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Effect of dietary protein level on caged Catfish Clarias lazera, raised under different stocking rates

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CATFISH fingerlings, *clarias lazera*, averaging 97.4 ± .7g in weight and 18.7 ± .09 cm in length were alloted to 12 treatments in duplicates using 24 floating circular cages. The treatments were arranged to contain four levels of dietary protein (20, 25, 30 and 40% cp) and three stocking rates of fish (50, 100 and 200 fish/m^3) in 4 X 3 factorial design. The fish per cage were maintained in 0.2 m^3 Nile water from the start of June to August 5. Fish performance, carcass traits and simple economical evaluation were performed.

The results revieled that the 20% CP diet was more efficient than the 25, 30 and 40% CP diets regarding fish performance, carcass traits and feeed cost per one kg fish or its flesh. As the stocking rate increased as fish performance and carcass traits decreased. However, the net revenue per cage increased to about 4 folds as a result of increasing fish stocking rate from 50 to 200 fish/m^3.

KEY WORDS (dietary protein level, stocking rate, catfish, cages).

It is believed that dietary protein plays an important role in fish nutrition. Law (1979) reported dietary protein levels more than 30% for fish raised in artificial cultures. However, Hassouna *et al* (1987) found dietary protein levels between 20 to 25% are adequate for raising catfish in aquaria. In pond culture, Lovell (1975) proposed levels of 25 to 33% protein in commercial catfish feeds. These findings reflect water environment changes which make the finite nutrient utilization extremely difficult as stated by Law (1979) who refered to water temperature, quality, flow and seasonal photoperiod changes as factors affecting fish nutrition.

Fish culture in cages has many advantages especially for small producers at times characterized by adequate enough temperature. Cages initial investiments are relatively small, their control is easy and they produce the optimum utilization of artificial food for growth beside the other advantages reported by Milne (1976) and Balarin & Haller (1982). On the other hand Lovell (1972) realized that the optimum density of fish in cages favors fast growth and highest possible yield.

The above findings may suggest, under captive conditions in running water with different stocking rates, that caged catfish may need dietary protein levels different than found in aquaria or ponds. Therefore, the current study aimed to, a) gain information on the effect of dietary protein level on caged catfish, *clarias lazera*, under different stocking rates, b) shade other hand Lowell (1972) realized that the optimum density of fish in cages favors fast growth and highest possible yield.

MATERIAL and METHODS

Catfish fingerlings *(Clarias lazera)* averaging 97.4 $\pm$ 0.7g in weight and 18.7 $\pm$ 0.09 cm in length were arranged in a factorial design of 3 stocking rates $\times$ 4 diets. The used stocking rates were 50, 100 and 200 fish/m^3. The experimental diets (Table 1) contained 20, 25, 30 and 40% CP respectively. The energy level of these diets (2.75 MCal ME/kg) was as stated by Wilson (1977). The 12 treatments were assigned in duplicates to 24 floating 0.3m^3 circular cages (Fig. 1). The fish per cage were maintained in 0.2m^3 water near El-Raiah El-Monoufy of the Nile at the Fish Culture Research Station, El-Kanater El-Khayria. Pelleted diets of 6mm diameter and 4 mm length were fed at a rate equivalent to 3% of total wet body weight/day (Stickney, 1977). Diets were placed in plastic containers hanged in cages 6 days a week, 2 times daily (8.0 a.m. and 3.0 p.m.). Water temperature and pH at 8.0 a.m. are presented in Table (2). The experiment began at the start of June and terminated on Augtst 5.

Fish weight and carcass traits were obtained. Feeds and flesh chemical analysis were in accordance to A.O.A.C. (1980). The energy values were obtained using the bomb calorimeter except that of diets ME in which it was estimated according to Church (1979). Specific growth rate % per day (SGR) was calculated by the equation, SGR % day = 100 (In Wi-In Wo)/T as reported by Omar (1984), in which In Wi is the natural log of final body weight, In Wo is the natural log of the initial body weight and T is the period in days. Statistical analysis followed those of Steel and Torrie (1980) using Waller - Duncan's Bayesian test whenever possible.

TABLE 1. Ingredients and nutritive analysis of the experimental diets.

