HAEMATOLOGY AND BIOCHEMICAL CHARACTERISTICS OF SYNODONTIS BUDGETTI AND, AUCHENOGLANIS OCCIDENTALIS FROM OGBESE RIVER, ONDO STATE, NIGERIA.

Bello-Olusoji, A. O.; Gbadamosi, K. O. and Akinbobola, E. T.

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Department of Fisheries and Aquaculture Technology, School of Agriculture and Agricultural Technology, The Federal University of Technology, Akure, Nigeria.

Correspondence
akinbobolataiwo62@gmail.com

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ABSTRACT

Phaematological and biochemical analyses have been recognized as helpful tools for monitoring fish health status. The haematological and biochemical characteristics of *Synodontis budgetti* (15) and *Auchenoglanis occidentalis* (15) collected from River Ogbese were analised from April to September 2024. The mean values of the haematological parameters of *A. occidentalis* and *S. budgetti* analysed were: WBC (0.54±0.19; 3.43±0.18), Lymphocytes (37.33±5.06; 39.27±4.97), RBC (0.53±0.13; 0.71±0.09), haemoglobin (1.93±0.37; 3.20±0.41), platelets (58.93±3.20; 75.73±5.16), MCV (133.95±3.85; 164.83±4.57), MCH (34.86±3.69; 33.73±3.80), MCHC (219.86±17.63; 224.53±16.93), and neutrophils (39.28±5.48; 38.00±4.73) respectively. A significant difference ($p<0.05$) was observed between *A. occidentalis* and *S. budgetti* in WBC and MCV when compared to each other using T-Test. While the mean values of the biochemical parameters were: Total protein (2.80±0.03; 2.30±0.15), albumin (2.87±0.03; 1.88±0.13), globulin (1.97±0.04; 0.94±0.08), creatinine (27.21±4.32; 37.38±3.30), ALT (58.61±3.64; 78.71±5.90), AST (77.30±2.26; 57.35±4.14), and ALP (12.15±6.02; 14.25±0.94). A significant difference ($p<0.05$) was observed between *A. occidentalis* and *S. budgetti* in ALP when compared with each other (12.15±6.02; 14.25±0.94). The results of this study provided a contribution to the knowledge of the characteristics of haematological and biochemical parameters of the *A. occidentalis* and *S. budgetti*.

Keywords: *Synodontis budgetti, Auchenoglanis occidentalis,* Haematological Characteristics, Biochemical Characteristics, Blood, Protein, Health.

1 | Introduction

Nigeria has abundant freshwater resources, including rivers, streams, floodplains, and reservoirs, which provide habitats for fish (Idowu, 2017). However, the country heavily relies on fish imports to meet domestic demand, despite the potential for increased local fish production through better fisheries management and aquaculture development (Egwui *et al.,* 2013). Water pollution is a major environmental concern, particularly in developing nations, where human activities disrupt aquatic ecosystems (Babalola & Agbebi, 2013). These disturbances often result in fish kills, changes in water chemistry, and loss of biodiversity. Since fish are in direct contact with their aquatic environment, changes in water quality cause physiological stress, which can be harmful if prolonged (Ugwu & Soyinka, 2018). Among the important

