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Article

Effect of protein content on growth parameters of grass carp *Ctenopharyngodon idella* cultured in earthen ponds.

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ABSTRACT
The current experiment was conducted in Basra Governorate in the ponds of the Aquaculture Unit at the Agricultural Research Station-College of Agriculture-University of Basra, located in Al-Haritha District, for the period from 4/3/2020 to 6/12/2020. Three thousand seven hundred sixty grass carp fingerlings, with an average weight of 16 ± 2.75 g and an average total length of 12.1 ± 0.1 cm, were used in the study. These fingerlings were divided into four treatments, each with 2 replicates, and each replicate was placed in one earthen pond of 600 m². Four diets were manufactured with different protein ratios (T1 20, T2 25, T3 30 and T4 35)%. The current experiment aimed to find the optimal proportion of protein in the grass carp diet, which achieves the best growth and lowest cost. The results of the current experiment were as follows: final average weights were (153.5, 167.4, 181.8 and 272.7) g, weights gain were (132.5, 147.6, 162.8 and 255.9) g, daily growth rates were (0.46, 0.52, 0.60 and 0.95) g/day, specific growth rates were (0.71, 0.78, 0.84 and 1.02) %/day and relative growth rates were (18.87, 20.46, 21.35 and 27.05) % for T1, T2, T3 and T4 respectively. T4 was significantly ($P \leq 0.05$) superior to the rest of the three treatments in all previous growth criteria. In contrast, none of these treatments showed significant differences ($P > 0.05$) for the same criteria. The best food conversion rate was for T4, and the worst rate was for T1 and T2.
Keywords: growth parameters, grass carp, *Ctenopharyngodon idella*

INTRODUCTION

Fish are living organisms similar to other animals in their need for protein, vitamins, mineral salts, growth factors, and energy sources necessary for growth, reproduction, and various physiological functions. Artificial feeds constitute more than 60-65% of fish production costs. It depends on the abundance of natural food in the ponds, and industrial feed allows for an increase in fish density, in addition to the fact that their surplus acts as an indirect fertilizer [1]. Food is the elixir of life for living organisms, including fish and its type and quality. It has a key role in the speed of growth, and the feed cost represents 80% of the total costs of fish production and cultivation [2]. Experiments have shown that grass carp Ctenopharyngodon idella not only controls aquatic weeds but also

grows very fast at the same time, and therefore, it is one of the best-cultured fish if its feed is available [3]. The various types of carp fish are among the main aquaculture fish in Iraq, as they are suitable for the cultural environment. They also belong to the cyprinidae family that most economic Iraqi fish belong to, especially the common carp Cyprinus carpio and grass carp [4]. Grass carp have been extruded from this family and attached to the xenocypridinae family by [5]. Grass carp was the first important freshwater cultivated species around the world in 2020, while the second was silver carp, Hypophthalmichthys molitrix, the third was Nile tilapia, Oreochromis niloticus, and the fourth was common carp [6]. In Iraq, the trend for breeding and cultivation was for common carp.

MATERIALS AND METHODS

1. Study area: The current study was conducted in Basra Governorate in the earthen ponds of the Aquaculture Unit at the Agricultural Research Station - College of Agriculture - University of Basra, located in Al-Hartha District, for the period from 4/3/2020 to 6/12/2020.

2. Study fish: 3760 grass carp fingerlings were used, with an average weight of 16 ± 2.75 g and an average length of 12.1 ± 0.1 cm.

3. Earthen culture ponds: Eight earthen ponds, with an area of 600 m² per pond with an average depth of 2 meters, were used. The ponds were dried before culturing processes. One pond was filled with water two days before the arrival of fish to reduce the presence of natural enemies to a minimum. All fish were placed in this pond and left for three days to acclimate before being divided into eight ponds filled with water later. 15-25% of the pond water is replaced daily, and about 75% of water is replaced during periodic sampling to facilitate catching fish samples.

