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Original Research Article

EFFECTS OF VARYING PROTEIN LEVELS ON *Clarias gariepinus* (BURCHELL, 1822) GROWTH, PROTEIN UTILIZATION AND YIELD IN HAPA SYSTEM

ABSTRACT

The study evaluated effects of varying dietary protein levels on growth, protein utilization, survival and yield of catfish *Clarias gariepinus* using floating hapa (1m x 1m x 1m) system. Fish fingerlings (4.50± 0.01g) were randomly stocked at 20 fish/m^3 hapa. Five diets with protein levels 40.0, 42.5, 45.0, 47.5 and 50.0% were fed to triplicate groups for 24 weeks. Growth responses and economic performances of fish harvested under various treatments were evaluated. Results showed that no significant differences ($p > 0.05$) were observed in metabolic growth rate, percentage survival, total feed intake, cost of feeding and total cost of production in all the treatments. However, significant differences ($p < 0.05$) existed in specific growth rates, gross profit, profit index and economic conversion ratio. The preferential diet being 42.5% protein, produced the best growth {mean final weight (946.89g), specific growth rate (3.21%/day)}; the best protein utilization {food conversion ratio (0.27), protein productive value (59.55%), protein intake (5.29g/day), the highest yield {net fish production (17,850kg/hapa), gross profit (₦4,774/hapa) and the best economic conversion ratio (58.98). From these results, *Clarias gariepinus* would grow best in floating hapa when fed diets containing 42.5% protein.

Key Words: Catfish, dietary protein, growth, survival, yield, profit index

INTRODUCTION

The African catfish, *Clarias gariepinus* is an omnivorous species indigenous to Africa and one of the most cultured species in sub Saharan Africa. It has been shown to have remarkable growth rate as well as high quality meat and excellent taste, hence, of great demand and commands good commercial value in Nigeria market (Adewolu *et al*., 2009). However, sufficient nutritional research has not been carried out on this economic species, thus, hindering the viability of commercial production in non-conventional culture system. Dietary protein has been appraised as the body block building nutrients and given the most prominent consideration in the formulation of fish feeds. Protein requirement of other catfish groups had been reported. Fagbenro *et al.* (1992) reported 42.5% dietary protein requirement for genetically induced hybrid catfish. Olufeagba and Aluko (1997) recommended 45% for triploid catfish while Jamabo and Alfred-Ockiya (2008) opined that 40% protein produced the best growth in *Heterobranchus bidorsalis*. However, NRC (1993) recommended between 38 and 55% for catfish culture in general. The present study has been designed to determine a proper dose response relationship regarding catfish growth and yield in floating net-hapa system for maximum profitability.

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MATERIALS AND METHODS

Experimental design

An outdoor concrete tank (8m x 5m x 1.65m) at Vika Farms Limited, Mbak Etoi, Uyo, Akwa Ibom State, latitude 5° 3' North and longitude 7° 56' East was used for the study. The experimental design was made up of a module consisting of 8.5m x 6.5m bamboo raft with sixteen 1.5m x 1.5m apartment fittable with 1m x 1m x 1m hapa placed on the concrete tank. Each hapa was rigged and suspended to maintain a depth of 0.75m in water and a free board of 0.25m. The float lines were tied to the four corners of each compartment using kuralon rope (No 15) as described by Otubusin (2000).

Diets preparation: Diet compositions for the feeding trial are presented in Table 1. All ingredients were carefully weighed out, mixed, made into pellets using 2mm meat mincer, air-dried and labelled separately according to diets.

Table 1: Ingredients (%/100g) and proximate composition (%) of experimental diets

Ingredients	40.0%	42.5%	45.0%	47.5%	50.0%
Fishmeal	17.21	18.60	20.00	21.53	3.06
Soy meal	17.20	18.60	20.00	21.53	3.06
Corn flour	23.97	18.20	12.43	06.75	01.12
Groundnut cake	34.51	37.50	40.46	43.10	45.66
Fish oil	07.00	07.00	07.00	07.00	07.00
Lysine	0.030	0.030	0.030	0.030	0.030
Methionine	0.030	0.030	0.030	0.030	0.030
Fish premix	0.030	0.030	0.030	0.030	0.030
Analyzed protein level	38.83	40.05	43.43	45.01	48.25
Analyzed lipid level	8.38	8.40	8.64	8.75	8.87
Gross energy (kJ/g)	17.27	17.24	17.38	17.36	17.55

Fingerling Rearing: Each hapa was randomly stocked with *Clarias gariepinus* (4.50±0.01g) at 20 fish/1m^{3}hapa and raised for 24 weeks. The stocked fish were fed at 5% of their body weight three times daily. The stocked fish (20%) were sampled fortnightly. Fish weights were measured using a Furi Digital Balance (Model: FEJ-6000) to the nearest 0.1g.

