

Species Composition and Physicochemical Characteristics of Termite Mounds in the New and Old Campuses of Bayero University, Kano, Nigeria

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ABSTRACT

The objectives were to collect and identify sample of termite species in Bayero University, Kano (BUK) and to determine the soil sample composition of the termite mounds in the two campuses. The study area comprises of non-academic area, academic area and staff quarters for ease of data collection. Sites were chosen sequentially based on 400m × 400m (1600m²) size to give 50% of the area. The number of mounds in each grid was counted, and the coordinates were also taken using a GPS device. The types of mound, such as mound associated with trees, buildings and on bare land were recorded. Each mound was dug, and castes obtained were identified at the Institute for Agricultural Research, Ahmadu Bello University, Zaria. Samples of soils from various mounds were collected, processed and analyzed for their physico-chemical properties. Descriptive statistics and students' t-test were used to summarize the data at $p < 0.05$. The results revealed three species of termites namely: *Macrotermes bellicosus*, *Eutermes parvulus* and *Nasutitermes* spp. The study further established that, the mound soil of *Nasutitermes* spp. contained higher calcium (3.12 cmol/kg), magnesium (2.52 cmol/kg), sodium (0.35 cmol/kg) and potassium (0.36 cmol/kg) than mound soils of both *Eutermes parvulus* and *Macrotermes bellicosus*. The termites mound soil of *Nasutitermes* spp. was found to be more fertile compared to other mound soils of termite species examined in this study. Therefore, it is recommended that termite mound soil of *Nasutitermes* spp. may be adopted by subsistence farmers for growing of crops in the study area as an alternative to the expensive inorganic fertilizers.

Keywords: Termites, Colonies, Grid method, Mound, Kano

1.0 INTRODUCTION

Termites are eusocial insects classified within the infraorder Isoptera and are distinguished by their colonial mode of life. Out of the twelve recognized termites families, Termitidae is the largest, accounting for approximately 75% of all known species (Chellappan and Ranjith, 2021). Termites play a dominant role as invertebrate decomposers of dead organic material in tropical and subtropical ecosystems (Griffiths *et al.*, 2019). Their ecological success is largely attributed to their advanced social organization and specialized capacity to exploit recalcitrant plant materials, particularly lignocellulosic substrates such as wood (Tuma *et al.*, 2020).

Termites are classified into four ecological groups: dry wood, damp wood, harvester, and subterranean termites (Kalleshwaraswamy *et al.*, 2022). Among these, only subterranean termites maintain continuous contact with the soil to meet their moisture requirements. Subterranean termites account for approximately 80% of economically significant species. In contrast to dry wood termites, which are readily dispersed across regions, most subterranean species exhibit limited distributions within their native ranges (Kalleshwaraswamy *et al.*, 2022).

Termites utilize a wide range of plant derived organic materials at varying stages of decomposition, including leaf litter, decaying wood, and soil humus. They play a

critical role in the recycling of woody and plant materials, alteration of soil properties, enhancement of soil structure and fertility, and serve as an important food resource for other organisms. Through their activities, termites redistribute soil particles and modify the mineral and organic composition of soils, as well as influence soil hydrology, drainage, and infiltration processes. In tropical ecosystems, termites are regarded as the dominant arthropod decomposers and therefore exert a strong influence on nutrient cycling and spatial nutrient distribution. Their substantial biomass contributes to their ecological dominance in tropical and subtropical environments (Stiblik, 2022). Termites are among the most abundant and efficient lignocellulose decomposing insects. Furthermore, they host nitrogen fixing microorganisms, and their foraging behavior contributes to increased soil nitrogen availability (Mullins *et al.*, 2021). Despite the ecological importance of termites in savanna ecosystems, limited information exists on the comparative distribution and soil modification effects of termite species within institutional landscapes in Northwestern Nigeria. This study aimed to assess termite species composition and evaluate the physicochemical properties of their mound soils in the new and old campuses of Bayero University, Kano. The objectives of the research are to collect and identify sample of termite species in Bayero University campuses and to determine

the soil sample composition of the termite mounds in the two campuses.

2.0 MATERIALS AND METHODS

2.1 Study Area

The Kano region ($12^{\circ}00' N$, $8^{\circ}13' E$; 481 m above sea level) lies within the Sudanian Savanna zone, which transitions into the Sahel toward the northern part of the region. The area receives a mean annual rainfall of approximately 849 mm, with the majority occurring between June and September. Climatic conditions are generally characterized by high temperatures throughout the year; however, relatively cooler conditions prevail from December to February. During this period, nighttime temperatures typically range between 14 and 16 °C (Shamsu & Safiyanu, 2017; StatsClimat.,2025).

2.2 Study Sites

The study was carried out at two locations within Bayero University Kano: the Old Campus ($11^{\circ}59' N$, $8^{\circ}28' E$) and the New Campus ($11^{\circ}58' N$, $8^{\circ}27' E$). The New Campus is predominantly characterized by grassland savanna vegetation and experiences relatively low levels of disturbance, with only scattered cultivation activities. In addition, it covers a larger land area compared to the Old Campus (Fig. 1). In contrast, the Old Campus is highly developed, with extensive physical infrastructure and a greater diversity of exotic tree species (Fig. 2).

