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Full Length Research Paper

Nutritional Profile and Reproductive Characteristics of the "Wesafu" Ecotype Cichlid in Epe Lagoon, Nigeria

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A common cichlid of the Epe Lagoon, Lagos, Nigeria is an important food fish and viable candidate for culture in meeting the millennium goal and vision 2020 in the subregion. The intense fisheries of this ecotype also pose a conservation issue. The comparative protein contents of the cichlid fishes were 21.80, 18.34, 19.13, 18.71 and 18.08% for Wesafu, *Sarotherodon galileaus, Sarotherodon melanotheron, Tilapia guineensis* and *Tilapia mariae*, respectively. The highest percentage of protein was obtained for Wesafu. The results of the lipid determination showed that Wesafu had 0.9% lipid which is higher than others with *T. guineensis* having the least (0.4%) value for lipid. The result showed that all the fish studied belong to low oil category and therefore can be classified as lean fish. The major component of fish muscle is moisture. There was a progressive increase in the number of ripe eggs (absolute fecundity) from larger fish to smaller one. However, the relative fecundity followed a reverse order. Female Wesafu produce only a few hundreds to less than 2,000 eggs per spawn but inter-spawning period varied from 25 to 30 days in the present study. It was observed that this parameter (spawning frequency) was not affected by the weight of the broodstock. Although Wesafu could be seen as a commercially important fish species based on its credentials of deeper body, high economic value, in terms of price, white flesh and good taste, its aquaculture potential may be affected by its low fecundity. On the courtship behavior, Wesafu exhibits a characteristic golden yellow radiation during breeding period. During courtship, the fish display a characteristics kissing lifestyle. This appears different from that of *Oreochromis niloticus* which displays a poking courtship behavior with the female swimming in front while the male pokes the side. The result of this finding showed that of all the brooders in all hapas, only females that had eggs/hatchlings in their mouthparts. This comes to show that Wesafu probably belong to the genus, *Oreochromis.* Although this study has identified Wesafu as a probable member of the genus, *Oreochromis*, there is the need to identify the fish at a molecular level to see if it belongs to any of the known species of *Oreochromis*, or perhaps a simple strain.

Key words: Ecotype cichlid, Wesafu, *Tilapiine* spp., breeding behavior, proximate composition.

INTRODUCTION

Throughout the world, aquaculture is seen as a panacea for meeting the increasing demand for fish, as catches from open waters are declining due to over exploitation and degradation of fish habitats. Fish production from inland open waters declined due to over exploitation, intensive agriculture, industrial development, erosion and siltation, reclamation of land for human settlement, pollution, destruction of mangrove forests, etc. Fish farming therefore appears to hold the key for improved

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global fish production.

Among the numerous species of fish for culture, tilapia is widely recognized as one of the popular species for a wide range of aquaculture systems worldwide. It is an ideal candidate for warm water aquaculture (Tahoun et al., 2008). Tilapia generally differs greatly in size and taxonomic group (Olojo et al., 2003). Worldwide, Nile tilapia (*Oreochromis niloticus*) culture increased during the year, 2001 to 2006 from 1,113,737 to 1,988,726 MT representing a growth of 79% (FAO, 2008), thus making it one of the fastest growing freshwater aquaculture species.

Tilapia spawn easily in captivity, use a wide range of natural foods as well as formulated diets, tolerate poor water quality and grows well at warm temperatures. These attributes, along with relatively low input costs, have made tilapia the most widely cultured freshwater fish in tropical and subtropical countries (Borgeson et al., 2006; El-Saidy and Gaber, 2005; Fasakin et al., 2005). Although the potential for tilapia culture is high, the production in Africa and more importantly, Nigeria is very low; the draw-back being the early maturity, uncontrolled reproduction in ponds leading to increased competition for food, reduction in growth rate which results in a phenomenon referred to as stunting (Fashina-Bombata et al., 2006, Baroiller and Toguyemi, 1996). There are generally low productions of fry of *O. niloticus* which is attributable to low fecundity, inadequate sex ratio, spawning techniques, broodstock nutrition and high fry mortality (Tahoun et al., 2008). Reproductive success in many species has been shown to be influenced by the broodstock, sex ratio, stocking density, age, size, nutrition and feeding regime. Broodstock productivity clearly represents the most significant constraint to commercial tilapia production in Nigeria.

