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Blood Parameters Reference Intervals in African Catfish *Clarias gariepinus* (Buchell, 1822) in Ibadan, Nigeria

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Abstract:
The females had higher Packed cell volume (PCV) and Haemoglobin (Hb) concentrations than males during the wet and dry seasons which also increased with increased age. The Red blood cell (Rbc) count was higher in wet season than dry season values in males. The females had a higher White blood cell (WBC) count than males during dry seasons. Adaptive immune responses were higher during the wet season than dry season. During dry season adaptive immune responses declined with increased age whereas innate immune responses increased with increased age. The influence of monocyte on innate immune responses was higher during the wet season than dry season. Females had higher erythrocyte sedimentation rate (ESR) than males during dry seasons. The females had a higher total plasma protein, serum potassium, sodium, alanine transaminase (ALT), aspartate transaminase (AST) and glucose values than males which also increased with increased age during dry and wet season. Total plasma protein, serum potassium, sodium, alanine transaminase (ALT) and glucose in the male were of higher values in wet season than dry seasons. The changes in PCV, Hb concentrations, Rbc, ESR, Creatinine and AST revealed that females appear to start sexual maturity earlier than males during wet season at 5 months of age. Sex, age, apparent developmental status and season influenced blood parameters. The obtained reference values and range of blood parameters would serve as a reliable baseline value in the culture of Clarias gariepinus aged 4, 5 and 6 months in earthen ponds for the interpretation of deviation from normal.

Keywords: *Age, baseline, earthen ponds, sex, season.*

1. Introduction

Blood tissue is a reflection of the physical and chemical changes occurring in organisms that gives a detailed information on the general metabolism and physiological status of fish in different groups of age and habitat [1]. Blood analysis is an essential component for successful fish farming, management and diseases investigation [2]. Furthermore, the blood condition of the fish is essential with regards to the health, food, economic and post-harvest needs of fish farmers and consumers [3]. [4] documented that fish haematology is an essential tool to the fisheries biologist, being a sensitive indicator of vital physiological and biochemical functions as well as revealing the nutritional, health and diseases status including stress responses of the organism subjected to changes in environmental conditions. [5] revealed that changes in the physiological state most often reflect alteration of hematological and biochemical values. The influence of season on blood parameters was also documented by [6] that there was a significant seasonal differences in erythrocyte and leukocyte cell counts, as well as in phagocyte count that affected respiratory burst. The increased interest in aquaculture has necessitated the need for establishment of normal haematological values in the different species of fish and the corresponding needs for the monitoring of health and production parameter which could be achieved by studying the haematological features of the various species and that RBC, Hb, lymphocyte and MCV differs significantly between the Bagrid catfish and the African catfish [7]. However, despite the overwhelming importance of
blood analysis, [8] documenting that one of the challenges in assessing the health status using heamatological parameters of natural fish population is the paucity of reliable references of the normal condition data between sex. Also [9] documented that it is of utmost importance for the determination of reference values of blood parameters since so many factors including species, age, sex, season and management system had been reported to have effects on the haemato-clinical chemistry values in fishes.
Therefore, the objective of this study is to investigate and determine some peripheral and plasma/serum blood parameters based on sex, age and season in field condition for a reliable reference values and ranges under normal condition to serve as an important diagnostic tools in veterinary medicine and also attempt to give guideline for interpretation of these parameters in African Catfish *Clarias gariepinus* a widely cultured fish in Nigeria owing to their high market price, fast growth rate and ability to withstand adverse pond conditions especially low oxygen content [10] in Ibadan, Nigeria.

1.1. Study Area

Ibadan is made up of eleven (11) local government areas is the capital city of Oyo State which is one of the 36 States of the Federal Republic of Nigeria including the Federal Capital Territory (FCT) Abuja. The development in Ibadan since 1980s has led to the categorization of the city into two: the metropolis and the wider Ibadan; the metropolis comprised of the five local governments that are located at the city centre while the wider Ibadan is comprised of the six local government areas located outside the built up area [11]. The metropolis is made up of Ibadan North West, Ibadan North, Ibadan North East, Ibadan South West and Ibadan South East These metropolis local governments are surrounded by the six local government areas of Akinyele, Lagelu, Egbeda, Ona-Ara, Oluyole and Ido. Ibadan is located approximately on longitude $3^0$5' to $4^0$36'East of the Greenwich Meridian, and latitude $7^0$23' to $7^0$55' North of the Equator [12]. Ibadan is on altitude of 237.7 meters above the mean sea level [13]. The 1991 Census figure is commonly disputed and it is believed that the population of Ibadan is in excess of three million people [14].

2. Materials and Methods

This involved the random sampling a total of 150 females and 150 males of apparently healthy catfish *Clarias gariepinus* using the criteria as suggested by [15] aged 4, 5, and 6 months (50 each during dry and wet season) for three years separately from some private earthen pond farms in Ibadan, Nigeria.

Sampling was done in the morning between 7 and 9 hours. The fishes were caught with nets and were tranquilized in 0.2mg benzocaine dissolved in 5ml acetone in 4 liters of water [16] before blood collection. Approximately 3.0ml of blood was collected from each fish through the caudal vein [17] with a 22-gauge needle attached to 5ml syringes. About 2ml was immediately dispensed into a heparinsed [18] commercial tube by Meus Srl Piove Disacco-Italy for hematology, while the remaining was dispensed into clean plain test tubes.

These tubes were appropriately labeled and transported in a container containing ice cubes to the laboratory. The samples for haematology were stored at 0^0C [19] in deep freezer awaiting the determination of blood parameters which were analyzed within 3 hours of collection to ensure accurate laboratory results [20]. After the determination of haematological parameters from the blood in the heparinised tubes, the remaining blood was centrifuged at 1200 rpm for 1min to obtain plasma for total protein determination using RANDOX KIT (UK) and read with Autospectrophotometer (Spectrum lab 23A Spectrophotometer). Blood collected in plane test-tubes (non heparinised) was allowed to clot at room temperature for 1 hour and centrifuged at 1200rpm for 5minuties. The serum was harvested using sterile Pasteur pipette and divided into 4 parts dispensed in 0.5 aliquots into scintillation vials (Fissons scientific apparatus) and stored at – 20^0c for biochemical estimation of Alanine aminotransferase (ALT) and Aspartate aminotransferase (AST), glucose, potassium, sodium and creatinine using appropriate kit and read with read Autospectrophotometer (Spectrum lab 23A Spectrophotometer).

PCV, Hb concentration and RBC counts determination were as described by [21]. Determination of WBC counts was as described by [21, 22]. Red blood cells and white blood cell counts were done manually [23]. Determination of ESR was by filling blood capillary tube completely with whole blood, then sealed with plastercin and allowed to stand for one hour with a measuring ruler, the levels of plasma and the total column were measured. The calculation of ESR expressed in mm/hr was:

Plasma level (cm)/ Total length of column (cm) x 50min.

According to manufacturer's instructions, the estimation of total protein, glucose and creatinine was done using diagnostic reagent Randox Kit®, estimation of ALT and AST was done using diagnostic reagent Quimicaclinica applicada South Africa (QCA) Kit® while estimation of potassium and sodium was done using was done using diagnostic reagent Teco diagnostics California USA Kit®.

Data for all the determinations were presented as means ± standard error of mean (SEM). The results were subjected to descriptive statistics one-way Analysis of variance (ANOVA) and Duncan Multiple Range Test (DMRT) while Student's t-test was used to compare the differences due to sex. Statistics were carried out using SPSS 16.0 Statistical Package (SPSS 17.0 for Windows, SPSS Inc., Chicago, IL, USA). Significant difference was accepted at probability level of $p \leq 0.05$.

3. Results

	4 months old		5months old		6 months old	
	Females♀	Males ♂	Females♀	Males ♂	Females♀	Males ♂
Parameters	n = 150	n = 150	n = 150	n = 150	n = 150	n = 150
Packed cell volume %	32.14±0.07^{c} 30 – 33	26.72±0.09**^{c} 24 – 29	36.45±0.11^{b} 34 -39	32.33±0.12**^{b} 29 – 35	40.83 ± 0.06^{a} 40 – 43	35.01 ± 0.01**^{a} 35 – 36
Haemoglobin g dl^{-1}	10.42±0.04^{c} 9 – 11	8.83±0.03**^{c} 8 – 10	12.26±0.05^{b} 11 – 13	10.72±0.06**^{b} 9 = 12	13.64±0.02^{a} 13 – 14	11.69±0.01**^{a} 11 – 12
Red blood cell x10^{12} l^{-1}	8.39±0.10^{c} 6 – 10	4.20±0.02**^{c} 3 – 5	11.19±0.10^{b} 10 – 12	8.29±0.13**^{b} 6 – 10	12.63±0.01^{a} 12 – 13	10.09±0.02**^{a} 9 – 12
White blood cell x10^{9} l^{-1}	11.70±0.08^{c} 9 – 13	8.68±0.04**^{c} 7 – 10	13.70±0.06^{b} 12 – 15	10.37±0.03**^{b} 9 – 11	15.11±0.01^{a} 14 – 16	12.03±0.01**^{a} 11 – 13
Lymphocyte %	66.63±0.29^{a} 61 – 72	67.05±0.62^{b} 58 – 76	66.87±0.22^{b} 60 – 72	63.71±0.49**^{a} 56 – 72	58.95 ± 0.03^{c} 58 – 61	59.53 ± 0.07^{a} 56 – 62
Neutrophil %	33.00±0.28^{b} 27 – 39	32.43±0.58^{c} 24 – 41	33.01±0.22^{b} 28 – 40	35.97±0.47**^{b} 28 – 43	41.27 ± 0.04^{a} 39 – 42	38.93 ± 0.06**^{a} 37 – 44
Monocyte %	0.31±0.04^{b} 0 – 1	0.63±0.06**^{b} 0 – 2	0.21±0.03^{b} 0 – 1	0.31±0.0.04^{c} 0 – 1	0.44±0.06^{a} 0 – 2	1.59 ± 0.04**^{a} 0 – 2
ESR mm hr^{-1}	1.93±0.06^{a} 1 – 3	3.14±0.11**^{a} 1 – 5	1.87±0.09^{a} 1 – 5	2.02±0.08^{b} 1 – 4	1.79 ± 0.03^{b} 1 – 2	1.33 ± 0.04**^{c} 1 – 2

