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Fry Production in Tilapia Rendalli Stocked in Suspended Earthen Pond Hapas at Different Sex Ratios

Research Article

Chapweteka D[1], Mzengereza K[1*], Zidana H[2]

[1] Department of Fisheries Science, Mzuzu University, Private Bag, Mzuzu, Malawi.
[2] National Aquaculture Center, Department of Fisheries, Ministry of Agriculture, Domasi, Malawi.

Abstract

The study was conducted to determine fry production and the survival rate of fry in different sex ratios of Tilapia *rendalli* reared in hapas. The fish were stocked at 3 fish /m^3 and was replicated three times for each sex ratio of 1♂:1♀ , 1♂:3♀ and 1♂:5♀ (male: female).The experiment was conducted for 90 days. Data was analyzed in SPSS (16) where one way ANOVA was performed. The results showed that number of fry produced at different sex ratios were significantly different ($P<0.05$), with sex ratio of 1:5 producing a highest number of fry (422.80 ± 1.19) as compared to the other treatments. This study has also shown that, a difference in sex ratio may also affect the survival rate of the fry, this may be due to number of fry produced to a specific sex ratio, in this case the low number of fry produced the higher the survival rate.

Keywords: *Tillapia rendalli*; Sex Ratio; Survival; Fry Production.

Introduction

Reproductive success in fish has been shown to be influenced by myriad factors some of which are the following; brood stock quality, sex ratio, stocking density, age, size, nutrition and feeding regime [9]. Sex ratio provides information on the representation of male and female fish by stating the proportion of male fish to female fish in a population and indicates the dominating sex of fish in a population which constitutes basic information in assessing reproductive potentials and estimating stock size in fish population [21]. In order to determine female spawning biomass, estimates of reproductive potential can be added to sex ratio information to give a better understanding and assessment of status of the stock relative to a biological indicator, which has been observed for some fish stocks [13].

Tilapias are among the known hardy species of fish. They tolerate and survive in relatively poor environmental conditions such as high stocking density, extremely poor water quality parameters e.g. low dissolved oxygen level, high ammonia and low temperatures and organically polluted water. Tilapias are also resistant to diseases [6]. In addition, Tilapias have the ability to tolerate wide range of salinity levels and they thrive well in culture environments [16]. Furthermore, Tilapias reproduce easily in captivity, have short food chain and convert remaining food and domestic wastes into high quality protein and grow fast, and are delicious. These characteristics provide the farmers a relatively low cost of production and make Tilapias among the excellent fishes for culture.

Tilapia is usually cultured in ponds, net cages (hapas) and concrete tanks [1]. Production of fry and fingerlings in hapas has several advantages. Hapas have the advantage as they can be placed in existing bodies of water where other fish species are present and do not require pond draining before the fry can be harvested [2]. Secondly, hapas are designed to allow the fish to be collected at one end so that the female can be removed with minimum disturbance to examine eggs or sac fry and this reduces biological stress of handling.

Tilapia rendalli feed at low trophic levels as they feed largely on macrophytes, it is resistant to stress and diseases, tolerance to a wide range of environmental conditions such as temperature, fairly fast growth and ability to reproduce readily in captivity and does not incubate eggs in the mouth, females do not stop feeding when breeding.

***Corresponding Author**:
Mzengereza K,
Mzuzu University, Department of Fisheries Science, Private Bag 201, Mzuzu, Malawi.
E-mail: kumbumzenge@gmail.com

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Although aquaculture has the potential to eliminate the supply gap (scarcity) of fingerlings, most fish farmers in the developing world are unable to access the fingerlings because of low production. Low production of Tilapia fingerlings could be attributed to very low density of brood stock, lack of spawning techniques, poor brood stock nutrition, high fry mortality, and in-appropriate sex ratio [17]. According to Khalfalla et al., (2008) [9] choosing the appropriate sex ratio of brood fish can help to improve fry production, reduce wastage of resources and reduce cost of production.

The sex ratio (ratio of fertilizable females to sexually active males at a given time) is a fundamental factor influencing the level of sexual selection. Besides, the overall adult sex ratio is a principal factor affecting sexual competition. If the adult sex ratio is biased towards one sex, potential rates of reproduction may not suffice extrapolating the trend of sexual competition. The sex ratio can also be influenced by the distribution of individuals in time and space, temperature and precopulatory guarding of multiple mates [5].

The present study was aimed at determining the appropriate sex ratio on fry production of *Tilapia rendalli* reared in hapas.

Methodology

Study area

The study was conducted at National Aquaculture Centre (NAC) in Domasi, Zomba, district (Figure 1) from January to April 2016.

Study design

Two hapa nets (Figure 2) with mesh size of 1.5 mm were installed in an earthen pond. There were 9 compartments (Figure 2) in each hapa of $15m^3$ in size. Brooders averaging 50g were stocked at a density 4 fish/m^3. The brood stock were fed isonitrogenous (23% CP) at 5% body weight twice a day. The experiment was laid out in Completely Randomised Design (CRD) and each treatment were replicated three times.

