Ann. For. Res. 65(1): 2769-2781, 2022
ISSN: 18448135, 20652445

EFFECT OF REPLACING SOYBEAN MEAL WITH DUCK WEED GROWN ON DOMESTIC WASTE WATER ON PRODUCTIVE TRAITS AND BIOACCUMULATION OF SOME HEAVY METALS IN COMMON CARP FISH

Nidhal T. AL-Taee
Animal Production Department, College of Agriculture and Forestry, Mosul University, Iraq
nidhal_tahseen@uomosul.edu.iq

ABSTRACT

Soybean meal is a major source of protein in the feed for common carp Cyprinus carpio L, which is imported in hard currency from outside the country and raises the prices of fish feed. The study attempts to exploit duckweed (Lemna sp.) as a protein source, partially replacing soybeans. To save the cost of fish feed. The research was conducted in the fish laboratory of the Department of Animal Production in the College of Agriculture and Forestry, University of Mosul. The experiment included feeding common carp fish with five experimental diets including duckweed in different amounts (0, 5, 10, 15, 20, 25, 30) % as an alternative to soybean meal in the total percentage. Within glass basins of size 40 x 40 x 60 cm. The statistical examination of the values of final weight gain and total weight gain (g/fish), percentage of relative growth rate, and specific growth showed that the experimental treatments differed significantly (P 0.05), where the first treatment (control) was highly significant compared to the other treatments, and it was (49.26 and 20). .53 and 0.88) g/fish, 71.48% and 1.09, respectively. The values of temperature and pH showed significant differences (P 0.05) between treatments, and the temperature for the first and second treatments (5% duckweed) was superior to the rest of the treatments, and it reached (25.80, 25.91) degrees Celsius, and pH (7.71, 7.70), respectively. Temperature affects the growth of fish by increasing their feed intake, and the pH on the physiological and growth activities of fish. The results showed that there were significant differences (P 0.05) for the concentration of dissolved oxygen between the treatments, as the concentration of dissolved oxygen decreased for the first and second treatment and reached (4.92 and 4.97 mg/L, respectively), and the highest concentration reached 5.65 mg/L for the fourth treatment (15% duckweed). The successful management of fish provides the necessary oxygen for respiration, maintenance of vital activities, growth and health of fish. The water temperature, dissolved oxygen and pH are related to each other to provide the appropriate environment for fish growth. duckweed were grown on domestic waste water, and the results of the study showed that there was no sensitivity to lead and copper concentrations by the atomic spectrometer, to ensure that there was no bioaccumulation of them in the plant and the food chain. It is inferred that silts are safe for use as a feed source and a partial substitute for soybean meal in fish diet in order to reduce feed costs. Good management of the pond environment is to monitor temperature, pH and dissolved oxygen concentration for their effect on the growth of common carp fish.

KEYWORDS: Duckweed; temperature; pH; carp; dissolved oxygen

INTRODUCTION

The increase in the population, the overfishing of fish, and marine pollution led to an increase in the demand for fish and to fill the local markets needs to search and find alternative solutions. Hence, the development of the fish farming process began under appropriate and controlled environmental conditions.

Attention was drawn to fish farming, especially fish. Common carp Cyprinus carpio L is the most collective freshwater fish types that have been inserted to internal waters such as lakes, dams, and streams in various areas (Vilizzi et al., 2015). Its good growth, ability to withstand harsh environments, and adaptability to industrial feeds have helped it to be introduced in Europe, North America, and Australia (Khan et al., 2016). Feeding fish represents more than 50% of the cost of culture and requires finding an alternative to expensive feed materials such as soybean meal (Sajid et al., 2016). One of these alternatives is the duckweed plant Lemna (duckweed) that grows Small buoyant (Xue et al., 2018). It is exceedingly cultivated in many that easily planted and harvested almost all year (Appenroth et al., 2015; Popa et al., 2017; Iqbal et al., 2019). The prosperity of duckweed under favorable conditions is similar to that of microbial development (Ali et al., 2016), due to its high production capability doubling each 16-18 hrs. Researchers deem water lentils to be a good feed ingredient for fish (Yılmaz et al., 2004; Kabir et al., 2009). It contains a high percentage of 35-45% protein, nutritional minerals, and little fiber, and it is a good protein source for fish in the feed composition. It contains essential amino acids, such as lysine and methionine, in high concentration. For this reason, duckweed is included in the composition of animal feeds. And because of its economic efficiency, it is cheap compared to other feed ingredients such as soybean meal, which is expensive.