4. Fish feed: Four commercial pellet diets (diameter of 4-6 mm) were manufactured by the feed plant of the Agricultural Consultant Office belonging to Agriculture College with different ratios of crude protein (20, 25, 30 and 35) % for treatments T1, T2, T3 and T4 respectively by using different feed ingredients (Table, 1). Fish were fed on these diets throughout the cultivation period. The chemical analysis of the different diets was carried out in the Al-Ghadeer Laboratory, located in the center of Babil Governorate, and three replicates were taken from each of the four treatments.

5. Environmental factors: The water temperature of the ponds was measured with the periodic fish sampling during the experiment using a Chinese-made mercury thermometer to the nearest degree Celsius. The salinity and pH of the ponds were also measured by a German device produced by the Yasa company, and the dissolved oxygen was measured using a digital device of the type Lovibond Senso Direct 150.

6. Fish weight measurements: About 10% of the fish were caught randomly by beach trawls approximately every 20 days (sometimes increased according to the available conditions) from each pond and weighed in the farm using an electronic scale to the nearest gram. The feeding ratio ranged between 3-5% of total fish weight, and the daily feed provided to the fish is adjusted according to the new weights. The fish were handily fed three times daily (morning, noon and afternoon) at the same feeding places for each pond.

7. Growth criteria: The following growth criteria were measured at the end of the experiment according to the following equations:

1. Weight Gain Rate(WGR)

WGR (g) = final weight - initial weight

2. Daily Growth Rate (DGR)

DGR (g/day) = (final - initial weight) / time.

3. Relative Growth Rate (RGR)

RGR (%) = (weight gain/initial weight) ×100.

4- Specific Growth Rate (SGR)

SGR (%/day) = [(Ln final weight – Ln initial weight)/time] x 100

5-Feed Conversion Rate (FCR)

FCR = consumed feed/weight gain

8. Statistical Analysis: Statistical software SPSS IBM (23) and Excel 2013 were used to analyze the data.

Ingredients	**Ratio%**			
	T1	T2	T3	**T4**
Fish meal	5	15	25	**38**
Soybean meal	22	22	22	**22**
Starch	2	2	2	**2**
Wheat flour	29	29	29	**29**
Wheat bran	40	30	20	**7**
The mixture of vitamins and minerals	2	2	2	**2**

Table 1. The proportions of the main components included in the composition of the experiment diets.

RESULTS

Table (2) shows the measurements of some environmental factors during the experiment. The water temperature was the most variable, and the highest temperature was recorded (38 °C) in August and the lowest (17 °C) in March, while the changes in the pH were limited and ranged between 7.4 in March and 8.7 in August. The salinity of the water in ponds ranged from 3.3 g/L in March to 6.0 g/L in August, while the highest dissolved oxygen concentration was 7.7 mg/L in March, and the lowest concentration was 4.3 mg/L in August.

Table (3) shows the different growth criteria for the treatments (final weight, weight gain, daily growth, specific growth rate, relative growth rate, and feed conversion rate) for grass carp in eight ponds, with the average of each treatment and the statistical analysis of these criteria. The final average weights recorded were (153.5, 167.4, 181.8, and 272.7) g for treatments T1, T2, T3, and T4, respectively. The final weight of T4 was significantly ($P \leq 0.05$) superior to the rest of the three treatments, and none of these treatments showed any significant differences ($P > 0.05$) between the final weight. It was found that the average weight gain of grass carp was (132.5, 147.6, 162.8, and 255.9) g for treatments T1, T2, T3, and T4, respectively. The weight gain of T4 was significantly

(P≤0.05) different from the three treatments, and none of these treatments showed any significant difference (P>0.05) between them.

The daily growth rates recorded were (0.46, 0.52, 0.60, and 0.95) g/day for T1, T2, T3, and T4, respectively. Statistical analysis proved that there were significant differences (P≤0.05) in the daily growth rate for T4 with the other three treatments, while there were no significant differences (P>0.05) between these three treatments. The specific growth rates of grass carp were (0.71, 0.78, 0.84, and 1.02) %/day for T1, T2, T3, and T4, respectively. Statistical analysis of the results proved significant differences (P≤0.05) of specific growth rate for T4 with the other three treatments. There were no significant differences (P>0.05) between these three treatments. The relative growth rates of the four treatments, respectively, were (18.87, 20.46, 21.35, and 27.05) %. The relative growth rate of T4 was significantly (P≤0.05) different from the other three treatments, while there were no significant differences (P>0.05) among these treatments.

