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Comparative anatomy of wild adult tilapia (*Oreochromis niloticus*) ovary during rainy and dry periods in Zaria, Nigeria

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Abstract

The study was undertaken to investigate the effects of rainy and dry periods on the gross and histological features of ovaries of *Oreochromis niloticus* in Zaria, Kaduna State, Nigeria. Twenty-four (24) adult wild tilapia fish with average weight of 300.17 ± 25.71 gm and 229.94 ± 23.68 gm was used during rainy and dry periods, respectively. They measured a standard body length of 24.00 ± 0.76 cm and 23.83±0.60 cm during rainy and dry periods, respectively. The fish were sourced from Zaria dam and transported live in open plastic troughs containing clean water to the Gross Anatomy Laboratory, Department of Veterinary Anatomy, Ahmadu Bello University Zaria. Each fish was euthanized using tricaine anaesthetic at 8 drops/litre of water. The ovaries were extracted, weighed and fixed in Bouin's fluid for 24 hours and processed histologically. Grossly, the ovaries of *O. niloticus* were highly vascularized and well developed during both rainy and dry periods. The average weight of both ovaries showed insignificant variation across the periods (0.125). The Gonado-somatic index value was insignificantly higher during rainy period (0.115) compared to dry period. Histologically, the ovaries were predominated by vitellogenic and post-vitellogenic follicles across both periods of the year. The tunica albuginea and interstitial connective tissues were thin during both periods. In conclusion, the results in this study revealed that adult wild tilapia fish had developed ovaries with predominant mature follicles during both rainy and dry periods suggesting that adult wild tilapia fish spawns during both rainy and dry periods in Zaria, Nigeria.

Keywords: Follicles, Gonado-Somatic Index (GSI), Ovaries, Wild tilapia, Zaria dam

Introduction

Nile tilapia *Oreochromis niloticus* (Linnaeus, 1758) is native to Africa, ranging from the upper Nile River south to the equator and west to the Atlantic coast 29° 32' 0.3768" N and 31° 16' 14.5020" E (Trewavas, 1983). The species is favored among aqua culturists for its ability to tolerate a wide range of environmental conditions, fast growth rate, successful reproductive strategies, and ability to feed at different trophic levels (Peterson *et al*., 2005). These adaptations allow them to be an extremely successful invasive species in subtropical and temperate environments (Peterson *et al.,* 2005). The Nile tilapia, *Oreochromis niloticus* belongs to the group of cichlids known as ''tilapias'' (McAndrew, 2000), which traditionally support major capture fisheries in most African inland waters (Lowe-McConnell, 2000; Jul-Larsen *et al.,* 2003). Tilapias tolerate a wide range of temperatures, salinities, and

water qualities and show high resistance to parasites and diseases (McAndrew, 2000). The relative ease and low cost of rearing tilapias have led to their widespread cultivation and introduction in tropical and subtropical areas (Lowe-McConnell, 2000). *Oreochromis niloticus* is the second most important cultured freshwater fish worldwide after carp (FAO, 2006).

The ovaries of Nile tilapia are paired, sac-shaped organs suspended from the wall of the coelom (Del Mundo, 1994). The outermost covering of the ovary is a membrane: the viscera peritoneum, the inner covering is the tunica albuginea which is composed of blood vessels and connective tissues (Masaru *et al.,* 1993). There is paucity of information on the periodic influence on the gross and histological features of the ovaries of adult wild tilapia fish in Zaria Nigeria.

Hence, the results obtained in this study will add to the existing literature on wild tilapia fish reproduction in Nigeria. Although, fish farming activities in Nigeria started over 50 years ago (Olagunju *et al.,* 2007), Nigeria has not been able to meet the protein requirement of its populace (FMARD, 2011).

Materials and Methods

Study area

The study was carried out in Zaria, Kaduna State, Nigeria. Zaria is located between Latitude 110 4'0" North, 70 42' 0" East (Tanko *et al.,* 2012). Zaria is situated in the northern Guinea Savanna Zone with a tropical continental climate possessing distinct rainy (May-October) and dry (November-April) seasons. Zaria has an average annual temperature of 24.9 ˚C/ 76.8 ˚F and rainfall of 1050 mm/ 41.3 inch (Climate office IAR-ABU Zaria, Kaduna-Nigeria). Zaria dam is located in Zaria city, it was constructed in 1975 on the river Galma to carter for Zaria township water supply and other benefits. The dam has a designed live reservoir capacity of 15.875 million m^3, length of 900 metres and a maximum height of 15 metres from the river bed (Tanko *et al.,* 2012). Zaria dam is located on latitudes 11˚07'45"E to 11˚08'20"E and longitudes 07˚46'N to 07˚48'N (Tanko *et al.,* 2012).

Experimental animals

Twenty-four adult wild *Oreochromis niloticus* were sourced from Zaria dam, Kaduna State, Nigeria during rainy and dry periods of the year 2017/2018. Twelve each were obtained during rainy period (May-October) and dry period (November-April). The fishes were transported live in open troughs containing clean water to the Gross Anatomy Laboratory, Department of Veterinary Anatomy, Ahmadu Bello University Zaria.