Table 1: Haematological parameters Means ± SEM and range reference values of Clarias gariepinus in earthen pond culture during dry season

** Highly significantly different at P≤0.001 (Student T-test)
Means of the same sex with the same letter super script on the same row are not significantly different according to DMRT at p≥0.05.

Parameters	4 months old		5months old		6 months old	
	Females♀	Males ♂	Females♀	Males ♂	Females♀	Males ♂
	n = 150	n = 150	n = 150	n = 150	n = 150	n = 150
Packed cell volume %	31.97±0.048^{c} 31 - 33	30.51±0.04**^{c} 30 - 31	34.75±0.05^{b} 34 – 39	33.79±0.05**^{b} 32 – 34	40.81 ± 0.17^{a} 36 – 42	38.87 ± 0.16**^{a} 33 – 40
Haemoglobin g dl^{-1}	10.67±0.02^{c} 10.30 – 11	10.02±0.02**^{c} 9.80 – 10.30	11.63±0.02^{b} 11.40 – 11.70	11.15±0.02**^{b} 10.50 – 11.30	13.48±0.06^{a} 11.90 – 13.90	12.84±0.05**^{a} 11.60 – 13.20
Red blood cell x10^{12} l^{-1}	12.13±0.06^{c} 10.40 – 12.75	12.03±0.02^{c} 11.76 – 12.30	14.27±0.02^{b} 13.98 – 14.36	14.23±0.02^{b} 13.48 – 14.32	15.93±0.07^{a} 14.07 – 16.50	15.78±0.0.07^{a} 14.25 – 16.25
White blood cellx10^{9} l^{-1}	15.33±0.05^{c} 14.80 – 15.80	13.63±0.17**^{c} 8.60 – 15	20.12±0.04^{b} 19.80 – 20.30	22.37±0.02**^{b} 22.32 – 23	29.50±0.13^{a} 26 – 30.50	24.54±0.11**^{a} 20.20 – 25.30
Lymphocyte %	69.93±0.08^{c} 69 -71	70.57±0.07**^{c} 69 - 72	74.88±0.04^{a} 72 – 76	76.08±0.05**^{a} 75 – 77	73.99 ± 0.04^{b} 73 – 75	72.88 ± 0.03**^{b} 72 – 73
Neutrophil %	29.31±0.08^{c} 28 – 30	28.43±0.07**^{a} 27 - 30	24.12±0.04^{a} 23 – 25	22.92±0.05**^{c} 22 – 24	25.09 ± 0.03^{b} 25 – 26	26.12 ± 0.04**^{b} 26 – 27
Monocyte %	0.76±0.0.04^{b} 0 – 1	1.00±0.00**^{a} 1- 1	1.00±0.00^{a} 1- 1	1.00±0.00^{a} 1- 1	1.00±0.00^{a} 1- 1	1.00 ± 0.00^{a} 1- 2
ESR mm hr^{-1}	4.45±0.08^{b} 2 – 5	5.45±0.09**^{b} 3 – 6	7.27±0.09^{a} 5 – 8	6.59±0.09**^{a} 5 – 8	1.97 ± 0.05^{c} 1 – 2	1.23 ± 0.04**^{c} 1 – 2

Table 2: Haematological parameters Means ± SEM and range reference values of Clarias gariepinus in earthen pond culture during wet season

** Highly significantly different at P≤0.001 (Student T-test)
Means of the same sex with the same letter on the same row of same sex are not significantly different according to DMRT at P≥0.05

Parameters	4 months old		5months old		6 months old	
	Males ♂ (wet)	Males ♂ (dry)	Males ♂ (wet)	Males ♂ (dry)	Males ♂ (wet)	Males ♂ (dry)
	n = 150	n = 150	n = 150	n = 150	n = 150	n = 150
Packed cell volume %	30.51±0.04	26.72±0.09**	33.79±0.05	32.33±0.12**	38.87 ± 0.16	35.01 ± 0.01**
Haemoglobin g dl^{-1}	10.02±0.02	8.83±0.03**	11.15±0.02	10.72±0.06**	12.84±0.05	11.69±0.01**
Red blood cell x10^{12} l^{-1}	12.03±0.02	4.20±0.02**	14.23±0.02	8.29±0.13**	15.78±0.0.07	10.09±0.02**
White blood cell x10^{9} l^{-1}	13.63±0.17	8.68±0.04**	22.37±0.02	10.37±0.03**	24.54±0.11	12.03±0.01**
Lymphocyte %	70.57±0.07	67.05±0.62**	76.08±0.05	63.71±0.49**	72.88 ± 0.03	59.53 ± 0.07**
Neutrophil %	28.43±0.07	32.43±0.58**	22.92±0.05	35.97±0.47**	26.12 ± 0.04	38.93 ± 0.06**
Monocyte %	1.00±0.00	0.63±0.06**	1.00±0.00	0.31±0.04**	1.00 ± 0.00	1.59 ± 0.04**
ESR mm hr^{-1}	5.45±0.09	3.14±0.11**	6.59±0.09	2.02±0.08**	1.23 ± 0.04	1.33 ± 0.04

Table 3: Comparative haematological Parameters Means ± SEM reference values of male Clarias gariepinus in earthen pond culture during wet and dry season

**Highly significantly different at P≤0.001 (Student T-test).

Parameters	4 months old		5months old		6 months old	
	Females♀(wet)	Females♀(dry)	Females♀(wet)	Females♀(dry)	Females♀(wet)	Females♀(dry)
	n = 150	n = 150	n = 150	n = 150	n = 150	n = 150
Packed cell volume (%)	31.97±0.05	32.14±0.07	34.75±0.05	36.45±0.11**	40.81 ± 0.17	40.83 ± 0.06
Haemoglobin g dl^{-1}	10.67±0.02	10.42±0.04**	11.63±0.02	12.26±0.05 **	13.48±0.06	13.64±0.02
Red blood cells x10^{12} l^{-1}	12.13±0.06	8.39±0.10**	14.27±0.02	11.19±0.10**	15.93±0.07	12.63±0.01 **
White blood cell x10^{9} l^{-1}	15.33±0.05	11.70±0.08**	20.12±0.04	13.70±0.06**	29.50±0.13	15.11±0.01**
Lymphocyte %	69.93±0.08	66.63±0.29 **	74.88±0.04	66.87±0.22**	73.99 ± 0.04	58.95 ± 0.03**
Neutrophil %	29.31±0.08	33.00±0.28**	24.12±0.04	33.01±0.22**	25.09 ± 0.03	41.27 ± 0.04 **
Monocyte %	0.76±0.0.04	0.31±0.04**	1.00±0.00	0.21±0.03 **	1.00±0.0.00	0.44±0.06 **
ESR mm hr^{-1}	4.45±0.08	1.93±0.06 **	7.27±0.09	1.87±0.09**	1.97 ± 0.05	1.79 ± 0.03*

Table 4: Comparative haematological Parameters Means ± SEM reference values of female Clarias gariepinus in earthen pond culture during wet and dry season

*Significantly different at P≤0.05 (Student T-test). ** Highly significantly different at P≤0.001 (Student T-test)

