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Effect of Stocking Density on the Growth Performance of Sex-Reversed Nile Tilapia (*Oreochromis niloticus*) Fingerlings Fed Unhatched Chicken Egg Diet

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Abstract: This study was conducted to investigate the effect of stocking density on the growth performance of sex-reversed Nile tilapia fingerlings; *Oreochromis niloticus* fed unhatched chicken egg diet. The male and female tilapias having an average weight of 500 g were paired up in two fiber glass tanks and hand-fed commercially available floating feed (45% protein) two times daily to satiation. Natural spawning of fish was allowed. The fries were treated with 17-α-methyltestosterone for 21 days. The fingerlings were stocked at three stocking densities (32 fish m^{-3}, 63 fish m^{-3} and 95 fish m^{-3}) in nine (9) circular fiber glass tanks, each with capacity of $3.08m^{-3}$ of water at a nominal flow rate of 2L/min and fed unhatched chicken egg diet throughout the experimental period (12 weeks). The tank was mounted indoor in a semi-flow through and arranged in a row. The results of the study showed that fish stocked at the lowest stocking density (32 fish m^{-3}) had a significantly higher ($P<0.05$) mean weight gain and better Feed Conversion Ratio (FCR) when compared to other treatments. No significant differences were observed in the Specific Growth Rate (SGR) between the treatments. Fish fed with unhatched chicken egg diet and stocked at 32 fish m^{-3} consumed significantly less feed when compared to other treatments. However, there was a significant difference among the treatments ($P<0.05$). Survival rates were high in all treatments and were not affected by density. The findings of this study demonstrated the enhanced growth performance of the androgen treated Nile tilapia fed unhatched chicken egg diet at the three stocking density. Based on the overall results, the lowest stocking density (32 fish m^{-3}) could be more preferred.

Key words: Nile Tilapia · Sex-Reversed · Unhatched Chicken Egg · Growth · Stocking Density

INTRODUCTION

Tilapia that is native to Africa and Middle East has emerged from mere obscurity to one of the most productive and internationally traded food fish in the world [1]. Farmed tilapia production throughout the world increased dramatically in recent years, increasing from 383,654 mt in 1990 to 2,326,413 mt in 2006 [2]. Because of their faster growth rate, tolerance to harsh environment and ease culture technique, tilapia offers the possibility of commercial and home-grown protein sources where wild capture fisheries are being depleted [3].

One of the major drawbacks in commercial tilapia production is the precocious maturity and following uncontrolled reproduction, resulting in increasing competition for feed followed by stunted growth and low commercial value [4, 5]. Monosex population systems show several advantages over mixed sex production systems like the choice for the faster growing sex of the species to be produced, lower environmental impact through escapes, preventing energy diversions into gonad production, courtship behavior and unwanted reproduction, reducing aggressive interactions during courtship behavior and larger uniformity of size at harvest [6]. In small scale Nile tilapia farming systems in Africa, only monosex production systems were found to be financially sustainable on a long term basis with mixed sex culture being unprofitable and culture systems include predator control, being an intermediate solution [7, 8].

Hormonal treatment is frequently used to sex reverse tilapia and achieve male monosex populations [6]. Several hormones and hormone analogues are used to achieve this goal. Among the most frequently used synthetic hormones is 17-α-methyltestosterone (MT) which works well in at least 23 species belonging to six families, namely Salmonidae (8 species), Cichlidae (5 species), Cyprinidae

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(5 species), Anabantidae (1 species), Poecilidae (3 species) and Cyprinodontidae (1 species) [9]. According to Gupta and Acosta [1], the technique, which involves the addition of steroids in feeds for a short period during the fry stage, proved to be easily applied, relatively consistent in producing nearly all male populations has been widely practiced by fish farmers.

Unhatched chicken egg which comprises of eggshell, infertile egg and culled chicks are by products from poultry production. If properly hydrolyzed can be used in fish feed formulation. It is rich in indispensable amino acids such as cysteine, threonine and arginine and pepsin digestible protein [10]. Although several works have been done using poultry by products in the formulation of feed for farmed animals [11-13], there is still a dearth of information on the grow-out performance of androgen treated monosex *Oreochromis niloticus* fingerlings fed unhatched chicken egg. Thus, the main objective of this study was to establish the optimal growth performance of sex reversed Nile tilapia fingerlings fed unhatched chicken egg as a rich-source of protein at three stocking densities.

