EFFECT OF LIPID LEVEL AND STOCKING DENSITY ON GROWTH PERFORMANCE, SURVIVAL RATE, FEED UTILIZATION AND BODY COMPOSITION OF NILE TILAPIA FRY (*OREOCHROMIS NILOTICUS*) REARED IN HAPA

Wafa Elshabrawy[1]; Eid A.E.[1] Amal Elfeky[1]; Mervat A.M.Ali[1] and Fatma Samir[2]

[1]*Department of Animal Production and Fish Resources, Faculty of agriculture, Suez Canal University, Ismailia, Egypt.*

[2]*Department of Fish Nutrition, Central Laboratory for Aquaculture Research, Agriculture Research Center, Giza, Egypt.*

Received 5/ 1/ 2020 *Accepted 28/ 1/ 2020*

ABSTRACT

The present study was conducted over a 120 day period to investigate the effects of lipid level and stocking density on the growth performance and survival of fry *Oreochromis niloticus* cultured in hapa in earthen pond. Fish with average initial weight 0.4 ± 0.01g were stocked at three different rates 250, 300 and 350 fry/m^3 corresponding to (2500, 3000 and 3500 fry/ hapa, three replicate/ treatment). At each density 3 lipid level (6, 8, and 10%). Fish were hand-fed to satiation four times /day (7, 11 am and 2, 5 pm) throughout the experimental period 120 days.

The results showed that final body weight, weight gain and specific growth rate (SGR) were positively affected by lipid level and inversely affected by stocking density and affected by their interaction. Survival rate was significantly affected by stocking densities. The maximum growth was obtained with 8% crude lipid (CL) at density (250 fry /m^3) whereas the lowest growth was obtained in 10% CL at high density (350 fry /m^3). The present study recommended that the optimum density 250 fry /m^3 and lipid level 8% in terms of growth performance and feed utilization under experimental conditions.

Key words: Lipid Levels, Stocking density, growth performance, feed utilization, body composition, Nile tilapia (*Oreochromis niloticus*).

INTRODUCTION

Tilapia is one of the most widely cultured fish in the world. Currently, farmed tilapia represents more than 75% of world tilapia production (FAO, 2009). Nile tilapia, *Oreochromis niloticus*, belongs to the second most-produced group of freshwater fish worldwide, the tilapias and other cichlids (FAO, 2014).

Appropriate lipid content in the diet is important for growth performance of fish; furthermore, it is also vital for the formulation of diets and final product quality (Rahimnejad *et al*., 2015). However, excessive or deficient lipid in diets leads to decreased feed consumption, reduced growth and reduced health (Liao *et al*., 2016). Dietary lipid was also reported to bring protein sparing effect, replacing protein, which may otherwise be used to provide energy (Beamish and Medland, 1986) to reduce organic matter and nitrogen losses (Lee and Putnam, 1973).

Fry are most commonly stocked at densities of 3000 to 4000 per m^2 of hapa, or flowing water tank (Ferdous *et al*., 2014) compared stocking densities of 1000, 1500 and 2000 per m^2 of hapa using *O. niloticus* and found best survival rate at 1000 and 1500 m^2 but lower survival at 2000 m^2. Fish stocking density has great impact on growth, survival, health, water quality and production (Moniruzzaman *et al*., 2015 and Asase *et al.,* 2016) Therefore, it is important to optimize the stocking density for the target species in aquaculture for desired level of growth and production. Knowing the best densities for a species is a critical factor for good husbandry practices and creating efficient culture system.

The aim of this study therefore is to study the effect of stocking density and lipid levels in fish diet on growth performance, feed utilization and economic analysis of Nile tilapia fry reared in hapa in earthen ponds.