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fish species in Nigeria, Synodontis, the largest genus of catfish in the family Mochokidae, is widely distributed across sub-Saharan Africa and plays a significant role in inland fisheries (Owolabi, 2008). Known as "squeakers" for their ability to produce sounds when disturbed, they have over 120 species across various freshwater systems, including the Nile River (Friel & Vigliotta, 2006; Ajiboye *et al.,* 2013). Similarly, bagrids are freshwater fish found across Africa and Asia, often inhabiting large rivers and lakes with muddy bottoms (Okpasuo *et al.,* 2016). They are highly adaptable to different water conditions and have diverse feeding habits (Valbo-Jørgensen *et al.,* 2009). Fish are highly sensitive to environmental changes, which can be monitored through blood analysis. Stressors such as pollution, climate change, and aquaculture handling affect their blood parameters, making them useful biomarkers for assessing fish health (Ayoola *et al.,* 2014; Docan *et al.,* 2018). Several factors, including seasonal changes, diseases, nutrient deficiencies, and stocking density, influence fish blood indices, impacting their overall well-being (Ahmed *et al.,* 2020; Khan, 2021; Seibel *et al.,* 2021). Understanding these physiological markers is essential for sustainable fisheries and aquaculture management (Ghirmai *et al.,* 2020; Parrino *et al.,* 2018; Refaey *et al.,* 2018). This study aimed to evaluate the basic haematological and biochemical characteristics of *S. budgetti* (Mochokidae) and *A. occidentalis* (Bagridae) in Ogbese River, Ondo state, Nigeria.

2 | Materials and Methods

2.1 | Study Area and Fish Collection

The study was carried out at Ogbese River in Ondo State (7° 45N, 5° 30E). fifteen (15) live and freshly caught by the artisan. *Synodontis budgetti* and *Auchenoglanis occidentalis* were collected and transported to the Limnology Laboratory of Fisheries and Aquaculture Technology at the Federal University of Technology, Akure

Blood Collection and Processing

Blood (2 ml per fish) was collected through the vertebral caudal blood vessel using a 5 ml disposable hypodermic syringe and needle. 10 ml sample bottles treated with the anticoagulant Ethylene Diamine Tetraacetic Acid (EDTA).

Haematological Analysis

Standard haematological procedures as described by Blaxhall and Daisley (1973) was used in the assessment of the various blood parameters as stated below;

The microhaematocrit method was used for the determination of packed cell volume (PCV). The cyanohaemoglobin method was used for the determination of haemoglobin and was determined photometrically. The white blood cell count in fish was determined in heparinized blood diluted by the Dacie's solution. The red blood cell count in fish blood was determined in heparinized blood diluted with the Hayem solution. The derived haematological indices of mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) were calculated using standard formula as described by Jain (1986).

Biochemical Parameters Analysis

Blood plasma, which was obtained from heparinized blood samples by centrifugation (4^0C, 800 ×g, 10 min) was used to determine selected biochemical indices. Biochemical indices analysed in blood plasma include: total protein, globulin, albumin, creatinine, alanine aminotransferase (ALT), Alkaline phosphatase (ALP) and aspartate aminotransferase (AST). The protein content of the fish was estimated by the Biuret method (Gornall *et al.,* 1949), using bovine

serum albumin as standard. Aspartate aminotransferase (AST) and alkaline phosphatase (ALT) activities were determined using the Ultraviolet test technique (Bergmeyer *et al.,* 1986). The activity of ALP was estimated using the kinetic Ultraviolet method. Globulin was obtained mathematically by the deduction of values obtained for serum total protein. Albumin values were estimated by using a commercial kit obtained from Qualigens Fine Chemicals. Creatinine value was determined according to Rock *et al.* (1987).

Statistical Analysis

Data collected were analysed statistically using Pearson's T-Test at $p<0.05$ as Statistical Package for Social Sciences (SPSS 22.0 for Windows).

3 | Results

3.1 | Haematological Parameters of *Auchenoglanis occidentalis* and *Synodontis budgetti* collected from Ogbese River

