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Effect of protein ratio on growth and survival of cultivated common carp larvae

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ABSTRACT

The current experiment was conducted in the Fish Laboratory belonging to Aquaculture Unit, Agriculture College, Basrah University. At the beginning of feeding experiment average larvae weight was 0.031 g. Common carp (*Cyprinus carpio*) larvae brought from Fish Hatchery of Marine Science Center. The experiment used to detect the protein ratio effects on growth and survival of common carp larvae. Three fish feed with protein ratio (T1 35, T2 40, T3 45)% and only fish meal of 55% protein (T4) were used to feeding 25 larvae in each aquarium to satiation six days a week. Twelve aquaria with dimensions of 60×40×30 cm were used for current experiment. Feeding experiment lasted for 54 days from 10th may to 3th July 2022. Results of current experiments revealed that the highest growth criteria were achieved by larvae fed on diet with protein ratio of 40% followed by larvae fed on diet with 45% protein ratio, while lowest growth criteria achieved by larvae fed on fish meal only. Highest survival rate (96.0%) was achieved by larvae fed on diet with 45% protein ratio and lowest survival rate (78.7%) was achieved by larvae fed on diet with 40% protein ratio. There were significant differences $P \leqslant 0.05$ between T2 with T3 and T4 in the survival rate, while there were no significant differences $P \geq 0.05$ between T1, T3 and T4.

1. Introduction

It is well known around the world that common carp, Cyprinus carpio is a very famous species that consist a significant part of inland freshwater systems production. [1] pointed out that this species was introduced to different inland systems of different regions such as lakes, dam lakes, rivers and streams, while [2] referred that common carp was the most important fish in Eastern European. It had been stated that common carp was introduced into many countries related to different continents such as Europe, Australia and North America [3]. The total world production in 2020 were (5315.0, 4896.6, 4407.2 and 4236.3) thousand tons for grass carp, Ctenopharyngodon idella, silver carp, Hypophthalmichthys molitrix, Nile tilapia, Oreochromis niloticus and common carp respectively [4]. Because of the absence of correct understanding on the scientific fish culture and management practices especially feeding strategies in Iraq, the common carp production at specific areas is much lower than other countries of the world. Two cultivation systems (Earthen ponds and floating cage

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consider as the main aquaculture systems in Iraq were that contributing to the majority of production. The annual production of Iraq hatcheries for common carp about 22 million at 2015 [5]. It had been represented that common carp consist about 63.5% of cultured fish species in Basrah province [6]. According to recent information, it consist now more than previous number. According to [7] common carps represent only 0.27% from the total fish numbers in Shatt Al-Arab river. The life of larvae fishes is a transition period from newly hatched larvae that fed on yolk globule to swimming larvae that can fed on live preys. The survival and success of larvae in natural habitats depend on food availability and escaping from predators. It had been stated that in intensive carp culture the replacement of freshly hatched Artemia nauplii by a more practical inert diet is still given a great deal of attention [8]. The Research Council of Norway refereed that under cultural conditions the success rate of fish larvae is high because of regulated food supply and absence of predators, but this council stated also that the mortality rate is still high under such conditions [9]. It had been pointed that carps larvae characterized by digestive systems and diets differ from the diets of adults, and these differences caused a differences in digestive requirements [10]. It is well known that larval requirements for optimal ingestion, digestion and absorption is important subject, so it is necessary to processing special diets to meet these requirements in order to obtain good growth and survival rates [11]. It had been stated that protein content was the most important components (45-75%) of fish tissues and it is necessary for maintenance and growth [12]. Fishes need high protein feeds comparing with other farm animals [13]. It had been pointed that protein requirements of fishes were 2-4 times more than other vertebrates [14]. It is necessary to know the optimum level of protein ratio in fish feed that differ according to species, age and physiological situation [15,16]. Islam et al. (2004) referred that main source of energy is the protein that plays an important role in determining the growth rate of fishes in different life stages especially larvae stages [17]. It had been pointed out that dietary protein requirements for fish species in the different studies ranged between 24% and 70%, depending on species and age [18]. It had been stated that protein had direct effect on growth, health and feed consuming of water organisms, and also excess protein may decrease growth, reduce immunity and deteriorate water quality [19]. The aim of present study is to investigate the growth and survival of the common carps larvae that fed on diets contain different protein ratio and also fed on fishmeal only.

