HEMATOLOGICAL PARAMETERS OF FRESHWATER FISH SPECIES IN MOROGORO, TANZANIA

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SUMMARY

Hematological parameters of four freshwater fish species of the genus Oreochromis (Tilapia) (*O. niloticus O. karomo* and *O. urolepis*) and the genus Clarias (catfish) (*C. gariepinus*) from natural and artificial habitats in Morogoro Tanzania were investigated using standard procedures. 122 samples (23 catfish, 99 tilapia) were used to study hemoglobin concentration (Hb), hematocrit (% packed cell volume (PCV)), and erythrocyte and leukocyte counts. Three species; *O. karomo*, *O. urolepsis* and *C. gariepinus* were obtained from Mindu dam (natural habitat). One species, *O. niloticus* was obtained from Kihonda aquacultural concrete tank culture system (artificial habitat). Catfish had significantly ($P<0.05$) higher values of all the measured parameters compared to tilapia from either of the two sources. Male catfish had significantly ($P<0.05$) higher PCV and Hb values compared to females. Except for higher values for white blood cell (WBC) counts in female tilapia ($P<0.05$) compared to males, there were no other differences between the measured parameters in tilapia with respect to species or sex. Female tilapia reared in a natural habitat had higher PCV and lower WBC compared to those reared in artificial habitat. In contrast, male tilapia reared in artificial habitat had higher WBC, but lower Hb compared to those reared in a natural habitat. This study provides basic hematological data of catfish and tilapia fish reared under tropical conditions. Results indicate that hematological parameters of fresh water fish depend on the species, sex, and the type of habitat, and denote consideration of these factors at the time of utilizing hematological parameters for diagnostic purposes.

INTRODUCTION

There is rise in small and large scale aquaculture in Africa and many places in the world as a result of increased demand for fish and fish products and stagnation or even fall of fish catches from natural habitats (FAO, 1996). In Tanzania, the avarage aquaculture

production is eatimated to be 1400 kgs/ha/yr on average tank size of 150-500 m^2 with an enomous potential of future expansion (Msolla *et al.*, 1998). Success of aquaculture depends greatly on understanding of the factors that limit fish productivity, which include nutrition, diseases, stocking density, dissolved oxygen concentration and presence of hazardous chemicals and pollutants in water. These factors have a direct impact on the hematological parameters of fish (Baker, 1969; Mwangulumba, 1997). Hematological parameters play a fundamental role in the diagnosis of fish diseases and other stress factors (Schaperclaus, 1939; Puchkov, 1964; Satchell, 1991). However before they can be exploited for diagnostic purposes, establishment of database of 'normal' hematological ranges in fishes of various species, ages, and different growth conditions is desirable. Therefore the aim of this study was to determine 'normal' levels of the key hematological parameters of freshwater fish from Mindu dam and Kihonda aquacultural concete tank rearing systems in Morogoro, Tanzania. Mindu dam was constructed in 1970s to primarily serve as a source of water for Morogoro urban population. At the moment, Mindu dam supplies water to about 70% of the people in the Morogoro Municipality, and it is also a source of substantial amount of fish to the urban dwellers.

MATERIAL AND METHODS

Study area and fish species

In the present investigation, fish were obtained from two sources: [1] Mindu dam (natural habitat) that covers an area of about 10 km^2 and is surrounded by Uluguru Mountains, which give rise three major rivers that feed the dam. The dam has an extra area of mashland (~3 km^2) where rivers enter the dam. [2] The second source of fish was an aquacultural concerete tank owned by Dr. B. V. Mnembuka. The tank is located in Kihonda suburb area approximately five kilometers from the town center along Dodoma highway. Mnembuka's aquacultural tank was constructed in 1999 using concrete walls and floor, and has dimensions of approximately 9 m length x 5 m width x 2 m height. Unlike fish in Mindu dam that depend entirely on aquatic microorganism, fish reared in Mnembuka's aquacultural tank live in an artificial conditions. They feed on aquatic organisms as well as feed supplements like milling byproducts. Fish sampling was done during the rainy season between April and May 2004.

identified based on morphological features described by Boomker (1981b). Counting was done in the 4 large squares (1 x 1 x 0.1 mm) at the 4 corners of the Neubeur counting chamber.