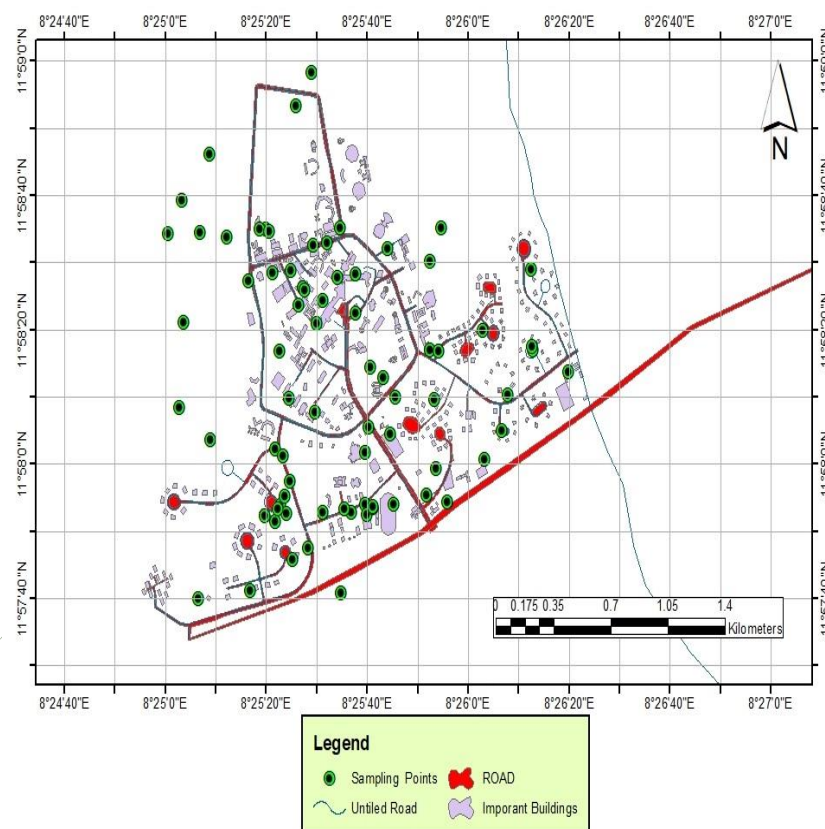


Fig. 1: Distribution Map of Termite Mounds in BUK New Campus.

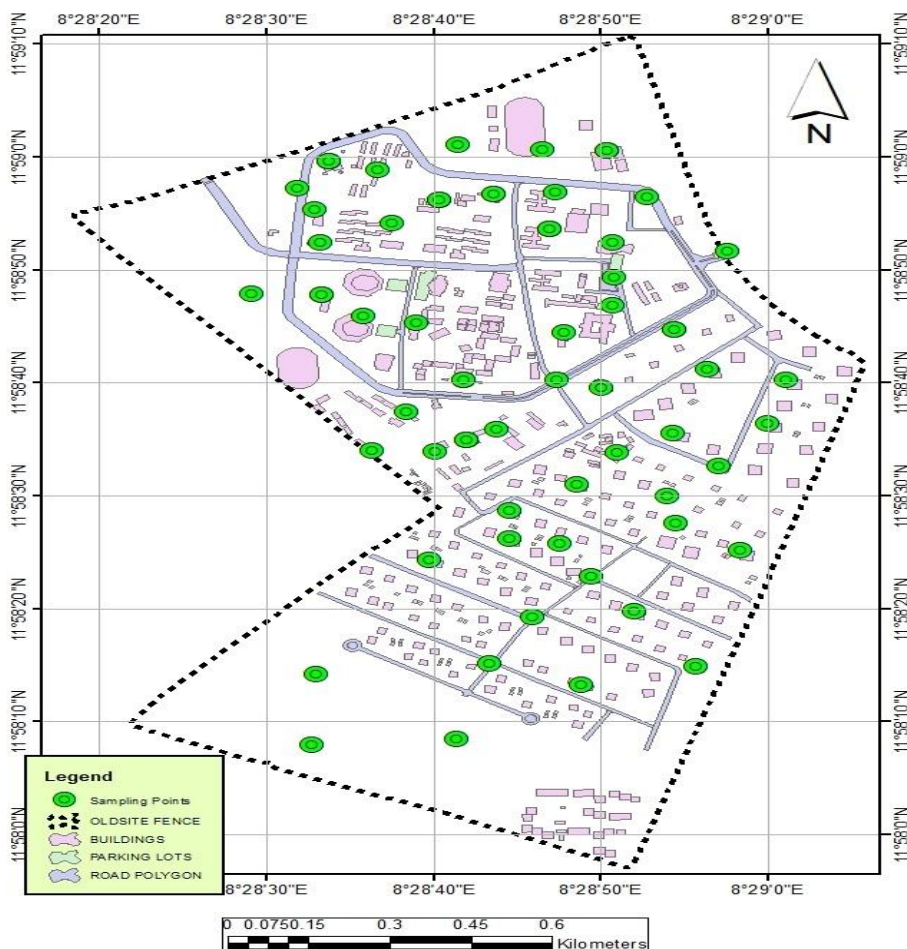


Fig. 2: Distribution Map of Termite Mounds in BUK Old Campus.

