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Effect of Using Different Ratios of Green Algae Powder (Haematococcus spp.) in Fish Diets on Growth Rates of Common Carp (Cyprinus carpio)

Mahmood Shakir Hashim* , Intisar M.A. Jabbar, Tariq H.Y. Al-Maliky, Ahmed Y. Lafta Hzaa and Aqeel A.A Al-Waeli

Department of Marine Biology, Marine Science Center, University of Basrah, Basrah, Iraq.

***Email: mahmood.hashim@uobasrah.edu.iq**

I. Abstract

The effect of adding different percentages of green algae powder (*Haematococcus* spp.) on the growth rates and survival rates of common carp fingerlings (*Cyprinus* carpio) was studied. Three diets were prepared: the first and second contained green algae powder, and the third was a control containing commercial fish protein. These diets were used to feed 99 fingerlings distributed among 9 plastic containers with a capacity of 25 liters, in 3 treatments (1, 2, and 3) distributed with three replicates for each treatment, with 11 fingerlings placed in each replicate. Treatments 1 and 2 contained 3% and 6% dried algae powder, respectively, while treatment 3 (the control) contained the commercial protein. Relative and qualitative growth rates, feed conversion ratios, and survival rates were calculated. Treatment 2 recorded the highest relative and qualitative growth rates and feed conversion ratios at 76.87%, 1.854%, and 2.375%, respectively. Treatment 1 recorded the highest survival rate at 95%. Significant changes ($p < 0.05$) were detected across the experimental treatments.

Keywords : *Artificial feeds, culture, green algae.*

II. Introduction

Fish farming is one of the most rapidly expanding food production systems in the world. This rapid expansion relies largely on the increase in fish feed production, most of which contains fishmeal as a primary protein source (Barrows & Hardy, 2002). Global fishmeal production ranges between 6-7 million tons per year. This continuous increase in demand for fishmeal is due to its use in animal feed, particularly in fish feed, which has resulted in increased demand and higher prices (FAO, 2001). Demand for fishmeal for aquaculture reached 32% of total world output in 1999 (New & Wijkstom, 2002) and 37% in 2000, with a projected 79% by 2015 (Chamberline, 2002). Fishmeal has grown increasingly costly over time due to its continued and rising usage in the fish feed business, in addition to being a restricted resource (FAO, 2004). There is continuous interest in employing plant-based ingredients in aquatic feeds, but little is known about the advantages of macroalgae (seaweed) in aquatic animal nutrition as a substitute for fishmeal. The most important effects of seaweed supplementation in aquaculture include increased growth performance, improved feed utilization efficiency, improved nutrient metabolism, and improved fatty acid quality (increased long-chain n-3 polyunsaturated fatty acids) in muscles (Valente et al., 2006), as aquatic seaweed is a source of polyunsaturated fatty acids required for fish growth

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(Rajauria, 2015). Furthermore, macroalgae have a high concentration of bioactive chemicals, which may be transformed into a variety of secondary metabolites with diverse biological functions (Gupta and Abu-Ghannam, 2011).

Some local studies have used various farming techniques, including mixed aquaculture and cage systems, and have employed seaweed in feeding aquatic larvae, resulting in high growth and survival rates, which encourages the establishment and sustainability of aquaculture projects (Al-Maliky 2013; Al-Maliky *et al.*, 2015; Al-Maliky 2017a; Al-Maliky 2017b; Al-Maliky *et al.*, 2022).

This research sought to investigate the use of algae as a replacement for fishmeal in fish feed in order to minimize feed costs and thereby support aquaculture operations with economically viable diets.

III. Materials and Methods

Common carp fingerlings were brought from the mud breeding ponds at the Marine Science Center and put into a 6-week feeding experiment after a 3-day acclimatization period. Three diets (1, 2, and 3) were used, two of which included commercial green algae powder (made in China) at a rate of 3% and 6% respectively. The third treatment consisted of a commercial fish protein concentrate, as detailed in Table 1. Chemical analysis was performed according to the methods described in AOAC (1998). Ninety-nine common carp fingerlings, weighing between 5.58 and 6.02 g, were used. These were distributed among nine 25-liter plastic tanks, with 11 fish per tank and three replicates for each of the three diets. The diets were given at a rate of 3% of the fish's body weight twice daily, with the amount modified weekly depending on the fish's weight increase. The effects of the diets were assessed using Hardy and Barrow's (2002) models for weight increase, specific gravity, relative growth rates, feed conversion ratio, and survival rates. The physical and chemical characteristics of the tank water were tested weekly using a USA.The MPS 556 YSI device measures temperature, pH, dissolved oxygen (mg/L), and salinity (mg/L).

Growth Measurements

A- **Total weight gain** (mg) = Final weight (mg) - Initial weight (mg).