The final count of WBC was obtained by using the formula described by Baker and Silverton (1976) as shown below.

$$\text{WBC count per x } 10^9/l = \frac{\text{total cells counted (N) x dilution x } 10^6}{\text{Volume assayed}}$$

For dilution of 1:20 and volume of 4 x 1 x 1 x 0.1 mm^3

$$= \frac{N \times 20 \times 10^6}{4 \times 1 \times 1 \times 0.1}$$

$$= 0.05N \times 10^9$$

$$= N \times 0.05 \times 10^9$$

Statistical analysis

Date statistical analysis was done using SAS (1988), and the model was:

$$Y = I + T + C + S + \varepsilon$$

Where Y= dependable variable

I= Intercept

T = Fish type (Catfish or Tilapia)

C = Fish source (Mindu or Kihonda)

S = Sex (Male or Female)

ε = Random error

RESULTS

Hematological parameters were studied in a total of 122 adult fish comprised of tilapia and cat fish as elaborated in Table 1. The weights, lengths and girths of sampled fish are presented in Table 2. Catfish and Tilapia from Mindu dam were of comparable sizes. Tilapia fish from Mindu dam were larger than to those from Kihonda aquacultural tank.

Table 2. Zootechnical data of tilapia and catfish from Mindu dam and Kihonda aquacultural tank

Parameters	Mindu tilapia	Kihonda tilapia	Mindu catfish
Weight (g)	139.8-1,160	52.8-205.2	136.7-1,325
*Length (cm)	19.5/17-41/35	15/12-22/19	26/22-61/54
Girth (cm)	15-27	11-16	11-24.5

*Total length/standard length where total length spans from the tip of the head to the end of the caudal fin and standard length exclude the caudal fin

Table 3 shows the raw means and ranges of hematological parameters (Hb, PCV, RBC and WBC) of these types of fish under different rearing systems. Catfish had higher values in most of the measured parameters compared to tilapia fish. Kihonda tilapia had higher mean Hb compared to tilapia fish from Mindu dam (9.23Vs 7.9 g/dl).

Table 3. Raw mean values and ranges of some hematological parameters in Catfish and Tilapia fish from Mindu dam and Kihonda aquacultural tank

Fish type	Parameter	Mean	Range
Mindu catfish	Hb (g/dl)	9.66	6.6 - 16.7
	PCV (%)	32.9	14 - 45
	RBC x 1012cells/l	3.06	2.05 - 4.08
	WBC x 109cells/l	12.3	6.4 - 16
Mindu tilapia	Hb (g/dl)	7.9	3.9 - 19.4
	PCV (%)	29.5	14 - 38
	RBC x 1012cells/l	2.44	1.25 - 3.79
	WBC x 109cells/l	7.08	5.2 - 10.05
Kihonda tilapia	Hb (g/dl)	9.23	3.9 - 18.8
	PCV (%)	26.5	19 - 33
	RBC x 1012cells/l	2.40	1.66 - 3.13
	WBC x 109cells/l	8.98	5.85 - 12.8

Shown in Table 4 are the square mean body weights and hematological parameters of tilapia fish from Mindu dam and Kihonda aquacultural tank. While the hematological parameters were not significantly different, Mindu tilapia were significantly ($P<0.0001$) heavier compared to Kihonda tilapia.

Table 4. The effect of rearing system on body weight and hematological parameters of tilapia

Parameter/Habitat	Mindu	Kihonda	Std error	P-value	Significant level
PCV (%)	29.2	26.6	0.96	0.569	NS
WBC count x10^9 cells/l	7.05	8.94	0.785	0.348	NS
RBC count x 10^{12} cells/l	2.44	2.42	0.144	0.955	NS
Blood Hb(g/dl)	7.90	8.82	0.346	0.196	NS
Body wt (g)	357.0	102.7	11.64	0.0001	****

Key: ****P<0.0001

Shown in Table 5 are the least square mean values of the measured hematological parameters in Catfish and Tilapia from Mindu dam and Kihonda aquacultural concrete tank. Catfish had significantly (P<0.05-P<0.001) higher values in all parameters.

Table 5. Mean values of some hematological parameters in Catfish and Tilapia from Mindu and Kihonda aquacultural tank

Parameter	Catfish	Tilapia	Std error	P-value	Significant level
PCV (%)	32.9	28.2	0.90	0.0007	***
WBC count x109 cells/l	12.30	7.89	0.240	0.0001	***
RBC count x 1012 cells/l	3.07	2.43	0.800	0.0001	***
Blood Hb(g/dl)	10.1	8.3	0.54	0.04	*

Key: ***P<0.001; *P<0.05

The effect of sex and fish rearing system on the measured hematological parameters are indicated in Table 6. Male catfish had higher (P<0.05) PCV and Hb compared to female catfish. There were no significant differences the measured hematological parameters for tilapia fish from Mindu dam and Kihonda aquacultural tank (Tables 4 and 6)

Table 6. The effect of sex on some hematological parameters of Catfish and Tilapia fish from Mindu dam and Kihonda aquacultural tank

