Bacterial Diversity and Abundance in Soil of Baturiya Wetland, Hadejia, Jigawa State

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A study was carried out to identify bacterial communities inhabiting the soil of Baturiya wetland, Hadejia, Jigawa state. Line transect was used to demarcate the study area randomly. The soil samples were collected using auger from four different sites to represent horizontal distribution and from a depth of 25 cm in each site to represent vertical distribution and transported to the laboratory for bacterial analyses using standard procedures. Serial dilution technique and streaking method were used to inoculate the samples on Nutrients Agar plates and incubated for 24 h at 32 ^{o}C. Colonies observed were identified using gross morphology, Gram staining reaction and biochemical tests. Bacterial counts determined using colony counter. Data obtained for bacterial counts was analyzed using Analysis of Variance with Duncan's New Multiple Rage Test used to separate significant means at 5% level. The result obtained revealed significant difference ($P \leq 0.05$) in the bacterial loads present in the four study sites. The result showed high bacterial loads ($1.64x10^{6}$cfu/g) in areas adjacent to the water bodies with high amount of debris. Five bacterial species were identified as follows: *Bacillus cereus, Bacillus thuringiensis, Escherichia coli, Klebsiella pneumonia* and *Proteus vulgaris* The result implies that the conservation status of the area is at risk as most decomposers were found deep inside the soil as the distribution is related with variations in organic carbon, clay content, and soil water characteristics at the field scale.

Keywords: Bacteria, Baturiya wetland, Diversity, Hadejia, Soil.

Introduction

A wetland referred to any geographic area with characteristics of both dry land and bodies of water (Douglas, 2009). It is a terrestrial habitat in which the soil is saturated with moisture either permanently or seasonally such areas may also be covered partially or completely by shallow pools of water (Mamman *et al*., 2023). The physico-chemical characteristics of wetland soils vary widely in accordance with the multiplicity and diversity of environmental, lithological and pedogenetic factors with which the wetlands are associated (Ofonime and Eduok, 2018). This means that wetlands are characterized by certain water regimes, plant species and soil characteristics (Winter, 2013). In most cases, the water level in wetlands called the water table is usually at above or just below the soil surface for enough time to restrict the growth of plant to those adapted to wet condition and promote the development of soil characteristics of wet environment (Mamman *et al*., 2023)

Wetland soils constitute vast, under-exploited and sometimes undiscovered ecologies in many countries, including Nigeria. The acidic nature of the wetland soils can influence soil biological community; a consequent of the acidic nature of the parent rock and the influence of the leached profile under high annual rainfall condition (Ogban *et al*., 2011; Ahukaemere *et al*., 2014). Studies carried out on selected wetlands in other parts of Nigeria have shown that, wetland soils have considerable agricultural potentials for the production of rice, maize, dry season vegetables, early yam species and cocoyam (Udoh *et al*., 2008; Ogban *et al*., 2011). Being on the transition between terrestrial and—aquatic ecosystems, wetlands are buffers for terrestrial run off thereby preventing eutrophication of inland as well as coastal waters.

Baturiya wetland, Hadejia Nguru is one of the major wetlands considered for conservation project (HNWCP, 1999) to conserve wildlife more especially the avi-fauna and tree species (International Union for Conservation of Nature/IUCN, 1980). It is essential for hydrological and ecological process and the area supports a rich floristic diversity and fauna, Wetlands act as a water filter, nutrients and sediments are abundant and that makes it possible for many species to live (HNWCP, 1999). However, despite the ecological and economical importance of Baturiya wetland in nutrient (re)cycling, reduction in global greenhouse gas emissions and new soil organic matter (SOM) models highlight the role of microorganisms in plant

litter decomposition and storage of microbial-derived carbon molecules (Yarwood, 2018) studies on the microbial communities in the area are lacking. The close proximity of oxic–anoxic conditions in this area, often created by the wetland plant roots, facilitates the simultaneous activity of aerobic as well as anaerobic microbial communities. More so, the diversity of microbial communities in Baturiya wetland is highly underexplored in comparison to soils and aquatic ecosystems (Bodelier and Dedysh, 2013). This could be attributed to the drying out of the wetland and other loss of ecosystem services due to climate change and other anthropogenic activities which present a great danger to the ecosystem biodiversity and the community livelihood options (Ujih and Ibrahim, 2020). This study therefore aimed at identifying bacterial diversity and abundance in the soil of Baturiya wetland.

