Blood Profile of the African Dwarf Giraffe Catfish, *Parauchenoglanis ansorgii* (Boulenger 1911)

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***Abstract*—The haematological and serum biochemical characteristics of Parauchenoglanis ansorgii were studied with variations to size, sex and season of the year. Haematological and serum biochemical characteristics of P. ansorgii were influenced by size of the fish and season of the year but not by sexual differences. Haematological parameters were better for adult fish and in dry season. Normal values for haematology and biochemistry of P. ansorgii were established as a working material upon which to base more studies.**

***Keywords*—haematology, serum biochemistry, African dwarf giraffe catfish, Parauchenoglanis ansorgii**

1. INTRODUCTION

Fishes are highly sought today because of their high nutritive values. Fish is a key ingredient on the global menu, a vital factor in the global environment and an important basis for livelihood worldwide [1]. According to [2] fish constitute a major source of animal protein to a large number of Nigerians. Fish is also widely acceptable because of its high palatability, low cholesterol and tender flesh [3]. Fish represents at least 55% of the animals protein consumed in the diet of Nigerians [4] with fish demand outstripping the supply this has led pressures on the natural fisheries reserves, which have been subjected to gross over fishing for several years. The knowledge of the ecology and physiology of some wild fish species is imperative for their captive culture in order to enhance fish supply for the populace. *Parauchenoglanis ansorgii*, family claroteidae a catfish found in Africa is one. As aquaculture expands, there is an increasing need for improved diagnostic methods. Haematological analysis will enhance fish cultivation by facilitating early detection of stress and or diseases that could affect production performance [5], [6]. The objective of this study is to determine the haematological and serum biochemical characteristics of *P. ansorgii* in the wild which will serve as basic data for other studies.

2. MATERIALS AND METHODS

2.1 *Experimental Animal*

Parauchenoglanis ansorgii was identified using Fish and Fisheries of Northern Nigeria by Reed *et al*., (1967). 35 specimens comprising 18 females and 17 males were used. Their mean weight was 71±11.62g and mean total length was 17.85±1.03cm The fishes were transported in 25L container under an optimum temperature (ice) to the Department of Animal and Environmental Biology Laboratory. The fish were considered normal on the basis of their external appearance and absence of symptoms of diseases.

2.2 *Blood Collection*

Parauchnoglanis ansorgii specimens were obtained from fishermen in Ogbese River. Total length, standard length and weight were measured using a fish measuring board and Ohaus Tripple Balance, respectively. Blood samples (2ml) respectively were collected per fish by puncturing the caudal blood vessels. Threafter, 2 ml blood was transferred into a tube containing ehylendiamine-tetra-acetic acid (EDTA, an anticoagulant) and stored at 4^0C in a refrigerator prior to haematological analyses. A duplicate 2 ml blood sample was transferred

into a tube containing lithium heparin,(anticoagulant) and centrifuged immediately at 12,000 rpm for 5 minutes in a refrigerated centrifuge. The serum was collected and stored at -4^{0}C prior to biochemical analyses. Packed cell volume (PCV), haemoglobin (HB) concentration, red blood cell (RBC) count and leukocytes (WBC) count and its differentials were determined using Minray® autohaematology (3000plus). Mean corpuscular haemoglobin (MCH), Mean corpuscular volume (MCV) and mean corpuscular haemoglobin concentration (MCHC) were calculated. Serum biochemical parameters such as total protein, albumin, glucose, blood urea and nitrogen, alkaline phosphatase (ALP), aspartate aminotransferase (AST), alanine aminotransferase (ALT) were determined using BTS, biosystem® photometer. Globulin was calculated from the difference between total protein and albumin value. Electrolytes such as sodium, chloride, and phosphorus were determined using PC-1000A Electrolyte analyzer. Descriptive statistics for mean, standard deviation were carried out for all data. All data were subjected to students't-test, regression and correlation analyses between total length and various haematological and biochemical parameters.