The values of the feed conversion rate were 9.32 for T1, 9.10 for T2, 6.47 for treatment T3 and 4.70 for. It is clear from the previous values that the best feed conversion rate was achieved by fishes of T4 and the worst feed conversion rate for fishes of T1 and T2. The results of the statistical analysis of the feed conversion rate showed significant differences (P≤0.05) between T4 and T3 and between them with T1 and T2. At the same time, there were no significant differences (P>0.05) between treatments T1 and T2.

Sampling date	**Environmental factors**			
	Water temperature (°C)	pH	salinity (g/l)	**Dissolved oxygen (mg/L)**
8/3/2020	17	7.4	3.3	**7.7**
3/4	21	7.8	4.1	**7.4**
23/4	23	7.9	4.3	**7.1**
12/5	26	8.1	4.7	**6.7**
2/6	28	8.2	5.0	**6.5**
22/6	28	8.4	5.5	**6.3**
12/7	33	8.5	5.7	**6.0**
1/8	38	8.7	6.0	**4.3**
8/9	28	8.3	5.7	**6.0**

28/9	27	8.1	5.4	**6.5**
18/10	24	7.6	5.1	**7.5**
11/11	22	7.7	4.0	**7.6**
6/12	18	7.5	3.6	**7.7**

Table 2. Some environmental factors of water during the experiment.

Growth criteria	**Earthen ponds**							
	T1P1	T1P2	T2P3	T2P4	T3P5	T3P6	T4P7	**T4P8**
Final weight (g)	147.1	160.0	180.6	154.3	170.8	192.8	257.0	**288.5**
Average	**153.5b**		**167.4b**		**181.8b**		**272.7a**	
Weight Gain (g)	125.1	0.49	0.56	0.48	0.56	176.1	240.0	**271.8**
Average	**132.5b**		**147.6b**		**162.8b**		**255.9a**	
DGR (g/day)	0.43	0.49	0.56	0.48	0.54	0.66	0.89	**1.01**
Average	**0.46b**		**0.52b**		**0.60b**		**0.95a**	
SGR (%/ day)	0.67	0.75	0.79	0.77	0.76	0.92	1.00	**1.05**
Average	**0.71b**		**0.78b**		**0.84b**		**1.02a**	
RGR (%)	17.98	19.77	20.62	20.30	19.4	23.30	26.33	**27.77**
Average	**18.87b**		**20.46b**		**21.35b**		**27.05a**	
FCR	9.79	8.86	8.91	9.29	6.27	6.68	4.83	**4.57**
Average	**9.32c**		**9.10c**		**6.47b**		**4.70a**	

Table 3. Growth criteria of grass carp fed feeds with different protein ratios. Different letters in the same rows show significant differences (P≤0.05)

DISCUSSION

The environmental factors measured in this study were suitable for the culture of grass carp, except for a few days when the temperature rose to 38°C, and forced to stop the feeding trials in order to avoid stress arising from high temperature and reduce the heat emitted by the fish as a result of feed metabolism. The best growth was achieved in the current experiment at a temperature range of 22-29°C, similar to what [7] found that the highest growth rate of grass carp was achieved at degrees 24-29 °C. The growth in the current experiment decreased at temperatures less than 22°C. This may be due to a decrease in the intensity of feeding and a decrease in metabolic rates. Eight found the best food intake rate for grass carp at a temperature of 25°C. [9] showed that the range required to achieve the best growth is at a temperature of 19.6-27.2 °C and a salinity level of less than 10 g/l. Most previous studies recorded similar results to the current experiment, such as [10]. The current experiment's results differed from those found by [11], recording a better temperature range of 28.5-32.9 °C. The highest salinity concentration was recorded in the current study at the beginning of the eighth month, reaching 6.0 g /l, and the lowest concentration (3.3 g / l) during the third month. [12] showed that the grass carp fish did not tolerate salt concentrations higher than 10 g/l., especially in the case of direct exposure to these concentrations. At the same time, [13] found that young grass carp did not tolerate sudden changes in salinity at 5 g/l.

