



COMPARATIVE ASSESSMENT OF THE EFFECTS OF TWO VEGETATION ZONE FORESTS ON SOIL MICROORGANISMS IN TARABA STATE, NIGERIA

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ABSTRACT: The study was carried out to assess, soil microbial abundance between montane and high forest zones of Taraba State, Nigeria. Two forest reserves were randomly selected out of the forest zones in Taraba State for this study; the forests were River Amboi and Ngel Yaki forest reserves for high forests and montane forest zones respectively. Two 10 kilometers line transects were established in each of the forest reserves along which 20 m x 20 m plots were laid at 2 kilometers intervals. Soil samples were systematically collected from each plot for onward transfer to the laboratory for analysis using standard laboratory procedures. Soil samples were analyzed for total bacterial count and total fungal count. Student's t-test was used to compare the soil microbial abundance between the two forest zones. There was no significant difference in total fungal count ($P < 0.05$) between Montane forest (2.150) and High forest (2.330). There was also no significant difference in total bacterial count between montane forest (115.80) and High forest (108.40). A total of six species of bacteria and seven species of fungi were identified in the two study locations.

Keywords: Microbial abundance, Total bacterial count, Student's t- test, Total fungal count

1. INTRODUCTION

Forest ecosystems are among some of the most diverse environments for the growth and development of varieties of flora and fauna. This is achieved by the influence of forests on the environment through processes such as addition of organic matter, watershed management, nutrient cycling and carbon sequestration. The forest floor provides a habitat for variety of microorganisms that play important roles in so many of the beneficial processes that make forests very important in sustaining our environment. Soil microorganisms are

important parts of forest ecosystems as they play crucial roles in organic matter decomposition as well as immobilization and mineralization of nutrients (Kennedy and Papendick, 1995). Soil microbial biomass also act important ecological indicators and are responsible for the decomposition and mineralization of plant and animal residues in the soil (Marinari *et al.*, 2006). These microbial populations in soils are of immense importance in the general functioning of ecosystems through their capacity to influence nutrient cycling in soils (Doran and Zeiss, 2000). Different environmental factors such amount and type of nutrients available, soil moisture,

aeration, pH as well as temperature affect the distribution of microorganisms in soils (Ogunmwoni *et al.*, 2008). More so, soil microorganisms are crucial in the maintenance of structure, quality and fertility of soils. Soil quality and health have been generally accepted to be influenced by the activity and other parameters of the soil microbial community (Cernohlavkova *et al.*, 2008), therefore, making them serve as early warning mechanisms of any stress situation in soil environment (Schloter *et al.* 2003). Different forest types exert different influences on soil microorganisms through direct and indirect influences on factors highlighted by Ogunmwoni *et al.*, (2008). Different forest types in different vegetation zones are likely to have different influences on soil microbes, it is on this basis that this research is aimed at investigating the influence of the two forest zone forests on soil microorganisms in Taraba state, Nigeria.

2. MATERIALS AND METHODS

2.1. Study Location

The experiment was conducted in two government forest reserves (Ngel Nyaki Forest Reserve, and River Amboi Forest Reserve) in Taraba State, Nigeria. Ngel Nyaki Forest Reserve is located towards the Western escarpment of Mambilla Plateau, lying between 1450-1600 m asl, (7° 14" N, 11° 04" E) (Akinsoji, 2013). The mean annual rainfall is approximately 1800 mm, most of which is confined between April and October followed by a dry season from November to March (Chapman and Chapman, 2001). The climate in this part of the country is relatively cool with an average temperature of 19.3 °C (Climate-Data. Org, 2013). The reserve comprises approximately 46 km² in area, 7.2 km² of which comprises one of the most floristically diverse submontane – montane forests, being rich in endemic or near endemic plant species rarely seen elsewhere. The reserve soil is volcanic and it can be reached on foot from Yelwa village after crossing the mayo Jigawal (Chapman and Chapman, 2001). River Amboi Forest Reserve (7° 14" N, 10° 38 E), is situated a few kilometers East of Baissa, Taraba State. It comprises approximately 20 km² in area of high forest, lying at 230 m above the sea level (Chapman and Chapman, 2001). The mean annual rainfall is approximately 1601 mm, most of the rainfall is confined in summer followed by winter. The average temperature is 26.8 C° (Climate-Data. Org, 2013).

