Available online at http://journal.bajas.edu.iq

College of Agriculture, University of Basrah

DOi:10.21276/basjas

Basrah Journal of Agricultural Sciences

ISSN 1814 – 5868 Basrah J. Agric. Sci., 30(2): 91-98, 2017 E-ISSN: 2520-0860

Laboratory experiments on cultivation of grass carp *Ctenopharyngodon idella* (Valenciennes, 1844)

Majid M. Taher

Department of Animal production, College of Agriculture, University of Basrah, Iraq

Corresponding author: e-mail: maj61ae@yahoo. com

Received 16 August 2017; Accepted 28 December 2017; Available online 15 January 2018

Abstract: Four laboratory experiments were conducted in Laboratory of Live Food-Aquaculture Unit- Agriculture College during 2015-2017. First experiment investigate the response of grass carp (*Ctenopharyngodon idella*) to pellet diet in comparison to aquatic plants. Second experiment conducted to investigate three protein levels (18, 20 and 22 %) of pelleted food. Third experiment conducted to investigate three protein levels (24, 27 and 30 %) of pelleted food, and fourth experiment to investigate three feeding ratio (2, 4 and 6 % of fish weight) of pelleted food. Results of first experiment appeared an obvious negative growth in fish fed on plant only and also positive growth in fish fed on pellets and also plant and pellets. Weight increments were (-10.78, 5.08 and 8.14) gm, SGR were (-0.39, 0.17 and 0.28) %/day, while DGR were (-0.22, 0.10 and 0.17) g/day for fish fed on plants, plants & pellets and pellets respectively. Weight increments for 95 days were (1.91, 2.82 and 2.86) g for fish fed on pelleted food of (18, 20 and 22)% protein levels respectively. SGR were (0.25, 0.27 and 0.31) %/day, while DGR were (0.028, 0.034 and 0.037) g/day, and FCR were 13.93, 13.03 and 9.09 for fish fed on pelleted food of (18, 20 and 22)% protein levels respectively. Weight increments for 141 days were (4.90, 4.80 and 4.81) g for fish fed on pelleted food of (24, 27 and 30)% protein levels respectively. SGR were (0.49, 0.46 and 0.50) %/day, while DGR were (0.035, 0.034 and 0.034) g/day, and FCR were 5.66, 5.45 and 5.63 for fish fed on pelleted food of (24, 27 and 30)% protein levels respectively. Weight increments for 142 days were (0.24, 2.30 and 3.24) g for fish fed on pelleted food with feeding ratios of (2, 4 and 6)% of fish weight respectively. SGR were (0.03, 0.26 and 0.35) %/day, while DGR were (0.002, 0.016 and 0.023) g/day, and FCR were 10.3, 5.7 and 7.9 for grass carp fed on pelleted food with feeding ratios of (2, 4 and 6)% of fish weight respectively.

Keywords: Grass carp, Growth, Food conversion rate, Pellets.

Introduction

Aquaculture is a relatively new word used to describe the art, science, and business of cultivation aquatic plants and animals in water instead of land. It is necessary to decreasing the density of a very crowded aquatic plant community in southern marshes of Iraq which is caused by "Eutrophication phenomenon". Greenfield *et al.* (2004) stated that there are various methods for controlling aquatic vegetation, but using grass carp

(*Ctenopharyngodon idella*) is the cheapest method. Cultivated grass carp consumed many tons of aquatic plants in different parts around world. Grass carp was among the few animals that cultivated in aquaculture consuming directly aquatic macrophytes and even this species is somewhat selective in what it will eat (Stickney, 2005). The grass carp is a herbivorous and feeds on macrovegetation, including grass and aquatic plants (Pillay, 2004). Based on production, the first cultured species around the world are grass carp, 370 million tones, followed by silver carp,346 million tones and common carp, 236 million tones (Bondad-Reantaso, 2007), while in 2010 grass carp reached about 430 million tones (FAO, 2012).