3. RESULTS

The haematological and biochemical characteristics of *P. ansorgii* in relation to sex differences were presented in Table 1 which showed no significant difference ($p > 0.05$) between males and females except monocytes and MCV values for females that are significantly ($p < 0.05$) higher males. Haematological and biochemical characteristics of *P. ansorgii* in relation to seasons are presented in Table 2. Differences in the values for wet and dry seasons were significant ($p < 0.05$) for PCV, WBC, RBC, HB, MCH, MCHC, potassium chloride and protein while other parameters are not significantly different ($p > 0.05$). Haematological and biochemical characteristics of *P. ansorgii* in relation to size variations were presented in Table 3 which showed significant differences ($p < 0.05$) between juveniles and adults. HB and MCH values of juveniles were significantly ($p < 0.05$) lower than that of adults.

4. DISCUSSION

Haematological and serum biochemical characteristics are significantly influenced by the wide range of environmental conditions experienced by fish [7], [8], [9], [10], [11]. The oxygen carrying capacities of fishes vary with life history stage, habits and environmental conditions [12]. Reference [13] reported that there are changes in the haematological and biochemical parameters of fish with regard to age or size. Sex of a fish has a great differentiation in various component of the blood of fish, depending upon the quantum of metabolic activities of the organism [14]. Reference [15] suggested that differences in hematocrit (PCV) between the two sexes of a fish are genetically determined, but [16] stated that it might be due to the higher metabolic activities of

TABLE 1: Haematological and biochemical parameters of male and female *P. ansorgii*

PARAMETERS	RANGE		MEAN		STANDARD DEVIATION		STAT. SIGN.
	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE	
PCV(%)	13-30	10-33	22.9	21.57	6.70	9.62	NS
WBC($\times10^9$)	29-134	20-104	69.86	64	43.40	35.05	NS
NEUTROPHILS(%)	51-61	46-61	54	52.43	4.86	4.86	NS
LYMPHOCYTES (%)	36-45	36-45	41.29	42	3.36	3.06	NS
MONOCYTES(%)	2-3	2-5	2.57	3.57	0.53	0.96	S
EOSINOPHILS(%)	1-2	1-2	1.43	1.43	0.53	0.59	NS
BASOPHILS(%)	0-2	0-2	0.86	1	0.69	0.82	NS
PLATELETS($\times10^9$)	21-580	24-298	197.86	129.71	222.92	103.06	NS
RBC ($\times10^{12}$)	1.02-2.17	0.64-2.21	1.58	1.45	0.43	0.67	NS
HAEMOGLOBIN(%)	48-114	28-121	80.86	73.43	27.67	36.71	NS
MCV(μ^3)	127.5-146.7	138.8-156.3	139.91	150.03	7.332	5.80	S
MCH(pg)	450-581.15	437.5-577.5	497.89	501.32	49.94	43.87	NS
MCHC(%)	147.4-396.5	280-370	332	332.49	84.1	31.65	NS
BUN(MOL/L)	1.14-1.83	1.17-2.1	1.48	1.59	0.27	0.31	NS
POTASSIUM(MOL/L)	2.94-3.5	3.1-3.56	3.35	3.36	0.18	0.15	NS
SODIUM(MOL/L)	140-148	142-145	144.29	143.57	2.63	1.13	NS
CHLORIDE(MOL/L)	136-145	132-147	139.14	139	3.48	5.94	NS
T. PROTEIN(G/L)	57.3-63	132-147	60.54	60.86	1.85	4.02	NS
ALB(G/L)	30-37	30.7-40.2	33.93	35.76	2.35	3.94	NS
GLB(G/L)	23.3-37.3	21.8-28.9	28.04	25.2	4.83	2.51	NS
AST(U/L)	13-18	14-23	15.43	17	1.90	3.0	NS
ALT(U/L)	3-8	3-6	5.86	4.71	1.68	1.11	NS
ALP(U/L)	165-241	195-234	202.57	209	22.36	12.94	NS
CHOL(MG/DL)	132-138	132-140	136.43	136.53	2.15	2.94	NS
GLUCOSE(MOL/L)	4.44-6.5	4.8-6.77	5.59	5.63	0.65	0.65	NS