2- Materials and Methods

The current experiment was conducted in the Fish Laboratory of Aquaculture Unit. Twelve aquaria, three for each treatment, of dimensions (60×40×30) cm provided with pumping aeration were used for feeding experiments. Common carp larvae brought after two days from hatchlings with average weight of 0.003 g from Fish Hatchery of Marine Science Center. The larvae fed on artemia eggs for 20 days and reached average weight of 0.031 g. Feed manufactured in the laboratory using raw materials such as fish meal, soybean meal floor, barley meal, wheat meal, wheat bran and vitamin premix in different ratios (Table, 1) to get different protein levels. Three fish feed with protein ratio 35% (T1), 40% (T2), 45% (T3) and only fish meal of 55% protein ratio (T4) were used to fed 25 larvae in each aquarium to satiation six days a week. More than 70 percent of water replace twice a week. Feeding experiment lasted for 54 days from ^{10th} may to ^{3th} July 2022 and all fishes weighed in each aquarium at the beginning of experiment and at the end.

Different growth criteria such as final weight (FW), weight gain (WG), daily growth rate (DGR), specific growth rate (SGR) and relative growth rate (RGR) in addition to survival rate were calculated according to the following equations:

Weight gain (WG, g) = FW-IW

Daily growth rate (DGR, g/ day) = FW-IW/ days

Specific growth rate (SGR, %/ day) = 100 x [(Ln FW) - (Ln IW)]/ days
Relative growth rate (%) = (WG/IW) x 100
Survival rate = (Final fish number/initial fish number) x 100
Where: FW = final fish weight (g) and IW = initial fish weight (g).

Statistical analysis of Variance (ANOVA) were used to subjected different values of growth criteria for all treatments and all mean values were compared by using the LSD tests at 0.5% probability level by SPSS program Ver. 26.

Table 1. Feed ingredients of the three different fish feed.

Feed types	Feed ingredients (%)					
	Fish meal	Soybean meal floor	Barley meal	Wheat meal	Wheat bran	Vitamin premix
T1 35% protein	40	23	10	5	20	2
T2 40% protein	50	26	5	5	12	2
T3 45% protein	60	30	5	1	2	2
T4	100	-	-	-	-	-

3- Results and Discussion

Table (2) showed the growth criteria of larvae fed different feeds in addition to survival rates. Highest survival rate (96.0%) was achieved by larvae fed on diet with 45% protein ratio and lowest survival rate (78.7%) was achieved by larvae fed on diet with 40% protein ratio (Figure, 1). Results of statistical analysis proved that there were significant differences ($P \leq 0.05$) in survival rate between T2 with T3 and T4, while there were no significant differences ($P > 0.05$) between T1, T3 and T4. Final average weights of larvae were (0.2912, 0.3945, 0.3495 and 0.2148) g for T1, T2, T3 and T4 respectively (Figure, 2). Statistical analysis of final weights reached by different fishes fed different diets appeared significant differences ($P \leq 0.05$) between T2 with T1 and T4, while there were no significant differences ($P > 0.05$) between T1, T3 and T4. Highest weight gain (0.3555 g) was achieved by larvae fed on diet with 40% protein ratio and lowest weight gain (0.1762 g) was achieved by larvae fed on fish meal only (Figure, 3). Statistical analysis of the weight gain reached by fishes fed different diets appeared significant differences ($P \leq 0.05$) between T2 with T3 and T4, while there were no significant differences ($P > 0.05$) between T1, T3 and T4. Highest daily growth rate (0.0070 g/day) was achieved by larvae fed on diet with 40% protein ratio and lowest daily growth rate (0.0033 g/day) was achieved by larvae fed on fish meal only (Figure, 4). Statistical analysis of daily growth rate reached by different treatments refered that there were significant differences ($P \leq 0.05$) between T2 with T3 and T4, while there were no significant differences ($P > 0.05$) between T1, T3 and T4. Specific growth rate of larvae were (3.7057, 4.2760, 4.0460 and 3.1614) %/day for T1, T2, T3 and T4 respectively (Figure, 5). Significant differences ($P \leq 0.05$) between T2 with T1 and T4 found from statistical analysis of specific growth rate results, while no significant differences ($P > 0.05$) found between T1 with T3 and between T2 and T3. Highest relative growth rate (911.8%) was achieved by larvae fed on diet with 40% protein ratio and lowest relative growth rate (455.4%) was achieved by larvae fed on fish meal only (Figure, 6). Statistical analysis of the results of relative growth rate proved that there were significant differences ($P \leq 0.05$) between T2 with T1 and T4, while there were no significant differences ($P > 0.05$) between T2 with T3 and between T1 with T3. It had been stated that larval rearing is a critical period for the successful culture of fishes, particularly in respect to cyprinid species [20], while [21] stated that the important food for common carp larvae in earthen ponds were artificial feed followed by algae, diatoms and copepods. Results of current experiment revealed that highest growth criteria were achieved by larvae fed on diet with protein ratio of 40% followed by larvae fed on diet with 45% protein ratio, while lowest growth criteria achieved by larvae fed on fish meal only. This results may be related to high energy needed for excretion excess quantity of protein that theses larvae cant deposit. It had been stated that the moderate protein requirement for fish was 42% and it is depend upon environment factors and

