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COMPARATIVE ANALYSIS OF EROSION RESISTANCE BETWEEN TERMITE MOUNDS AND SURROUNDING SOILS IN NIGERIAN DEFENCE ACADEMY, AFAKA, KADUNA STATE, NIGERIA

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ABSTRACT

A combination of chemical elements, organic matter and rainfall weaken surface rocks and render them liable to water erosion, but insignificantly affect termite mounds. The study is embarked upon to identify the concentration of Ca, Fe, Na, C, and organic matter content in termite mounds and adjacent soils to deduce the influence of resistance of termite mount to erosion. Data on the chemical elements and organic matter contents were generated through laboratory tests using heat, and an Atomic Absorption Spectrophotometer to read the values. The percentage of the chemical elements was calculated as: Instrument Reading multiplied by Extraction Volume 50ml divided by the weight of samples. The percentage of organic matter contents were determined using weight loss on ignition by an oven-dried soil sample. The set of data was analyzed by comparing the difference in magnitude of the chemical concentration and organic matter content in both the samples. The values differ insignificantly by 0.02%, 0.001%, 0.21%, 0.01%, and 0.24% for Ca, C, Fe, Na, and organic matter respectively. From the result, the resistance of termite mound to erosion is not influenced by the chemical concentration and organic matter content, but due to the maintenance of the mound by the termites, tapering end toward the atmosphere, fairly straight with steep slopes, and have dome shape that reduces effects of forceful fall of the raindrop. Further study should be conducted to determine the influence of chemical elements and organic matter on surface erosion for sustainable development of soils.

Keywords: Termites' mound, adjacent soil, erosion, rainfall, organic content, chemical composition

INTRODUCTION

The biosphere and lithosphere are components of the environment that provide space for interaction between living and non-living organisms (Certomà, 2006**)**. The Earth's crust in which termites live has a strong influence on colony size, establishment, distribution, and materials required for survival (Muvengwi, Davies, Parrini & Witkowski, 2018). Termites contribute to Earth's surface heterogeneity by containing elevated levels of soil moisture and nutrients relative to the surrounding ground cover (Muvengwi *et al*., 2018).

The mounds are constructed primarily by a mixture of organic materials and clay components which are glued by termites' feces, saliva and other secretions. The mounds are high above the ground surface protect the colony and store food, **t**hey are solid with inhibit the absorption of rain, and penetration of predators, and consist of chambers (Enagbonma & Babalola, 2019).

Weathering and erosion are the physical processes that affects bare surface covers. This is because weathering disintergrate and alters the chemical composition while erosion removes the loosed surface materials from where they belong by flowing downslope for greater stability (Areola, Irueghe, Ahmed, Adeleke & Leong, 2006). Soil erosion depends on organic matter and moisture content, compactedness, chemical and biological characteristics; and the surface must be bare and loose (Tulu, 2002). For comparison between termite mounds and adjacent soils, emphasis is placed on organic matter content and calcium (Ca), carbon (C), iron (Fe) and sodium (Na) concentrations.

Studies have been carried out on the agricultural importance of termite mounds in India (Subi & Sheela, 2020); the difference between physiochemical composition of termite mounds and adjacent soils in south-eastern Nigeria (Obi, Ibia & Isaiah**,** 2019; South Africa (Enagbonma & Babalola, 2019); importance of termites in Ghana (Arhin, Esoah & Birdie, 2019**);** and spatial distribution of termite mounds between geological substrates in African savanna (Muvengwi *et al*., 2018). None of these studies related the physical properties and chemical composition of termites' mound to water erosion.

It is observed that termites' mounds are the prominent insect solid built-up features that are higher above the ground surface, have heterogeneous Clour to the immediately surrounding soil surface, are relatively resistant to water erosion, devoid of plant growth and consist of chambers. Therefore, it is essential to identify the organic matter content and concentration of Ca, C, Fe and Na in termites' mounds and adjacent soils to deduce reasons that make mounds comparatively more resistant to water erosion than the adjacent soils.