Note: PCV- Packed Cell Volume; WBC- White Blood Cells; RBC- Red Blood Cells, MCH- Mean Corpuscular Haemoglobin:; MCV- Mean Corpuscular Volume; MCHC- Mean Corpuscular Haemoglobin Concentration; ALP- Alkaline Phosphatase; AST-Aspartate Aminotransferase; ALT- Alanine Aminotransferase ; CHOL- Cholesterol; BUN-Blood Urea and Nitrogen; T. PROTEIN- Total Protein; NS- Non-Significant; S-Significant; STAT. SIGN.-Statistical Significance ($p < 0.05$)

males compared to females. The insignificant difference observed in the haematological and serum biochemical parameters of the male and female *P. ansorgii* was similar to the findings of [17], [18], [19]. Mean value WBC obtained for male and female *P. ansorgii* was higher than that of *H. longifilis* as reported by [20] and for *Mormyrus rume* as reported by [19]. Reference [21] stated that animals with low white blood cells are susceptible to high risk of disease infection, while those with high leucocyte counts are capable of generating antibodies in the process of phagocytosis and have high degree of resistance to diseases. The high WBC of *P. ansorgii* could be an indication of the wellbeing and ability of the fish to withstand pathogen invasion. However, the PCV value for *P. ansorgi* was lower than that recorded by [22] for *Catla catla* and that by [23] for *Cyprinion marostomus*. The result of haemoglobin obtained in this work for male and female was not significant but [24] reported higher haemoglobin concentration in males of *Clarias batrachus* and attributed this to the more aggressive nature of the males. The significant ($p < 0.05$) differences observed in monocytes values between male and female *P. ansorgii* could be attributed to part of the immunological processes of female fish as reported by [25] that fish with high WBC value will be more able to defend itself from invading pathogens and antibody mediated responses.

TABLE 2: Haematological and biochemical parameters of *P. ansorgii* in wet and dry seasons

PARAMETERS	RANGE		MEAN		STANDARD DEVIATION		STAT. SIGN.
	WET	DRY	WET	DRY	WET	DRY	
PCV(%)	10-20	23-33	15.57	28.86	4.47	3.08	S
WBC($\times10^9$)	20-62	34-134	39.51	94.3	16.42	33.43	S
NEUTROPHILS(%)	46-61	51-56	53.14	53.14	6.01	1.67	NS
LYMPHOCYTES (%)	36-45	38-56	41.57	41.71	3.95	2.29	NS

MONOCYTES(%)	2-5	2-4	3.43	2.57	0.98	0.79	NS
EOSINOPHILS(%)	1-2	1-2	1.43	1.57	0.53	0.53	NS
BASOPHILS(%)	0-2	1-2	0.57	1.29	0.7	0.49	NS
PLATELETS($\times 10^9$)	32-580	21-438	216.86	110.71	183.88	150.42	NS
RBC ($\times 10^{12}$)	0.64-1.32	1.62-2.21	1.04	1.99	0.27	0.21	S
HAEMOGLOBIN(%)	28-68	79-121	50.29	104	15.25	14.42	S
MCV(μ^3)	127.43-156.3	138.3-154.6	144.76	145.29	10.59	5.98	NS
MCH(pg)	437.5-515.15	484.5-581.2	478.9	522.27	29.78	33.78	S
MCHC(%)	280-369.23	313-396.3	332.07	359.4	27.33	27.24	S
BUN(MOL/L)	1.14-2.1	1.33-1.83	1.48	1.59	0.35	0.21	NS
POTASSIUM(MOL/L)	2.94-3.5	3.39-3.56	3.27	3.43	0.19	0.05	S
SODIUM(MOL/L)	142-148	`40-145	144.57	143.29	2.15	1.70	NS
CHLORIDE(MOL/L)	138-147	132-138	142.86	135.29	2.91	2.36	S
T.PROTEIN(G/L)	56-61	60-69	58.69	63.86	1.89	3.39	S
ALBUMIN(G/L)	30-35	31.7-40.2	32.86	36.84	1.87	3.18	NS
GLOBULIN(G/L)	23.3-29.5	21.8-37.8	25.94	27.37	2.42	5.39	NS
AST(U/L)	13-23	14-18	16.29	16.14	3.3	1.77	NS
ALT(U/L)	3-8	4-7	5.14	5.43	1.95	0.98	NS
ALP(U/L)	165-241	198-210	207.71	203.86	25.61	5.08	NS
CHOL(MG/DL)	132-140	132-138	137.14	135.71	2.79	2.06	NS
GLUCOSE(MOL/L)	4.8-6.61	4.44-6.677	5.61	5.60	0.43	0.79	NS