2.3 Termites Survey

The survey of termites in the area was carried out using grid methods as described by (Royal Geographical Society, 2023).

2.3.1 Grid Method

Study sites were chosen sequentially based on $400\text{m} \times 400\text{m}$ (160000m^2) to give 50% of the area. Sample size was determined, and study plots (sampling stations) were selected. The BUK New Campus (31) sampling stations were selected. The same procedure was applied for selecting grids in Old campus (16). The number of these stations selected reflects relative size of accessible area in each site. Observer would walk from one end of the grid to another to scan the area. The number of mounds in each grid were counted and recorded as well as the type of mounds; mounds associated with trees and buildings and on bare land were counted and recorded. The number of mound per grid varied depending on the location. The types of mounds were dug using a digger.

2.4 Termites Collection and Identification

A grid was overlaid on a map of the study area, and coordinates for sampling points were generated using random number tables. Sample collection was conducted as close to these locations as practicable. Termites were collected by hand and transported to the Multipurpose Laboratory, Bayero University, Kano, where they were separated from debris. Worker and soldier castes (major and minor) were sorted and preserved in 80% ethanol. Specimens were examined using a real-time imaging dissecting microscope at the Insect Museum of the Institute for Agricultural Research, Ahmadu Bello University, Zaria. Termite identification was based on the taxonomic descriptions of Ackerman *et al.* (2009) and Anantharaju *et al.* (2018).

2.5 Soil Sample Collection and Analysis

Mound soil samples were collected from three randomly selected locations on campus. The study focused exclusively on comparing mound soils among the three termite species, with one soil sample collected per species and without including surrounding non-mound

soils. Samples were obtained from three distinct types of termite mounds: those associated with trees, buildings, and bare land. Each mound was excavated to a depth of approximately 30 cm. All samples were labeled, numbered, and dated in accordance with established procedures (APHA, 2005). Soil analyses were conducted in the Soil Laboratory of the Department of Soil Science, Modibbo Adama University, Yola, Adamawa State, Nigeria, following standard analytical procedures. The gravel fraction (>2 mm) of each sample was determined gravimetrically after air-drying and sieving through a 2 mm mesh. Particle-size distribution was determined using the Bouyoucos hydrometer method, as described by Gee and Bauder (1986). Soil pH was measured in water at a soil-to-solution ratio of 1:2.5 using a Pye Unicam Model 290 MK pH meter. Organic carbon was determined by the Walkley–Black acid dichromate wet oxidation method (Nelson & Sommers, 1986). Total nitrogen was analyzed using the standard macro-Kjeldahl method (Bremner & Mulvaney, 1982). Available phosphorus was determined using the Bray-1 extraction

method (Bray & Kurtz, 1945). Exchangeable bases (Ca^{2+} , Mg^{2+} , K^{+} , and Na^{+}) were extracted with neutral (pH 7.0) ammonium acetate (NH_4OAc) and quantified following the procedure described by Anderson and Ingram (1993).

2.6 Data Analysis

Data collected were analysed using descriptive statistics and students' t-test were used to summarize the data at $p < 0.05$.

3.0 RESULTS

Among the collected samples, three species of termites were found and identified viz., *Macroterme bellicosus*, *Eutermes parvulus* and *Nasutitermes* spp. The result of the species of termites found in the study area is shown in Table 1. Termites were identified using an identification key compiled by the Institute for Agricultural Research, Ahmadu Bello University, Zaria. Species level identification was based on the morphological characteristics of body parts, as illustrated in the photographs below.

Table 1: Composition of Termite Species in New and Old Campus of Bayero University, Kano

Species	Campus	
	New (%)	Old (%)
<i>Macroterme bellicosus</i>	19 (25.33)	27 (42.19)
<i>Eutermes parvulus</i>	17 (22.67)	14 (21.88)
<i>Nasutitermes</i> spp	39 (52.00)	23 (35.94)

