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The Dynamics of Mycological Assemblage of Mairua Reservoir, Katsina State, Nigeria

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ABSTRACT

A mycological study of some selected species of fungi in relation to fishing was conducted at Mairua Reservoir. The people of the area are mainly agriculturalist, but fishing is the major activity taking place around the reservoir. Wtaer samples were collected monthly from February-April and June-August 2020. Spatially the data were analysed using Analysis of Variance (ANOVA) and temporally using independent t-test. Findings on the mycological study shows that the yeast count range between 9.42±3.91 and 18.38±1.04 (10^6 CFU/ml) while the mold count range between 5.20±1.74 and 7.58±1.97 (10^7 CFU/ml) in various sampling sites. The order of the occurrence of fungal isolates across the various sampling sites was Aspergillus niger (30.23%), Cladosporium sp. (25.58%), Aspergillus flavus (16.28%), Penicillium sp. (16.28%) and Fusarium sp. (11.63%). The prevalence of these pathogenic fungi in the water could affect fish growth. Hence, there should be adequate sensitization to educate households and farmers bordering the reservoir on the danger associated with loading the reservoir with waste materials.

Key Words: Reservoir, Mycology, Physicochemical, Fishing, Mairua, Katsina

INTRODUCTION

Numerous physical, chemical, and biological interactions within the aquatic ecosystem determine the water quality of the aquatic environment. Aquatic animals' lives are either directly or indirectly impacted by the quality of the water (Sayeshwara, 2010). Monitoring the quality of the water is a crucial first step in protecting the environment. By conducting physical and chemical analyses that could demonstrate the existence of hazardous and biological monitoring, water quality monitoring could be evaluated (Sweidean et al., 2015). Aquatic life is known to be negatively impacted by chemical, physical, and biological pollution, which has a major impact on the biosphere (Nicolae, 2007). Despite this, micromycetes are essential to the upkeep of aquatic environments. Aquatic life and water quality are at risk from high concentrations of certain species, like molds (Scaeteanu

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et al., 2012). Mold-released mycotoxins pose a major risk to the health and welfare of fish. Among fungi genera involved in fish diseases *Aspergillus* and *Fusarium*, which can cause natural infections in freshwater species (Refai *et al*., 2010).

Fishing and aquaculture are both net water consumers, and the majority of aquaculture uses a significant amount of water in both quantity and quality (Muir and Beveridge, 2011). Boyd (2010) asserts that the culture of accepting the poor quality of fishing water poses the biggest threat to the profitable production of fish. The best conditions for the survival of fish and other biota, which are crucial to the food chain, are provided by the physiochemical and biological qualities of the water in fish ponds and reservoirs (Gupta and Gupta, 2014). Compared to a water source with poor water quality, a reservoir with good water quality is likely to produce more and larger fish (Boyd, 1998). Animal tissues become contaminated by microorganisms in the aquatic environment, making them unfit for human consumption (Ghaware and Jadihao, 2015).

MATERIALS AND METHODS

Study Area

Mairua Reservoir lies between latitude $11^{0}34'0''$N to latitude $11^{0}36'0''$N of the equator and longitude $75^{0}14'0''$E to longitude $7^{0}16'0''$E of GWM (Figure 1). It's in Katsina State's Funtua Local Government Area. Funtua is bounded to the north by Faskari Local Government Area (LGA), to the northeast by Bakori LGA, to the east by Danja LGA, to the south by Giwa LGA (Kaduna State), and to the west by Dandume LGA (Mshellia, 2010). Funtua Town's hydrological features include reservoirs like Mairua Reservoir and Gwaigwaye Reservoir, which are primarily utilized for farming and fishing. The dominant approach of fishing followed is the usage of trawl internet, in a few instance, the drag internet is likewise use. The observe vicinity is properly tired with the aid of using a community of rivers and streams. (Babsal, 1998). The vicinity falls below the Northern-Guinea Savannah Zone, with a plants together with broad-leaved species with tall tussock grasses of guinea affinities blended up with fine-leaved species of thorny bushes with non-stop quick and feathery grass cover (Onamade, 2014). According to the 2006 population estimate, Funtua LGA has a population of 255,751 (National Population Commission, 2006).Taking into account an annual growth of 3.5% from 2007 to 2019, the estimated population is 399,890.The rainy season starts in May and ends in

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early October, while the dry season lasts longer from November to April, with total rainfall varying between 600 and 90 mm2 per year.