Note: PCV- Packed Cell Volume; WBC- White Blood Cells; RBC- Red Blood Cells, MCH- Mean Corpuscular Haemoglobin:; MCV- Mean Corpuscular Volume; MCHC- Mean Corpuscular Haemoglobin Concentration; ALP- Alkaline Phosphatase; AST-Aspartate Aminotransferase; ALT- Alanine Aminotransferase ; CHOL- Cholesterol; BUN-Blood Urea and Nitrogen; T. PROTEIN- Total Protein; NS- Non-Significant; S-Significant; STAT. SIGN.-Statistical Significance ($p < 0.05$)

Reference [24] stated that MCV value reflects the size of red blood cells by expressing the volume occupied by a single red blood cell. The MCV value obtained for *P. ansorgii* was lower than that recorded by [26] for Rainbow trout but the MCH for *P.ansogii* was higher than that for *Catla catla* reported by [22] and *Mormyrus rume* reported by [19]. Higher MCH value in *P. ansorgii* might confer higher likelihood of survival in harsh environment to the fish. Reference [27] reported that high level of MCHC indicates more haemoglobin in a unit of Red Blood Cells. The insignificant difference in MCHC values between male and female indicated relative equal amount of haemoglobin in the red blood cells in both sexes of *P. ansorgii*. Reference [28] reported that through biochemical constituents of the fish blood, the metabolic disturbances of fishes could easily be assessed. The biochemical values such as protein, glucose, cholesterol, albumin for *P.ansorgii* were similar to that reported by [24] for *Claraias batrachus*, [19] for *Mormyrus rume* and [29] for *Clarias gariepinus*. Serum protein gives an index of health status of the brood fish [30] and as an indicator of nutritional status [31]. The high protein in *P. ansorgii* may be due to food sufficiency in

TABLE 3: Haematological and biochemical parameters of juveniles and adults *P. ansorgii*

PARAMETERS	RANGE		MEAN		STANDARD DEVIATION		STAT. SIGN.
	JUVENILE	ADULT	JUVENILE	ADULT	JUVENILE	ADULT	
PCV(%)	10-30	13-33	20.6	23.11	10.09	6.77	NS
WBC($\times 10^9$)	20-124	29-134	69.32	65.57	46.76	35.41	NS
NEUTROPHILS(%)	47-54	46-61	51.8	53.89	2.77	4.86	NS
LYMPHOCYTES (%)	40-45	36-45	42.6	41.11	2.30	3.48	NS
MONOCYTES(%)	2-4	2-5	3	3.11	1	1.09	NS
EOSINOPHILS(%)	1-2	1-2	1.6	1.33	0.55	0.71	NS
BASOPHILS(%)	0-2	0-2	1	0.89	0.71	0.78	NS
PLATELETS($\times 10^9$)	30-238	21-580	104.6	196.67	85.77	200.45	NS
RBC ($\times 10^{12}$)	0.64-2.17	1.02-2.21	1.45	1.54	0.76	0.43	NS
HAEMOGLOBIN(%)	28-114	48-121	72.8	79.56	41.43	26.76	S
MCV(μ^3)	138.25-156.3	127.45	144.48	145.32	7.44	9.09	NS
MCH(pg)	437.5-525.35	450-581.15	486.88	508.13	35.12	39.37	S
MCHC(%)	280-380	313-396.43	338.69	350.1	40.32	24.33	NS
BUN(MOL/L)	1.17-2.1	1.14-1.83	1.58	1.52	0.36	0.26	NS
POTASSIUM(MOL/L)	3.2-3.42	2.94-3.56	3.64	3.35	0.09	0.19	NS