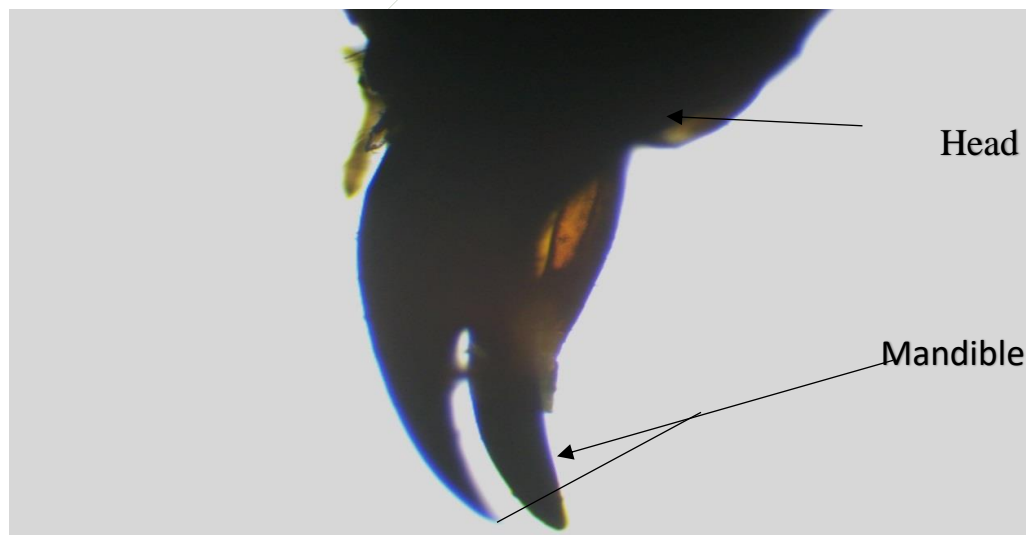
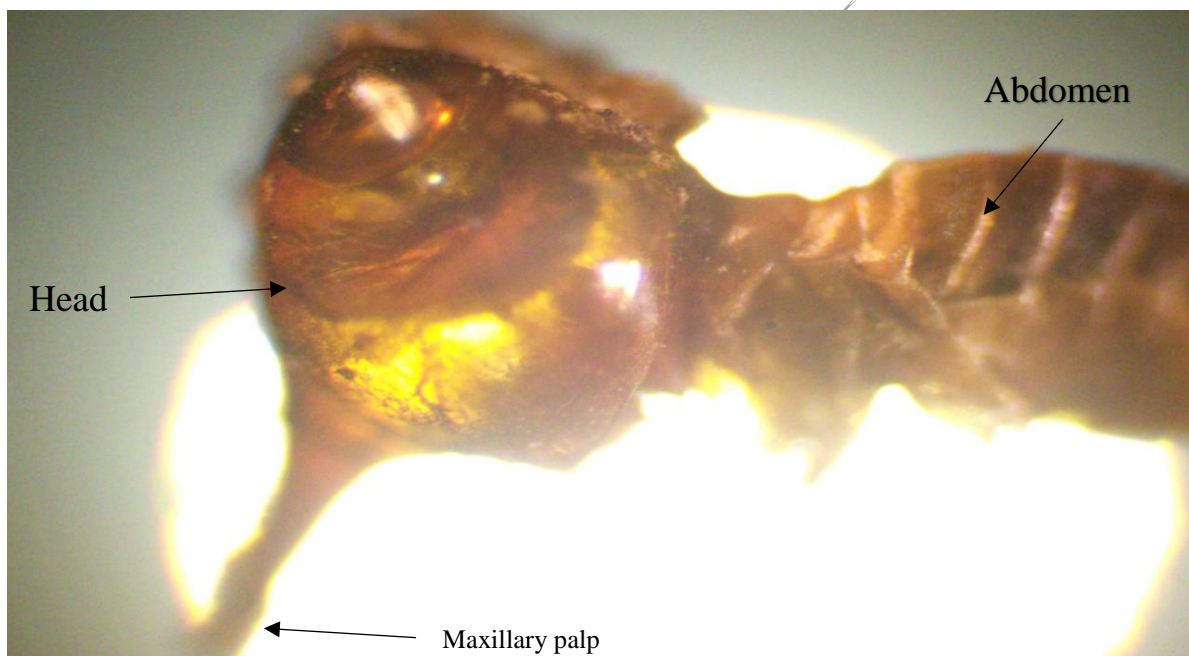


Plate I: Head of *Macroterme bellicosus* soldier termite

Plate II: Head of *Eutermes parvulus* soldier termitePlate III: Head of *Nasutitermes* spp. soldier termite

3.1 Distribution of Termite Species in the Study Area

During the sampling, 505 termites were collected where 347 samples had soldiers and 158 samples had workers. The total number of termite mounds found in the study area is 139 where 75 mounds in new campus and 64 mounds in old campus (Fig. 4). The distribution of termite mounds in non-academic area of new campus

showed that a total of 29 mounds were found (Fig. 5), those attached to trees were 15 (51.72%), those on bare lands were 14 (48.28%) and those attached to buildings were 0 (0.00%). Also, in the old campus, the distribution of termite mounds in non-academic area showed that a total of 26 mounds were found (Fig. 5), those attached to trees were 12 (46.15), those on bare lands were 11

(42.31%) and those attached to buildings were 3 (11.54%).

The distribution of termites mounds in academic area of new campus showed that a total of 26 mounds were found (Fig. 5), those attached to trees were 8 (30.77%), those on bare lands were 17 (65.38%) and those attached to buildings were 1 (3.85%). While in old campus, the distribution of termite mounds in academic area showed that a total of 15 mounds were found (Fig. 5), those attached to trees were 5 (33.33%), those on bare lands were 9 (60.00%) and those attached to buildings were 1 (4.35%).