Parameters	4 months old		5months old		6 months old	
	Females♀	Males ♂	Females♀	Males ♂	Females♀	Males ♂
	n = 150	n = 150	n = 150	n = 150	n = 150	n = 150
Total plasma protein gl^{-1}	3.98±0.01[c] 3.70 - 4.20	3.49±0.02**[c] 3 - 3.70	4.45±0.01[b] 4.20 – 4.60	3.95±0.01**[b] 3.60 – 4.20	5.65 ± 0.01[a] 5.50 – 5.80	4.33 ± 0.00**[a] 4.10 – 4.40
Potassium meg l^{-1}	21.57±0.17[c] 17 – 24	13.73±0.17**[c] 9 – 16	34.05±0.41[b] 28 – 42	18.77±0.22**[b] 15 – 25	55.00 ±0.08[a] 54 - 56	38.25 ± 0.04**[a] 38 - 39
Sodium meg l^{-1}	34.31±0.18[c] 31 – 37	25.01±0.18**[c] 21 – 37	60.32±1.22[b] 44 – 82	32.13±0.36**[b] 27 – 40	96.74 ± 0.16[a] 94 - 99	71.51 ± 0.14**[a] 70 - 74
Creatinine g l^{-1}	1.09±0.00[c] 1 – 1.11	1.03±0.00**[c] 1 – 1.10	1.15±0.01[b] 1 – 1.24	1.11±0.01**[b] 1 – 1,21	2.45 ± 0.00[c] 2.42 – 2.50	1.22 ± 0.00**[a] 1.21 – 1.22
ALT Int Units l^{-1}	30.65±0.32[c] 26 - 36	22.49±0.15**[c] 20 – 25	34.75±0.13[b] 33 – 37	28.01±0.33**[b] 20 – 32	54.74 ± 0.19[a] 52 - 58	34.25 ± 0.11**[a] 33 - 36
AST Int Units l^{-1}	47.00±0.51[c] 40 - 56	35.11±0.20**[c] 30 – 38	52.77±0.21[b] 50 – 58	47.91±0.40**[b] 40 – 54	96.24 ± 0.15[a] 94 - 98	49.00 ± 0.13**[a] 47 - 51
Glucose g l^{-1}	51.23±0.19[c] 48 - 55	44.21±0.17**[c] 38 – 46	67.60±0.30[b] 62 – 73	54.64±0.42**[b] 46 – 62	83.00 ± 0.06[a] 82 - 84	60.51 ± 0.07**[a] 60 – 62

Table 5: Blood chemistry parameters Means ± SEM and range reference values of Clarias gariepinus in earthen pond culture during dry season

** Highly significantly different at P≤0.001 (Student T-test)
Means of the same sex with the same letter on the same row are not significantly different according to DMRT at p≥0.05.

Parameters	4 months old		5 months old		6 months old	
	Females♀	Males ♂	Females♀	Males ♂	Females♀	Males ♂
	n =150	n =150	n =150	n =150	n =150	n =150
Total plasma protein g l^{-1}	4.17±0.01[c] 3.50 – 4.30	4.10±0.00**[c] 4 – 4.20	4.49±0.01[b] 4.40 – 4.60	4.45±0.01**[b] 4.30 – 4.60	6.19 ± 0.01[a] 6.10 – 6.30	5.97 ± 0.00**[a] 5.90 - 6
Potassium meg l^{-1}	41.46±0.10[c] 40 – 43	41.04±0.12*[c] 39 – 43	51.94±0.10[b] 51 – 54	49.68±0.10**[b] 47 - 52	55.56 ±0.08[a] 54 – 57	54.26 ± 0.04**[a] 52 – 55
Sodium meg l^{-1}	62.13±0.08[c] 61 – 63	58.97±0.12**[c] 57 – 61	63.95±0.08[b] 62 - 65	62.13±0.12**[b] 60 - 65	78.20 ± 0.12[a] 77 – 80	75.76 ± 0.04**[a] 75 - 78
Creatinine g l^{-1}	1.19±0.00[c] 1.09 – 1.21	1.21±0.00**[c] 1.19 – 1.22	1.20±0.01[b] 1.01 – 1,23	1.22±0.00*[b] 1.21 – 1.22	2.10 ± 0.01[a] 2.10 – 2.11	2.10 ± 0.00[a] 2.09 – 2.10
ALT Int Units l^{-1}	65.49±0.17[c] 64 – 67	63.89±0.08**[c] 62 – 65	72.23±0.09[b] 71 – 74	70.39±0.08**[b] 69 - 71	74.85 ± 0.51[a] 74 – 77	72.64 ± 0.07**[a] 72 - 74
AST Int Units l^{-1}	43.49±0.12[c] 42 – 45	41.95±0.07**[c] 41 – 44	53.63±0.09[b] 52 – 55	53.13±0.11**[b] 51 - 55	66.14 ± 0.12[a] 65 – 68	64.63 ± 0.06**[a] 63 - 65
Glucose g l^{-1}	62.57±0.09[c] 62 – 64	60.01±0.06**[c] 59 - 61	74.99±0.11[b] 74 – 76	73.91±0.06**[b] 73 - 75	84.95 ± 0.12[a] 82 – 87	83.69 ± 0.39**[a] 83 - 84

Table 6: Blood chemistry parameters Means ± SEM and range reference values of Clarias gariepinus in earthen pond culture during wet season

* Significantly different at P≤0.05 (Student T-test). ** Highly significantly different at P≤0.001 (Student T-test)
Means of the same sex with the same letter on the same row are not significantly different according to DMRT at P≥0.05

Parameters	4 months old		5 months old		6 months old	
	Males ♂ (wet)	Males ♂ (dry)	Males ♂ (wet)	Males ♂ (dry)	Males ♂ (wet)	Males ♂ (dry)
	n =150	n =150	n =150	n =150	n =150	n =150
Total plasma protein g l^{-1}	4.10±0.00	3.49±0.02**	4.45±0.01	3.95±0.01**	5.97 ± 0.00	4.33 ± 0.00**
Potassium meg l^{-1}	41.04±0.12	13.73±0.17**	49.68±0.10	18.77±0.22**	54.26 ± 0.04	38.25 ± 0.04**
Sodium meg l^{-1}	58.97±0.12	25.01±0.18**	62.13±0.12	32.13±0.36**	75.76 ± 0.04	71.51 ± 0.14**
Creatinine g l^{-1}	1.21±0.00	1.03±0.00**	1.22±0.00	1.11±0.01**	2.10 ± 0.00	1.22 ± 0.00**
ALT Int Units l^{-1}	63.89±0.08	22.49±0.15**	70.39±0.08	28.01±0.33**	72.64 ± 0.07	34.25 ± 0.11**
AST Int Units l^{-1}	41.95±0.07	35.11±0.20**	53.13±0.11	47.91±0.40**	64.63 ± 0.06	49.00 ± 0.13**
Glucose g l^{-1}	60.01±0.06	44.21±0.17**	73.91±0.06	54.64±0.42**	83.69 ± 0.39	60.51 ± 0.07**

Table 7: Comparative blood chemistry parameters Means ± SEM reference values of male Clarias gariepinus in earthen pond culture survey during wet and dry season

** Highly significantly different at P≤0.001 (Student T-test)

Parameters	4 months old		5 months old		6 months old	
	Females♀(wet)	Females♀(dry)	Females♀(wet)	Females♀(dry)	Females♀(wet)	Females♀(dry)
	n =150	n =150	n =150	n =150	n =150	n =150
Total plasma protein g l^{-1}	4.17±0.01	3.98±0.01**	4.49±0.01	4.45±0.01**	6.19 ± 0.01	5.65 ± 0.01**
Potassium meg l^{-1}	41.46±0.10	21.57±0.17**	51.94±0.10	34.05±0.41**	55.56 ±0.08	55.00 ±0.08**
Sodium meg l^{-1}	62.13±0.08	34.31±0.18**	63.95±0.08	60.32±1.22*	78.20 ± 0.12	96.74 ± 0.16**
Creatinine g l^{-1}	1.19±0.00	1.09±0.00**	1.20±0.01	1.15±0.01**	2.10 ± 0.01	2.45 ± 0.00**
ALT Int Units l^{-1}	65.49±0.17	30.65±0.32**	72.23±0.09	34.75±0.13**	74.85 ± 0.51	54.74 ± 0.19**
AST Int Units l^{-1}	43.49±0.12	47.00±0.51**	53.63±0.09	52.77±0.21**	66.14 ± 0.12	96.24 ± 0.15**
Glucose gl^{-1}	62.57±0.09	51.23±0.19**	74.99±0.11	67.60±0.30**	84.95 ± 0.12	83.00 ± 0.06**

Table 8: Comparative aged based baseline blood chemistry parameters Means ± SEM reference values of female Clarias gariepinus in earthen pond culture during wet and dry season

* Significantly different at P≤0.05 (Student T-test) ** Highly significantly different at P≤0.001 (Student T-test PCV, at 4 months old, the females had higher highly significant (p≤0.001) value of 32.14±0.19% than the males with 26.72±1.12%; at 5 months old, the females had a higher highly significant (p≤0.001) value of 36.45±1.39% than the males with 32.33±1.46% and at 6 months old, the females had a higher highly significant (p≤0.001) value of 40.83±0.73% than the males with 35.01 ± 0.08%. PCV in both the females and males had significant (P ≤ 0.05) increase with age (Table 1).

