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COMPENSATORY GROWTH FOR DIFFERENT STOCKING PRACTICES IN NILE TILAPIA (*OREOCHROMIS NILOTICUS*) FINGERLINGS

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Abstract

The objective of this work was to verify the occurrence of compensatory growth in Nile tilapia (*Oreochromis niloticus*) reared in hapas, after being stocked at high densities, followed by a period under different lower densities. Nile tilapia monosex fingerlings (mean 1.4g ± standard error 0.02) were used to establish six experimental groups with varied stocking density schedules: two control groups A_1 and B_1 (15 and 30 fish / m^2, respectively); A_2 and B_2 (30 and 60 fish /m^2 then reduced to 15 and 30 fish /m^2 after 4 weeks, respectively); A_3 and B_3 (60 and 120 fish /m^2 then reduced to 30 and 60 fish /m^2 after 4 weeks and re-reduced to 15 and 30 fish /m^2 after 8 weeks, respectively).The experiment lasted for 12 weeks, six experimental periods 2 weeks each. Decreasing stocking density in the experimental groups A_2, A_3, B_2, and B_3 after 4 weeks was accompanied with notable increase in the specific growth rate (SGR %) and decrease in feed conversion ratio (FCR) during the 3rd experimental period (4-6 weeks). Returned decrease the stocking density in A_3 and B_3 after 8 weeks results in another phase of compensatory growth response in terms of better growth rate and feed utilization. Final body weight of A_1, A_2, and A_3 (19.39, 19.48, and 19.22 g, respectively) didn't differ significantly while final body weight of B_2 (16.41 g) was significantly ($p \leq 0.05$) higher than those of B_1 (14.22 g) and B_3 (12.93 g). Overall SGR% didn't differ significantly between A_1, A_2, and A_3 (3.12, 3.13, and 3.11, respectively) whereas, B_2 showed a significantly ($p \leq 0.05$) higher SGR% (2.93) than those of B_1 and B_3 (2.76 and 2.65, respectively). Feed conversion ratio was significantly ($p \leq 0.05$) lower in A_3 (2.21) while the control group B_1 showed the highest FCR (2.85). Body moister and ash contents tend to be higher while lipids and protein tends to be lower in the experimental groups which expressed compensatory growth response as compared with the control groups. The results of this study suggest full and over compensation response in Nile tilapia fingerlings for reducing stocking density in different regulations which may be used in optimizing space and feed utilization in tilapia production.

Key words: Nile tilapia, stocking density, compensatory growth, body composition.

INTRODUCTION

Egyptian tilapia production amounted with 867.557 metric tons from which about 87.5% (759.601 metric tons) produced from aquaculture (GAFRD, 2014). Tilapia culture requires fundamental amount of appropriate feed for preferable growth. Feeding cost accounts for about 65%-70% of total operational costs. The dramatically increase in aquatic feeds prices in Egypt during the last few years limits the net profit of tilapia farms which in turn increases the importance of looking for better culture practices that can reduce the production costs substantially.

Compensatory growth is a phase of accelerated growth when favorable conditions are restored after a period of growth depression (Ali *et al*., 2003). Such accelerated growth allows animals that subjected to unfavorable condition to partially or completely catch up in body size with those that have not undergone that depression (Kim and Lovell, 1995; Johansen *et al*., 2001; Yang *et al*., 2015).Compensatory response was reported for different growth depression causes that includes feeding regime (Chakraborty *et al.*, 2004), deprivation (Yang and Jeong-Yeo, 2010), salinity (Damsgard and Aenesen, 1998), temperature (Maclean and Metcalfe, 2001), and stocking density (Tomas *et al*., 2015). Appropriate exploitation of compensatory growth may result in increased growth rate and feed efficiency so it represents a considerable option that has the potential to reduce production costs in different aquaculture systems.

The aim of this study was to evaluate compensatory growth response in Nile tilapia fingerlings after a period of growth suppression, induced by rearing in hapas at high densities, followed by a period under different reduced densities.

