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EFFECT OF STOCKING DENSITY AND DIET'S TYPE ON PRODUCTIVE PERFORMANCE AND ECONOMIC EFFICIENCY OF AFRICAN CATFISH *Clarias gariepinus* UNDER SEMI-INTENSIVE SYSTEM

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SUMMARY

Two experiments were conducted to evaluate the optimum stocking density and diet's type recently used in catfish farms, on both growth performance and economic efficiency of African catfish Clarias gariepinus. The first experiment tested three different stocking density of catfish with average weight of 46.83 g ± 1.62 at a rate of 4, 8 and 12 catfish/m^3 (T_1, T_2 and T_3) in hapas (4 × 6 × 0.80 (in depth) m). The experiment started on 24 may, 2014 and continued for 186 days. The results showed that the low stocking T_1 was the best in both growth performance and economic efficiency. The second experiment was conducted in earthen ponds using catfish with average body weight of 56.5 ± 1.05 g to evaluate three types of diets: poultry slaughters wastes (offal and dead chicken) PO, food factories wastes (FF) and artificial feed (AF). The experiment started on 15 May, 2014 and continued for 210 days. The results indicated that PO and FF diets were better than AF for economic efficiency and the treatment of PO diet was the best in all treatments in growth performance and economic efficiency.

In conclusion, catfish can be cultured under high stocking density (T_3) without causing any problems and the low stocking T_1 was the best in both growth performance and economic efficiency in semi-intensive at earthen ponds system. In addition, using non-traditional diets of poultry slaughter wastes (PO) and wastes of food factory (FF) could be used to reduce the costs of production.

Keywords: African catfish Clarias gariepinus, poultry offal diet, factory by products and stocking density

INTRODUCTION

Recently, African catfish, *Clarias gariepinus* is generally considered to be one of the most important tropical fresh water fish species for aquaculture (Dada and Wonah, 2003), and is considered as valuable species not only in Egypt, but also in many other parts of the world because of their high growth rates, tolerance of a wide range of temperature and dissolved oxygen levels. Catfish is considered an important and desirable commercial species worldwide because of its good palatability and high fecundity (Hecht *et al*., 1996; Rad *et al*., 2003; Soltan and Tharwat, 2006 and Amisah *et al*., 2009).

In the last few years catfish farming spread in Fayoum governorate, Egypt as a result of low cost of feeding by using unconventional materials and fish stocking density of 4-6 tons/feddan (30-50 thousand catfish/feddan). Catfish production in Egypt reached 48,750 ton which representing about 3.55% of the total fish production (GAFRD, 2012).

Stocking density is one of the main factors determining fish growth (Engle and Valderrama, 2001 and Rahman *et al*., 2005) and the final biomass harvested (Boujard *et al*., 2002). Limiting the optimum stocking density for any species is a critical factor not only for designing an efficient culture system (Leatherl and Cho, 1985) but also for optimum husbandry practices. Controlling the fish size and production are the two important tasks to meet the market demands (Aksungur *et al*. 2007).

The effects of stocking density on growth and survival have been studied on some African catfishes (Haylor, 1992; Ewa-Oboho and Enyenihi, 1999; Coulibaly *et al*., 2007; Jamabo and Keremah 2009; Edward *et al*., 2010 and Dasuki *et al*., 2013). However, maximum stocking density is limited by the biology of the organisms (Hecht and Pienaar, 1993; Baras and Joblin, 2002). High densities can intensify stress which may lead to an increase in fish diseases. In some species, increasing stocking density usually results in stress conditions, such as aggressive behavior and dominance which leads to enhancing energy requirements resulting in reduced growth, food utilization and net yield (Begout-Anras and Lagardère, 2004).

Fish feed products are mostly based on ingredients derived from crop residues. On the other hand, vast resources of slaughterhouse /poultry /silkworm by-products, which are termed as wastes and are rich in proteins and minerals, are freely available in most of the countries. Utilization of these so called waste materials in the production of fish feeds will not only solve the problem of nutritional needs of fish but also help in reducing environmental pollution caused by the discarded animal tissues scattered all over the rural as well as urban areas leading to public nuisance and vector breeding centers. Poultry by-product meals (PBM) are valuable alternative protein sources for carnivorous fish and have been tested in diets for channel catfish (Lochmann and Phillips, 1995 and Gomaah, 2006).