feeding ratio [19], while [22] stated that better growth (0.056 g day-1) reached by common carp fry fed on diet of 35.2% protein content with lowest survival rate (75%), followed by 30% protein content feed, but fry feed on 28% protein diet without animal protein achieved poorest growth rate (0.039 g day-1) with highest survival rate (90%), so the researchers recommended diets with animal protein for better growth performance of common carp fry. It had been stated that optimum protein ratio for grass carp juveniles was 41-43% [23], while [24] pointed out that protein ratio of 40% was better from economic view than 20, 30 and 35% for young grass carp. Many researchers claimed that better foods for common carp were life preys such as artemia, but [25] stated that there is a possibility for rearing common carp larvae on artificial feed with high growth rate and survival especially when supplemented with vitamins and minerals, where excellent survival rate (95%) and the larvae reached average weight of 1.89 g after 21 days. It had been stated that the larvae of koi carp, *Cyprinus carpio* fed on chopped tubificid worms showed significantly better growth results compared to the larvae fed on crushed pellet feed and mixed diet of 50% pellet + 50% chopped tubificid worms, and also the highest survival rate 56.66% was shown by larvae fed on the chopped tubificid worms which was significantly higher than other two types of feed [20], while [26] mentioned that incorporation of soy protein concentrate levels of 60 or 70% in the diet lead to slowing the growth of common carp larvae, while a level of 40% did not adversely affect survival or growth rate.

The survival rate in current experiment was better than the survival rate of many studies such as [27] who recorded 45% survival rate for common carp larvae fed on cake artificial feeding. It had been recorded significant larger mouth-gape for goldfish *Carassius auratus* that fed on moving prey than those browsed cysts from the tank bottom or dry feed items, and also their larvae and juveniles had a higher survival rate and grew faster when fed on decapsulated Artemia cysts than on a mixed live/dry diet of *Artemia* nauplii and dry feed [28]. The best length and body growth rates achieved by tench larvae fed exclusively *Artemia* nauplii, where it reached 20 mm body length and 0.9 g body weight of around, while larvae receiving artificial feeds reached the 10-15 mm body length and 0.20-0.25 g body weight [29].

Table 2. The survival rate and growth criteria achieved by common carp larvae fed feeds with different protein content.

Growth Criteria	35% Protein (T1)			40% Protein (T2)			45% Protein (T3)			Fish meal (T4)		
	R1	R2	R3	R1	R2	R3	R1	R2	R3	R1	R2	R3
Survival Rate (%)	88	96	80	88	72	76	96	92	100	100	92	92
Average	88.0 ab			78.7 b			96.0 a			94.7 a		
Final Weight (g)	0.2709	0.2571	0.3455	0.3404	0.4389	0.4042	0.3371	0.3996	0.3117	0.1783	0.2322	0.234
Average	0.2912 bc			0.3945 a			0.3495 ac			0.2148 b		
Weight Gain (g)	0.2326	0.2178	0.306	0.3017	0.3999	0.365	0.2982	0.3605	0.2724	0.1398	0.1936	0.1951
Average	0.2521 bc			0.3555 a			0.3104 ac			0.1762 b		