MATERIALS AND METHODS

Experimental settings:

This study was conducted from 26th of June to 18th of September 2015 at a privet tilapia hatchery in San-El-Hagar, Sharkia, Egypt. Nile tilapia *Oreochromius niloticus* monosex fingerlings (mean 1.4g ± standard error 0.02) were used to form six treatments with three replicates of each at 18 hapas (1 X 2 X 1 m). Two control groups A_1 and B_1 which were stocked at 15 and 30 fish / m^2, respectively while the other four experimental groups were stocked as follows: A_2: 30 fish/ m^2 and then reduced to 15/ m^2 after 4 weeks; A_3: 60 fish/ m^2 and then reduced to 30 and 15 fish / m^2 after 4 and 8 weeks, respectively; $B_{2:}$ 60 fish/ m^2 and then reduced to 30 fish / m^2 after 4 weeks; $B_{3:}$ 120 fish/ m^2 and then reduced to 60 and 30 fish / m^2 after 4 and 8 weeks, respectively.

The experiment lasted for 12 weeks, six experimental periods 2 weeks each. Experimental hapas were installed into 0.2 ha. earthen pond. Approximately 20% of the water was exchanged daily to keep good water standards. Water temperature ranged between 25 and 32 °C, pH value ranged between 7.2 and 8, water salinity ranged between 2300 and 2800 mg / L, and water depth maintained at 150 cm during the experimental period. Fish were fed with 6% of their body weight with commercially extruded dry pellets (30% crude protein, 6.1% crude fat).

Growth parameters:

At 2 weeks interval fish were weighed and the following growth indexes were calculated for each hapa as follows: Specific growth rate (SGR) = $100 \times (\ln W_f - \ln W_i) / t$, where ln is the natural logarithm, W_f is the final weight, W_i is the initial weight in grams, and t is the time in days; Feed conversion ratio (FCR) = $F/(W_f - W_i)$, where F is the dry weight of feed offered to the fish, W_f is the final weight, and W_i is the initial weight**;** Average daily gain (ADG) = $(W_f - W_i) / t$ where W_f is the final weight, and W_i is the initial weight and t is the time in days. At the end of the experiment the body weight and body length were measured and the fish condition was evaluated**.** The condition factor of the fish was estimated using the formula K = $(W/L^3) \times X$, where *W* is the fish weight (g), *L* is the total length (cm), and *X* is a constant equal to 100.

Analysis of body composition:

At the beginning of the experiment, 20 fish were sampled for analysis of the initial body composition. At the end of the experiment, 10 fish from each hapa were sampled randomly and frozen at -20°C for chemical analysis. The contents of crude protein, lipid, ash, and water were determined for the fish according to the methods of (AOAC, 1995). Samples were oven dried to constant weight at 70°C to determine water content. Crude protein was analyzed after acid digestion. Total lipid was analyzed by Soxhlet extraction with petroleum ether at 40-60°C. Ash was determined by combustion at 550°C in a muffle furnace for 6 hours.

Statistical analysis:

Differences among the experimental groups at the end of the experiment concerning their body weights (g), body length (cm), condition factor (K), SGR%, and FCR values were analyzed by one-way analysis of variance (ANOVA). As the experiment proceeded, the initial weights within each experimental period for each group changed. Therefore, at each measurement time differences in body weight (g), SGR%, FCR, and ADG were evaluated by analysis of covariance (ANCOVA) using the initial weight at each experimental period as a covariate. When necessary, Duncan's multiple range test (Duncan, 1955) was used for multiple comparisons. Statistical analyses were performed using SPSS 22 (IBM SPSS, 2013).

