Effect of different ages of African catfish (*Clarias gariepinus*)broodstock on reproductive performance and fries production

Abstracts.
This study was conducted at the hatchery complex of Akwa Ibom State University to investigate the effect of different ages of African catfish(*Clarias gariepinus*) on their reproductive performances. Eighteen(18) broodstock of *Clarias gariepinus*(3 males and 3 females) from each age group, six months, twelve months and eighteen months old with average body measurement of 1.1kg and 32cm for six month, 1.8kg and 43cm for 12 months and 2.5 kg and 65.7cm for 18 months were selected from AKSU fish farm labeled treatment A, B and C for the study. 3 male broodstock from each treatment were sacrificed for milt extraction without hormonal inducement. The milt from each treatment were separately pooled into one volume and divide into three portions each diluted with 2ml of normal saline solution. Three female broodstock from each treatment were separetely induced with ovaprim at a single dosage of 0.5ml/kg body weight of fish and allowed for a latency period of ten hours at water temperature of 26^oC before stripping manually. 3g of egg from each broodstock was mixed with the diluted milt and activated with 100 mls of normal saline.The fertilized eggs were incubated in aerated indoor concrete tanks in 3 replicates. % fertilization were accessed six (6) hours after incubation, % hatchability was accessed twenty-six hours (26) after incubation, while the percentage survival and fry production success in each treatment was accessed after ten (10) days post hatching. The results reveal that the reproductive parameters considered in this study significantly ($p<0.05$) increased with age of broodstocks. The percentage fertilization of egg from the least to the oldest broodstock were 63.67± 0.88, 69.50 ± 0.87 and81.83± 5.05 respectively. The percentage hatchability of the oldest broodstock was 82.62 ± 1.6 significantly ($P< 0.05$) higher than 64.79 ± 2.74 (12 months) with the least value of 49.04 ± 5.76 recorded for six month old brood stock.The oldest broodstock had the highest percentage survival 83.14 ± 3.16 andfry production success of 56.05± 0.06while the least broodstock (6 month old) had the least value of survival54.59 ± 2.42 and fry production success of 17.17 ± 2.59%.

1.0 Introduction

The need for more knowledge of artificial propagation of African catfish require urgent attention since captured fisheries is declining as result of climatic and environmental challenges (Otoh,*et. al*.,2023a). Fish remained the cheapest source of protein, readily available, affordable and acceptable at all ages of humanity.The declining of captured fisheries projected aquaculture as the only alternative source for acheivement of mass production of fish to meet the increasing need of protein for human sustainability (Otoh*et. al*., 2022, Udoh and Otoh, 2017).Generally, importance of fish in human diet and economic progress of our society is already recognised (Otoh*et. al.*, 2023 a, b) and this is achieved through aquacultural practice.

However, the success of aquaculture begins at the hatchery levels where the reproductive performances of the fish will be determined for seed productions.African cat fish such as Heterobranchus and Clarias species remained the most culturable species of significant in Nigeria and beyond (Otoh and Udoh, 2018a,b., Oyeleye *et. al*., 2016). This is due to the unique characteristic of these species such as fast growth rate, good taste, generally accepted for consumption , high stocking density, high market price and high resistance to disease and ability to reproduce in captivity (Nlewadim *et. al*., 2011; Nya, *et. al*., 2017, Otoh, *et. al*., 2020a; Otoh and Udoh, 2018a; Otoh and udoh, 2019;Otoh,*et. al*., 2022, Udo and Otoh, 2023; Otoh,*et. al*.,2023a).

Although the growth of fish depends on availability of good feed(Otoh and Udoh,2018a; Ekanem *et. al*., 2000)of which a single feed stuff component cannot achieve. Heterobranchus and clarias readily accept any supplementary feed and their growth rate is unique within a short period of culture according to Nlewadim *et. al*., (2011) compare to other species.

