

Variations in biochemical composition of freshwater cichlid fish, *Oreochromis mossambicus*, in two lentic water bodies of Tumkur district, Karnataka

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Abstract

The present study is undertaken to investigate the biochemical composition in cichlid fish, *Oreochromis mossambicus*, in two lentic water bodies of Tumkur district, Karnataka, during May 2022 to April 2023. Glucose, glycogen, total proteins, total lipids, and free amino acids were estimated. In tank 1, the glucose content varied from 2.09 $\mu\text{mol/mg}$ in gills and 21.04 $\mu\text{mol/mg}$ in liver. However, glycogen level deviated between 2.32 $\mu\text{mol/mg}$ in gills and 11.21 $\mu\text{mol/mg}$ in liver. While, total protein content varied from 4.11 $\mu\text{mol/mg}$ in gills and 49.01 $\mu\text{mol/mg}$ in muscles. Total lipid content varied from 23.09 $\mu\text{mol/mg}$ in liver and 130.52 $\mu\text{mol/mg}$ in muscle. Nevertheless, free amino acids deviated from 1.59 $\mu\text{mol/mg}$ in kidney and 39.00 $\mu\text{mol/mg}$ in liver. In tank 2, glucose content varied from 3.51 $\mu\text{mol/mg}$ in gills and 15.60 $\mu\text{mol/mg}$ in muscles. Glycogen level was highest in liver 9.98 $\mu\text{mol/mg}$ and lowest in the kidney with 3.01 $\mu\text{mol/mg}$. Total protein level fluctuated from 5.05 $\mu\text{mol/mg}$ in gills and 48.01 $\mu\text{mol/mg}$ in muscle tissue. The total lipids were minimum in the kidney with 38.05 $\mu\text{mol/mg}$ and maximum in muscles with 76.80 $\mu\text{mol/mg}$. Free amino acids content was lowest in the kidney with 1.99 $\mu\text{mol/mg}$ and maximum in the muscles with 30.15 $\mu\text{mol/mg}$. The investigation showed that the chemical composition is not the same in all tissues and months. It was also observed that the biochemical composition of fish depends mostly on size, maturity, gender as well as breeding season. Total proteins and total lipids were highest in muscle tissue. Glucose content was lower in the Gills, but Glycogen was minimal in the Gills and the Kidney. However, free amino acids were lower in the kidney. The reduction of Protein, Glycogen, and lipid contents may be due to the utilization towards the maturation of the gonads.

Keywords: *Oreochromis mossambicus*, glucose, glycogen, total protein, total lipid, free amino acids, two lentic water bodies

Introduction

Fish are very rich in nutrients and are important in human diets. They also play a big role in the ecosystems of water bodies. *Oreochromis mossambicus* is a type of freshwater fish that is widely consumed. It is farmed in India and has both nutritional and economic value. This fish is found in rivers, lakes, and reservoirs across South Asia. Because it grows quickly, has a large body size, and is in high demand, it is a main focus of fish farming research (Mimansa Kiran and Mridula Renu Sinha, 2025)^[25].

Fish is a source of protein and provides useful products, as well as economically important material to many countries. The alteration of the habitat and over-exploitation lead to the erosion of the fish species. It is a well-known fact that the biochemical composition is an utmost importance in increasing the technology for evolving judicious pisciculture management

(Kiran, 2018)^[20]. Proteins and carbohydrates are two basic nutrients that are needed by all living organisms for their physiological processes. Proteins are important for building muscle and connective tissues. They are also needed for many physiological processes, such synthesis of enzymes, supporting the immune system, helping tissue heal, and forming amino acids.

Even though fish muscle tissues have more proteins and lipids, they contain less carbohydrate. However, carbohydrates still have an important role in energy production, balancing body fluids, and stress. How many carbohydrates are stored in a fish muscles depends on its diet, the temperature of the water, and its general health. In fish farming, changing the diet and environmental

conditions can affect carbohydrate storage in the fish body, which in turn influences energy consumption and growth. Along with proteins and lipids, carbohydrates help in energy utilization by managing stored sugar, muscle movement, and immune system function (Mimansa Kiran and Mridula Renu Sinha, 2025)^[25].