The nutritional requirements of young grass carp differ from those of adult fish, as juveniles require higher protein content than adults [14]. Determining the specific nutritional needs of grass carp, especially protein, has been a contention among researchers. [15] concluded that the protein required for grass carp larvae growth is 33%, fingerlings 30%, and adults 25%. [16] adopted a protein percentage close to some of the parameters of the current study for fingerlings and adults, 42 and 35%, respectively, while [17] showed that 34.13-38.31% protein is the optimal rate for the growth of juvenile grass carp. [18] showed that less than 40% is the best protein level for grass carp growth, while [19] determined 25% as the best protein for grass carp growth and also showed that the percentages 27% and 30% did not lead to an increase in the weight of grass carp and these percentages were close to the percentages of some of the treatments of the current study. [20] found results differ from current results, where they don't notice any significant differences in the growth of fishes fed on diets of 25 and 35% protein ratio.

The results of the current study showed that grass carp fed on a 35% protein diet recorded higher final weight (272.7 g) compared with the other three treatments. The current study recorded a higher final weight in treatments T3 and T4 than was recorded by [21] for grass carp fed nearly the same protein ratio diet; this discrepancy may be due to the difference in culture periods in the two studies. [9] recorded les final weights (50.35, 54.45, and 36. 75 g) compared with the current experiment; this may be due to the difference in the average initial weight for both studies, 6.3 g compared with 16 g, as well as the difference in the season and duration of the two studies.

The results of the current study showed that the highest rate of weight gain (255.9 g) was recorded by grass carp fed a 35% protein diet, while the lowest (132.5 g) was recorded by grass carp fed a 20% protein diet. The current study outperformed [20] in the average weight gain value as it was (1.6, 2.5, and 3.47) g for their three treatments, respectively, and this may be due to the differences in fish ages and the culturing periods of the two studies. Twenty-one recorded weight gains (1.92 and 5.37) g, as the fish were fed on a processed ration containing the same percentage of crude protein found in the rations of T3 and T4

in the current experiment, so this large discrepancy between the results of the two studies may be due to the difference in the duration of the two studies and culture methods.

The daily growth rates in the current experiment were (0.46, 0.52, 0.60, and 0.95) g/day for T1, T2, T3, and T4, respectively. [22] recorded a daily growth rate of 0.43 g/day for the hybrid grass carp cultured under laboratory conditions and fed on zooplankton and phytoplankton. The results of the current study differed from those of [23] who used aquatic and terrestrial plants to feed grass carp for five months, where the daily growth rate ranged between 1.67-2.91 g/day.

Specific growth is one of the criteria used to evaluate fish growth in nutrition research in which different experimental diets are used in terms of the proportions of substances to be tested for their effects on some of the original components of the diet [24]. [25] reached a specific growth rate of 14.05%/day, which is higher than what was recorded in the current study, by using three types of live foods to feed grass carp larvae, and this is due primarily to the difference in the initial weight between the two studies and secondly to the high value of the proteins present in live foods. The results of the current experiment also contrasted negatively with those of [11] in the value of the specific growth rate (1.34%/day) for grass carp fed on processed diets. [24] recorded an SGR% of 0.01 %/day, while [19] recorded an SGR% of 0.28%/ day; these values were less than the values of the current experiment, which may be due to the absence of natural food in their laboratory experiments on grass carp. The current study also recorded a higher SGR than (0.12%/day) in the study of [26] grass carp cultivated in ponds with an area of 1500 m².