Hb, at 4 months old, the females had a higher highly significant (p≤0.001) value of 10.42±0.43 g dl^{-1}than the males with 8.83±0.38g dl^{-1}; at 5 months old, the females had a higher highly significant (p≤0.001) value of 12.26±0.65 g dl^{-1}than the males with 10.72±0.74g $dl^{-1}$and at 6 months old, the females had a higher highly significant (p≤0.001) value of 13.64±0.18 g dl^{-1} than the males with 11.69±0.08 g dl^{-1}. Using DMRT, as seen in Table 1, Hb, in both the females and males had significant (P ≤ 0.05) increase with age (Table 1).

Red blood cells (RBC), at 4months old, the females had a higher highly significant (p≤0.001) value of 8.39±1.19 cell$X10^{12}$ l^{-1}than the males with 4.20±0.23cell$X10^{12}$ l^{-1}; at 5 months old, the females had a higher highly significant (p≤0.001) value of 11.19±1.19 cells10^{12} l^{-1}than the males with 8.29±1.64cells$X10^{12}$ l^{-1}.and at 6 months old, the females had a higher significant (p≤0.001) value of 12.63±0.10 cells$X10^{12}$ l^{-1}than the males with 10.09±0.18cells$X10^{12}$ l^{-1}. RBC, in both the females and males had significant (P ≤ 0.05) increase with age (Table 1).

WBC, at 4 months old the females had a higher highly significant (p≤0.001) value of 11.70±0.94 cells$X10^{9}$ l^{-1}than the males with 8.68±0.47cells$X10^{9}$ l^{-1}; at 5 months old the females had a higher highly significant (p≤0.001) value of 13.70±0.69 cells$X10^{9}$ l^{-1}than the males with 10.37±0.41cells$X10^{9}$ l^{-1}; at 6 months old the females had a higher significant (p≤0.001) value of 15.11±0.67 cells $X10^{9}$ l^{-1} than the males with 12.03±0.06cells $X10^{9}$ l^{-1}. Wbc count in both the females and males had significant (P ≤ 0.05) increase with age (Table 1).

Lymphocytes (Lymph), at 4 months old the females had a lower non-significant value of 66.63±3.51 % than the males with 67.05±7.63 %; at 5 months the males had a lower highly significant (p≤0.001) value of 63.71±6.02 % than the females with 66.86±0.22%; at 6 months the females had a lower non-significant value of 58.95 ± 0.30% than the males with 59.53 ± 0.83 %. Using DMRT as seen in Table 1, lymphocyte in the females at 4 and 5months values difference was non-significant but a higher significant (P ≤ 0.05) value that at 6months. Lymphocyte in the males, at 4months had a higher significant (P ≤ 0.05) value than at 5 and 6months. (Table 1).

Neutrophils at 4 months old the females had a higher non- significant value of 33.00±3.47 % than the males with 32.43±7.04 %; at 5 months old the females had a lower highly significant (p≤0.001) value of 33.01±2.70 % than the males with 35.97±5.79%; at 6 months old the females had a higher highly significant (p≤0.001) value of 41.27 ± 0.51 % than the males with 38.93 ± 0.73%. Neutrophils at 4, 5 and 6 months, the females had a significant increase at 6months old while the male had significant increase with increase age. (Table 1).

Monocytes at 4 months old the females had a lower highly significant (p≤0.001) value of 0.31±0.46 % than the males with 0.63±0.68%; at 5 months old the females had a lower non-significant value of 0.21±0.41 % than the males with 0.31±0.47 %; at 6 months old the females had a lower highly significant (p≤0.001) value of 0.44±0.72 % than the males with 1.59 ± 0.51%. Monocytes in the females at 4 and 5months differences was non-significant but both were a lower significant (P ≤ 0.05) value than at 6months. In the males, at 4months had a higher significant (P ≤ 0.05) value than at 5month which was a lower significant (P ≤ 0.05) value than at 6months. (Table 1).

Erythrocyte sedimentation rate (ESR), at 4 months old the females had a lower highly significant (p≤0.001) value of 1.93±0.72 mm hr^{-1}than the males with 3.14±1.32mm hr^{-1}; at 5 months old the females had a lower non-significant value of 1.87±1.15 mm hr^{-1}than the males with 2.02±1.01 mm hr^{-1}; at 6 months old, the females had a higher highly significant (p≤0.001) value of 1.79 ± 0.42 mm hr^{-1}than the males with 1.33 ± 0.47mm hr^{-1}. ESR value differences in the females at 4, 5 and 6 months was non-significant. In the males there was a significant (P ≤ 0.05) decrease with increase in age. (Table 1).

PCV, at 4 months old, the females had higher highly significant ($p \leq 0.001$) value of 31.97±0.048 than the males with 30.51±0.04; at 5 months old, the females had a higher highly significant ($p \leq 0.001$) value of 34.75±0.05% than the males with 33.79±0.05% and at 6 months old, the females had a higher highly significant ($p \leq 0.001$) value of 40.81 ± 0.17% than the males with 38.87 ± 0.16%. PCV in both the females and males had significant ($P \leq 0.05$) increase with age (Table 2).

Hb, at 4 months old, the females had a higher highly significant ($p \leq 0.001$) value of 10.67±0.02g dl^{-1}than the males with 10.02±0.02g dl^{-1}; at 5 months old, the females had a higher highly significant ($p \leq 0.001$) value of 11.63±0.02g dl^{-1} than the males with 11.15±0.02g $dl^{-1}$and at 6 months old, the females had a higher highly significant ($p \leq 0.001$) value of 13.48±0.06g dl^{-1} than the males with 12.84±0.05g dl^{-1}. Using DMRT, as seen in Table 2, Hb, in both the females and males had significant ($P \leq 0.05$) increase with age (Table 2).

Red blood cells (RBC), at 4months old, the females had no significant different value of 12.13±0.06 cell$X10^{12}$ l^{-1} with the males with 12.03±0.02 cell$X10^{12}$ l^{-1}; at 5 months old, the females had no significant different value of 14.27±0.02 cell$X10^{12}$ l^{-1} with the males with 14.23±0.02 cell $X10^{12}$ l^{-1} and at 6 months old, the females had no significant different value of 15.93±0.07cell$X10^{12}$ l^{-1} with the males with 15.78±0.0.07 cell$X10^{12}l^{-1}$. RBC, in both the females and males had significant ($P \leq 0.05$) increase with age (Table 2)

WBC, at 4 months old the females had a higher highly significant ($p \leq 0.001$) value of 15.33±0.05 cells$X10^{9}$ l^{-1}than the males with 13.63±0.17 cells$X10^{9}$ l^{-1}; at 5 months old the females had a lower highly significant ($p \leq 0.001$) value of 20.12±0.04 cells$X10^{9}$ l^{-1} than the males with 22.37±0.02cells$X10^{9}$ l^{-1}; at 6 months old the females had a higher significant ($p \leq 0.001$) value of 29.50±0.13 cells $X10^{9}$ l^{-1} than the males with 24.54±0.11cells $X10^{9}$ l^{-1}. Wbc count in both the females and males had significant ($P \leq 0.05$) increase with age (Table 2).

Lymphocytes (Lymph), at 4 months old the females had a lower highly significant ($p \leq 0.001$) value of 69.93±0.08% than the males with 70.57±0.07%; at 5 months the females had a lower highly significant ($p \leq 0.001$) value of 74.88±0.04% than the males with 76.08±0.05%; at 6 months the females had a higher highly significant ($p \leq 0.001$) value of 73.99 ± 0.04% than the males with 72.88 ± 0.03%. Lymphocyte in the females and male was highest at 5months of age (Table 2).

Neutrophils at 4 months old the females had higher highly significant ($p \leq 0.001$) value of 29.31±0.08% than the males with 28.43±0.07%; at 5 months old the females had a higher highly significant ($p \leq 0.001$) value of 24.12±0.04% than the males with 22.92±0.05%; at 6 months old the females had a lower highly significant ($p \leq 0.001$) value of 25.09 ± 0.03% than the males with 26.12 ± 0.04%. Neutrophils in the females was highest at 5months of age whereas it was highest at 4 months of age in the males (Table 2).

Monocytes at 4 months old the females had a lower highly significant ($p \leq 0.001$) value of 0.76±0.0.04% than the males with 1.00±0.00%; at 5 and 6months old the females and male had the same value of 1.00±0.00%. Monocytes in the females was lowest at 5months of age whereas in the males there was no differences at 4, 5 and 6 months of age (Table 2).

Erythrocyte sedimentation rate (ESR), at 4 months old the females had a lower highly significant ($p \leq 0.001$) value of 4.45±0.08mm hr^{-1}than the males with 5.45±0.09mm hr^{-1}; at 5 months old the females had a higher highly significant ($p \leq 0.001$) value of 7.27±0.09mm hr^{-1} than the males with 6.59±0.09 mm hr^{-1}; at 6 months old, the females had a higher highly significant ($p \leq 0.001$) value of 1.97 ± 0.05 mm hr^{-1}than the males with 1.23 ± 0.04 mm hr^{-1}. ESR in the females and male was lowest at 6 months of age (Table 2).

