GROWTH AND PRODUCTION OF *CLARIAS GARIEPINUS* REARED IN CONCRETE PONDS AT DIFFERENT SIZES AND STOCKING RATES

Ragab A . Mohammed
National Institute of Oceanography and Fisheries Fish Rearing Lab., Al-Kanater Al-Khayria, Egypt

Key words: Growth, reproduction, *Calrias*, concrete ponds, sizes, stocking rates.

ABSTRACT

Clarias gariepinus as one of the main freshwater fishes was reared in concrete ponds at three initial sizes and three stocking rates. In the first experiment, three concrete ponds were stocked with the same initial fish size of about 189 g at three stocking densities of 5, 8 and 10 fish/m^3, while in the second experiment, three size groups ranging from 90 to 120 g, from 170 to 200 g and larger than 200 g of *Clarias gariepinus* were reared in three ponds (one pond for each size) at stocking rate of 5 fish/m^3 for 95 days. Ponds were supplied with underground water which was partially drained every day.

Fishes were fed with supplementary feed containing 32% protein at 3% of body weight 6 times a week. Results showed that *C. gariepinus* weight increased from about 189g to 427.3, 352.4 and 295.03g in ponds stocked with 5, 8 and 10 fish/m^3 respectively. Present results showed also that weight gain (g), average daily gain (g/fish/day) and the specific growth rate decreased with increasing stocking density. Gain in body weight and the average daily gain of *C. gariepinus* increased with increasing initial weight, while specific growth rate decreased with the increase in initial body weight. Economically, results indicated that *C. gariepinus* weighed 170 to 200g at stocking rate of 5 fish/m^3 could be considered as the best size and stocking rate for rearing them intensively in concrete ponds.

INTRODUCTION

In Egypt the demand for fish as a source of cheap animal protein was increased as a result of the rapid increase in Egyptian population. Nile catfish *Clarias gariepinus* is considered as one of the important fish in fresh water catches. Recently, the culture of many tropical catfish species has been intensified by increasing stocking density and feeding level (Li, 1989). Garling and Wilson (1976) reported that the optimum dietary protein level for catfish ranged from 22 to 32% crude protein. Robinson and Li (1993) indicated that practical diets as low as 24-26% protein do not negatively affect channel catfish growth and the use of commercial diets with less than 32% protein could reduce production costs. Allen (1972) mentioned that the growth rate and feed efficiency of catfish decreased with the increase in stocking density. De Kimp and Micha (1974) stated that the individual growth of *Clarias lazera* is equally a function of the rate of stocking density.

In an experiment for production Nile catfish, Brown and Gratzek (1980) reported that a high production was attained with high stocking density. They added that growth rate of *C. gariepinus* in ponds increased with the increase in fish size. Filipiak *et al.* (1995) mentioned that African catfish *Clarias gariepinus* (W_0 = 75g)grew faster than *Oreochromis niloticus* (W_0 = 60g) when they were reared together in cages placed in cooling water at densities of 100 fish/m^3. Middendorp (1995 c) reared catfish with initial weight of 189g at densities of 0.04, 0.10 and 0.15 catfish/m^3 with hand sexed males tilapia (*O. niloticus*) (W_0 = 163g) and found that catfish growth was negatively correlated with catfish stocking density. Middendorp (1995 a and b) found that African catfish at stocking rate of one fish/m^3 grew from 39 to 200g after 180 days in monoculture system, and their average daily gain increased with the increase in initial body weight. On the other hand, specific growth rate decreased from 1.7 to 1.3 with catfish weighing 56.7 and 200g respectively.

The present investigation was designed to study the effects of both stocking rate and the initial body size of catfish (*Clarias gariepinus*) on their growth and production in the concrete ponds. The other objective of this work was to utilize these ponds during winter months where no *Tilapia* species can be reared during this period due to their sharp decrease in growth rate.