RESULTS AND DISCUSSION

Consecutive growth performance and feed utilization:

Results (Table 1) revealed that after 4 weeks the body weight of the experimental group A_1 (5.9 g) which stocked with the lowest stocking density ($15/m^2$) was significantly ($p \leq 0.05$) higher than all another experimental groups whereas the experimental group B_3 which stocked with the highest density ($120/m^2$) showed the lowest body weight (3.66 g). As for feed conversion ratio (FCR) within the same experimental period A_1 showed significantly ($p \leq 0.05$)

lower FCR estimates than those of other experimental groups which showed progressive sequenced values according to stocking density. Generally, growth rates decrease and feed conversion ratios increase with increasing stocking density. These results were corresponds to a number of previous studies like Yousif (2002) who stated a general principle, that increasing the number of fish (density) will adversely affect fish growth. Breine *et al.* (1996) and Aksungur *et al*. (2007) mentioned that 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 feed utilization.

Compensatory response has been referred as rapid growth when favorable conditions are restored following a period of growth depression, occasioned by suboptimal conditions of different depression causes *e.g.* feed deprivation (Yang and Jeong-Yeo, 2010), low temperature (Nicieza and Metcalfe, 1997), hypoxic conditions (Foss and Imsland, 2002), exposure to toxic compounds (El Ghazali *et al.*, 2009) and high densities (Marques and Lombardi, 2011). Table 1 and Fig. 1 indicate that reducing the stocking density after 4 weeks in the experimental groups A_2, A_3, B_2, and B_3 results in an improvement in the SGR% from 3.31, 3.05, 3.02, and 2.43, respectively during the 2nd experimental period (2-4 weeks) to 3.86, 3.71, 3.33, and 2.97, respectively during the 3rd experimental period (4-6 weeks). At the same time the SGR% in the control groups A_1 and B_1 decreased from 3.46 and 3.26 to 3.11 and 2.22, respectively. As for feed utilization, the experimental groups A_2, A_3, B_2, and B_3 showed a notable decrease in FCR from 1.90, 2.10, 2.14, and 2.78, respectively within the 2nd experimental period (2-4 weeks) to 1.56, 1.67, 1.90, and 2.18, respectively during the 3rd experimental period (4-6 weeks). On contrast, FCR increased in the control groups A_1 and B_1 from 1.80 and 1.94 to 2.05 and 3.15, respectively during the same periods (Table 1 and Fig. 2).

Fig. 1. Specific growth rate SGR% /day at 2 weeks interval of Nile tilapia fingerlings reared under different stocking strategies for 12 weeks.

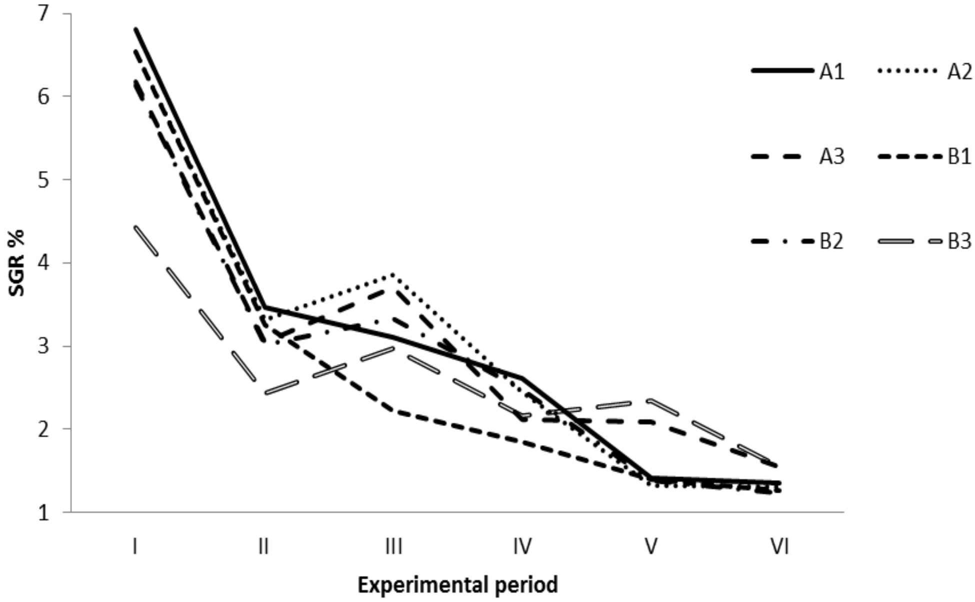
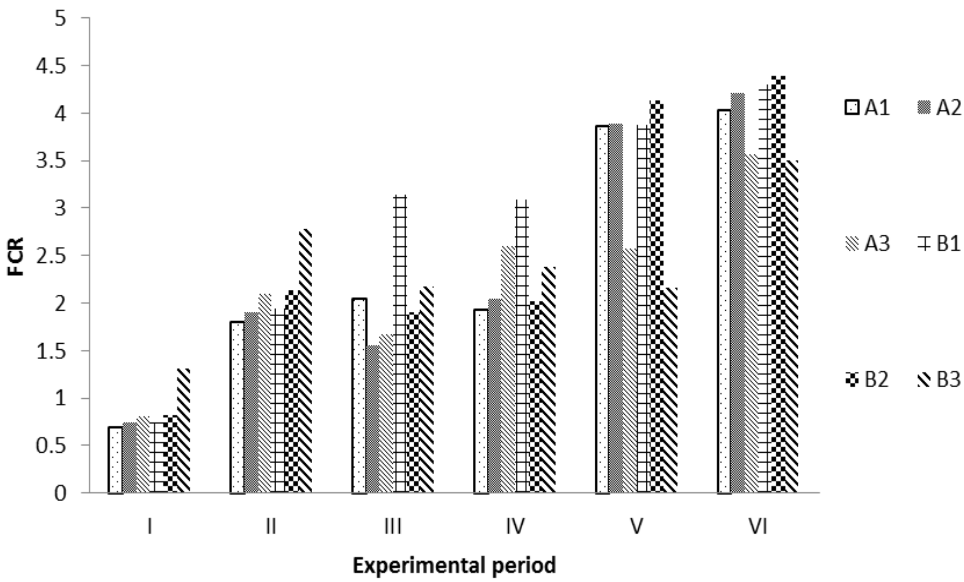


