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GROWTH PERFORMANCE OF GRASS CARP, *CTENOPHARYNGODON IDELLA*, AND HYBRID GRASS CARP FINGERLINGS FED ON DIFFERENT TYPES OF AQUATIC PLANTS AND ARTIFICIAL DIET I N CONCRETE BASINS

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ABSTRACT

Grass carp *Ctenopharyngodon idella* and hybrid grass carp (grass carp female x bighead carp male *Aristichthys nobilis* fingerlings were fed three types of aquatic plants: duckweed *Lemna lemna*, pondweed *Potamogeton pectinatus*, coontail *Ceratophyllum demersum*, and prepared artificial diet (34.8% CP). Consumption of grass carp fingerlings for all plants was greater than that of hybrid fingerlings and consumption of duckweed was higher among all treatments for both fish species. Average daily gain (ADG) of both grass and hybrid carp fingerlings was higher when fish were fed duckweed (0.58 g/fish/day) and prepared artificial diets (0.51 g/fish/day). Despite of being higher in crude protein content and also being balanced, artificial diet resulted in lower gain and ADG than duckweed. It was observed that increasing ash and fiber content of food ration lead to a decrease in growth performance. The data indicate that low consumption rates of aquatic plants of hybrids may questionable as a plant biocontrol agent. It could be concluded that:Optimal P:E ratio for grass carp fingerlings is 39.5 mg/kcal and 59.7 mg/kcal for hybrid grass carp.Grass carp utilizes aquatic weeds better than artificial diet.Duckweed is more beneficial in feeding grass carp more than pondweed and coontail.

INTRODUCTION

Grass carp, *Ctenopharyngodon idella*, were first introduced to Egypt in 1982. Since then they have become very important and are raised at fish farms and irrigation channels throughout the country as a biological control agent for submersed aquatic weeds. The grass carp has been studied extensively for a number of years for biological control of aquatic weeds (Mehta *et al*., 1976; Zon, 1979; Shireman and Maccina, 1981; Markmann, 1982; Nour *et al*., 1989; and Essa, 1994). Although this fish is an effective control of many aquatic plant species. Fishery biologists in the United States, Mexico and other European countries (Sutton *et al*., 1981; Cassani and Caton, 1983) concerned that reproducing populations might cause negative environmental impact on native fish species and wildlife. For this reason, research was initiated in Hungary and Egypt for hatchery production of hybrid grass carp (female grass carp, *Ctenopharyngodon idella* x male bighead carp, *Aristichthys nobilis*). The hybrid has been reported to be triploid and theoretically sterile, which negates the risk of reproducing grass carp populations (Marian and KraSzni, 1978; Beck *et al*., 1982 as well as Essa, 1987). Hybrid grass carp are produced as a potential substitute for the grass carp. The hybrid grass carp, however, has not been investigated sufficiently to determine its potentiality in weed control. Therefore, the present study was initiated to determine vegetation consumption and conversion efficiencies for selected aquatic

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plants and growth rates of small hybrids grass carp reared in concrete basins. Comparison studies with pure species grass carp were also employed during the present investigation.

MATERIAL AND METHODS

The present study was carried out at El-Nozha Hydrodrom Surrounding Drain Fish Farm, Hatchery Unit, Alexandria Governorate.

Hybrid fry were produced according to techniques described by Woynarovich and Harvath (1980) as well as Essa (1987). During spawning season (April – June), broodstock of grass and bighead carps were collected and weighed individually for calculating the pituitary dosage and placed in holding tanks. The pituitary treatment started the day after the spawners have been accommodated in the hatchery in order to let the fish discard their gut contents. Spawners in the tank were partly anaesthetized using Quinoldine (10 ppm) to minimize stress. As a priming dose, the female grass carp was induced to spawn by receiving a dose of 3 mg Common carp (Cyprinus carpio) pituitary gland (Cpg) per kg of body weight. Later, 10-12 hours, the same anesthetic procedure was followed, then males of grass and bighead carps received 1.5 mg Cpg / kg fish, while females grass carp received additional dose of Cpg (3 mg / kg fish). Both injections were intramuscularly administered (IM). Prior to stripping, the same anesthetic procedure was followed. The fish were dried and the eggs were stripped into a plastic bowl. Immediately after the eggs stripping, milt from bighead carp male was added over the eggs. The contents are mixed "dry" immediately with a plastic spoon carefully. The settled hatchery water (22-24○C) was poured over the mixture of eggs and milt to prolong the motility of sperm and preventing eggs from sticking together leading to increase the fertilization rates (Woynarovich, 1982). Within 10–20 minutes after the eggs are water – borne, the cortical reaction takes place causing a swelling of the eggs. These swollen eggs are introduced into the incubator jars (7 liter each) for 26 hours incubation period (552–620 hour – grade = average water temperature x 26 hours). After hatching, of grass and hybrid carps, larvae were kept in special Zug jars (50 l), till the first feeding stage (5 day old). Rearing of newly hatched grass and hybrid carps fry was conducted in small earthen ponds (600 m2 water volume each) at a density of 15 000 fry/ 100 m2 (90 000 fry per pond) in monoculture system, and fed on a diet (soybean meal 25%, wheat meal 25%, fishmeal 25%, sesame cake 15% and blood meal 10%) containing 35% crude protein at daily rate of one kilogram per 100 000 fry for six days a week.