MATERIAL AND METHODS

This work was carried out in some concrete ponds in a private fish farm at Al-Kanater Al-Khayria, Qalubia Governorate. Five concrete ponds had equal area of 35 m^2 each were chosen. These ponds were supplied with underground water, using a pump machine. About one third of pond water was drained every day.Moreover, all pond water was completely drained every week and replaced with new underground water. Water depth was maintained at 100 $\pm$ 10 cm during the experimental period which extended from November 1999 to February 2000 for a period of 95 days. The underground water was chemically analyzed according to APHA (1993).

Fingerlings of Nile catfish, *Clarias gariepinus* were bought from Al-Obour market and acclimatized in one of the concrete ponds for a period of 15 days before the start of the experiment. In the first experiment, three of the experimental ponds (No. 1, 2 and 3) were chosen for rearing fingerlings of *Clarias gariepinus* with initial weight from 187.06 to 189.86g under different stocking densities of 5, 8 and 10 fish/m^3 (180, 280 and 350/pond), respectively. There was no noticeable variation in the initial weight among the experimental treatment groups (Table 3). Stocking densities in the present study were chosen according to De Kimp and Micha (1974) who recommended that the ideal density of catfish in ponds ranged between 2 and 10 fish/m^3. In the second experiment, catfish were divided into three groups according to their initial body weights. Weights of the first size group ranged from 90 to 120g, while the second one from 170 to 200g and the third group was stocked with catfish larger than 200g. Three ponds (No.1, 4 and 5) were stocked with 180 Nile catfish each (5 fish/m^3) from the three fish size groups.

The reared fishes were fed on an artificial practical diet containing the recommended dietary protein of 32% as mentioned by Li and Lovell (1992) who reported that the optimum dietary protein for channel catfish ranged from 25% to 45% and the commercial catfish feeds typically contain 32% protein. The total metabolized energy contents of the used diet was 2269k.cal./kg. Feeds were offered to fish 6 times a week at 3% of body weight, twice every day at 9 a.m. and 4 p.m. for a period of 95 days. Constituent and approximate composition of the used diet are shown in Table (1).

Water temperature of the experimental ponds was ranging between 12 and 20°C with average of 15 $\pm$ 3.2 °C, pH of pond water ranged between 8.08 and 8.30, while dissolved oxygen was at least 6.2 mg/L throughout the experimental period due to supplying the pond water with air from an air compressor. The other water characteristics are shown in Table (2). Random samples of the reared fish (about 10% from each pond) were monthly weighed to the nearest 0.1g, mortalities were recorded daily in each pond, weight of the supplementary feed was readjusted monthly according to the increase in body weight. Quantity of the consumed diet in the different ponds was determined.

The economic evaluation of results principally depended upon prices of purchased fishes, quantity and cost of the consumed diet and the public sale of fish production from the different stocking densities and different sizes. The economic evaluation was carried out according to Green (1992).

RESULTS AND DISCUSSION

Results of Table (2) show that average water pH was 8.18, total soluble salts was 736ppm, total nitrogen was 3.57ppm, and soluble phosphate was 0.434ppm, The other water quality criteria are shown in the same table. From these results, it can be noticed that water quality was within the suitable range for fish culturing according to Hepher and Pruginin (1981).

For studying the effects of stocking rates on growth and production of *Clarias gariepinus*, the present results showed that growth rate decreased with the increase in the stocking densities. Table (3) indicated that monthly increment in fish body weight of *C. gariepinus* ranged between 32and 68g/fish after the first 30 days of rearing according to stocking rates. Results also showed that weight gain percentage decreased from 36.4% to 16.9% after the first month as a result of the increase in stocking rate. Gain in body weight increased with each advance in the period of rearing of catfishes, where it increased from 68g to 92g, from 48g to 60g and from 32g to 39g for the stocking rates 5,8 and 10 fish/m^3 respectively. These results confirmed that gain in fish body weight increased by each increase in the initial body weight, while it decreased with the increase in their stocking rates during the same period as mentioned by Allen (1972) who reported that growth rate of catfish decreased with the increase in stocking rate. Middendorp (1995 c) found also that catfish growth was negatively correlated with catfish stocking density due to feed competition near the end of the experiment.