2.2. Sampling method

2.2.1. Site selection

The two forest reserves were randomly selected from the list of forest reserves in Taraba state representing the two

distinct forest types. Ngel Nyaki Forest Reserve was selected in the Montane Forest Zone, while River Amboi Forest Reserve was selected in the High Forest Zone of the State. Two 10 km line transects were established across each of the selected forest reserves. 20m x 20m plots were established at interval of 2 km making a total of 5 sampling plots per transect.

2.3. Soil Sample Collection

Top soil samples were collected at 0 - 15 cm depth with the use of soil auger. Five (5) soil samples were collected per plot one at the center and four at the vertex of the plot which were mixed to form a composite sample. The soil samples were immediately stored in air tight containers and put in labelled ice packs for transportation (Ogunmwonyi *et al.*, 2008).

2.4. Microbial Analysis

The soil microbes were analyzed using serial dilution method in the laboratory as described by Cheesbrough (1993).

2.4.1. Total bacteria count

This was carried out using colony counting machine procedure for all bacterial colonies. The sample was cultured on the prepared nutrient agar that was sterilized by autoclave at temperature of 121 °C pressure at holding of 15 minutes; the media was allowed to cool down at room temperature and kept at 4 °C before culturing. It was followed by gram staining and biochemical test as described by Cheesbrough (1993).

2.4.2. Total fungi count

The total fungal count was done using filtration method, after inoculation with PDA at 37 °C for 7 days. It was filtered and slides were then prepared and fungi identified using compound microscope as used by Cheesbrough (1993).

2.5. Statistical Analyses

Student's t-test was used to compare the difference between the two forest zones of Taraba State. All statistical analysis was carried out using statistic 9.0 software.

3. RESULTS AND DISCUSSION

3.1. Abundance of soil bacteria

The results for the abundance of soil bacteria are presented in Tables 1 and 2. The results indicated that

there were no significant differences ($P < 0.05$) in the abundance of bacteria between the two forest zones. The highest bacterial count (115.800) was however, recorded in the montane forest which is not significantly different ($P < 0.05$) from the high forest zone (108.400). Various species of bacteria were isolated and identified during laboratory analysis. Six different bacteria species were identified at the two research sites (Table 3). The identified species were *Bacillus spp*, *Staphylococcus spp*, *Streptococcus spp*, *E. coli*, *Lacto bacillus* and *Pseudomonas*. Several factors such as moisture, temperature, and humidity (Skopp *et al.*, 2000) affect the abundance of soil microorganisms, mountain forests

have also been shown to have distinct distribution of microorganisms based on elevation. This mechanism of distribution is still poorly understood, but the relatively higher abundance of bacteria on the mountain forest may be due to higher moisture as a result of higher precipitation and also greater litter quantity on the forest floor. Jose and Rosa (2016) also reported significantly higher bacterial abundance in the montane forest, likewise Lin and Chiu (2016) also reported a similar finding where they reported bacterial abundance was higher at higher elevation forests. Similarly, Whitaker *et al.* (2014) had shown that, the abundance of bacteria significantly increases at higher altitudes.

Table 1: T- test Group Mean for Total Bacterial and Fungal Count for Montane and High Forest

Parameters	Vegetation Type	Mean	Standard Deviation	Standard Error
TBC	Montane Forest	115.800	17.850	5.645
	High Forest	108.400	17.070	5.398
TFC	Montane Forest	2.150	0.295	0.094
	High Forest	2.330	0.613	0.194

TBC = Total Bacterial Count

TFC = Total Fungal Count

Table 2: T-test Comparing the Means of Total Bacterial Count and Fungal Count in the Montane and High Forests

Parameters	t-test	Degree of freedom	Significant (2-tailed)
TBC	0.947	18	0.356
TFC	-0.837	18	0.414

TBC = Total Bacterial Count

TFC = Total Fungal Count

Table 3: Bacterial Isolation in the Montane and High Forests

Sample code	Organisms	G X R	Cultural Characteristics	C	CO	IND	OX	CT	N	U	TSI
HF1	<i>Bacillus</i>	Rod in chain	Large white	+	+	+	-	-	+	+	+
HF2	<i>Bacillus</i>	Rod in Chain	Large white	+	+	-	+	-	+	+	+
HF3	<i>Staphylococcus</i>	Cocci in chain	Large white	+	-	-	+	-	+	+	+
HF4	<i>E. Coli</i>	Cocci in chain	Muroid flat	+	+	+	-	-	-	+	+
HF5	<i>Bacillus subtilis</i>	Rod in chain	Muroid flat	-	+	+	-	+	-	+	-
HF6	<i>Staphylococcus</i>	Rod in chain	Muroid flat	+	+	-	-	+	-	+	-
HF7	<i>Pseudomonas</i>	Rod in chain	Flat green pigment	+	+	-	-	+	-	-	+