Item	Dietary CP %			
	20	25	30	40
Ingredients, %				
Yellow corn	39.9	39.2	29.4	13.7
Rice bran	19.0	18.0	7.9	10.0
Wheat bran	16.0	9.5	11.5	6.1
Soybean meal	4.5	10.0	19.9	20.0
Decorticated cottonseed meal	1.0	1.7	7.0	8.9
Fish meal	13.6	17.0	19.0	25.3
Blood meal	1.0	1.1	1.0	7.0
Meat meal	1.0	1.0	1.0	5.0
Corn oil	3.0	1.5	2.3	3.0
Vitamin mineral premix*	1.0	1.0	1.0	1.0
Nutritive analysis				
ME**, M cal/kg.	2.75	2.75	2.75	2.75
CP, %	20.13	25.13	29.90	39.99
DM, %	86.40	89.48	89.57	90.76

* Sorb product (Sorb, 75017 Paris, France).

** Calculated after Church (1979).

TABLE 2 Water temperature and pH during the experimental period.

Item	Min.	Max.	Sv.	SE*
Water temperature, C°.	23.1	26.3	25.0	0.30
Water pH.	6.5	7.0	6.8	0.07

* Standard error.

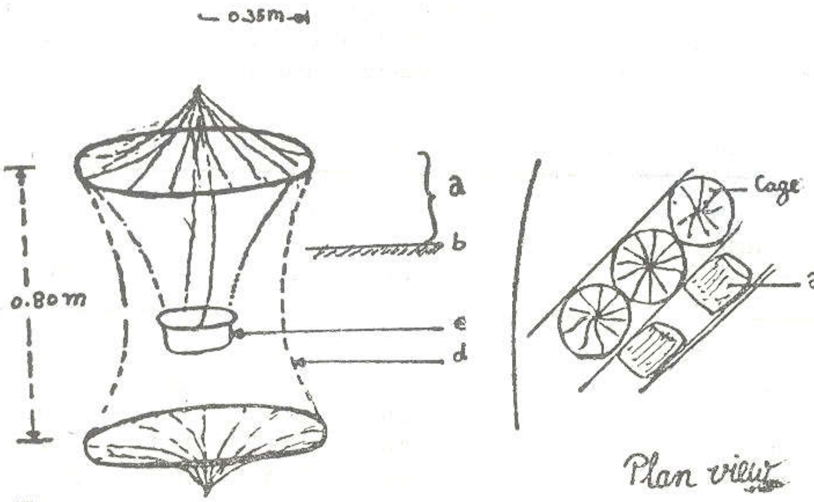

Figure 1. Cage shape and specifications. a) floating materials, b) Water level, c) Feed container, d) Net (1 cm diameter).

RESULTS and DISCUSSION

Performance : Final wet weight, rate of gain and specific growth rate percent per day (SGR % d) decreased significantly ($P < .01$) by increasing either dietary CP level or fish stocking rate (Table 3). However, the significant differences regarding dietary CP level or fish stocking rate were not more than 2.5% and 3.4% respectively. Converse results were obtained by many authers. Hastings & Dupree (1969) and Lovell (1972) observed a linear increase in catfish growth with the increase in dietary CP level up to 40% in aquaria and up to 28.30% in ponds. Hassouna *et al.* (1987) found in aquaria experiment a positive non-linear growth with increasing dietary CP level, but the differences regarded were not more than 3.8% with those fed the 25, 30 and 40% CP diets. The decrease in growth data with increasing the level of stocking rate was observed also by Robison & Newton (1982) who reared catfish at stocking rates of 200 and 300 fish/m^3. They found a higher decrease (about 29%) in final wet weight of fish than found herein (about 2.4%). The lower decrease found herein may due to the lower stocking rates used in the present study (50, 100 & 200 fish/m^3).

Feed intake (Table 4) among treatments was about the same except that of CPI and CPI/MEI ratio which were increased as a result of increasing protein level in the diet. Feed efficiency data (Table 5) showed that the 20% diet is better utilized than the other diets regarding the consumption of DM or CP per gain. It was observed that MEI/gain with the 20% CP diet was higher ($P < .01$) than those of the 20 and 30% CP diet than that of the 20% CP one. However, the differences were not more than 31%. The differences in dietary DM percentages and that of growth rates are behind these phenomena. A negative significant ($P < .01$) relationship was found between feed efficiency and fish stocking rate. However, the

TABLE 3. Wet weight and gain for caged catfish subjected to 4 dietary protein levels and 3 stocking rates.