Given these, the study is conducted in estricted areas like the Nigerian Defence Academy (NDA) Permanent Site, Afaka which is insignificantly affected by human activities like arable farming and bush burning that could alter the organic matter content and chemical composition of the soils. The study aims to identify organic matter content, and Ca, C, Fe and Na concentration in termites' mounds and adjacent soils with the view to deduce reasons that make mounds comparatively more resistant to water erosion than adjacent soils while the objectives include: to identify the magnitude of organic matter content and Ca, C, Fe and Na concentration in termites' mounds and adjacent soils; and to deduce the causes of resistance of the mounds to water erosion.

The study is important to researchers by generating concentrations of Ca, C, Fe and Na in termite mounds and adjacent soils in a restricted area from significant arable farming and bush burning that can be used for further studies. Likewise, the observable characteristics of the mounds can be used for comparative studies elsewhere. More importantly, it has deduced the causes of resistance of termite mounds to water erosion which can be used to carry out further research on how to control bare surfaces against erosion. The result is beneficial to individuals by stating that termite mounds are resistant to erosion, thus, the mound materials can be harvested for plastering of mud buildings.

The scope of the study is restricted to NDA Permanent Site, Afaka. The area is selected because it is insignificantly affected by human activities like arable farming, pastoralism and bush burning that alter the organic matter and chemical composition of soils. The study identified the magnitude of organic matter contents and concentration of Ca, C, Fe and Na in mounds and adjacent soils in 2023. Comparative analysis for differences in organic matter and chemical concentrations was adopted to deduce possible reasons that prevent mounds from significant water erosion. The physical properties investigated are organic matter while the chemical elements are restricted to Ca, C, Fe and Na interact with soil moisture and disintegrate surficial soils.

Background to NDA Afaka

NDA Afaka is approximately located between latitude $10^0$35'32.15" and $10^0$39'33.41"N of the Equator and between longitude $7^0$21'41.95" and $7^0$23'52.37"E of the Prime Meridian. The area is bounded by River Chikaji to the north, Mando-Burku High Way to the south, river Mando to the east, and Kaduna-Airport Road to the west as shown in Figure 1 (Kaduna SE, Sheet 123 SE). It has an approximate landmass of 37.77 km^2 (Google Earth, 2023.

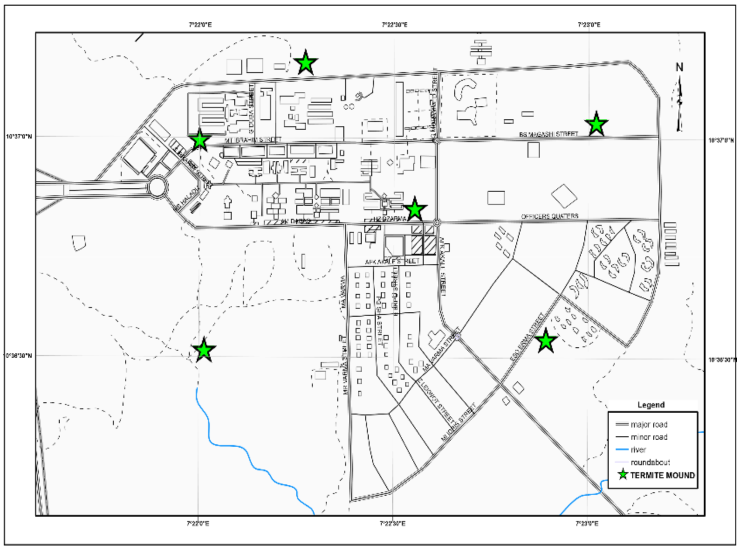

Figure 1: NDA Permanent Site, Afaka

The rainy season usually starts in April and end in October with the wettest months are July (179mm), August (259mm) and September (212mm) while the dry season is from November to April of the following year (Earth Eclipse, 2021). The average annual rainfall amount is about 998mm while the average temperature is about 29.3^0C. March is the warmest month with an average temperature of about 22.9^0C while the coldest months are August to January with about 19.3^0C. In the wet season temperature ranges from 20 to 30^0C while 25 to 30^0C in the dry season (Earth Eclipse, 2021).

The soils are made up of a mixture of sand and clay that varies from grey to black colours, are generally sticky, impervious to water in some parts, and have low litter status except of the stream basin soils (Field Observations, 2023). The highlands ranges from 618 to 650m above mean sea level while the drainages include ephemeral streams like Chikaji a tributary to river Mando (Google Earth, 2023).