Effects of fish age on breeding success and gamete quality varies. Some studies (Madu,*et. al*., 2003) have reported increase while others (Masoumeh,*et. al*., 2012) reported decline in some traits. Some studies also suggest that increasing paternal age may be associated with degenerative and declining gamete quality. Otoh and Udoh,(2018a) demonstrated that males of 3½ and 2½-year old produced better fertilization ability based on parental age. Viable and profitable hatchery management require choosing the best-suited male and female broodstock from different ages in the farm. Age remains a natural parameter for assessment of lifetime of individual and a biological prerequisite for determination of sexual maturity of living organism of which fish is included (Otoh and Udo, 2019). Since the age of fish has influence on the quality of the gametes, which determine the success and reproductive performances of fish at the hatchery levels, the need for investigation of age of African catfish (*Clarias gariepinus*) on reproductive performances become necessary which is the focus of this study.

2.0 Material and Methods

2.1 Location of Study

The research was conducted at the Fish Farm Complex (Fig. 1b) of Akwa Ibom State University, Obio Akpa campus (Fig. 1a), located between latitude 5°17′N and 7°27′N, Longitude 7°27′E and 7°58′E. The area has an annual rainfall ranging from 3500– 5000 mm and average monthly temperature of 25°C in the tropical rainforest zone of southeast Nigeria (Otoh and Udoh, 2018a).

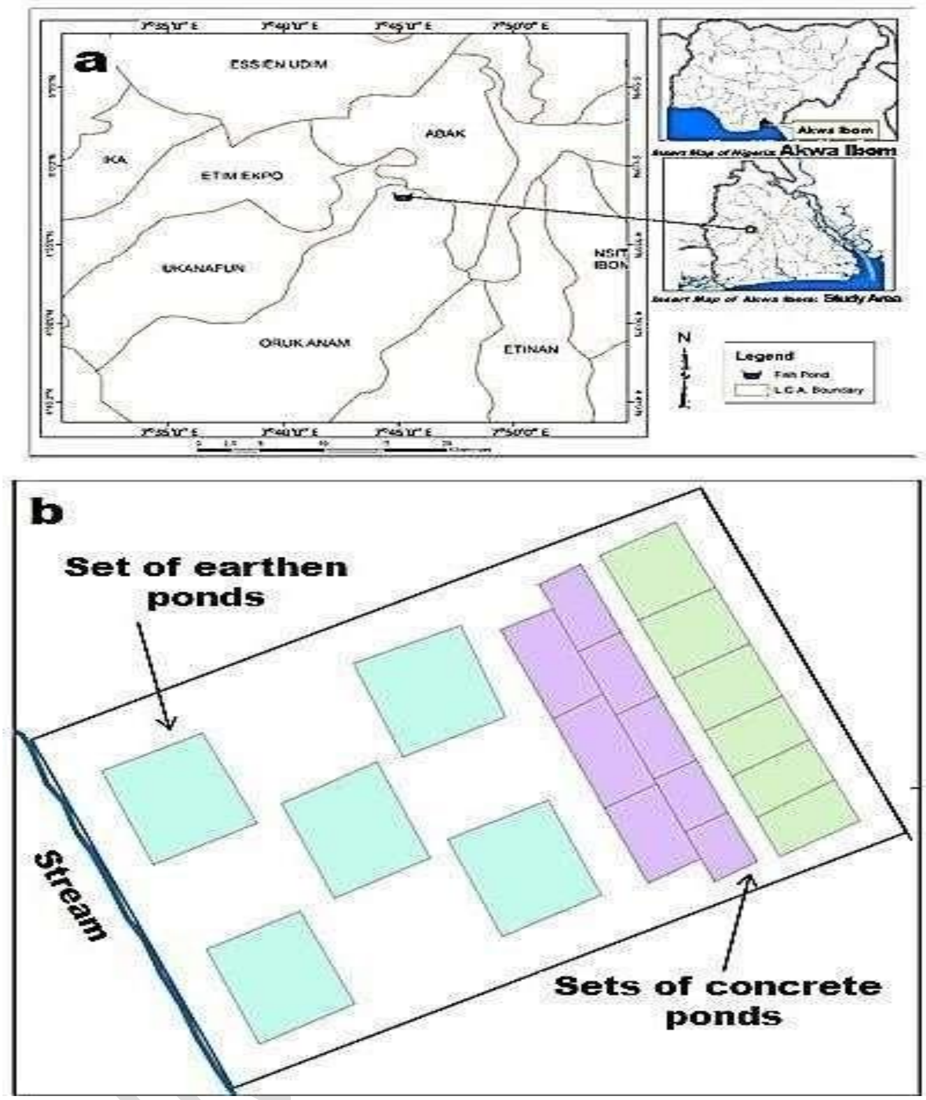

Fig. 1: A cross section of map of Nigeria showing Akwa Ibom with an inset showing the location (a) and layout (b) of the University Fish Farm Complex