DGR (g/day)	0.0043	0.0040	0.0057	0.0056	0.0074	0.0068	0.0055	0.0067	0.0050	0.0026	0.0036	0.0036
Average	0.0047 bc			0.0070 a			0.0057 ac			0.0033 b		
SGR (%/day)	3.6228	3.4782	4.0161	4.0250	4.4828	4.3208	3.9989	4.3043	3.8348	2.8385	3.3229	3.3228
Average	3.7057 b			4.2760 a			4.0460 ab			3.1614 c		
RGR (%)	607.3	554.2	774.7	778.9	1025.4	931.1	766.6	922.0	693.1	363.1	501.5	501.5
Average	645.4 bc			911.8 a			793.9 ac			455.4 b		

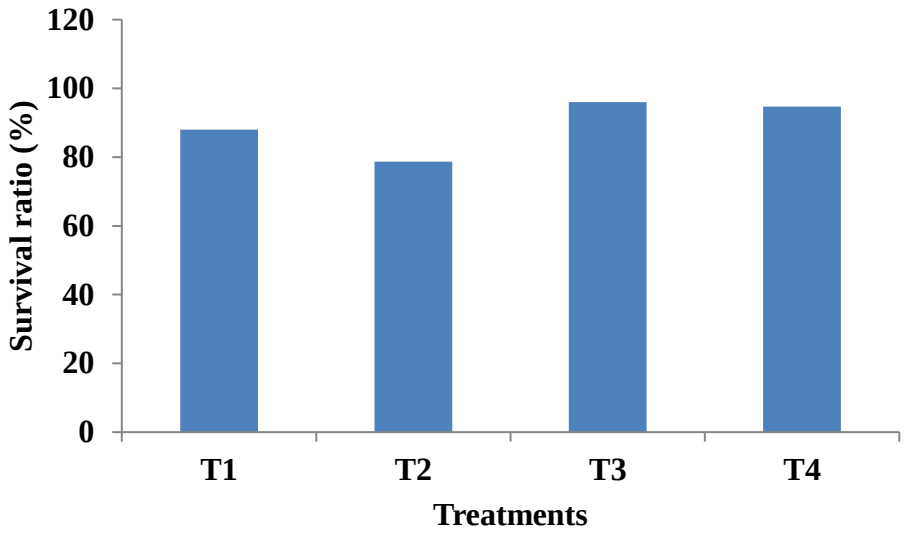

Fig. 1. Survival rate of common carp larvae fed different feeds.

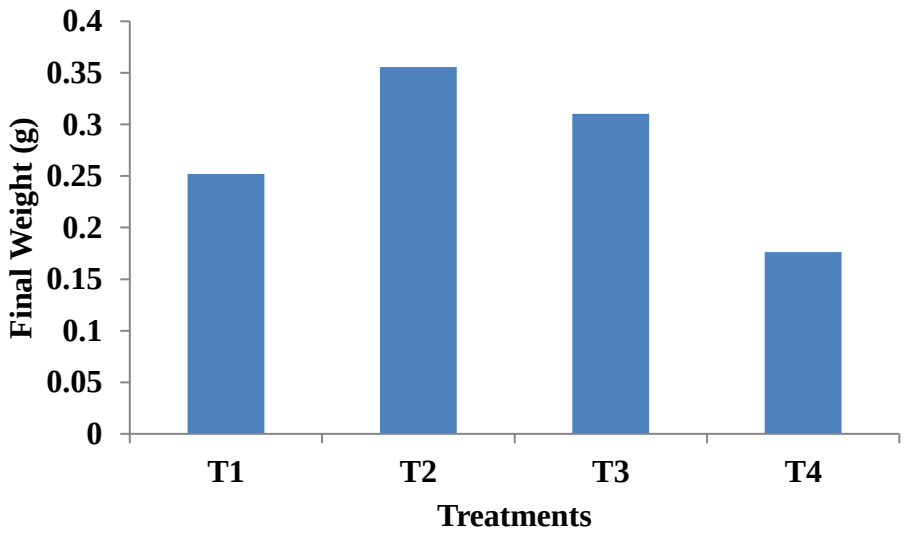

Fig. 2. Final weights reached by common carp larvae fed different feeds.