The area is located within the Guinea Vegetation Zone of northern Nigeria with distinct wet and dry seasons (Mfonobong, 2020). The vegetation cover is characterized by sparse woody plants and tall annual grasses. In the dry season (December to April) all the grasses wither and dry up while some tree species like *Parkia biglobosa* shed leaves and remain dormant. The dry leaves and grasses add humus to the soil reduce erosion. The vegetation cover has been removed in some places for the construction of accommodation and training grounds that aid surface flow while other places are preserved against arable farming and fuelwood harvesting.

Landuse land cover of the area includes dense vegetation covers along the stream basins; sparse vegetation covers areas affected insignificantly by arable farming; bare rock surfaces like basement complex rocks around the primary school premises, shooting range and around spots complex; and built-up areas such as office accommodations, barracks, cadets' battalions, training grounds (parade ground, spots complex and trenches); and access roads. The conversion of vegetation cover to a man-made environment encourages surface and channel flow.

Background to Termites and Mounds

Termites are ground-dwelling social insects living in colonies that produce significant physical and chemical modifications in soils (Afolabi, Ezenwa & Dauda, 2014). The animal operates within optimum temperature from 24 to 35^0C, and may not survive at temperature above 100^0F or below 25^0F (Arhin, Esoah & Birdie, 2019). Termites make contribution in upholding soils' chemical and physical parameters by excavating and breaking down organic materials when constructing the mounds (Enagbonma & Babalola, 2019).

The mounds are constructed by a mixture of organic materials and clay components which are glued by termites' feces, saliva, and other secretions. The mounds are solid inhibit significant absorption of rain, hinder the penetration of predators, and consist of chambers that house, protect the colony and store food (Enagbonma & Babalola, 2019). Termite mounds are among the most visible animal landforms of many tropical Earth's surface which vary from about 6 to 7m deep into the ground, strongly influencing the soil properties as compared to surrounding soils (Afolabi *et al.*, 2014).

Conceptual Framework and Review of Literature

From the concept of "Environmental Ecology" there is interaction between organisms and components of their abiotic environment that are mutually reactive, affecting each other in various ways. The Earth's crust provides materials to termites for shelter building and sources of food (Ferdausi, Shaik & Tiwari, 2021; Bhosale, 2015).

A study on the nature and characteristics of termite mounds of coastal plain sands of south-eastern Nigeria used soil parameters like pH, organic matter, phosphorus, calcium, magnesium, sodium and potassium to determine the magnitude of difference between the surface and subsurface soils. The results reveal insignificant differences between some of the parameters compared, but significant variation occur in organic matter, magnesium, clay and silt (Obi *et al*., 2019**)**. Subi & Sheela (2020), in the study on the agricultural importance of termite mounds in India, stated that it improves physical and chemical characteristics of soil by breaking down organic materials. The mound soils have higher concentrations of nitrogen, calcium, phosphorus, sulfur, magnesium, pH, clay, aluminum and potassium than the surrounding soils. Application of termite mound soils improves the growth, yield and nutrient contents of crops such as okra, rice, bean, tomato, sorghum and maize (Subi & Sheela, 2020).

Results on the study on the economic importance of termites and termite-terrane in mineral exploration in Ghana reveal that termites are social insects that are used as food by various animals including man, and serve as traditional medicine in some cultures. Traditionally, some communities use termite mounds in making bricks, pots and plastering walls; and termite nests are collected and used as poultry feeds, especially for domestic fowls (Arhin *et al*., 2019). The tunnels and galleries in termite mounds have positive advantage on soil properties such as texture, water infiltration rates and nutrient contents. Termites contribute to the decomposition of dead wood which would have piled up and subdued young plants from germinating, thus, affecting plant growth for human use (Arhin *et al*., 2019). Termites contribute to soil fertility and soil formation processes, and create similar landforms on the surface of the Earth. Termites are destructive as a result of their feeding habits. They cause damage to crops, timbers in buildings and fences (Arhin *et al*., 2019).

