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Resting Systems During Spawning Season; A Determinant Factor In the Production of Ecotype Cichlid 'Wasefu'

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ABSTRACT

The study evaluated the production rate of wasefu tilapia paired for spawning and rested in two different receptacles of hapa and earthen pond. The resting period was 12 days after each production cycle. Hapa was placed in an earthen pond of (7 x 1.5 x 4) m in a (1 x 1 x 1) m. A pairing of 3:1 was grouped into (A) production of larvae without rest (this served as a control), (B) spawning broodstock that was rested in hapa for 12 days, and (C) spawning broodstock that was rested in Earthen Pond in triplicates. A total of 120 broodstock were selected and stocked in the hapa consisting of 90 females and 30 males gravid broodstock of (110-188) g for the male and female at a range of (110-145) g in the hapa that was hung in the earthen pond mate and produced swim-up fries continually for control experimental units and rested in hapa and earthen pond for the B and C. Rested broodstock in the earthen pond produced a considerable number of fry compared to the ones rested in the hapa. In contrast, the unit that was not rested during the study period produced the lowest number of fry.

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INTRODUCTION

The aquaculture sector has become undeniably the major protein source for the global population (Irabor et al., 2016; 2021a; 2021b; 2022a). Consequently necessitates increased production of both table size and fish seeds. Strategies such as species diversification and artificial fish breeding have been employed to further meet this demand (Irabor et al., 2022b; 2022c; 2022d; 2023). Originally tilapia is a native of Africa, although it is widely cultured in most of the world because of its natural traits (Nwachi et al., 2020; Nwachi and Irabor 2022). It is referred to as aquatic chicken because of its ability to reproduce in captivity however, man-induced breeding is also practiced effectively (Prabu et al., 2019). During this breeding, the choice of strain, culture medium, and fish species are important factors to consider. There is also a need to select strains superior to their preceding generation using the available technology (Policar et al., 2019; Irabor et al., 2024). Although stock traits are important, it should be noted that some fish species have unique characteristics relating to the number of eggs that can be produced (Castanheira et al., 2015).

Nicole et al. (2014) infer that poor broodstock management coupled with an asynchronous spawning cycle remains one of the key salient limitations to commercial tilapia production. Fish live in aquatic environments, so managing where to keep the parent fish is important. Several juveniles are lost in hapa during fry production due to water pollution. This indicates that managing water quality in the breeding system is not only required but essential if good results (production of healthy fish seeds) are the goal.

Tilapia is found in virtually all water bodies despite varying salinity, there is tilapia in all water bodies (Irabor et al., 2022). The Wasefu tilapia whose name means; washed clean in a lagoon' is a strain that is majorly found in Nigeria (Megbowon and Fashina-Bombata, 2019). However, production of this strain is limited to natural recruitment by fish farmers, a practice that limits commercial output and a tendency to rely on the harvest from the lagoon as reported by Megbowon (2019) and Fashina-Bombata (2014). Few farmers that attempted to produce the seed of this strain overstretched the broodstock and ended up not meeting both the farm target and fish seed need of the grow-out farmers. Hence a need to find ways to ensure that the seed demand is achieved for food purposes and to reduce pressure placed on the Wasefu strain in the lagoon.

Bhujel et al. (2007) is of the view that premature spawning is a result of the variations associated with the somatic growth rate and gametogenesis and this is further attributed to the recruitments from the natural habitat. Although El-Sayed (2006) suspected that stock management that separates the production grow-out process from reproduction could serve as a solution. A report by Tahoun et al., (2008) infers that success recorded in reproduction is a factor of quantity and quality of feed given, sex ratio, and most importantly the resting period after each production cycle. It is of note that the quality of resting place for the Wasefu strain has not been examined and needs to differ from one fish to another. It is a strain of tilapia found with potential that could be developed for aquaculture hence a need to know the best breeding method for optimum productivity. This study was therefore conducted to examine the effects of post-breeding rest in varying receptacle on the breeding performance of Wasefu strain broodstock and evaluation of the breeding success based on the total number of swim-ups produced after resting.

MATERIAL and METHOD

Experimental Site

The study was conducted at Okpu farm in Ughelli Delta State to elucidate the resting system of Ecotype Cichlid 'Wasefu' found in the Lagoon. The study was carried out between the 23rd of January and to 23rd of April 2023. A total of two hundred broodstock was brought from a commercial fish farm in Lagos and transported to the experimental site with the aid of an oxygen tank.