The feed conversion rate is one of the important criteria for determining the utility of consumed feed [27]. The values of the feed conversion rate were (9.32, 9.10, 6.47, and 4.70) for T1, T2, T3, and T4, respectively. These results differed from the results of [29], as the feed conversion rates of grass carp for the six treatments (25, 27, 29, 31, 33, and 35% crude protein) ranged between 3.30-3.57. [28] recorded a 3.1 feed conversion rate for grass carp. Some results of the current study also differed from those of [18], where the best food conversion rate (1.73) was achieved at 40% protein in their laboratory study on grass carp. The results of the current study differed from those of [9], where the feed conversion rate for juvenile grass carp fed on a diet made with 26.37% protein was 1.3, which may be due to the difference in the initial weight.

CONCLUSIONS

Since the cost of fish production is mostly due to feed costs, and the highest component of the cost is protein, especially animal protein, the current experiment aims to find the lowest percentage of protein in the diets provided to grass carp that achieve best results in growth and productivity, and then encourage Iraqi culturists to cultivate this carp.

References

1 Al-Muzain, A. A-M. (**2010**). Feed and fish feed. Public authority for fisheries development library. http://kenanaonline.com/users/DrMezayn/posts/196935

2 Al-Janabi, Mohamed F. ; Al-Noor, Jalal M. & Al-Dubakel, Adel Y. (2021). Evaluation of Thepax and endo vit. C As growth promoters for common carp *Cyprinus Carpio*. Nat. Volatiles & Essent. Oils, **2021**; 8(6): 1976-1992. https://www.nveo.org/index.php/journal/article/view/3858

3 Sinha, R. P. & Gupta, M. V. (1975). On the growth of grass carp, *Ctenopharyngodon idella* Val. in composite fish culture at Kalyani, West Bengal Indi. Aquaculture, 5(3): 283-290. https://doi.org/10.1016/0044-8486(75)90005-8

4 Assal, Z. F. (**2015**). Using substitutes for pituitary hormones in the artificial propagation of common carp (*Cyprinus carpio*) and grass carp (*Ctenopharyngodon idella*). Ms. Thesis, Technical College / Al-Musayyib, Al-Furat Al-Awsat Technical University– Iraq, 85 pp. (In Arabic).https://iqdr.iq/search?q=&field=0&type=reg&filter=Saac5bde0aa35e2df_S7e2a59d64041eabf,S8b11844d720ge22b_Sfd2533487de48727,S31e8a82948b889af_S13d63fc7973b493178f0

5 Tan, M. & Armbruster, J. W. (**2018**). Phylogenetic classification of extant genera of fishes of the order Cypriniformes (Teleostei: Ostariophysi). Zootaxa, 4476(1): 6-39. https://doi.org/10.11646/zootaxa.4476.1.4

6 FAO (2022). The state of world fisheries and aquaculture 2022. Towards Blue Transformation. Rome, 266 pp. https://doi.org/10.4060/cc0461en.

7 Saleh, J. H.; Al-Mukhtar, M. A.; Hassouni, K. H. & Yassin, A. T. (**2008**). Culture of grass carp *ctenopharyngodon idella* Val. in Fadak farm-Basrah Iraq. Iraqi Journal of Aquaculture, 5(1): 13-20. https://search.emarefa.net/detail/BIM-337992

8 Taher, M. M. (**2020b**). Effects of fish weight and water temperature on feed intake of grass carp, *Ctenopharyngodon idella* (cuvier and valenciennes, 1884). Journal of Basrah Researches Sciences, 46(2): 76-87. https://www.iasj.net/iasj/article/200288

9 Muhammad, S. J.; Al-Dubakel, A. Y. & Gowdet, A. I. (**2022**). Effect of the feeding on artificial diet or alfalfa plant on the growth of grass Carp *Ctenopharyngodon idella* Val. 1844 fingerlings cultivated in the earthen ponds. Biological and Applied Environmental Research, 6(1): 1-13. https://doi.org/10.37077/25200860.2022.35.1.04

10 Al-Shukurji, S. S. & Ahemed, H. A. (**2013**). Testduckweed *Lemna* spp. as a potential food for grass carp *Ctenopharhyngodon idella* and common carp *Cyprinus carpio* L. Al-Anbar Journal of Veterinary Sciences, 6(1): 44-55.