B- using Jobling (1993) and the following formulas:

- **Relative Growth Rate (%)** = {Weight gain (mg) / Initial weight (mg)} × 100.

- **Specific Growth Rate (SGR)**= (Ln W2 – Ln W1 / T2 – T1) × 100,

where W1 and W2 are the body weight (mg) at the beginning and end of the growth period, respectively, and T2 – T1 is the growth period in days.

C- Survival Rate %: The survival rate of juvenile shrimp was calculated based on Teng *et al.* (1985): Survival Rate % = (Final number at the end of the experiment / Total number at the beginning of the experiment) × 100.

D- Feed Conversion: The utilization rates of live and artificial feed were calculated based on Hepher (1988) by extracting the values of the following measures:

Feed Conversion Ratio = Feed intake (mg) / Weight gain (mg).

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Statistical analysis

For statistical analysis, SPSS version 15 program was used, and One-way ANOVA method with LSD levels less than 0.05.

Results

Shows Table 1 the chemical composition of the raw material (dried algae) (on a dry weight basis), with a protein content of 23.12%.

Table (1). Chemical composition of commercial green algae, Haematococcus spp., used in feed rations.

Algae	Contents (%)				
	Moisture	**Fat**	**Protien**	Carbohydrates	**Ash**
Haematococcus spp.	**2.54**	**2.09**	**23.12**	**51.45**	**20.80**

Table 2. Chemical composition of the prepared feed rations (on a dry weight basis), with a protein content of 27.33% in the first ration and 28.72% in the second ration, respectively.

Table (2). Chemical composition of the feed rations prepared in the feeding experiment.

Treatment	Contents (%)				
	Moisture	**Fat**	**Protien**	Carbohydrates	**Ash**
1	**5.12**	**4.37**	**27.33**	**52.02**	**11.16**
2	**4.98**	**4.09**	**28.72**	**50.41**	**11.80**
3	**5.07**	**4.55**	**28.66**	**49.69**	**12.03**

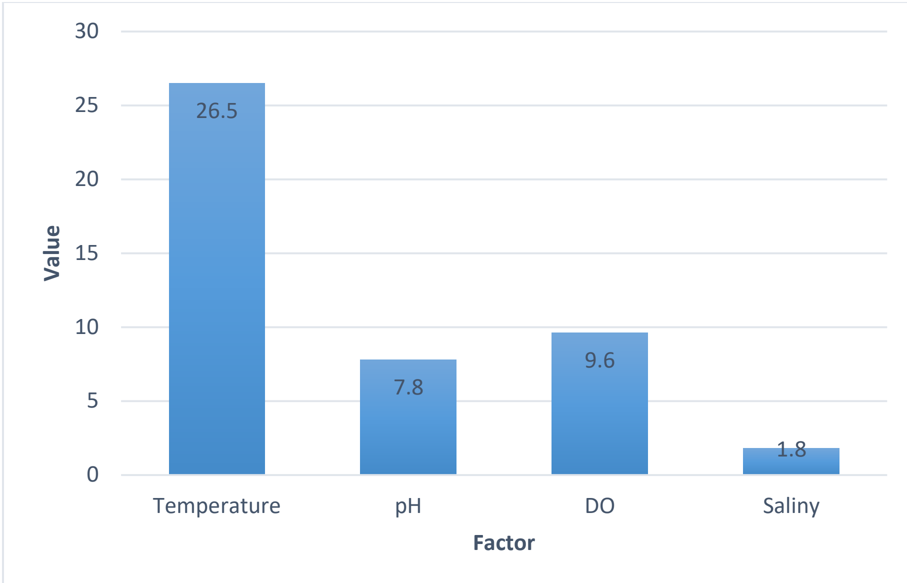

Figure 1. Environmental Measurements of the Experimental Ponds

Fig. 1. shows the environmental measurements taken from the pond waters during the experiment.