Enagbonma & Babalola (2019), analyzed the difference between the physicochemical components of termite mounds and the surrounding neighboring soils in South Africa. The result showed that organic carbon, pH, magnesium, potassium, zinc, iron, phosphorus, copper, and clay content are more in termite mounds than in the corresponding neighboring soils. Afolabi *et al*. (2014), in study on comparative analysis of physicochemical composition of macrotermes mound material and the surrounding soils of different habitats of two termite species in Minna, Nigeria, indicate that the sand fractions of both mound materials and surrounding soils ranged from 844.90 to 871.00g kg-1; silt contents fluctuate from 48.76 to 57.10g kg-1; clay contents range from 74.87 to 98.18g kg-1; pH value varied from 6.355 to 6.677; and organic carbon contents range from 15.342 to 22.458g kg-1. The chemical characteristics of the mound materials show that the composition is close to that of the surrounding soil.

The chemical elements that react with some minerals of a rock include: sodium (Na), calcium (Ca), magnesium (Mg), potassium (K), silica (Si) aluminum (Al), iron (Fe) Resistance of soils to water and wind erosion depends on organic matter content that have strong cohesive forces between particles and the glue-like characteristics of humus. The soft and light soil particles are bonded together by some cementing agents like organic matter, and liming materials like calcium carbonate (Encyclopedia Britannica, 2015).and zinc (Zn) (Monkhouse, 1975).

The specific chemicals and organic carbon are not agents of erosion, but they influence soil structure by weakening or cementing when reacted with water from the atmosphere (Yuan, Lin, Wang, Yang, Fang, Ni, & Shi, 2023). Study on the influence of chemicals on soil indicates that excess calcium (Ca) in soils has negative effects on soil structure. It influences soil aggregation and structure formation by functioning as a bridging cation, thus, it improves the articulation of soil particles (Sun, Guo, Weindorf, Sun, Deb, Guofeng, Neupane, Lin & Raihan, 2021). Dissolved sodium in water increases erosion by 1.4 times. The chemical aids scattering of surface soil by destroying its aggregation that accelerates erosion. High sodium in soil reduces absorbency because it weakens soil structure (The Free Library, 2023). When rocks containing iron are exposed to air and water, the iron undergoes oxidation which weakens the rocks and makes them crumble. Thus, its concentration regulates weathering and erosion in soil (The American Geosciences Institute, 2018). Organic carbon is solid matter that is stored in soils that cause flocculation, improve soil structure, aeration and provide resistance to erosion, and aid soil bulk density (Hancock, Kunkel, Wells & Martinez, 2019).

Studies on the role of water in rock disintegration indicate that the chemical reaction between rock minerals and chemical components of water (H, O_2) alters the rock composition and stability that cause disintegration. Water is a solvent in which some rock minerals become soluble and the products are transported away in solution while some minerals absorb water, expand and change chemical composition leading to the disintegration of the rock (Areola *et al*., 2006).

Results of studies especially those of Obi *et al*. (2019**);** Subi & Sheela (2020); Arhin *et al*. (2019); and Enagbonma & Babalola (2019) are important by stating the physiochemical characteristics of termite mounds and adjacent soils, agricultural importance of termite mound and importance of termites. Therefore, there is a need to find out the levels of organic matter and Ca, C, Fe and Na in both termite mounds and adjacent soils to deduce the reasons that termite mounds are resistant to water erosion.

MATERIALS AND METHODS

Data required are the magnitude of organic matter and chemicals **(**Ca, C, Fe and Na**)** of both termite mounds and adjacent soils. Magnitude of the physical and chemical properties are used to deduce possible reasons that prevent mounds from significant erosion by water.

Samples of termite mounds and adjacent soils were collected from the field using hand trowel while the geometrics of the sample points were identified using a Global Poisoning System (GPS). Samples were collected in April when the land was significantly devoid of water moisture. The mound materials were collected on the surface (an areas relatively exposed to rainfall than the inner tunnels) at one metre high from the ground surface. This is to exclude the influence of splash erosion of the surface soil properties on the mounds. The adjacent soil samples were collected at 0-10cm deep. This is the soil limit that is mostly affected by water erosion, and zone of interaction between chemical and biological components of the soil. The adjacent soil samples were collected 2 metre away from the sample mounds, and on the comparatively higher slopes to remove mixing by the downslope flow.