Methodology: The study was conducted at the Nigerian Institute for Oceanography and Marine Research (NIOMR), Sapele, Delta State, Nigeria. Nine (9) circular fiber glass tanks were used, each with capacity of $3.08m^{-3}$ of water at a nominal flow rate of 2L/min. The tank was mounted indoor in a flow through and arranged in a row. Nile tilapia, *O. niloticus* broodstock were procured from the NIOMR farm and acclimatized for a week. The male and female tilapias were paired up in the fiber glass tank. After natural spawning, the parents were removed while the fries were fed formulated feed with 17α-methyltestosterone for 21 days. Thereafter, the fries were fed Coppens® feed until they grew to fingerling stage. The unhatched chicken eggs were collected from the hatchery unit of Zartech Farms, Sapele, Delta State, Nigeria. The unhatched chicken eggs were boiled at 100ºC for 30 minutes, oven dried at 102ºC and finally sun dried for 4 days; milled and incorporated into the experimental diet as the main source of protein. The fingerlings were stocked at three stocking densities (32 fish m^{-3}, 63 fish m^{-3} and 95 fish m^{-3}) and fed unhatched chicken egg diet throughout the experimental period. Proximate analysis of the unhatched chicken egg diet was carried out. Sampling of the cultured fish was carried out bi-weekly for a period of 12 weeks for the collection of data to determine the variation among the treatments. Throughout the entire culture period different water quality parameters like temperature, dissolved oxygen, pH, nitrate, nitrite and total ammonia were regularly monitored. Data collected were subjected to statistical test using analysis of variance (ANOVA). Mean separation was done using Duncan Multiple Range Test and Least Significant Difference. All tests were carried out at 5% probability level (P<0.05). The Genstat Statistical Package (version 8.1) was used for the analysis.

RESULTS

The data for the proximate analysis of the tested diet (g/100g DM) is presented in Table 1. At the end of the experiment (12 weeks), the growth parameters were significantly affected by density. The highest mean weight gain of 69.19 g was recorded for Treatment I that was stocked at 32 fish m^{-3} while the least mean weight gain of 63.73 g was observed in Treatment III stocked at 95 fish m^{-3}. In general, final mean weight increased with decreasing stocking density. However, the fish growth rate proceeded in a linear fashion throughout the treatment as shown in Fig. 1. No significant differences were observed in Specific Growth Rate (SGR) between the treatments (Table 2).

Table 1: Proximate compositions (g/100 g DM) of unhatched chicken egg diet

Nutrients (%)	Unhatched chicken egg diet
Dry matter	87.5
Crude protein	38
Crude fiber	12
Ether extract	25
Ash	18
Calcium	10
Phosphorus	0.6
Nitrogen Free Extract	7

Table 2: Growth performance of *Oreochromis niloticus* fed unhatched chicken egg diet

	TREATMENTS		
Parameters	I	II	III
Initial mean weight (g)	1.15^{a}	1.09^{a}	1.02^{a}
Final mean weight (g)	70.34^{a}	66.75^{b}	64.75^{c}
Mean Weight gain (g)	69.19^{a}	65.66^{b}	63.73^{c}
Specific Growth Rate (%/day)	4.88^{a}	4.88^{a}	4.92^{a}
Survival rate (%)	81.67^{c}	87.50^{b}	98.90^{a}
Feed intake (g feed/fish)	69.86^{c}	125.88^{b}	229.57^{a}
Feed conversion Ratio	0.99^{c}	1.89^{b}	3.55^{a}

abc: Means with different superscripts in the same row are significantly different (P < 0.05)

I = 32 fish/m^3 II = 63 fish/m^3 III = 95 fish/m^3

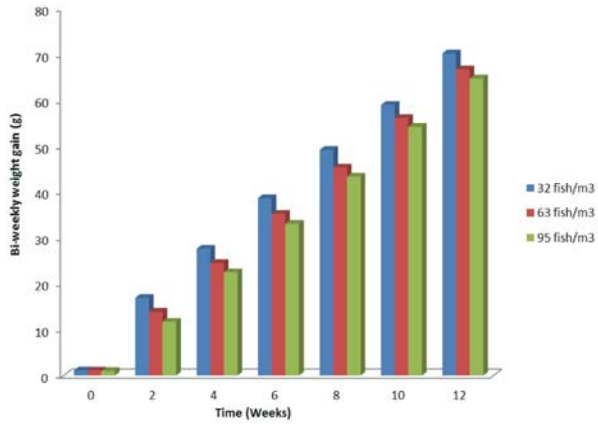

Fig. 1: Bi-weekly weight gain of *Oreochromis niloticus* stocked at different stocking densities and fed unhatched chicken egg diet.