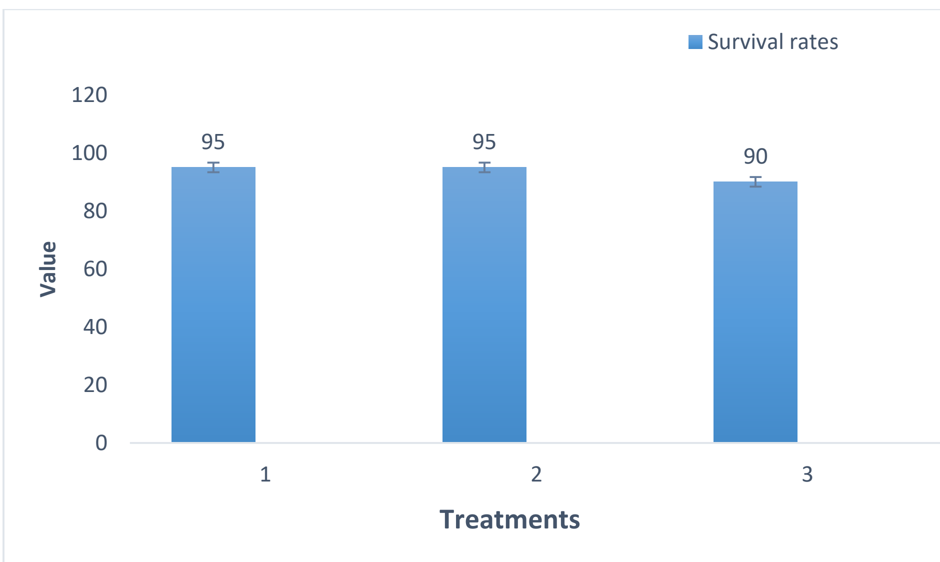

Figure 2. Fish survival rates at the end of the feeding trial

Fig. (2) shows the survival rates of the fish at the end of the experiment.

Table (3) shows the growth indicators during the trial period.

Table (3). Growth Indicators During the Trial Period.

Treatment	Initial weight	Final weight	Weight gain	SGR	RGR	FCR
1	**5.58± 0.02**	**9.44 ± 0.03**	**3.86** ±0.02	**65.22 ± 0.02 a**	**1.22 ± 0.01a**	**2.87**
2	**5.91± 0.03**	**9.89** ± 0.04	**3.98** ±0.03	**68.76 ± 0.03 b**	**1.41 ± 0.03b**	**2.55**
3	**6.02± 0.02**	**8.73**± 0.02	**2.71**± 0.02	**57.81 ± 0.01 c**	**0.97 ± 0.01 c**	**3.01**

Different letters indicate significant differences ($p < 5.0$) between the treatments

IV. Discussion

Environmental measurements of the experimental ponds showed that the water pH values were 7.4–8.2, which is within the pH range suitable for the growth of common carp and other carp species (6.8–9.5, i.e., towards alkalinity) (FAO, 2019). The water temperature was also within the appropriate limits for the aforementioned fish farming, as stated by Hepher (1988), ranging between 25–30°C. He also indicated that the fish can tolerate a salinity of up to 11‰, while the dissolved oxygen concentration should not fall below 3 mg/L. Previous research has investigated the addition of 5% algae (Ulva spp.) to the diets of carnivorous fish such as European sea bass (Dicentrarchus labrax) (Valente *et al*., 2006) and rainbow trout (Güroy *et al.*, 2011), but no negative impacts have been seen. Impact on growth performance. Other studies have investigated the addition of up to 10-15% algal powder to fish diet with greater amylase activity (such as herbivorous species) (Hidalgo *et al*., 1999), which are known to digest algae products more effectively (Montgomery et al., 1980; Diler et al., 2007). This is because their strong amylase activity aids seaweed digestion (Norambuena *et al.* 2015).

Furthermore, Craig and Helfrich (2002) indicated that excessive energy levels in fish feed can lead to nutritional imbalances. A deficiency in protein and carbohydrates, coupled with an excess of fat, can result in low weight, and conversely, low energy levels can lead to weight loss. In a study by De Silva & Perera (1984), differences in protein digestion were observed in fish under laboratory conditions. It can be argued that high-protein feeding may be ineffective when fish have high digestibility, as a lower protein intake may be sufficient to meet their requirements. Furthermore, adding seaweed to aquatic feeds can improve pellet texture, integrity, and water stability, leading to increased feed consumption (Cruz-Suárez *et al*., 2002). Improved fish growth is attributed to the vitamin and mineral content of seaweed (Hashim & Mat Saat, 1992) and increased fat accumulation and nutrient uptake (Nakagawa, 1997). The present study's findings indicated the efficacy of adding algae to experimental meals, notably treatment 2, which resulted in the greatest end weight, weight growth, and RGR and SGR. This demonstrates the viability of including algae into common carp diets. meal conversion rates (FCR) were adequate, but survival rates were high, perhaps due to the fish's acceptance of the meal offered and the quality of the water throughout the trial period.

V. Conclusions

The results showed higher weight gain in both diets supplemented with algae powder. Similarly, SGR and relative growth rates (RGR) were the best in treatments 1 and 2. Feed conversion ratios (FCR) were also improved. This indicates that adding green algae powder to the fish diet had a positive effect on growth rates during fish farming, necessitating further studies to increase production in a shorter time and with higher survival rates.

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The document presents an analysis of the Force-Dynamics Model applied to selected stories in Surat al-Kahf from the Quran, examining the interaction between divine will and human agency. The primary focus is on the stories of the Companions of the Cave, the encounter of Prophet Musa with Al-Khidr, and the journey of Dhul-Qarnayn.