HF = High Forest, MF = Montane Forest, GXR = Grams Reaction, C = Catalase test, CO = Coagulase test, IND = Indole test, OX = Oxidase test, CT = Citrate test, N = Nitrate Reduction, U = Urea utilization, TSI = Triple Sugar Ion + = Present and - = Absent

Table 3 Cont'd

Sample code	Organisms	G X R	Cultural Characteristics	C	CO	IND	OX	CT	N	U	TSI
HF8	<i>Bacillus</i>	Rod in chain	Milk and white flat	+	+	+	-	+	-	-	-
HF9	<i>Pseudomonas</i>	Rod in chain	Green pigment in flat	+	+	+	-	+	-	-	+
HF10	<i>E. Coli</i>	Cocci in cluster	Flat and white	+	+	-	+	+	-	-	-
MF1	<i>Lactobacillus</i>	Rod	White	+	-	+	+	-	+	+	+
MF2	<i>Streptococcus</i>	Rod in cluster	White	+	+	-	-	-	+	+	+
MF3	<i>Staphylococcus</i>	Rod	White	+	-	+	+	-	+	+	+
MF4	<i>Bacillus</i>	cocci	Cream milky	+	+	-	-	-	+	+	-
MF5	<i>Staphylococcus</i>	cocci	Crem milky	+	-	+	+	+	-	+	+
MF6	<i>Staphylococcus</i>	cocci	Crem milky	+	+	-	+	+	-	-	+
MF7	<i>E. coli</i>	Cocci in chain	Mucoid flat	-	-	+	+	+	-	-	-
MF8	<i>Pseudomonas</i>	Rod	Green pigment	+	+	-	-	+	-	-	+
MF9	<i>Pseudomonas</i>	Rod	Green pigment	+	-	+	+	+	-	-	-
MF10	<i>Staphylococcus</i>	Rod	White	+	-	-	+	+	-	-	-

HF = High Forest, MF = Montane Forest, GXR = Grams Reaction, C = Catalase test, CO = Coagulase test, IND = Indole test, OX = Oxidase test, CT = Citrate test, N = Nitrate Reduction, U = Urea utilization, TSI = Triple Sugar Ion + = Present and - = Absent

3.2. Abundance of soil fungi

The results of the abundance of fungi (Tables 1 and 2) indicated that there were no significant differences between the vegetation zones ($P < 0.05$) in the abundance of fungi between the two forest zones. The abundance of fungi was lower at the montane forest which recorded 2.1500 while the high forest recorded higher fungal count of 2.3300 with t-value of 0.414 ($P < 0.05$). The relatively higher fungal count in the high forests compared to the montane forest is most likely due to the effect of temperature, the optimal temperature range required for the growth of fungi range between 25 - 30° C, and the mean annual temperature of high forest is 26.8° C. Fungi thrive in moist environment with high temperatures (Bisset and Parkinson, 2000), montane forest is characterized by low temperatures which are not conducive for the growth of the fungal communities. However, other researchers have given a different view on this; Jose and Rosa (2016) and Whitaker *et al.* (2014) both reported higher fungal counts on montane forests. A total of seven species of fungi were identified in this study. The identified species were *Aspergillus flavus*, *Aspergillus fumigatus*, *Aspergillus niger*, *Candida tropicalis*, *Fusarium*, *Parasitigun* and *Penicillin* (Table 4).

Table 4: Identified Fungus Species in the Montane and High Forests

Fungi	Montane forest	High forest
<i>Aspergillus flavus</i>	√	√
<i>Aspergillus fumigatus</i>	√	√
<i>Aspergillus niger</i>	√	√
<i>Candida</i>	√	√
<i>Fusarium</i>	√	√
<i>Parasitigun</i>	√	√
<i>Penicillin</i>	√	√

<i>Aspergillus flavus</i>	√	√
<i>Aspergillus fumigatus</i>	√	√
<i>Aspergillus niger</i>	√	√
<i>Candida</i>	√	√
<i>Fusarium</i>	√	√
<i>Parasitigun</i>	√	√
<i>Penicillin</i>	√	√

4. CONCLUSION

The abundance of soil bacteria and fungi has been shown in montane and high forests to have no significant difference between the two forests indicating little difference in the abundance of these soil microorganisms in the two vegetation zones of Taraba state. A total of six bacteria and seven fungal species were identified in the study.

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