MATERIALS AND METHODS

The experiment:

The experiment was conducted at private fish farm, Ismailia Governorate, Egypt, the experiment aim to investigate the effect of stocking density and lipid levels in fish diet on the growth performance, feed utilization, survival and

economic analysis of mono-sex male tilapia (*Oreochromis niloticus*) fry reared in hapa in earthen pond. This study was factorial designed (3 stocking ×3lipid levels). Stocking densities 250, 300 and 350 fry/ m^3 and lipid levels was 6, 8 and 10%.The experiment was lasted for 120 days.

Experimental Unit:

The hapa (2x 5x 1m) were selected randomly to accommodate the relevant treatments. Fry of mean (±SE) initial weight of 0.40± 0.01g was stocked in experimental hapa. Fish were stocked in 250, 300 and 350larvae/m^3hapa randomly divided into three equal experimental groups (2500, 3000 and 3500 fry / three replicate hapa). The hapa were supplied all day with air blowers.

Experimental Fish:

Fry monosex of Nile tilapia (*O. niloticus*) with average initial body weight of 0.40 ± 0.01 g were obtained from Abbassa Fish Hatchery, Sharkia governorate, Egypt. Fish were homogenous in body weights and apparently healthy. Fish were acclimated to farm conditions for 2 weeks, before the experiment study.

Experimental Diets:

The diets were formulated from practical ingredients (Table 1) where the protein levels was 40% (Ferdous *et al*., 2014) and lipid levels 6, 8 and 10% and Metabolizable energy354, 364 and 373 Kcal/100g. The experimental diets were prepared by individually weighing of each component thoroughly mixing the mineral, vitamins and additives with corn. This mixture was added to the components together with oil. Water was added until the mixture became suitable for making granules. The wet mixture was passed through CBM granule machine powder. The produced powder were dried at room temperature then kept until experimental start. The composition and proximate analysis of the experimental diets are presented in (Table 1). The fish were hand-fed to satiation four times /day (7, 11am and 2, 5pm) throughout the experimental period 120 days.

Experimental Methodology:

At the beginning and at the end of experiment 100 fish sample was taken to determine chemical analysis of body composition. The tested diets were analyzed for crud protein (CP %) ether extract (EE %), Crude fiber (CF %), ash (%) and moisture. While whole body composition of fish samples were also analyzed except crud fiber (CF %) according to the procedures described by standard methods according AOAC (2014).

The nitrogen free-extract (NFE %) was calculated by differences. Fish were weighed every week.

Table 1. Ingredient and Chemical composition of the experimental diets fed to *Oreochromis niloticus* fry.

Ingredient	Lipid levels		
	6	8	10
Fish meal	43	43	43
Soybean meal	22	22	22
Yellow cornmeal	32	30	28
Fish oil	1	2	3
Corn oil	-	1	2
Vitamin premix[1]	1	1	1
Mineral premix[2]	1	1	1
Total	100	100	100
Chemical composition (%)			
Moisture	7.8	7.7	7.8
Crude protein	40.6	40.5	40.1
Crude lipid	6.4	8.2	10.2
Ash	8.2	8.1	8.0
Crude fiber	2.31	2.53	2.48
NFE[3]	42.49	40.67	39.22
ME Kcal/100g[4]	464.50	441.82	452.09
P/E ratio[5]	87.4	91.66	88.70
Price LE	15.60	15.80	16.00

[1,2] each Kg vitamin & mineral mixture premix contained Vitamin A, 4.8 million IU, D3, 0.8 million IU; E, 4 g; K, 0.8 g; B1, 0.4 g; Riboflavin, 1.6 g; B6, 0.6 g, B12, 4 mg; Pantothenic acid, 4 g; Nicotinic acid, 8 g; Folic acid, 0.4 g Biotin,20 mg ,Mn, 22 g; Zn, 22 g; Fe, 12 g; Cu, 4 g; I, 0.4 g, Selenium, 0.4 g and Co, 4.8 mg.

[3] Nitrogen Free Extract = 100 – (%Protein + %Fat + %Fiber + %Ash).