SODIUM(MOL/L)	142-144	140-148	143	144.44	0.71	2.29	NS
CHLORINE(MOL/L)	133-147	132-145	139.2	139	5.97	4.21	NS
T.PROTEIN(G/L)	56-68	57.3-69	60.8	61.53	4.60	3.45	NS
ALB(G/L)	30.7-40	30-40.02	35.34	34.58	3.49	3.30	NS
GLOBULIN(G/L)	24.2-28	21.8-37.2	25.54	27.2	1.48	4.85	NS
AST(U/L)	14-23	13-18	16	16.33	3.94	1.65	NS
ALT(U/L)	4-5	3-8	4.8	5.56	0.45	1.81	NS
ALP(U/L)	198-215	165-241	204.4	206.55	7.02	22.16	NS
CHOLO(MG/DL)	136-140	132-138	138	135.56	1.87	2.40	NS
GLUCOSE(MOL/L)	4.8-5.8	4.44-6.7	5.4	5.72	0.42	0.69	NS

Note: PCV- Packed Cell Volume; WBC- White Blood Cells; RBC- Red Blood Cells, MCH- Mean Corpuscular Haemoglobin:; MCV- Mean Corpuscular Volume; MCHC- Mean Corpuscular Haemoglobin Concentration; ALP- Alkaline Phosphatase; AST-Aspartate Aminotransferase; ALT- Alanine Aminotransferase ; CHOL- Cholesterol; BUN-Blood Urea and Nitrogen; T. PROTEIN- Total Protein; NS- Non-Significant; S-Significant; STAT. SIGN.-Statistical Significance ($p < 0.05$)

Ogbese River. Reference [32] reported that glucose level in blood is an indicator of stress in fish; it is continuously required as an energy source by all body cells and must be maintained at adequate levels in the plasma. The present study revealed high glucose value in *P.ansorgii*, which was similar to the findings of [24] for *Clarias batrachus*, [33] for *Caspian kutum*. Reference [34] reported that liver plays an important role in cholesterol homeostasis by regulating plasma lipoprotein metabolism and lipid output in bile. The cholesterol concentration in *P.ansorgii* was higher than that for *C. batrachus* reported by [24] but lower to the record of [35] for *Capoeta capoeta gracilis*. The non-significant differences in haematological and biochemical parameters for male and female in this study could be attributed to the similarity in the diet and physiological status of both sexes, these findings were comparable with the report of [19], [35]. Seasonal fluctuations in haematological and biochemical parameters observed for *P.ansorgii* was in agreement with the report on some fresh water fishes that have been reported [19], [36], [37], [22]. However, *P.ansorgii* has better haematological parameters during the dry season as against wet season. The observed variations in *P. ansorgii* could be attributed to higher activities in migration and spawning [3] during the wet season could be stressful to this fish species. There was no significant difference in the biochemical characteristics of *P. ansorgii* between the two seasons. The range of serum biochemical value observed for *P. ansorgii* was similar to the report by [19] for *Mormyrus rume* and [38] for Tilapia hybrid. Alanine aminotransferase (ALT) and aspartate aminotransferase (AST) are non-plasma specific enzymes that are localized in tissues cells of liver, heart, gills, kidneys, muscles and other organs and their presence in the blood plasma may give specific information about organ dysfunction [39].The low level of AST and ALT observed in *P.ansorgii* showed that they have not suffered hepatic cell damage which could have led to the leakage of the enzymes into the extracellular space. The high level of glucose observed in *P. ansorgii* in the wet season and dry season could also indicate good health status, relatively free from infections, since infections are reported to depress plasma glucose levels in fish. Serum Sodium value for *P. ansorgii* was similar to the findings of [38] for tilapia and [40] for *H. niloticus.* Reference [41] acknowledged that size of a fish is a very crucial factor in the establishment of fish haematological profiles. The significantly higher values observed in the blood parameters of adult over juveniles of *P. ansorgii* was in agreement with the findings of [42] who observed the influence of size on the haematology of *Clarias buthupogun*, which increased with size. Reference [43] found that the values of HB, RBC and PCV increased as the fish size increase. Similar results were obtained for *Tilapia zilli* [44], *Cyprinus carpio*, [45] and *Amphiprouscuchia* [46]. Haematological profiles of *P. ansorgii* agrees with the general trend in the relationship between blood parameters and body size, that is the bigger the fish, the higher the values of its haematological and biochemical parameters. This could be attributed to greater ability of the large size fish to access and digest food [19], [47] also suggested that the difference might be due to the higher metabolic rate of the bigger fish compared to smaller ones, furthermore [12] stated that oxygen carrying capacity of fishes vary with life history stage, habits and environmental conditions. This study was also similar to [48] who reported that both the haemoglobin contents and Erythrocyte counts tend to increase with length and age of fish, [49] also observed similar findings in *Pleuronectes platessa*.