Although *O. niloticus* is the leading species of tilapia cultured globally, there exists an unidentified cichlid „Wesafu", in Epe lagoon, Lagos, Nigeria where it is highly priced. This unidentified cichlid grows to 1,500 g, 414 mm in the wild. At present, there is paucity of information on the origin of the species of fish.

A number of studies have been conducted on the morphometric and meristic characteristics, age and growth, food and feeding habit, nutritional requirement, amino acid profile and biochemical characterization of the fish (Fashina-Bombata and Hammed, 2010; Hammed et al., 2010, 2011, Fashina-Bombata et al., 2005a, 2005b, 2006, 2008). These studies showed some unique characteristics in this cichlid. However, the proximate composition, breeding characteristic and DNA studies have not been addressed and could provide some basic information and clue as to the identity of this fish. This study therefore focused on the proximate composition, breeding characterization and placing Wesafu in the appropriate genera;RAPD technique was employed to show the genetic diversity and relatedness with other cichlid in Epe lagoon, Nigeria.

MATERIALS AND METHODS

Sampling

Fresh specimens of Tilapiine fishes were purchased at Ebute Chief landing site, Epe lagoon, Lagos State. The samples were collected aseptically and transported in an insulated container under chilled condition to the Fish Technology Laboratory, Nigerian Institute for Oceanography and Marine Research Victoria Island, for analysis.

Proximate composition

Proximate analyses were carried out in triplicate on the samples after dressing. These analyses included moisture content, total lipid, crude protein and ash.

Moisture content

The moisture content was determined by drying the sample to constant mass using the oven-dry method (AOAC, 1994). At first, the initial weight of the samples was taken. Then samples were dried in the oven (Memmet 854 Schwabach) at about 105±2°C for about 8 to 10 h until a constant weight was reached and cooled in a desiccator and weighed again .Then the samples were minced in an electric grinder. The percentage of moisture content was calculated by the following equation:

Percentage (%) of moisture = (weight loss/original weight of sample) × 100.

Determination of fat content

Dried samples were finely ground and the fat was extracted with a non-polar solvent, ethyl ether using the modified Bligh and Dyer procedure. After extraction, the solvent was evaporated and the extracted materials weighed. The percentage of fat content was calculated as:

Percentage (%) of fat = (weight of extract/weight of sample) × 100.

Determination of protein

Protein content of the fish was determined by micro-Kjeldahl method. It involves conversion of organic nitrogen to ammonium sulphate by digestion with concentrated sulphuric acid in a micro- Kjeldahl flask. The digest was diluted, made alkaline with sodium hydroxide and distilled. The liberated ammonia was collected in a boric acid solution and was determined titrimetrically. The percentage of protein in the sample was calculated by the following equation:

Percentage (%) of protein = (c-b) × 14 × d × 6.25/a × 1000 × 100

where, a = Sample weight (g); b = volume of NaOH required for back titration and neutralize 25 ml of 0.1 N H_2SO_4 (for sample); c = volume of NaOH required for back titration and neutralize 25 ml of 0.1 N H_2SO_4 (for blank); d = normality of NaOH used for titration; 6.25 = conversion factor of N to protein while 14 = atomic weight of N.