Item	Stocking rate ($fish/m^3$)	Dietary CP% level				Av	SE
		20	25	30	40		
Initial wet weight/ fish, g.	50	97.57	97.45	97.42	97.49	97.48	
	100	96.65	97.51	97.50	97.37	97.21	
	200	97.50	97.43	97.34	97.45	97.43	
	Av	97.17	97.46	97.42	97.44		0.33
Final wet weight/ Fish, g.	50	327.52	326.83	325.09	324.72	326.04^{A}	
	100	324.00	324.02	324.81	325.27	324.53^{B}	
	200	324.69	323.66	316.65	308.23	318.31^{C}	
	Av	325.40^{A}	324.84^{B}	322.18^{C}	319.41^{D}		0.24
Rate of gain/ fish/ day, g.	50	3.65	3.64	3.61	3.61	3.63^{A}	
	100	3.61	3.60	3.61	3.62	3.61^{B}	
	200	3.61	3.59	3.48	3.35	3.51^{C}	
	Av	3.62^{A}	3.61^{B}	3.57^{C}	3.53^{D}		0.009
SGR%/ d	50	1.92	1.92	1.91	1.91	1.92^{A}	
	100	1.92	1.91	1.91	1.91	1.91^{B}	
	200	1.91	1.91	1.87	1.83	1.88^{C}	
	Av	1.92^{A}	1.91^{B}	1.90^{C}	1.88^{D}		0.001

Averages in the same row or column with different superscripts are different ($P < .01$). Av, Overall average; SE, standard error; SGR % d, specific growth rate per day.

TABLE 4 : Daily feed intake per fish and feed energy protein ratio for caged catfish subjected to 4 dietary levels and 3 stocking rates

Item	Stocking rate (Fish/m^3)	Dietary CP % level				Av	SE
		20	25	30	40		
DMI/fish/day, g.	50	6.00	6.00	6.00	5.99	6.00	
	100	5.99	5.99	5.99	6.00	5.99	
	200	5.99	5.98	6.00	5.96	5.98	
	Av	5.99	5.99	5.99	5.98		0.08
MEI/fish/day, Kcal.	50	19.09	18.43	18.41	18.15	18.52	
	100	19.07	18.40	18.40	18.17	18.51	
	200	19.06	18.37	18.41	18.07	18.48	
	Av	19.07	18.40	18.41	18.13		0.54
CPI/fish/day g	50	1.397	1.684	2.001	2.639	1.930	
	100	1.396	1.681	2.000	2.641	1.930	
	200	1.394	1.679	2.001	2.627	1.925	
	Av	1.36^{D}	1.681^{C}	2.001^{B}	2.636^{A}		0.01
CPI/MEI ratio, mg/Kcal.	50	73.180	91.373	108.691	145.399	104.66	
	100	73.204	91.359	108.696	145.350	104.65	
	200	73.138	91.399	108.691	145.379	104.65	
	Av	73.174^{D}	91.377^{C}	108.693^{B}	145.376^{A}		0.001

Averages in the same row or column with different superscripts are different ($P < .01$). Av, Overall average; SE, standard error.

differences were not more than 3.6, 3.1 and 5.7% for the consumption per gain of DM, ME and CP respectively. The significant poorer feed efficiency at the higher stocking rates reported by Allen (1974) and Robison × Newton (1982) may support these findings.

The efficient utilization of the 20% CP diet when compared with the other diets found above may be due to the natural feeds, water quality and its flow as concluded from the work of the following authers. Devaraj (1976) observed that the supplemental feed was second in importance among other food items consumed. Hays (1980) found a high density of the other fish in the vicinity of cages. Also, the effect of water quality and its flow was cited by Law (1979). Moreover, the effect of dissolved oxygen was stated by Bardach *et al.* (1972) and Andrews *et al.* (1971). The protein energy ratio of the first diet was about 73 mg/Kcal which was 20% lower than that recommended by Wilson (1977). However, this ratio could be used in catfish diets under similar circumstances to that presented herein.

TABLE 5 Feed efficiency for caged catfish subjected to 4 dietary protein levels and 3 stocking rates.

