EFFECT OF SEX AND AGE ON THE SURVIVAL, REPRODUCTIVE AND GROWTH PERFORMANCE OF *OREOCHROMIS NILOTICUS*

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Abstract

Seed productivity of two different age (8 and 4 months) and sizes (females 74 ± 2.65 & 39.2 ± 1.71 g. and males 99.1 ± 6.18 & 44.1 ± 5.4 g) of *Oreochromis niloticus* brooders was evaluated. Total number of 256 *Oreochromis niloticus* were divided into 4 equal groups and reared in hapas that fixed in concrete tanks (6 x 2.7 x 1.2 m) with water temperature 26-30 °C for 63 days. The first group consisted of 32 fish 8-month old females and 32 fish 4-month old males, whilst the second contain 32 fish 4-months old females and 32 fish 4 month old males. Males and females of the third and fourth groups were of the similar ages, 8-month and 4 month, respectively. A formulated diet (30 % protein) was used for feeding the resulting four groups of *O. niloticus* fry for 50 days which were reared in hapa (1 x 1 x 1 m) suspended in concrete ponds. Fry of the first group were untreated *O. niloticus* (1.3 ± 0.16 g). Fry of the second group was mono sex female *O. niloticus* (1.59 ± 0.16 g). Fry of the third group was monosex male, *O. niloticus* (1.4 ± 0.2 g) and fry of the fourth group was hybrid female *O. niloticus* and male *O. aureaus* (1.66 ± 0.14 g).

The result showed that the highest seed production (130 ± 6.16 seed/female) was obtained from the 3rd group (8 months old females and males) followed by group 1 that produced production 60 ± 1.36 seed/female (8 months old females and 4 months old males). Seed production was lowest (15±1.9 seed/female) in 4th group where 4 months old females and males were kept together. Highest relative fecundity (1.76±0.08) and highest total seed production (4160±196.98 seed) from females of the third treatment in each spawning. Lowest relative fecundity (0.38±0.05) and seed production (480±60.83 seed) were observed in the fourth treatment.

Growth rate of monosex male hybrid group was faster than that of the other groups and had final weight 7.12 ± 0.55 g with weight gain of 5.716 ± 0.72 g, while, the lowest growth rate was recorded in the first group (untreated *O. niloticus*) with final weight of 3.31± 0.18 g and weight gain of 2.02 ±

0.29 g. On the other hand, untreated fry of *O. niloticus* showed the highest survival rate (92 ± 3.61 %) followed by the hybrid *O. niloticus* (88 ± 2.65 %) and the lowest survival rate was recorded in mono sex female group (20.67 ± 2.08 %). It seems that crossing of tilapia hybrid (*Oreochromis niloticus* × *Oreochromis aureus*) broodfish to obtain tilapia hybrid fry was the best for growth performance and probably for human safety.

Key word: Reproductive performance, growth performance, *Oreochromis niloticus* age and size variations.

INTRODUCTION

Nile tilapia (*Oreochromis niloticus*) has rapidly become an important species for aquaculture, although their intensive culture remains constrained by poor synchrony and low fecundity (Mendoza *et al.* 2004). Among factors considered to be important in seed production are brood fish age and size (Berrios–Hernandez, 1979). For raising the skill of hatchery management procedures of tilapia, hatchery operations have tended to increase the number of broodfish in order to optimize tilapia seed production and guarantee mass production of homogenous stock of first-feeding fry, (Bhujel *et al.*, 2001 and Bhujel, 2000). In earthen ponds spawning takes place in April and May and may extend to November with a maximum spawning in early summer (Mires, 1983). Spawning of *Oreochromis niloticus* for production of pure or crossed fry is an established practice in fish farms. A single female may spawn three to four times during summer season. After introduction of the breeding stocks into the spawning pond the first fry are expected to be seen after three weeks. Number of eggs per spawn may differ among species, but within species the number of eggs increased with increasing weight of female (Badawy, 1993). Mohamed *et al.*, (2003) approximated egg production of only the first spawning of different sizes of Nile tilapia females, from the same age group, by a linear predictive regression curve.