The objective to study the effect of using duckweed in different proportions as a partial substitute for soybean meal in experimental carp diets on some production parameter.

MATERIALS AND METHODS

The study of fish laboratory of the Department of Animal Production for a period of two months utilizing 21 glass tanks (40 x 60 x 40) cm put on iron bearings of three floors. The tanks supplied with a type of air pump (RS-510; Chinese origin, suppling all basins (AUTO SAN type air compressor).

Fingerlings of common carp (FgC) were utilized in the growth. Cyprinus carpio L was put in ponds having saline solution (3 g/L) for five min. until stress signs on the fish appeared to dispose of microorganism and external parasites, if any(Rigobelo ,2018). 168 FgC fish (28 ± 1 g/fish); were spread to (21 glass tanks; 8fish/bowl – 3 replicates) .These fish were kept in the ponds for two weeks to acclimatize them to the laboratory and pond environment and to learn to eat.

The basins were made of liquefied water by means of a large tank in the lab. The water was stored one day to free of Cl_2 at a modest temperature (25-30) C using air conditioners.

Fish not fed each of execrable waste and food residues organized daily that partially replacing by siphoning (20-25) % pure water. The fish fed two times per 24 hrs until the search experiments begin.

The glass tanks water temperature was 25 °C to supply a carp fish suitable growth (Evan et al., 2014) and the dissolved oxygen in the tanks was measured using a field device from EXTECH Model D0600 and had a rate of 5.5 mg/L. The pH (LABTECH (DIGITAL pH METER) ranged (7-7.3) (Evan et al., 2014).

The raw feed materials were imparted and crushed by a lab. mill, and 5 diets were made via substituting water lentils (partial substitute for soybean meal) in different ratios (0, 5%, 10%, 15%, 20%, 25 %, 30%) for (1, 2, 3, 4, 5, 6, 7) respectively treatments, and the control treatment (1) was free of duckweed plant, the feed materials ratios were mixed well for the homogeneity reasons on a cup of warm H2O, then put in the National type meat mincer machine (Japanese; holes 4 mm), where little and coherent gratings were created and dried in the lab. Per 72 hrs. and cutting into small pieces suiting fish mouth, put in opaque bags due to prevent from light exposure and kept in plastic containers. The fish were fed diets at a ratio (3-5) % from body weight, and the system provided 3 meals per 24 hrs. The ratio amount introduced to the fish treatment increasing count on the weight earn, the fish weights measuring every 15 days utilizing a sensitive electronic scale (0.01) gm (Citizen of Chinese origin) for a period of two months. The feeding cut off 24 hrs. each 7 days, which increasing the fish's appetite for feeding.

Fish Growth Measuring Methods

The measuring standard fish growth calculation were taking over for improving the impact of replace water lentils as a soybean meal fractional substitute on their growth symbolized via accounting the total weight gain of fish (TWG), and the growth rate of fish Growth Rate (GR) (Pitcher and Hart, 1982), Fish Relative Growth Rate (RGR) (Uten, 1978), Specific Growth Rate (SGR) for fish (Jobling and Koskela, 1996), depending on the equations:

$$Total\ weigt\ (g/fish) = Final\ Weight - Inital\ weight$$

$$Daily\ weight\ \left(\frac{g}{Fish}\right) = \frac{Final\ weigt - initial\ weight}{The\ number\ of\ date}$$

$$Daily\ growth\ rate\ \left(\frac{\frac{g}{fish}}{day}\right) = \frac{weight\ gain(g)}{Duration\ experiment(g)}$$

$$\text{Relative growth (\%)} = 100/(\text{Initial weight (g/fish)})$$

$$Specific\ growth\ rate = \frac{\log final\ weight - \log initial\ weight}{Number\ of\ Date}$$

Carried out according to the Atomic Absorption Spectrophotometer (AOAC) (1984). The results were resolved statistically utilizing the Complete Randomized Design (CRD) via the Statistical Package for Social Science (2017, V25, SPSS). In resolving the impact of treatment transactions and testing the significant various among the mean, the traits studied by Duncan's multiple rang test (Duncan, 1955).