Animal by-products such as meat, bone meal and poultry by-product meal have considerable potential as feed ingredients in fish production systems (Fasakin *et al*., 2005 and Wei *et al*., 2006) and were comparatively less expensive than fish meal (Abdel-Warith *et al*., 2001). These animal protein ingredients are good sources of amino acids with high protein content, total digestible dry matter and energy similar to fish meal (Bureau *et al*., 2000). Therefore, poultry by-product meal is considered a probable replacement for fish meal (Muzinic *et al*., 2006 and Rawles *et al*., 2006).

Poultry offal, a by-product of the broiler processing plant and processors in local markets is sufficiently available to be recycled as animal protein source for use in fish feeds. In addition, Faturoti (2000) reported that local chicken offal (cooked and dried) contained 61.6% crude protein (CP), 16.5% crude lipid, 3.5%crude fiber, 9.0% ash and 8.3% moisture. Faturoti (2000) in a growth response studies observed best gross profit and profit index at 75% and 100% inclusions of chicken offal in the diet of *Clarias gariepinus*.

Therefore, the present study aimed to discuss the possibility of use high stocking density in culture with maintaining a non-significant impact on the growth and the lack of problems in semi intensive farming in ponds with a lack of water change and also comparison between unconventional feed (poultry slaughters wastes and food factory wastes) and conventional feed (artificial feed) which is used commercially in most farms for economic efficiency of farmed African catfish.

MATERIALS AND METHODS

Two trials were conducted to evaluate the effect of stocking density and diet's type recently used commercially in catfish farms on both growth performance and economic efficiency of African catfish *Clarias gariepinus* under semi-intensive system. The first experiment was conducted to evaluate the effect of different stocking densities (4, 8 and 12 catfish/m^3 T_1, T_2 and T_3) on both growth performance and economic efficiency at fish farm in Faculty of Agriculture, Fayoum University, Egypt, in hapas experimental unit (4 × 6 ×0.80 m) under semi intensive system. The experiment started on 24 May, 2014 and continued for 186 days with catfish of an initial weight was 46.83 ± 1.62 g. Each of the treatments was replicated twice. Fish were fed twice daily an artificial floating feed containing 27.1% crude protein five days a week at 3% of total biomass per treatment for the first three months, then 1% for the remaining culture months. Sampling of fish was taking monthly, early in the morning to determine new weight and adjusted feed quantity.

The second experiment was conducted to evaluate effects of three types of diets; poultry slaughters wastes (offal and chicken dead) PO, wastes of food factories (FF) and artificial feed (AF) on both growth performance and economic efficiency of African catfish in six earthen pond in commercial fish farm in Sakshouk village, Fayoum governorate, Egypt. Each treatment had two replicates, the fish of an initial weight of 56.5± 1.05 g and stocked at a rate of 16000/pond. This experiment started on 15 May, 2014 and continued for 210 days. Catfish feed a diet, at a rate of 3% of total fish biomass for first three months and then was decreased to 1% until experiment ended, twice daily every day except Friday as follows: First diet (PO) fed moist. The second diet (AF) from El-Baraka factory and the third diet (FF) mixture wastes of biscuits, pasta and beans break factories. Water was exchanged every two days at a rate of 0.3 of total water pond. At the end of the experiment growth and economic parameters were determined.

Parameters measurements:

At the end of the experiment, growth parameters and survival rate were measured as follows:

- ***Weight gain*** = Final weight - Initial weight (Effiong *et al.*, 2009).
- ***Daily gain*** = Weight gain, g /period in days. (Effiong *et al.*, 2009).
- ***Specific growth rate (SGR,%)*** = 100 (ln Final weight-ln Initial weight)/period in days, where ln is the natural log. (Effiong *et al.*, 2009).
- ***Feed conversion ratio (FCR)*** = feed offered / weight gain (Effiong *et al.*, 2009).
- ***Survival rate (SR) %=*** Final number of fish /Initial number of fish × 100.(Charo-Karisa *et al.*, 2006).
- ***Profit index (PI)*** = value of fish produced/ total costs (Abu *et al.*, 2010)

Chemical analysis:

The used diets and fish were analyzed for their proximate composition in triplicates following the methods described by AOAC (2000).