2.2 Acquisition of Brood Stocks

A total of 18 broodstocks (3 male and 3 female) each belonging to 3 different age group such as 6 months old, 12 months old and 18 months old with average body measurement of 1.1kg and 32cm for six month, 1.8kg and 43cm for 12 months and 2.5 kg and 65.7cm for 18 months.

2.3 Milt Extraction:

Three males from each of the three age group were sacrificed for milt extraction without hormonal inducement.The milt from each age group were pooled together into one volume and divided into 3 portions, each was diluted with 2m/s of normal saline (9g salt) and preseeved below the temperature of 7^0c.

2.4 Hormonal Inducement:

3 female broodstock from each age group were transferred to hatchery and induced with ovaprim hormones ata single dosage of 0.5 ml/kg body of fish(Asangusung,*et.al*., 2020) and allowed at a latency period of ten hours before stripping.

2.5 Stripping of eggs:

Eggs from each sample was stripped into a separate plastic containers. 3g of eggs from each sample containing approximately 2000 oecytes was measured into 9 separate containers. Eggs in each container was mixed with the diluted milt for fertilizationsand activated with 100ml of 0.9 % saline solution, after the first 5 minutes, the saline solution was decanted.

2.6 Incubation:

Incubation of the fertilized eggs was carried out in nine breeding tanks, 3 tanks per treatment.The fertilized eggs were uniformly spread in a monolayer on a kakaban (Shreded Nylon Sacks) and incubated in aerated indoor concrete tanks (during incubation, water levels was maintained at $30cm^3$ depth).Six hours after incubation, the colour variations between the eggs were observed. Clear and transparent eggs were considered fertilized while dead / white and Opaque ones were regarded as unfertilized(Dead eggs) and were siphoned out of the spawning tanks after 35 hours (Otoh and Udoh, 2019; Udoh, 2000; otoh, *et. al*., 2020 a, b; Otoh,*et. al*., 2022; Otoh,*et. al* 2023a).

The percentage fertilization were calculated by the avaerage of fivedetermination of the fertilized eggs per 200 eggs siphoned based on colour. Five different locations of the breeding tanks were marked and 200 eggs siphoned from each location and the white eggs recorded (Udoh, 2000; Otoh,v*et. al*.,2020b). The total larvae survival was determined by 10 days post hatching. Percntage egg fertilization, hatchability and survival were determined as follows:

% Fertilization of eggs = (No. of eggs fertilized /total number of eggs) x 100

% Hatchability = (number of hatchlings / total number of fertilized eggs) x 100.

Percentage hatchability was obtained by direct counting of unhatched eggs as well as the numbers of eggs hatched in each incubating tank.

% Survival was calculated during initial feeding according to the following formula:

% Survival = (number of live larvae / total number of larvae hatched) x 100 (Udoh, 2000).

Efficiency of hatching was evaluated by the method of Rana (1995):

Fs (%) = Kf.Kh.Ks/10,000 where:

Fs = Success rate (%) of fry production at 10-day post hatching.
Kf = % Fertilization of eggs
Kh = % Hatchability of eggs
Ks= % survival of 10-days-old swim-up fry (Rana, 1995).

2.7 Statistical Analysis

Data collected were subjected to one-way analysis of variance (ANOVA) to test for significant difference with the aid of predictive analytical software version 18.0. Probability level of ($P<0.05$) was considered significant. Replicates were treated as random effect while age of the fish were treated as fixed effect.

3.0 Result

The research on the comparative effect of different ages of broodstock in the reproductive performances of *Clarias geriepinus* revealed that the physiochemical parameters of each treatment in this study shows no significant difference ($p>0.05$). Dissolved oxygen, temperature and pH measurement ranged between 5.21±0.01-5.26±0.01mg/L, 27.03±0.01-27.06±0.01(^{0} C) and 6.92± 0.01-6.96± 0.01 (Table 1) respectively.