[4] Gross Energy based on protein (5.65 Kcal/g), fat (9.45 Kcal/g) and carbohydrate (4.11Kcal/g). According to **(NRC, 2011).**

[5] Protein to Energy Ratio. (crud protein / GE Kcal).

Water quality parameters:

Water temperature and dissolved oxygen were measured by metteler Toledo, model 128.s/No1242 respectively. Other water quality including pH and ammonia were measured every two days by pH meter (Orion model 720 A, s/no 13062) and ammonia meter by Hanna ammonia meter respectively. The averages of water quality parameters are presented in (Table 2).

Measurements:

1- Growth performance parameters:

The growth performance parameters were calculated according to the following equations:

Weight gain (WG) = final weight (g) – initial weight (g);

Average daily gain (ADG) = (W1 – W0)/ T;

Where: W1: Final body weight (g); W0: Initial body weight (g); T: Experimental period (days).

The specific growth rate (SGR, %/d) = {Ln final mean body weight – Ln initial mean body weight / time intervals (days)} x 100.

2 -Feed and protein utilization parameters:

Feed and protein utilization parameters are calculated according to the following equations:

The feed conversion ratio (FCR) is expressed as the proportion of dry food fed required per unit live weight gain of fish.

FCR = Feed intake (g) / weight gain (g);

Feed Intake (FI): Amount of consumed feed per period;

Protein efficiency ratio (PER) = weight gain (g)/CP intake (g).

3- Survival rate (SR %):

SR (%) = Number of fish survived at the end of the experiment / Number of fish stocked at the start of the experiment X 100.

Chemical analysis of fish body:

At the end of experiment, fish were removed, counted and weighed. Different growth parameters and parameters of feed calculated. Five fishes from each hapa were taken to carry out chemical analysis of the fish body. Chemical analysis of feed ingredients, experimental diets and fish carcasses were carried out according to the methods of AOAC (2014).

Economical Evaluation:

The estimation was based on the local retail sale market price of all the dietary ingredients at the time of the study. Cost of 1 kg ingredients (Table 1)

- Feed cost of kg: Calculated from the price of feed ingredient and the cost per kg gain (FCR ×price of kg feed).
- Feed cost= Price of Kg feed consumed
- Reduction % of feed cost of Kg gain was calculated as a percentage from the highest value.

Statistical Analysis:

The data obtained in this study were analyzed by one-way ANOVA procedure of Statistical Analysis System (SAS Institute, 1999). Means were compared by Duncan's new multiple ranges test (Duncan, 1955).

RESULTS AND DISCUSSION

The effect of stocking density and dietary lipid levels on water quality:

The mean values of the water parameters are shown in Table 2. All water quality parameters measured had no significant differences among treatments ($P<0.05$). Mean temperature ranged from 27.2 to 28.5 °C. Concentrations of

dissolved oxygen 6.4 mg/l, pH from 7.78 to 7.9 mg/l, ammonia 0.02 mg/l. Water parameters were within tolerable range throughout the experimental period. As no apparent difference in water quality parameters were found among the treatments, the data for each experiment for the whole experimental period were pooled. Water quality was found to be within the acceptable range for tilapia growth (Stickney, 1979 and Moniruzzaman *et al*., 2015). The water quality data for dissolved oxygen, temperature, pH and ammonia measured during the study period were all within the optimum range for rearing *O. niloticus* (Boyd, 1998).

Table 2. Average water quality criteria of monosex fry affected by stocking density and lipid levels.