Termite mounds were purposively selected to avoid abandoned mounds, and to ensure even distribution. Thus, active (has signs of evidence of recent constructions) termite terranes were purposively selected as shown in Figure 1. The width and height of the mounds were determined using measuring tape, and the geometrics were identified using GPS.

A total of twelve (12) samples were harvested with a spade from six (6) samples each of termites mounds and adjacent soils. The samples were labeled and kept independently in white polythene bags to inhibit adulteration of the samples. The bags were tied firmly to ensure safe conveyance to National Soil and Water Laboratory KM 2, Kaduna-Abuja Expressway, Goni-Gora, Kaduna, Kaduna State for analysis. In the laboratory, **t**he samples were crushed to obtain a homogenous samples, and sieved with a 2mm sieve to remove debris.

To determine the chemical contents of Na, Ca, Fe and C, 0.5 g of the samples was added to 100 ml glass beaker. Then 50ml of mixed acid was added (650 ml + HNO_3 + 80 ml per chloric + 20ml H_2SO4). The solution was heated on a hot plate until the volume was reduced to about 5 ml. It was allowed to cool, then rinsed with distilled water and filtered into a 50 ml volumetric flask, and transferred to a clean plastic container that was read using Atomic Absorption Spectrophotometer. The percentage of the chemical elements was calculated as Instrument Reading multiplied by Extraction Volume (50ml) divided by the weight of the sample.

The percentage of organic carbon of both the mound and adjacent soils was determined by loss on ignition in which the organic carbon is burnt off**.** Thus, measuring weight lost by an oven-dried soil sample when heated. The organic matter test was carried out to deduce water infiltration and water holding in the two sets of samples. The slope was calculated as a percentage by converting the rise (height) and run (perimeter) into the same units, then dividing the rise by the run, and multiply by 100.

The sets of data were analyzed by comparing the magnitude of the organic matter content and chemical concentration of the mound and adjacent soils. Significant difference in organic matter and chemical concentration influence articulation of soil structure. If magnitude of the compared parameters is significantly more in mound materials than in the adjacent soils suggests resistance to erosion. On the other hand, if the parameters are more in adjacent soils suggests that the resistance of mounds to erosion is not related to the parameters, but to the cementing force of the termite saliva, frass, feces, poop, and the matured reddish laterite brought from the deep interior of the Earth's crust.

RESULTS AND DISCUSSIONS

Table 1 presents a summary of the results of field observations on geometrics and sizes of sample mounds.

Table 1: Geometrics of Sample Termite Mound and Sizes

Sample No.	Geometrics			Height (m)	Width (m)	Slope (%)
	Latitude (N)	Longitude (E)	Altitude Above Mean Sea Level (m)			
1	$10^0$36'59.32"	$07^0$22'00.56"	636	2.6	6.3	80.0
2	$10^0$37'12.19"	$07^0$22'50.18"	641	2.0	3.8	100.0
3	$10^0$36'49.06"	$07^0$22'34.37"	640	2.9	6.4	90.0
4	$10^0$37'10.65"	$07^0$23'60.80"	666	1.3	3.1	80.0
5	$10^0$36'39.39"	$07^0$22'00.40"	664	3.0	6.4	90.0
6	$10^0$36'31.26"	$07^0$22'54.42"	664	2.0	4.2	95.0

Source: Field Study, 2023

From Table 1, the sample mounds are located between latitude $10^0$36'31.26" to $10^0$27'12.19"N of the Equator and between longitude $07^0$22'00.40" to $07^0$23'60.80"E of the Prime Meridian. The elevation of the spots where the mounds appear is between 636 to 666m above mean sea level. The height of the mounds is between 1.3 to 3.0m while the width differs from 3.1 to 6.4m. More importantly, the mounds rise between 80.0 to 100%.

The mounds have tapering ends, thus, they are broader at the base and narrower towards the top as shown in Figure 2. The narrower end towards the atmosphere is to reduce surface that is heated by the direct overhead Sun, and to reduce surface cover that is affected by vertical rainfall. The surface covers are rough, all the mounds have vents at the base, some have recent evidence of construction by the termites, and the mounds are fairly straight with a dome shape (Figure 2) not as the adjacent pediment that is relatively flat.