Item	Stocking rate (fish/m)	Dietary CP % level				Av	SE
		20	25	30	40		
DMI/gain, g/g	50	1.64	1.65	1.66	1.66	1.65^C	
	100	1.66	1.66	1.66	1.66	1.66^B	
	200	1.66	1.67	1.72	1.78	1.71^A	
	Av	1.65^D	1.66^C	1.68^B	1.70^A		0.01
MEI/gain, Kcal/g	50	5.23	5.06	5.10	5.03	5.11^C	
	100	5.26	5.11	5.10	5.02	5.13^B	
	200	5.28	5.12	5.29	5.39	5.27^A	
	Av	5.26^A	5.10^C	5.16^B	5.15^B		0.03
CPI/gain, g/g	50	0.38	0.46	0.55	0.73	0.53^C	
	100	0.39	0.47	0.55	0.73	0.54^B	
	200	0.39	0.47	0.58	0.78	0.56^A	
	Av	0.39^D	0.47^C	0.56^B	0.75^A		0.01

Averages in the same row or column with different superscripts are different $< .01)$. Av, Overall average; SE, standard error.

Fish number and carcass traits

Fish number per kg (Table 6) tended to increase by increasing dietary protein level (2.0% difference) or stocking rate (2.3% difference). Dressing and flesh percentages decreased ($P < .01$) by increasing dietary protein level and stocking rate. However, the effect of dietary protein level on fish number/Kg, dressing % and flesh % were not more than 2, 3.1 and 7.8% respectively. On the other hand the effect of stocking rate on these traits were not more than 3%.

The chemical analysis of fish flesh (Table 7) showed no marked dietary effect, since the differences were less than 1%. However fish number, dressing and flesh percentages beside the chemical analysis may show that the 20% CP diet is better than the other diets.

TABLE 6 : Number per kg, dressing and flesh percentages of catfish subjected to 4 dietary CP levels and 3 stocking rates

Item	Stocking rate (Fish/m³)	dietary CP % 20	25	30	40	Av	SE
Number of fish/kg	50	3.05	3.06	3.08	3.08	3.07	
	100	3.09	3.09	3.09	3.07	3.09	
	200	3.08	3.09	3.16	3.24	3.14	
	Av	3.07	3.08	3.11	3.13		
Dressing, %	50	67.05	65.62	65.33	65.26	65.82^{A}	
	100	66.76	65.39	65.17	65.26	65.65^{B}	
	200	66.66	65.21	64.54	63.88	65.07^{C}	
	Av	66.82^{A}	65.41^{B}	65.01^{C}	64.80^{D}		0.06
Flesh, %	50	34.88	33.39	32.72	32.56	33.39^{A}	
	100	34.46	32.86	32.46	32.51	33.07^{B}	
	200	34.26	32.61	31.77	31.06	32.43^{C}	
	Av	34.[illegible]^{A}	32.95^{B}	32.32^{C}	32.04^{D}		0.08

Averages in the same row or column with different superscripts are different ($P < .01$). Av, overall average; SE, standard error.

Feed and production costs

Feed costs per Kg fish or flesh (Table 8) increased as the level of dietary CP increased up to about 2 folds. Similar state was observed by Bardach *et al,* (1972) and Hassouna *et al,* (1987). Comparing the 20% CP diet with those contained 25, 30 and 40% CP, the differences were about 17, 51 and 85% to produce one Kg fish and were 23, 60 and 99% to produce one Kg flesh. These results showed that the first diet is more economic than the other diets.

The production costs of cages under different stocking rates (Table 9) when catfish fed the lowest cost diet, *i.e.* the 20% CP one showed an increase in net revenue up to about 4 folds as a result of increasing fish stocking rate.

In conclusion under the experimental conditions the 20% CP diet is better utilized than the other diets. Also, the highest stocking rate (200 fish/m^3) is more economic than the other lower stocking rates. However, further work is needed to reduce the CP content in the diet and to increase the rate of fish stocking.

TABLE 7. Flesh chemical analysis of catfish subjected to 4 dietary CP levels and 3 stocking rates.

Item	Dietary CP %				dit %
	20	25	30	40	
DM, %	26.20	26.17	26.05	26.02	0.7
Energy, MCal/Kg.	1.260	1.259	1.260	1.259	0.1
Moist., %.	73.80	73.83	73.95	73.98	0.2
Protein, %.	19.71	19.52	19.53	19.53	0.1
Ash, %	1.97	1.96	1.97	1.97	0.1

dif % difference between the highest and the lowest figures in the same row

TABLE 8. Feed cost per Kg fish or flesh for catfish reared in cages using diets differing in their protein content.