Data collection

Sampling was done every two weeks where fry were counted (Figure 3) in each hapa and thereafter transferred to a separate hapa to avoid cannibalism. Fry from the previous sampling periods were concurrently counted to deduce survival rate.

Survival rate

Survival rate (%) = (Total number of fry counted/Number of fry stocked) × 100

Water quality parameters

Water temperature, Dissolved Oxygen and pH were determined in the morning around 8.00 am and late in the afternoon around 4.00 pm using Horiba U–10 water checker.

Data analysis

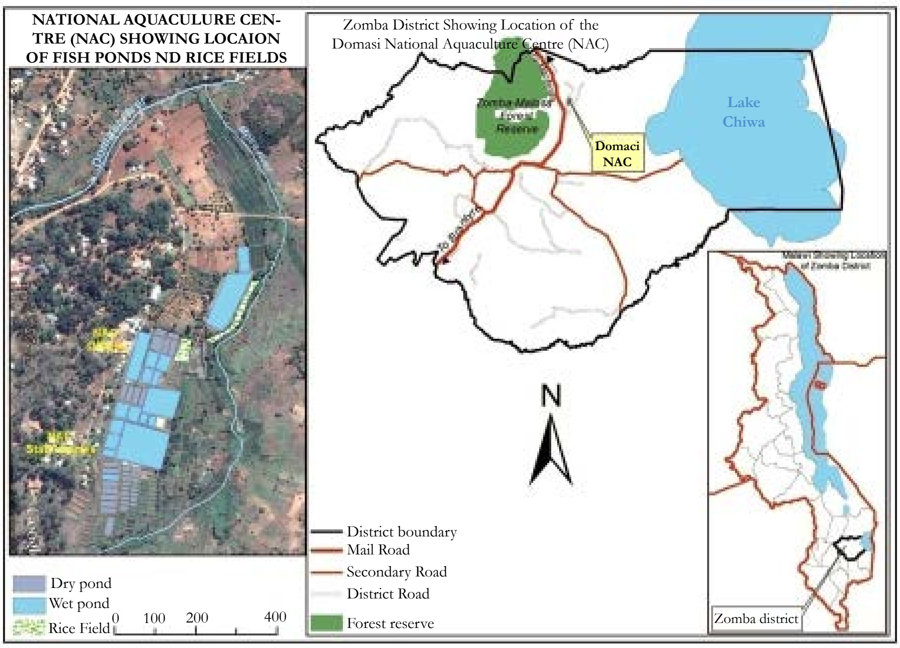
Data was analysed using Statistical Package for Social Scientist (SPSS) version 20. One way Analysis of Variance (ANOVA) was used to compare the treatment means at 95% confidence level, and Duncan Multiple Range Test (DMRT) was used to separate significantly different means. Microsoft excel was used in the production of figures and graphs.

Results

Number of fry

The results (Table 1) of the present study show that the number

Figure 1. Map of Zomba district.



National Aquaculture center

Figure 2. Layout of Hapas.

Figure 3. Fry counting.

Table 1. Effect of sex ratio on fry production.

Sex ratio	Number of fry produced
1:1	386.33±1.27^{c}
1:3	392.47±1.07^{b}
1:5	422.80±1.19^{a}

Values (Mean±SE) in a column with different superscript letters are significantly different (P<0.05); Where Treatment 1 (1:1 sex ratio), Treatment 2 (1:3 sex ratio) and treatment 3 (1:5 sex ratio).

of fry from different, Sex ratios (treatments) were significantly different (P<0.05) where by treatment 3 had a higher number of fry compared to the treatment 1 and 2.

Survival rate of fry

The results (Figure 4) of the present study show that there was a significant difference (P<0.05) in of survival rate among the treatments.

The result (Figure 4) show that treatment 1and 2 were almost the same as shown on the mean in the table. It also shows that treatment 1 and 2 had a high mean survival compare to treatment 3.

Water quality parameters

There were no significant differences (P<0.05) in water quality parameters. Thus, the differences in number of fry produced and survival for different treatments cannot be attributed to water quality.

Discussion

Effect of sex ratio on fry production

The present study show that the number of fry from different sex ratios (treatments) were significantly different (P<0.05). Treatment 3 had more number of fry (422) followed by treatment 2 (392) and finally treatment 1 (386) (Table 1). This is in agreement with a study by Torrans and Hiott (1990) [19] who reported that higher production of bait-or forage-sized blue tilapia were at the highest female density than those at lower densities. Similarly, Bautista et al. (1988) [1] reported the best seed production of Nile tilapia (*Oreochromis niloticus*) at a sex ratio of 1: 4 at a broodstock stocking density of 4 fish/ m^2.

Figure 4. The effect of sex ratio on fry survival rate.