Table 1: Mean water Quality Parameters of the Incubating Tanks

	Stripped egg stages

	Stage 1	Stage 2	Stage 3	Stage 4
Temperature (˚C)	27.05 ± 0.05	27.03 ± 0.01	27.04 ± 0.02	27.06 ± 0.04
pH	6.92 ±0.02	6.93 ±0.01	6.95 ±0.25	6.96 ±0.01
Dissolved oxygen (mg/L)	5.21 ± 0.20	5.23 ± 0.40	5.25 ± 0.150	5.26 ± 0.20

Effect of broodstock age (months) on percentage fertilization rates of *Clarias geriepinus* broodstock reared in concrete aquaculture ponds is presented in Fig. 2. The percentage fertilization of eggs obtained from six(6) months old broodstock was 63.67± 0.88 which shows significant (p<0.05) difference with the percentage fertilization of eggs obtained from twelve (12) months old broodstock 69.50 ± 0.87 of *Clarias geriepinus.* The oldest broodstock of Eighteen (18) months old had the highest percentage fertilization value of 81.83 ± 5.05 which is significantly (p<0.05) different from the percentage fertilization of eggs obtained from 6 and 12 months old broodstock. Therefore, fertilization Increase with age of broodstock.

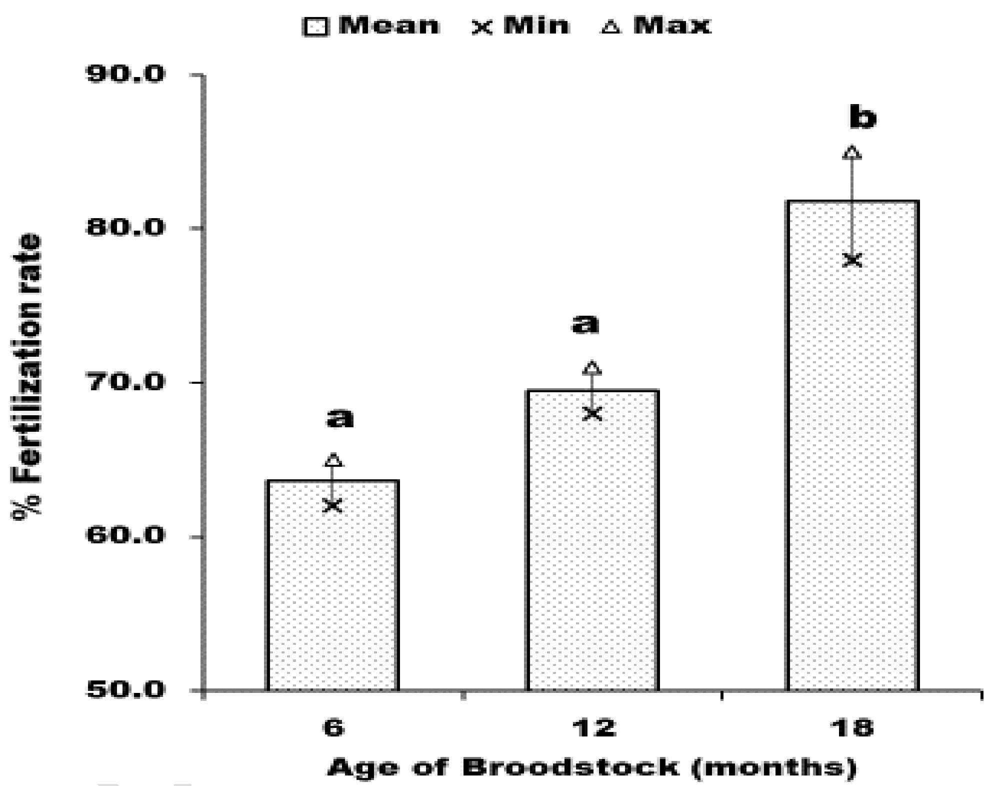

Fig. 2: Percentage Fertilization Rate of *Clarias gariepinus* Brood Stock at Different Ages

Effect of broodstock age (months) on percentage hatching rates of *Clarias geriepinus* broodstock reared in concrete aquaculture ponds is presented in Fig. 3. From the statistical analysis,six(6) months old broodstocks showed percentage hatchability value of 49.04 ± 5.79 while Twelve (12) months old broodstocks showed percentage hatchability value of 64.79 ± 2.74. With the variation in the hatchability value among the two treatment, statistical analysis revealed that they were significantly ($p<0.05$) different. Eighteen (18) months old broodstocks had percentage hatchability value of 82.62 ± 1.6 and showed significant ($p<0.05$) difference with percentage hatchability value of eggs obtained from six and twelve months old broodstocks.