Fig. 2. Feed conversion ratio (FCR) at 2 weeks interval of Nile tilapia fingerlings reared under different stocking strategies for 12 weeks.



Furthermore, the experimental groups A_2 and A_3 showed a significantly ($p \leq 0.05$) higher SGR% and lower FCR after density reduction (3rd experimental period) as compared with the control group A_1 in spite of they were reared under the same stocking density 15/m^2 (A_2) or even at higher density 30/m^2 (A_3) during this stage. Similarly, the experimental groups B_2 and B_3 have significantly ($p \leq 0.05$) higher SGR% and lower FCR as compared with the control group B_1 regardless of being stocked with the same density 30/m^2 (B_2) or higher density 60/m^2 (B_3). These results led to suggest that compensatory growth response was occurred after reducing the stocking density of Nile tilapia fingerlings reared at deferent levels of initial stocking density.

The current results were in agreement with Vera-Cruz and Mair (1994) and Basiao *et al.* (1996) who reported that stocking density and social interactions have consequences for compensatory growth in Nile tilapia, relative growth losses caused by crowding conditions were rapidly eliminated when the fish were returned to lower, control densities. Additionally, Marques and Lombardi (2011) and Tomas *et al.* (2015) mentioned a similar compensatory growth response for stocking density reduction in rainbow trout and Malaysian prawns. Many studies suggest that such superior growth patterns during the compensation period may be attributed to hyperphagia behavior (Xie *et al.*, 2001). In the present study, hyperphagia behavior could not be observed in as much as feed was not offered "*ad libitum*". Other studies correlate between compensatory growth and changes in metabolic rates. Wieser *et al.* (1992) listed four phases of metabolic rates during a study on the compensatory response to different starvation regimes. In the current study decreasing the density could be accompanied with lower competition for shared resources and lower social interactions in the rearing unit which may reduce the activity during compensation period that could contribute to compensatory gain by increasing the proportion of the energy available to growth. Increase in the energy available for growth after restocking at optimal condition will result in better feed conversion efficiency. Boujard *et al.* (2000) reported that feed conversion efficiency of re-alimented fish were superior to controls of rainbow trout and he concluded that compensatory growth was entirely caused by an increase in growth efficiency, with no hyperphagic responses. Generally, increases in feed conversion efficiency have been reported in several species, achieving compensatory growth (Oh *et al*., 2007 and Wei *et al*., 2008).