Growth determination

Mean weight gain (MWG) (g) = final weight (g) – initial weight (g)
Average daily growth (ADG) = MWG (g)/length of feeding trial (days)
Relative growth rate (RGR) = 100[MWG (g)/mean final weight (g)]
Metabolic growth rate (MGR) = $(W_1-W_0)/[\{(W_0/1000)^{0.8}+ (W_1/1000)^{0.8}\}/2]t$
Where: W_0 = initial weight (g); W_1 = final weight (g); t= duration of feeding trial (days)
Specific growth rate (SGR, %/day) = $100(\ln W_2 - \ln W_1)/T_2-T_1$
Where: W_2 = Weight at time T_2; W_1 = Weight at time T_1

Protein utilization determination

Feed conversion ratio (FCR) = Total dry feed fed (g)/MWG (g)
Protein efficiency ratio (PER) =MWG (g)/amount of protein fed (g)

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Protein productive value (PPV) = 100[(final fish carcass protein- initial carcass protein)/ Crude protein intake]

Protein index (PI) = Survival $(W_1-W_0)t$

Nitrogen metabolism (NM) = $[0.54(W_1-W_0)t]/2$

Where: 0.54 is experimental constant; W_1= Fish final weight (g); W_0 = Fish initial weight (g); t = duration of feeding trial (days)

Percentage survival rate (%SR) = 100(number at end of feeding trial/number at start of feeding trial).

Economic Analysis

Cost of feeding (COF) = Price of feed x total feed intake

Profit index (PI) = Value of fish (₦)/cost of feed (₦)

Economic conversion ratio (ECR) = Cost of diet x FCR

Data Analysis

Data analyses were carried out using Statistical Package for Social Sciences (SPSS 19.0, 2010 version).

Results

The results of growth performances and survival rates of *Clarias gariepinus* fed diets containing different protein levels for 24 weeks are shown in Table 2. From the results, all the growth indices were highest in diet containing 42.5% protein. There were no significant differences ($p > 0.05$) in metabolic growth in all the treatments. Fish fed with the 42.5% protein diet had the best growth performance ($p < 0.05$), with a mean weight gain of 942.38±2.33g, average daily growth of 5.88g/day and relative growth rate of 218.85±0.58. The least weight gain (769.13±2.29g) and poorest specific growth rate (3.15±0.00%/day) was observed in fish fed with 50% protein diet. Generally, there was an inverse relationship between protein level and growth performance of fish.

Table 2: Growth performances of *Clarias gariepinus* fed diets containing different protein levels for 24 weeks.

Variables	40.0%	42.5%	45.0%	47.5%	50.0%
MIW[1]	4.51±0.01	4.51±0.01	4.51±0.01	4.51±0.02	4.50±0.01
MFW[2]	884.17±0.82^{c}	946.89±2.33^{d}	843.27±6.61^{b}	790.23±8.04^{a}	773.63±2.29^{a}
MWG[3]	879.66±0.82^{c}	942.38±2.33^{d}	838.70±6.61^{b}	785.72±8.05^{a}	769.13±2.29^{a}
ADG[4]	5.32±0.01^{a}	5.88±0.01^{c}	5.77±0.04^{b}	5.38±0.05^{a}	5.32±0.01^{a}
RGR[5]	198.74±0.31^{a}	218.85±0.58^{c}	214.79±1.50^{b}	200.54±2.38^{a}	198.33±0.93^{a}
MGR[6]	2.96±0.00	2.96±0.00	2.96±0.00	2.94±0.02	2.95±0.01
SGR[7]	3.16±0.00^{a}	3.21±0.00^{b}	3.20±0.00^{b}	3.16±0.01^{a}	3.15±0.00^{a}

*Means with different superscript letters within a row are significantly different ($p < 0.05$). Where: [1]mean initial weight (g); [2]mean final weight (g); [3]mean weight gain (g); [4]average daily growth (g/day); [5]relative growth rate; [6]metabolic growth rate (g/kg$^{0.8}$/day); [7]specific growth rate (%/day);

The results of protein utilization of *Clarias gariepinus* fed diets containing different protein levels for 24 weeks are shown in Table 3. The ability of fish to convert food given to

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muscle increased with increasing protein level in diet. The best food conversion (0.27±0.00), protein efficiency (9.41±0.02), protein index (5.29±0.18g/day), nitrogen metabolism (44.76±0.15) and protein productive value (59.55±0.6%) were obtained in group fed with 42.5% protein diet. Inverse relationship also existed between protein content in diet and protein utilization of catfish.

Table 3: Protein utilization and survival rates of *Clarias gariepinus* fed diets containing different protein levels for 24 weeks.