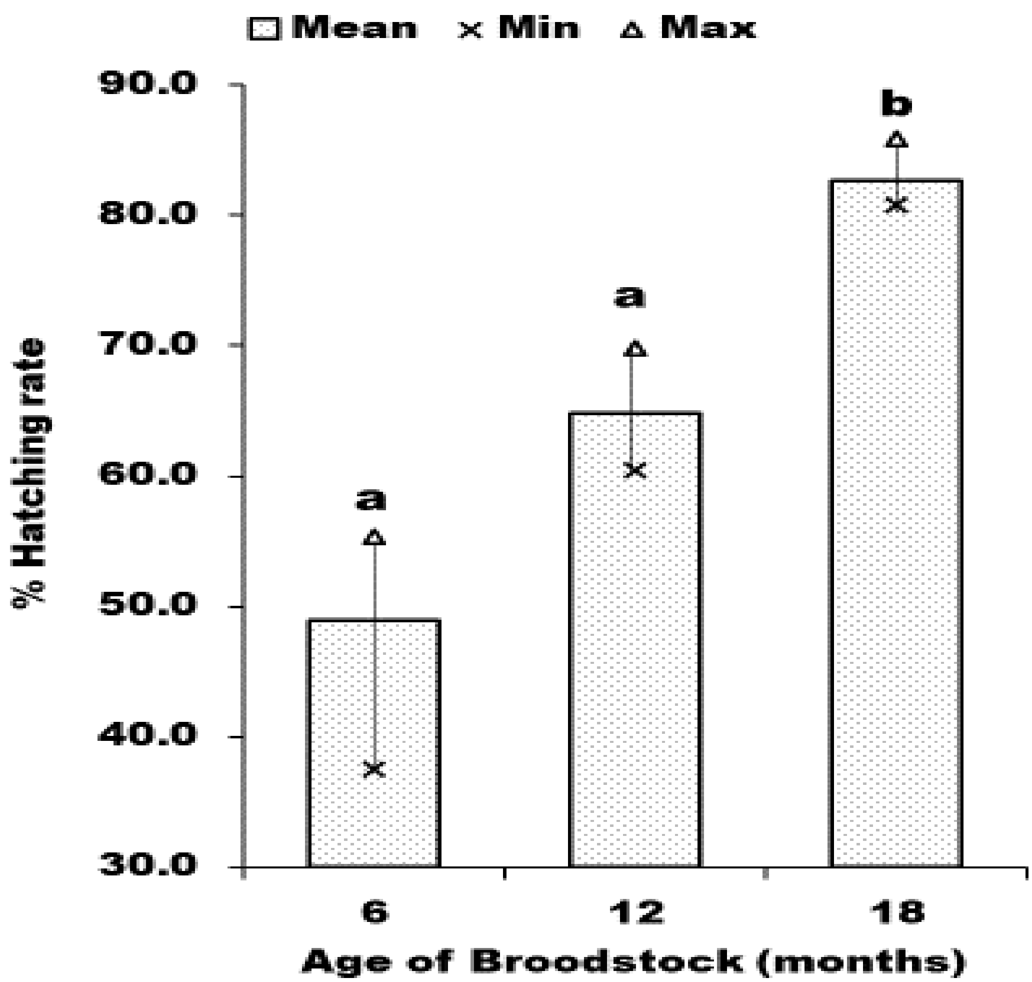

Fig. 3: Percentage Hatchability Rate of *Clarias gariepinus* Brood Stock at Different Ages

Effect of broodstock age (months) on percentage fry survival rates at 10-day-old of *Clarias geriepinus*broodstock reared in concrete aquaculture ponds is shown is Fig. 4. The percentage survival of ~~Frys~~friesobtained from six (6) months old broodstock had percentage survival value of 54.59 ± 2.42 which is significantly ($p<0.05$) higher than the percentage survival value of ~~Frys~~ fries obtained from Twelve (12) months old broodstock whereas the percentage survival value of ~~Frys~~ fries obtained from Eighteen (18) months old broodstock was 83.14 ± 3.61 and is significantly ($p<0.05$) different from that of six and Twelve months old broodstock.The least survival value was observed in twelve (12) months old broodstock.