Determination of ash

The ash content was determined by igniting the samples at about

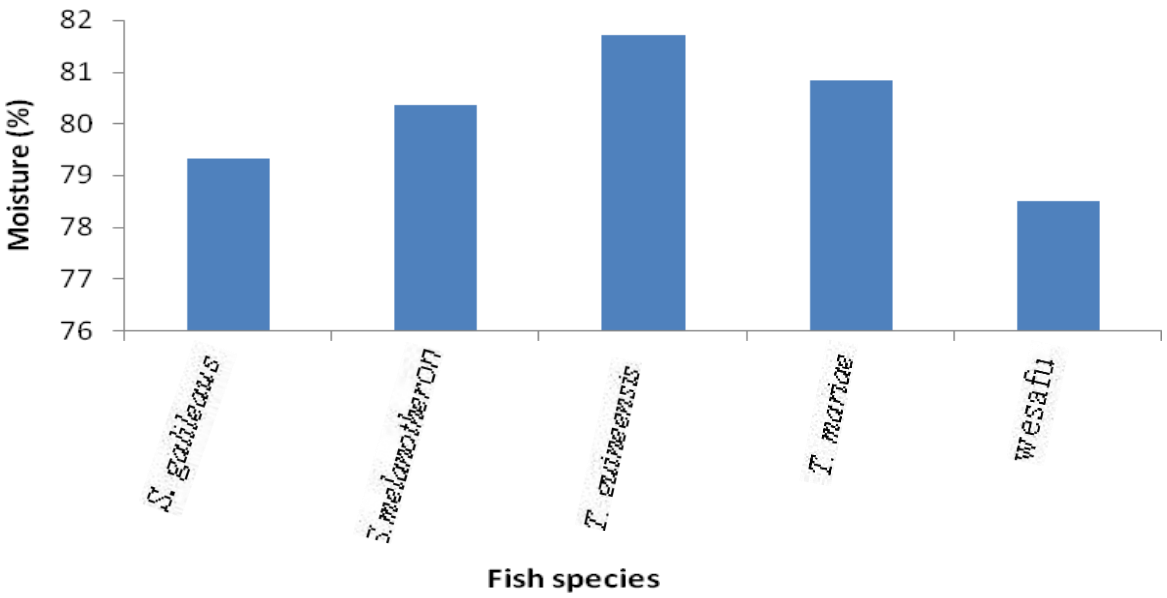

Figure 1. Moisture content of 5 species of tilapiine fishes from Epe Lagoon, Lagos.

550 to 600°C for 5 to 6 h until the sample were completely free of carbon particles (residue become white) in a Carbolite Sheffield LMF3 muffle furnace. The percent of ash was calculated as follows:

Percentage (%) of ash = (weight of ash / weight of sample) × 100

Statistical analysis

Data were analyzed by using SPSS 12 statistical programme with five percent level of significance.

Breeding characterization

The breeding study involved single pair mating of gravid broodstock (143.1 to 310.6 g) in triplicate batches in 1 m × 1 m × 1 m hapas installed in 0.1 ha fish pond in a private fish farm in Badagry. Female broodstocks were divided into 4 groups based on weight: Less than 150 g (A), 150 to 200 g (B), 200 to 250 g (C) and 250 g and above (D). The hapas were covered with net (2 cm mesh size) to prevent fish from jumping out. Fish were daily fed 3 to 5% body weight with Coppens[(c)] feed, imported from Netherland and the mouth of both sexes observed regularly for the presence of eggs/hatchlings and the condition of the genital papilla which may still be swollen even few days after the female has released eggs. The courtship behavior was observed from time to time and documented. Individual weight of fish was recorded every 2 weeks. The sex of fish with eggs/hatchlings in the mouth was noted and recorded for each spawn. The number of eggs fertilized were also counted and recorded. The inter-spawning period (number of days) were also observed and recorded for each hapa. The following reproductive parameters were determined according to (Mair et al., 2004):

i. Absolute fecundity: The number of seed per spawning per female
ii. Relative fecundity: The number of seed per unit weight of female
iii. Inter-spawning period: Number of days between successive spawning.

RESULTS

Proximate analysis

Figures 1 to 4 show the results of proximate composition of sample of cichlid fishes collected from Epe lagoon. The major component of fish muscle was moisture (Figure 2). The moisture content ranged between 78.50 and 81.70% with *Tilapia guineensis* having the highest value and Wesafu the least. The values were 79.33, 80.35, 81.70, 80.83 and 78.50% *for Sarotherodon gelileaus, Sarotherodon galileaus, T.guineensis, Tilapia mariae* and Wesafu, respectively.

The result of lipid content showed a range of 0.4 to 0.9% with Wesafu having the highest lipid content (0.9%) and *T.guineensis* the least (0.4%). Others are *S. galileaus* (0.65%), *S. melantheron (0.82%)* and *T. mariae* (0.6%) (Figure 3).

The ash content of the sample were 1.75, 1.75, 1.00, 1,30 and 1.20% for *S. galileaus, S. melanotheron, T. guineensis, T. mariae* and Wesafu, respectively (Figure 4). The values of crude protein were 18.34, 19.13, 18.71, 18.08 and 21.80% for *S. galileaus, S. melanotheron, T. guineensis, T. mariae* and Wesafu, respectively. The result showed Wesafu to have the highest crude protein value (Figure 5).