Materials and Methods

Study area

The study was conducted at Baturiya wetland (Long 10º 10'and 10º 35'N and Lat 12º 35' and 12º 57' E) (Terpstra, 2003). The wetland is located 20 km South-east of Hadejia Jigawa State (Kabir, 2006) and within the Sahel savanna zone of Nigeria. The wetland covers an area of 320 km^2. It is characterized by two distinct seasons in a year, the rainy season (May-September) and the long dry season (September-April) (Terpstra, 2003). The wetland is in the list of Ramsar wetlands of international importance. The vegetation of the area is a typical Sudano-Sahelian type with total forest cover very much below national average of 14.8%. Due to both natural and human factors, forest cover is being depleted, making the area highly vulnerable to desert encroachment. The vegetation is also made up of vast grazing lands suitable for livestock production (Anonymous, 2013).

Soil sampling and experimental design

Line transect was used to demarcate four areas randomly. The soil samples were collected using auger from the four different sites to represent horizontal distribution and from a depth of 25 cm in each site to represent vertical distribution and transported to the laboratory for bacterial analyses using standard procedures in a completely randomized design with five replications. Microbial analysis of the soil samples followed the procedure described by Ameh and Kawo (2017). Serial dilution technique was used to form a stock solution. About 1 ml of the sample was inoculated onto nutrient agar using pour plate technique and incubated for 24 h at 32 ºC. Enumeration of soil inhabiting bacteria was conducted in colony forming unit per gram (CFU/g) using colony counter and identified using gross morphology, Gram staining reaction and biochemical tests. Data obtained for bacterial counts was analyzed using Analysis of Variance with Duncan's New Multiple Rage Test used to separate significant means at 5% level.

Results

The result obtained revealed significant difference ($P \leq 0.05$) in the bacterial loads present in the four study sites. The result showed high bacterial loads ($1.64x10^6$cfu/g) in areas adjacent to the water bodies with high amount of debris.

Table 1: Bacterial counts at Different Soil Locations in Baturiya wetland

Study Site	Bacterial Load (CFU/g)
A	$1.23x10^{6b}$
B	$1.15x10^{6c}$
C	$1.12x10^{6c}$
D	$1.64x10^{6a}$

N.B: Values with the same superscript(s) down a column are NOT significantly different (P≤0.05)

Table 2 showed the result for biochemical characterization of the soil inhabiting bacteria obtained from Baturiya wetland. The result revealed the presence of five bacterial species present in the soil samples identified as follows: *Bacillus cereus, Bacillus thuringiensis, Escherichia coli, Klebsiella pneumonia* and *Proteus vulgaris.*

Table 2: Biochemical characterization of Bacterial species from soil of Batutriya wetland

Gram's reaction	Cell morphology	Spore	IND	MR	VP	CIT	MOT	CAT	Organism
-ve	Short rod	None	+	+	-	-	+	+	*Escherichia coli*
+ve	Rod	+	-	-	+	+	+	+	*Bacillus cereus*
+ve	Rod	+	-	+	-	-	+	-	*Bacillus thuringiensis*
-ve	Rod(short)	-	-	-	+	+	-	+	*Klebsiellapneumoniae*
-ve	Rod	-	+	+	+	+	-	+	P*roteus vulgaris*

Discussion

The area with high bacterial count is the one closed to water body. This implies that the conservation status of the area is at risk as most decomposers were found deep inside the soil as the distribution is related with variations in organic carbon, clay content, and soil water characteristics at the field scale. More so as Pérez and Restrepo (2008) puts it, the water from such type of wetland is not bacteriologically safe for human consumption. Bacterial community in the soil of Baturiya wetland can degrade several types of organic compounds (Reyes-Sosa *et al*., 2018; Tong *et al*., 2021). The relative abundance of these degrading bacteria in the soil of Baturiya wetland provides a good surface for agricultural activities. The presence of an array of different bacterial species in the soil of Baturiya wetland have indicated the relative importance of the soil in sustaining floral diversity besides being useful in bioremediation of pollutants as described by Macaulay (2015).The presence of *Bacillus* spp in the wetland soil reported by the present study is in agreement with that of the finding of Udotong *et al*. (2008) who reported *Bacillus* spp among the predominant soil inhabiting bacteria in Eket wetland, Southeast, Nigeria. However, the bacterial species identified in Baturiya wetland differed from the ones identified by Ballesteros *et al*. (2023) from seven wetlands in Columbia. This disparity could probably be attributed to the variation in climatic conditions and edaphic factors in the study areas. Similarly, Sira *et al*. (2010) reported the occurrence of *Klebsiella* sp and *Proteus vulgaris* in soil contaminated with petroleum products. This probably shows the significance of organic compounds in the survival of these bacterial species. Therefore, organic matter-degrading bacterial species are ubiquitous in many environments (Head *et al*., 2006).

Conclusion

It was concluded that five different bacterial species were found inhabiting Baturiya wetland soil and their loads varied with locations. Areas that are mostly flooded have higher bacterial loads.

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