RESULTS AND DISCUSSION

Fish growth measuring criteria

The statistical analysis data of the mean initial weight (gm/fish) referred no significant differences between the verity treatments, as the average weights rang (27.80 to 29.15) gm/fish (Table 1,). The statistical analysis data of the final weight (gm/fish) referred significantly differentiation (P≤ 0.05). The control treatment outperformed all treatments and amounted to (49.26) g/fish, and the second treatment 5% of duckweed outperformed. The third treatment was 10% and the fourth was 15% of duckweed, and they amounted respectively to (44.34, 38.97, 40.64) g/fish. It was observed significant differentiation (P≤ 0.05) in the whole increase ratios (gm/fish) among the verity treatments, and the control treatment outperformed all treatments and accounted (20.53) g/fish, and the second treatment 5% was superior to the third treatment 10% and the fourth 15 % and reached (16.03, 11.16, 12.39) g/fish, respectively, and no significant differences of the rest treatments. The results of the daily growth ratio (gm/fish) improved significant differentiations, where the control outperformed all treatments and amounted to 0.88 g/fish, and the second 5% outperformed the third treatment 10% and the fourth 15 % of duckweed amounted to (0.79, 0.69, 0.72) g/fish, respectively, and no significant differentiation between the rest of the treatments.

Table 1. Effect of different levels of duckweed on growth parameters and weight gain of common carp fish fed for 56 days (mean ± standard error.

studied traits Treatment	starting weight (g/fish)	final weight (g/fish)	total weight gain (g/fish)
Control (1)	0.05 ± 28.72 a	0.05 ± 28.72 a	1.33 ± 20.53 a
duckweed 5% (2)	0.50 ± 28.31 a	0.50 ± 28.31 a	1.45 ± 16.03 b
duckweed 10% (3)	0.30 ± 27.80 a	0.30 ± 27.80 a	0.06 ± 11.16 c
duckweed 15% (4)	0.60 ± 28.25 a	0.60 ± 28.25 a	0.51 ± 12.39 c
duckweed 20% (5)	0.21 ± 28.70 a	0.21 ± 28.70 a	0.76 ±14.21 bc
duckweed 25% (6)	0.58 ± 28.06 a	0.58 ± 28.06 a	0.92 ± 13.76 bc
duckweed 30% (7)	0.00 ± 29.15 a	0.00 ± 29.15 a	1.09± 14.08 bc

* The different letters within the same column for the studied trait indicate significant differences (P≤ 0.05).

Plants contain different types and concentrations of anti-nutritional factors that directly affect feed use in farm animal nutrition (Francis et al., 2001). It was found that the duckweed plant contains some anti-nutritional factors such as tannin, phytic acid, and cyanide in high proportions. NRC, 2011).

The decrease in growth as a result of an increase in the concentration of duckweed in the nutritional diets is due to the imbalance of amino acid composition in the duckweed protein, where the values of water lentils were high in the amino acids methionine and lysine compared with soybean meal and meat and bone meal (Evans et al., 2014).

It was observed in our current research that when replacing water lentils in the experimental diets of common carp leads to a decrease in the rate of weight gain and growth rate, and this was indicated by Stadtlander et al. (2019) when he fed rainbow trout (Oncorhynchus mykiss) On different levels of water lentil plant where growth parameters were decreased.

Rigobelo, (2018) indicated that increasing the percentage of water lentils in the ration led to a decrease in the growth of Nile tilapia (Oreochromis niloticus). Noor et al., (2000) indicated that when adding different levels of duckweed, the growth parameters of Thai silverfish (Barbonymus goionotus) decreased.

The statistical analysis data of the relative growth rate and the specific growth rang improved were significant differences between the treatments ($P \leq 0.05$), where the control treatment outperformed all treatments for the characteristics of relative growth rate and qualitative growth, reaching (71.48, 1.09) respectively, followed by the treatment The second treatment was 5% (56.82, 0.91), respectively, and it was superior to the third treatment 10% and the fourth 15% of water lentils for the characteristics of the relative growth rate and the specific growth rate, which amounted to (40.15, 0.68, 43.97, 0.74), respectively, and there were no significant differences Among the rest of the coefficients shown in Table (2).