The results (Table 1 and Fig. 1 & 2) showed that during the 4th experimental period (6-8 weeks) the superiorities of A_2, A_3, B_2, and B_3 were dropped to certain extent. SGR% of A_2 and A_3 (2.45 and 2.11, respectively) didn't differ significantly from that of the control group A_1 (2.61); FCR of A_2 (2.05) didn't differ significantly from that of A_1 (1.93); SGR% of B_3 (2.16) didn't differ significantly from that of the control group B_1 (1.84); ADG of B_3 (0.14) didn't differ significantly from that of B_1 (0.16). These results led to suggest that the compensatory response for reducing density in tilapia fingerlings was clearly evident during the first 2 weeks. Similar results were reported with Gaylord and Gatlin (2000) who showed that increase in feed efficiency of channel catfish *Ictalurus punctatus* was transient, lasting only the first 2 weeks of re-feeding.

After 8 weeks stocking density of A_3 and B_3 were re-decreased to 15/ m^2 and 30/m^2, respectively. After such reduction densities of A_1, A_2, and A_3 were adjusted at 15/m^2 and those of B_1, B_2, and B_3 were also adjusted at 30/m^2. Results indicate that another phase of compensatory growth response was noted in A_3 and B_3 groups in spite of such stocking density equalization. SGR% of A_3 (2.09) was significantly ($p \leq 0.05$) higher than those of A_1 and A_2 (1.41 and 1.33 respectively). ADG of A_3 (0.28) was significantly ($p \leq 0.05$) higher than all other experimental groups. FCR of A_3 (2.58) was significantly ($p \leq 0.05$) lower than those of A_1 and A_2 (3.87 and 3.89 respectively). Similarly, B_3 also showed the same significantly ($p \leq 0.05$) higher growth rate and lower feed conversion ratio as compared with another groups with the same density (B_1 and B_2) (Table 1).

Table 1. Two weeks interval final weight (W_f), specific growth rate (SGR % / day), feed conversion ratio (FCR), and average daily gain (ADG) of Nile tilapia fingerlings reared under different stocking strategies for 12 weeks.