Morphometric parameters

The weight and length of each fish were determined using Mettler Toledo balance with sensitivity of 0.01 gm (Vastro India) and measuring tape, respectively. The weight and dimensions of the ovaries were determined using Mettler Toledo balance with sensitivity of 0.001 gm (Vastro India) and digital Vernier calliper (model number Y308 Henny), respectively. Photographs were taken using canon digital camera power shot (SX170 IS) with 64-megapixel sensor (focal length: 28-448mm, 7.5cm (3.0") TFT.

The gonado-somatic index was used for following up periodic variations in the gonads weight as related to the body weight of each fish in gram by the formula: GSI = Gonad weight/Fish body weight X 100 (Mahmoud & Badia, 2014).

Harvest of ovary

Each fish was euthanized using tricaine MSS anaesthetic at 8 drops/litre of water (Bowser, 2001). A mid-ventral incision was made between the pectoral fins to about one centimeter to the genital opening (a cylindrical opening situated caudal to the anal opening) and the ovaries were carefully extracted using scalpel blade, pair of scissors and forceps.

Histology

The extracted ovaries were fixed in Bouin's fluid for 24 hours, dehydrated through series of ascending concentrations of ethanol (70%, 90%, 100%, 100%, 100%) for 2 hours at each concentration, cleared in xylene, embedded in paraffin wax and sectioned at 5µg. Hematoxylin & Eosin was used for histological evaluation (Cek *et al*., 2001).

Data analysis

All data obtained were expressed as mean ± standard deviation (n=24). Statistical comparison between rainy and dry periods was made by subjecting the data to independent student t-test using GraphPad Prism version 5.0 for windows. Values of $P < 0.05$ were considered significant.

Results

The average body weight was 300.17 ± 25.71 gm and 229.94 ± 23.68 gm during rainy and dry periods, respectively. They measured a standard body length of 24.00 ± 0.76 cm and 23.83 ± 0.60 cm during rainy and dry periods, respectively. From the results

presented in Table 1, the average weight of both ovaries showed insignificant variation across both evaluated periods (0.125). The mean Gonado-somatic index (GSI) value was insignificantly higher during rainy period (0.115) compared to dry period. Plates 1 and 2 show well-developed and highly vascularized ovaries of *Oreochromis niloticus* during dry and rainy periods, respectively. Plates 3 and 4 show a very thin tunica albuginea and thin interstitial connective tissue with predominant vitellogenic and post-vitellogenic follicles during dry and rainy periods, respectively.

Discussion

The mean value of length and weight obtained for *O. niloticus* in this study which are often used in determining the maturity of the fish agrees with the report of Xiao *et al.* (2014). However, ovarian development in tilapia fish is influenced by several factors which includes hormonal, environmental and nutrition (Xiao *et al.,* 2014). The female reproductive organ of *O. niloticus* is composed of a pair of yellowish oval shape ovaries which are covered by visceral peritoneum and are anchored to the body wall by mesovarium, this is in agreement with the findings of Del Mundo (1994), who reported that Thailand and Taiwan strains of Nile tilapia, have a pair of sac-shaped ovaries covered by visceral peritoneum from the outside and tunica albuginea (containing blood vessels and connective tissues) from the inside. The study of the effects of rainy and dry periods on the ovary of an adult wild *O. niloticus* has not been documented in Nigeria to the best of our knowledge. Hence, the results obtain from this study would add

Table 1: Mean ± SD values of body weight, length and ovarian parameters of adult wild tilapia fish (*O. niloticus*) during rainy and dry periods

Parameters	Mean± SD (n=24)		p-value
	Dry Period	Rainy Period	
BW (gm)	229.94 ± 23.68	300.17 ± 25.71	0.115
BL (cm)	23.83 ± 0.60	24.00 ± 0.76	0.873
LO (cm)	10.00 ± 0.29	10.25 ± 0.66	0.754
DO (cm)	1.17 ± 0.12	1.77 ± 0.43	0.299
WO (gm)	3.93 ± 0.32	4.21 ± 1.39	0.125
GSI	1.27 ± 0.11	1.40 ± 0.35	0.115

Key: BW= Body weight, BL= Body length, LO= Length of ovaries, DO= Diameter of ovaries, WO= Weight of ovaries and GSI= Gonado somatic index

P<0.05 are statistically significant

Plate 1: Extracted ovaries of *Oreochromis niloticus* during dry period showing a pair of yellowish, and well –developed, Oval shaped ovaries with oviduct. Key: LO= Left ovary, M= Mesovarium, O= Oviduct, RO= Right ovary

Plate 2: Extracted ovaries of *Oreochromis niloticus* during rainy period showing a pair of yellowish and well developed oval shaped yellowish ovaries with oviduct. Key: LO= Left ovary, M= Mesovarium, O= Oviduct, RO= Right ovary