Water quality measurement:

Water temperature, pH, dissolved oxygen (DO), ammonia nitrogen (NH_3-N), nitrate and salinity throughout the experimental period were measured periodically every week in the morning and at noon by centigrade thermometer, Orion digital pH meter model 201, oxygen meter, Cole Parmer model 5946, HACH test kit ammonia mid-range 0-3 mg/L model NI-8 , HACH test kit Nitrate/Nitrite model NI-12 and TDS apparatus, respectively for both experiments

Statistical Analysis:

Statistical analyses were performed using SPSS (2007), one way analysis of variance was used. Significance among treatments was evaluated at the 5 % probability level using Duncan (1955).

At the end of each experiment, the pond was drained and the fish were harvested and weighed. The cost-benefit analysis was carried according to current local market prices of African catfish in Egyptian L.E.

RESULTS AND DISCUSSION

Experiment 1:

Water quality:

Water quality parameters during the present study were within the suitable ranges for catfish culture (Boyd and Litchtkoppler, 1979; Viveen *et al*., 1985, Auta, 1993 and Adakole, 2000) and are presented in Table (1). Water temperature ranged from 22 to 30 °C with an average of (28°C), dissolved oxygen ranged from 5.5 to 6.3 mg/L, with an average of (6.02 mg/L), water pH ranged from 7.90 to 8.05, with an average of (7.97). Ammonia concentration was not detected. Salinity was almost stable.

Table 1. Mean (±SE) of water quality parameters of hapas stocked with different densities of African catfish during the first experiment

Months	Temp., °C	DO, mg/L	pH	NH_3-H, mg/L	NO_3 mg/L	Salinity, ‰
June	28± 0.80	6.3±0.29	7.95±0.21	0	0	0.3
July	30± 0.82	6.2±0.29	7.90±0.20	0	0	0.3
August	30± 0.81	5.9±0.28	7.95±0.22	0	0	0.3
September	28± 0.80	5.9±0.28	7.95±0.21	0	0	0.3
October	27± 0.79	5.8±0.27	8.00±0.22	0	0	0.3
November	25± 0.78	6.0±0.28	8.05±0.23	0	0	0.3
Average	*28± 0.80*	*6.02*±0.29	*7.97±0.21*	*0*	*0*	*0.3*

***Effect of stocking density on growth performance*:**

The studied growth parameters in first experiment are presented in Table (2). Final mean body weight, weight gain, average daily gain and specific growth rate (SGR) were decreased with increasing stocking density. There were significant differences in these parameters among densities of 4, 8 and 12 catfish/m^3. African catfish stocking at low density recorded the highest final weight, weight gain, average daily gain, SGR and survival being 875 g/fish, 826 g/fish, 4.44 g/day and 1.55%/day, respectively. However, the stocking density 12 fish/m^3 had the lowest estimates (595, 546, 2.94 and 1.34, respectively). Survival rate was not significant but was better at the low density than the high density. The high survival rate recorded in all the treatments could be partially attributed to the physico-chemical parameters of the water and also due to the good health condition of the fish. The survival of catfish ranged between 97.08 – 98.75% which was comparable to similar work that was done by Osofero *et al*. (2007) and Dasuki *et al*. (2013). Low mortality (2.92%) which was recorded in this study seemed to be an indication of proper handling of experimental procedures or the high tolerance of the fish handling.

In fact, under crowded conditions at higher stocking densities, fish suffer stress as result of aggressive feeding interaction and eating less resulting in growth retardation (Bjoernsson, 1994). Stocking density has been considered to be chronically stressful to the reared animals (Sugunan and Katiha, 2004). Several studies have also demonstrated that increased stocking density has a negative effect on survival rate and growth (Rowland *et al*., 2004) as well as Ellis *et al*. (2002) reported that, Rainbow trout growth and feeding ratio was better at low stocking density compared to the growth and feeding ratio of fish at higher stocking density in our trial. High stocking density led to increase activity (air breathing, swimming), decrease aggression and high density can be negatively affected water quality according to Diana and Fast (1989) and higher stocking density often resulted in higher ammonia concentrations