The results for staff quarters area of new campus showed that a total of 20 mounds were found (fig 5), those attached to trees were 12 (60.00%), those on bare lands were 8 (40.00%) and those attached to buildings were 0 (0.00%). In contrast to old campus, the total number of termite mounds found in staff quarters were 23 (Fig. 5), those attached to trees were 19 (82.61%), those on bare lands were 3 (13.04) and those attached to buildings were 1 (4.35%).

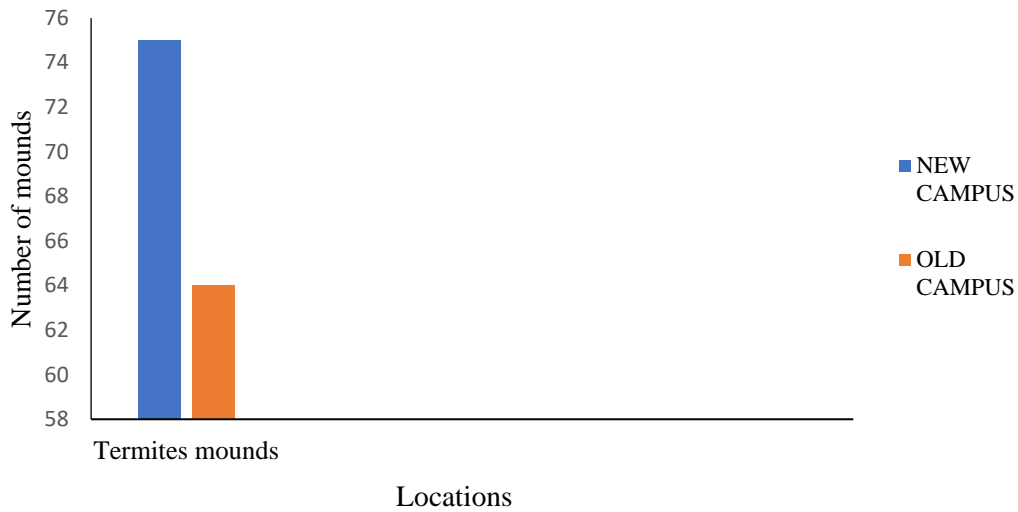