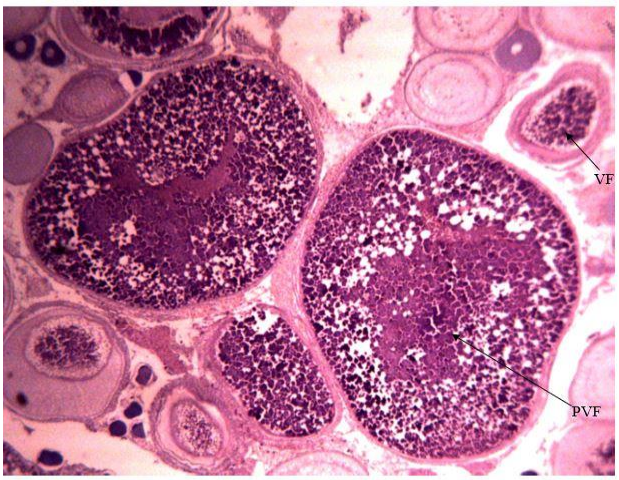

Plate 3: Histological section of the ovary of *Oreochromis niloticus* during dry period showing vitellogenic and post-vitellogenic follicles at 5µg. H&E X100. Key: PVF= Post-vitellogenic follicle, VF= Vitellogenic follicle

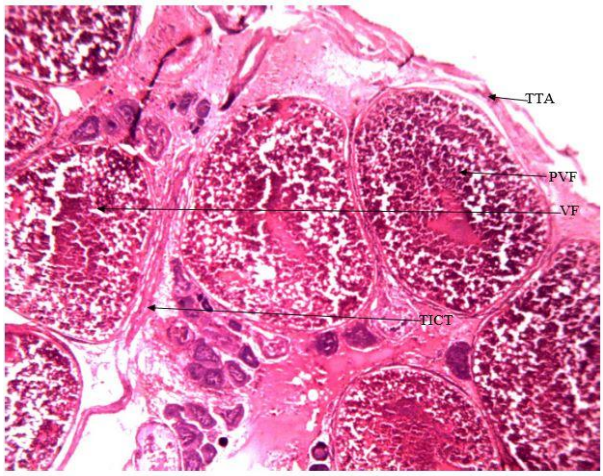

Plate 4: Histological section of the ovary of *Oreochromis niloticus* during rainy period showing vitellogenic and post-vitellogenic follicles with thin interstitial connective tissue and tunica albuginea at 5µg. H&E X100. Key: PVT= Post-vitellogenic follicle, TICT= Thin interstitial connective tissue, TTA= Thin tunica albuginea, Vitellogenic follicle

to the existing literatures on tilapia fish reproduction in Nigeria. Grossly, during both dry and rainy periods, the ovaries of *O. niloticus* were observed to be well developed and highly vascularized, this may suggest that the Nigerian Nile tilapia spawns during both rainy and dry periods, this is in agreement with the findings of Demeke (1996), who reported that the Ethiopian Nile tilapia breeds during both rainy and dry season. This equally agrees with the findings of Mark *et al.* (2004), who reported that costal Mississippi watershed tilapia reproduces all year round. Although, slightly bigger ovaries were observed during rainy period, suggesting a higher spawning rate during rainy period, probably due to abundant phytoplanktons, this disagrees with the findings of Demeke (1996), who reported that the Ethiopian Nile tilapia breeds higher during dry season. The average weight of both ovaries shows insignificant variation across rainy and dry periods (0.125), which may equally suggest that the gonads of *O. niloticus* are fully functional across both periods of the year, this is in contrary with the report of El-Zoghby *et al.* (2008) who reported that the weight, size and diameter of the reproductive organs of Catfish are significantly higher during spawning season compared to non-spawning season. The mean GSI value was insignificantly higher during rainy period (0.115) compare to dry period, this may suggest that although tilapia fish spawns during both dry and rainy period, but the gonads are more fully functional during rainy period than dry periods, this disagrees with the finding of Demeke (1996) who reported a higher GSI value during dry season in Ethiopian Nile tilapia. Histologically, the ovaries of *O. niloticus* was predominated by vitellogenic and post-vitellogenic follicles during both rainy and dry periods, which further suggest that the ovary is fully functional across both periods, this is in agreement with the findings of Del Mundo (1994) who reported that the ovaries of Thailand and Taiwan strains of Nile tilapia was predominated by matured follicles across all seasons. The tunica albuginea and interstitial connective tissue were thin during both rainy and dry periods, this may be due to the pressure exerted by the distended ovary with mature follicles. This agrees with the findings of Mahmoud and Badia (2014) who reported a thin tunica albuginea and thin interstitial connective tissue during spawning season of *Clarias lazera*.

In conclusion, the results obtained in this study, revealed that adult wild tilapia fish spawns during both rainy and dry periods in Zaria Nigeria. Although, tilapia fish was observed to breed more during rainy season, possibly due to the availability of more phytoplankton during rainy period, as nutrition plays crucial role in reproduction.

Conflicts of Interest

The authors declare no conflict of interest.

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