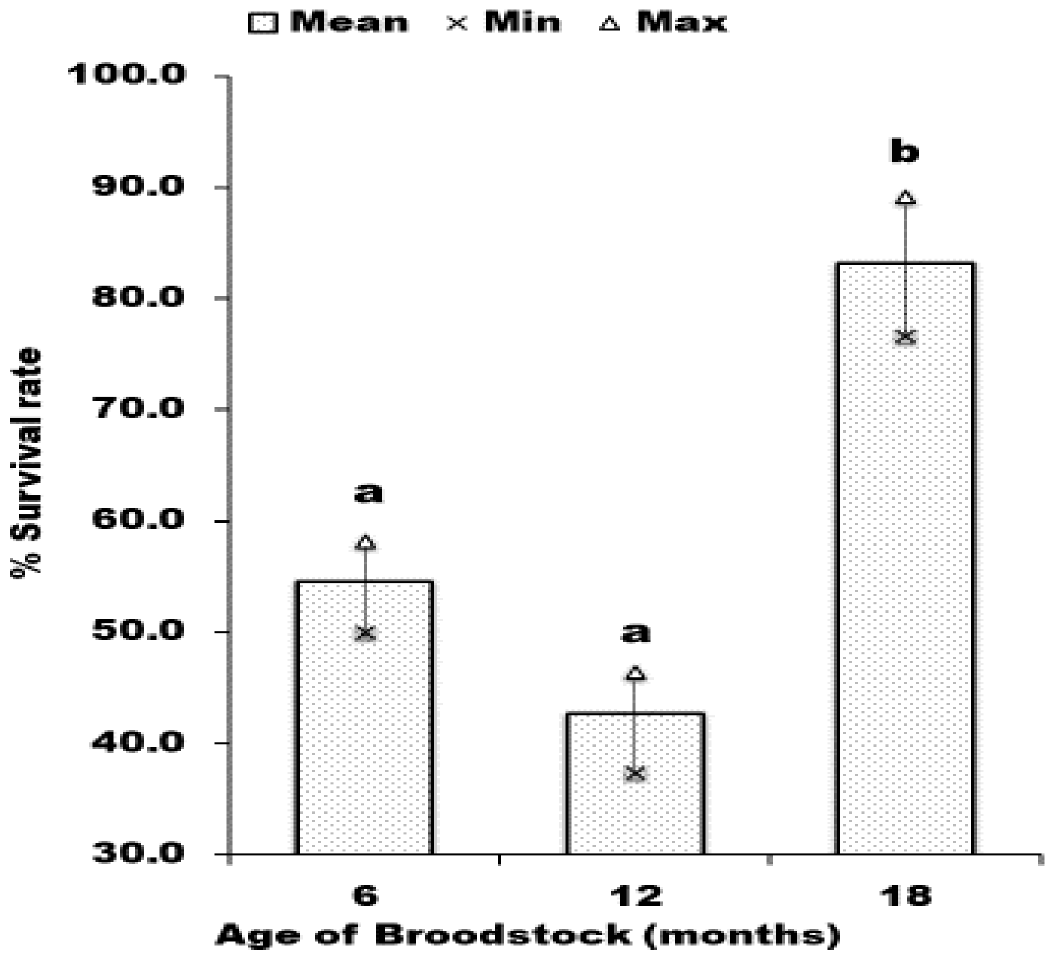

Fig. 4: Percentage Survival Rate of *Clarias gariepinus* Brood Stock at Different Ages

Effect of broodstock age (months) on percentage fry production successof *Clarias geriepinus* broodstock reared in concrete aquaculture ponds is presented in Fig. 5. According to the analysis, six(6) months old broodstock produced percentage fry production success value of 17.17 ± 2.59 while Twelve (12) months old broodstock produced fry production success value of 19.17 ± 1.17 but showed no significant difference ($p<0.05$) among the two. However, Eighteen (18) months old broodstock of *Clarias geriepinus* produced the highest value of percentage fry production success of 56.05 ± 0.06 which significantly ($p<0.05$) differ from that of six and twelve months old.