Fish and other aquatic animals also help in weed control of the system, for example, about 80 kg of weed is consumed for producing 1 kg of grass carp in a rice field (De Silva and Davy, 2010). Grass carp have herbivorous appetites and consume large quantities of higher aquatic plants and it can be cultured only by fertilized the ponds without need for artificial feeds (Halver and Hardy, 2002).

Grass carp was selected as the most obvious and safest choice due to availability of its food in near Iraq Marshes and it can serve as biological control to decreasing the thick floating-submerge plant " due to Eutrophication" which make problems in marshes because it make layer covering water surface and prevent sun light to penetrate to lower layer. It has been noticed that many fishes died in Chebaish Marsh at hot summer of 2008 because of deep decreasing of dissolved oxygen especially at early morning.

Native to the Amur River in Russia – and often called the white amur – grass carp are exotics in most regions for vegetation control (Stickney, 2005). Production of grass carp was most applicable in regions where supplemental feeds were expensive or unavailable (Halver and Hardy, 2002).

Grass carp fingerlings and food-sized fish feed exclusively on aquatic plants in nature, and most producers of grass carp used pelleted feed. In most polyculture ponds consisting of grass carp stocked in combination with silver carp or bighead carp, the production system should be managed for grass carp. The uneaten feed, and other organic materials, can provide detritus for cultivated bighead carp or nutrients for the primary production to produce phytoplankton that is eaten by silver carp (Parker, 2012). Grass carp prefer nutrient-rich ponds overgrown with aquatic plants. For artificial feeding grass and legumes are more suitable. The daily requirement of grass carp for plants can be as high as 15±20 percent of body weight (HorvaÂth *et al*., 2002).

A pilot project was carried out in Chebaish at 2008 for rearing grass carp in floating cage on nine native aquatic plants. *Potamageton* spp. were the first preferred aquatic plants by cultivated grass carp. *Potamageton perfoliatus* is easily differentiated from other species by its leaves that surrounded its stem. These leaves are dark green in color, ovate in shape with many fins. The spike is short (about 2.5 cm) carried by long carrier (about) 4-5 cm. This plant grows in marshes and shallow waters and found in small quantities in Karmat Ali River (Al-saadi and Al-Mayah, 1983).

The aim of present experiments is, (1) to produce grass carp fish depending on local aquatic plants and at the same time reducing plant cover in Southern Iraqi marshes and softening the fishing press on marshes by promote new methodologies of fish farming, (2) to determine best protein levels and feeding ratios that give economical production of grass carp fed on pelleted feeds in Iraq.

Materials and Methods

Four laboratory experiments were conducted to investigate suitable feeding ratio, suitable protein ratio in pelleted food and cultivation of grass carp depending on plants or pelleted food. Six aquariums, two for each treatment, of dimensions (60×40×30) cm provided with pumping aeration and heaters were used for feeding experiments conducted at Laboratory of Live Food- Aquaculture Unit- Agriculture College. Every experiment lasted not less than 50 days and water temperature between 25-28

^{0}C during all experiment periods depending on heaters and air-condition of the laboratory. First experiment was used to investigate the response of grass carp to pellet diet in comparison to aquatic plants. These fishes were fed six days a week on plant (50% of fish weight), plant and pellets (25% plant and 2.5% pellets), and pellets only (5% of fish weight). Second experiment used to investigate three protein levels (18, 20 and 22 %) of pelleted food, third experiment used to investigate three protein levels (24, 27 and 30 %) of pelleted food, and fourth experiment used to investigate three feeding ratio (2, 4 and 6 % of fish weight) of pelleted food.

Potamageton perfoliatus collected, many times during first experiment period, by hand from Karmat Ali River, opposite Najeabae Electric Station. Plant was washed by tap water and put in two fiberglass tanks of 250 letters in small hatchery of Fisheries Department. These tanks were provided with aeration and artificial fluorescent light. Grass carp fish for all experiments brought from ponds of Marine Science Center and transferred to live food laboratory by small plastic container. Ten fish were put in each aquarium for one week for acclimatization. Water of aquariums changed two times a week. Fish were weighed periodically to change the daily food.