It was observed during the current research that the daily weight gain, the relative growth rate %, and the specific growth in the feeding rations using duckweed at different levels were lower than the control treatment without duckweed. This decrease in growth is related to the decrease in food intake by common carp and trout (Evan et al., 2014), and that nutritional deficiency reduces the growth rate of fish, different levels of duckweed reduce digestion and growth rate in the diet due to the difficulty of digesting raw plant components because duckweed contain a kind of Indigestible fibers are generally complex molecules represented by cellulose and starch (Evan et al., 2014), because cellulose is difficult for fish to digest while starch is converted to glucose and in turn, provides energy. Fagbenro et al., (2004) show that an increase in fiber content in fish and plant-based diets has a negative effect on weight gain, protein metabolism, and growth response in Nile tilapia, Ali & Al-ASGAH, (2001) When the level of fiber was greater than 100 g/kg, it reduced the feeding efficiency and food digestibility of tilapia fish, which led to poor fish growth. In addition, duckweed contain anti-nutritional factors that may negatively affect the feeding efficiency of fish (Krogdahl et al., 2010).

Table (2): The different levels impact on duckweed parameters of weight gain, relative growth,and specific growth of common carp fish fed for 56 days (mean ± standard error).

studied traits Treatment	starting weight (g/fish)	final weight (g/fish)	total weight gain (g/fish)
Control (1)	0.05 ± 28.72 a	0.05 ± 28.72 a	1.33 ± 20.53 a
duckweed 5% (2)	0.50 ± 28.31 a	0.50 ± 28.31 a	1.45 ± 16.03 b
duckweed 10% (3)	0.30 ± 27.80 a	0.30 ± 27.80 a	0.06 ± 11.16 c
duckweed 15% (4)	0.60 ± 28.25 a	0.60 ± 28.25 a	0.51 ± 12.39 c
duckweed 20% (5)	0.21 ± 28.70 a	0.21 ± 28.70 a	0.76 ±14.21 bc
duckweed 25% (6)	0.58 ± 28.06 a	0.58 ± 28.06 a	0.92 ± 13.76 bc
duckweed 30% (7)	0.00 ± 29.15 a	0.00 ± 29.15 a	1.09± 14.08 bc

* The different letters within the same column for the studied trait show significant differences (P≤ 0.05).

The research results agreed with Effiong and Sanni, (2009) when replacing different levels of duckweed to the diets of catfish Heterobranchus log files, where the control treatment outperformed the rest of the treatments. Patra and Mohapatra (2013) indicated that when carp fish were fed lentil diets at different levels for 120 days, the control treatment was superior to all treatments.

The statistical analysis data of temperature (Table 3) indicated that there were significant differences (P≤ 0.05) among all. The control treatment and the 5% duckweed treatment were superior to the rest of the treatments, and they reached (25.80, 25.91 °C), respectively. And there are no significant differences between the rests of the transactions. The results of the statistical analysis of dissolved oxygen indicated that there were significant differences (P≤ 0.05) between the experimental treatments, where the fourth treatment outperformed 15% of duckweed overall treatments and amounted to (5.65 mg/L), while the value of dissolved oxygen decreased within the first treatment. The fourth for the rest of the treatments amounted (4.92, 4.97 mg/liter), respectively. The results of the statistical analysis of the pH showed that there were significant differences among the treatments, the control and the second (5%) of duckweed outperformed the rest of the treatments, and amounted to (7.71, 7.70), respectively, which tended to basal than the two treatments. the third 10% and the seventh 30% (7.38, 7.03), respectively.