Glycogen is an important energy source for muscles in living organisms and is used during muscle activity and stored in mainly in liver. Glycogen levels vary between different tissues. The nutritional value of fish is well known around the world. Lipids are the most important chemical components in fish, according to Ganeshwade *et al.*, (2016)^[17] and Akpınar (1986b)^[2]. Fish store lipids in various organs, especially in muscles and the liver. Unlike mammals, which store lipids mainly in fat tissue, fish store them differently. Generally, fish lipids contain n-3 series unsaturated fatty acids, which help to lower the levels of triglycerides and cholesterol in the blood. This can reduce the chances of sudden heart attacks and the risk of thrombosis, which is a major cause of heart attacks. Some studies have shown that n-3 fattyacids can help in the treatment of certain cancers, like breast cancer, as reported by Konar *et al.*, (1999)^[21] and El-Sayed *et al.*, (1984)^[15].

The biochemical components of fish have mostly been studied in India to understand their nutritional value. Fish proteins are easily digested and are known to have good biological value and promote growth (Shekar and Cristy, 2014)^[30]. These proteins contain all ten essential amino acids that are suitable for human consumption (Bhilave *et al.*, 2013; Arunachalam *et al.*, 2017)^[4, 9]. Biochemical constituents of fish have been analyzed for the nutritional value of fish. Fish proteins are relatively high in digestibility

and considered to have high biological and growth-promoting value (Shekar and Cristy, 2014) ^[30], which comprises all ten essential amino acids in a desirable quantity for human consumption (Bhilave *et al.*, 2013; Arunachalam *et al.*, 2017) ^[4, 9].

Biochemical compositions of fish are of interest in relation to the food values of fish and evaluating their physiological needs at different periods of life. Several researchers have studied the depletive effects of maturation and spawning on the chemical composition of fishes (Appa Rao, 1967; Pandey *et al.*, 1976; Piska & Prasad, 1991; Kiran & Puttaiah, 2005; Ashashree *et al.*, 2013) ^[3, 5, 19, 29]. The seasonal variations in biochemical variations of Cichlid fish have not been given much attention in *Oreochromis mossambicus* of the lentic water bodies of Tumkur district. Hence, keeping in view the importance of fish, an attempt has been made to study the above aspect.



Fig 1: Gangasandra Tank Melekote Tank

Experimental Animal and sampling of specimens

O. mossambicus specimens were collected with the help of a dragnet. They were then anaesthetized using MS222 (Ethyl 3-aminobenzoate methane sulphonate) to retain the properties of biomolecules and enzymes. Specimens of average length of 20- 25cms and weighing 250- 300gms were used for the analysis. They were dissected at the site, and the tissues, such as gill, muscle, liver, and kidney, were carefully removed and transferred to a suitable medium (phosphate buffer solution). In the laboratory, the tissues were washed with ice-cold saline and homogenized in cold 50Mm phosphate buffer (pH7.4) to give 10% homogenate (w/v). The homogenate was centrifuged at 1000rpm for 10 min at 0 °C in a cooling centrifuge to remove cell debris. The homogenate was used for estimations.

Biochemical studies

Different biochemical parameters are analyzed for gill, muscle, liver, and kidney tissue samples. Glucose and Glycogen were estimated by the anthrone method of Carroll *et al.*, (1956) ^[11]. Total protein was estimated by the method of Lowry *et al.* (1951) ^[23]. Total free amino acids were estimated by the method of Moore *et al.*, (1954) ^[26]. Total lipids were estimated by Folch *et al.*, (1957) ^[16].

The anthrone method for Glucose and Glycogen estimation

The anthrone method, as described by Carroll *et al.*, (1956) ^[11], estimates glucose and glycogen by dehydrating the carbohydrate to form furfural, which then reacts with anthrone to produce a blue-green color. This color is measured at 620nm using a colorimeter, and a standard curve made with glucose is used for quantification. The

Materials and Methods

Study Area

The study was conducted in two water reservoirs located in the Tumkur District of Karnataka, India. The Gangasandra tank (Tank1) is a perennial water body situated approximately 8 km away from Tumkur city, with a water spread area of 83.2 hectares. The second reservoir, the Melekote tank (Tank2), is also a perennial one, located 1.59 km away from Tumkur city and covering a water spread area of 47.2 hectares. Notably, a sewage treatment plant is located near the Melekote tank. Both tanks are extensively utilized for fish farming and serve multiple purposes, including irrigation and drinking water for local farmers. These reservoirs were chosen for the study due to their significant role in aquaculture and agriculture in the region. (Fig 1).

method requires dissolving anthrone in concentrated sulfuric acid to create the reagent, and the final color is measured after heating the samples.