Both grass carp and hybrid fingerlings were removed from rearing earthen ponds after about 60 days of rearing period, and acclimated to experimental conditions in concrete basins for several days prior to initiation of feeding experiments for 15 weeks. Feeding experiments were conducted in sixteen concrete basins (6 m3 water volume each) with water flow rate of approximately 1.75 m3/day. Pond water temperature, oxygen and pH were recorded weekly. Total fish number per basin were 30 fish (5 fish/m3) and fish fingerlings were divided into two groups; grass and hybrid carps, each group were divided into four treatments and each treatment was applied in replicates (basins) and fed on one of the tested four types of food ration: duck weed (Lemna lemna); pond weed (Potamogeton pectinatus); coontail (Ceratophyllum demersum); and pelleted diet (34.80% protein). The artificial diet composition is shown in Table (1). Each dietary treatment was applied in replicates (basins).

Chemical analysis of the experimental diet and different tested aquatic plants are shown in Table (2) and were determined according to procedures of AOAC (1985). For each food (Duck weed (Lemna lemna); pond weed (Potamogeton pectinatus); coontail (Ceratophyllum demersum); and

pelleted diet (34.80% protein) two basins were stocked with grass carp and other two with hybrid grass carp. The initial stocking weight for grass carp and hybrids fingerlings averaged 30.6 g and 29.8 g, respectively. Experimental plants were placed in a fine mesh net bag and hand spun for 30 second to remove surface moisture. A preweighed plant ration was then placed into each basin to determine the feeding consumption, in the next feeding time the remaining plants were removed from the basins and weighed, a new portion of the tested diets was added, then the plants daily weight consumed plants were determined per fish (on a wet weight basis). All fish were weighed to the nearest 0.1 g biweekly. Fish growth performance and feed utilization parameters were calculated according to Ballestrazi et al. (1994).

Table 1: The experimental artificial prepared diet composition fed to grass and hybrid carps.

Ingredients:	%
Fish meal	25
Soybean meal	25
Blood meal	10
Wheat milling by-product	38
Vitamin and mineral mixture*	2
Total	**100**

Table 2: Chemical analysis of the tested aquatic plants, duck weed (*Lemna lemna*), pond weed (*Potamogeton pectinatus*) and coontail (*Ceratophylum demersum*) and prepared diet (on DM basis).

ITEM	DUCK WEED	POND WEED	COONTAIL	PREPARED DIET
Moisture	7.00	10.15	7.32	7.60
Dry matter	93.00	89.90	92.7	92.4
Crude protein	16.93	14.02	17.72	37.70
Ether extract	11.40	0.43	1.04	7.80
Crude fiber	3.70	9.50	12.80	9.70
Ash	6.24	3.21	15.57	9.20
Nitrogen free extract	54.73	62.69	45.55	28.00
Gross energy (kcal/100g)	428.0	341.9	296.9	401.3
P:E (mg/kcal)*	36.9	36.6	54.1	93.9

* As described by Omar (1984).

RESULTS AND DISCUSSION

Nursing period

During embryogenesis phase, the cross– breeding of grass carp (C.idella) females with bighead carp (A. nobilis) males showed no significant differences ($p<0.5$) with their pure line species, grass carp, in fertilization and hatching rates (84.60 vs 83.08% and 71.52 vs 72.14%, respectively) as shown in Table (3). Moreover, the hybrid exhibited positive heterosis values in fertilization and hatching rates (11.07% and 6.92%, respectively).

During nursing period, hybrids of grass and bighead carps exhibited good growth rates from fry through fingerling

stages (Table 3) and analysis of variance revealed slightly significant differences ($p<0.5$) between hybrids and pure line species in this parameter. The pure line species showed higher body weight and survival rates than those of cross- breeds. This result may be attributed to the weakness of pharyngeal grinding apparatus in hybrids that resulted in less mastication of food materials. The results of feed conversion ratio during the present study (Table 3) confirm this finding. The results demonstrated that grass carp have utilized feed more efficient than the hybrids

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Table 3: Data on the hatchery procedures, rearing processes, growth performance and feed utilization of grass and hybrid carps larvae.