Table 2. Effect of different stocking densities on growth performance of African catfish under semi intensive system (Mean±S.E)

Items	Treatments			SED**
	T_1	T_2	T_3	
Initial mean body weight, g	49.00[a] ±2.0	42.50[a] ±2.5	49.00[a] ±1.0	4.74
Final mean body weight, g	875[a] ±25.0	710[b] ±30.0	595[c] ±5.0	55.68
Weight gain, g	826[a] ±27.0	667.5[b] ±27.5	546[c] ±6.0	55.16
Average daily gain, g	4.44[a] ±0.15	3.59[b] ±0.15	2.94[c] ±0.03	0.30
SGR, % /day	1.55 [a] ±0.04	1.51[a] ±0.01	1.34[b] ±0.02	0.05
Survival rate%	98.75[a] ±1.3	97.50[a] ±0.63	97.08[a] ±0.83	2.30

* Average in the same row having different superscripts significantly different at ($P \leq 0.05$).

** SED, standard error of a difference between two means

Effect of stocking density on feed utilization:

As shown in Table (3) feed intake, FCR, PER, PPV and EPV% had significant differences. The T_1 had the highest feed intake, PER, PPV% and EPV% but better FCR than other treatments (1465, 2.06, 34.12 and 0.21, respectively). Whereas, the T_3 had the lowest FI and poor FCR, PER, EER and EPV% (1045, 1.91, 1.91, 30.87, 0.12 and 0.19, respectively.

Table 3. Effect of different stocking densities on feed utilization of African catfish through under semi intensive system (Mean±S.E)

Items	Treatments			SED**
	T_1	T_2	T_3	
Feed intake, g/fish	1465^a ±35	1255^b ±45	1045^c 2.0	80.62
FCR	1.77^b ±0.015	1.88^a ±0.010	1.91^a ±0.021	0.04
PER	2.06^a ±0.018	1.95^b ±0.010	1.91^b ±0.021	0.04
PPV%	34.12^a ±0.24	33.32^a ±0.23	30.87^b ±0.34	0.68
EER	0.12^a ±0.001	0.12^a ±0.0008	0.12^a ±0.0001	0.01
EPV%	0.21^a ±0.005	0.19^b ±0.001	0.19^b 0.006	0.03

* Average in the same row having different superscripts significantly different at (P≤0.05).
** SED, standard error of a difference between two means

In the present study, FCR was significantly influenced by increasing stocking density of African catfish. This was in agreement with other reports using African catfish as well as in other species (Cruz and Ridha, 1989 and Almazán-Rueda, 2004). This is in agreement with El-Sayed (2002) who reported a negative correlation between growth and feed efficiency in Nile tilapia stocked at various densities. In addition, Lambert and Dutil (2001) found a negative effect of an increased stocking density of Cod *Gadus morhus* on the condition index and postulated decreased food intake as the cause. A decreased food intake is often associated with increased stress and the food conversion ratio is decreased with increasing stocking density. However, Watanabe *et al*. (1990) reported that feed conversion of Florida red tilapia fed supplementary feed did not differ at densities ranging from 100 to 300 /m^3.

The reduction in FCR with increasing density can be attributed to the feeding behavior of catfish (Almazán-Rueda, 2004). However, Hecht *et al*. (1997) reported that at high density, African catfish react faster to the presence of food and consumed a meal much faster than at low density. Hecht and Uys (1997) also found that the time it took for fish to respond to food and to consume a meal was decreased with increasing density. In addition, Papoutsoglou *et al*. (1998) found that the feed efficiency ameliorated in faster growing fish, while El-Sayed (2002) reported a negative correlation between growth and feed efficiency in Nile tilapia stocked at various densities.

Effect of different stocking densities on economics efficiency:

The production costs are the main aspects of economical evaluation. The economical evaluation of African catfish *Clarias gariepinus* in this experiment converted as cultured in earthen ponds (pond/ feddan/ 4000 m^2 net water) shown in Table 4. The costs of culture/ponds was 122,968 L. E. with T_1, 206,352 L.E. T_2 and 258,152 L. E. at T_3. Selling price, L.E/pond was 138,200, 221,520 and 277,280 for T_1, T_2 and T_3, respectively. Net returns L. E. /pond was 15,232, 15,168 and 19,128 for T_1, T_2 and T_3, respectively. The growth and mortality of *Clarias gariepinus* cultured at various stocking densities were not initially affected by density but, the overall harvest productions in terms of final weight and size were directly related to the stocking density. As the stocking density was increased, the weight gain was decreased; this depicts an inverse relationship as was observed in similar works by Otubusin and Olaitan (2001).