11 Hossain, M. M.; Ali, M. L.; Khan, S.; Haque, M. M. & Shahjahan, M. (**2020**). Use of Asian watergrass as feed of grass carp. Aquaculture Reports, 18: 1-7. https://doi.org/10.1016/j.aqrep.2020.100434

12 Jaafar, Raghad Sh. & Ahmed, Sumaya M. (**2011**). Effect of salt stress on osmoregulation and energytic consumption in Grass carp *Ctenopharyngodon idella*(Val.,1844). Iraqi Journal of Aquaculture, 8(1):15-38. https://www.iasj.net/iasj/article/47326

13 Ahmed, S. M. & Jaafar, R. S. (**2013**). Effect of salt stress on energy usage and growth in grass carp Ctenopharyngodon idella (Valenciennes, 1844) and Common carp (Carpio Cyprinus L.). Iraqi Journal of Aquaculture, **2013**, Volume 10, Issue 1, Pages 1-24.

14 Shireman, J. V. & Maceina, M. S. (**1981**). The utilization of grass carp (*Ctenopharyngdon idella*) for hydrilla control in lack Baldwin, Florida. Journal of Fish Biology, 19: 629-636.https://doi.org/10.1111/j.1095-8649.1981.tb03829.x

15 Köprücü, K. (**2012**). Effects of dietary protein and lipid levels on growth, feed utilization and body composition of juvenile grass carp (*Ctenopharyngodon idella*). Journal of FisheriesSciences.com, 6(3): 243-251. https://www.itmedicalteam.pl/articles/effects-of-dietary-protein-and-lipid-levels-on-growth-feed-utilization-and-body-composition-of-juvenile-grass-carp-cteno-104950.html

16 Khan, M. A.; Jafri, A. K. & Chadha, N. K. (**2004**). Growth reproductive performance muscle and egg composition in grass carp *Ctenpharyngodon idella* (Valenciennes), fed hydrilla or formulated diets with varying protein levels. Aquac. Res. 35: 1277-1285. https://doi.org/10.1111/j.1365-2109.2004.01150.x

17 Liang, Hualiang; Xu, Hao; Ge, Xianping; Zhu, Jian; Ren, Mingchun & Mi, Haifeng (2022). Water temperature affects the protein requirements, growth performance, and nutritional metabolism of grass carp (*Ctenopharyngodon idella*) juveniles. Aquaculture Reports, Volume 25: 2352- 5134. https://www.sciencedirect.com/science/article/pii/S2352513422002630

18 Ghazala, R.; Tabinda, A. B. & Yasar, A. (**2011**). Growth response of juvenile grass carp (*Ctenopharyngodone idella*) fed isocaloric diets with variable protein levels. The Journal of Animal and Plant Sciences, 21(4): 850-856. http://www.thejaps.org.pk/docs/21-4/41.pdf

19 Taher, M. M. (**2017**). Laboratory experiments on cultivation of grass carp *Ctenopharyngdon idella* (Valenciennes, 1844). Basrah Journal of Agriculture Science, 30(2): 91-98. https://doi.org/10.37077/25200860.2017.57

20 Nekoubin, H. & Sudagar, M. (**2012**). Effect of formulate and plant diets on juvenile grass carp's growth performance and survival rate (*Ctenopharyngodon idella*). World Journal of Fish and Marine Sciences, 4(4): 386-389. http://idosi.org/wjfms/wjfms4(4)12/11.pdf

21 Nekoubin, H. & Sudagar, M. (**2013**). Effect of different types of plants (*Lemna Sp*., *Azolla filiculoides* and Alfalfa) and artificial diet (With two protein levels) on growth performance, survival rate, biochemical parameters and body composition of grass carp (*Ctenopharyngodon idella*). Journal of Aquaculture and Research Development, 4(2): 1-6.https://www.walshmedicalmedia.com/open-access/effect-of-different-types-of-plants-lemna-sp-azolla-filiculoides-and-alfalfa-and-artificial-diet-2155-9546.1000167.pdf