One of the problems associated with tilapia culture is the early sexual maturation and uncontrolled reproduction in ponds. A great deal of work has been done looking for solutions such as manual sexing, predator stocking, hybridization,

gynogenesis and steroid-sex reversal to produce all male tilapia. Mair and Little (1991) evaluated some of these solutions, especially in the developing countries, and reported that traditional techniques have no longer been adopted widely in aquaculture. Manual sexing is laborious and requires large fish size and skill. The major disadvantages of this method are human error in sexing and the wastage of females. Intraspecific and intergenic hybridization are known to produce all-male progeny. However difficulty in maintaining pure parental stocks that consistently produces 100% male offspring, poor spawning success and incompatibility of breeders resulting in low fertility. Therefore, studies on the genetic basis of sex determination of *Oreochromis niloticus* and other *Oreochromis* species have been developed by Mair *et al.* (1991) to provide an alternative and effectual monosex breeding program for producing all- male offspring (Desprez *et al.* (2003) and for generating YY-male broodstock that could be considered safe and friendly as no hormones are applied to fish.

Relative fecundity of female *Oreochromis niloticus* ranged from 2.29 to 3.62 fry / gm of body weight in hapas throughout a spawning season (Elghobashy and Farag, 2002). Sex reversal of newly hatched fry is generally accomplished via oral administration of 17α- methyl testosterone (MT), which has been incorporated into a starter fish feed at 60 mg MT / kg feed for 28 days (Popma and Green, 1990).

Hybridization of two fish species might result in a monosex population or highly skewed sex ratios (Pruginin *et al.*, 1975). Some of the best examples were those of tilapia hybrids where several hybrid combinations of tilapia species resulted in mono sex or skewed male percentage populations (Wohlfarth and Hulata, 1983). All male hybrids grew faster than mixed sex parental groups primarily because of the slower growth rates of females in the parental groups. Some experiments indicated that male hybrids grow faster than males of the parent species Smitherman *et al.* (1984).

Feminization of sexually undifferentiated tilapia progeny from normal crosses has been achieved by many authors (Rosenstein and Hulata, 1994; Mair and Santiago, 1994 and Mohamed *et al.*, 2004) in *Oreochromis niloticus* and in a

number of other *Oreochromis* species. Sex reversal of tilapia either by feminization or masculinization must begin before the gonadal tissue of fry has differentiated into testes or ovaries. Functional sex reversal is most easily achieved through oral application of estrogens or androgen incorporated into the feed and administered during the period of sex differentiation which is believed to be 30 days according to Alvendia-Casauay and Carino (1988). However, Popma and Green (1985) reported that fry can be effectively sex reversed in 20 days, but occasionally only 95% of the fry develop as phenotypic males. They also stated that the labile period sex reversal success is very wide ranging from 25 to 59 days in *O. niloticus*

The aim of the present study was to evaluate the reproductive capability so growth performance as well as survival of different ages and weight groups of *Oreochromis niloticus* females throughout successive spawning to establish possible broodstock management strategies that may be adopted by hatcheries to improve large scale fry production.

MATERIALS AND METHODS

Two different age and size groups of *Oreochromis niloticus* females and males brooders, 8 and 4 months old having average body weights of 74 ± 2.65 & 39.2 ± 1.71 g. and 99.1 ± 6.18 & 44.1 ± 5.4 g, for females and males respectively, were assessed throughout 3 successive harvestings seasons, at an interval time of 21 days. Four experimental groups were demand among 12 concrete ponds (6 x 2.7 x 1.2 m) with 3 replicate in each. Individual experimental groups contain 32 female and 32 male. The first group contained females, 8 months old (74 ± 2.65 g.) and 4 months old males (44.13 ± 2.35 g.). Second group contained 4 months females (39.2 ± 1.71 g.) and 8 months old males (99.1 ± 4.71 g.). Third group contained 8 months old females (74.03 ± 1.00 g.) and 8 months old males (99.1 ± 6.18 g.) and fourth group contained 4 months females (39.23 ± 1.27 g.) and 4 months males (44.07 ± 2.72 g.). The experiment lasted 63 days through April and May. Fish were fed 6 days a week and water was

renewed every week. Water temperature ranged 26 to 30 °C during the experimental course.