Experimental period / Weeks	Trt. /density (fish/m²)	W_f (g)	SGR% /day	FCR	ADG (g/day)
I / 0-2	A_1/15	3.63[a]	6.81[a]	0.70[c]	0.16[a]
	A_2/30	3.5[ab]	6.54[ab]	0.75[bc]	0.15[b]
	A3/60	3.33[b]	6.18[bc]	0.81[b]	0.13[c]
	B1/30	3.5[ab]	6.54[ab]	0.75[bc]	0.15[b]
	B2/60	3.3[b]	6.14[bc]	0.82[b]	0.13[c]
	B3/120	2.6[c]	4.42[c]	1.31[a]	0.09[d]
	PSE	0.05	0.11	0.03	0.03
II / 2-4	A1/15	5.9[a]	3.46[a]	1.80[d]	0.16[a]
	A2/30	5.56[b]	3.31[ab]	1.90[c]	0.14[a]
	A3/60	5.11[c]	3.05[b]	2.10[b]	0.12[b]
	B1/30	5.52[b]	3.26[ab]	1.94[c]	0.14[a]
	B2/60	5.03[c]	3.02[b]	2.14[b]	0.12[b]
	B3/120	3.66[d]	2.43[c]	2.78[a]	0.08[c]
	PSE	0.07	0.08	0.9	0.05
III / 4-6	A1/15	9.12[ab]	3.11[bc]	2.05[b]	0.23[b]
	A2/15	9.56[a]	3.86[a]	1.56[c]	0.28[a]
	A3//30	8.6[bc]	3.71[a]	1.67[c]	0.25[ab]
	B1/30	7.55[d]	2.22[d]	3.15[a]	0.14[c]
	B2/30	8.02[cd]	3.33[b]	1.90[b]	0.21[b]
	B3/60	5.54[e]	2.97[c]	2.18[b]	0.13[c]
	PSE	0.23	0.17	0.18	0.01
IV / 6-8	A1/15	13.17[ab]	2.61[a]	1.93[d]	0.28[a]
	A2/15	13.38[a]	2.45[a]	2.05[cd]	0.28[a]
	A3//30	11.55[c]	2.11[ab]	2.60[b]	0.21[bc]
	B1/30	9.77[d]	1.84[b]	3.09[a]	0.16[c]
	B2/30	11.3[c]	2.48[a]	2.02[cd]	0.23[b]
	B3/60	7.51[e]	2.16[ab]	2.38[b]	0.14[c]
	PSE	0.37	0.16	0.14	0.01
V/ 8-10	A1/15	16.03[a]	1.41[c]	3.87[b]	0.20[b]
	A2/15	16.22[a]	1.33[c]	3.89[b]	0.20[b]
	A3/15	15.45[a]	2.09[b]	2.58[c]	0.28[a]
	B1/30	11.89[c]	1.4[c]	3.88[b]	0.15[c]
	B2/30	13.78[b]	1.38[c]	4.00[a]	0.17[c]
	B3/30	10.42[d]	2.34[a]	2.17[d]	0.20[b]
	PSE	0.31	0.10	0.29	0.01
VI / 10-12	A1/15	19.39[a]	1.36[b]	4.03[b]	0.24[ab]
	A2/15	19.48[a]	1.31[b]	4.22[a]	0.23[ab]
	A3/15	19.22[a]	1.55[a]	3.57[c]	0.26[a]
	B1/30	14.22[c]	1.27[b]	4.31[a]	0.16[c]
	B2/30	16.41[b]	1.24[b]	4.39[a]	0.19[bc]
	B3/30	12.93[c]	1.54[a]	3.5[c]	0.17[bc]
	PSE	0.51	0.11	0.23	0.02

[ab…]Within classification any two means having the same script are not significantly different using Duncan test $p \leq 0.05$.

Total growth and feed utilization evaluation:

Ali *et al.* (2003) reviewed the compensatory growth of fishes and he reported the degree of compensation as the attainment of a size status relative to the size achieved by an organism that has not experienced any phase of growth depression causes. He listed three degrees of compensation, 1) full compensation, when the depressed animals eventually achieve the same size at the same age as non-effected contemporaries, 2) partial compensation, when the effected animals fail to achieve the same size at the same age but do show relatively rapid growth rates, and may have better food conversion ratios when they re-allocated in favorable condition, and 3) overcompensation occurs when the animals that had experienced to un-favorable condition achieve a greater size at the same age than non-effected animals.

The results (Table 2) revealed that the final body weight of the experimental groups A_1, A_2, and A_3 (19.39, 19.48, and 19.22g. respectively) didn't differ significantly. Similarly, final body weight of the experimental group B_3 (12.93 g) didn't differ significantly from that of the control group B_1 (14.22g). These findings led to report full compensation response in Nile tilapia fingerlings reared in land based hapas when the density decreased from 30 to 15 fish /m^2 (group A_2); from 60 to 30 and then to 15 fish / m^2 (group A_3); from 120 to 60 and then to 30 fish /m^2 (group B_3) within 12 weeks rearing period. At the same time, the final body weight of B_2 (16.41g) was significantly ($p \leq 0.05$) higher than that of B_1 (14.22 g) so, over compensation response occurred when the stocking density of Nile tilapia fingerlings decreased from 60 to 30 fish /m^2 after 4 weeks within a total rearing period of 12 weeks.

Anderson and Neumann (1996) mentioned that condition factors used in stress studies, Goede and Barton (1990) referred declines in condition factor to changes in nutritional or energy status, which may be caused by external stress. The final condition factor of the experimental groups B_2 (1.95) was significantly higher than those of other groups while the lower condition factor were listed in both control groups A_1 and B_1 (1.74 and 1.78, respectively)

(Table 2). These results indicate that compensatory response for decreasing the stocking density of tilapia fingerlings may results in producing seeds with favorable higher condition factor.