Table 4. Effect of different stocking density on economic efficiency (Mean±S.E)

Items	Treatments		
	T_1	T_2	T_3
Costs, L.E/pond			
Feed	110,168 ±2632	188,752±6768	235,752±266
Fish	4,800	9,600	14,400
Other costs	8,000	8,000	8,000
Total costs, L.E.	122,968±2632	206,352±6768	258,152±266
Pond biomass, kg	13,820±220	22,152±936	27,728±352
Selling price, L.E/ pond	138,200±2200	221,520±9360	277,280±3520
Net returns/pond	15,232±432	15,168±2592	19,128±3520
Profit index	12.38 ±0.62	7.35 ±1.01	7.41 ± 1.16

Price of one kg selling fish = 10 L.E., Feed price/kg = 4.70

As shown in Table (4) T_1 has an economic advantage, it achieved the lowest costs compared with T_2 and T_3 so it has the highest profit index when compared with other treatments.

Effect of stocking density on chemical composition

Results of the chemical composition of whole body fish are shown in Table 5. Crude protein was significantly affected by stocking density (P≤0.05) but other chemical components (dry matter, total lipids, ash and gross energy) were insignificantly affected. The lowest protein content in fish body was obtained at high density T_3 (16.2%), while the highest one was obtained in T_2 (17.10%).

Table 5. Effect of different stocking density on chemical composition (Mean±S.E)

Items	Treatments				Start
	T_1	T_2	T_3	SED**	
Dray matter (DM)	27.70^{a} ±0.10	27.50^{a} ±0.20	27.70^{a} ±0.20	0.42	28.64
Crude protein (CP)	16.55^{ab} ±0.25	17.10^{a} ±0.20	16.20^{b} ±0.06	0.45	16.98
Either extract (EE)	8.20^{a} ±0.30	7.35^{a} ±0.15	8.00^{a} ±0.20	0.55	7.23
Ash	2.95^{a} ±0.15	3.05^{a} ±0.15	3.50^{a} ±0.40	0.64	4.43
Gross energy (GE), kcal/g	1.708^{a} ±0.014	1.658^{a} ±0.002	1.669^{a} ±0.018	0.03	1.645

* Averages in the same row having different superscripts are significantly different at ($P \leq 0.05$).
** SED, standard error of a difference between two means

The second experiment:
Water quality:

The water quality parameters recorded in this study (Table 6) ranged from (23– 30), (7.90 – 8.05), (5.5-5.8 mg/l), (0-0.4 mg/L) and (2.3-2.8‰) for temperature, pH, dissolved oxygen, ammonia and salinity, respectively. The values were within the suitable ranges for catfish culture (Boyd and Litchtkoppler, 1979; Viveen *et al*., 1985, Auta, 1993 and Adakole, 2000).

Effect of diet's type on growth performance:

The data on growth parameters are presented in Table (7) indicated that final mean body weight, weight gain, average daily gain and SGR were better with PO and AF than FF diet. There were significant differences in these parameters between PO and FF and also between AF and FF. PO diet recorded an average final weight of 907.5 g/fish and weight gain of 851g/fish, with an average daily gain of 4.05 g/fish and SGR of average 1.32%. Although there were no significant differences between poultry offal and artificial feed diet, PO diet was the best diet in all treatments in terms of final weight, weight gain, daily gain SGR and survival rate. Survival rate was not significant, both PO and AF diet was better estimated than FF diet (98.75, 98.75 *vs*. 97.5%).