Fig. 4: Total Distribution of Termite Mounds in the Study Area

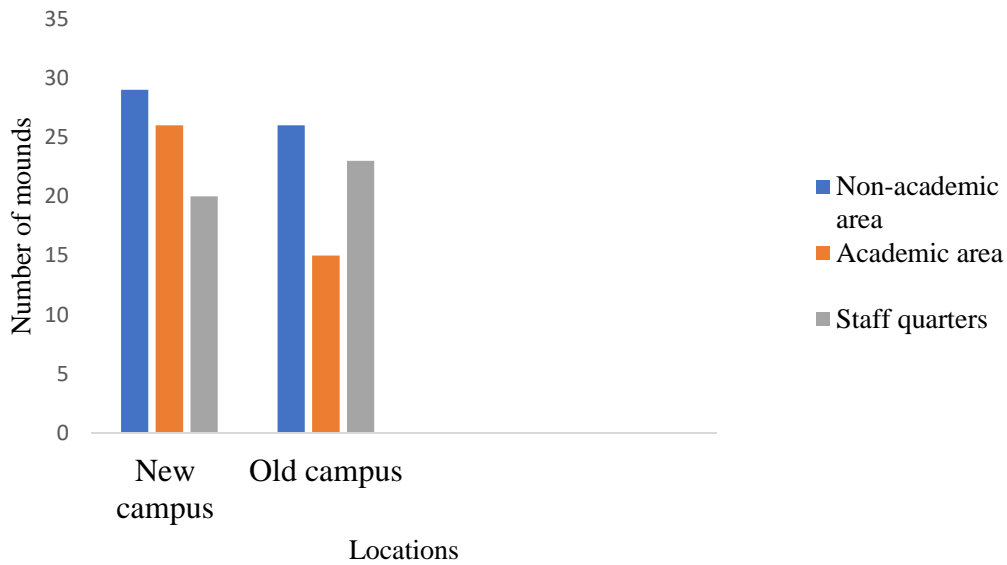


Fig. 5: Distribution of Termite Mounds in New and Old Campus

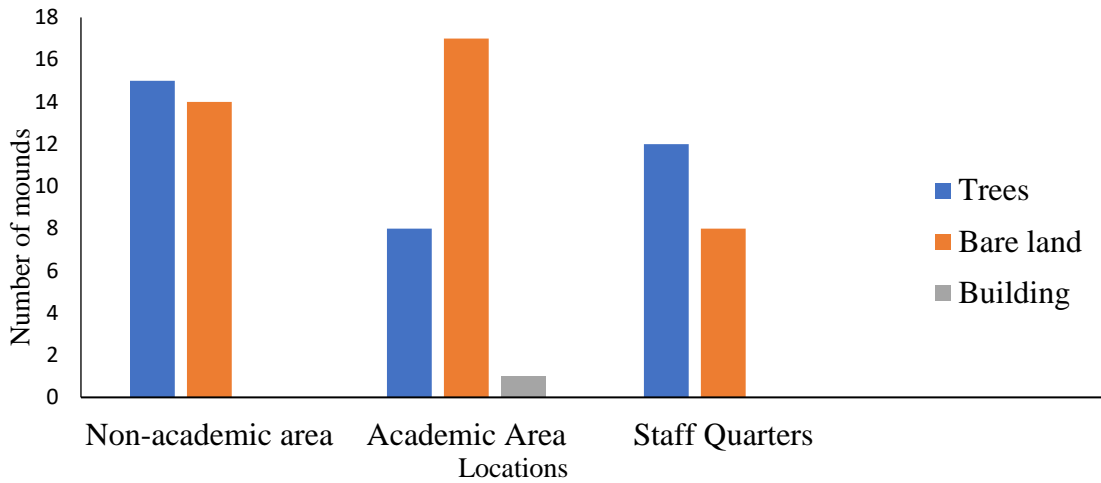


Fig. 6: Distribution of Termite Mounds in New Campus

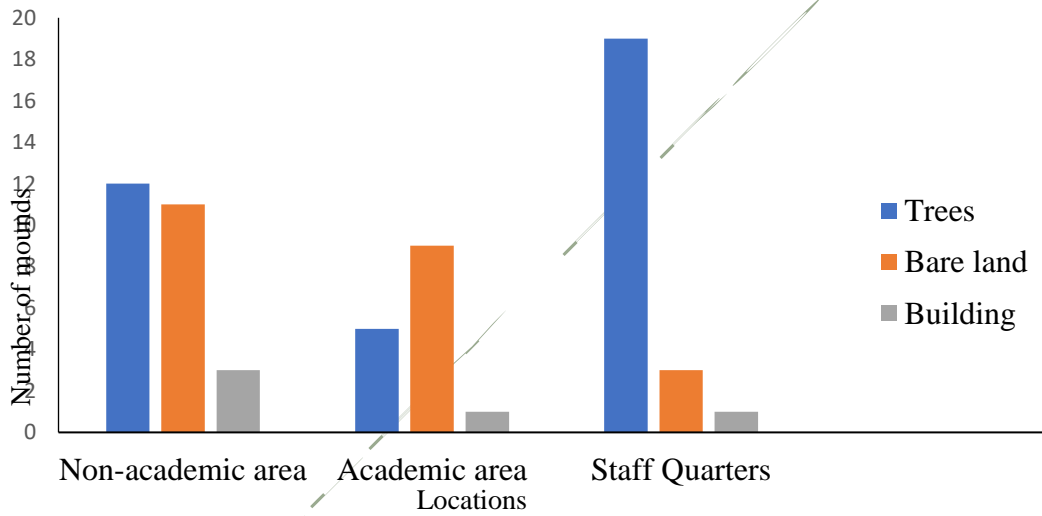


Fig. 7: Distribution of Termite Mounds in Old Campus

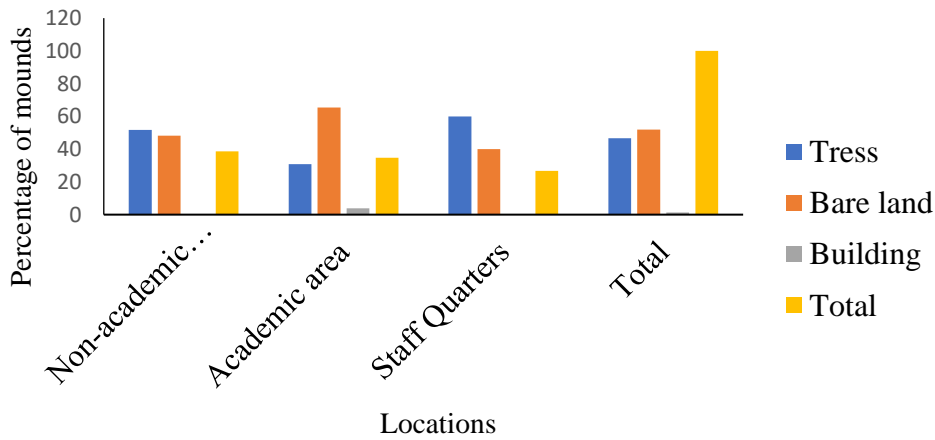


Fig. 8: Overall Distribution of Termite Mounds in New Campus (%)