Treatment	Density Fry/m^3								
	250			300			350		
Lipid levels	6	8	10	6	8	10	6	8	10
Water temperature (°C)	27.20±1.10			27.20±1.10			28.50±1.10		
Dissolved oxygen (mg/l)	6.40±0.18			6.40±0.18			6.40±0.18		
pH	7.78±0.0			7.78±0.0			7.90±0.0		
NH_3	0.02±0.01			0.02±0.01			0.02±0.01		
Transparency (cm)	32.3±1.4			32.3±1.4			32.3±1.4		

*Average for the whole experimental period

The effect of stocking density and dietary lipid levels on Growth performance:

The different growth parameters (final body weight, weight gain, specifi growth rate (SGR) of Nile tilapia (*O. niloticus*) fry fed with 6, 8 or 10% lipid diets at different densities are shown in Table 3 and 4. The results showed that the different growth parameters were significantly ($P<0.05$) affected by dietary lipid level and stocking density and their interaction.

The maximum final body weight was obtained in fish fed with 8% lipid at all stocking density 250, 300 and 350fry/m^3). Also, the maximum body weight gain was obtained at fish fed with lipid level (8% lipid and density 250fry/m^3) was 140±0.01g, whereas the lowest final body weight obtained in fish fed10% crude lipid was (112.20±0.01g) at high density (350 fry/m^3).

These results are in agreement with Jauncey (2000) who suggested that to maximize protein utilization, dietary fat concentration should be between 8 and 12% for tilapia up to 25 g, and 6 to 8% for larger fish.

Similar results were obtained by Sayed (2017) who revealed that 8% lipid in diet of milkfish juveniles was optimal for the better growth and survival. In the present study, BWG, SGR, PER and FER increased with increasing lipid levels in the diets up to 8% crude lipid. The same trend was found by (Moniruzzaman *et al*., 2015). Some other authors had reported that high dietary lipid levels might reduce fish growth (Ellis and Reigh, 1991).

In contrast, some species such as beluga can utilize lipid levels up to 24 %, this may be due to different fish species or experimental conditions .The growth reduction at high lipid levels could be due to the reduced ability to digest and absorb high lipid, reduce in feed intake and/or fatty acid imbalance in feed (NRC, 2011).

Stocking density is an important factor affecting growth of fish, food supply and environmental conditions in which fish are reared. It has been reported to have a negative relationship with growth and survival of several fish species (Larsen *et al.,* 2012) Decreased weight gain with increasing stocking density has been observed in a number of fish species. For example, in *O. niloticus* stocking density varies with the size of the fish and the rearing system (Osofero *et al*., 2009). Similar trends were also observed in catfish (*Clarias batrachus*) where there was decreased growth, SGR and survival of larvae stocked at higher densities (3000–5000 m^2) and the decreased growth was attributed to crowding, which resulted to difficulties in movement of the fish to reach the food, thereby depressing the feeding rate (Sahoo *et al*., 2004).

Table 3. Growth performance for Nile tilapia fry, fed on three lipid levels in three different stocking density.