The results (Table 2) pointed out that although A_2 and A_3 groups reared under higher stocking densities as compared with the control group A_1 for a periods of 4 and 8 weeks, respectively the overall SGR% of A_2 and A_3 (3.13 and 3.11 respectively) didn't differ significantly from that of the control group A_1 (3.12). Additionally, FCR of the experimental group A_3 (2.21) was significantly lower than that of the control group A1 (2.40). Furthermore, B_2 group showed significantly higher SGR% (2.93) and lower FCR (2.56) than those of B_1 (2.76 and 2.85, respectively) in spite of being reared for 4 weeks under double stocking density. These results led to suggest that observed compensatory growth response for reducing the stocking density may be utilized in producing less costly tilapia seeds even through sparing significant areas for some times or through improving the feed conversion efficiency.

Table 2. Body weight (g), total body length (Cm), condition factor (CF), specific growth rate (SGR %), and feed conversion ratio (FCR) of Nile tilapia fingerlings reared under different stocking strategies for 12 weeks.

Treatment	Body weight (g)	Body length (cm)	CF	SGR% /day	FCR
A_1	19.39^a	10.36^a	1.74^c	3.12^a	2.40^c
A_2	19.48^a	10.26^a	1.8^{bc}	3.13^a	2.41^c
A_3	19.22^a	10.16^a	1.82^{bc}	3.11^a	2.21^d
B_1	14.22^c	9.26^b	1.78^{bc}	2.76^c	2.85^a
B_2	16.41^b	9.43^b	1.95^a	2.93^b	2.56^b
B_3	12.93^c	8.9^c	1.88^{ab}	2.65^d	2.39^c
PSE	0.51	0.13	0.02	0.03	0.08

$^{ab\cdots}$Within classification any two means having the same script are not significantly different using Duncan test $p \leq 0.05$.

Body composition analysis:

The results of body composition analysis (Table 3) indicated that the control croup A_1 showed significantly lower moister content (76.4 %). As for ash content A_3 and B_2 groups expressed significantly ($p\leq 0.05$) higher ash content (4.29 and 4.49 %, respectively). The lipid content in the control group A_1 (4.66%) was significantly higher than other experimental groups. Similarly, as in lipids higher protein content was recorded in the control groups A_1 (15.39 %) followed with A_2 and B_1 (15.13 and 14.69%, respectively) while the lowest protein contents were listed in A_3 and B_3 groups (12.23 and 12.03%, respectively). Generally, higher moister and ash while lower lipids and protein were recorded in the experimental groups which perform compensatory growth response for reducing stocking density as compared with control groups. These results were in agreement with Ali *et al.* (2003) who reported that the pattern of growth compensation may vary between body components and also with Yang *et al*. (2015) who obtained lower protein and lipid with higher moisture and ash concentrations in Nile tilapia which expressed a compensatory growth response to different feeding regimes as compared to control group.

Table 3. Proximate body composition of Nile tilapia fingerlings reared under different stocking strategies for 12 weeks.

	Moister	Ash	Lipid	Protein
Initial	70.3	4.69	6.92	18.44
A_1	76.4^{c}	3.6^{b}	4.66^{a}	15.39^{a}
A_2	76.94^{c}	3.68^{b}	4.29^{b}	15.13^{a}
A_3	79.80^{a}	4.29^{a}	3.51^{c}	12.23^{b}
B_1	77.52^{bc}	3.67^{b}	4.19^{b}	14.69^{a}
B_2	79.2^{ab}	4.49^{a}	3.43^{c}	12.82^{b}
B_3	81.08^{a}	3.47^{b}	3.38^{c}	12.03^{b}
PSE	0.62	0.13	0.07	0.42

$^{ab\ldots}$Within classification any two means having the same script are not significantly different using Duncan test $p\leq 0.05$.