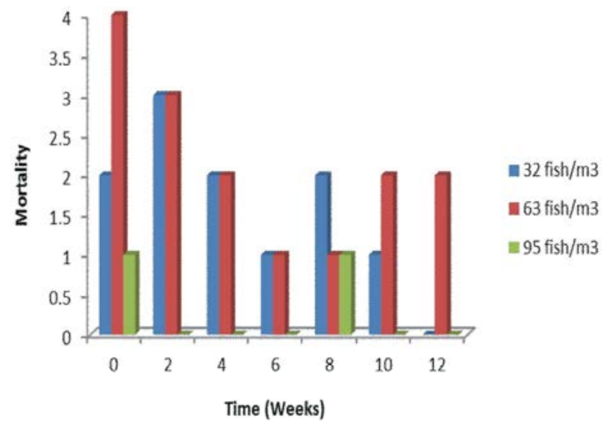

Fig. 2: Mortality of stocked fish fed unhatched chicken egg diet at various stocking densities over time.

Survival rate exceeded 80% in all treatments (Table 2) but there were significant differences among the treatments. The highest survival rate of 98.9% was recorded in Treatment III.

The result of the feed intake shows that there was a significant difference among the treatments ($P<0.05$). Each feed intake increased progressively from a low of 69.86 g for Treatment I to a high of 229.57 g for Treatment III. The result of the study indicates that fish fed with unhatched chicken egg diet and stocked at 32 fish m^{-3} in Treatment I consumed significantly less feed when compared to other treatments.

Feed conversion ratio (FCR) varied significantly among the treatments. The research findings shows that fish fed with unhatched chicken diet and stocked at 32 fish m^{-3} in Treatment I had the lowest FCR of 0.99 while Treatment III with fish stocked at 95 fish m^{-3} had the highest FCR of 3.55 as shown in Table 2. Thus, fish stocked at 32 fish m^{-3} in Treatment I had the best FCR.

DISCUSSION

The results of the study as shown in Figure 1 shows that growth rate were favorable in Treatment I with fish stocked at the lowest stocking density of 32 fish m^{-3}. The highest mean weight gain of 69.19 g observed in Treatment I could be as a result of the low stocking density. This is in accordance with [14] who reported that sex-reversed Nile tilapia stocked in ponds at a low density of 3 fish m^{-2} had higher growth than at a higher density of 6 and 9 fish m^{-2}. In water re-circulating tanks, [15] obtained a significantly higher mean daily weight gain (0.77 g $fish^{-1}day^{-1}$) for 75 g male red tilapia hybrid stocked at a density of 50 fish m^{-3} compared with stocking densities of 100 and 200 fish m^{-3}. The linear increase in the mean body weight with time observed in all treatments of this study (Fig. 1) indicated the favorable environmental conditions for growth and that the maximum carrying capacity of the system was not reached [16]. On the other hand, [17, 18] reported that stocking density is an inhibitory factor for fish growth and this could be attributed to the lowest weight gain recorded in Treatment III stocked at 95 fish m^{-3}. Similarly, [19] stated that increased fish biomass of Nile tilapia in cages had a significant negative effect on the final mean body weight. Helser and Almcida [20] and Nameho *et al*. [14] also argued that competition for food and living space could also be a possible factor. According to Ouattara *et al*. [21], increased stress could also be an inhibitory factor.

Survival rate were not affected by stocking density (Fig. 2) which is consistent with [22] who reported that mortality in Nile tilapia raised in cages was not dependent on stocking density [23, 24] also argued in favor of the above statement that survival rate is not dependent on stocking density. In view of these, it could be asserted that the highest survival rates of 98.9% recorded in Treatment III with fish stocked at highest stocking density of 95 fish m^{-3} could be attributed to favorable water quality parameters maintained during the culture period.

The highest feed intake recorded in Treatment III with fish stocked at the highest stocking density (Table 2) is not in agreement with the research findings reported by Clark *et al*. and Zonneveld and Fadholi [25, 26] for red tilapia.

The feed conversion ratio (FCR) of 0.99 recorded in Treatment I as shown in Table 2 is an indication that *O. niloticus* fed unhatched chicken egg diet converted the feed better to flesh. Bhikajee and Gobin [27] stated that lower FCR indicate more efficient extraction of nutrients from the food and conversion into flesh.

CONCLUSION

This study clearly demonstrated the enhanced growth performance of androgen treated monosex *Oreochromis niloticus* fed unhatched chicken egg meal at three stocking densities. Therefore, it appears that growing the androgen treated monosex *O. niloticus* using unhatched chicken egg meal as a rich-protein source at a lower density of 32 fish m^{-3} would be more preferred. The culturing of the species at a lower stocking density using a low cost diet would also enhance the growth performance of the species and thus control the undesirable reproduction in tilapias. However, further research is needed to ascertain the digestibility coefficients of the tested feed ingredients in the formulated diet. The gonadal development of the androgen treated monosex *O. niloticus* should also be thoroughly examined.

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