Pelleted food manufactured in the laboratory using raw materials such as fish meal, bran, flour, corn, starch and vegetable oil in different ratios to get different protein levels. Feeding ratio for experiments 2 and 3 was 5% of fish weight, while protein levels for pelleted feed in experiments 1 and 4 was 28%. Growth parameters such as specific growth rate (SGR), daily growth rate (DGR) and growth increment (GI), in addition to food conversion rate (FCR) were calculated according to the following equations:

$SGR = \{(\ln w_2 - \ln w_1)/t\} \times 100$

$DGR = (w_2 - w_1)/t$

$WI = w_2 - w_1$

FCR = Food consumed/weight gain

By application of SPSS (version 18), the data were subjected to one-way analysis of variance (ANOVA) to determine the difference between the means and the significant differences were tested by LSD Test.

Results

No fish mortalities occurred in all experiments. Table (1) showed interval average weights of reared grass carp fed on plant, plant & pellets and only pellets during first experiment. Table (2) exhibited some growth parameters of grass carp fed on plants, plants & pellets and pellets. Weight increments were (-10.78, 5.08 and 8.14) g for fish reared on plant, plant & pellets and only pellets respectively.

Table (1): Average weights of reared grass carp fed on plant, plant & pellets and pellets.

Date	Average of fish weight (Mean± SD) for different food materials (g)		
	Plants	Plants &Pellets	Pellets
8th April 2015	61.75±15.3	60±15.1	56.08±14.3
22 April	57.09±14.3	63.12±15.9	58.5±15.3
9th May	51.32±14.7	61.58±16.9	60.58±16.7
27th May	50.97±13.8	65.08±18.3	64.22±17.9

Table (2): Growth parameters for reared grass carp fed on plant, plant & pellets and pellets.

Growth Parameters	Feeding Material		
	Plants	Plants & Pellets	Pellets
(%/day) SGR	-0.39 a	0.17 b	0.28 c
DGR (g/day)	-0.22 a	0.10 b	0.17 c
Weight Increment (g)	-10.78 a	5.08 b	8.14 c

* Different letters in one row is significantly different (P≤0.05).

There was an obvious negative growth noticed in grass carp fed on plant only and also positive growth in grass carp fed on pellets and also plant and pellets. SGR were (-0.39, 0.17 and 0.28) %/day, while DGR were (-0.22, 0.10 and 0.17) g/day for grass carp fed on plants, plants **&** pellets and pellets respectively. Statically analysis explained significant differences (P≤0.05) in all growth parameters between grass carp fed on plants, plants & pellets and pellets.

Table (3) revealed interval average weights of reared grass carp fed on pelleted food of (18, 20 and 22)% protein levels during second experiment. Table (4) exhibited some growth parameters for these fishes. The growth of these fishes were very low, where weight increments for 95 days were (1.91, 2.82 and 2.86) g for grass carp fed on pelleted food of (18, 20 and 22)% protein levels respectively. SGR were (0.25, 0.27 and 0.31) %/day, while DGR were (0.028, 0.034 and 0.037) g/day, and FCR were 13.93, 13.03 and 9.09 for grass carp fed on pelleted food of (18, 20 and 22)% protein levels respectively. Statically analysis showed no significant differences (P≥0.05) in SGR between grass carp fed on 18% protein and grass carp fed on 20%, while there were significant differences (P≤0.05) between them and grass carp fed on 22%. There were significant differences (P≤0.05) in DGR and weight increments between grass carp fed on 18% protein and grass carp fed on 20% and 22% protein level. FCR values were very high with significant differences (P≤0.05) between grass carp fed on 22% protein and grass fed on 18% and 20% protein. It was concluded that these levels of protein especially 18% and 20% in the diet of grass carp are not enough for their feeding requirements. Table (5) exhibited interval average weights of reared grass carp fed on pelleted food of (24, 27 and 30)% protein levels during third experiment.

Table (3): Average weights of reared grass carp fed on pelleted food of (18, 20 and 22)% protein levels.