Tissues containing glycogen are first homogenized and prepared, while, samples for free glucose are processed accordingly. Samples are treated with concentrated sulfuric acid, which acts as both a solvent and a dehydrating agent, converting carbohydrates into furfural derivatives. The anthrone reagent is added to the samples. A green or blue-green color develops due to the reaction between the furfural derivatives and the anthrone, forming a colored condensation product. The intensity of the color, which is proportional to the carbohydrate concentration, is measured using a colorimeter or spectrophotometer at a maximum absorption wave length of 620nm. A standard curve is prepared by measuring the absorbance of known concentrations of glucose. The unknown concentration of glucose or glycogen in the samples can then be determined by comparing their absorbance to the standard curve.

Estimation of total lipid

The total lipids were determined using the method described by Folch *et al.*, (1957) ^[16]. A known volume of sample was homogenized with 1 ml of methanol and 2 ml of chloroform, to which another 2 ml of chloroform: methanol (2:1 v/v) was added and thoroughly mixed. Then, 0.2 ml of 0.09% sodium chloride solution was added. The mixture was poured into a separating funnel, mixed, and allowed to stand for several hours. The lower phase was collected, and 0.5 ml of the extract was transferred to a clean test tube. This was then placed in a vacuum desiccator over silica gel, dissolved in 0.5 ml of concentrated sulphuric acid, and mixed well. The tube was plugged with non-absorbent

cotton wool and placed in a boiling water bath for 10 minutes. After cooling at room temperature, 0.3 ml of the acid digest was used for analysis. For standards, 0.5 mg of cholesterol was used, and for blanks, 0.5 ml of distilled water was used. To each tube, 5 mL of vanillin reagent was added. The mixture was shaken well and allowed to stand for 30 minutes. The developed colour was measured at 250 nm. The lipid content was expressed as $\mu\text{mol}/\text{mg}$ of muscle.

Estimation of total protein

Protein content in the muscle was determined after trichloro acetic acid precipitation using the method of Lowry *et al.*, (1951) [23]. The muscles (20 mg) were isolated and homogenized, and a 2% homogenate was centrifuged at 3000 rpm for 15 min. The supernatant was discarded, and the residue was suspended in 1.0 ml of 0.1N sodium hydroxide solution. 0.5 ml of this solution, equivalent to 10 mg of muscle, was transferred to a clean test tube, and 4 ml of copper carbonate solution was added. The thoroughly mixed contents were kept at room temperature for 30 min. The colour developed was read at 600 nm against a reagent blank in a UV-visible spectrometer. Bovine serum albumin (Sigma Chemical Co.) was used to construct the standard graph. The protein content in the muscle was expressed as $\mu\text{mol}/\text{mg}$ wet weight of muscle.

Estimation of Free Amino Acids.

The Moore *et al.* (1954) [26] method for total free amino acid estimation is a ninhydrin-based assay that uses a spectrophotometric approach. In this method, amino acids are reacted with ninhydrin, which produces a purple color. The intensity of this color, measured by a spectrophotometer, is directly proportional to the concentration of the amino acids present.

The method relies on the reaction of amino acids with ninhydrin to form a colored product. Alpha amino acids react with excess ninhydrin to produce a purple product called Ruhemann's purple. The original method used pyridine as a solvent and stannous chloride to reduce part of the ninhydrin to aid in the reaction. The absorbance of the colored solution is measured using a spectrophotometer or colorimeter. The wavelength used depends on the specific reaction conditions and the amino acid being analyzed.

The absorbance reading is used to determine the concentration of amino acids, as the color intensity is directly proportional to the amino acid concentration.

Results and Discussion

When comparing the biochemical composition in both tanks, in tank 1 glucose content was minimum in gills with $2.09 \mu\text{mol}/\text{mg}$ (September 2022) and maximum in liver with $21.04 \mu\text{mol}/\text{mg}$ during May 2022. Glycogen level was highest in the liver ($11.21 \mu\text{mol}/\text{mg}$) during May 2022 and lowest in the gills and kidney with $2.32 \mu\text{mol}/\text{mg}$ and $2.98 \mu\text{mol}/\text{mg}$ during July 2022 and September 2022, respectively (Table 1).

Total protein level fluctuated from $4.11 \mu\text{mol}/\text{mg}$ in gills (August 2022) and $49.01 \mu\text{mol}/\text{mg}$ in fish muscles (May 2022). However, total lipids were minimum in the liver with $23.09 \mu\text{mol}/\text{mg}$ (July 2022) and maximum in muscle with $130.52 \mu\text{mol}/\text{mg}$ during May 2022. Free amino acid content was lowest in the Kidney with $1.59 \mu\text{mol}/\text{mg}$ during September 2022 and highest in the liver with $39.00 \mu\text{mol}/\text{mg}$ during April 2023 (Table 1).