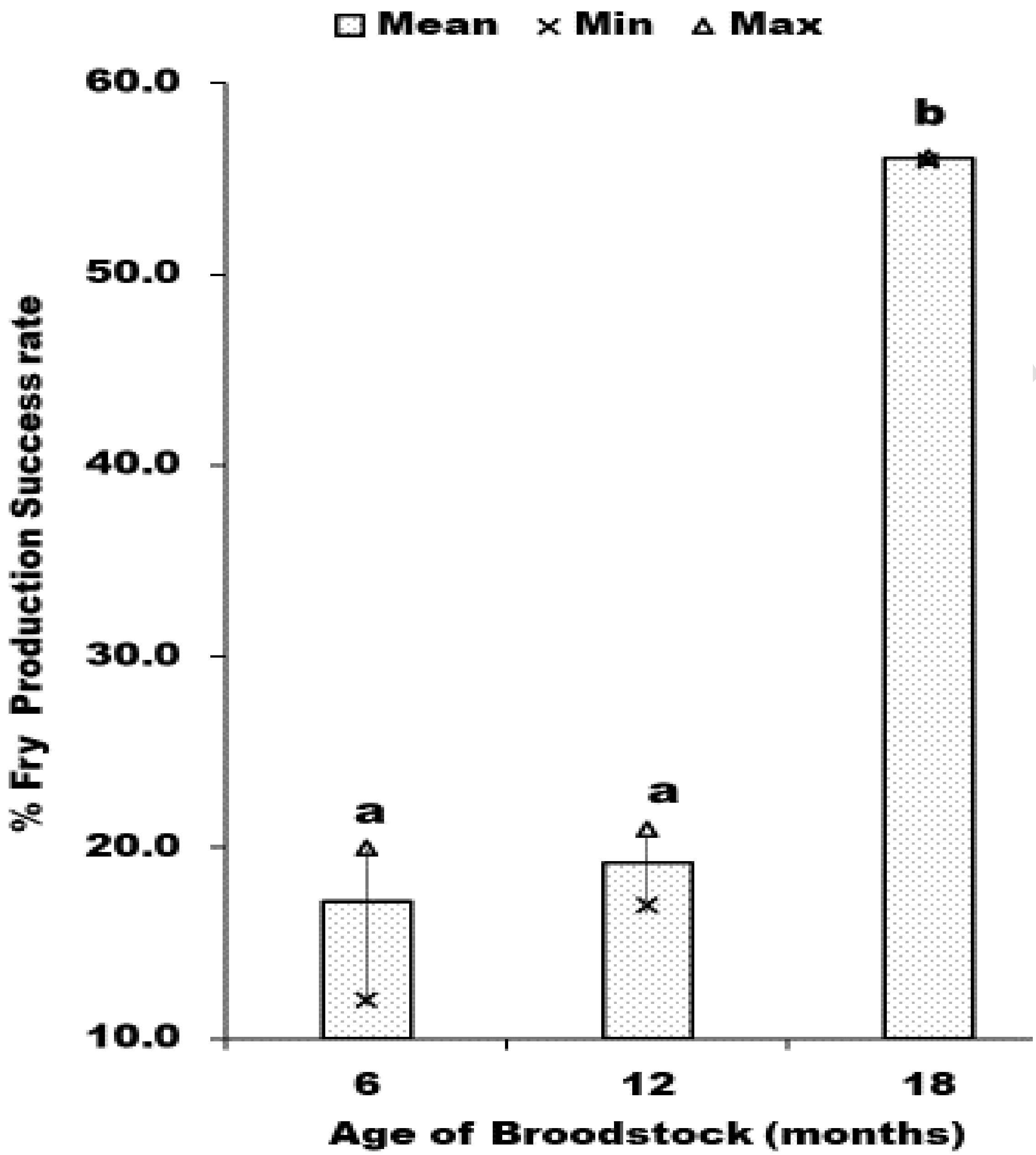

Fig. 5: Percentage Fry Production Success of *Clarias gariepinus* Brood Stock at Different Ages

4.0 Discussion

The knowledge of the fact that over 50% of the stripped eggs from African catfish do not survive till fingerling stage during artificial propagation, called for investigation of age effects on the reproductive performances of *Clarias gariepinus*.The study revealed that the physico-chemical parameters of water observed in this study showed no significant difference ($P<0.05$) and were within the tolerable limit according to (Eyo, 2023, George and Atakpa, 2015; Jonah *et. al*., 2020).