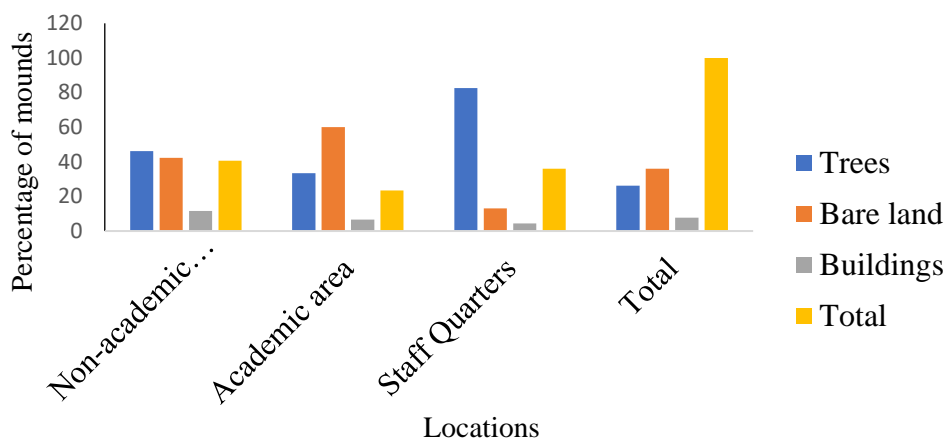


Fig. 9: Overall Distribution of Termite Mounds in Old Campus (%)

Table 2: Mean Distribution of Termites in New and Old Campus

Location/Site		New Campus	Old Campus
Location	Non-Academic	9.67a	8.67a
	Academic	8.67a	5.00b
	Staff Quarters	4.00b	7.67a
Site	Trees	11.67a	12.00a
	Bare land	10.33a	7.67b
	Building	0.33b	1.67c

3.2 Physicochemical Properties of Termite Mounds Soil

The physicochemical properties of the termite species mound soils are shown in Table 4. The sand fractions of the mound soils ranged from 56.80 to 70.80%. The mound soil of *Nasutitermes* spp. gave significantly higher values of sand fractions than both *Macrotermes bellicosus* mound soil and *Eutermes parvulus*. The silt contents ranged from 11.20 to 19.20%. The clay contents ranged from 10.00 to 24.00%. *Eutermes parvulus* mound soil gave the highest clay content. The pH of the mound soil ranged from 6.18 to 6.70 with the *Macrotermes bellicosus* mound soil giving the highest value. Organic carbon contents ranged from 8.28 to 13.87 g/kg. *Nasutitermes* spp. mound soil gave the highest value of organic compound (13.87 g/kg). The present data indicate that electrical conductivity (EC) was 0.20 dS/m in soils from *Eutermes parvulus* mounds and 0.26 and 0.24 dS/m in soils from *Macrotermes bellicosus* and

Nasutitermes spp. mounds, respectively. Total nitrogen concentrations ranged from 0.10 to 0.15%. The organic carbon and organic matter contents of *Nasutitermes* spp. mound soils were substantially higher than those of *Eutermes parvulus* and *Macrotermes bellicosus*, with values ranging from 10.97 to 18.92 g/kg and 8.28 to 14.27 g/kg, respectively. Calcium and magnesium concentrations ranged from 1.96 to 3.12 cmol/kg and 0.76 to 2.52 cmol/kg, respectively, with the highest Ca^{2+} and Mg^{2+} levels observed in *Nasutitermes* spp. mound soils. Potassium and sodium concentrations ranged from 0.23 to 0.36 cmol/kg and 0.22 to 0.35 cmol/kg, respectively. Overall, mound soils of *Nasutitermes* spp. exhibited numerically higher concentrations of calcium, magnesium, and potassium, as well as significantly greater sand fractions and organic carbon contents, compared with mound soils of *Eutermes parvulus* and *Macrotermes bellicosus*.

Table 3: Textural and Physicochemical Properties of Termite Mounds Soil in the Study Area

Parameters	<i>Eutermes parvulus</i>	<i>Macrotermes bellicosus</i>	<i>Nasutitermes spp</i>	
Sand (%)	56.80	68.80	68.80	70.80
Silt (%)	19.20	11.20	11.20	19.20
Clay (%)	24.00	20.00	20.00	10.00
TC	SCL	SCL	SCL	SL
pH	6.46	6.70	6.70	6.18
EC (dS/m)	0.20	0.26	0.26	0.24
OC (g/kg)	10.97	8.28	8.28	13.87
OM (g/kg)	18.92	14.27	14.27	23.90
Total N (%)	0.12	0.10	0.10	0.15
AVP (mg/kg)	6.30	9.10	9.10	7.00
Ca ²⁺ (cmol/kg)	2.28	1.96	1.96	3.12
Mg ²⁺ (cmol/kg)	1.72	0.76	0.76	2.52
K ⁺ (cmol/kg)	0.23	0.28	0.28	0.36
Na ⁺ (cmol/kg)	0.22	0.26	0.26	0.35
TEB (cmol/kg)	4.45	3.26	3.26	6.37
TEA (cmol/kg)	2.20	2.00	2.00	2.60
ECEC (cmol/kg)	6.65	5.26	5.26	8.97
PBS (%)	66.91	62.00	62.00	71.00

Key: TC= Total carbon, SCL= Sandy Clay Loam, SL= Shrinkage limits, TEB= Total Exchangeable Bases, TEA= Total Exchangeable Acidity, ECEC= Effective Cation Exchange Capacity, PBS= Percentage Base Saturation