On the other hand, weight gain percentage (WG%) throughout the period of the study decreased with each advance in the period of rearing. Table (3) showed that weight gain percentage decreased from 36.4 to 27.5% for the lowest stocking rate (5 fish/m^3) after 95 days. Similarly, this percentage decreased from 25.4 to 20.5% and from 16.9 to 15.2% for the other two stocking densities of 8 and 10 fish/m^3

respectively which confirmed the pervious results of Middendorp (1995-c).

Table (4) showed that the highest final body weight of *Clarias gariepinus* after 95 days of rearing was 427.28g for the lowest stocking rate (5 fish/m^3) while the lowest final body weight of 295.03g was observed with the maximum stocking rate (10 fish/m^3).These results emphasized the result of average daily gain which decreased from 2.53 to 1.11g/fish/day by increasing stocking density from 5 to 10 fish/m^3, respectively. The same trend was observed with specific growth rate which decreased from 0.87 to 0.46 by increasing stocking rate from 5 to 10 fish/m^3 confirming the previous results of De Kimp and Micha (1974) who reported that average daily gain of Nile catfish increased with the decrease in the stocking rate. El-Agamy *et al.* (1992) found that the average daily gain of catfishes was 2.54, 2.13 and 1.42g/fish/day and the feed conversion ratio was 3.08, 3.13 and 4.2 for catfish stocks of 100, 150 and 200 fish/m^3 in cages, respectively.

From the present results,it can be deduced that the survival rate of *Clarias gariepinus* differed from pond to another. The lowest percentage of 89.7% was recorded for the highest stocking density, while the best survival rate of 92.14% was attained at stocking density of 8 fish/m^3.

Concerning the variations in the feed conversion ratio (FCR), table (4) showed that it increased from 3.14 (for stocking 5 fish/m^3) to reach 7.01 in the highest stocking density treatment (10 fish/m^3). This result may be due to competition on feed as a result of increasing fish stocking rates. Moreover, growth of the reared fishes did not proceed at the same degree of feed consumed. This result agrees with those of Al-Agamy *et al.* (1992) who mentioned that FCR increased with the increase in stocking density of *Clarias gariepinus* in floating cages.

For studying the effects of stocking densities on Nile catfish production, Table (4) shows that total production increased with the increase in stocking rate. The highest fish production of 2.647 kg/m^3 was recorded for the highest stocking rate,while the minimal production of 1.978 kg/m^3 was observed for the lowest stocking rate (5 fish/m^3). These results agree with those reported by Brown and Grantzek (1980) and Fagbenro (1987) who showed that net production of African catfish was significantly higher at the highest catfish density. On the other hand, Middendorp (1995-c) reported that catfish production was not significantly higher at higher densities.

Table (4) shows that the highest total weight gain of 1.203 kg/m^3 was obtained for stocking 8 fish/m^3, while the lowest weight gain (0.944 kg/m^3) was recorded with the highest stocks.

With respect to growth parameter of *Clarias gariepinus* reared in the concrete ponds with different initial weights, Table (3) indicates that monthly increment in fish body weight increased with the increase in initial body weight. Gains in fish weight days were 60.5, 68 and 78 g / fish for *C gariepinus* for the three size groups respectively. On the other hand, results showed that weight gain percentage was decreased from 55.3 to 22.1%, from 36.4 to 27.5% and from 30.6 to 21.2% for the small, medium and the large size groups respectively throughout period of the experiment, in spite of gain in body weight with advancing the period of rearing. This may be due to that large fishes can consume large quantity of the added feed and consequently the increase in body weight would be higher for the largest size group whilst the lowest increase in weight was recorded for the smallest size of the reared catfish.