Variables	40.0%	42.5%	45.0%	47.5%	50.0%
FCR[8]	0.28±0.00[b]	0.27±0.00[a]	0.27±0.01[a]	0.28±0.01[b]	0.29±0.00[c]
PER[9]	9.08±0.07[d]	9.41±0.02[e]	8.45±0.23[c]	7.93±0.16[b]	7.25±0.08[a]
PPV[10]	49.08±1.75[d]	59.55±0.56[e]	41.78±0.55[c]	36.95±2.12[b]	31.83±1.10[a]
PI[11]	4.80±0.00[b]	5.29±0.18[d]	5.00±0.34[c]	4.76±0.21[b]	4.61±0.19[a]
NM[12]	40.67±0.00[a]	44.76±0.15[c]	44.00±0.26[b]	41.13±0.40[a]	40.52±0.15[a]
SR[13]	90.00±0.00	90.00±0.00	86.67±6.01	88.33±3.33	86±3.33

*Means with different superscript letters within a row are significantly different ($p < 0.05$). Where: [8]food conversion ratio; [9]protein efficiency ratio; [10]protein productive value (%); [11]protein index (g/day); [12]nitrogen metabolism; [13]percentage survival rate (%).

In all diet levels tested feed consumption, cost of feed supply and total cost of production were not significantly different ($p > 0.05$). There was an inverse relationship between net fish production, gross profit, and value of fish (Table 4). The best economic conversion ratio (58.98±0.13), profit index (8.50±0.02) and gross profit (₦4,774/hapa) were recorded in fish fed with the 42.5% protein diet.

Table 4: Cost benefit evaluation of *Clarias gariepinus* fed diets containing varying levels of protein in floating hapa system for 24 weeks.

Variables	40.0%	42.5%	45.0%	47.%	50.0%
TFI[1]	254.97±2.75	261.93±1.19	264.37±6.26	253.53±4.51	255.2±2.42
COF[2]	1000±10.62	1050±38.17	1047±95.82	1048±54.96	1061±40.77
TCP[3]	4100±10.2	4150±38.17	4147±95.82	4148±54.96	4161±40.77
VOF[4]	8107±7.50[c]	8925±30.87[e]	8432±57.37[d]	8032±35.01[b]	7781±31.85[a]
NP[5]	16215±14.84[b]	17850±60.82[d]	16865±15.7[c]	16064±71.04[b]	15561±63.66[a]
GP[6]	40006±12[c]	4774±26[e]	4285±26[d]	3884±48[b]	3619±27[a]
PI[7]	8.11±0.08[b]	8.50±0.02[c]	8.09±0.22[b]	7.67±0.15[ab]	7.33±0.08[a]
ECR[8]	61.84±0.64[b]	58.98±0.13[a]	62.17±1.60[c]	65.62±1.27[d]	68.61±0.73[e]

*Means with different superscript letters within a row are significantly different ($p < 0.05$). Where: [1]total feed intake (g); [2]cost of feeding (₦/hapa); [3]total cost of production (₦/hapa); [4]value of fish @ ₦500/kg; [5]net production (kg/hapa); [6]gross profit (₦/hapa); [7]profit index; [8]economic conversion ratio.

Discussion

The culture of *Clarias gariepinus* in net-hapas seems to be feasible if these results are compared with those obtained in conventional culture systems. At the end of the 168-day feeding trial, the percentage survival rate ranged from 88.33 to 90.00%. These values were comparable with survival of *Heterobranchus longifilis* (90%) cultured in earthen pond by Babalola and Apata

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(2006). However, in this study survival rates were not affected by dietary protein levels. The growth performances of *Clarias gariepinus* were influenced by dietary protein levels. Similar results were also reported in hybrid catfish fry by Diyaware *et al*. (2009), in *Chrysichthys nigrodigitatus* fingerlings by Adewolu *et al*. (2009) and in *Heterobranchus longifilis* larvae by Babalola and Apata (2006). Diyaware *et al* (2009) also reported that growth rate and weight gain increased progressively with dietary protein level to a maximum at 50%. Jana *et al* (2006) observed high growth in terms of live weight gain and specific growth rate in milkfish (*Chanos chanos*) fed at 40% protein level. In addition, Alatise *et al* (2005) reported that catfish fingerlings fed with 40% protein gave the best growth (SGR: 1.06%/day and FCR: 0.62). In this study, best growth was observed in fish fed 42.5% protein. The intraspecific differences observed could be explained by the varieties of methodology (feed formulation and feeding rate tests) and culture system used in individual experiment. In this study, low protein content in diet resulted to increased fish growth. This could be seen in fish fed diet containing 42.5 % protein producing better growth when compared with those fed between 45.0 and 50.0 % protein diets. This indicated the capacity of this species to accept and utilize compounded diet with moderate protein contents. The highest feed conversion ratio of 0.26 obtained in this study was better than 1.28 observed in *Clarias gariepinus* fed with 40% protein (Sotolu, 2010). The highest ($p < 0.05$) profit index and economic conversion ratio of fish fed 42.5% protein diet probably pointed to the fact that this dietary protein level may be better in economic terms than all other protein diets in this study. This is also reflected in lack of significant differences ($p > 0.05$) in metabolic growth rate in all treated fish. High growth performance and fish production obtained in this study points to the realization that biological and economic benefits could be achieved in intensive culture of catfish in floating net-hapa system.

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