An artificial diet (30 % protein) was used for feeding the resulting four groups of *O. niloticus* fry with 3 replicates each for 50 days. Each replicate contained 100 fry reared in a hapa (1 x 1 x 1 m) which was suspended in the experimental concrete pond. Fry of the first treatment was produced from normal *O. niloticus* (1.3 ± 0.16 g.). Fry of the second treatment (1.59 ± 0.16 g.) yielded mono sex *O. niloticus* females (After the yolk sac absorption period, according to Mohamed *et al.*, 2004 and Farag *et al.*, 2007 using the same feminizing agent, 17-β-ethynylestradiol. Fry were fed 6 days a week for 4 weeks on feminizing agent feed treated with 17-β-ethynylestradiol, 150 mg/kg feed). Fry of the third treatment (1.4 ± 0.2 g.) was *O. niloticus* monosex males produced according to Guerrero and Guerrero (1988) and Popma and Green, (1990) using 17α- methyl testosterone (60 mg/kg feed). Fry of the fourth treatment (1.66 ± 0.14 g.) was hybrid from female *O. niloticus* and male *O. aureaus* adopting the same methodology in Pruginin *et al.* (1975) and Wohlfarth & Hulata (1983).

Analysis of variance and Duncan's (1955) multiple range tests were used to detect differences in seed production due to treatment effects.

RESULTS AND DISSCUSION

Table (1) showed that the highest seed production (130 ± 6.16 seed/female) expressed in terms of seed/female, was obtained from the third group where 8 months old females and males, respectively, were utilized. Brood of this group had the largest size, (74.03 ± 1.002 g.) and (99.0 ± 6.2 g.). This is followed by group (1) was 60 ± 1.36 seed/female produced from 8 months old females (74 ± 2.65 g.) and 4 months old males (44.13 ± 5.4 g.). Seed production of the smallest brood 4-months females was 39.23±1.97g and males was 44.07±2.7 g. Group (4) was the lowest seed production (15±1.9 seed/female). Data showed that highest relative fecundity (1.76±0.08) and highest total seed production (4160±196.98

seed) were observed from females of the third group. However, lowest relative fecundity (0.38±0.05) and seed production (480±60.83 seed) showed in the fourth group.

Seed productions were recorded increased gradually with increasing brood body weight (group 1 &3). This trend coincides with Badawy (1993) who reported that egg production increased with increasing female's weight. The present results were in agreement with those obtained by Elghobashy and Farag (2002). They found that *O. niloticus* fry production ranged from 154.24 to 220.4 fry / female / spawn in hapas, also with those recorded by Farag, (2003) who found that the number of fry / g female body weight for *O. niloticus* female was 1.81±0.42 fry/g.

According to the results obtained by Hughes and Behrends (1983), Siraj *et al.* (1983) and Watanabe and Kuo (1985) the egg and fry production of females of group 1&3 was expected to be much greater number than that of the younger females of group 2 and 4. Statistical analysis showed that a simple linear equation could be used for producing the number of seed/harvest in relation to the body weight of females for group 1 and 3 : $y = 1.9152 x - 18.496$, where Y = number of seed per harvest and X = weight of female brooder.

Growth and gonadal development in fish, as in all vertebrates, are controlled, in part, through the orderly release of hormones from the neuroendocrine system. Supplementation of diets with steroids accelerates fish growth (Sindhu and pandian, 1984). As demonstrated in Tables (2 & 3) growth rate of hybrid males group was faster than that of other groups followed by mono sex male group. These results an agreement with that of Smitherman *et al.* (1984) who illustrated that male hybrid grow faster than mixed sex parental groups, primarily because of the slower growth rates of females. Pruginin *et al.* (1975) found that male hybrids produced by crossing *O. niloticus* × *O. hornorum* grew 30 % faster than mixed sex fingerlings of *O. hornorum* over a 126 days growing period. They found that fish received 60 mg MT / kg of feed during the hormone treatment period was 13.2 % larger than the non-treated fish.