Male PCV during the wet season, at 4 months old, value of 30.51±0.04 % was highly significant ($p \leq 0.001$) higher than the value of 30.51±0.04 % during dry season; at 5 months old, the wet season value of 33.79±0.05% was highly significant ($p \leq 0.001$) higher than dry season value of 32.33±0.12% and at 6 months old, the wet season value of 38.87 ± 0.16% was highly significantly ($p \leq 0.001$) higher than dry season value of 35.01 ± 0.01% (Table 3).

Male Hb concentration during the wet season, at 4 months old, value of 10.02±0.02 g dl^{-1} was highly significant ($p \leq 0.001$) higher than the value of 8.83±0.03g dl^{-1} during dry season; at 5 months old, the wet season value of 11.15±0.02 g dl^{-1} was highly significant ($p \leq 0.001$) higher than dry season value of 10.72±0.06g dl^{-1} and at 6 months old, the wet season value of 12.84±0.05 g dl^{-1} was highly significantly ($p \leq 0.001$) higher than dry season value of 11.69±0.01g dl^{-1} (Table 3).

Male red blood cells (RBC) during the wet season, at 4 months old, value of 12.03±0.02 cells$X10^{12}$ l^{-1} was highly significant ($p \leq 0.001$) higher than the value of 4.20±0.02 cells$X10^{12}$ during dry season; at 5 months old, value of 14.23±0.02 cells$X10^{12}$ l^{-1} was highly significant ($p \leq 0.001$) higher than the value of 8.29±0.13cells$X10^{12}$ during dry season and at 6 months old, value of 15.78±0.0.07 cells$X10^{12}$ l^{-1} was highly significantly ($p \leq 0.001$) higher than the value of 10.09±0.02cells$X10^{12}$ during dry season (Table 3).

Male WBC count during the wet season, at 4 months old, value of 13.63±0.17 cells$X10^{9}$ l^{-1} was highly significant ($p \leq 0.001$) higher than the value of 8.68±0.04 cells$X10^{9}$ l^{-1} during dry season; at 5 months old, value of 22.37±0.02 cells$X10^{9}$ l^{-1} was highly significant ($p \leq 0.001$) higher than the value of 10.37±0.03 cells$X10^{9}$ l^{-1} during dry season; at 6 months old, value of 24.54±0.11 cells$X10^{9}$ l^{-1} was highly significantly ($p \leq 0.001$) higher than the value of 12.03±0.01cells$X10^{9}$ l^{-1} during dry season; (Table 3).

Male lymphocytes (Lymph), during the wet season, at 4 months old, value of 70.57±0.07% was highly significant ($p \leq 0.001$) higher than the value of 67.05±0.62% during dry season; at 5 months old, value of 76.08±0.05% was highly significant ($p \leq 0.001$) higher than the value of 63.71±0.49% during dry season; at 6 months old, value of 72.88 ± 0.03% was highly significantly ($p \leq 0.001$) higher than the value of 59.53 ± 0.07% during dry season (Table 3).

Male neutrophils during the wet season, at 4 months old, value of 28.43±0.07% was highly significant ($p \leq 0.001$) lower than the value of 32.43±0.58% during dry season; at 5 months old, value of 22.92±0.05 % was highly significant ($p \leq 0.001$) lower than the value of 35.97±0.47% during dry season; at 6 months old, value of 26.12 ± 0.04% was highly significantly ($p \leq 0.001$) lower than the value of 38.93 ± 0.06% during dry season (Table 3).

Male monocytes during the wet season, at 4 months old, value of 1.00±0.00 % was highly significant ($p \leq 0.001$) higher than the value of 0.63±0.06% during dry season; at 5 months old, value of 1.00±0.00 % was highly significant ($p \leq 0.001$) higher than the value of 0.31±0.04% during dry season; at 6 months old, value of 1.00 ± 0.0.00% was highly significantly ($p \leq 0.001$) lower than the value of 1.59 ± 0.04% during dry season (Table 3).

Male erythrocyte sedimentation rate (ESR), during the wet season, at 4 months old, value of 5.45±0.09 mm hr^{-1} was highly significant ($p \leq 0.001$) higher than the value 3.14±0.11 mm hr^{-1} during dry season; at 5 months old, value of 6.59±0.09 mm hr^{-1} was highly significant ($p \leq 0.001$) higher than the value of 2.02±0.08 mm hr^{-1} during dry season; at 6 months old, value of 1.23 ± 0.04 mm hr^{-1} was highly significantly ($p \leq 0.001$) lower than the value of 1.33 ± 0.04 mm hr^{-1} during dry season (Table 3).

Female PCV during the wet season, at 4 months old, value of 31.97±0.05% was not significantly different with the value of 32.14±0.07% during dry season; at 5 months old, the wet season value of 34.75±0.05 % was highly significantly ($p \leq 0.001$) lower than dry season value of 36.45±0.11% and at 6 months old, the wet season value of 40.81 ± 0.17 % was not significantly different with the value of 40.83 ± 0.06% during dry season (Table 4).

Female Hb concentration during the wet season, at 4 months old, value of 10.67±0.02 g dl^{-1} was highly significantly ($p \leq 0.001$) higher than the value of 10.42±0.04g dl^{-1} during dry season; at 5 months old, the wet season value of 11.63±0.02 g dl^{-1} was highly significantly ($p \leq 0.001$) lower than dry season value of 12.26±0.05g dl^{-1} and at 6 months old, the wet season value of 13.48±0.06 g dl^{-1} was not significantly different with the value of 13.64±0.02g dl^{-1} during dry season (Table 4).

Female red blood cells (RBC) during the wet season, at 4 months old, value of 12.13±0.06 cells$X10^{12}$ l^{-1} was highly significantly ($p \leq 0.001$) higher than the value of 8.39±0.10 cells$X10^{12}$ during dry season; at 5 months old, value of 14.27±0.02 cells$X10^{12}$ l^{-1} was highly significantly ($p \leq 0.001$) higher than the value of 11.19±0.10cells$X10^{12}$ during dry season and at 6 months old, value of 15.93±0.07 cells$X10^{12}$ l^{-1} was highly significantly ($p \leq 0.001$) higher than the value of 12.63±0.01 cells$X10^{12}$ during dry season (Table 4).

Female WBC count during the wet season, at 4 months old, value of 15.33±0.05 cells$X10^{9}$ l^{-1} was highly significantly ($p \leq 0.001$) higher than the value of 11.70±0.08 cells$X10^{9}$ l^{-1} during dry season; at 5 months old, value of 20.12±0.04 cells$X10^{9}$ l^{-1} was highly significantly ($p \leq 0.001$) higher than the value of 13.70±0.06 cells$X10^{9}$ l^{-1} during dry season; at 6 months old, value of 29.50±0.13 cells$X10^{9}$ l^{-1} was highly significantly ($p \leq 0.001$) higher than the value of 15.11±0.01 cells$X10^{9}$ l^{-1} during dry season; (Table 4).

Female lymphocytes (Lymph), during the wet season, at 4 months old, value of 69.93±0.08 % was highly significantly ($p \leq 0.001$) higher than the value of 66.63±0.29% during dry season; at 5 months old, value of 74.88±0.04% was highly significantly ($p \leq 0.001$) higher than the value of 66.87±0.22% during dry season; at 6 months old, value of 73.99 ± 0.04 % was highly significantly ($p \leq 0.001$) higher than the value of 58.95 ± 0.03% during dry season (Table 4).

Female neutrophils during the wet season, at 4 months old, value of 29.31±0.08 % was highly significantly ($p \leq 0.001$) lower than the value of 33.00±0.28% during dry season; at 5 months old, value of 24.12±0.04 % was highly significantly ($p \leq 0.001$) lower than the value of 33.01±0.22% during dry season; at 6 months old, value of 25.09 ± 0.03 % was highly significantly ($p \leq 0.001$) lower than the value of 25.09 ± 0.03% during dry season (Table 4).

Female monocytes during the wet season, at 4 months old, value of 0.76±0.0.04% was highly significantly ($p \leq 0.001$) higher than the value of 0.31±0.04% during dry season; at 5 months old, value of 1.00±0.00% was highly significantly ($p \leq 0.001$) higher than the value of 0.21±0.03% during dry season; at 6 months old, value of 1.00 ± 0.00% was highly significantly ($p \leq 0.001$) higher than the value of 0.44±0.06 % during dry season (Table 4).

Female erythrocyte sedimentation rate (ESR), during the wet season, at 4 months old, value of 4.45±0.08 mm hr^{-1} was highly significantly ($p \leq 0.001$) higher than the value 1.93±0.06 mm hr^{-1} during dry season; at 5 months old, value of 7.27±0.09 mm hr^{-1} was highly significantly ($p \leq 0.001$) higher than the value of 1.87±0.09mm hr^{-1} during dry season; at 6 months old, value of 1.97 ± 0.05 mm hr^{-1} was significantly ($p \leq 0.05$) higher than the value of 1.79 ± 0.03 mm hr^{-1} during dry season (Table 4).