Table 6. Overall mean (±S.E.) of water quality parameters during the second experiment

Month	Treatments	Temp., °C	DO, mg/L	pH	NH_3-H, mg/L	Salinity, ‰
May	**PO**	26±0.78	5.8±0.28	8.00±0.27	0.0	2.3±0.10
	FF	26±0.78	5.8±0.27	8.00±0.28	0.0	2.3±0.10
	AF	26±0.78	5.8±0.28	8.00±0.27	0.0	2.4±0.11
June	**PO**	27±0.79	5.7±0.28	7.95±0.27	0.0	2.5±0.11
	FF	27±0.79	5.8±0.27	8.00±0.27	0.0	2.3±0.11
	AF	27±0.79	5.8±0.28	8.00±0.27	0.0	2.4±0.12
July	**PO**	29±0.80	5.7±0.26	7.90±0.27	0.0	2.5±0.12
	FF	29±0.80	5.7±0.27	8.05±0.28	0.2±0.1	2.4±0.11
	AF	29±0.80	5.7±0.27	8.00±0.27	0.0	2.3±0.12
August	**PO**	30±0.81	5.6±0.28	7.95±0.27	0.2±0.1	2.4±0.12
	FF	30±0.81	5.8±0.28	7.95±0.27	0.2±0.1	2.5±0.12
	AF	30±0.81	5.7±0.27	7.90±0.27	0.0	2.3±0.11
September	**PO**	28±0.79	5.6±0.27	7.90±0.27	0.4±0.1	2.6±0.13
	FF	28±0.79	5.6±0.28	7.95±0.27	0.4±0.1	2.5±0.12
	AF	28±0.78	5.7±0.28	8.00±0.28	0.2±0.1	2.6±0.13
October	**PO**	26±0.77	5.7±0.27	7.95±0.27	0.4±0.1	2.5±0.12
	FF	26±0.77	5.7±0.28	8.00±0.27	0.4±0.1	2.5±0.12
	AF	26±0.78	5.6±0.27	8.00±0.27	0.2±0.1	2.5±0.13
November	**PO**	25±0.76	5.5±0.28	7.90±0.27	0.4±0.1	2.8±0.13
	FF	25±0.76	5.6±0.27	8.05±0.29	0.4±0.1	2.7±0.13
	AF	25±0.77	5.7±0.27	7.95±0.27	0.2±0.1	2.8±0.13
December	**PO**	23±0.76	5.5±0.27	8.00±0.27	0.4±0.1	2.5±0.12
	FF	23±0.75	5.6±0.27	8.00±0.27	0.4±0.1	2.5±0.12
	AF	23±0.76	5.5±0.27	7.90±0.27	0.2±0.1	2.6±0.12

Results presented in Table (7) showed that the best growth performance was with PO diet. This performance was superior to those of AF and FF fed fish possibly due to Poultry offal as a high quality animal protein and Poultry offal contained reasonable amount of proximate components, essential amino acids and important minerals according to Hossain *et al.* (1989) and the crude protein of the chicken offal is slightly higher than that of local fish meal. The fat content of the chicken offal was higher than that of local fish meal. Faturoti (2000) reported that local chicken offal (cooked and dried) contained 61.6% crude protein (CP), 16.5% crude lipid, 3.5% crude fiber, 9.0% ash and 8.3% moisture.

Table 7. Effect of diet's type on growth performance (Mean±S.E)

Items	Diet's type			SED**
	PO	AF	FF	
Initial mean body weight, g	56.5^{a}± 1.5	56.5^{a} ±3.5	56.5^{a} ±1.5	5.79
Final mean body weight, g	907.5^{a} ±32.5	855^{a} ±25.0	730^{b} ±10.0	59.69
Weight gain, g	851^{a} ±31.0	798.5^{a} ±21.5	673.5^{b} ±8.5	54.69
Average daily gain, g	4.05^{a} ±0.15	3.80^{a} ±0.10	3.21^{b} ±0.04	0.29
SGR, % /day	1.32^{a} ±0.004	1.29^{a} ±0.015	1.22^{b} ±0.006	0.03
Survival rate%	98.75^{a} ±1.25	98.75^{a} ±1.25	97.50^{a} ±0.10	5.00

* Average in the same row having different superscripts significantly different at (P≤0.05).
** SED, standard error of a difference between two means

In addition, Nengas *et al.* (1999) reported that PBM can be used without amino acid supplementation to replace 50% of the FM in diets for gilthead seabream. Gomaah (2006) stated that PBPM can be a replacement of fish meal protein at 35% in African catfish diets. The positive effect of the diets based on PBM is because of the increase in n-6 level in the muscle of fish. It is thought, as an important factor, that affects the nutritional quality of fish muscle. Therefore, future investigation should be focused on using PBM as a replacement of fish meal with supplementation of high amount of amino acids to improve the growth performance and acceptability fatty acid profiles especially n- Poultry 3 for fish according to (Gümüş and Aydin, 2013).