Breeding characterization

The result of this study shows a progressive increase in absolute fecundity with corresponding increase in fish weight. However, the relative fecundity decreased with increase in the fish weight (Table 1). It was observed that

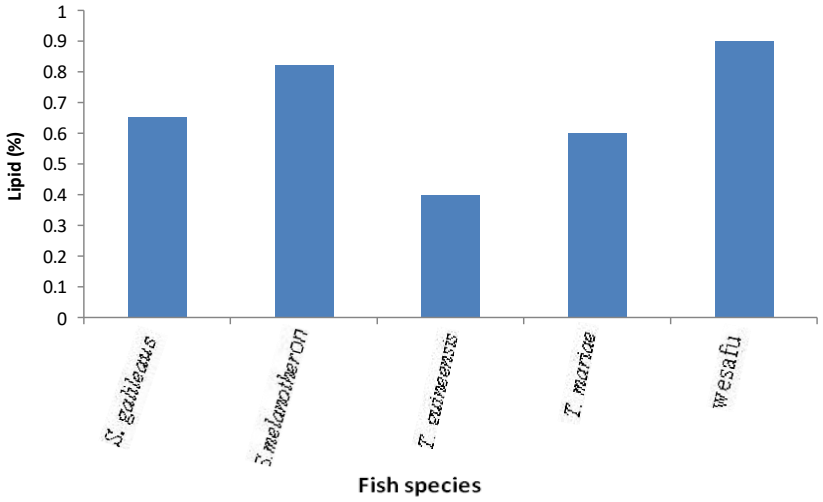

Figure 2. Lipid content (%) of 5 species of tilapiine fihes obtained from Epe Lagoon, Lagos.

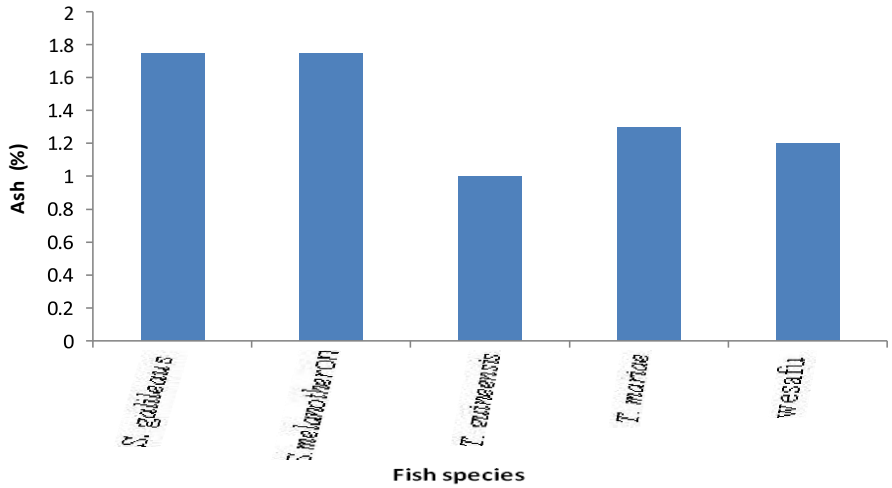

Figure 3. Ash content of 5 species of tilapiine fishes obtained from Epe lagoon, Lagos.

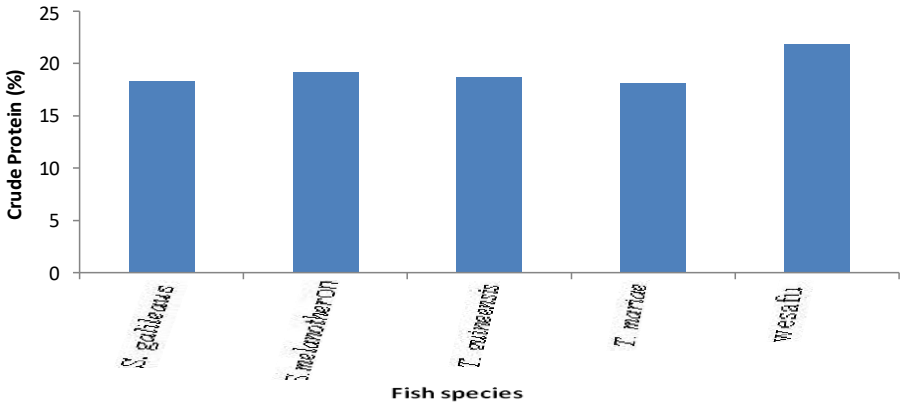

Figure 4. Crude protein content of 5 tilapiine fishes ontained from Epe lagoon, Lagos.