Haematological parameters of *A. occidentali* and *S. budgetti* collected from the Ogbese River are presented in Table 1. The white blood cell counts mean value was higher in *S. budgetti* (3.43±0.18), while *A. occidentalis* recorded the lower mean value (2.54±0.19). A significant difference ($p<0.05$) was observed between the species in WBC when compared to each other. lymphocyte mean value was also higher in *S. budgetti* (39.27±4.97), while the lower value was recorded in *A. occidentalis* (37.33±5.06). Similarly, *S. budgetti* had the higher mean value of monocytes (1.44±0.22), while the lower mean value of monocytes was observed in *A. occidentalis*. Neutrophils higher mean value in *A. occidentalis* (39.28±5.48), while *S. budgetti* had the lowest mean value of neutrophils (38.00±4.73). An insignificant difference ($p>0.05$) was observed between the species in lymphocytes, monocytes and neutrophils when compared to each other. Red blood cell counts mean value was higher in *S. budgetti* (0.71±0.09), while *A. occidentalis* had the lower mean value of red blood cell counts (0.53±0.13). Mean corpuscular volume and mean corpuscular haemoglobin concentration mean value were higher in *S. budgetti* (164.83±4.57, 224.53±16.93), while *A. occidentalis* recorded the lower mean value (133.95±3.85, 219.86±17.63). *A. occidentalis* had the higher mean value of mean corpuscular haemoglobin (34.86±3.69), while *S. budgetti* recorded the lower mean value

Table 1 | Haematological parameters of *Auchenoglanis occidentalis* and *Synodontis budgetti* collected from Ogbese River

	Parameters												
Species	**WBC (10^9/L)**	**LYM (10^9/L)**	**MON (%)**	**NEU (%)**	**EOS (%)**	**BAS (%)**	**RBC (10^{12}/L)**	**HGB (g/L)**	**HCT (%)**	**MCV (fl)**	**MCH (pg)**	**MCHC (g/L)**	**PLT (10^9/L)**
AO	2.54±0.19	37.33±5.06	1.33±0.15	39.28±5.48	1.00±0.11	0.00±0.00	0.53±0.13	1.93±0.37	8.87±1.46	133.95±3.85	34.86±3.69	219.86±17.63	58.93±3.20
SB	3.43±0.18	39.27±4.97	1.44±0.22	38.00±4.73	1.00±0.13	0.00±0.00	0.71±0.09	3.20±0.41	12.46±1.39	164.83±4.57	33.73±3.80	224.53±16.93	75.73±5.16
P-value	0.01*	0.53ns	0.09ns	0.39ns	0.27ns		0.51ns	0.09ns	0.20ns	0.03*	0.58ns	0.73ns	0.50ns
T-test	*	Ns	Ns	Ns	Ns		Ns	Ns	Ns	*	Ns	Ns	Ns

Note: Values with ns in the column indicate non-significantly difference and * indicate significant difference at ($P<0.05$). Data presented are means and standard deviation (mean ± SD) for *Auchenoglanis occidentalis* and *Synodontis budgetti* from three replicates.

Key; *A. occidentalis* = *A. occidentalis*, SB = *S. budgetti*

Table 2 | Biochemical parameters of Auchenoglanis occidentalis and Synodontis budgetti collected from Ogbese River

	Parameters						
Species	**Total protein (g/dl)**	**Albumin (g/dl)**	**Globulin (g/dl)**	**Creatinine (µmol/l)**	**ALT (u/L)**	**AST (u/L)**	**ALP (u/L)**
AO	2.80±0.03	2.87±0.03	1.97±0.04	27.21±4.32	58.61±3.64	77.30±2.26	12.15±6.02
SB	2.30±0.15	1.88±0.13	0.94±0.08	37.38±3.30	78.71±5.90	57.35±4.14	14.25±0.94
P-value	0.62ns	0.48ns	0.98ns	0.09ns	0.91ns	0.89ns	0.01*
T-test	Ns	Ns	Ns	ns	ns	ns	*

Note: Values with ns in the column indicate non-significantly difference and * indicate significant difference at (P<0.05). Data presented are means and standard deviation (mean ± SD) for *Auchenoglanis occidentalis* and *Synodontis budgetti* from three replicates.