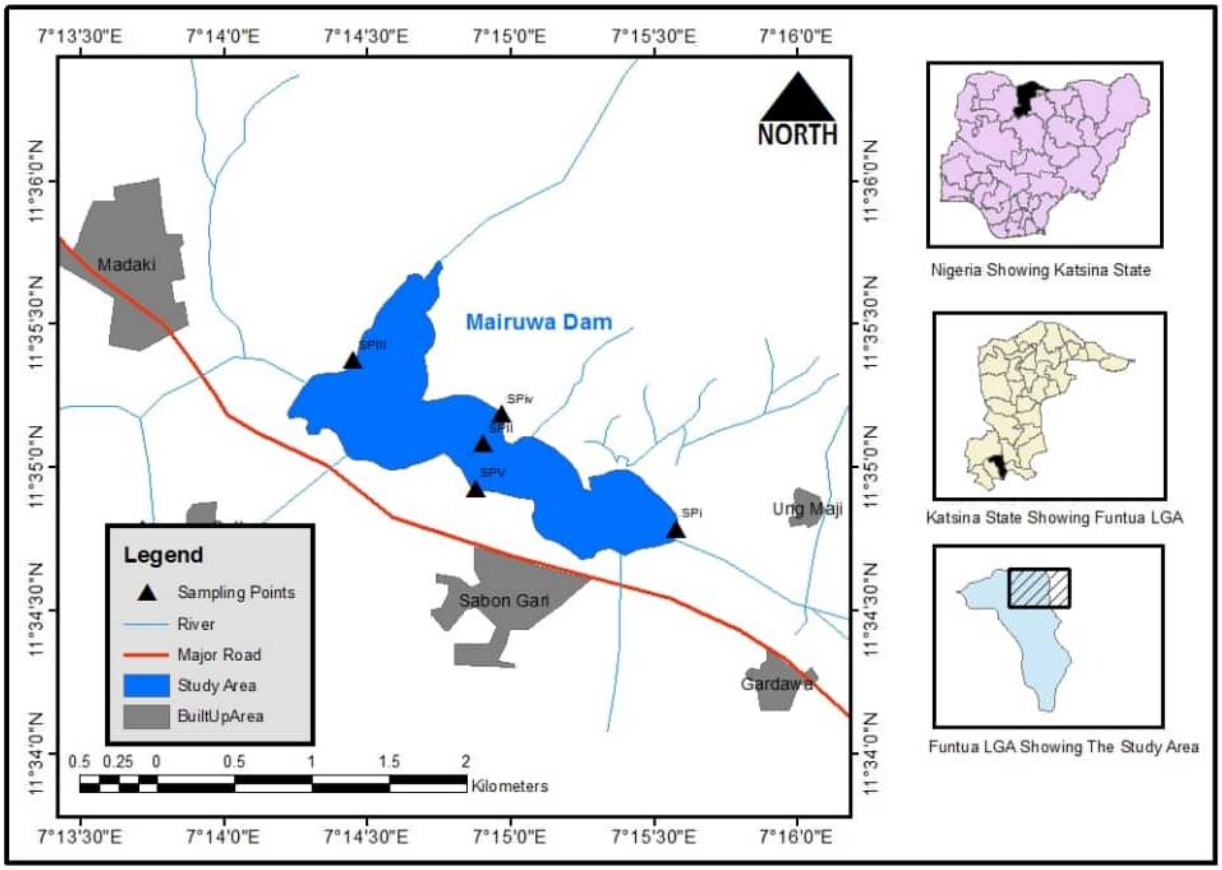

Figure 1: Mairua Reservoir and Sampling Points, Katsina State

Source: Adapted from Landused Map of Funtua LGA, 2019

Methods of Data Collection

Water Sampling Points Selections

The procedural plan called for monthly water sampling during the periods February–April and June–August 2020 (three months each in the dry and wet seasons). Water samples were collected in the morning (6:00 am–7:00 am) in five separate strata. The first strata was designated as sampling point I (SPI) and was located upstream (or at the inlet) between latitude 11035ˈ6″N. For the selected reservoir longitude 7014ˈ28″E, the second sampling point (SPII) was located midway between latitude 11035ˈ8˝N. Longitude 7014ˈ41˝E of the reservoir was selected, the third sampling point (SPIII) was selected downstream (or outlet) between latitude 11035ˈ12˝E north of the reservoir and longitude 7014ˈ15˝E, the fourth sampling point (SPIV) was selected midway between latitude 11035ˈ39˝N and longitude 7014ˈ44˝E of the reservoir, and the fifth sampling point was selected between latitude 11035ˈ0˝N and longitude 7014ˈ38˝E of the reservoir, a distance of 220 m from the center to the west between SPI, SPII, and SPIII. m between SPIV, SPII and SPV, adapted from Tasi`u and Dabo (2017), Ibrahim & Nafi (2017) and Guo et al. (2019). The coordinates of each sampling point were collected using Global Positioning System "GPS" to map the sampling points using ArcGIS 10.3. Data on the physicochemical properties of the reservoir were taken from Dabo (2021).

Samples Collection

To ensure quality control, clean bottles were also used for sampling. Samples were collected by carefully stepping into the reservoir to avoid agitating the water. The sample bottle was carefully lowered to collect the undisturbed water. Minimum effort was made to touch the edges or lid of the sample bottle.

Laboratory Technique

Furthermore, Potato Dextrose Agar (PDA) was prepared by dissolving 19.5g in 500ml of distilled water, agitated, heated autoclaved at 121°C for 15 minutes.1ml of each water samples was transferred into 9ml of sterile distilled water to obtain a concentration of 10^{-1}, followed by transfer to another test tube to obtained 10^{-2} up to 10^{-6} consecutively. The already autoclaved media were poured into a clean petridish and allowed to solidify, followed by inoculation of 1ml of each serially diluted samples from 10^{-4} to 10^{-6} and inoculated for 7 to 10 days. Prior to inoculation after 72 hours, colonies were counted and recorded as number of colonies multiply by dilution factor (Cheesbrough, 2006).