ITEM	GRASS CARP	HYBRID CARP
1- Hatchery procedure:		
Eggs fertilization rate (%)	83.08	84.60
Eggs incubation period (hours)	23 – 25	24 – 27
Hatching rate	72.14	71.52
2- Rearing processes (60 days):		
Survival rate	81.69	79.4
Condition factor	2.43	2.14
3- Growth performance:		
Initial body weight (g)	0.001	0.001
Final body weight (g)*	36.07^{a}	30.91^{b}
Average daily gain (ADG g/fish/day)*	0.60^{a}	0.52^{b}
Specific growth rate (SGR%/day)	17.5	17.2
4- Feed utilization:		
Feed conversion ratio (FCR)	1.74^{b}	1.80^{a}
Feed intake (FI)	62.8	55.0
Protein intake (PI)	22.7	19.1
Protein efficiency ratio (PER)	1.60	1.60

*Different superscripts indicate statistically significant differences ($p\leq 0.05$)

Aquatic plants proximate analysis

Table (2) shows that crude protein of duckweed (L.lemna) and coontail (Ceratophyllum demersum) was approximately similar (16.93% and 17.72%), while that of pondweed (Potamogeton pectinatus) was slightly lower (14.02%) and artificial diet was the highest in crude protein content (37.7%). Duckweed was higher in ether extract (11.4%) and nitrogen free extract (54.73%) than coontail (1.04% and 45.55%, respectively). Pondweed was the lowest in ether extract (0.43%) while the higher in soluble carbohydrates (62.69%). Differences in fiber content were observed between experimental plants, where coontail recorded the highest value (12.8%) then pondweed (9.5%) and duckweed was the lowest (3.7%). Ash content was higher

in coontail (15.57%) then duckweed (6.24%) and lower in pondweed (3.21%). Duckweed has the highest value in gross energy (424 mg/kcal) between all experimental food items, followed by the artificial diet (401.3 mg/kcal), while coontail was the lowest (296.9 mg/kcal). Protein to energy ratio calculations illustrated a similarity between duckweed (36.9 mg/kcal) and pondweed (36.6 mg/kcal) while coontail was higher (54.1 mg/kcal) and the artificial diet was the highest (93.9 mg/kcal) between treatments.

Consumption

Grass carp exhibited greater consumption rates than hybrid, when expressed as total consumption or as a percentage of body weight (Table 4). The highest total consumption of aquatic plants was occurred in fish fed duckweed (1165 and 922 g/fish) followed by fish fed pond weed (1120 and 710 g/fish) for both grass and hybrid carps, respectively. The lowest value of consumption between fish fed aquatic plants was observed in fish fed coontail (954 and 612 g/fish) for grass and hybrid carps, respectively. The differences may be attributed to the high nutritive value of duckweed (high fat content and lower fiber content). In agreement with the present results, Haroun (1995) reported that small and tender plants such as Lemna is excellent feed for herbivorous fish because of its relatively high protein content, low fiber and tannin contents, which reflect its high nutritive value. Despite of being the lowest total consumption values (205 and 156 g/fish) for grass and hybrid carps fed on pond weed, respectively, prepared diet resulted in better weight gain and feed conversion ratio than pond weed and coontail for both fish groups.

The differences between total consumption by grass and hybrid carps increased over the 15–week period because of the faster growth rates of the grass carp (Table 4). The pharyngeal grinding apparatus is not as strong in the hybrid possibly resulting in less efficient feeding and mastication of food material. We collected hybrid faecal pellets from the basin bottoms that contained vegetation pieces, which were virtually intact, indicating ineffective mastication. Thereby, hybrid grass carp consumed all three types of aquatic vegetation offered at rates lower than that of grass carp.

Table 4: Effects of vegetation and prepared diets on the total diet consumption, weight gain, and feed conversion ratio of grass and hybrid carps fingerlings.

ITEM	TOTAL CONSUMPTION (G/FISH)		MEAN FISH WEIGHT GAIN (G)		CONSUMPTION (%) OF FISH WEIGHT PER DAY		FEED CONVERSION RATIO	
	G	H	G	H	G	H	G	H
1-Duck weed	1165	922	61.30	43.92	20.31	17.06	19.00	20.99
2-Pond weed	1120	710	39.01	22.41	32.75	29.53	28.71	31.68
3-Coontail	954	612	32.30	20.12	29.19	25.76	29.54	30.42
4-Prepared diet	205	156	53.50	38.50	6.90	5.84	3.83	4.04

* G: grass carp H: hybrids

Survival rates:

Survival rates of experimental fish are presented for both grass and hybrid carps in Table (5). Hybrid survival rates were lower than grass carp in all groups except fish fed pondweed, was similar to pure line grass carp. The lowest survival rate between hybrid groups was of that fed coontail, while grass carp fingerlings fed duckweed and prepared diet demonstrated higher survival rates. The lower survival rates in fish fed pondweed and coontail may be attributed to

the higher levels of fiber content in these aquatic plants, which increase gastric evacuation process rate and decrease gastric evacuation time that reduce the profitability of food ration.