Effect of diet's type on feed utilization of African catfish:

As shown in Table (8) there were significant differences in feed intake, FCR, PER, PPV and EPV%. The highest feed intake and FCR values were recorded with PO (4850 and 5.69). These are due to that the diets were offered as wet shape. There were significant differences among studied diet types where those fed with the AF had the highest PER, PPV, EER and EPV%, but those that were fed with PO had the lowest estimates (2.01, 34.65, 0.12 and 0.19 vs. 0.64, 10.61, 0.04 and 0.07, respectively).

Table 8. Effect of diet's type on feed utilization of African catfish (Mean±S.E)

Items	Diet's type			SED**
	PO	AF	FF	
Feed intake, g/fish	4850^{a} ±350	1460^{c} ±80	2875^{b} ±125	537.63
FCR	5.69^{a} ±0.20	1.83^{c} ±0.05	4.27^{b} ±0.13	0.35
PER	0.64^{c} ±0.02	2.01^{a} ±0.05	0.86^{b} ±0.03	0.09
PPV%	10.61^{c} ±0.24	34.65^{a} ±1.07	14.05^{b} ±0.53	1.73
EER	0.04^{c} ±0.001	0.12^{a} ±0.003	0.05^{b} ±0.001	0.01
EPV%	0.07^{c} ±0.002	0.19^{a} ±0.006	0.09^{b} ±0.003	0.03

* Average in the same row having different superscripts significantly different at (P≤0.05).
** SED, standard error of a difference between two means

These results indicated that, feed intake, g/ fish was higher with poultry offal diet than factory by product and artificial feed may be due to this fish is an omnivorous scavenger (Teugel *et al*., 1990) and poultry offal diet (PO) as animal protein ingredients is good sources of amino acids with high protein content, total digestible dry matter and energy similar to fish meal according to Bureau *et al*. (2000). FCR, PER, PPV, EER and EPV were the best with those fed with the AF because artificial feeds is scientifically formulated, adequately supplied and artificial diets may be either complete or supplemental. Complete diets supply all the ingredients i.e. (protein, carbohydrates, fats, vitamins, and minerals) necessary for the optimal growth and health of the fish. In contrast, Pfeffer *et al*. (1995) found that increasing the dietary proportion of poultry slaughter by-products decreased protein and lipid digestibility in rainbow trout, and may be due to limiting amino acids (histidine, methionine + cystine, lysine and phenylalanine) in poultry offal content according to Tacon and Jackson (1985), feather, connective tissue and skin contents which are considered to be difficult for fish to digest (Hasan and Amin 1997 and Hardy, 2000). These results are in agreement with Tabinda and Butt (2012) who reported that chicken intestine is rich in protein but unfortunately not being utilized as protein source in fish feed.

Effect of types of diets on profitability of African catfish cultured in earthen ponds:

The production costs are the main aspects of economical evaluation. The economical evaluation of *Clarias gariepinus* cultured in earthen ponds under effect of the three diets showed that the costs of culturing/ ponds was 89,600 L.E. with first treatment (PO), 122,592 L.E. (AF) and 81,800 L. E. with (FF). Selling price, L.E/ pond were 143,450, 135,140 and 113,880 with PO, AF and FF diet respectively. Net returns L.E. /pond was 53,850, 12,548 and 32,080 with PO, AF and FF diet , respectively (Table 9).

Table 9. Effect of diet's type on economic efficiency of African catfish (Mean±S.E)

Items	Diet type		
	PO	AF	FF
Costs, L.E/pond			
Feed	58,200±4200	109,792±6016	69,000±3000
Fish	4,800	4,800	4,800
Other costs	26,600	8,000	8,000
Total costs, L.E.	89,600±4200	122,592±6016	81,800±3000
Pond biomass, kg	14,345±695	13,514±566	11,388±156
Selling price, L.E/ pond	143,450±6950	135,140±5660	113,880±1560
Net returns/pond	53,850±2750	12,548±356	32,080±1440
Profit index	60.10±0.25	10.24±0.79	39.22±3.20

Price of one kg selling fish = 10 L.E

Price of kg feed = 1, 4.70 and 1.5 L.E from poultry offal, artificial feed and factory by product, respectively.