Figure 2: Termite mounds
Source: Field Study, 2023

The dome or circular shape prevents the mound from demolition by strong horizontal wind. Likewise, because of the steep slope of 80.0 to 100% (Figure 2) the mounds cannot retain significant water on the surface to weaken the mounds to aid erosion but the water flows downslope immediately it falls on the mounds. Mounds are steep and tall (Figure 2) that are insignificantly affected by erosion than the adjacent soils that are on gentle slopes.

The Magnitude of Chemical Composition in Termite Mounds and Adjacent Soils

From Table 2, the results of laboratory tests on the magnitude of the chemical composition of the sample mounds and adjacent soils indicate insignificant difference in Ca, C, Fe and Na. From the results, termite mound has more calcium (24.15mg/kg) and iron (211.65mg/kg) than adjacent soils while adjacent soils have more carbon (0.42 mg/kg) and sodium (15.13mg/kg) than termite mound. Table 2 presents results of chemical composition in termite mounds and adjacent soils.

Table 2: Magnitude of Chemical Concentrations in Termite Mounds and Adjacent Soils

Termite Mounds (mg/kg)					Adjacent Soils (mg/kg)				
Sample No.	**Calcium (Ca)**	**Carbon (C)**	**Iron (Fe)**	**Sodium (Na)**	**Sample No.**	**Calcium (Ca)**	**Carbon (C)**	**Iron (Fe)**	**Sodium (Na)**
1(a).	67.70	1.40	5725.60	316.30	1(b).	82.00	1.99	5506.60	334.20
2(a).	53.60	0.94	5627.20	281.90	2(b).	72.00	1.42	5201.30	225.90
3(a).	75.50	2.36	3091.20	302.40	3(b).	97.00	1.94	2876.50	382.30
4(a).	87.70	1.84	5718.00	261.10	4(b).	72.10	2.96	5463.80	300.30
5(a).	267.60	1.06	5697.00	275.30	5(b).	94.50	2.05	6010.70	262.00
6(a).	66.80	1.31	5598.70	237.00	6(b).	56.40	1.08	5128.30	260.10
Total	**618.90**	**8.91**	**31457.70**	**1674.00**		**474.00**	**11.44**	**30187.20**	**1764.80**
Average	**103.15**	**1.49**	**5242.95**	**279.00**		**79.00**	**1.91**	**5031.30**	**294.13**

Source: National Soil and Water Laboratory Analysis Goni Gora, Kaduna, 2023

Organic Matter Contents in Termite Mounds and Adjacent Soils

Table 3 presents results on magnitude of organic matter contents in termite mounds and adjacent soils.

Table 3: Organic Matter Content in Termite Mounds and Adjacent Soils

Organic Matter Content			
Termite Mounds		**Adjacent Soils**	
Sample No.	**Magnitude (%)**	**Sample No.**	**Magnitude (%)**
1(a).	0.81	1(b).	1.15
2(a).	0.54	2(b).	0.82
3(a).	1.37	3(b).	1.12
4(a).	1.07	4(b).	1.71
5(a).	0.61	5(b).	1.19
6(a).	0.76	6(b).	0.62
Total	**5.16**		**6.61**
Average	**0.86**		**1.10**
Difference	**- 0.24**		

Source: National Soil and Water Laboratory Analysis Goni Gora, Kaduna, 2023

From Table 3, the results on organic matter contents in termite mounds and adjacent soils indicate adjacent soil exceeds termite mounds by 0.24%. From the result, it is deduced that termite mounds are more slippery than adjacent soils because it has 0.86% concentration of organic matter than adjacent soils with 1.10%. Therefore, the mound absorbs insignificant rainfall that breaks down the surface into smaller pieces that are transported as solifluction to the pediment. Adjacent soils with more (1.10) organic matter content retain more moisture and is more liable to erosion because their permeability is higher which reduce cohesion.

Magnitude of Organic Matter Content and Chemical Concentration

Table 4 presents differences in magnitude of chemical concentration and organic matter contents in the termites' mounds and adjacent soils.