Results of Table (5) indicate that maximum final body weight of 504.39g was obtained in the largest "third" group of the reared fish, while the lowest weight was recorded for the smallest group. This result means that weight gain increased with the increase in the initial body weight, where it was 193.94, 240.22 and 248.5 for the small, medium and the largest size groups after 95 days, confirming the previously result of Middendorp (1995-b) who found that growth rate of catfish increased with each increase in initial body weight. Concerning the variation in the average daily gain, present data showed that average daily gain (ADG) increased with the increase in initial body weight for the same stocking rate. The maximum ADG of 2.61 g/fish/day was obtained for *C. gariepinus* the was highest initial weight of 255.89g, while the lowest ADG of 2.04 g/fish/day was observed for the small reared fishes emphasizing the result of Middendorp (1995-b). On the other hand, the highest specific growth rate of 1.07 was attained in the first pond where the small catfishes were reared while the lowest specific growth rate of 0.71 was attained for the largest size group. This result agrees with De Kimp and Micha (1974), who found that growth rate of *Clarias gariepinus* increased by increasing fish size, where the average daily gain was 1.5, 1.75 and 4.5 g/fish/day for fish that weighed 10-40g, 40-110g and 110-450g respectively. They added that fish more than 1 kg rapidly double their weight when they were small in number and fed with a rich food.

Comparing the differences between survival rate of *Clarias gariepinus* during the experimental period, table (5) showed that there was no observed differences between the survival rate for the different sizes, but the suitable weight for rearing catfish was within the second group which ranged between 170 and 200g.

Results also showed that total weight gain (kg/m^3) increased with the increase in the initial size. Table (5) shows that there was no remarkable difference between gain in fish weight for the medium and the largest group of the reared catfishes, while the difference between them and that of the smallest catfishes stocked was noticeable. The lowest value of 0.887 kg/m^3 was recorded with the small catfish (Table, 5).Consequently, the highest fish production of 2.263 kg/m^3 was recorded for the largest catfish reared, while the lowest fish production of 1.387 kg/m^3 was in the fourth pond where small catfish were reared.

Feed conversion ratio (FCR) increased with the increase in initial body weight. FCR was 2.50, 3.14 and 4.21 for the small, medium and the largest reared *Clarias gariepinus*. The highest FCR for the largest catfish may be due to that large catfish can consume more quantities from the added diets, whilst their growth rate did not go similar to their demand of feeding.

Economic evaluation:

Table (6) indicates that total initial fish weight (kg/pond) differed from pond to another according to their stocking rates and their different initial body weights. Moreover, feed intake varied from treatment to another. The highest feed intake was 183.82 kg/pond but the lowest feed intake of 72.23 kg/pond was recorded for the smallest group.

Concerning fish production, it can be seen that total production increased with the increase in both stocking rates and the initial body weight of the reared fishes.

From the economic point of view, Table (6) shows that the highest fish production of 92.64 kg/pond was obtained with highest stocking rates (10 fish/m^3) while the maximum profit of 119.48 L.E./pond was attained for the lowest stocking rate (5 fish/m^3). On the other hand, the present results indicate that the highest fish production of 79.19 kg/pond was recorded with the largest *Clarias gariepinus* reared whilst the net profit of this pond (90.43 L.E.) was lower than that of pond No.1, where medium size (average initial weight=187.06g) was reared and produced 69.22kg with net profit 119.48 L.E. The lowest production and lowest profit were recorded for the smallest catfish reared.

These results emphasized that *Clarias gariepinus* ranging between 170 and 200g at stocking rate of 5 fish/m^3 was the most suitable size for the economical production.

Statistical analysis according to Snedecor and Cochran (1980) is shown in table (7) which indicates that difference between initial body weight in the first experiment was non significant, while the differences between initial weight in the second experiment and the final body weight in the two experiments were highly significant .

REFERENCES

Allen, K.U. (1972). Determination of the effect for stocking density and flow rate on survival, growth and feed conversion of catfish in tanks, in factors affecting the growth and production of channel catfish in raceways. Tech. Assis. Proj. U.S. Dept. of Commerce, p. 11.

APHA (American Public Health Association) (1993). Standard Methods for the Examination of the Water and Waste-Water Including Bottom Sediments and Sludges. APHA, Washington U.S.A.

Brown, E.E. and Gratzek, J.B. (1980). Fish Farming Handbook Food, Baib Tropical and Goldfish avi Publishing Company Ince. Westport. Connecticut 391 pp.

De Kimp, P. and Micha, J.C. (1974). First guidelines for the culture of *Clarias lazera* in Central Africa. Aquaculture, *4*: 227-247.