5. CONCLUSION

This study has shown that haematological and biochemical characteristics of *P. ansorgii* were significantly influenced by size of the fish and season of the year and insignificantly influenced by sex. Blood characteristics were better in dry season for both sexes and sizes. There was no significant difference in blood characteristics between the males and the females while adult fish has better blood profiles. The normal values for haematology and biochemistry of *P. ansorgii* have been established. This data on *P. ansorgii* will contribute to studies on fish physiology and fish culture.

REFERENCES

[1] Bene, C. and Heck S.. Fisheries and millennium development goals: solutions for Africa. NAGA World fish centre Q. 28:14-18. 2005

[2] Ademola-Aremu, O. O., Aina, O. M., Adetiloye, A. O. Levels of lead, cadmium and chromium in *Oreochromis niloticus* in Lagos state lagoon. Ethiopian journal of Environmental studies and management 2(3): 13-18. 2009

[3] Eyo, A.A. Fish Processing Technology in the tropics. National Institute for Freshwater Fisheries Research, University of Ilorin. 66-70. 2001

[4] Anyanwu, P.E., Oladipo A.E, Pepple P.C., and Ebonwu B.I. The suitability of redsnapper, *Lutjanus dentatus* for the control of tilapia. (*Sarotherodon melanotheron)* population in brackish water ponds. Journal of Aquatic Science, 10: 211- 215. 2002

[5] Rehulka J., Minarik B., Rehulkov A.E. Red blood cell indices of rainbow trout, *Onchorhynchus mykiss* (Walbaum) in aquaculture. Aquaculture Research. 35: 529 - 546. 2004

[6] Tavares-Dias M, Barcellos J.F.M. Peripheral blood cells of the armored catfish *Hoplosternum littorale* Hancock, 1828: a morphological and cytochemical study. Brazil Journal of Morphological Science 22: 215 - 220. 2005

[7] Folmar, L.C. Effects of chemical contaminants on blood chemistry of teleostean fish: a bibliography and synopsis of selected effects. Journal of Environmental Toxicology and Chemistry, 12:337-375. 1993

[8] Houston, A.H. Review: are the classical hematological variables acceptable indicators of fish health? Transactions of the American Fish Society, 6:879–894 1997

[9] Luskova, V. Factors affecting hematological indices in free-living fish populations. Acta Veterinaria Brno 67:249–255. 1998

[10] O'Neill M.D, Wesp H.M,Mensinger, A.F, Hanlon, R.T. Initial baseline blood chemistry of the Oyster Toadfish, *Opsanus tau*. Biological Bulletin 195:228– 229. 1998

[11] Edsall, C.C. A blood chemistry profile for lake trout. Journal of Aquatic Animal Health 11:81–86. 1999

[12] Laglar, K.F., Bardach, J.E. and Miller, R.R. Ichthyology: The study of Fishes. John Wiley and Sons Inc., New York, U.S.A. 544. 1977

[13] Satheeshkumar P., Ananthan G., Senthil Kumar D., Jagadeesan, L. Hematology and biochemical parameters of different feeding behaviorof teleost fishes from Vellar estuary, India. Comparative Clinical Pathology 21(6):1187–1191. 2012

[14] Svoboda, M.,Kouril, J., Hamackova, J., Kalab P., Savina L.,Svobodova Z.,Vykusova, B."Biochemicalprofile of blood plasma of tench (*Tincatinca*L.) during pre- and postspawning period", ActaVeterinaria Brno. 70:259–268. 2001

[15] Fourie, F.L.R, Hatting, J. A seasonal study of hematology of carp, *Cyprinus carpio* from a locality in the Transvaal, South Africa. Zoology of Africa 2(1):75-80. 1976