Date	Average weight (Mean± SD) for different protein levels (g)		
	18%	20%	22%
2nd Mar 2016	10.73±2.82	11.23±2.56	10.84±2.01
13th March	10.29±2.86	11.25±2.60	10.58±2.07
27th March	11.7±3.33	12.44±2.72	11.70±2.32
11th April	11.95±3.88	13.09±3.03	11.95±2.10
25th April	11.70±3.28	12.92±3.03	12.36±2.29
15th May	12.05±2.97	13.35±3.16	12.92±2.42
5th June	12.64±3.34	14.05±3.43	13.70±2.57

Table (4): Growth parameters for reared grass carp fed on pelleted food of (18, 20 and 22)% protein levels.

Growth Parameters	Protein levels (%)		
	18	20	22
(%/day) SGR	0.25 a	0.27 a	0.31 b
DGR (g/day)	0.028 a	0.034 b	0.037 b
Weight Increment (g)	1.91 a	2.82 b	2.86 b
FCR	13.93 a	13.03 a	9.09 b

* Different letters in one row is significantly different (P≤0.05).

Table (6) explained some growth parameters for these fishes. Weight increments for 141 days were (4.90, 4.80 and 4.81) g for grass carp fed on pelleted food of (24, 27 and 30)% protein levels respectively. SGR were (0.49, 0.46 and 0.50) %/day, while DGR were (0.035, 0.034 and 0.034) g/day, and FCR were 5.66, 5.45 and 5.63 for grass carp fed on pelleted food of (24, 27 and 30)% protein levels respectively. Statically analysis revealed no significant differences (P≥0.05) in all growth parameters between grass carp fed on pellets contain (24, 27 and 30)% protein levels. Table (7) showed interval average weights of reared grass carp fed on pelleted food with feeding ratios of (2, 4 and 6)% of fish weight during fourth experiment. Table (8) show some growth parameters for these fishes. Weight increments for 142 days were (0.24, 2.30 and 3.24) g for grass carp fed on pelleted food with feeding ratios of (2, 4 and 6)% of fish weight respectively. SGR were (0.03, 0.26 and 0.35) %/day, while DGR were (0.002, 0.016 and 0.023) g/day,

Table (5): Average weights of reared grass carp fed on pelleted food of (24, 27 and 30)% protein levels.

Date	Average weight (Mean ±SD) for different protein levels (g)		
	24%	27%	30%
27th Nov. 2016	4.98±1.03	5.31±0.79	4.63±0.95
20th December	5.79±1.45	6.00±1.01	5.07±1.32
9th Jan. 2017	5.76±1.47	5.96±1.04	5.75±1.24
31th January	6.48±1.32	6.38±0.98	6.97±1.22
26th February	7.52±1.38	7.44±1.09	7.33±1.36
19th March	8.62±1.53	8.67±1.21	8.45±1.42
16th April	9.88±1.61	10.11±1.34	9.44±1.52

Table (6): Growth parameters for reared grass carp fed on pelleted food of (24, 27 and 30)% protein levels.

Growth Parameters	Protein levels (%)		
	24	27	30
(%/day) SGR	0.49 a	0.46 a	0.50 a
DGR (g/day)	0.035 a	0.034 a	0.034 a
Weight Increment (g)	4.90 a	4.80 a	4.81 a
FCR	5.66 a	5.45 a	5.63 a

and FCR were 10.3, 5.7 and 7.9 for grass carp fed on pelleted food with feeding ratios of (2, 4 and 6)% of fish weight respectively. Statically analysis showed significant differences (P≤0.05) in all growth parameters between grass carp fed on feeing ratios of (2, 4 and 6)% of fish weight.

Table (7): Average weights of reared grass carp fed on pelleted food with feeding.

Date	Average weight (Mean± SD) for different feeding ratios (g)		
	2%	4%	6%
27th Sep 2015	5.2±0.97	5.2±0.66	4.99±0.93
20th October	5.58±1.11	5.31±0.73	5.44±0.98
9th November	5.35±1.08	5.41±0.86	6.01±1.02
31th November	5.09±1.01	5.62±0.88	6.56±1.12
26th December	5.31±1.11	5.88±0.98	7.12±1.31
19th Jan 2016	5.33±1.09	6.12±1.02	7.77±1.45
16th February	5.44±1.13	7.5±1.12	8.23±1.44

Table (8): Growth parameters for reared grass carp fed on pelleted food with feeding ratio of (2, 4 and 6)%.