Moreover, the plates were also observed for colonial morphology for individual identification, followed sub culturing to obtain a pure culture for proper identification (Atlas of Food Microbiology, 2013).Small loop of each colonies were taken and placed on the slide followed by

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addition of lacto phenol cotton blue for proper visualization and assessment using Systematic Microscopes B1 Series

RESULTS AND DISCUSSIONS

Seasonal Variation in Yeast and Mold Counts of Water from Mairua Reservoir

There was no significant difference in yeast counts (10^6 CFU/ml) in the dry (13.06±3.72 10^6 CFU/ml) and wet (14.37±3.20 10^6 CFU/ml) seasons (p = 0.354). But there was a significant difference ($p < 0.05$) in mold counts in the dry (5.08±1.38$10^7$ CFU/ml) and wet (7.64±1.45$10^7$ CFU/ml) seasons (Table 1). Both human and fish health could be affected by mold and yeast. Water molds infections can represent the cause of losses in freshwater fish (Iqbal *et al*., 2012).

Table 1: Seasonal Variation in Yeast and Mold counts of water from Mairua Reservoir

Seasons	Yeast count (10^6 CFU/ml)	*p*-value	Mold Count (10^7 CFU/ml)	*p*-value
Dry	13.06±3.72[a]	0.354	5.08±1.38[a]	0.001
Wet	14.37±3.20[a]		7.64±1.45[b]	

Values (Means±SD) followed by different letters in the same column are significantly different at P≤0.05.

Sources: Field Survey, 2020

Variation in Yeast and Mold Counts in Mairua Reservoir across Sampling Points

In addition, the yeast count (10^6 CFU/ml) from five sampling points ranged from 9.42±3.91 (10^6 CFU/ml) recorded at SPIII to 18.38±1.04 (10^6 CFU/ml) recorded at SPI, respectively. There was a significant difference (p <0.05) in yeast count of SPI, SPII, SPIII and SPV. The occurrence of the yeast counts in the five sampling points was in the order: SPI > SPIV > SPII > SPV > SPIII According to analysis of variance, there was no significant difference (p <0.05) in mold counts (10^7 CFU/ml) across the various sampling points.