Item	Dietary CP level %			
	20	25	30	40
(1) Number of fish/Kg.	3.07	3.08	3.11	3.13
(2) Cost of Kg diet, PT.	19.62	23.77	30.25	37.52
(3) Consumed feed to produce Kg fish, Kg.	1.341	1.299	1.310	1.299
(4) Feed cost/Kg of fish, PT.	26.310	30.877	39.628	48.738
(5) Relative % of feed cost per Kg of fish.	100	117	151	185
(6) Flesh produced from one Kg of fish, g.	344.95	329.67	323.84	320.32
(7) Feed cost per Kg flesh, PT.	76.27	93.66	122.37	152.15
(8) Relative % of feed cost per Kg flesh.	100	123	160	199

(3), feed intake per day X 63 X fish number ÷ 100.

(4), 3) X 2).

(5), (26.31/26.31) 100, (30.877/26.310) 100, ... etc.

(6), final weight per fish X flesh % X fish number per Kg.

(7), [4)/6)] X 1000.

(8), (76.27/76.27) 100, (93.66/76.27) X 100 .... etc.

TABLE 9. Production costs of cages under different stocking rates when catfish fed the 20% CP diet.

Item	Stocking rate (Fish/m³)		
	50	100	200
(1) Number of fish /cage	10	20	40
(2) Feed consumption/cage, Kg	4.375	8.736	17.471
(3) Feed cost/cage, L.E.	0.858	1.714	3.428
(4) Fish produced/cage, Kg	3.275	6.480	12.988
(5) Total revenue/cage, L.E.	5.568	11.016	22.080
(6) Net revenue/cage, L.E.	4.710	9.302	18.652
(7) Relative % of net revenue	100	197	396

2), 1) X Feed intake per fish per day X 63 days.
3), 2) X 19.62 PT per Kg 20% CP diet.
4), 1) X final weight per fish in Kg.
6), 5) — 3), excluding the other factors, since all cages were on
6), 5) — 3), excluding the other factors, since all cages were on the
the same administrative conditions.
7), (4.71/4.71) 100, (9.302/4.71) 100, (18.652/4.71) 100.

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تأثير مستوى بروتين الغـذاء على أسماك القرموط المرباه في أقفاص باستخدام معدلات مختلفة من الأسماك

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اكاديمية البحث العلمى بالقاهرة

استخدم فى هذا البحث أصبعيات أسماك القرموط Clorias lazera ذات وزن ٩٧ر٤ + ٧ر جم وذات طــول ١٨ر٧ + ٠٩ر سم ٠ وزعت الاصبعيات على ١٢ معاملة فى أزواج باســتخدام ٢٤ قفص دائرى عائم ٠ وزعت المعاملات بحيث تحتوى أربعة مستويات من بروتين الغذاء (٢٠ ، ٢٥ ، ٣٠ ، ٤٠٪ بروتين) وثلاثة معــدلات تخزين (٥٠ ، ١٠٠ ، ٢٠٠ سمكة فى م٣) فى تصميم عاملى ٠ ووضعت الأسماك فى الأقفاص فى حيز من المـاء قدرة ٢رم٣ من أول يونيو الى ٥ أغسطس ٠ وأخــذت قياسات المظهر والجودة بجانب تقييم اقتصادى بسيط ٠

وأوضحت النتائج أن العليقة التى احتوت على ٢٠٪ بروتين خام كانت أكفأ من العــلائق المحتوية ٢٥ ، ٣٠ ، ٤٠٪ بروتين خـام وذلك بالنسبة للقياسات المظهرية ونسب التصافى والتشافى وسعر السمك وسعر لحمه ٠ ولوحظ أن ارتفاع معدل تخزين الأسماك فى الأقفاص أدى الى قلة الصفات المظهرية ونسب التصافى والتشافى ، ولكن رغم ذلك وجد أن صافى العائد الاقتصادى للقفص ازداد حوالى ٤ مرات نتيجة رفع معدل التخزين من ٥٠ سمكة الى ٢٠٠ سمكة فى المتر المكعب من المـاء ٠