Total protein, at 4 months old the females had a higher highly significant ($p \leq 0.001$) value of 3.98±0.16g l^{-1} than the males with 3.49±0.18g l^{-1}; at 5 months old the females had a higher highly significant ($p \leq 0.001$) value of 4.45±0.10g l^{-1}than the males with 3.95±0.14g l^{-1}; at 6 months old the females had a higher highly significant ($p \leq 0.001$) value of 5.65 ± 0.11g l^{-1}than the males with 4.33 ± 0.04g l^{-1}. Total protein increased significantly ($p \leq 0.05$) with age in both the female and male (Table 5).

Potassium (K^+), at 4 months old, the females had a higher highly significant ($p \leq 0.001$) value of 21.57±2.06meg l^{-1} than the males with 13.73±2.08meg l^{-1}; at 5 months old the females had a higher highly significant ($p \leq 0.001$) value of 34.05±5.06meg l^{-1}than the males with 18.77±2.68meg l^{-1}; at 6 months old the females had a higher highly significant ($p \leq 0.001$) value of 55.00 ±1.00 meg l^{-1}than the males with 38.25 ± 0.44meg l^{-1}. Potassium increased with increased age in both females and males. Potassium (K^+), increased with increased age in both the female and male (Table 5)

Sodium (Na^+) at 4 months old, the females had a higher highly significant ($p \leq 0.001$) value of 34.31±2.17meg l^{-1} than the males with 25.01±2.15meg l^{-1}; at 5 months old, the females had a higher highly significant ($p \leq 0.001$) value of 60.32±14.98meg l^{-1} than the males with 32.13±4.39meg l^{-1}; at 6 months old the females had a higher highly significant ($p \leq 0.001$) value of 96.74 ± 1.95meg l^{-1}than the males with 71.51 ± 1.67meg l^{-1}. Sodium (Na^+), increased with increased age in both the female and male (Table 5).

Creatinine, at 4 months old, the females had a higher highly significant ($p \leq 0.001$) value of 1.09±0.00g/l than the males with 1.03±0.04g l^{-1}; at 5 months old, the females had a higher highly significant ($p \leq 0.001$) value of 1.15±0.10g l^{-1}than the males with 1.11±0.07g l^{-1}; at 6 months old the females had a higher highly significant ($p \leq 0.001$) value of 2.45 ± 0.03g l^{-1}than the males with 1.22 ± 0.00g l^{-1}. Creatinine increased with increased age in both females and males. (Table 5).

Alanine aminotransferase (ALT), at 4 months old, the females had a higher highly significant ($p \leq 0.001$) value of 30.65±3.94IU l^{-1}than the males with 22.49±1.81IU l^{-1}; at 5 months old, the females had a higher highly significant ($p \leq 0.001$) value of 34.75±1.59IU l^{-1}than the males with 28.01±4.00IU l^{-1}; at 6 months old the females had a higher significant ($p \leq 0.001$) value of 54.74 ± 2.36IU l^{-1}than the males with 34.25 ± 1.31IU l^{-1}. ALT increased with increased age in both females and males. (Table 5).

Aspartate aminotransferase (AST), at 4 months old, the females had a higher highly significant ($p \leq 0.001$) value of 47.00±6.23IU l^{-1}than the males with 35.11±2.49IU l^{-1}; at 5 months old, the females had a higher highly significant ($p \leq 0.001$) value of 52.77±2.60IU l^{-1} than the males with 47.91±4.84IU l^{-1}; at 6 months old the females had a highly significant ($p \leq 0.001$) value of 96.24 ± 1.80IU l^{-1}than the males with 49.00 ± 1.59IU l^{-1}. AST increased with increased age in both females and males. (Table 5).

Glucose at 4 months old, the females had a higher highly significant ($p \leq 0.001$) value of 51.23±2.30g l^{-1}than the males with 44.21±2.05g l^{-1}; .at 5 months old the females had a higher highly significant ($p \leq 0.001$) value of 67.60±3.67g l^{-1}than the males with 54.64±5.13g l^{-1}; at 6 months old the females had higher highly significant ($p \leq 0.001$) value of 83.00 ± 0.70g l^{-1}than the males with 60.51 ± 0.87g l^{-1}. Glucose increased with increased age in both females and males. (Table 5).

Total protein, at 4 months old the females had a higher highly significant ($p \leq 0.001$) value of 4.17±0.01g l^{-1} than the males with 4.10±0.00g l^{-1}; at 5 months old the females had a higher highly significant ($p \leq 0.001$) value of 4.49±0.01g l^{-1}than the males with 4.45±0.01g l^{-1}; at 6 months old the females had a higher highly significant ($p \leq 0.001$) value of 6.19 ± 0.01g l^{-1}than the males with 5.97 ± 0.00g l^{-1}. Total protein increased significantly ($p \leq 0.05$) with age in both the female and male. (Table 6)

Potassium (K^+), at 4 months old, the females had a higher significant ($p \leq 0.05$) value of 41.46±0.10meg l^{-1} than the males with 41.04±0.12meg l^{-1}; at 5 months old the females had a higher highly significant ($p \leq 0.001$) value of 51.94±0.10meg l^{-1}than the males with 49.68±0.10meg l^{-1}; at 6 months old the females had a higher highly significant ($p \leq 0.001$) value of 55.56 ±0.08meg l^{-1}than the males with 54.26 ± 0.04meg l^{-1}. Potassium increased significantly ($p \leq 0.05$) with age in both the female and male. (Table 6).

Sodium (Na^+) at 4 months old, the females had a higher highly significant ($p \leq 0.001$) value of 62.13±0.08meg l^{-1} than the males with 58.97±0.12meg l^{-1}; at 5 months old, the females had a higher highly significant ($p \leq 0.001$) value of 63.95±0.08meg l^{-1} than the males with 62.13±0.12meg l^{-1}; at 6 months old the females had a higher highly significant ($p \leq 0.001$) value of 78.20 ± 0.12meg l^{-1}than the males with 75.76 ± 0.04meg l^{-1}. Sodium (Na^+), increased significantly ($p \leq 0.05$) with age in both the female and male. (Table 6).

Creatinine, at 4 months old, the females had a lower highly significant ($p \leq 0.001$) value of 1.19±0.00g l^{-1} than the males with 1.21±0.00g l^{-1}; at 5 months old, the females had a lower significant ($p \leq 0.05$) value of 1.20±0.01g l^{-1}than the males with 1.22±0.00g l^{-1}; at 6 months old the females had a non-significant ($p \geq 0.05$) difference value of 2.10 ± 0.01g l^{-1} with the males with 2.10 ± 0.00g l^{-1}. Creatinine increased significantly ($p \leq 0.05$) with age in both the female and male. (Table 6).

Alanine aminotransferase (ALT), at 4 months old, the females had a higher highly significant ($p \leq 0.001$) value of 65.49±0.17IU l^{-1}than the males with 63.89±0.08IU l^{-1}; at 5 months old, the females had a higher highly significant ($p \leq 0.001$) value of 72.23±0.09IU l^{-1}than the males with 70.39±0.08IU l^{-1}; at 6 months old the females had a higher significant ($p \leq 0.001$) value of 74.85 ± 0.51IU l^{-1}than the males with 72.64 ± 0.07IU l^{-1}. ALT increased significantly ($p \leq 0.05$) with age in both the female and male. (Table 6).

Aspartate aminotransferase (AST), at 4 months old, the females had a higher highly significant ($p \leq 0.001$) value of 43.49±0.12IU l^{-1}than the males with 41.95±0.07IU l^{-1}; at 5 months old, the females had a higher highly significant ($p \leq 0.001$) value of 53.63±0.09IU l^{-1} than the males with 53.13±0.11IU l^{-1}; at 6 months old the females had a highly significant ($p \leq 0.001$) value of 66.14 ± 0.12IU l^{-1}than the males with 64.63 ± 0.06IU l^{-1}. AST increased significantly ($p \leq 0.05$) with age in both the female and male. (Table 6).

Glucose at 4 months old, the females had a higher highly significant ($p \leq 0.001$) value of 62.57±0.09g l^{-1}than the males with 60.01±0.06g l^{-1}; .at 5 months old the females had a higher highly significant ($p \leq 0.001$) value of 74.99±0.11g l^{-1}than the males with 73.91±0.06g l^{-1}; at 6 months old the females had higher highly significant ($p \leq 0.001$) value of 84.95 ± 0.12g l^{-1}than the males with 83.69 ± 0.39g l^{-1}. Glucose increased significantly ($p \leq 0.05$) with age in both the female and male. (Table 6).

Male total plasma protein during the wet season, at 4 months old, value of 4.10±0.00 g l^{-1} was highly significantly ($p \leq 0.001$) higher than the value of 3.49±0.02g l^{-1} during dry season; at 5 months old, the wet season value of 4.45±0.01g l^{-1} was highly significantly ($p \leq 0.001$) higher than dry season value of 3.95±0.01g l^{-1} and at 6 months old, the wet season value of 5.97 ± 0.00g l^{-1} was highly significantly ($p \leq 0.001$) higher than dry season value of 4.33 ± 0.00 g l^{-1} (Table 7).