Growth:

It was observed that growth of all fish groups on all diets was more rapid when the water temperature was above 19ºC. Grass and hybrid carps grew significantly ($p<0.5$) better when fed duckweed or prepared artificial diet. After week 15, grass and hybrid carps fed duckweed showed averages growth rates of 0.58 g and 0.42 g /day, respectively. Sutton (1982) using larger grass carp hybrids (mean weight = 259.5 and 173.5 g) in a closed circulating system found that hybrids fed only duckweed or trout chow gained 0.60 and 0.46 g/day, respectively. These growth rates are nearly similar to the observed values in the present experiment; minor variations are probably due to factors like fish size and water temperature. Small carps (fry and fingerlings) have different dietary requirements to adults (Shireman and Maceina, 1981; Essa, 1994). Small grass carp, even after they switch to vegetation, require greater amounts of protein and/or other essential nutrients. Because the dietary requirements of hybrid grass carp are not known, we assume, however, that hybrid nutritional requirements (included P:E ratio) are at least equal to those of grass carp or greater. In the present experiment, grass carp fed on the duck weed, which contained moderate amount of protein (15.70%), higher amount of gross energy (424.9 kcal/100 g) and lower P:E ratio (36.9 mg/kcal), illustrated better average daily gain (0.58 g/fish/day) than the other grass or hybrid carps fed aquatic plants, pondweed (0.37 g/fish/day) and coontail (0.31 g/fish/day) or artificial diet (0.51 g/fish/day) as shown in Table (5). It has been hypothesized that length / total length ratio differences between grass carp and the hybrids might explain lower consumption and slower growth of the hybrid. Hybrids have shorter gut lengths; thereby they might not utilize food materials as efficiently as much food materials, or cannot consume dietary nutrients in the case of increasing fiber content. Thus, it was observed, in the present study, that increasing fiber content in the aquatic plant decreased average daily gain.

In contrast, grass and hybrid carps fed on coontail vegetation diet exhibited significantly ($p<0.5$) lowest values of growth and survival rates (Table5) despite of being higher in protein (16.4%) and P:E ratio (54.1 mg/kcal) between vegetations, but higher also in fiber content (11.90%). This might be due to high contents of ash and fiber contents in coontail and also it may be attributed to the plant surface contamination by periphyton, mainly diatoms, such plant would be of low nutritive value (Boyed, 1974; Haroun, 1995 and Essa, 1997).

On the other hand, analytical results of the experimental aquatic plants and prepared diet have illustrated that there are great differences in gross energy content and protein energy ratios (P:E) among these experimental food rations. Duckweed's protein energy ratio (36.9 mg/kcal) resulted in the higher growth performance, while increasing protein energy ratio in the artificial diet (93.9 mg/kcal) decreased significantly ($p<0.5$) growth performance of both grass and hybrid carps.

Table 5: Growth performance of grass and hybrid carps fed on vegetation and prepared diets for fifteen week in concrete basins ($6m^3$ each).

Item	Species	Tested diets			
		Duck weed	Pond weed	Coontail	Prepared diet
Stocking data:					
Initial weight (g)	G	30.60	30.60	30.60	30.60
	H	29.80	29.80	29.80	29.80
Harvesting data:**					
Final weight (g)	G	91.90[a]	69.61[c]	62.90[d]	84.10[b]
	H	73.72[a]	52.21[c]	49.92[d]	68.43[b]
No. of fish harvested/ basin	G	29.00	28.00	27.00	28.00
	H	28.00	28.00	27.00	28.00
Survival rate (%)	G	96.67[a]	93.33[b]	93.33[b]	96.67[a]
	H	93.33[a]	93.33[a]	90.00[b]	93.33[a]
Average Daily gain (ADG) (g/fish/day)	G	0.58[a]	0.37[c]	0.31[d]	0.51[b]
	H	0.42[a]	0.21[c]	0.19[d]	0.37[b]

* G: grass carp H: hybrids

** In the same raw, different superscripts indicate statistically significance ($p \leq 0.05$)

CONCLUSION

Lower consumption of aquatic plants and reduced growth performance of hybrid fingerlings, produced from grass carp females and bighead males, comparing with grass carp may indicate that: 1) Hybrids are questionable as a biocontrol agent, and the fish used in the present study were below stocking size (> 300mm T.L.), therefore, evaluation is preliminary; 2) the optimal protein energy ratio in grass carp fry's feed could be 36.9 mg/kcal when fed on duckweed, and 3) additional studies using larger hybrids in ponds and lakes are required for full evaluation of this fish potentiality in aquatic plant management.

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