Table 4: Differences in Chemical Concentration and Organic Matter Content

	Chemical Composition (mg/kg)							Organic Matter Content (%)		
S/N	**Chemical element**	**Termite mound (mg/kg)**	**Termite mound %**	**Adjacent soils (mg/kg)**	**Adjacent soils %**	**Difference (mg/kg)**	**Difference (%)**	**Termite mounds (%)**	**Adjacent soils (%)**	**Difference (%)**
1.	Calcium (Ca)	103.15	0.10	79.00	0.08	24.15	0.02			
2.	Carbon (C)	1.49	0.001	1.91	0.002	- 0.42	- 0.001	0.86	1.10	- 0.24
3.	Iron (Fe)	5242.95	5.24	5031.30	5.03	211.65	0.21			
4.	Sodium (Na)	279.00	0.28	294.13	0.29	- 15.13	- 0.01			

Source: National Soil and Water Laboratory Analysis Goni Gora, Kaduna, 2023

From Table 4, the concentration of chemical elements and organic matter content in termite mounds and adjacent soils indicates insignificant difference. Thus, Ca, C, Fe, and Na contrast by 0.02%, 0.001%, 0.21%, and 0.01% in that order while carbon varies by 0.24%. From the result, termite mound have more calcium (0.10%) than adjacent soils (0.08%). The more calcium in termite mound than adjacent soil suggest that termite mounds are more resistant to erosion than adjacent soils. This is because calcium further articulate termite mound materials.

From Table 4, adjacent soil have more (0.002%) concentration of carbon than termite mound (0.001%). The 0.001% greater concentration of the inorganic carbon in adjacent soils than termites mound is insignificant. The insignificant (0.001%) greater difference in adjacent soil suggest that both termite mound and adjacent soils are from the same parent material from which the carbon was derived. From the result, it can be deduced that erosion is insignificantly influenced by inorganic carbon in both termite mound and adjacent soils.

From Table 4, termite mound have more (5.24%) concentration of iron than adjacent soils (5.03%). The higher (0.21%) iron concentration in termite mounds than adjacent soil suggests that the mounds are more resistant to erosion because the mounds particles are more cemented because it is constructed with more matured clays brought by termites from the inner Earth's crust that have insignificant organic matter content than adjacent soils.

From Table 4, termite mound have 0.28% of sodium while adjacent soil has 0.29%. The more (0.01%) sodicity of adjacent soil than termite mound advocates that adjacent soil is affected more by water erosion due to greater weakening of soil particles than the termite mound because of more infiltration of water into the adjacent soils that dilute the soil particles. The higher sodicity of soil the more it is subjected to erosion due to the greater solution of the particles.

From Table 4, termite mound have 0.86% of organic carbon while adjacent soil has 1.10%. From the result, the more (0.24%) organic matter in adjacent soils than termite mounds suggests that termite mounds are more resistant to erosion because it inhibit infiltration of water due to cemented mound structure than adjacent soils that allows more water infiltration that disintergrates surface soil structure that aid erosion.

The result of the study is in line with Encyclopedia Britannica (2015), that the resistance of termite mounds to water erosion is due to strong cohesion between organic matter particles that have glue-like characteristics.

CONCLUSION

From the results, the chemical concentration of termites' mounds and adjacent soils indicate insignificant differences like 0.02%, 0.001%, 0.21% and 0.01% for calcium, carbon, iron and sodium in that order while the difference in organic matter content is also minor by 0.24%. Ca and Fe are more in termite mounds while C and Na are more in adjacent soils. Likewise, organic matter is more in adjacent soil than termite mound.

From the result, it is deduced that the observed resistance of termite mounds' to water erosion is not caused by the chemical concentration and organic matter content, but due to the continuous rehabilitation of the mound by termites whenever it is affected by erosion, its narrower tapering end towards the direction of the falling rainwater and relatively higher slopes that ranges from 80.00 to 100.00%.

RECOMMENDATION

Based on the result, organic matter on the surface should be protected by inhibiting indiscriminate bush burning to articulate soil particles, and to protect the soil from splash and surface wash. More importantly, further research should be carried out on comparative analysis in organic matter content in soils on affected and restricted land management practices for sustainable development of soils on the affected land management practices.

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