	Density Fry/m^3								
	250			300			350		
Lipid levels	**6**	**8**	**10**	**6**	**8**	**10**	**6**	**8**	**10**
Initial weight (g)	0.40 ±0.01	0.40 ±0.01	0.40 ±0.01	0.40 ±0.01	0.40 ±0.01	0.40 ±0.01	0.40 ±0.01	0.40 ±0.01	0.40 ±0.01
Final weight (g)	126.24 ±0.2^c	140.4 ±0.36^a	130.3 ±0.01^b	120.2 ±0.35^d	130.3 ±0.01^b	125.4 ±0.03^c	115.6. ±0.010^e	120.2 ±0.01^d	112.2 ±0.10^e
Body weight gain[1] g	125.84 ±0.01^c	140.00 ±0.01^a	129.9 ±0.01^b	119.8 ±0.01^d	129.9 ±0.01^b	125± 0.01^c	115.2 ±0.01^e	119.8 ±0.01^d	111.8 ±0.01^e
Specific growth rate[2]	5.60 ±0.01^b	5.71± 0.01^a	5.63 ±0.01^b	5.55 ±0.01^c	5.63 ±0.01^b	5.59± 0.01^b	5.51 ±0.01^c	5.55 ±0.01^c	5.48 ±0.01^c
Feed Intake (g)	239.09 ±0.01^d	238.00 ±0.01^d	272.16 ±0.01^b	251.58 ±0.01^b	246.81 ±0.01^c	287.5 ±0.01^a	253.44 ±0.01^b	239.6 ±0.01^d	258.06 ±0.01^c
Feed conversion ratio (FCR)[3]	1.90 ±0.01^c	1.71 ± 0.3 ^{d}	2.10 ±0.01^b	2.10 ±0.1^b	1.90 ±0.01^c	2.30 ±0.2^a	2.20 ±0.01^a	2.00 ±0.01^b	2.30 ±0.01^a
Feed efficiency	0.52 ±0.10^b	0.59± 0.10^a	0.48 ±0.10^d	0.48 ±0.10^d	0.53 ±0.10^b	0.43 ±0.10^f	0.45 ±0.10^e	0.50 0.10^c	0.43 ±0.10^f
Protein efficiency ratio (PER)[4]	1.30 ±0.10^b	1.46 ±0.10^a	1.19 ±0.10^c	1.17 ±0.10^e	1.30 ±0.10^b	1.08 ±0.10^g	1.12 ±0.10^f	1.23 ±0.10^d	1.08 ±0.10^g
survivability (%)[6]	90.00 ±1.00^a	90.00 ±1.00^a	90.00 ±1.00^a	84.00 ±1.00^b	84.00 ±1.00^b	84.00 ±1.00^b	76.00 ±1.00^c	76.00 ±1.00^c	76.00 ±1.00^c

Data are presented as average for the whole experimental period. Mean values followed by different superscript letters in the same raw indicate significantly different (P<0.05).

Table 4. ANOVA.

Parameters	Df	Mean Square						
		Final weight	Weight gain	SGR	Feed intake	Feed conversion	Feed efficiency	Survival
Stocking density	2	148.09 ***	148.134 ***	2.04503 ***	2.58453 ***	0.90167 ***	0.03303 ***	0.2036 ***
Lipid	2	62.144 ***	62.1272 ***	0.81814 ***	335.161 ***	0.03163 ***	0.71083 ***	335.16 ***
SXL	4	0.2714 ***	***	0.00889 ***	18.3367 *	0.04511 *	0.00115	0.0060 *
Error	16	0.0152		5.3611e	11.6917	11.6917	3.1944	0.0018

S stocking density, L Lipid level, SXL
ǂ P<0.05; ** P<0.01.

Yousif (2002) reported that increasing the number of fish (density) will adversely affect fish growth. Social interactions through competition for food and/or space can negatively affect fish growth, hence higher stocking densities leads to increased stress and that resulting increase in energy requirements causing a reduction in growth rates and food utilization (Ni *et al*., 2014). This explanation is in conformity with the study done by (Aksungur *et al*., 2007). The results indicated that the percent weight gained in different stocking densities which coincides with the findings of Ali *et al*. (2016) was also relevant with present study.

The highest specific growth rate of monosex Nile tilapia fry was obtained in group of fish fed 8% lipid and density 250 fish/m^3 while the lowest SGR obtained in group of fish fed 10% lipid and density 350 fish/m^3. Similar study was conducted by (Samad *et al*., 2016 and Islam *et al*., 2017) they got relevant results.

The effect of stocking density and dietary lipid levels on Feed utilization:

Results of feed intake, feed conversion ratio (FCR), protein efficiency ratio (PER) and Feed efficiency (FE) of Nile tilapia (*O. niloticus*) larvae fed different lipid levels at three densities are shown in Table 3and 4. The FCR were improved significantly (P<0.05) for Nile tilapia larvae which fed diet containing 8% crude lipid than the rest of experimental groups. It appeared that

fish could adjust feed intake to satisfy energy requirements (Kaushik and Medale, 1994). Feed consumption was negatively related to dietary energy content (Ellis and Reigh, 1991).