Key; *AO* = *A. occidentalis*, **SB** = *S. budgetti*

(33.73±3.80). There was no significant difference (p>0.05) between the two species in Red blood cell counts and Mean corpuscular haemoglobin concentration when compared with each other, but a significant difference (p<0.05) was observed between the species in mean corpuscular volume when compared with each other. *S. budgetti* also recorded the higher mean value in haemoglobin (3.20±0.41), while *A. occidentalis* had the lower mean value of haemoglobin (1.93±0.37). An insignificant difference (p>0.05) was observed between the species in haemoglobin when compared to each other. Also, *S. budgetti* had the higher mean value of platelets (75.73±5.16), while *A. occidentalis* had the lower mean value of platelets (58.93±3.20). An insignificant difference (p>0.05) was observed between the species in platelets when compared to each other.

3.2 | Biochemical Parameters of *Auchenoglanis occidentalis* and *Synodontis budgetti* collected from the Ogbese River

Table 2 depicts the biochemical parameters of *Auchenoglanis occidentalis* and *Synodontis budgetti* collected from the Ogbese River. The total protein mean value was higher in *A. occidentalis* (2.80±0.03), while *S. budgetti* recorded the lower mean value of total protein (2.30±0.15). Also, albumin mean value was higher in *A. occidentalis* (2.87±0.03), while the lower mean value of albumin was recorded in *S. budgetti* (1.88±0.13). Similarly, globulin mean value was higher in *A. occidentalis* (1.97±0.04), while *S. budgetti* had the lower mean value of globulin (0.94±0.08). An insignificant difference (p>0.05) was observed between the species in total protein, albumin and globulin when compared to each other. Creatinine and ALT mean values were higher in *S. budgetti* (37.38±3.30, 78.71±5.90), while *A. occidentalis* had the lower mean value of Creatinine and ALT (27.21±4.32, 58.61±3.64). However, there was no significant difference (p>0.05) between the species in Creatinine and ALT when compared to each other. *A. occidentalis* had the higher mean value of AST (77.30±2.26), while *S. budgetti* recorded the lower mean value of AST (57.35±4.14). An insignificant difference (p>0.05) was observed between the species in AST when compared to each other. *S. budgetti* was found with the higher mean value of ALP (14.25±0.94), while *A. occidentalis* had the lower mean value of ALP (12.15±6.02). A significant difference (p<0.05)

Table 3 | Haematological Parameters of Auchenoglanis occidentalis and Synodontis budgetti compared with Reference Data

Species	Parameters													
	WBC (10^9/L)	LYM (10^9/L)	MON (%)	NEU (%)	EOS (%)	BAS (%)	RBC (10^{12}/L)	HBG (g/L)	HCT (%)	MCV (fl)	MCH (pg)	MCHC (g/L)	PLT (10^9/L)	REFERENCES
Auchenoglanis occidentalis	2.54	37.33	1.33	39.29	1	0	0.53	1.93	8.87	133.95	34.86	219.86	58.93	Present Study
Synodontis budgetti	3.44	39.28	1.44	38	1	0	0.71	3.20	12.46	164.83	33.73	224.53	75.73	Present Study
Chrysichthys nigrodigitatus	39.79	ND	ND	ND	ND	ND	5.40	1.19	33.6	63.74	1.97	33.31	ND	Onyia *et al.,* 2019
Synodontis batensoda	10.16	ND	ND	ND	ND	ND	9.14	2.99	39.00	49.64	1.64	33.32	ND	Onyia *et al.,* 2019
Clarias gariepinus	4130	45.90	ND	ND	ND	ND	3.21	12.12	32.80	10.24	39.28	37.57	ND	William *et al.,* 2016
Chrysichthys nigrodigitatus	10.69	1.33	0.33	8.50	0.00	0.00	2.97	97.29	29.28	95.19	30.53	33.32	ND	Ugwu and Soyinka, 2018
Clarias gariepinus	8.34	84.64	3.88	11.32	0.00	0.00	1.68	3.52	ND	ND	ND	ND	ND	Baraya and Abdulrazak, 2022
Heterobranchus longifilis	22.51	ND	ND	ND	ND	ND	2.39	11.04	33.00	141.42	45.69	32.93	ND	Okorie-kanu and Unakalamba, 2014

ND = Not determined

was observed between the species in ALP when compared with each other.