Growth Parameters	Feeding ratio (%)		
	2	4	6
(%/day) SGR	0.03 a	0.26 b	0.35 c
DGR (g/day)	0.002 a	0.016 b	0.023 c
Weight Increment (g)	0.24 a	2.30 b	3.24 c
FCR	10.3 a	5.7 b	7.9 c

* Different letters in one row is significantly different (P≤0.05).

Discussion

The grass carp starts feeding on macro-vegetation at length of 2.5–3cm, and is reported to ingest up to 50 per cent of its weight in the form of terrestrial plants (Martyshev, 1983). Grass carp stops feeding at a temperature of 10–12°C, while at temperatures above 20°C, it eats large amounts of grass. The negative growth in first experiment of current study cannot be attributed to water temperature because all aquariums have the same water temperature and negative growth occur in two aquariums only.

If they didn't receive enough green vegetation, grass carp suffer inflammation of the intestine (enteritis) due to the consumption of cereals, and this causes significant losses, so to avoid this problem and to produce a healthy grass carp population, it should be stocked according to the plant population of the pond, and in the case of overstocked populations, additional green vegetation should be fed at least during the second part of the season (HorvaÂth *et al.*, 2002). Previous paragraph showed the importance of aquatic plants in the feeding of grass carp, while results of this experiment appeared negative growth in aquariums that received plant only (*P. perfoliatus*), and better growth with aquariums that received pellets only from aquariums that received both aquatic plants and pellets feed. The herbivorous grass carp feeds upon higher plants, and also consumed some of the supplementary feed that used for common carp (HorvaÂth *et al*., 2002).

The negative growth for grass carp fed on plants only may be attributed to the lack of plants for essential amino acids such as lysine and methionine that must be come from

animal sources only (Halver & Hardy, 2002). Wild grass carp and cultivated grass carp in external ponds can get some feeds of animal source at least that they are attached to the plants. In this experiment plants are washed then fed to grass carp, so plants will lost most of attached animals such as small invertebrates that consider an important feeds part that have important essential amino acids. Chalal *et al*. (2014) stated that grass carp may give highest increase in weight from vegetable that cultivated on the bed of fish pond during lean season, and it was 63.4 and 38.8 percent higher than silver and common carp respectively. Hemlata *et al.* (2016) stated that intensive cultivation of grass carp depending on indigenous amphibious plant *Zizania latifolia* give excellent average growth of 2550 g during 10 month, while Riberio *et al*. (2014) pointed that growth of grass carp when fed on commercial meal is better than growth of this fish when fed on forage plus commercial meal or millet plus rye-grass.

Results of current experiments for protein levels in pelleted food proved that protein levels of 18% and 20% not enough for feeding requirements of grass carp, and protein level of 24% gives good results, while increasing protein levels to 27% and 30% didn't increase growth parameters. It can be concluded that 25% was better protein level in pelleted food that gives better growth and lower FCR. This result are differ from the results of Pillay and Kutty (2005), whom stated that juveniles of herbivorous grass carp require high levels of protein similar to that needed by salmon and trout. Al-Jader and Al-Sulevany (2012) stated that protein level of 30% for reared common carp gave better growth and lower FCR comparing of 25% and 35% protein levels. Hussain and Yadav (2016) stated that the presence of grass carp in poly cultured reduced food conversion rate of common carp and mrigal (*Cirrhinus mrigala*).

Results of fourth experiment pointed that 2% feeding ratio were enough only for maintenance of grass carp, where weight increments for 142 days only 0.24 g. It was concluded that may be 5% feeding ratio give better results of growth and FCR. This result deal with the result of Taher *et al.* (2014) where best result for common carp reared in floating cages attained with feeding ratio of 5% comparing with 3% and 7%.