In tank 2 glucose content was minimum in gills with $3.51 \mu\text{mol}/\text{mg}$ during September 2022 and maximum in muscle with $15.60 \mu\text{mol}/\text{mg}$ during April 2023. Glycogen level was highest in liver ($9.98 \mu\text{mol}/\text{mg}$) during May 2022 and lowest in the kidney with $3.01 \mu\text{mol}/\text{mg}$ during September 2022. (Table 1).

Total protein level fluctuated from $5.05 \mu\text{mol}/\text{mg}$ in gills (September 2022) and $48.01 \mu\text{mol}/\text{mg}$ in muscle tissue during May 2022. The total lipids were minimum in the kidney with $38.05 \mu\text{mol}/\text{mg}$ during September 2022 and maximum in muscle with $76.80 \mu\text{mol}/\text{mg}$ during April 2023. Free amino acids content was lowest in the kidney with $1.99 \mu\text{mol}/\text{mg}$ during September 2022 and maximum in the muscle with $30.15 \mu\text{mol}/\text{mg}$ during April 2023. (Table 1).

Therefore, any change in biochemical constituent indicates the stress inflicted on the metabolic functions of this fish required for maintaining a healthy physiological state. The result obtained in this study has provided the detailed knowledge on the biochemical composition of this cichlid fish species in two lentic water bodies of Tumkur district. Therefore, from the above results it is clear that Melekote tank fishes exhibit higher physiological stress responses than those in Gangasandra tank.

Discussion

Fish is a good source of protein and plays a major role in the global food market. It can help to meet the need for protein and ensure proper nutrition in the future. The biochemical composition of fish, changes during the spawning season and different environmental conditions. (Damian *et al.*, 2007; Boran and Rangoda, 2011) [10, 13]. Many studies have looked at how the composition of different fish species changes. (Stansby, 1962; Love, 1970) [22, 31]. The composition of fish can vary depending on where they are found (Afroza Begum *et al.*, 2013; Folch *et al.*, 1957) [1, 16]. Changes in biochemical constituents in fish depends on its diet, habitat and season. (Deka *et al.*, 2012; Begum and Minar, 2012; Begum *et al.*, 2012) [6, 7, 14]. Protein composition play a major role in fish's growth and development. It helps the body to synthesize enzymes and hormones (Wilson, 1986) [33] and also provides energy (Halver and Hardy, 2002) [18]. According to Tripathy *et al.*, (2006) [32] protein levels in different organs of the fish, like the liver, intestine, gills, muscles, and ovaries, can increase when they are exposed to certain chemicals (Tripathy, Singh, and Shasmal, 2006; Bheem Rao and Sanjeevaiah, 2023) [8, 32].

Glycogen is the main biochemical constituent and it is reserved in the liver and muscles. Fish liver is useful for studying different environmental conditions and its impact on detoxifying capacity of liver. (Yang and Chen, 2003) [34]. The fats in fish that help to prevent heart disease in humans. Most of the enzymes that break down fats are found in the fish's intestine (Piggot and Tucker, 1990) [28]. The maturity and age of fish in the same species can also cause big differences in the total fat levels (Marks, 1980) [24]. A lower amount of fat in tissues may be due to utilizing fat to combat and adjust to different environmental conditions. (Chezhian *et al.*, 2010) [12]. These differences can be because of various factors like the type of fish, the season, and habitat. (Bheem Rao and Sanjeevaiah, 2023) [8].

Statistical analysis: Student t-test

Interpretation of t and P Values for Fish Biochemical Assays

The t and P values presented in the data set represent the comparative analysis of biochemical parameters measured in various tissues (gill, muscle, liver, and kidney) of fish samples obtained from two experimental tanks. The critical P value (t = 2.06) is used as the threshold to determine statistical significance at the 0.05 level. When the calculated F value exceeds 2.06, the difference in biochemical responses among tissues or between tanks is considered statistically significant (Table 2).

Overall, the data show distinct patterns of variability in the biochemical responses across tissues and tanks. In Tank 1, the gill tissues exhibit high t values (14.333, 17.535, 6.873, and 6.056), suggesting that biochemical activities such as enzyme expression, oxidative stress, or metabolite accumulation in gills are significantly different compared to other tissues. Similar trends are observed in Tank 2, where gill t values (13.989, 21.434, 6.254 and 5.906) exceed the critical limit, confirming a strong tissue-dependent variation (Table 2). Since gills are directly exposed to waterborne conditions, these significant variations may be attributed to environmental stress or exposure to contaminants.