El-Agamy, A.E.; Labib, W.; El-Serafy, S.S. and El-Kashif, M.A.E. (1992). Observatioins on the growth of *Clarias lazera* reared in cages at three stocking rates. Egypt. J. Appl. Sci., 7(6): 484-491.

Fagbenro, O.A. (1987). Re-cruitment control and production of *Tilapia guineesis* (Dumeril) with the predator *Clarias lazera* (Valenciennes). Nigerian Journal of Basic and Applied Science. *2*: 135-140.

Filipiak, J.; Dasowski, J. and Trzebiatowski, R. (1995). Comparison of the effects of cage rearing of African catfish (*Clarias gariepinus*) and Nile tilapia (*Oreochromis nilotica*) in cooling water. Arch. Ryb. Pol. Fish. *3*(1): 95-105.

Galing, D.L. and Wilson, R.P. (1976). The optimum dietary calorie to protein ration for channel catfish fingerlings. *Ictalurus punctatus* J. Nutr. *106*: 1369-1375.

Green, B.W. (1992).Substitution of organic manure for pelleted feed in tilapia production. Aquaculture, *101*: 213.

Hepher, B. and Pruginin, Y. (1981). Commercial Fish Farming. Fish and Aquaculture Research Station. Israel, John Wiely and Sons Inc. New York, Toronto.

Li, M.H. (1989). Effect of dietary protein content on weight gain of channel catfish stocked intensively in earthen ponds. M.Sc. Thesis Auburn, University, Auburn, AL. 48.

Li, M.H. and Lovell, R.T. (1992). Growth, feed efficiency and body composition of second and third year channel catfish fed various concentrations of dietary protein to satiety in production ponds.

Middendorp, A.J. (1995-a).Pond farming of Nile tilapia, *Oreochromis niloticus* (L.) in northern Cameroon. Adding hand-sexed male tilapia to graze the dense algal blooms in ponds with African catfish, *Clarias gariepinus* (Burchell). Aquaculture Research, *26*(10): 749-754.

Middendorp,A.J.(1995-b). Pond farming of Nile tilapia, *Oreochromis niloticus* (L.) in northern Cameroon. Mixed culture of large tilapia (>200g) with cattle manure and cotton seed cake as pond inputs and African catfish, *Clarias gariepinus* (Burchell).Aquaculture Research, *26*(10): 723-730.

Middendorp, A.J. (1995-c). Pond farming of Nile tilapia, *Oreochromis niloticus* (L.) in northern Cameroon. Controlling a sexing error of 1% in hand-sexed male tilapia monosex culture by African catfish, *Clarias gariepinus* (Burchell). Aquaculture Research, *26*(10): 739-747.

Robinson, E.H. and Li, M.H. (1993). Protein quantity and quality of catfish feeds. Technical Bulletin 189, Mississippi, Agriculture and Frostry Experiment Station, Missisippi State University, Starkiville Ms.

Snedecor , G. W , and Cochran , W .G . (1980). Statistical Methods 6th Ed Iowa state univ ., Press . Iowa USA .

Table (1): Constituents of the experimental diet

Ingredients	Protein %	Lipid	Energy	G/100g	protein	Lipid	M.t. energy
Rice bran	12.9	13.0	1630	45.0	5.81	5.81	733.5
Soybean meal	44.0	0.8	2230	20.0	8.80	0.16	446.0
Meat meal	54.4	7.1	2000	15.0	8.16	1.06	300.0
Fish meal	60.5	9.4	2820	15.5	9.37	1.46	437.1
Cotton seed oil	---	100	8800	4.0	---	4.0	352.0
Vitamins	---	---	---	0.5	---	---	---
Total				100.0	32.14	12.49	2268.6

Table (2): Some water characteristics

Temp. °C	Dissolved Oxygen Mg/L	E.C. Umhos/cm	Nitrogen ppm	Phosphorus ppm	Soluble salts ppm	Soluble cations m.e./L.	Soluble anions m.e./L.	Fe ppm	Cu ppm
15 $\pm$ 3.22	7.2 $\pm$ 0.4	1.15	3.57	0.434	736	11.77	11.77	0.08	0.002