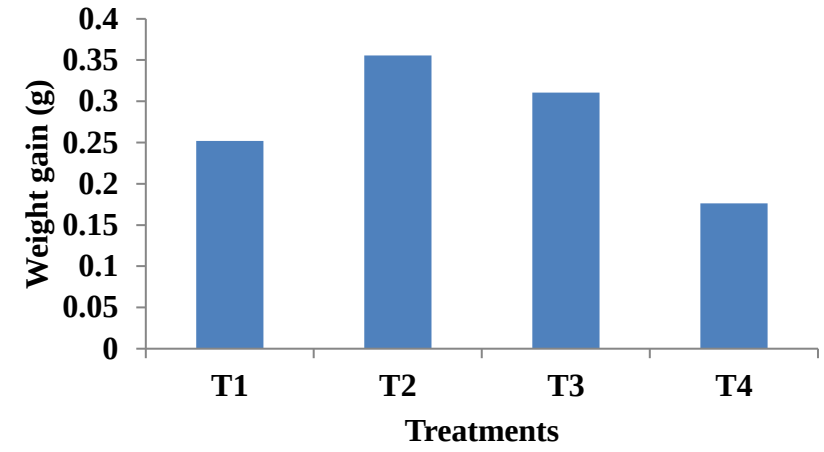

Fig. 3. Weight gain of common carp larvae fed different feeds.

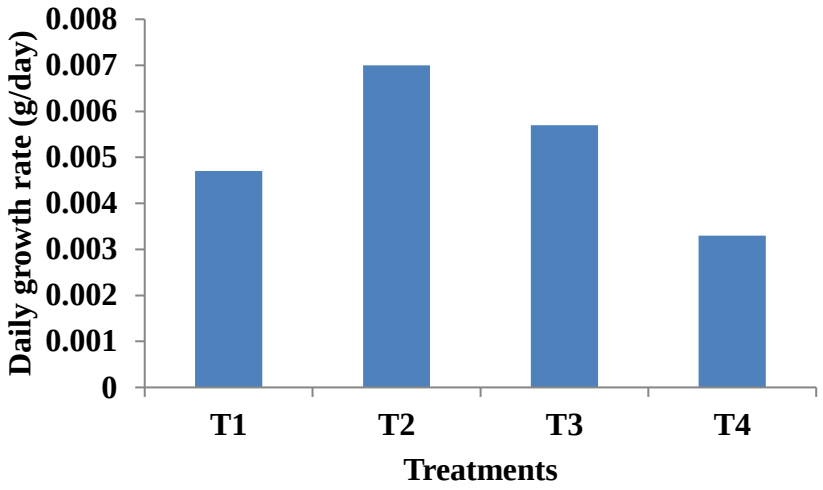

Fig. 4. Daily growth rate of common carp larvae fed different feeds.

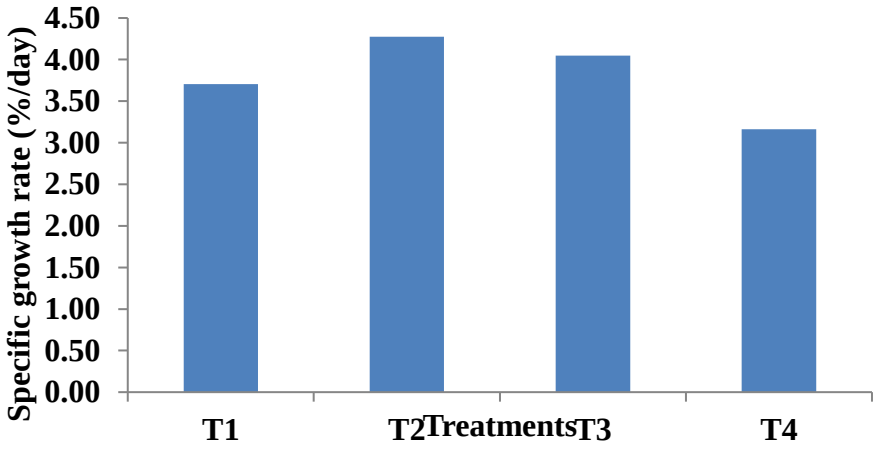

Fig. 5. Specific growth rate of common carp larvae fed different feeds.