The muscle tissues show relatively lower t values in most cases (ranging from 0.083 to 14.818), with only a few instances above the critical limit. This indicates that the biochemical parameters in muscles are less influenced by external tank conditions, likely reflecting their more stable metabolic activity. The liver, a major detoxifying organ, shows several t values above the critical threshold (e.g., 14.894, 18.954, 6.600, 6.362), suggesting that hepatic metabolism and detoxification mechanisms differ significantly between tanks, possibly due to differential exposure to organic or inorganic stressors.

The kidney tissues also show several markedly high t values (13.720, 15.183, 21.056, 26.069), emphasizing big statistical differences. Since kidneys play a vital role in excretion and ionic regulation, these significant variations suggest that water quality parameters or pollutant loads may be influencing renal function distinctly across tanks.

In summary, the results indicate significant biochemical variability in gill, liver, and kidney tissues, while muscle tissues remain relatively stable. These differences highlight the sensitivity of gills and kidneys as biomarkers for aquatic environmental monitoring and demonstrate that Melekote tank fishes exhibit higher physiological stress than those in Gangasandra tank.

Table 1: Monthly variations in Biochemical composition (µmol/mg) in different organs of *Oreochromis mossambicus* during May 2022 to April 2023

			May 2022	June 2022	July 2022	Aug 2022	Sept 2022	Oct 2022	Nov 2022	Dec 2022	Jan 2023	Feb 2023	March 2023	April 2023
Glucose	Tank 1	Gill	7.80	4.11	2.19	2.55	2.09	2.87	3.01	3.21	3.96	3.01	6.78	6.80
		Muscle	15.04	12.05	11.08	11.65	12.02	13.00	13.89	12.00	9.36	9.50	15.10	16.66
		Liver	21.04	11.04	11.89	12.65	12.01	12.32	13.21	14.01	14.52	15.50	18.90	20.50
		Kidney	9.00	9.37	9.87	7.22	8.00	10.22	10.00	10.008	11.76	11.90	12.00	13.50
	Tank 2	Gill	6.20	6.11	3.55	3.6	3.51	4.10	4.02	5.5	4.64	4.50	5.00	5.50
		Muscle	14.9	14.00	10.10	9.92	8.90	10.11	10.85	10.22	11.12	11.98	12.00	15.60
		Liver	12.5	13.21	10.10	11.2	9.43	12.66	13.00	11.55	13.52	13.50	14.25	15.00
		Kidney	11.5	10.09	9.9	8.7	7.21	9.97	9.05	9.15	9.44	9.99	10.25	11.25
Glycogen	Tank 1	Gill	6.91	2.56	2.32	2.56	3.89	3.44	3.56	4.40	4.50	4.88	5.62	6.90
		Muscle	8.0	4.39	3.11	4.09	4.65	6.08	6.21	5.85	5.90	6.00	7.90	7.50
		Liver	11.21	8.65	8.54	6.09	6.43	6.34	7.21	7.10	8.0	9.50	10.00	10.50
		Kidney	7.98	3.31	3.21	3.04	2.98	4.32	5.01	6.0	6.0	6.50	6.99	6.78
	Tank 2	Gill	6.61	7.05	4.15	3.50	3.11	4.99	4.70	3.98	5.34	5.00	5.99	6.34
		Muscle	8.11	9.50	4.55	5.64	5.12	5.00	6.33	6.12	6.34	6.75	7.25	8.00
		Liver	9.98	9.01	5.09	4.9	4.22	6.17	6.21	6.88	7.70	7.25	7.50	8.80
		Kidney	8.25	8.50	3.3	3.2	3.01	5.2	3.88	4.98	5.04	5.09	6.00	7.25
Total Protein	Tank 1	Gill	9.52	5.01	4.21	4.11	5.22	5.96	5.55	6.01	6.66	6.50	8.72	9.10
		Muscle	49.01	27.08	28.06	25.45	29.00	30.00	35.80	33.15	36.56	38.50	40.98	48.90
		Liver	34.59	16.09	15.01	18.21	18.22	20.06	23.99	25.60	30.00	32.99	36.90	35.00
		Kidney	22.57	12.00	11.33	12.42	11.22	13.32	15.21	15.10	20.96	20.00	24.50	25.00
	Tank 2	Gill	10.01	10.35	6.05	6.05	5.05	6.65	5.77	6.51	7.68	7.50	7.00	9.50
		Muscle	48.01	41.02	30.0	27.88	27.91	31.75	30.95	33.75	36.00	35.00	30.00	41.50
		Liver	33.25	32.51	19.5	21.22	19.22	20.25	20.88	20.75	23.36	23.00	22.00	30.50
		Kidney	24.98	25.00	15.55	18.35	17.85	19.15	20.29	20.78	19.04	19.05	20.10	25.25
Total lipids	Tank 1	Gill	89.00	50.01	45.05	53.09	50.09	55.09	58.09	66.08	68.8	70.00	80.88	78.99
		Muscle	130.52	75.69	79.22	85.04	76.01	85.11	90.09	88.67	100.8	100.50	120.30	123.66
		Liver	49.99	25.55	23.09	25.01	24.01	28.61	25.11	29.02	30.0	36.70	48.90	45.50
		Kidney	69.00	48.8	40.88	35.05	42.01	50.01	49.22	45.66	52.00	57.88	69.00	66.50
	Tank 2	Gill	63.33	54.99	50.12	41.22	44.75	50.15	51.61	55.05	54.40	50.50	51.25	60.10
		Muscle	76.11	70.75	56.22	50.75	58.12	61.22	60.58	61.89	69.80	69.00	70.00	76.80
		Liver	72.11	75.90	50.88	50.09	52.75	68.98	67.11	59.91	69.40	70.00	71.25	75.50
		Kidney	58.12	60.21	39.54	39.81	38.05	45.88	47.82	46.22	42.40	45.00	48.90	50.50
Free Amino acids	Tank 1	Gill	9.06	3.08	4.09	3.69	4.59	5.08	5.29	5.09	5.28	5.36	6.99	9.50
		Muscle	20.80	7.04	7.74	7.58	8.88	9.09	10.99	10.28	10.26	15.90	19.50	18.99
		Liver	36.90	19.59	18.90	19.90	18.99	21.98	20.09	21.90	20.67	28.90	30.90	39.00
		Kidney	3.66	2.02	1.79	2.09	1.59	2.98	2.89	2.79	2.35	3.00	4.50	4.00
	Tank 2	Gill	16.11	14.00	10.99	11.45	11.00	14.00	14.21	14.00	14.81	14.90	15.00	15.26