Experimental Set Up

Three resting systems were evaluated in triplicates, the systems that serve as the treatment were classified as follows: (A) production of larvae without rest (this served as a control), (B) spawning broodstock that was rested in hapa for 12 days and (C) spawning broodstock that was rested in Earthen Pond for 12 days. A total of 120 broodstock were selected and stocked in the hapa consisting of 90 females and 30 males based on the modified methods of Nwachi and Esa (2016) and Mohamad et al. (2021). The broodstock (Ecotype Cichlid 'Wasefu') was stocked at 145 g from a range of (110-188) g for the male and female 120 g at a range of (110-145) g.

Conditioning of Broodstock and Stocking

The test fish were manually sexed and stocked into a set of two (2 x 1 x 3) m. They were fed with extruded commercial feed (Aqualife) of 30% crude protein at 3mm to satiation at 0900 hrs and 0500hrs daily for 14 days before the commencement of the study. Conditioned Broodstock was carefully selected, and paired at a ratio of 1:3 for male and female fish they were stocked in hapa of (1 x 1 x 1) m and hanged so that the total water depth of the pond was 0.6 m in an earthen pond of (7 x 1.5 x 4) m. The hapa was placed in a randomized manner to eliminate the effect of location on the study.

The matured broodstock of Ecotype Cichlid 'Wasefu' (male and female) that was paired were allowed to mate after clipping the mouth of the male to avoid the incidence of injury during courtship to the female. The male fish was removed from the hapa after day 14 at which time fry has been produced. However, the broodstock in the control hapa was allowed to continually reproduce without removing the male after spawning. The broodstock in system 'B' was rested in the hapa while the 'C' system test fish were removed and rested in the Earthen pond of (2 x 1 x 3) m.

Water Quality Analysis

The major water parameters that are required to culture fish as inferred by Boyd and Lichtkoppler (1979) were monitored. The temperature was measured with a thermometer, dissolved oxygen was measured with a DO meter, and a pH meter was used to measure the hydrogen ion concentration. A reducing reagent was used to measure the Nitrite and Ammonia concentration of the pond.

Harvesting of Fries

Fries were harvested by making the broodstock congregate at one side of the hapa before carefully removing it with a scoop net. This process reduces the incidence of fry mortality, similarly, the mouth of the fish was examined for yolk sac and fry that might have sake refuge. This was carried out after every 14 days, the harvested fry was counted using a modified gravitational method as inferred by Stuart et al. (2020) for all the treatments in the study.

The hatching percentage was calculated by: $\frac{\text{No of fry before resting}}{\text{No of fry after resting}} \text{ x } 100$

Data Analysis

The data collected were subjected to a one-way analysis of variance (ANOVA) using SPSS 26 statistical tools. The mean was separated for significant differences using the Duncan Multiple Range Test.

RESULTS

The mean temperature during the study period ranges from 25.34 to 25.98 ^{0}C in the first month of the study with a temperature of 25.34 ^{0}C being the lowest. In the 4th month, the highest temperature of 26.22 ^{0}C was recorded. The mean level of ammonia recorded at the earthen pond housing the hapa ranges from 0.2879 to 0.3001 mgL^{-1} although in the 4th month with an increased temperature a level of 0.2879 mgL^{-1} was recorded the peak level was at 0.3001 mgL^{-1} at the 3rd month. The dissolved oxygen was lowest in the second and fourth months although during the first and third months, the value obtained was 8.83 mgL^{-1} and 8.00 mgL^{-1}.

Table 1. Mean monthly water quality parameter at the production and resting of broodstock

S/N	Parameters	January (Month 1)	February (Month 2)	March (Month 3)	April (Month 4)	Errors
1	Temperature (^{0}C)	25.34±0.21^{c}	26.21±0.32^{a}	25.98±0.16^{b}	26.22±0.29^{a}	0.004
2	Ammonia (mgL^{-1})	0.2899±0.23^{b}	0.3000±0.11^{a}	0.3001±0.14^{a}	0.2879±0.30^{b}	0.031
3	Dissolve oxygen (mgL^{-1})	8.83±0.07^{a}	7.98±0.20^{b}	8.00±0.33^{ab}	7.89±0.42^{b}	0.045
4	pH	6.23±0.22^{b}	6.00±0.17^{b}	6.12±0.24^{b}	6.56±0.20^{a}	0.065
5	Total dissolved solids (mgL^{-1})	0.200±0.09^{c}	0.222±0.08^{b}	0.232±0.12^{a}	0.231±0.14^{a}	0.008

a,b: Significance of means at the 0.05 level indicated by different letters.