4.0 DISCUSSION

The present study identified three termite species within the study area: *Macrotermes bellicosus*, *Eutermes parvulus*, and *Nasutitermes spp*. These species are characteristic of savannah ecosystems, which aligns with earlier reports that associate them with savannah vegetation zones (Adeoye, 2023). Among the species recorded, *Nasutitermes spp*. was the most abundant, followed by *Macrotermes bellicosus*, while *Eutermes parvulus* was the least represented. The higher occurrence of *Nasutitermes spp*. (44.6%) may be linked to the prevailing vegetation structure and soil conditions within the campuses, which likely provide suitable habitat and nesting materials. Vegetation type and soil chemical composition are known to influence termite distribution and mound-building activity (Cheik *et al.*, 2019; Fagundes *et al.*, 2021). The dominance of mound-building termites in the study reflects their ecological adaptation to savannah environments. Termite mounds have been widely reported to modify surrounding soil properties, thereby creating localized zones of altered fertility (Bera *et al.*, 2020). Differences in mound abundance between the new and old campuses may further reflect variations in land use, disturbance level, and vegetation cover.

Particle-size distribution showed clear interspecific differences in mound soil texture. Soils from *Eutermes parvulus* mounds exhibited higher clay content compared to those of *Macrotermes bellicosus* and *Nasutitermes spp*. This clay enrichment may result from selective particle utilization during mound construction, particularly for improving water retention and structural stability. Clay particles enhance cohesion and water-

holding capacity, properties essential for mound durability (Ezé *et al.*, 2020). In contrast, *Nasutitermes spp*. mound soils recorded relatively higher sand content, while silt fractions were comparable between *Eutermes parvulus* and *Nasutitermes spp*. These variations suggest species-specific preferences in construction materials, possibly influenced by ecological requirements and surrounding soil characteristics. Mound physicochemical properties may also be affected by factors such as mound age, developmental stage, and local pedogenetic processes.

Organic carbon (OC) and organic matter (OM) contents were notably higher in *Nasutitermes spp*. mound soils than in those of the other two species. Elevated organic content in termite mounds has been widely attributed to termite feeding activity, incorporation of humified materials, and deposition of saliva and fecal matter (Chisanga *et al.*, 2020; Lou *et al.*, 2022). The digestive processes of termites chemically and biologically transform ingested material, contributing to the stabilization of organic matter within mound soils (Zavarzina *et al.*, 2021). Through litter fragmentation and stimulation of microbial activity, termites accelerate organic matter decomposition and enhance aggregate formation, which improves soil structure and moisture retention. The relatively lower OC and OM values observed in *Eutermes parvulus* and *Macrotermes bellicosus* mound soils suggest differences in feeding habits or construction materials among species.

Phosphorus concentration was highest in *Macrotermes bellicosus* mound soils, indicating possible variation in the source materials used during mound construction. Termite feeding behavior and selective transport of soil

particles from deeper horizons can significantly influence nutrient accumulation, particularly phosphorus (López-Hernández, 2023). The observed nitrogen levels also varied among species, with *Nasutitermes* spp. recording the highest concentration. Nitrogen plays a vital role in plant growth and ecosystem productivity (Shrivastava *et al.*, 2020), and its variation among mound soils further supports the view that termite activity contributes to localized nutrient enrichment.

Electrical conductivity (EC) values of all mound soils were low and well below the threshold for salinity problems in agricultural soils (Vittori Antisari *et al.*, 2020). This suggests that the mound soils are not saline and would not pose limitations to crop growth. Exchangeable bases (Ca^{2+} , Mg^{2+} , K^{+} , and Na^{+}) were generally low across the study sites, consistent with the nutrient status of tropical savannah soils in West Africa (Oku *et al.*, 2021). However, relatively higher concentrations of calcium, magnesium, and potassium were observed in *Nasutitermes* spp. mound soils, reinforcing their comparative fertility advantage.

Overall, the findings confirm that termite species differ in their influence on soil texture and nutrient composition. Among the species examined, *Nasutitermes* spp. demonstrated greater potential for soil enrichment, particularly in terms of organic matter and exchangeable bases. These results highlight the ecological significance of termite activity in modifying soil properties and suggest potential applications of termite mound soils, especially those of *Nasutitermes* spp., as natural soil amendments in low-fertility savannah environments.

5.0 CONCLUSION

The study documented three termite species within the study area, with *Nasutitermes* spp. emerging as the most abundant and widely distributed. This dominance suggests strong ecological adaptation to the prevailing environmental conditions. Importantly, the physicochemical assessment of mound soils revealed notable nutrient enrichment, particularly in organic carbon (OC), calcium (Ca), and magnesium (Mg).

6.0 RECOMMENDATIONS

The university should adopt an integrated termite management approach that safeguards infrastructure. Majority of the university land is non-academic area therefore the university should make good use of the parts that are infected with termite mounds for agricultural purposes. This will go a long way to boost food security. It is recommended that smallholder farmers in the study area adopt termite mound soil from *Nasutitermes* spp. as a sustainable alternative to conventional inorganic fertilizers.

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