	Muscle	30.0	25.98	14.22	15.85	14.21	18.52	18.02	18.91	20.92	21.00	21.50	30.15
	Liver	25.21	24.13	15.85	14.05	15.0	20.84	23.38	23.89	25.47	25.00	26.00	27.50
	Kidney	5.65	5.70	6.75	2.03	1.99	3.11	3.00	3.01	2.45	3.15	3.45	5.00

Note: Tank 1: Gangasandra Tank; Tank 2: Melekote Tank.

Table 2: Students t test calculated among the different experimental setup for the Biochemical assay. (µmol/mg)

SN	Parameter	Tank	Gill		Muscle		Liver		Kidney	
			t value	P=2.06	t value	P=2.06	t value	P=2.06	t value	P=2.06
1	Glucose (µmol/mg)	Tank 1	14.333	2.06	2.654	2.06	5.876	2.06	13.720	2.06
		Tank 2	13.989	2.06	1.473	2.06	6.362	2.06	13.389	2.06
2	Glycogen (µmol/mg)	Tank 1	3.427	2.06	5.544	2.06	6.350	2.06	0.454	2.06
		Tank 2	3.886	2.06	0.904	2.06	3.375	2.06	2.326	2.06
3	Total Proteins (µmol/mg)	Tank 1	17.535	2.06	4.267	2.06	4.383	2.06	8.832	2.06
		Tank 2	21.434	2.06	6.509	2.06	2.906	2.06	15.183	2.06
4	Total lipids (µmol/mg)	Tank 1	6.873	2.06	14.818	2.06	6.215	2.06	0.024	2.06
		Tank 2	6.254	2.06	0.083	2.06	6.600	2.06	21.056	2.06
5	Total free amino acids(µmol/mg)	Tank 1	6.056	2.06	7.053	2.06	14.894	2.06	26.069	2.06
		Tank 2	5.906	2.06	1.018	2.06	18.954	2.06	12.201	2.06