Lowest growth rate in the first group (untreated *O. niloticus*) fry where average final weight was 3.31±0.18 g and weight gain was 2.02 ± 0.29 g followed by mono sex female group with final weight of 4.21±0.3 g and weight gain of 2.56 ± 0.21 g. Similar results were obtained by Piferrer and Donaldson (1992) who found that the mean of body weight of fry treated with 17β-estradiol or 17∝-ethynylestradiol was higher than those in the control group. The present results were also in agreement with those obtained by Guerrero and Guerrero (1988) who reported that tilapia masculinized with MT grew faster than both females and untreated males.

The mean percentages of survival rate of fry mixed *O. niloticus* had the highest survival rate (92 ± 3.61 %) followed by the hybrid *O. niloticus* (88 ± 2.65 %), while, the smallest percentages of survival rate was observed in mono sex female group (20.67 ± 2.08 %). The present results similarly to Lovshin (1977) found that survival rate of tilapia hybrids (female *O. niloticus* × male *O. hornorum*) ranged from 94 to 100 % while, Guerrero (1975) found no significant difference in survival rate between *O. aureus* fry treated with MT at the dose of 15, 30 and 60 mg /kg of feed for 120 days and the control. On the other hand, Jensen and Shelton (1979) found that there were no significant differences in simulate between O. *aureus* reared for 5 weeks and fed on different doses of estrogen and the control. The author obtained a survival rate ranged from 95 to 100 %.

The present results showed that tilapia hybrid (♀*Oreochromis niloticus* ×♂*Oreochromis aureus*) fry was probably the best for growth performance and for human safety.

Table 1. Effect of size variation on reproductive performance of *Oreochromis niloticus.*

Treatment	Initial						Final		
		weight		length	Condition factor		weight		length
	Mean	±SD	Mean	±SD	Mean	±SD	Mean	±SD	Mean
Oreochromis niloticus	1.298	0.16	3.02	0.28	4.93	1.54	3.31	0.18[d]	5.56
Mono sex female	1.655	0.14	4.50	0.45	1.92	0.64	4.21	0.30[c]	6.06
Monosex male	1.585	0.16	4.11	0.86	2.81	1.57	5.92	0.55[b]	6.56
Hybrid (O. n. x O. a.)	1.40	0.2	3.50	0.58	3.71	1.63	7.12	0.55[a]	7.06
F value							160.1		6.42
probability							0.0001		0.0014
Significance							***		**

Table 2. Growth performance of varied sex *Oreochromis niloticus* through the 50 days of

Treatment	Initial						Final		
		weight		length	Condition factor		weight		length
	Mean	±SD	Mean	±SD	Mean	±SD	Mean	±SD	Mean
Oreochromis niloticus	1.298	0.16	3.02	0.28	4.93	1.54	3.31	0.18[d]	5.56
Mono sex female	1.655	0.14	4.50	0.45	1.92	0.64	4.21	0.30[c]	6.06
Monosex male	1.585	0.16	4.11	0.86	2.81	1.57	5.92	0.55[b]	6.56
Hybrid (O. n. x O .a.)	1.40	0.2	3.50	0.58	3.71	1.63	7.12	0.55[a]	7.06
F value							160.1		6.42
probability							0.0001		0.0014
Significance							***		**

Table 3. Weight gain, specific growth rate and survival rate for different sexes of *Oreochromis niloticus* through 50 days

Treatment	weight gain	(g)	Specific growth rate		Survival rate	(%)
	Mean	±SD	Mean	±SD	Mean	±SD
Oreochromis niloticus	2.02	0.29^{d}	0.02	0.003^{c}	92	3.61^{a}
Mono sex female	2.56	0.22^{c}	0.02	0.001^{c}	20.67	2.08^{c}
Monosex male	4.33	0.68^{b}	0.03	0.004^{b}	35	2^{b}
Hybrid (O. n. x O. a.)	5.72	0.72^{a}	0.03	0.004^{a}	88	2.65^{a}
F value	103.27		40.86		561.24	
probability	0.0001		0.0001		0.0001	
Significance	***		***		***	

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أثر الحجم والعمر علي النمووالأداء التناسلي لأسماك البلطي النيلي

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المعمل المركزي لبحوث الثروة السمكية