3.3 | Haematological Parameters

Packed cell volume (PCV) is a key diagnostic tool that measures erythrocyte concentration in the blood (Bolade and Ndidi, 2021). The mean PCV values recorded in this study were 8.87% for *A. occidentalis* and 12.46% for *S. budgetti*, significantly lower than those reported for Synodontis batensoda (39.00%) (Onyia *et al.,* 2019) and *Chrysichthys nigrodigitatus* (29.28%) (Ugwu and Soyinka, 2018). The variations in PCV values may be due to species differences, nutritional status, environmental factors, or exposure to pollutants (Rizal *et al.,* 2018).

Haemoglobin concentration reflects the oxygen-carrying capacity of erythrocytes (Bolade and Ndidi, 2021). Differences in haemoglobin levels may be attributed to species variation, environmental stressors, or nutritional deficiencies. In this study, *A. occidentalis* had a haemoglobin concentration of 1.93 g/dL, while *S. budgetti* had 3.20 g/dL. These values were lower than those reported for Clarias gariepinus (3.52 g/dL) by Baraya & Abdulrazak, 2022 and Heterobranchus longifilis (11.04 g/dL) by Okorie-Kanu & Unakalamba, (2014), but higher than the 1.19 g/dL recorded for *C. nigrodigitatus* (Onyia *et al.,* 2019).

Red blood cell counts is a key indicator of oxygen transport efficiency in fish by (Wells, 2009). In this stydy, RBC values recorded were 0.53 $\times 10^6/\mu L$ for *A. occidentalis* and 0.71 $\times 10^6/\mu L$ for *S. budgetti*, which are significantly lower than 3.52 $\times 10^6/\mu L$ those reported for *C. gariepinus* by Baraya & Abdulrazak (2022), and 9.14 $\times 10^6/\mu L$ *S. batensoda* by Onyia *et al.,* (2019). Low RBC counts can indicate of anaemia, which can inpair oxygen transport and hinder growth performance in fish (Alamanda *et al.*, 2007; Yanuhur *et al.*, 2021).

Erythrocytic indices help classify anaemia types in

Table 4 | Biochemical Parameters of *Auchenoglanis occidentalis* and *Synodontis budgetti* compared with Reference Data

Species	Parameters							REFERENCES
	Total Protein (g/dl)	Albumin (g/dl)	Globulin (g/dl)	Creatinine (µmol/l)	ALT (u/L)	AST (u/L)	ALP (u/L)	
Auchenoglanis occidentalis	2.80	2.87	1.98	27.28	58.61	77.30	12.15	Present Study
Synodontis budgetti	2.30	1.88	0.94	37.38	78.70	57.35	14.25	Present Study
Chrysichthys nigrodigitatus	ND	ND	ND	ND	12.98	66.06	88.01	Ugwu and Soyinka, 2018
Clarias gariepinus	4.16	2.84	ND	ND	5.00	7.48	74.24	Baraya and Abdulrazak, 2022
Clarias gariepinus	ND	ND	ND	ND	44.87	56.57	30.73	Melefa and Okoloye, 2023
Heterobranchus longifilis	3.86	1.53	2.40	ND	38.86	49.55	9.33	Okorie-kanu and Unakalamba, 2014
Clarias gariepinus	ND	ND	ND	0.414	ND	ND	ND	Abdel-Hay *et al.,* 2021

ND = Not determined

fish (Campbell, 2004). The mean corpuscular volume values recorded were 133.95 fL (*A. occidentalis*) and 164.83 fL (*S. budgetti*), both higher than those reported for *C. nigrodigitatus* (63.73 fL) and *S. batensoda* (49.64 fL) (Onyia *et al.,* 2019). Similarly, MCH values were higher than previous records, suggesting species-specific variations or environmental influences (Bolade & Ndidi, 2021).