Fish are considered to be cold-blooded (Ectotherms). The Fish physiology impacted strongly via temperature, that reflects on the metabolic rate, the energy and behavior balance (Jeffries et al.,2014), enzymatic reactions, cellular respiration, oxygen consumption, and metabolic rates (Liu et al., 2019 and Kamunde et al., 2019). Also temperature impacts nutrition and growth, and this reflect on food consumption, availability of appropriate nutrients, adequate sensory perception, and ability to move. Beside the above also impacts the sensitivity of sensory organs, including vision, hearing, smell, and taste, thus reducing fish nutrition and affecting growth. (Rønnestad et al., 2013 and Golovanov et al., 2014). Coldwater temperature decreases the digestion of nutrients, by decreasing rates of digestion, increasing GI transit time, and decreasing rates of GI emptying (Miegel et al., 2010). The water temperature affects the activity of all enzymes, as it directly affects the digestion and metabolism of nutrients such as proteins and fats (Fang et al., 2010). Bio accumulation of heavy metals in the food chain:

The duckweed plant used as a component of fish feeding ration was grown by replacing it with soybean meal on an aqueous medium from domestic waste water and in order to ensure the plant's safety from the accumulation of heavy elements represented by lead and copper in it and to indicate its suitability for feeding fish and in order to ensure that these juices are not transferred within the food chain To ensure that they do not accumulate in human food and then in human tissues, the process of estimating the concentration of the elements lead and copper in waste water was an indication of the presence of these two elements in the water. From the place of its launch from a residential neighborhood and until it reached the duckweed plant development site, about 2 km away, its course was interspersed with many herbs and reeds that could filter many of the water-borne substances as well as the distance that led to the sedimentation of plankton that may be carrying these pollutants In addition to the fact that household waste water is poor in lead and copper, which can appear in industrial areas, and therefore when analyzing the plant, the device did not show sensitivity Because of the two concentrations of lead and copper in the plant, and thus the food chain was clean of their accumulation, which encourages the use of duckweed to feed common carp fish. The results of the research agreed with the findings of Al-Taee (2010) The accumulation of heavy elements in the water lentil plant depends on the contents of the growth medium.

Table (3): The effect of temperature, dissolved oxygen, and pH on the growth of common carp fish (56 days) (mean ± standard error).

Studied traits Treament	Temperature	Dissolved oxygen	pH
Control	0.20 ± 25.80	0.03 ± 4.92	0.04 ± 7.71
(1)	a	cd	A
duckweed 5%	0.70 ± 25.91	0.01 ± 4.97	0.16 ± 7.70
(2)	a	cd	A
duckweed 10%	0.57 ± 23.83	± 5.380.07	0.07 ± 7.38

(3)	b	ab	B
duckweed 15% (4)	0.38 ± 22.98 b	0.15 ± 5.65 a	0.02 ± 7.10 Bc
duckweed 20% (5)	0.24 ± 23.88 b	± 5.330.03 abc	0.06 ± 7.38 B
duckweed 25% (6)	0.49 ± 23.50 b	± 5.260.01 abcd	0.13 ± 7.15 Bc
duckweed 30% (7)	0.38 ± 22.88 B	± 5.220.26 bcd	0.06 ± 7.03 C

* The different letters within the same column for the studied trait indicate significant differences ($P \leq 0.05$).

Temperature has a significant and positive effect on the nutrition and growth of common carp fish Cyprinus carpio male Oyugi et al. (2012) When rearing carp fish at different temperatures (16, 20, 24 and 28) the temperature of 24 °C achieved good growth Compared to other degrees, the best temperature for searching for food and eating feed was 24-28 °C for carp fish.
Desai and Singh (2009) indicated that feeding carp fish at 28°C was better than 32°C, which gave the best growth and increase in feeding efficiency.
Kausar and Salim (2006) observed that rearing Labeo rohita fish at temperature 24-26°C gave the best growth from 20-22 degree Celsius. With an average temperature of 19°C compared to the tanks with an average 14.8°C (Khan et al., 2004). Increasing the temperature leads to an increase in the activity of digestive enzymes, this leads to an acceleration of the digestion of nutrients, and gives better growth (Evans et al., 2014). Hilge (1985) set the optimum degree celsius was at (25-28) °C and the best was 27°C. for the high growth of the European catfish, Silurus glanis.
Differences in pH are important in modulating enzyme activity under physiological and pathological conditions (Evan et al., 2014). The pH level has a significant regulatory effect on the brains of carp (Conte, 2001). While there are some studies indicating that the pH has different aspects to the physiology of common carp fish.
The pH level plays an important role in fish growth (Miron et al., 2008), and the increase or decrease in the pH leads to a disturbance of the acid-base balance, ion regulation and NH4 secretion (Wood, 2017). Heydarnejad (2012) indicated that common carp gave the best water pH growth (7.5-8.0), and alkaline environment could cause fish death through gill damage, lower plasma concentrations, and reduced NH3 excretion (Lease et al., 2003). Thus, when the degree of alkalinity increases, it leads to a decrease in ammonia secretion and an increase in the loss of ions (Townsend and Baldisserotto, 2001). The study showed that the growth coefficients of carp increase with increasing the pH of the water (6.0 - 8.0), and the best growth achievement appears