[16] Raizada, M. N, Jain K.K, Raizada, S. Monthly variations in the hematocrit values (PCV) in a teleost, Cirrhinusmrigala (Ham.). Journal of Comparative Physiology 3:196– 198. 1983

[17] Orun I.and Erdeml A.U. Astudy on blood parameters of *Capoetatrutta* (Heckel, 1843) Journal of Biological Sciences 8:508–11. 2002

[18] Fagbenro, O. A., Adebayo O. T., Osho, B., Ajayi, C. B. and Raji, A. A. Haematological profile of *Parachanna (Channa) obscura* GUNTHER 1861, *Malapterurus electricus* GMELIN 1789 and *Malapterurus minjiriya* SAGUA 1987. Animal research international 2(2): 297-300. 2005

[19] Odedeyi, D. O., Fagbenro O. A., Bello Olusoji A., Adebayo O. T. Haematological profile of the Elephant snout fish, *Mormyrusrume*(Valenciennes 1846). Biological and Environmental sciences Journal for the Tropics 6(1):89- 95. 2009

[20] Erondu, E. S., Nnubia C., Nwadukwe O. Haematological studies on four catfish species raised in fresh water ponds in Nigeria. Journal of Applied Ichthyology. 9:250-256. 1993

[21] Soetan, K.O., Akinrinde, A.S. and Ajibade, T.O. Preliminary studies on the haematological parameters of cockerels fed raw and processed guinea corn

(*Sorghum bicolor)* Proceedings of 38th Annual Conference of Nigerian Society for Animal Production. 49- 52. 2013

[22] Binod, B. P., Rama P. P. and Ajay K. P. Seasonal Variations in Certain Hematological Factors of *Catla catla* (Hamilton 1822). IOSR Journal of Applied Physiology. 6: 1-7. 2014

[23] Orun, I., Dorucu M. and Yazlak H. Haematological parameters of three cyprinid fish species from Karakaya Dam Lake, Turkey. Online Journal of Biological Sciences, 3**:** 320- 328. ,2003

[24] Gayatri, A., Prafulla K., Mohanty. Haematological and Serum Biochemical Parameters in different Sexes of Walking Cat Fish, *Clarias batrachus* (Linnaeus, 1758). International Journal of Science and Research 3: 1914-1917. 2012

[25] Kumar, V., Cotran, R. S., and Robbins, S. L. Basic pathology 5th Edition. W. B. Suders Company, Philadelphia. 1992

[26] Velisek, J., Svobodova, Z., Piackova, V. Effects of phenoxy ethanol anaesthesia on haematological profile of Common Carp (*Cyprinus carpio*) and Rainbow Trout (*Oncorhychus mykiss*). Journal of Comparative Physiology, 76: 487- 429. 2007

[27] Robbins S. L, Cotran, R.S., Kumar, V. "Pathologic basis of disease", 5th edition. W.B. Saunders Company, 583-615. 1974

[28] Jamalzadeh, H. R.,Keyvan, A.,Ghomi, M. R., Gheradi, F. " Comparison of Blood Indices in Healthy and Fungal Infected Caspian Salmon (*Salmo truttacaspius*)", African Journal of Biotechnology. 8: 319-322. 2009

[29] Agatha A. N., Juliana R. J. Seasonal variations in serological profiles and growth status of farmed and wild *Clarias gariepinus* (Burchell 1822) obtained from Anambra, Nigeria. Journal of Agricultural Science and Technology B5: 205- 215. 2015

[30] Swain P., Sahoo, P. K., Routray, P.,Sahoo, S. K.,Gupta, S. D., Meher, P. K.,Sarangi, N. "Nonspecific Immune Parameters of Brood Indian Major Carp *Labeo rohita* and their Seasonal Variations", Fish & Shellfish Immunology. 22:38- 43. 2007

[31] McCarthy D. H., Stevenson J. P., Roberts M. S. "Some Blood Parameters of the Rainbow Trout (*Salmo gairdneri* Richardson)"Journal of Fish Biology, 5:1- 8. 1973