22 Kilambi, R. V. & Zdinak, A. (**1982**). Food intake and growth of hybrid carp (female grass carp, *Ctenopharyngodon idella*× male bighead, *Aristichthys (Hypophthalmichthys*) *nobilis*) fed on zooplankton and Chara. Journal of fish biology, 21(1): 63-67. https://doi.org/10.1111/j.1095-8649.1982.tb02824.x

23 Zolfinejad, K., Khara, H. & Filizadeh, Y. (**2017**). Food preference and growth of grass carp, *Ctenopharyngodon idella* (Cuvier and Valenciennes, 1844) fed some aquatic and terrestrial plants. Iranian Journal of Fisheries Science, 16 (4) :1278-1286. URL: http://jifro.ir/article-1-2964-en.html

24 Majhi, S. K.; Das, A. & Mandal, B. K. (**2006**). Growth performance and production of organically cultured grass carp *Ctenopharyngodon idella* (Val.) under mid-hill conditions of Meghalaya; North Eastern India. Turkish Journal of Fisheries and Aquatic Sciences, 6(2): 105-108. https://dergipark.org.tr/en/pub/trjfas-ayrildi/issue/13285/160577

25 Al-Nour, S. S.; Ali, M. H. & Ghazi, A. H. (**2007**). The use of live food in rearing the larvae of grass carp *Ctenopharygodon idella.* Iraqi journal of aquaculture, 4(1): 37-50.https://ijaqua.uobasrah.edu.iq/index.php/jaqua/article/view/282 https://www.iasj.net/iasj/download/147cc21fad7e9574

26 Al-Zubaidy, N. .; Al-Mubarak, N. F. .; Ahmed, A. M. . The Effect Of Fertilization And Repeated Mowing On Some Vegetative Characteristics And Yield Of Panicum Mombasa Plant. JLSAR 2021, 2, 34–45

27 Kristan, J.; Blecha, M. & Policar, T. (**2018**). Survival and growth rates of juvenile grass carp Ctenopharyngodon idella overwintered in ponds and recirculating aquaculture systems including a comparison of production economics. Turkish Journal of Fisheries and Aquatic Sciences, 19(3): 261-266. https://www.cabdirect.org/cabdirect/abstract/20183368479

28 Elem, O. (**2021**). Feed conversion ratio calculator. Reviewed by Wojciech Sas, PhD candidate and Jack Bowater Last updated: Nov 30, 2021.https://www.omnicalculator.com/biology/fcr

29 Singh, U. P.; Pandey, N.; Bisht, N. & Bisht, H. C. S. (**2013**). Growth performance of exotic carp in poultry waste recycled ponds, International Journal of Advanced Research, 1(7): 239-248. https://journaldatabase.info/articles/growth_performance_exotic_carps.html

30 AL-JOBOORY, W. M; Abed, Y. M; Salah, A. M; Hussen, N. S. Efficiency of Some Fertilizing Combinations on Growth and Yield in Okra (L) Abelmoschus esculentus. Indian Journal of Ecology, 2021, 48, pp. 338–340

31 Mohamed, M. A.; Hassan, T. S. & Abbas, L. M. (**2017**). Effect of different levels of crude protein on some growth traits of common carp *Cyprinus carpio* L. reared in floating cages. Iraqi Agricultural Research Journal, 22 (2):118-130. https://www.iasj.net/iasj/article/149910

32 Taher, M. M. (2020a). Effects of fish density on growth and condition factor of grass carp, *Ctenopharyngodon idella* cultivated in earthen ponds. Marsh Bulletin Journal, 15(2): 62-72. https://www.iasj.net/iasj/issue/11627

33 Al-Hassan, M., Ibade, K., Ahmed, Z. Relative Efficiency Of Salicylic Acid, Decis Expert And Sivanto Prime And Their Combinations In Controlling Of Myzus Persicae (Sulzer) On Broccoli. Anbar Journal Of Agricultural Sciences, 2022; 20(2): 289-302. doi: 10.32649/ajas.2022.176562

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