تم عمل دراسة لتقييم إنتاجية الزريعة لاربع مجموعات من أمهات البلطي النيلي ذات عمرين ٨ ، ٤ شهور و بمتوسط وزن للاناث ٧٤±٢,٦٥ ، ٣٩,٢±١,٧١ جم و للذكور ٩٩,١ ± ٦,١٨ ، ٤٤,١±٥,٤ جم في أحواض خراسانية. المجموعة الأولي كان عمرها ٨ شهور للاناث و٤ شهور للذكور ، وعمر المجموعة الثانية ٤ شهور للاناث و٨ شهور للذكور، والمجموعة الثالثة كان عمرها ٨ شهور للاناث و٨ شهور للذكور والمجموعة الرابعه كان عمرها ٤ شهور للاناث و٤ شهور للذكور. تراوحت درجة الحرارة أثناء التجربة بين ٢٦- ٣٠°م. واستمرت التجربة لمدة ٦٣ يوما تم صيد الأحواض فيها ٣ مرات كل ٢١ يوما لتجميع الزريعة والبيض فى ١٢ حوض خراسانى (١,٢x٢,٧x٦ متر). وكذلك تم عمل دراسة لتقييم معدلات النمو والحياه لاربع مجموعات من زريعه مختلفه من البلطى النيلى فى هابات ١x١x١ متر مثبته فى احواض خراسانيه لمدة ٥٠ يوم مغذاه على عليقه ٣٠ % بروتين حيوانى. المجموعه الاولى زريعه مختلطه من البلطى النيلى (١,٣±٠,١٦ جم) والمجموعه الثانيه وحيد جنس اناث من البلطى النيلى (١,٥٩±٠,١٦ جم) والمجموعه الثالثه وحيد جنس ذكورمن البلطى النيلى (١,٤±٠,٢ جم) والمجموعه الرابعه وحيد جنس هجين من اناث البلطى النيلى مع ذكور البلطى الاوريا (١,٦٦±٠,١٤ جم).

كانت أعلي إنتاجية من الزريعة والبيض هي من أمهات المجوعة الثالثة حيث عمرالاناث والذكور ٨ شهور وصلت إنتاجيتها ١٣٠±٦,١٦ زريعه لكل أم في التفريخه الواحده، تلاها إنتاجية أمهات المجموعة الاولى ٦٠±١,٣٦ زريعه لكل أم في التفريخه الواحده حيث عمرالاناث ٨ شهور والذكور٤ شهور ، بينما اقل إنتاجية لأمهات المجموعة الرابعه ١٥±١,٩ زريعه لكل أم في التفريخه الواحده حيث عمرالاينات ٤ شهور والذكور٤ شهور. ومن الجزء الثانى من التجربه لوحظ أعلى معدل نمو فى المجموعه الثانيه حيث زريعة وحيد الجنس الهجين من البلطى النيلى والاوريا حيث متوسط الوزن النهائى كان٧,١٢±٠,٥٥ جم واعطى وزن مكتسب ٥,٧١٦±٠,٧٢ جم بينما اقل معدل نمو فى المجموعه الاولى حيث البلطى النيلى المختلط

حيث متوسط الوزن النهائى كان ٣,٣١±٠,١٨ جم وأعطى وزن مكتسب ٢,٠٢±٠,٢٩ جم خلال فترة التجربة. بينما اعلى معدل احياء (٩٢±٣,٦١%) كان فى زريعة البلطى النيلى المختلط يليه زريعة البلطى النيلى وحيد الجنس الهجين (٨٨±٢,٦٥%) ولكن اقل معدل احياء فى البلطى النيلى وحيد الجنس الاناث وكان ٢٠,٦٧±٢,٠٨%.

تتلخص هذه الدراسة إلى أن متوسط عدد الزريعة كان يزداد بأزدياد وزن الأمهات وأن تزاوج اناث البلطي النيلي مع ذكور البلطي الاوريا للحصول على زريعة البلطي الهجين تعطي أفضل النتائج بالنسبة لمعدلات النمو وأكثر أمنا للبيئة والانسان من استخدام الهرمونات فى الانقلاب الجنسى للاسماك.