The hydrogen ion concentration value ranges from 6.00 to 6.56 throughout the study period. A total dissolved solid of 0.200 mgL^{-1} was recorded in the first month, 0.222 mgL^{-1} in the second month, and 0.231 mgL^{-1} in the last month of the study (Table 1).

In Table 2 the broodstock parameter inferred that the mean weight of the female fish was 124 g at the onset of the study but increased to 130 g. The male broodstock was at an initial weight of 156 g and a final weight of 156 g at the end of 120 days. The specific growth rate for the male and female fish was 0.047 g/day and 0.040 g/day respectively, with a survival rate of 95% for the female and 99% for the male.

Table 2. Characteristics of broodstock at the Okpu farm Ughelli Delta State

Parameters	Female (g)	Male (g)
Initial weight (g)	$124{\pm}0.32^{b}$	$156{\pm}0.65^{a}$
Final weight (g)	$130{\pm}0.41^{b}$	$165{\pm}0.008^{a}$
Specific growth rate (g/day)	$0.040{\pm}0.23^{b}$	$0.047{\pm}0.09^{a}$
Survival rate (%)	$95{\pm}0.30^{b}$	$99{\pm}0.11^{a}$

a,b: Significance of means at the 0.05 level indicated by different letters.

Production capability of Wesafu Cichlid tilapia before resting as shown in Table 3 showed that after a total number of 56 days, there was no significant difference between the number of fries produced in group A (without resting), B (resting in hapa, and C (resting in an earthen pond).

Table 3. Production capability of 'Wesafu' Cichlid tilapia before the resting System

	Resting system		
	Without resting	Hapa	Earthen pond
Number of days	56	56	56
Number of larvae	$173{\pm}0.56^{b}$	$173{\pm}0.22^{b}$	$174{\pm}0.32^{a}$
Weight of larvae(g)	$1.903{\pm}0.44^{b}$	$1.903{\pm}0.16^{b}$	$1.914{\pm}0.14^{a}$
Mean spawning days	$20{\pm}0.31^{a}$	$20{\pm}0.51^{a}$	$20{\pm}0.71^{a}$

a,b: Significance of means at the 0.05 level indicated by different letters.

Similarly, no significant variation was also recorded in the weight of the larvae in the system that was examined. The mean number of days for actual spawning to take place also remains the same for all the studied receptacles.
Table 4 gives the production capability of 'Wesafu' Cichlid tilapia after resting, the male broodstock was removed from the production system to stop the process of production in groups B (resting of fish in hapa) and C (resting in earthen pond) while the control is group A (production of fish without resting). The number of larvae

produced in group A was 875 while groups B (hapa) and C (earthen pond) had 1435 and 1540 respectively. The weight of larvae that were produced was 9.625 g for group A while groups B and C had 15.785 and 16.94 g respectively. The mean spawning days of group B were related to that of group C.

Table 4. Production capability of 'Wesafu' Cichlid tilapia after 12 days of resting

	Resting system		
	Without resting	Hapa	Earthen pond
Number of days	33	33	33
Number of larvae	875±0.31[c]	1435±0.54[b]	1540±0.73[a]
Weight of larvae (g)	9.63±0.12[c]	15.79±0.17[b]	16.94±0.26[a]
Mean spawning days	25±0.51[b]	18±0.12[a]	17±0.52[a]

a,b,c: Significance of means at the 0.05 level indicated by different letters.

After 120 days of production, 'Wesafu' Cichlid tilapia total larvae in group A was 2275, group B (hapa) had 5945 while 6749 were produced in the group C (earthen pond) system. There was no relationship between the weight of the larvae in the groups. Although the mean spawning day in group B (hapa) was related to that found in group C (earthen pond), while it takes 23 days for spawning to occur in group A (Without resting).