The best FCR was obtained in 8% lipid diet at density 250 larvae/ m^3(1.71) and the poorest FCR (2.30) was obtained in 10% lipid at densities (300 fry/m^3) with insignificant difference (P>0.05). The highest values of PER and FE (1.46 and 0.59) were obtained in 8% lipid at density (250 fry/m^3). The lowest values of PER and FE (1.08 and 0.43) were obtained in diet containing 10% lipid at high density (350 fry/m^3) with insignificant difference (P>0.05). Improved feed conversion efficiency and protein efficiency ratio with increasing dietary lipid level till 8% and theses are in agreement with other studies (Einen and Roem, 1997). In contrast, (Peres and Oliva-Teles, 1999) did not observe protein sparing effect of lipid when they fed European sea bass juveniles diets. This may be due different fish species or environmental condition.

The present findings agreed with the findings of (Begum, 2009) who recorded food conversion ratio (FCR) values ranged from 1.03 to 1.20 on tilapia (*O. niloticus*) culture at the field. The lower FCR value might be due to tilapia is known to be a predominantly omnivorous fish, consuming phytoplankton, zooplankton and decaying suspended organic matter. The fish might be properly utilized most of the formulated feed and the utilized feed helped in production of natural food by releasing nutrients through decomposition. In ponds, where feeding was practiced, uneaten feed and metabolic waste made nutrient enrichment, that increases plankton production.

The percentage of survival as recorded in the present study in Table 3. Survival was found to be negatively influenced by stocking densities. It might be due to the high competition and space among the fishes. The highest survival percent (90%) was obtained in stocking density 250 fry/m^3 while the lowest survival (76%) in stocking density 350 fry/m^3.These results are similar with the findings of (Sayed *et al*., 2008 and Cremer *et al*., 2002).

The effect of stocking density and dietary lipid levels on body composition:

The effect of stocking density and dietary lipid levels on body composition is presented in Table 5. Dietary lipid level had a significantly ($P<0.05$) affected body lipid content. In the present study, the lipid contents of fish were positively correlated with dietary lipid level. In agreement with Moniruzzaman *et al*. (2015). Tabachek (1986) stated that when dietary lipid was too high, the excess lipid was deposited within body tissues. Williams and Robinson (1988) reported that body lipid was increased with increased dietary lipid. Siddiqui *et al.* (1988) stated that there was an inverse relationship between water content and lipid content of *O. niloticus* larvae. Ash content also affect by lipid level and stocking density.

Table 5. Effects of stocking density on body composition of Nile tilapia fry (% dry weight) in experiment.

	Density Fry/m^3								
	250			300			350		
Lipid levels	**6**	**8**	**10**	**6**	**8**	**10**	**6**	**8**	**10**
Moisture	73.10 ±0.01^a	72.30 ±0.01^b	72.78 ±0.01^b	73.98 ±0.01^a	72.89 ±0.01^b	72.85 ±0.01^b	73.14 ±0.01^a	72.41 ±0.01^a	72.5 ±0.01^b
Protein	16.60 ±0.35^a	16.50 ±0.01^a	16.6 ±0.03^a	16.50 ±0.2^a	16.50 ±0.36^a	16.50 ±0.01^a	16.50 ±0.01^e	16.6 ±0.01^a	16.80. ±0.10^a
Lipid	5.40 ±0.01^b	6.40 ±0.01^a	6.60 0.01^a	5.50 ±0.01^{bc}	6.50 ±0.01^a	6.60 ±0.01^a	5.40 ±0.01^b	6.00 ±0.01^a	6.60 ±0.01^a
Ash	4.90 ±0.11^a	4.80 ±0.11^a	4.02 ±0.21^b	4.02 ±0.21^b	4.11± 0.41^b	4.05 ±0.43^b	4.96 ±0.41^a	4.99 ±0.12^a	4.10 ±0.41^b

Data are presented as mean plus SEM. Means values followed by different superscript letters indicate significantly different ($P<0.05$).