CONCLUSION

The results of the present study indicate that compensatory growth response occurred in Nile tilapia fingerlings after a period of growth suppression, stimulated with rearing in hapas at high densities, followed by a period under different reduced densities. Such compensation response was accompanied with lower utilized areas and better feed conversion efficiency which may help in improving tilapia commercial production.

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النمو التعويضى لممارسات استزراع مختلفة فى أصبعيات البلطى النيلى

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الملخص العربى

الهدف من هذة الدراسه هو التحقق من حدوث نمو تعويضى فى أسماك بلطى نيلى مرباه فى هابات بعد تحزينها بكثافات عاليه تتبع بفترة على كثافات منخفضه مختلفه. استخدمت أصبعيات بلطى نيلى وحيد الجنس (١.٤جرام±٠.٠٢) فى تكوين ٦ مجموعات تجريبيه وفقا لترتيب كثافات تخزين مختلفه: مجموعتين مقارنه أ١ و ب١ (١٥ و ٣٠ سمكه / م٢ على الترتيب) ، أ٢ و ب٢ (٣٠ و ٦٠ سمكه / م٢ ثم تخفض الى ١٥ و ٣٠ سمكه/ م٢ بعد ٤ أسابيع على الترتيب)، أ٣ و ب٣ (٦٠ و ١٢٠ سمكه / م٢ ثم تخفض إلى ٣٠ و ٦٠ سمكه/ م٢ بعد ٤ أسابيع ويعاد تخفيضها إلى ١٥ و ٣٠ سمكه / م٢ بعد ٨ أسابيع على الترتيب). التجربه استمرت لمده ١٢ اسبوعا ٦ فترات تجريبيه كل منها اسبوعين. تخفيض الكثافه بعد ٤ أسابيع فى المجموعات التجريبيه أ٢ و أ٣ و ب٢ و ب٣ كان مصحوبا بزياده ملحوظه فى معدل النمو النوعى وانخفاض فى معامل التحويل الغذائى خلال الفترة التجريبيه الثالثه (٤: ٦ أسابيع). تخفيض الكثافة مرة أخرى بعد ٨ أسابيع فى أ٣ و ب٣ تسبب فى مرحله أخرى من النمو التعويضى فى صورة معدل نمو و استغلال غذاء أفضل. وزن الجسم النهائى لم يختلف معنويا بين المجموعات التجريبيه أ١، أ٢ ، أ٣ (١٩.٣٩ ، ١٩.٤٨، ١٩.٢٢ على الترتيب) فى حين ان الوزن النهائى للمجموعه التجريبيه ب٢ (١٦.٤١) كان أعلى معنويا($p \leq 0.05$) عنه فى كلا من ب١ (١٤.٢٢) و ب٣ (١٢.٩٣). معدل النمو النوعى الاجمالى لم يختلف معنويا بين أ١، أ٢ ، أ٣ (٣.١٢، ٣.١٣، ٣.١١ على الترتيب) فى حين ان المجموعه التجريبيه ب٢ أظهرت معدل نمو نوعى (٢.٩٣) أعلى معنويا ($p \leq 0.05$) عن المجموعات ب١ و وب٣ (٢.٧٦ ، ٢.٦٥ على الترتيب). معامل التحويل الغذائى كان أقل معنويا ($p \leq 0.05$) فى أ٣ (٢.٢١) فى حين ان المجموعه المقارنه ب١ أظهرت أعلى معامل تحويل غذائى (٢.٨٥). محتوى الجسم من الرطوبه والرماد اتجاها الى ان يكونا أعلى فى حين ان الليبيدات الكليه والبروتين اتجاها الى ان يكونا أقل فى الجموعات التى أظهرت نموا تعويضيا عنهم فى المجموعات المقارنه .نتائج هذة الدراسه تقترح نموا تعويضيا كاملا وفوق تعويض فى أصبعيات البلطى النيلى كاستجابه لخفض الكثافه بأنظمه مختلفه وهو ما يمكن استخدامه فى معظمه الاستفادة من المساحه والغذاء فى انتاج البلطى.