Table 2: Variation in Yeast and Mold Counts in Mairua Reservoir across Sampling Points

Counts	Sampling Sites					Mean value
	SPI	SPII	SPIII	SPIV	SPV	
Yeast count (10^6 CFU/ml)	18.38±1.04[a]	14.03±1.79[be]	9.42±3.91[c]	14.25±3.46[ae]	12.48±1.15[cde]	13.71±3.79
Mold Count (10^7 CFU/ml)	7.58±1.97[a]	5.20±1.74[a]	6.07±3.88[a]	6.53±1.42[a]	6.18±0.87[a]	6.32±2.24

Keys: SP – Sampling points: SPI- water inlet; SPII- mid-stream; SPIII- downstream; SPIV- west of the reservoir; SPV- east of the reservoir. Values (Means±SD) followed by different letters in the same row are significantly different at $p < 0.05$ (Tukey's HSD test).

Sources: Field Survey, 2020

Furthermore, the mold counts observed in SPI, SPII, SPIII, SPIV and SPV were 7.58±1.97, 5.20±1.74, 6.07±3.88, 6.53±1.42 and 6.18±0.87 (10^7 CFU/ml), respectively (Table 2). *Aspergillus* and related molds generally grow faster and are more resistant to high temperatures and low water activity than *Penicillium* spp. and tend to dominate spoilage in warmer climates (Adebayo-Tayo *et al.*, 2012).

Prevalence of Fungi Isolated from Mairua Reservoir

Also, the study shows that the isolated fungi at SPI had frequencies and percentage of occurrence of 3 (42.86%), for *Aspergillus niger*, 6 (28.57%) at SPII. The study also shows that the SPV had the least occurrence of fungal isolates: *Aspergillus niger* 1 (33.33%). It was also observed that

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Aspergillus niger had the highest frequency occurrence 13 (30.23%) in all the five samplings. Additionally,the study shows that the isolated fungi from SPI had frequencies of occurrence of 1 (14.29%) for *Fusarium* sp. The study further shows that the isolated fungi from the SPII had frequencies and percentage occurrence of 3 (14.29%) for *Fusarium* sp.

The study further shows that the isolated fungi from SPI had frequencies of occurrence of 1 (14.29%) for *Aspergillus flavus* and also isolated fungi from the SPII had frequencies and percentage occurrence of 4 (19.05%) for *Aspergillus flavus*. Moreover, the study shows that the isolated fungi from the SPII had the highest frequencies and percentage occurrence of 4 (19.05%) for *Penicillium* spp. The study shows that the isolated fungi from SPI had frequencies of occurrence of 2 (28.57%) for *Cladosporium* species. The study further shows that the isolated fungi from the SPII had frequencies and percentage occurrence of 4 (19.05%) for *Cladosporium* species (Table 3).

Table 3: Prevalence of fungi isolated from Mairua Reservoir

Fungal Isolates	**SPI**	**SPII**	**SPIII**	**SPIV**	**SPV**	**Total**
Aspergillus niger	3(42.86%)	6(28.57%)	2(50%)	1(12.5%)	1(33.33%)	13(30.23%)
Aspergillus flavus	1(14.29%)	4(19.05%)	1(25%)	1(12.5%)	0(0%)	7(16.28%)
Penicillium sp.	0(0%)	4(19.05%)	0(0%)	2(25%)	1(33.33%)	7(16.28%)
Fusarium sp.	1(14.29%)	3(14.29%)	0(0%)	1(12.5%)	0(0%)	5(11.63%)
Cladosporium sp.	2(28.57%)	4(19.05%)	1(25%)	3(37.5%)	1(33.33%)	11(25.58%)
Total	7(100%)	21(100%)	4(100%)	8(100%)	3(100%)	43(100%)

Keys: SPI (upstream), SPII (middle), SPIII (downstream), SPIV (middle towards east) and SPV (middle towards west)
Sources: Field Survey, 2020

Additionally, the finding of the current study shows a great variety of micromycetes found in the studied area as *Aspergillus* spp., *Cladosporium* spp., *Fusarium* spp., and *Penicillium* spp (Table 3). In agreement with the current findings, Njoku *et al*. (2015) identified fungi genera *Aspergillus* sp., *Penicillum* sp., *Cladosporium* sp., *Mucor* sp. and *Fusarium* sp. from pond water. *Aspergillus* and *Penicillum* species also formed the dominant group of fungi in their study. Similarly, the observation in the present study is consistent with the work of Stavrescu-Bedivan *et al*. (2016), who isolated *Aspergillus niger*, *Aspergillus flavus*, *Penicillium* sp., *Fusarium* sp. and *Cladosporium* species from Lake dominated by fishing activities. Obire and Anyanwu (2009) also noted that *Aspergillus* and *Penicillum* species are believed to penetrate into the environment through dead plant materials and remain for a long period of time. Similarly, Eze and Ogbaran (2010) cited *Penicillum* spp. as the most abundant fungi during his study on the micro- biological and physiochemical of fish pond water in Ughelli, Delta State Nigeria. In contrast to the present result, Fafioye (2011) reported *Cladosporium* spp. as the dominant fungi species.