Male potassium during the wet season, at 4 months old, value of 41.04±0.12 meg l^{-1} was highly significantly ($p \leq 0.001$) higher than the value of 13.73±0.17 meg l^{-1} during dry season; at 5 months old, the wet season value of 49.68±0.10 meg l^{-1} was highly significantly ($p \leq 0.001$) higher than dry season value of 18.77±0.22 meg l^{-1} and at 6 months old, the wet season value of 54.26 ± 0.04 meg l^{-1} was highly significantly ($p \leq 0.001$) higher than dry season value of 38.25 ± 0.04 meg l^{-1} (Table 7).

Male sodium during the wet season, at 4 months old, value of 58.97±0.12 meg l^{-1} was highly significantly ($p \leq 0.001$) higher than the value of 25.01±0.18 meg l^{-1} during dry season; at 5 months old, value of 62.13±0.12 meg l^{-1} was highly significantly ($p \leq 0.001$) higher than the value of 32.13±0.36 meg l^{-1} during dry season and at 6 months old, value of 75.76 ± 0.04 meg l^{-1} was highly significantly ($p \leq 0.001$) higher than the value of 71.51 ± 0.14 meg l^{-1} during dry season (Table 7).

Male creatinine during the wet season, at 4 months old, value of 1.21±0.00 g l^{-1} was highly significantly ($p \leq 0.001$) higher than the value of 1.03±0.00 g l^{-1} during dry season; at 5 months old, value of 1.22±0.00 g l^{-1} was highly significantly ($p \leq 0.001$) higher than the value of 1.11±0.01 g l^{-1} during dry season; at 6 months old, value of 2.10 ± 0.00 g l^{-1} was highly significantly ($p \leq 0.001$) lower than the value of 1.22 ± 0.00 g l^{-1} during dry season; (Table 7).

Male alanine aminotransferase (ALT), during the wet season, at 4 months old, value of 63.89±0.08 Int Units l^{-1} was highly significantly ($p \leq 0.001$) higher than the value of 22.49±0.15 Int Units l^{-1} during dry season; at 5 months old, value of 70.39±0.08 Int Units l^{-1} was highly significantly ($p \leq 0.001$) higher than the value of 28.01±0.33 Int Units l^{-1} during dry season; at 6 months old, value

of 72.64 ± 0.07 Int Units l^{-1} was highly significantly ($p \leq 0.001$) higher than the value of 34.25 ± 0.11 Int Units l^{-1} during dry season (Table 7).

Male aspartate aminotransferase (AST) during the wet season, at 4 months old, value of 41.95±0.07 Int Units l^{-1} was highly significantly ($p \leq 0.001$) higher than the value of 35.11±0.20 Int Units l^{-1} during dry season; at 5 months old, value of 53.13±0.11 Int Units l^{-1} was highly significantly ($p \leq 0.001$) higher than the value of 47.91±0.40 Int Units l^{-1} during dry season; at 6 months old, value of 64.63 ± 0.06 Int Units l^{-1} was highly significantly ($p \leq 0.001$) higher than the value of 49.00 ± 0.13 Int Units l^{-1} during dry season (Table 7).

Male glucose, during the wet season, at 4 months old, value of 60.01±0.06 g l^{-1} was highly significantly ($p \leq 0.001$) higher than the value 44.21±0.17 g l^{-1} during dry season; at 5 months old, value of 73.91±0.06 g l^{-1} was highly significantly ($p \leq 0.001$) higher than the value of 54.64±0.42 g l^{-1} during dry season; at 6 months old, value of 83.69 ± 0.39 g l^{-1} was highly significantly ($p \leq 0.001$) higher than the value of 60.51 ± 0.07 g l^{-1}during dry season (Table 7).

Female total plasma protein during the wet season, at 4 months old, value of 4.17±0.01g l^{-1} was highly significantly ($p \leq 0.001$) higher than the value of 3.98±0.01g l^{-1} during dry season; at 5 months old, the wet season value of 4.49±0.01g l^{-1} was highly significantly ($p \leq 0.001$) higher than dry season value of 4.45±0.01g l^{-1} and at 6 months old, the wet season value of 6.19 ± 0.01g l^{-1} was highly significantly ($p \leq 0.001$) higher than dry season value of 5.65 ± 0.01g l^{-1} (Table 8).

Female potassium during the wet season, at 4 months old, value of 41.46±0.10meg l^{-1} was highly significantly ($p \leq 0.001$) higher than the value of 21.57±0.17meg l^{-1} during dry season; at 5 months old, the wet season value of 51.94±0.10 meg l^{-1} was highly significantly ($p \leq 0.001$) higher than dry season value of 34.05±0.41meg l^{-1} and at 6 months old, the wet season value of 55.56 ±0.08meg l^{-1} was highly significantly ($p \leq 0.001$) higher than dry season value of 55.00 ±0.08meg l^{-1} (Table 8).

Female sodium during the wet season, at 4 months old, value of 62.13±0.08meg l^{-1} was highly significantly ($p \leq 0.001$) higher than the value of 34.31±0.18meg l^{-1} during dry season; at 5 months old, value of 63.95±0.08meg l^{-1} was significantly ($p \leq 0.05$) higher than the value of 60.32±1.22meg l^{-1} during dry season and at 6 months old, value of 78.20 ± 0.12 meg l^{-1} was highly significantly ($p \leq 0.001$) lower than the value of 96.74 ± 0.16 meg l^{-1} during dry season (Table 8).

Female creatinine during the wet season, at 4 months old, value of 1.19±0.00g l^{-1} was highly significantly ($p \leq 0.001$) higher than the value of 1.09±0.00 g l^{-1} during dry season; at 5 months old, value of 1.20±0.01g l^{-1} was highly significantly ($p \leq 0.001$) higher than the value of 1.15±0.01g l^{-1} during dry season; at 6 months old, value of 2.10 ± 0.01g l^{-1} was highly significantly ($p \leq 0.001$) lower than the value of 2.45 ± 0.00g l^{-1} during dry season; (Table 8).

Female alanine aminotransferase (ALT), during the wet season, at 4 months old, value of 65.49±0.17 Int Units l^{-1} was highly significantly ($p \leq 0.001$) higher than the value of 30.65±0.32Int Units l^{-1} during dry season; at 5 months old, value of 72.23±0.09Int Units l^{-1} was highly significantly ($p \leq 0.001$) higher than the value of 34.75±0.13Int Units l^{-1} during dry season; at 6 months old, value of 74.85 ± 0.51 Int Units l^{-1} was highly significantly ($p \leq 0.001$) higher than the value of 54.74 ± 0.19Int Units l^{-1} during dry season (Table 8).

Female aspartate aminotransferase (AST) during the wet season, at 4 months old, value of 43.49±0.12Int Units l^{-1} was highly significantly ($p \leq 0.001$) lower than the value of 47.00±0.51Int Units l^{-1} during dry season; at 5 months old, value of 53.63±0.09Int Units l^{-1} was highly significantly ($p \leq 0.001$) higher than the value of 52.77±0.21Int Units l^{-1} during dry season; at 6 months old, value of 66.14 ± 0.12Int Units l^{-1} was highly significantly ($p \leq 0.001$) lower than the value of 96.24 ± 0.15Int Units l^{-1} during dry season (Table 8).

Female glucose, during the wet season, at 4 months old, value of 62.57±0.09 g l^{-1} was highly significantly ($p \leq 0.001$) higher than the value 51.23±0.19g l^{-1} during dry season; at 5 months old, value of 74.99±0.11g l^{-1} was highly significantly ($p \leq 0.001$) higher than the value of 67.60±0.30g l^{-1} during dry season; at 6 months old, value of 84.95 ± 0.12g l^{-1} was highly significantly ($p \leq 0.001$) lower than the value of 83.00 ± 0.06g l^{-1}during dry season (Table 8)

4. Discussion

The higher PCV and Hb concentrations in females than males during the wet and dry seasons within the age bracket of 4, 5 and 6 months; in both the female and male during the dry and wet season also increased with increased age (4, 5 and 6 months) may mean that the females are more active than the males and these activities increased with age may be due to the increased haemopoietic activity of the kidney in addition to the decreased dysfunctional red blood cells in the blood with increased age. It appears that these increased activities may also be related to increased stress (beneficial) level as fish subjected to stress usually has increase in hematocrit and heamoglobin level [24]. [25] Also suggested that the increase in Hb concentration could be a first indicator of an adaptational improvement in the oxygen transportation capacity of the blood. The higher PCV and Hb concentrations in wet season than dry season values in males at 4, 5 and 6 months of age may be due higher metabolic activities during wet season than dry season to maintain homeostasis due to lower environmental temperature. The lower PCV and Hb concentrations in wet season than dry season values in female at 5 months of age may be due lower metabolic activities during wet season than dry season as a result of the start of change of resources allocation from growth to reproductive stage at 5 months of age during wet season than dry season since decreases in haemoglobin concentration signifies that the fish's ability to provide sufficient oxygen to the tissues is restricted considerably and will result in decrease of physical activity [26; 27]. These may mean that females appear to start sexual maturity earlier than males during wet season at 5 months of age.