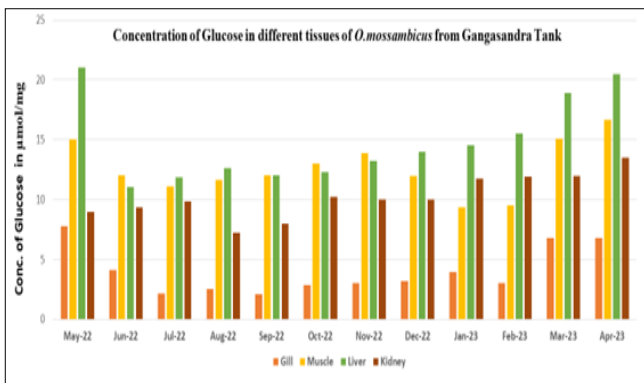


Fig 2: Concentration of Glucose in different tissues of *O. mossambicus* from Gangasandra Tank

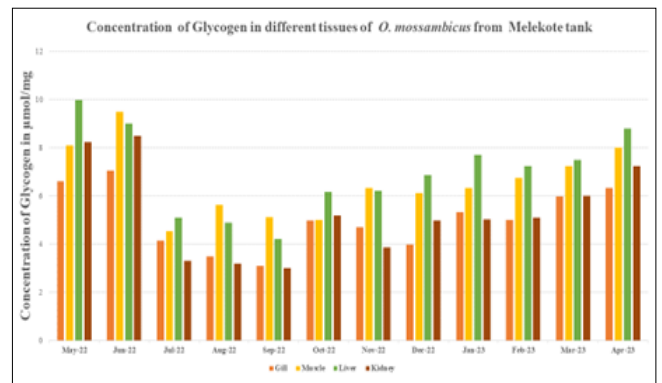


Fig 5: Concentration of Glycogen in different tissues of *O. mossambicus* from Melekote Tank

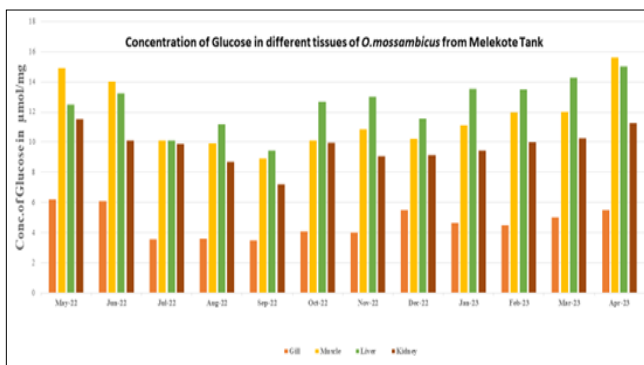


Fig 3: Concentration of Glucose in different tissues of *O. mossambicus* from Melekote Tank

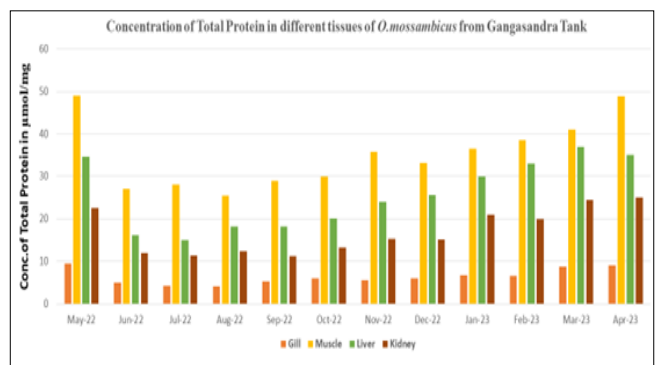


Fig 6: Concentration of Total Proteins in different tissues of *O. mossambicus* from Gangasandra Tank

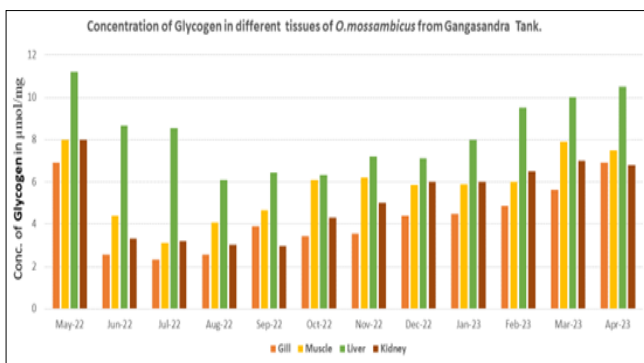


Fig 4: Concentration of Glycogen in different tissues of *O. mossambicus* from Gangasandra Tank