However, this study was limited to the assessment of water quality for fishing activities and assessment on the effect of water quality on the fishes was not conducted. The reservoir water becomes an ideal culture medium for the proliferation of fungal pathogens, which are important causes of aquatic poisoning (Eze and Ogbaran, 2010). Stavrescu-Bedivan *et al*. (2016) asserts that fungal pathogens can produce diseases in aquatic organisms. Thus, fungal contaminations are influenced by environmental stressors, like poor water quality and temperature, infections being more severe in the cold season (Refai *et al*., 2010; Pachade *et al*., 2014).

The findings correspond with that of Njoku *et al*. (2015), who identified fungi genera *Aspergillus* sp., *Penicillum* sp., *Cladosporium* sp., *Mucor* sp., and *Fusarium* sp. in aquatic habitat. In addition, it has been reported that the fungal contamination of fish may constitute a public health hazard due to mycotoxin production (Hassan *et al*., 2011). The micromycetes *Aspergillus* spp. can produce superficial and subcutaneous mycoses, such as infections of the skin, nails, hair and mucous membranes and indigestion caused by swallowing contaminated water; otitis media or pneumonia, while *Fusarium* spp., *Pinicillium* spp., *Cladosporium* spp. can produce allergies and mycotoxicoses (Hageskal *et al*., 2006; Bandh, 2012).

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Table 4.14: Correlation between the mycological and physicochemical parameters of Mairua Reservoir

Parameters	Temp	EC	TDS	pH	NO_3^-	DO	Chloride	BOD	Yeast	Mold
Temp (°C)	1.000									
EC (µS/cm)	**.790****	1.000								
TDS (mg/l)	**.677****	**.491****	1.000							
pH	**-.750****	**-.885****	-0.**440***	1.000						
NO_3^- (mg/l)	-0.379*	-0.062	-0.182	0.167	1.000					
DO (mg/l)	**-.744****	**-.981****	**-.465****	**.851****	-0.011	1.000				
Cl^- (mg/l)	-0.271	**-.651****	0.092	**.617****	0.087	**.679****	1.000			
BOD (mg/l)	-.**709****	**-.873****	-0.254	**.802****	0.308	**.839****	**.669****	1.000		
Yeast (10^6 CFU/ml)	0.088	-0.068	0.200	-0.070	-0.072	0.053	0.216	0.134	1.000	
Mold (10^7 CFU/ml)	0.130	-0.329	0.161	0.253	-0.251	0.326	0.**459***	0.348	**.577****	1.000

**.Correlation is significant at the 0.01 level (2-tailed). *.Correlation is significant at the 0.05 level (2-tailed). Temp- Temperature, E.C- Electrical conductivity; TDS- Total dissolved solids; NO_3- Nitrates; DO- Dissolved oxygen; BOD- Biochemical oxygen demand.

Sources: Field Survey, 2020

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In addition strong correlation between pH and DO (*r* = 0.851), Cl^- (*r* = 0.617), and BOD (*r* = 0.802). Moreover, there is a strong correlation between DO and chloride (*r* = 0.679) and BOD (*r* = 0.839) and chloride and BOD (*r* = 0.669) and mold (*r* = 0.459) and also observed between yeast count (*r* = 0.200) and mold count (*r* = 0.161). (Table 4.14).

CONCLUSION

The presence of pathogenic fungal species can reduce fish yields, cause diseases and economic losses, and also endanger the final consumer (humans), especially if fish caught from reservoirs are not properly treated. Continuous monitoring of microbial inflows can provide fish farmers with direct information on strategies to prevent and reduce fish mortality. Furthermore, it helps to maintain good water quality in the reservoir, which is relevant for producing large and healthy fish for human consumption. Further studies should be carried out on the surface and body organs of the fish to determine the microbial load.

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