The higher Rbc count in females than males during dry seasons and the no difference during wet season within the age bracket of 4, 5 and 6 months may mean that during dry season female need more oxygen tension in tissues than males. However, during the wet

season there is no difference in their oxygen demand in both the female and male may mean that oxygen tension is not critical during wet season which is in agreement the findings that an increase in RBC count is associated with fish subjected to low oxygen tension [28]. Rbc count increased with increased age bracket of 4, 5 and 6 months during dry season in both the female and male including the males during the wet season. Rbc count in female was lower at 5 months of age than at 4 and 6 months of age may mean that oxygen tension was more critical during dry season for the male and the demand increased with age; for the female, it appears that at 5months of age the lower Rbc count may account for lower oxygen tension in tissues which may have resulted in reduced activities due probably the start of change of resources allocation from growth to reproductive stage. Rbc count in females and males within the age bracket of 4, 5 and 6 months during wet season was higher than dry season may be due to higher metabolism and oxygen tension in tissue. Again using these values, it may appear that females start the change of allocation of resources for growth to reproduction earlier than males during wet season at 5 months of age.

The higher WBC count in females than males within the age bracket of 4, 5 and 6 months during dry seasons may mean that a better mobilization of the immune response than the males. During the wet season, the female had a lower value than the male at 5 months of age which may mean lower mobilization of the immune response than the males. The increased WBC count in females and males within the age bracket of 4, 5 and 6 months during dry and wet seasons may mean that mobilization of the immune response increased with age. WBC count in females and males within the age bracket of 4, 5 and 6 months during wet season was higher than dry season may be due to higher metabolism, a more favourable environment during wet season for the development and enhancement of the immune response. These findings mean that the female within the age brackets of 4, 5 and 6 months' immune system stimulation and susceptible to environmental and pathological stressors is much more than the males and these immune system stimulations and susceptible to environmental and pathological stressors increased with age increase in both the female and the male which is enhanced more during the wet season than the dry season. This is in agreement with the findings of [29] that postulated that in disease diagnostics, a higher WBC count is usually positively correlated to the immune system stimulation for defense against diseases and environmental stressors and The lower count of WBC suggests less susceptible to environmental and pathological stressors [30]. Generally, granulocytes and monocyte subpopulations are involved in the innate immune response whereas the main role in adaptive immunity is played by lymphocytes [31]. Also The higher value of circulating lymphocyte will be able to defend itself from invading pathogen both by cell-mediated and humoral - mediated responses [32].

The higher lymphocytes value in females than males at 5 months of age during dry seasons may mean that the females developed an earlier and better adaptive immune response than the males which collapsed at 6 months of age. The higher lymphocytes value in males than females at 4 and 5 months of age during wet seasons may mean that the males developed an earlier and better adaptive immune response than the females which collapsed at 6 months of age with the female having later and better adaptive immune response than the males at 6 months of age. The lymphocytes value in female and males declined with increased age (4, 5 and 6 months) during dry season may mean that adaptive immune response also declined with increased age (4, 5 and 6 months). The lymphocytes value during the wet season was higher than dry season in both the female and male within the age bracket of 4, 5 and 6 months may also be due to higher metabolism a more favourable environment during wet season for the development and enhancement of the immune responses. The higher values of lymphocytes in both the females and males within the age bracket of 4, 5 and 6 months during the wet season than dry season means that adaptive immune response was higher during the wet season than dry season.

The higher neutrophil value in males than females at 5 months of age during dry seasons may mean that the males developed an earlier and better innate immune response than the females which collapsed at 6 months of age with the female having a higher neutrophil value which mean that females during dry season developed a later and better innate immune response than the males. The higher neutrophil value in females than males at 4 and 5 months of age during wet seasons may mean that the females developed an earlier and better innate immune response than the males which collapsed at 6 months of age with the male having a higher neutrophil value which mean that males during wet season developed a later and better innate immunity than the females. During the dry season, the increase in neutrophil value in males with increased age in males may mean increase in the development of innate immune response whereas the increase was observed later at 6 months of age. During the wet season, innate immune response in both the female and male decline at 5 months and increased at 6 months of age. The lower values of both the females and males within the age bracket of 4, 5 and 6 months during the wet season than dry season means that innate immune response was higher during the dry season than wet season.

The higher monocyte value in females than males at 4 months of age during dry seasons may mean that the females developed an earlier innate immune response than the males which collapsed at 5 and 6 months of age with the male having a higher monocyte value which mean that males during dry season developed a later innate immune response than the females. The higher monocyte value in females than males at 4 of age during wet seasons may mean that the females developed an earlier innate immune response than the males which collapsed at 5 and 6 months of age with the male having no different monocyte value from the female which mean that at 5 and 6 months of age, when discriminant monocyte influence on innate immune response was not significant. During the dry season, the decline in monocyte value in males at 5 months of age may mean a decrease in the development of innate immune response whereas the increase was observed in both the females and male later at 6 months of age may mean that the male developed innate immune response earlier than the female. During the wet season, innate immune response in male was lower than in the dry season at 6 months of age whereas in the female, wet season had a higher developed innate immunity within the age bracket of 4, 5 and 6 months. Monocyte value The higher values during wet season in both the females and males than dry season within the age

bracket of 4, 5 and 6 months may mean that the influence of monocyte on innate immune response was higher during the wet season than dry season.

The higher erythrocyte sedimentation rate (ESR) value in females than males within the age bracket of 4, 5 and 6 months during dry seasons and at 5 and 6 months of age during the wet season may be due to a higher level of concentration of fibrinogen [33] and tissue destruction [34] in females. In both the female and male during the dry and wet seasons ESR was lowest at 6 months of age indicative of lower level of fibrinogen concentration and tissues destructions at 6 months of age. In the males during the wet season, it appears that fibrinogen concentration and tissues destructions was higher than during the dry season at 4 and 5 months of age whereas it was lower at 6 months of age may be due to increased and reduced metabolic activities respectively. In the females within the age bracket of 4, 5 and 6 months during the wet season, it appears that fibrinogen concentration and tissues destructions was higher than during the dry season may be due to higher metabolic activities probably for growth. It may therefore mean that the male may have started the changed of resource allocation from growth to reproduction during wet season at 6 months of age.

The higher total plasma protein, serum potassium, sodium, alanine transaminase (ALT), aspartate transaminase (AST) and glucose values during dry and wet seasons in females than males may be due to higher biochemical metabolism in female than males within the age bracket of 4, 5 and 6 months. The lower creatinine level in females during wet season at 4 and 5 months of age and higher creatinine level at 6 months of age than the males may be due to lower biochemical metabolism and/or reduced activity and decreased muscle mass with the attendant lower kidney problems at 4 and 5 months of age whereas at 6 months of age may be due to higher biochemical metabolism and/or increased activity with the attendant higher kidney problems.

The higher creatinine level in females during dry season at 4, 5 and 6 months of age than the males may be due to higher biochemical metabolism and/or increased activity with the attendant higher kidney problems. It appears that the wet season if more conducive for the female at 4 and 5 months of age for growth. It also appears that there was no start of change of resource allocation for growth to reproduction even at 6 months of age during dry season. Total plasma protein, serum potassium, sodium, creatinine, alanine transaminase (ALT), aspartate transaminase (AST) and glucose increased with increased age (4, 5 and 6 months) during dry and wet season. These may be due to increased maturation of the organs involved in the biosynthesis/secretion; increased metabolism and/or tissue(s) demand and stress with increased age. The total plasma protein, serum potassium, sodium, alanine transaminase (ALT) and glucose in the male were of higher values in wet season than dry seasons may be due to higher biochemical metabolism. The creatinine level in male which was higher at 4 and 5 months and lower at 6 months of age during the wet season than dry season may be due to higher and lower biochemical metabolism/activities respectively. These lower metabolism and/or activities and probably decrease in muscle mass may be the start of resource allocation for growth to reproduction in males which was 6 months of age during wet season. The creatinine level in females which was higher at 4 months of age and lower at 5 and 6 months of age during the wet season than dry season may be due to higher and lower biochemical metabolism/activities. These lower metabolism and/or activities and probably decrease in muscle mass may be the start of resource allocation for growth to reproduction in females which was may be 5 months of age. Aspartate transaminase (AST) level in females which was higher at 4 and 6 months of age and lower at 5 of age during the wet season than dry season may be due to higher and lower biochemical metabolism/activities. These lower metabolism and/or activities may be the start of resource allocation for growth to reproduction in females which was 5 months of age during the wet season.

5. Conclusion

Sex, age, apparent developmental status and season influenced blood parameters in *Clarias gariepinus*. The obtained reference values and range of blood parameters would serve as a reliable value in the culture of *Clarias gariepinus* aged 4, 5 and 6 months in earthen ponds. Farmers are advised to culture *Clarias gariepinus* sex separately for the table for a maximum of 5 months for the females and 6 months for males during wet season whereas for both female and male during dry season it should be for a minimum of 6 months to utilize their full growth potential before they start allocating the resources for growth to reproductive purposes.

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