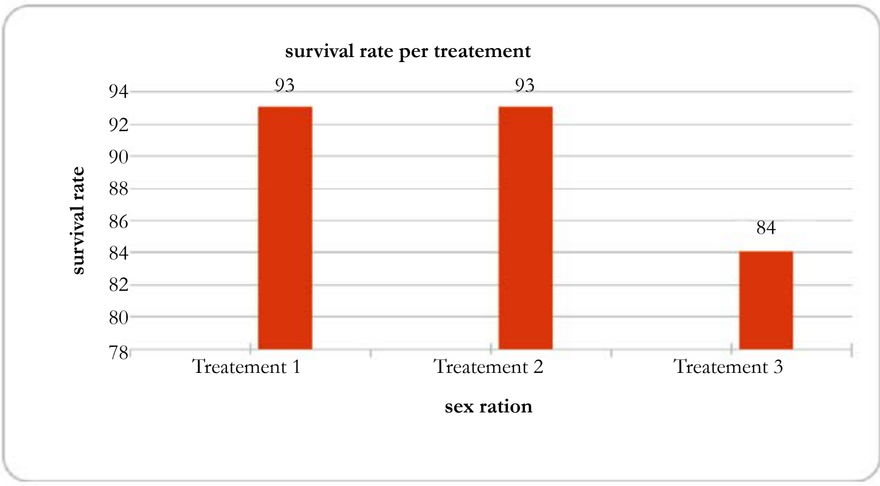


Table 2. Water quality parameters(mean ± SE).

	Mean water Score		
	temperature (°C)	pH	Dissolved oxygen
Minimum	26.9^a±1.7	7.0^a±0.3	7.44^a±0.9
Maximum	33.7^a±1.7	8.7^a±0.3	8.45a±0.5

Values are significantly different at (P<0.05)

Elsewhere, Muntaziana et al., (2011)[12] reported that some unfertilized eggs were observed in the first clutch of 1:1 sex ratio than 1:3 sex ratio treatment. This might have been due to competition between males during spawning activity that caused some eggs to remain unfertilized. Against the foregoing, it can be argued without reasonable doubt that in the presented study treatment 1 produced lower (386) number of fry than other treatments owing to fierce fights among male brooders that might have been spending more time charging over each other instead of fertilizing the eggs. Grant et al., (1995)[8] affirms that higher male density led to increase aggression and male to male competition reduce the opportunity for female to spawn. Mills and Reynolds (2003)[11] reported that there was low competition between males and higher spawning frequency with females occurred when fewer males were encountered during spawning activity. Therefore, the present study suggests that due to high number of males in treatment 1 there was high competition between males since the stocking density was (1♂:1♀) hence lower number of fry produced than other treatments (1:3 and 1:5 sex ratios).

Effect of sex ratio on fry survival rate

The results (Figure 4) of the present study show that there were significant differences in the survival rate of fry (P<0.05) among all treatments. Treatment 1 and treatment 2 were not significantly different both with their mean percentage value were 93% survival rate while treatment 3 had 84 % rate of survival. It can be concluded,therefore, that treatment 1 and 2 had a superior survival rate than treatment 3. Therefore, results of the present study are consistent with finding of Grant et al., (1995)[8], Khater (2002)[10] and Mills and Reynolds (2003)[11], who reported better performance of females stocked at lower sex ratios 1 :2 and 1:3 (male : female) than those stocked at higher 1:4 and 1:5 (male: female) sex ratios.

High stocking densities lower the survival rate of cultured fish due to stress, poor water quality due to increased biomass and other density dependent factors which, therefore, result into increased mortality rates [7]. In corroboration to the foregoing, Osofero, (2009)[14] reports that there is an inverse relationship between stocking density and survival rate. Therefore, survival rates registered in the present study where treatment 3 had low survival rate because the number of fry was more than the other treatments hence increased density lead to mortality due to stress of overcrowding, competition for space and food as well as deteriorating physic-chemical water quality parameters. During sampling, fry were subjected to stress of handling and this may have possibly caused mortality apart from natural mortality which is usually high in fry and fingerings. However, El Sherif, (2009)[7] reported that survival rate of up to 100% can be accompanied by good environmental conditions.

Water quality parameters play an important role in the biology and physiology of fish [3]. Throughout the experimental period, the water quality parameters (Table 2) in all the treatments remained within the range required for tilapias [4, 15]. Therefore, the differences in number of fry in different sex ratios could not have been attributed to variations in water quality parameters.

Conclusion

According to the results of the present study, sex ratio of 1:5 had higher (422.80±1.19) number of fry than other treatments of 1:1 (386.33±1.27) and 1:3 (392.47±1.07) (male: female); this is due to high number of female broodstock stocking density. The study observed that due to high number of male broodstock in treatment 1(1♂:1♀), there was a high competition between male-male hence female broodstock were failing to spawn leading to lower number of fry. In addition, the study also found out that treatment 1 and 2 had a high survival rate (93%) than treatment 3 (84.3%). This is due to lower number of fry to treatments that reduces the stress of biological crowding and competition for space and food than treatment 3 where high stocking density lead to stress leading to mass mortality.

Recommendations

The study has found out that sex ratio of 1:3 produced a good number of fry and registered a high survival rate compared to 1:1 and 1:5 sex ratios. Therefore, the study advocates that fish farmers in Malawi should adopt a sex ratio of 1:3 (male:female) for *Tilapia rendalli* for mass fry/fingerling production. Furthermore, farmers must be sensitized that they may alternatively use a sex ratio of 1:5 (male: female) for mass fry/fingerling production with relatively low fry/fingerling survival rates.

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