3 treatment, had the best Protein Efficiency Ratio (PER%), significantly higher, at the probability level significantly ($P<0.05$) which was 0.86%, followed by T4, T1 and T2 treatments, 0.81%, 0.53%, and 0.23%, respectively.

Additionally, the protein productive value (PPV %) reached its maximum value in the T3 treatment, which was 0.64%, followed by the T4, 0.58%, while the other treatments T2, and the T1 treatments, had the lowest values which were 0.49% and 0.22%, respectively.

While the treatments T3 (10.20%), T4 (9.02%), and T2 (6.37%) groups beat the control group T1 (2.04%), their Fat Efficiency Ratio (Fat ER %) were considerably, at the probability level significantly ($P<0.05$).



	FPC1	FPC2	FPC4	FPC6	FPC8	FPC10	FPC12
T1	5.25	5.47	5.71	5.83	6.14	6.33	6.59
T2	5.38	5.63	5.83	6.58	7.21	7.82	9.16
T3	5.38	5.99	6.57	6.98	7.98	8.62	10.74
T4	5.34	5.79	5.9	6.62	7.36	8.16	10.07

Figure 1. Feed provided cumulative to experimental fish by using different moringa leaves floating on water.

Feed provided cumulatively by using different types of moringa leaves exposes that the T3 treatment, which uses 4% MOLW, has the highest level from the second week of the experiment until the final week of it, in comparison to decaying at other treatments under the same rearing conditions. This may be because the optimal rate for using moringa as common carp feed is not to supersede 4% only.

When compared to the fish given the diets containing 30, 40, and 50% *M. oleifera* leaf meal, there was a significant difference in the feed conversion ratio ($P<0.05$), While Mizory and Altaee, (2023) demonstrate in their study that the addition of 4% of moringa leaves to the diet as a supplement was the most effective in promoting carp fish development when compared to the control treatments of 0%, 2%, 4%, and 6% moringa leaves. furthermore, there was no difference in the fish fed the control diet, 10 and 20% *M. oleifera* leaf meal diet (Dienye and Olumuji, 2014).

Adeshina *et al.* (2018) discovered that supplemented meals can improve the juvenile growth of *Cyprinus carpio* in a study connected to moringa leaf meal. WG, SGR, PER, and FCR of common carp have shown significant improvements. Fish immune response is also markedly enhanced by moringa leaf meal. The local environment, the availability of food, and the population density all influence how quickly common carp develop. With the exception of modest papers on food and feeding, age, and fertility, no such thorough investigation of the scientific and social aspects of this foreign species has been carried out under these agro-climatic conditions since its introduction (Yaqoob, 2021).

Dissolved oxygen, Temperature degree and pH was recorded continuously throw study period, No observable changes were found, Dissolved oxygen (D.O.) Its value ranged from 5.95 to 6.83; temperature varied from 24 to 26 °C; while pH varied from 6.88 to 8.04. This little variation could be the result of the laboratory settings being fixed for the experiment, since the lab had a split device with a large air compressor and only a partial daily water exchange of the basins by around 30%.

CONCLUSIONS

1. Moringa can be added in a low rations to the diets of common carp.
2. All growth parameters investigated in the experiment have increased from the inclusion of Moringa leaves in the diets of common carp fish.
3. According to this study, adding 4% of Moringao leifera leaf/water meal to the diet led to the greatest weight gain.

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CONFLICT OF INTEREST

None of the authors has a financial or personal relationship with other people or organizations that could inappropriately influence or bias the content of the paper.

تقيم أداء النمو والاستفادة من الغذاء للكارب الشائع Cyprinus carpio المغذاة على أوراق المورينجا اوليفيرا الطافية على الماء كمكملات غذائية

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قسم الإنتاج الحيواني / كلية الزراعة والغابات / جامعة الموصل / الموصل / العراق[2]

الخلاصة

كان الهدف من هذه الدراسة هو تقييم آثار استخدام المورينجا أوليفيرا على مستويات مختلفة للعلائق الغذائية لأسماك الكارب الشائع. تم تغذية الأسماك في المختبر وتغذيتها على اوراق المورينجا الطافية على الماء بمستويات مختلفة وهي 2٪، 4٪ و6٪. مقارنة مع عليقة السيطرة بدونها. تم تغذية الأسماك مرتين يوميًا بنسبة تغذية تبلغ 3%. تم وزن الاسماك كل أسبوعين حتى الأسبوع الأخير من التجربة (84 يومًا). كانت المعاملة T3، والتي شملت اضافة نسبة 4٪ من أوراق المورينجا اوليفيرا الطافية على الماء، تمتلك أعلى قيمة لمعدل النمو النسبي 99.65، وهو أعلى عند مستوى احتمالية (P <0.05) من المعاملةT4، التي احتوت على 6٪ 88.79، ثم المعاملة الغذائية T2 التي احتوى على 2٪ 70.08، فيما سجلت معاملة السيطرةT1، التي احتوت على 0٪، أقل قيمة وهي 25.54. كانت هناك ثلاثة متغيرات في النظام الغذائي T3 كانت ذات دلالة إحصائية: معدل النمو اليومي 0.32غم/ يوم، معدل التحويل الغذائي 3.42، ومعدل النمو النوعي 0.82. سجلت المعاملة الغذائية T3 أفضل نسبة كفاءة بروتين (0.86)، تلتها المعاملات T4 و2T وT0 بالنسب 0.81 و0.53 و0.23 على التوالي. من حيث قيمة البروتين المنتج، حققت المعاملة T3 أعلى قيمة وهي 0.64، تلاها T4 وT2 وT1 بالنسب 0.58 و0.49 و0.22 على التوالي. نستنتج مما سبق أن إضافة بذور المورينغا بنسب 2 و4 و6 إلى النظام الغذائي عززت أسماك الكارب الشائع كلاً من متغيرات النمو وبعض العوامل الأخرى لأسماك التجربة. لكن المستوى الأفضل للإضافة كان 4٪.

الكلمات المفتاحية: أوراق المورينجا، تغذية الأسماك، الأداء.

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