Table (3): Monthly increment (g) in body weight and the weight gain percentage

Pond No.	Stocking rate Fish/m^3	Initial weight (g)	1st month weight gain		2nd month weight gain		3rd month weight gain	
			(g)	%	(g)	%	(g)	%
3	10 fish/m^3	189.96	32.0	16.9	35.0	15.8	39	15.2
2	8 fish/m^3	189.25	48.0	25.4	55.0	23.2	60	20.5
1	5 fish/m^3	187.06	68.0	36.4	80.0	31.4	92	27.5
4	5 fish/m^3	109.50	60.5	55.3	66.0	38.8	67	22.1
5	5 fish/m^3	255.89	78.0	30.6	82.0	24.6	88	21.2

Table (4): Effect of stocking density on growth of *Clarias lazera*

Pond No.	1	2	3
Number of fish/pond	180	280	350
Stocking rate (fish/m^3)	5	8	10
Initial weight (g/fish)	187.06 ± 15.04	189.25 ± 15.74	189.86 ± 14.11
Final weight (g/fish)	427.28 ± 23.76	352.40 ± 68.46	295.03 ± 24.45
Weight gain (g/fish)	240.22	163.15	105.17
Average daily gain (g/fish/day)	2.53	1.72	1.11
Specific growth rat	0.87	0.65	0.46
Number of fish at harvest	162	258	314
Survival rate	90.0	92.1	89.7
Total production (kg/m^3)	1.978	2.598	2.647
Gain in weight (kg/m^3)	1.112	1.203	0.944
Feed conversion ratio	3.14	4.27	7.01

Table (5): Effect of different initial sizes on growth of *Clarias lazera*

Fish group	1st group	2nd group	3rd group
Number of fish/pond	180	180	180
Initial weight (g/fish)	109.50 ± 7.27	187.06 ± 15.04	255.89 ± 22.84
Final weight (g/fish)	303.44 ± 30.56	427.28 ± 23.76	504.39 ± 27.23
Weight gain (g/fish)	193.94	240.22	248.5
Average daily gain (g/fish/day)	2.04	2.53	2.61
Specific growth rate	1.07	0.87	0.71
Number of fish at harvest	160	162	157
Survival rate	88.89	90.0	87.2
Total production (kg/m^3)	1.387	1.978	2.263
Gain in weight (kg/m^3)	0.887	1.112	1.112
Feed conversion ratio	2.50	3.14	4.21

Table (6): The economic evaluation

Pond No. / Stocking rate	3 10	2 8	1 5	4 5	5 5
Total initial weight (kg/pond)	66.45	52.99	33.67	19.71	46.06
Feed intake (kg/pond)	183.82	161.98	111.72	72.23	139.45
Cost of feed (L.E./pond)	220.58	194.38	134.06	86.68	167.34
Cost of stocked fish (L.E./pond)	182.24	145.72	92.59	54.20	138.18
Total fish production (kg/pond)	92.64	90.92	69.22	48.55	79.19
Price of fish production (L.E./pond)	416.88	431.87	346.10	218.48	395.95
Price of fish production (L.E./m^3)	11.91	12.34	9.89	6.24	11.31
Profit (L.E./pond)	13.56	91.77	119.48	77.60	90.43

Table (7) Summary of analysis of variance (ANOVA)

a- The first experiment

S O V	initial weight				Final weight			
	df	SS	MS	F	df	SS	MS	F
total	80	17585.95	--	--	80	367086.2	--	--
stock	2	95.46	47.73	.21	2	210606.96	105303.48	52.49
error	78	17490.49	224.24	--	78	156497.24	2006.1	

LSD at 0.05 = 22.59

at 0.01 =29.96

b - the second experiment,

S O V	initial weight				Final weight			
	df	SS	MS	F	df	SS	MS	F
total	53	206874.7	--	--	53	408025.26	--	--
stock	2	193095.6	96547.8	357.3	2	369956.93	184978.46	247.81
error	51	1379.22	270.18	--	51	38068.33	746.44	--

LSD at 0.05 = 10.96

at 0.01 = 14.69

LSD at 0.05 = 18.2

at 0.01 = 24.93