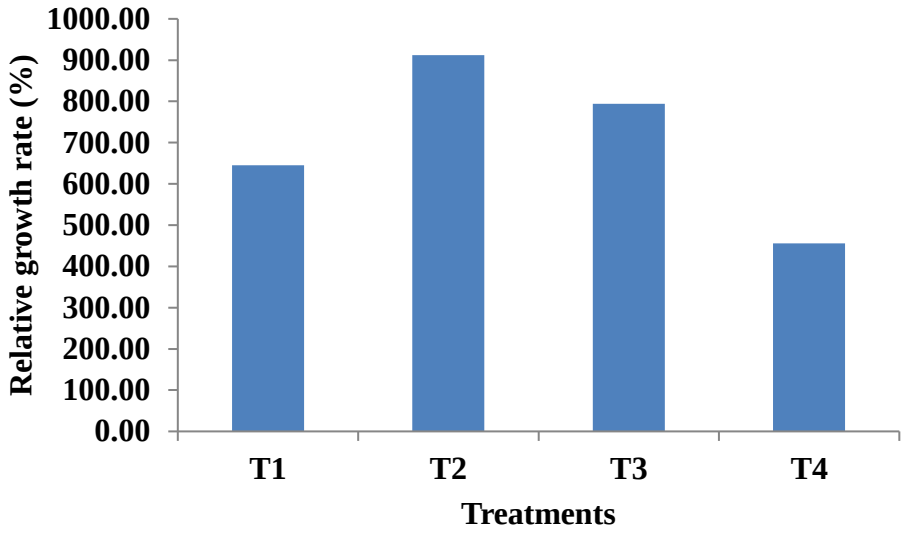

Fig. 6. Relative growth rate of common carp larvae fed different feeds.

4. Conclusion

It was concluded from the current experiment results that better growth criteria was achieved by common carp larvae fed on diet with 40% protein ratio and worthiest growth criteria achieved by larvae fed only on fishmeal.

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تأثير نسبة البروتين في نمو وبقاء يرقات اسماك الكارب الشائع المستزرعة

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الملخص

اجريت الدراسة الحالية في مختبر اسماك وحدة الاستزراع المائي في كلية الزراعة، جامعة البصرة على يرقات اسماك الكارب الشائع Cyprinus carpio بمعدل وزن 0.031 غم والتي جلبت من مفقس اسماك مركز علوم البحار. صممت التجربة لمعرفة تاثير نسبة البروتين في العليقة في بقاء ونمو هذه اليرقات، اذ استعملت ثلاثة علائق بنسب بروتين مختلفة (T1 35%, T2% 40, T3 45%) والمعاملة الرابعة غذيت اليرقات باستعمال مسحوق السمك الحاوي على 55% بروتين. غذيت اليرقات (25 يرقة لكل حوض زجاجي) لحد الاشباع ستة ايام من الاسبوع في الاحواض الزجاجية ذات الابعاد (60×40×30) سم والمجهزة بمضخات تهوية. استغرقت التجربة 54 يوم من العاشر من شهر مايو الى الثالث من شهر تموز عام 2022. اظهرت نتائج الدراسة الحالية ان اعلى معايير للنمو سجلت من قبل اليرقات المتغذية على نسبة بروتين 40% تتبعها اليرقات المتغذية على نسبة 45%، بينما اقل معايير نمو سجلت من قبل اليرقات المتغذية على مسحوق الاسماك. تحقق اعلى معدل بقاء(96.0%) بواسطة اليرقات المتغذية على نسبة بروتين 45% واقل معدل (78.7%) بواسطة اليرقات المتغذية على 40% نسبة بروتين. بين التحليل الاحصائي لنتائج معدل البقاء وجود فروقات معنوية P≤0.05 بين T2 مع T3 وT4، بينما لا توجد فروقات معنوية P≥0.05 بين T1 مع T3 وT4.

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