at the pH (7.5-8.0). Wu, (1993) found that the pH range 7.0-8.0 yields the best performance for many physiological responses and enzyme activities in carp.

Dissolved O2 is the most important factor that requires constant monitoring in aquaculture production systems especially for the fish aerobic metabolism (Timmons et al. 2001). The good management of O2 as it is important for fish to breathe and maintain their health led to success in production, and levels of dissolved O2 can affect the toxicity of ammonia and nitrite.

The metabolic ratio is strongly influenced by the O2 concentricity in the breeding environment, and as the dissolving O2 decreases, also respiration and feeding activities. The growth rate is reduced and the potential for disease increases, and thus fish cannot eat when dissolved oxygen is low (Evans et al., 2014).

It was found in many studies that the relation between O2 saturation and fish food intake is interrelated. Mallya (2007) when using different levels of oxygen saturation (60, 80, 100, 120 and 140)% for Atlantic halibut observed that the best growth rate was at 80%-120% saturation. Evans et al. (2014) declared that the catfish varies feeding with degree (°C) temperature and O2 availability, and whenever the O2 content reduces to 59% and less, it affects the feeding and the fish begin to lose appetite. Jobling (1995) reported a lack of appetite for rainbow trout (Oncorhynchus mykiss), especially when the O2 saturation reduces more than 60%. Evns et al., (2014) noticed that the blue tilapia Oreochromis aureus decreased in weight as a result of lack of appetite and nutrition for not getting enough oxygen for European sea bass L. Dicentrarchus labrax, and this was obtained by Buentello et al. (2000) for Ictalurus punctatus catfish and Pichavant et al. (2001) for common carp. Cyprinus carpio L.

CONCLUSİONS

Common carp Cyprinus carpio L. rely heavily on soybean meal as a source of protein, and importing it from abroad drives up the cost of fish feed. The goal of the current study is to use duckweed (Lemna sp.) as a source of protein. Make use of a partial replacement for soybean meal to reduce the cost of fish feed. The study was conducted in the Department of Animal Production's fish lab at the College of Agriculture and Forestry of the University of Mosul. In five different experimental diets for common carp fish, duckweed was substituted for soybean meal in varying amounts (0, 5, 10, 15, 20, and 30 %) during the experiment.

In the experiments, glass aquariums were used. The experimental treatments varied substantially (P 0.05), with the first treatment (control) being highly significant in comparison to the other treatments, according to statistical analysis of total and daily weight gain values (gm/fish), relative growth rate percent, and specific growth. They were, in that order, 49.26, 20.53, 0.88 g/fish, 71.48 %, and 1.09. The first treatment performed better than the control and the second duckweed by 5% over the other treatments, with temperatures reaching (25.80, 25.91) °C, and pH 7.71, and 7.70 on the straight, according to the statistical analysis of the temperature and pH readings.

The percentage of dissolved oxygen was statistically analyzed, and the results showed significant differences (P 0.05) between the treatments. The first, control and fourth treatments performed better than duckweed by 15% over the second and seventh treatments, with 4.92, 5.65, 4.97, and 5.22, respectively. The plants are safe to use as a feed source in the diets of common carp fish because the lack of water required to produce the duckweed plant resulted in minimal bioaccumulation of copper and lead components within the food chain, including the plant.

Acknowledgments
My special thanks and gratitude to my parent and their continued support in life, my beloved wife, all members of my University of Mosul/Collage of Agriculture and Forestry and all my friends.

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