Analysis revealed that reproductive paremeters such as; fertilization, hatchability, survival and fry production success observed in this studysignificantly ($p<0.05$) increased with the age of the broodstocks. The oldest broodstock (18month old) had the highest percentage fertilization value of 81.83 ± 2.05 followed by 12 month old 69.50 ± 0.87 while 6 month old broodstock had the least fertilization value of 63.67 ± 0.88.This could be attributed to the maturity of the gonads. 18 months *C. gariepinus* broodstock are likely to have fully developed gonads, resulting in higher sperm and egg quality. This ensures better fertilization success compared to younger individuals whose gonads may not be fully matured. Furthermore, older broodstocks have have had more time to develop hormonal systems necessary for reproductive success. Hormones play a crucial role in regulating reproductive processes such as gamete production and spawning behaviour, leading to more efficient fertilization.This result is in line with the observation of Otoh andUdoh, (2019) and Umana, (2020) but disagree with Bovand and khara,(2017) whose report of the age effect on the reproductive performances was the reverse of this study.

A significant (P<0.05) difference was also observed in the percentage hatchability with the age of broodstock . The oldest broodstock had the hightest hatchability value of 82.62 ± 1.63 which is significantly (P<0.05) higher than 69.50 ± 0.87 and 63.67 ± 0.88 hatchability obtained from 12 and 6 months old broodstock., similar result was observed byOtoh,*et. al*.,(2020 a, b) who observed the hatchability increase with the age of broodstock. This could be attrbituted to several factors such as maturity level, hormone development and overall physiological readiness for reproduction. At 18 months of age, *C. gariepinus* are likely to be more sexyually mature compare to those at 6 and 12 months. This increase maturity can lead to higher reproductive success due to factors such as better egg quality, increased hormone levels promoting spawning behaviour and overall better parental care behaviour

The percentage survival of the oldest broodstock 84.14 ± 3.61 was significantly (P<0.05) higher than the percentage survival of the other two ages of survival, the least percentage survivalof 42.67 ± 2.73 was observed in 12 month old broodstock while 54.59 ± 2.42 percentage survival was observed in 6 months old broodstock.This result could be attributed to several factors such as; 1) size and strength: 18 months broodstock are generally larger and more robust compared to the younger individuals. Larger size often correlates with better resilience to environmental stressors and predators, leading to higher survival rates; 2) immune system development: as *C. gariepinus* mature, their immune systems become more developed, providing better resistance to diseases and pathogens. This enhanced immune response contribute to improved survival rates, especially in aquaculture settings where disease outbreak can occur; 3) reproductive fitness: broodstocks at 18 months are in their prime reproductive age, which indicates overall fitness and health. Individuals with higher reproductive fitness often possess better genetic traits that can confer advantages in survival and adaptation to changing environmental conditions; 4) energy reserves: older broodstocks may have accumulated greater energy reserves, which can sustain them during periods of food scarcity or stress. Sufficient energy reserves enhance their ability to withstand advverse conditins and increase survival rates.

Broodstock age on fry production success also revealed significant (p<0.05) difference with age. This could be as a result of fertilization and hatchability rate of eggs as well as the management system at the hatchery level.However,Otoh, *et. al*., (2020a) in his study observed that the survival of the fry increases with the age of the broodstock.

5.0 Conclusion

Based on the result of findings in this study, it is observed that the reproductive performance of *Clarias gariepinus* is primarily dependent on the age of the brood stock. The results of % fertilization, % hatchability, % survival rate and fry production success were excellent for *C. gariepinus* brood stock of one year and six months (18 months). Therefore, *C. gariepinus* broodstock of a higher age group will give a better reproductive performance and is recommended for effective breeding programme in artificial or man-made environment.

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