[32] Percin, F. and Konyalioglu, S. "Serum Biochemical Profiles of Captive and Wild Northern Bluefin Tuna (*Thunnus thynnus* L. 1758) in the Eastern Mediterranean", Aquaculture Research, 39:945- 953. 2008

[33] Farid F., Zeynab A., Hossain R., Mohammad K. K "A comparative study of some blood factors in male and female Caspian kutum (*Rutilus frisiikutum*) brood stock from the southern basin of the Caspian Sea",Turkish Journal of Veterinary and Animal Sciences 37:.320-325. 2013

[34] Teshima S. I. Sterol Metabolism. Memorie Fac. Fish Kagoshima University21:69- 147. 1972

[35] Fateme, Y.and Hossein, K. Changes in blood chemistry and hematological indices *Capoeta capoeta gracilis* in relation to age, sex, and geographic location. Comparative Clinical Pathology *24:791–795*. 2014

[36] Odedeyi, D. O. Seasonal, sex and size variation in some blood parameters of snake head fish (*Parachanna obscura*, Gunter 1861) in Ose River, Southwest-Nigeria. Global institute for research & education, 2 (4):107-110. 2013

[37] Jerônmo, G. T., Laffite, L. V., Speck G. M. and Martins M. L. Seasonal influence on the haematological parameters in cultured Nile Tilapia from Southern Brazil. Brazil journal of biology, 71(3)719-725. 2010

[38] Hrubec, T.C., Cardinale, J.L., and Smith, S.A. Haematology and plasma chemistry reference intervals for cultured tilapia (*Oreochromis* hybrid). Veterinary Clinical Pathology 29 (1): 7-12. 2000

[39] Gabriel, U.U. and George, A.D.I. Plasma enzymes in *Clarias gariepinus* exposed to chronic levels of round up (glyphosate). Environment and Ecology, 23 (2): 271-276. 2005

[40] Fagbenro, O., Adedire, C. O., Ayotunde, E. O. and Faminu,E.O. Haematological profile, food composition and digestive enzyme assay in the gut of the African bony- tongue fish, *Heterotis (Clupisudis) niloticus* (Cuvier 1829)

Osteoglossidae. Tropical Zoology. 13:1-9. 2000

[41] Akinrotimi, O. A., Abu, O.M.G., Ansa, E. .J., Edun, O.M. and George, O.S. Haematological responses of Tilapia guineensis to acute stress. International Journal of Natural and Applied Science 5(4): 338-343. 2009

[42] Kori-Siakpere, O. and Egor, V.E. Haematological characteristics of the African mudfish, *Clarias buthupugon* (Pisces : Clariidae). Bulletin of Science Association of Nigeria 21: 177 – 185. 1997

[43] Jawad, L. A.; Al-Mukhtar, M. A. & Ahmed, H. K. The relationship between haematocrit and some biological parameters of the Indian Shad, *Tenualo sailisha* (Family clupidae). Animal Bioderversity 27 (2) 47-52. 2004

[44] Ezzat, A. A.,Shabana, M. B. and Farghaly, A. M. Studies on the blood characteristics of *Tilapia zilli* (Gervais) Journal of Fish Biology, 6: 1- 12. 1973

[45] Grinich, N. P. & Terwilliger, R. C. The Quaternary structure of an unusual high-molecular weight. Intracellular haemoglobin from the Bivalve Mollusks *Barbatiareeveana.* Biochemical Journal 189:1-8. 1980

[46] Banerjee, V. Haematology of the fresh water eel, *Amphipnous cuchia* (Hamilton): Erythrocyte dimensions with special reference to body length, Sex and Season. Comparative Physiology and Ecology, 2 (2).68-73. 1986

[47] Chaudhuri, S. H. Pandit, T. & Benerjee, S. Size and sex related variations of some blood parameters of *Sarotherodon mossambica*. Environment and Ecology 4(1):61-63. 1986

[48] Das B.C. Age related trends in the blood chemistry and haematology of the Indian carp (*Catla catla*). Gerontologia 10:47–64. 1965

[49] Preston, A. Red blood values in the plaice (*Pleuronectes platessa L*) Journal of Marine Biology 39:681- 687. 1960