Conclusions

It was concluded from current experiment that wild grass carp get the essential amino acids from animals attached to the plants, so at cultivation of this fish depending only on plants from the environment, it was recommended to harvest these plants daily and fed them to this fish. Better protein level in the pelleted diet of cultivated grass carp was 25%.

References

Al-Jader, F.A-M. & Al-Sulevany, R.S. (2012). Evaluation of common carp *Cyprinus carpio* L. performance fed at three commercial diets. Mesoptamia J. Agric., 40(4): 20-26.

Al-Saadi, H.A. & Al-Mayah, A-R.A. (1983). Aquatic plants of Iraq. Centre for Arab Gulf Studies Publications, 52. Univ. Basrah. 192 pp.

Bondad-Reantaso, M.G. (2007). Assessment of freshwater fish seed resources for sustainable aquaculture. FAO Fisheries Technical Report. 501. 669pp.

De Silva, S.S. & Davy, F.B. (2010). Success Stories in Asian Aquaculture. International Development Research Centre. Springer Science and Business Media, B.V.: 221pp.

Chalal, R.S.; Kumar, A.; Bisht, A.; Ram, R. N. & Kumar, P. (2014). Farmers

innovation for increasing livelihood from vegetable cultivation in fish pond bed during lean season. J. Exp. Zool. India, 17(1): 1-3.

Engle, C.R. (2010). Aquaculture economics and financing. Management and analysis. A John Wiley & Sons, Ltd. Publication, 260pp.

Greenfield, B.K.; David, N.; Hunt, J.; Wittmann, M. & Siemering, G. (2004). Review of Alternative Aquatic Pest Control Methods for California Waters. Oakland, C.A. San Francisco Estuary Institute. 109pp.

Halver, J.E. & Hardy, R.W. (2002). Fish Nutrition. 3rd ed. Academic Press. 824pp.

Hemlata, S.; Singh, Kh.R. & Devi, W.S. (2016). Studies on the growth of grass carp, *Ctenopharyngodon idella* (Cuvier and Val.) fed on amphibious plant *Zizania latifolia* under intensive fish culture. International Journal of Research and Scientific Innovation, 3(11): 28-31.

HorvaÂth, L.; TamaÂs, G. & Seagrave, C. (2002). Carp and Pond Fish Culture. 2nd ed. Fishing News Books, A division of Blackwell Science Ltd.: 185pp.

Hussain, M.S. & Yadav, C.N.R. (2016). Optimization of grass carp for supplementing feed and fertilizer in carp polyculture. International Journal of Fisheries and Aquatic Studies, 4(4): 467-472.

FAO (2012). The State of World Fisheries and Aquaculture. Food and Agriculture Organization of the United Nation. Rome: 238pp.

Martyshev, F.G. (1983). Pond Fisheries. Russian Translation Series 4. A.A. Balkema, Rotterdam. 454pp.

Parker, R. (2012). Aquaculture Science. 3nd ed. Delmar Publications: 672pp.

Pillay, T.V.R. (2004). Aquaculture and the Environment. 2nd ed. Fishing News Books, an imprint of Blackwell Pub. Ltd.: 196pp.

Pillay, T.V.R. & Kutty, M.N. (2005). Aquaculture Principles and Practices. 2nd ed. Blackwell Pub. Ltd.: 624pp.

Riberio, M.O.; Werle, S.; Scharnoski, E.M.; Castoldi, R. & Noleto, R.B. (2014). Weight-length relationship and the condition factor for the grass carp (*Ctenopharyngodon idella*) with different diets. Rev. Agro. Amb., 8(2): 303-315. (Abs.).

Stickney, R.R. (2005). Aquaculture: An Introductory Text. Texas Sea Grant. College Programme, Texas A. & M. University. CABI Publ.: 265pp.

Taher, M.M.; Al-Dubakel, A.Y. & Saleh, J.H. (2014). Effects of feeding ratio on growth and food conversion rate of common carp *Cyprinus carpio* reared in floating cages. Iraqi J. Aquacult., 11(1): 15-26. (In Arabic).