Fish Type and source	Parameter	Male	Female	Std error	P-value	Significant level
Mindu catfish	PCV (%)	35.7	28.6	2.21	0.04	*
	WBC x 10^9 cells/l	12.10	12.65	0.68	0.6	NS
	RBC x10^{12} cells/l	3.10	3.03	0.20	0.8	NS
	Hb (g/dl)	10.7	8.0	0.69	0.01	**
Mindu tilapia	PCV(%)	28.2	30.1	1.13	0.1	NS
	WBC x 10^9 cells/l	6.77	7.33	1.146	0.05	NS
	RBC x10^{12} cells/l	2.43	2.45	0.196	0.87	NS
	Hb (g/dl)	7.4	8.3	0.43	0.15	NS
Kihonda tilapia	PCV(%)	27.1	26.1	0.782	0.34	NS
	WBC x 10^9 cells/l	8.84	9.03	0.424	0.76	NS
	RBC x10^{12} cells/l	2.48	2.35	0.092	0.30	NS
	Hb (g/dl)	9.1	9.3	1.05	0.92	NS

Key: **P<0.01; *P<0.05; NS: Non-significant

DISCUSSION

The aim of the present investigation was to determine baseline hematological parameters of freshwater fish namely tilapia and catfish and the influence of rearing systems in Morogoro, Tanzania. We have provided baseline data that may be useful for clinical diagnosis of fish diseases in Tanzania and similar tropical conditions. The data obtained in this study demonstrate that in the same environment, catfish have higher PCV, WBC and RBC counts, and Hb levels compared with tilapia, and signify the importance of considering sex and habitat differences for diagnostic purposes.

The differences in body sizes of the fish obtained from a natural habiat (Mindu dam) compared to those from Kihonda aquacultural tank (Tables 2 and 5) were probably due to the species, growth stage and the sampling method used in this study. During

sampling, we selected larger fish because larger body size was found to be convenient for handling for blood sampling and larger fish provided sufficient volumes of blood. Mindu dam being a larger in size and with many fishermen bringing their fish offshore each morning for sale, offered a greater chances of selecting larger fish. Kihonda Aquacultural tank being smaller in size and with fish being continuously harvested was likely to provide tilapia fish with smaller body size most of them being young stock.

The values of the hematological parameters obtained from both tilapia and catfish in this study (Table 3) are within the reported ranges in other studies (Hattingh, 1972; Keen *et al.*, 1990; Wilhelm *et al.*, 1992). The finding that catfish had higher PCV, WBC and RBC counts, and Hb levels compared with tilapia compared with tilapia are agreed with those of Hattingh (1972) in South African fresh water *Claris garipepinus* and *Tilapia mossambica* fish. The reason for variation between catfish and tilapia is likely due to species and therefore genetical differences. However, the type of environment preferred by catfish may contribute to these differences. Catfish usually live in muddy water at the bottom of fresh water bodies where oxygen tension is low and which has high crustaceans and worms to feed onto whereas tilapia spend most of their time in the clear well aerated waters at the top layers. Thus, catfish are more exposed to protein rich feeds and low oxygen tension, which is a potent stimulus for increased RBCs synthesis (Houston and de Wilde, 1969; Houston, 1980).

The effects of sex and habitat on some hematological parameters were also evident in this study (Table 6). It has been reported that hematological parameters in fish vary with sex and the breeding season depending on changes of hormone levels in blood (Eisler, 1965). In this study, male catfish had significantly higher PCV and Hb values compared to females, which was consistent with the findings of Keen *et al.*, (1990) in catfish. However, female tilapia fish from Mindu dam had higher PCV and Hb values compared to males (Table 6). Eisler (1965) reported that during spawning, female fish tend to have high numbers of blood cells especially RBCs due to the hormonal changes (high levels of estrogen) that occur in the body of the fish. Thus, it was possible that the majority of the female fish sampled from Mindu dam were in the spawning stage. Leukocyte counts in female fish increase during the breeding season (Puchkov, 1964). The observed non-signifucantly higher number of WBCs in the female tilapia fish from Mindu and those from Kihonda tank compared to male tilapia suggests that these female tilapia were possibly in their breeding season that

normally occurs during the rainy season in April to June, which coincided with the sampling period. The significantly higher levels of WBCs in female tilapia in Kihonda compared to their counterparts in Mindu dam was either due to slight differences in the peak breeding time for fish under artificial rearing system compred to those in the wild or due to stresses associated with artifical rearing or both of these factors. The impact of the rearing system is supported by the obsrved increase WBCs counts male tilapia from Kihonda compared to those from Mindu dam.

In conclusions, hematological parameters of fish are of diagnostic importance and even in the assessing of environmental factors such as pollution and fish health especially with the rise in commercial fish farming. This study provides baseline data that may be useful for clinical diagnosis of fish diseases in Tanzania and other tropical area. Our findings indicate that catfish had higher PCV, WBC and RBC counts, and Hb levels compared with tilapia. Hematological parameters are highly influenced by sex of fish suggesting that they type of sex, habitat and the breeding season need to be considered when assessing these parameters for diagnostic causes.

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