The effect of stocking density and dietary lipid levels on economic evaluation:

Calculation of economic efficiency of the tested diets based on the cost of feed, costs of one Kg gain in weight and its ratio with the control group is shown in Table (6).

The percent of feed cost of kg gain relative to the highest 100% (lipid and density 350 fish/ m^3) were 72.50% of group of fish fed 8% lipid and density

250 fish/m^3. The highest feed cost /kg gain (36.80 LE) on group of fish fed diet containing 10% lipid and density 350 fish/m^3 and the lowest feed cost 26.67 LE in group of fish fed diet containing 8% lipid and density 250 fish/m^3. The present result supports the findings of Hasan, (2007) and Begum, (2009).

Table 6. An economical Analysis of experimental fry reared in haps at 3 stocking density and 3 lipid levels.

Parameters	Density fry/m3								
	250			300			350		
Lipid levels	6	8	10	6	8	10	6	8	10
Cost of Kg diets LE	15.60	15.80	16.00	15.60	15.80	16.00	15.60	15. 8	16.00
Feed cost LE	29.64	26.67	32.76	33.18	30.02	36.34	35.20	32.00	36.8
Relative % of feed cost of Kg gain	80.54	72.47	91.30	90.16	81.60	98.80	95.65	86.95	100

Feed cost of kg: Calculated from the price of feed ingredient and the cost per kg gain (FCR ×price of kg feed).
Feed cost= Price of Kg feed consumed

CONCLUSION

It could be concluded that the optimum lipid level 8% and stocking density 250 fry /m^3 in term of growth performance and feed utilization under these experimental condition

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تأثير مستوى الدهون وكثافة التخزين على أداء النمو ومعدل الاعاشة ومكونات الجسم ليرقات سمك البلطي النيلي (*Oreochromis niloticus*) المربى فى هابات

وفاء الشبراوى[1]، عبد الحميد عيد[1]، أمال الفقي[1]،
ميرفت محمد علي[1]، فاطمة سمير[2]

[1] قسم الإنتاج الحيواني والثروة السمكية ، كلية الزراعة ، جامعة قناة السويس ، الإسماعيلية ، مصر.
[2] قسم بحوث التغذية، المعمل المركزى لبحوث الثروة السمكية، مركز البحوث الزراعيه، الجيزه، مصر.

الملخـص العربـي

أجريت هذه الدراسة على مدى فترة 120 يوم لدراسة تأثير مستوى الدهون وكثافة التخزين على أداء النمو والاعاشة ليرقات سمك البلطى النيلى *Oreochromis niloticus* المرباه في كثافات مختلفة 250 ، 300 ، 350 يرقه/ م3 الموافق (2500 ، 3000 ، 3500 /هابا ، ثلاث مكررات / للمعاملة). في كل كثافة ثلاث مستويات من الدهون (6 ، 8 ، 10 ٪) ، تم تغذية الأسماك باليد إلى حد الإشباع أربع مرات في اليوم (7 ، 11 صباحا ، 2 ، 5 مساء) طوال الفترة التجريبية 120 يوما.

أظهرت النتائج أن وزن الجسم النهائي ، الوزن المكتسب، ومعدل النمو النوعى (SGR) تأثر إيجابيا بمستوى الدهون وتأثر عكسيا بكثافة التخزين كما تأثر بالتداخل فيما بينهما. كما لوحظ ان افضل معدل للاعاشة عند مستوى 8% دهن وكثافة 250 يرقة/م^3 .تم الحصول على أقل معدل نمو في 10٪ دهن بكثافة عالية (350 يرقه / م ^{3}). فأوصت الدراسة الحالية بأن تكون الكثافة المثلى 250 يرقة/ م^3 ومستوى الدهون 8٪ من حيث أداء النمو والاستفادة من تحت هذه الظروف التجريبية.