Effect of diet's type on chemical composition of African catfish:

Body chemical composition and energy content of catfish at both beginning and end of the experiment are shown in Table (10). The results showed that significant differences ($P \leq 0.05$) were obtained in CP, EE, ash and GE of body composition at the end of the experimental period, however DM had no significant difference. The highest protein and ash content were shown for those fed the AF and had the lowest EE and GE (6.75 and 1.610), however those fed the FF diet had the lowest CP and ash% (16.40 and 3.05%) and the highest EE and GE (8.40 and 1.718).

Table 10. Effect of diet's type on chemical composition of African catfish (Mean±S.E)

Items	Diet's type				Start
	PO	AF	FF	SED**	
Dray matter (DM)	$27.73^a \pm 0.13$	$27.80^a \pm 0.20$	27.85^a 0.05	0.34	28.93
Crude protein (CP)	$16.50^b \pm 0.20$	$17.25^a \pm 0.05$	$16.40^b \pm 0.10$	0.32	16.48
Either extract (EE)	$8.00^a \pm 0.20$	$6.75^b \pm 0.05$	$8.40^a \pm 0.10$	0.32	7.53
Ash	$3.23^b \pm 0.13$	$3.80^a \pm 0.10$	$3.05^b \pm 0.15$	0.31	4.92
Gross energy (GE), kcal/g	$1.686^a \pm 0.007$	$1.610^b \pm 0.007$	$1.718^a \pm 0.015$	0.03	1.64

* Average in the same row having different superscripts significantly different at ($P \leq 0.05$).

** SED, standard error of a difference between two means

CONCLUSION

From the results obtained, it can be concluded that catfish can be cultured under high stocking density (T_3) without causing any problems in semi-intensive at earthen ponds system, and using non-traditional diets of poultry slaughter (PO) and wastes of food factory (FF) could be used to reduce the costs of production

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تـأثير كثافـة التخـزين ونـوع العليقـة علـى مظـاهر النمـو والكفـاءة الإقتصـادية للقرمـوط الافريقـى تحـت نظـام التربيـة شـبه المكثفة

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اجريت تجربتان لتقييم الكثافة المثلى ونوع العليقة والمستخدمة مؤخرا فى مزارع القراميط على كلا من مظاهر النمو والكفاءة الاقتصادية للقرموط الافريقى باستخدام مكررين فى كل تجربة. التجربة الاولى اختبرت ثلاثة كثافات تخزين مختلفة للقراميط بمتوسط وزن 46.83 ± 1.62 جم وهى 4، 8 و 12 قرموط/م^3 فى هابات (4 × 6 م بعمق مياة 0.8 م) وبدأت التجربة فى 24 مايو 2014 واستمرت لمدة 186 يوم واوضحت النتائج ان الكثافة المنخفضة 4 قرموط/م^3 افضل فى كل من مظاهر النمو والكفاءة الاقتصادية. التجربة الثانية اجريت فى احواض ترابية باستخدام قراميط متوسط وزنها 56.5 ± 1.05 جم لتقييم ثلاثة انواع من العلائق (مخلفات ممجازر الدواجن (الاحشاء والدجاج النافق)، عليقة مصنعة و مخلفات مصانع الاغذية) وبدأت فى 15 مايو و لمدة 210 يوم واوضحت النتائج ان علائق مخلفات مجازر الدواجن ومصانع الاغذية كانت احسن من العليقة المصنعة فى الكفاءة الاقتصادية وكانت افضلهم مخلفات مجازر الدواجن فى مظاهر النمو, والكفاءة الاقتصادية.

نستنتج انه يمكن تربية القراميط بكثافة عالية بدون حدوث مشاكل والكثافة المنخفضة الاحسن فى مظاهر النمو والكفاءة الاقتصادية واستخدام العلائق الغير تقليدية من مخلفات مجازر الدواجن ومصانع الاغذية يمكن استخدامها لتقليل تكاليف الانتاج