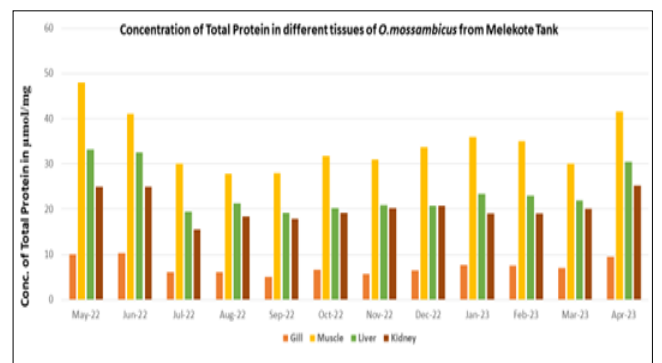


Fig 7: Concentration of Total Proteins in different tissues of *O. mossambicus* from Melekote Tank

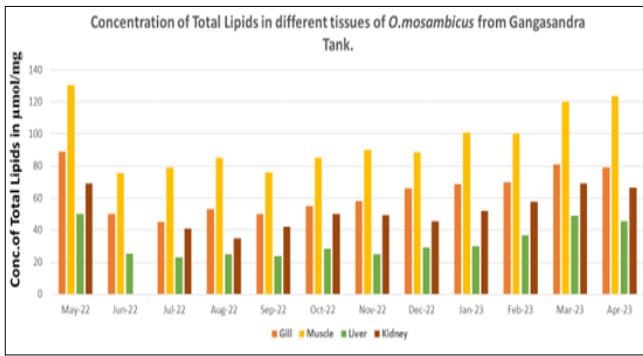


Fig 8: Concentration of Total Lipids in different tissues of *O. mossambicus* from Gangasandra Tank

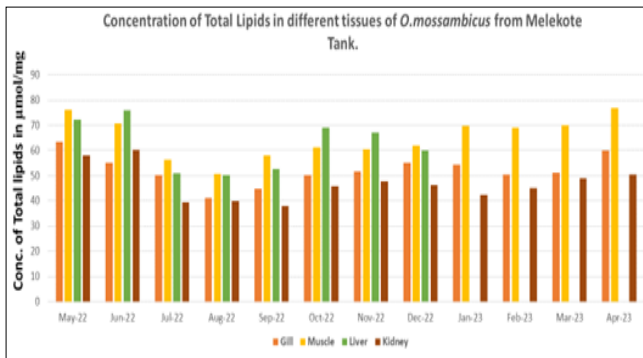


Fig 9: Concentration of Total Lipids in different tissues of *O. mossambicus* from Melekote Tank

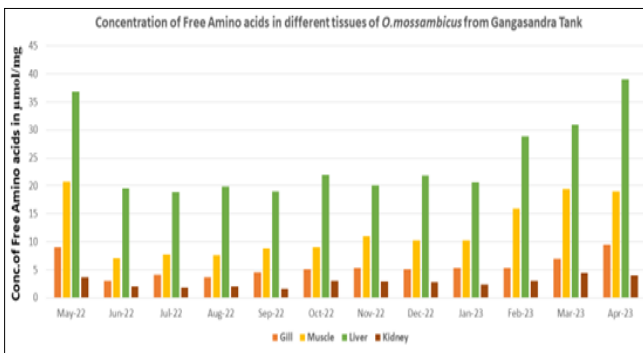


Fig 10: Concentration of Free Amino acids in different tissues of *O. mossambicus* from Gangasandra Tank

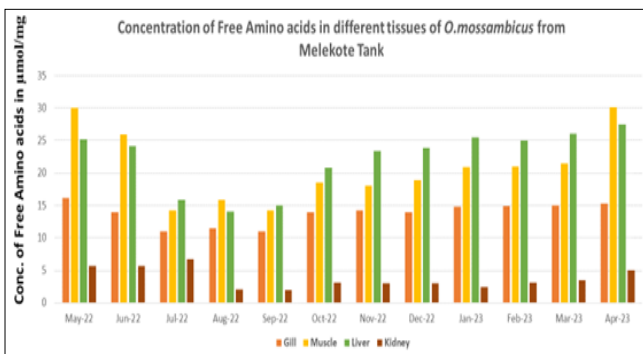


Fig 11: Concentration of Free Amino acids in different tissues of *O. mossambicus* from Melekote Tank

Conclusion

Biochemical studies of fish tissues are very important tool to study the impact of different xenobiotics and environmental conditions on fish metabolism. These studies show that protein in the fish is used to build the body during different

stages of growth. The biochemical variability is observed in gill, liver, and kidney tissues, while muscle tissues remain relatively stable. These differences highlight the sensitivity of gills and kidneys as biomarkers for aquatic environmental monitoring and demonstrate that Melekote tank fishes exhibit higher physiological stress than those in Gangasandra tank.

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