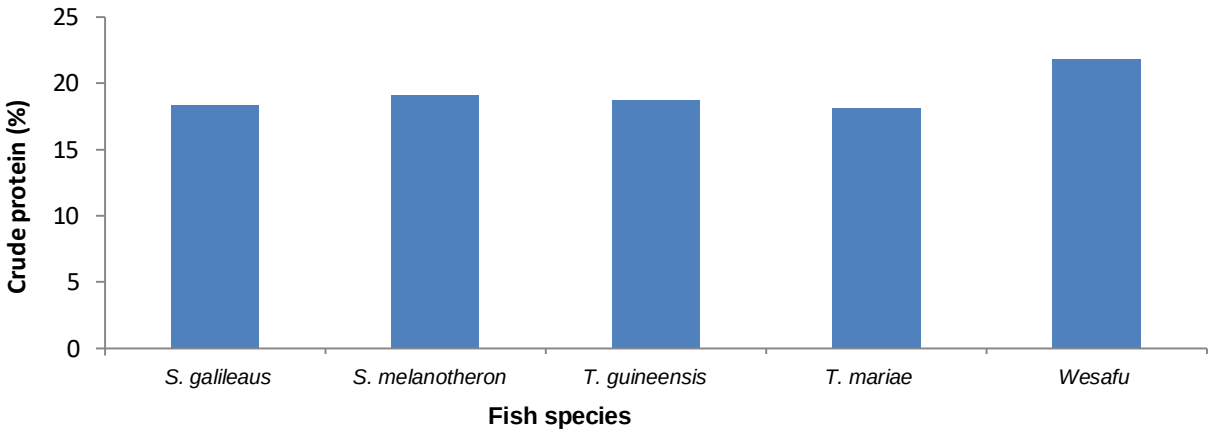

Figure 5. Crude protein content of 5 tilapiine fishes obtained from Epe lagoon, Lagos.

Table 1. Effect of fish weight on absolute and relative fecundity of an ecotype cichlid „Wesafu" bred in hapa.

Treatment	Wt. of female broodstock (g)	Wt. of male broodstock (g)	Absolute fecundity	Relative fecundity	No. of fertilized eggs	Fertilization (%)	Av. no. of swim - up fry/ g of female
A	150.0±8.9	150.0±6.1	951±18.7	6.63±1.9	876±9.9	91.2	6.04±1.7
B	190.0±12.7	180.0±15.7	1042±14.7	5.8±1.8	894±9.7	88.3	4.67±1.2
C	240.0±11.6	225.0±14.9	1078±18.5	5.05±1.1	921±9.5	83.2	4.14±0.7
D	290.0±16.3	290.0±14.2	1165±19.7	3.98±1.2	1003±11.7	85.5	3.42±1.1

Table 2. Inter-spawning period and brooding sex of the cichlid.

Treatment	Wt. of female broodstock (g)	Wt. of male broodstock (g)	Range of Inter-spawning period (days)	Brooding sex
A	150.0±8.9	150.0±6.1	25-28	F
B	190.0±12.7	180.0±15.7	25-29	F
C	240.0±11.6	225.0±14.9	26-29	F
D	290.0±16.3	290.0±14.2	25-29	F

the average number of fry per gram weight of female decreased with increase in female body weight. The results further show that percentage fertilization was highest in Group A than B, C and D with slight numeric differences. Furthermore, there appeared to be no significant variation in the inter-spawning period among the four groups. The range was between 25 and 30 days, (Table 2). It is worthy of note that in all the single pair mating carried out; the brooding sex was female, suggesting that the unidentified cichlid is most probably, a maternal mouth brooder. It comes to confirm the fish as a member of the genera, *Oreochromis*.

DISCUSSION

The major component of fish muscle is moisture. The moisture content of the fishes studied varied between 78.80 and 80.83%. The moisture content for fish sample was within reasonable range as reported by Gallagher et al. (1991). FAO (1999) reported that moisture and lipid content in fish muscle were inversely related and their sum is approximately 80% with other components accounting for the remaining 20% which partially agreed with the finding of the present study. In summary, the finding of this present study reveals the nutritional significance of Wesafu among other cichlids of Epe Lagoon.