Table 5. Production capability of 'Wesafu' Cichlid tilapia after 120 days

	Resting system		
	Without resting	Hapa	Earthen pond
Number of days	120	120	120
Number of larvae	2275±1.87[c]	5945±2.45[b]	6749±0.56[a]
Weight of larvae (g)	25.025±0.67[c]	65.395±1.34[b]	74.239±1.56[a]
Mean spawning days	23±0.33[b]	19±0.72[a]	18±0.45[a]

a,b: Significance of means at the 0.05 level indicated by different letters.

DISCUSSION

Water Quality Analysis

The water quality of the experimental tanks (Earthen Pond) was 25.94^{0}C a mean temperature value that agrees with the assertion made by Makori et al. (2017) on the physicochemical parameter of the earthen pond. Similarly, the mean values for ammonia and dissolved oxygen was 0.2945 mgL^{-1} and 8.175 mgL^{-1} respectively, this values relate to the recommended standard by Boyd, and Lichtkoppler (1979). The mean values recorded for total dissolved solids was 0.2213 mgL^{-1} and hydrogen ion concentration (pH) 6.2 which were within the recommended as opined by El-Sayed (2006). The water quality parameter as observed in the study were within the recommended standard for optimum performance of the sampled fish. It is proper to assert that changes that were observed were a result of the observed variables in the study.

Fry Production Capacity Before Resting

Results showed that there was no significant difference in the production rate of group A (without resting), group B (hapa), and group C (earthen pond). This could be related to the fact that at the initial pairing of the broodstock in the same pond the same condition applies hence there is little or no variation in the larvae produced, their weight, and even the days it took them to produce as shown in Table 3. This assertion is similar to the report of Ridha and Cruz (2003) on Nile tilapia (*Oreochromis niloticus*).

Generally, the production of tilapia seeds involved functional pairing to mass aggregation, the effect at which various researchers express different opinions. In this study, the quantities of fry produced at the different resting periods were examined. Broodstock was selected based on the modified methods of Nwachi and Dasuki (2017). The 'Wesafu' tilapia were paired and their ability to produce fry was evaluated in three different manners in the same receptacle; (i) evaluating the number of fries produced with the number of days before the next production if paired fish were not rested after production, (ii) when broodstock was rested in hapa after production and (iii) at a period at which the resting of the broodstock was done in the earthen pond.

Fry Production Capacity After Resting

In this study, broodstocks in groups B and C were subjected to rest for 12 days. During production the group B was rested in hapa while the earthen pond was used as a resting place for group C. However, group A was not subjected to rest. The variation in the various treatments resulted in the varying production rates recorded after 33 days of pairing as shown in Table 4. Although there are no significant differences in the number of fries produced in groups B and C, the actual number indicated that the two systems that were rested were more productive. A total of 1435 and 1540 fries were produced in groups B and C respectively, while the lowest value of 875 fries was produced in group A. This form of variation was also recorded by Abou-Zied (2015) for other strains of tilapia making it possible to assert that wasefu tilapia has a preference regarding the type of receptacle that is used for resting after each circle of production (breeding). In the same vein, there was a reduction in the number of days that the fish spent before producing in the two groups (B and C) that were rested.

Creating extra advantage of generally increasing yield with the use of the production process as reported by Lovshin and Ibrahim, (1988) and Ridha and Cruz, (2015).

Total Fry Production

After 120 days of continuous production for group A, the total fry produced was less than those fries produced by groups B (Hapa) and C (Earthen Pond). These groups (B and C) were significantly related to each other based on the final number of fries that were produced while group A was significantly different from the rest stock. It is of note that the rested system gave more fry both in number and in weight. The number of days taken before the production in the rested groups (B and C) were significantly related but different from those of group A.

CONCLUSION and RECOMMENDATIONS

The water quality parameter that prevailed during the study at Okpu farm was at the range that is acceptable both for the production of broodstock and fries.

Resting of the broodstock that was paired at 3:1 for the female to male in the earthen pond increased output considering the number of fries that was produced.

A total resting period of 15 days made a difference in fry production compared to continuous production without resting.

Good broodstock management was a procedure that added positively to the total fry production.

It is therefore recommended that the study should be carried out a few more times in different commercial hatchery sites and fry from this study should also be raised to maturity to observe variation in the growth and general wellbeing of the fish.

The results of this finding should be made available to the government extension office for onward transmitting and further onsite testing.

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Conflict of Interest Statement

The authors have declared that there are no competing interests.

Authors Contribution

The authors contributed equally to the research.

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