White blood cell (WBC) reflect immune function and stress responses in fish (Magnadottir, 2006). The WBC counts for *A. occidentalis* (2.54 $\times 10^3/\mu L$) and *S. budgetti* (3.44 $\times 10^3/\mu L$) were significantly lower than those for *S. batensoda* (10.16 $\times 10^3/\mu L$) (Onyia *et al.,* 2019) and *C. gariepinus* (8.34 $\times 10^3/\mu L$) (Baraya and Abdulrazak, 2022). Higher WBC levels indicate better immune defence (Chand, 2021). Variations in lymphocytes, neutrophils, and monocytes were also observed, reflecting species-specific immune responses (Shah & Altindağ, 2005).

Platelet counts were higher in *S. budgetti* (75.73 $\times 10^3/\mu L$) than *A. occidentalis* (58.93 $\times 10^3/\mu L$). Increased platelet counts may indicate organ stress and potential liver or kidney dysfunction (Yuri Gasparyan *et al.,* 2011).

Biochemical Parameters

Total protein concentration provides insights into organ function and metabolic health (Knowles *et al.,* 2006). Protein depletion may result from malnutrition, stress, or hepatic disorders (McCue, 2010; Singh & Samartha, 2022). Total protein values for *A. occidentalis* (2.80 g/dL) and *S. budgetti* (2.30 g/dL) were lower than those of C. gariepinus (4.16 g/dL) (Baraya & Abdulrazak, 2022) and H. longifilis (3.86 g/dL) (Okorie-Kanu and Unakalamba, 2014).

Albumin levels, synthesized in the liver, reflect protein metabolism and immune function (McCue, 2010). Albumin levels can vary due to species mobility, reproductive stage, and environmental factors (Andreeva, 2010). The albumin values recorded were 2.87 g/dL (*A. occidentalis*) and 1.88 g/dL (*S. budgetti*), higher than those for H. longifilis (1.53 g/dL) (Okorie-Kanu & Unakalamba, 2014).

Globulin, a key immune protein, was lower in *A.*

occidentalis (1.98 g/dL) and *S. budgetti* (0.94 g/dL) compared to H. longifilis (2.40 g/dL) (Okorie-Kanu & Unakalamba, 2014). Changes in globulin levels impact immune function (Peres *et al.,* 2015).

Liver enzymes, including aspartate aminotransferase (AST) and alanine aminotransferase (ALT), indicate liver health (Polakof *et al.,* 2012). AST levels ranged from 57.35–77.30 U/L, higher than C. gariepinus (7.48 U/L) (Baraya & Abdulrazak, 2022) and H. longifilis (49.55 U/L) (Okorie-Kanu & Unakalamba, 2014). ALT levels (58.61–78.70 U/L) were also elevated compared to previous reports. Elevated AST and ALT levels suggest liver stress due to environmental toxins (Palanivelu *et al.,* 2005). Alkaline phosphatase (ALP) levels (12.15–14.25 U/L) were lower than C. nigrodigitatus (88.01 U/L) (Ugwu & Soyinka, 2018) and C. gariepinus (30.73 U/L) (Melefa & Okoloye, 2023) but higher than H. longifilis (9.33 U/L) (Okorie-Kanu & Unakalamba, 2014). ALP variations indicate liver and bone metabolism issues.

Creatinine, a muscle metabolism marker, ranged from 27.28–37.38 µmol/L, significantly higher than C. gariepinus (0.14 µmol/L) (Abdel-Hay *et al.,* 2021). Increased creatinine levels may result from muscle breakdown or chronic kidney disease (Bolade and Ndidi, 2021).

4 | Conclusion

The results of this study provide information on the haematological characteristics and biochemical parameters of the *A. occidentalis* and *S. budgetti*. This investigation may be helpful as a tool to monitor the health status of *A. occidentalis* and *S. budgetti* and other related fish species. The evaluation of haematological and biochemical parameters will also serve as baseline data for fish health assessment and environmental monitoring.

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