The protein contents of the cichlid fishes were 21.80, 18.34, 19.13, 18.71 and 18.08% for Wesafu, *S. galileaus, S. melanotheron, T. guineensis* and *T. mariae,* respectively. The values varied considerably from species to species. This is in agreement with Alkobaby et al. (2008) who reported that the chemical composition of fish muscle varies greatly from species to species even among individuals within the same species. According to

the author, such variation depends on age, size, sex, environment and season. Sallam et al. (2007) further stressed that the variation is closely related to feed intake, migratory, swimming and sexual changes associated with spawning. The highest percentage of protein was obtained for Wesafu in this study, which is probably due to the presence of certain amino acids in Wesafu which may be absent in other cichlids studied. Hammed et al. (2010) reported that Wesafu has the highest value of phenylalanine, isoleucine, leucine and valine than other cichlid studies from the lagoon.

The results of the lipid determination showed that Wesafu had 0.9% lipid which is higher than others with *T. guineensis* having the least (0.4%) value for lipid. The result showed that all the fish studied belong to low oil category and therefore can be classified as lean fish. Stansby (1982) and Ackman (1989) reported that fishes with lipid content below 5% are lean fishes.

There was a progressive increase in the number of ripe eggs (absolute fecundity) from larger fish to smaller one. However, the relative fecundity followed a reverse order. This may be attributed to the age of the brooders. Smith et al. (1991) reported that older two year old red tilapia female produced more seed per clutch but fewer seed per unit weight than younger, one year old females. The author further established that despite a large average clutch size, seed production was lower in older 2 year old female due to lowering spawning frequency, suggesting fewer reproductively active individuals of longer inter-spawning periods. Furthermore, Little and Hulata (2000) reported that, larger, older fish can perform well in intensive hatchery systems, although frequency of spawning and clutch size decline with size and age. El-Sayed and Gaber (2005) reported that small Nile Tilapia broodfish produced many more eggs, with shorter inter-spawning period than large fish. It was also found that large eggs contained more yolk and led to larger fry with better growth and higher resistance to starvation and severe environmental conditions. One may therefore ask whether it is better to use small fish, which could collectively yield more eggs per culture unit, or larger fish with higher individual egg production but longer intervals. Poor handling efficiency of large fish is a problem in hapa and tank-based hatchery systems where broodstocks are individually handled to harvest mouthbrooded seed. In practice, fish larger than 300 g are difficult to handle quickly and efficiently, more importantly for a highly jumping fish like Wesafu capable of jumping over 80 cm above the flood plane in hapa. Extra care is required to prevent fish escape.

Female Wesafu produce only a few hundreds to less than 2,000 eggs per spawn but inter-spawning period varied from 25 to 30 days in the present study. It was observed that this parameter (spawning frequency) was not affected by the weight of the broodstock. This is in agreement with the report of Popma and Lovshin (1996) which stated that, under appropriate environmental conditions, tilapias spawn frequently (every 4 to 6 weeks) and at young age (usually less than 6 months) but overall fecundity is low. Although Wesafu could be seen as a commercially important fish species based on its credentials of deeper body, high economic value, in terms of price, white flesh and good taste (Fashina- Bombata et al., 2005b), its aquaculture potential may be affected by its low fecundity (Fashina-Bombata and Somotun, 2008). This is not a desirable aquacultural trait because greater number of female brood stock is required to sustain a commercial aquaculture production. On the positive side, however, the need for many broodstock decreases the risk of inbreeding depression, an important management problem in the farming of more fecund fish species.

On the courtship behavior, Wesafu exhibits a characteristic golden yellow radiation during breeding period. Smaller fish have a more or less silvery colouration. During courtship, the fish display a characteristics kissing lifestyle which the opposite sex quickly understands. During the period, the male and female bring their opened mouth close to touch each other and then separate. This appears different from that of *O. niloticus* which displays a poking courtship behavior with the female swimming in front while the male pokes the side. The different courtship behavior of the two species has thwarted hybridization effort for now but still remains an option for tilapia programme development in Nigeria.

This study showed that only females had eggs/hatchlings in their mouthparts. This comes to show that Wesafu probably belong to the genus*, Oreochromis.* Popma and Lovshin (1996) reported that all maternal mouth brooders are classified as Oreochromis since 1983. Although this study has identified Wesafu as a probable member of the genus, *Oreochromis*, there is still the need to identify at a molecular level to see if it belongs to any of the known species of *Oreochromis* or simply a variant of any of them. This opens a window of opportunity for researchers in tilapia genetics, for which collaboration is sought.

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