ASSESSMENT OF PHYSICAL AND CHEMICAL PROPERTIES OF THE TERMITARIA ACROSS SOKOTO-RIMA RIVER VALLEY, EAST OF KWAKWALAWA VILLAGE, DUNDAYE DISTRICT OF WAMMAKO L.G.A, SOKOTO STATE

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Abstract

In this study, Termitaria, the termite mounds in the study area have been observed to be common within the fadama lands. By virtue of several literatures that have indicated that the physical and chemical fertility qualities of mounds are often higher than the surrounding upland soils. Some physical and chemical parameters of the mounds were therefore, examined and compared with the latter. In the light of this objective, soil samples of the mounds and those of the upland soils were collected and analysed. The results further confirmed that the fertility qualities of the physical and chemical parameters of the mounds were higher than that of the upland farms. The mounds soils are therefore, recommended to be harnessed as organic fertilisers to raise the fertility status of the upland farmlands.

***KEY WORDS**: Termitaria, Fertility, Fadama land, Upland*

Introduction

Termites build mounds called Termiteria which have colonised the western flank *fadama* lands bisected by the artery road across the rivers Sokoto and Rima linking the permanent site of Usmanu Danfodiyo University, Sokoto when approaching the campus from the west of Sokoto metropolis. The mounds were developed on hydromorphic soils (*fadama)* and arranged naturally in series at an almost regular interval from the first gate of the permanent site of the campus to Kwakwalawa village through the valley and bridges of rivers Sokoto and Rima channels respectively. Their presence are substantially different from the surrounding landscape, especially during the dry season when the grasses are nearly absent and thus, very visible. The mounds are currently redundant, occupying arable land use space unutilised for cropping purposes. They are indeed, unharnessed by the farmers as if it has no fertility value as part of the land resources. This justifies the need to study these termite mounds.

Again, Termiteria are the Termite mounds built by the Termites. Termites are social insects because they have some degree of social organisations which construct subterranean nest. They are small insects like an Ant but called white Ant found chiefly in tropical area just as earthworms are in abundance in temperate areas, they do a lot of damage by eating wood (Young, 1976; Isirimah *et al;* 2003). Termite constitutes the insect order "Isoptera" (Vines and Rees, 1971). Their feeding habit vary between species and their diets largely consists of living and dead woods such as fallen trunk timbers for buildings; living and dead herbaceous vegetable matter and humus as well as sucking the juice of fruits within them (Vines and Rees, 1971; Isirimah *et al*; 2003). The main constituent of wood is cellulose with small quantities of sugars and nitrogenous substances. The mounds are therefore, composed of fabric of re-packed soil particles often mixed with excreta. They are biologically distinctive in their ability to digest polysaccharides including cellulose and in some species lignin (Vines and Rees, 1971). According to Young (1976), some of the characteristics of termite makes the mounds possess higher qualities of fertility than the surrounding soils (upland); more clay and less coarse sand within the mounds, greater structural aggregate, better root growth because of the constant mixing of the upper 1.5m which counteract profile differentiation; the pH is nearly higher by one unit or more, the colour is different; higher content of carbon, nitrogen and exchangeable bases, especially calcium. In addition, calcium carbonate is claimed to be in concentration of several percentages forming concretions as explained by less downward water movement within mounds than in the surrounding soils (Watson, 1969). This explains why carbonates are not leached away.

In the light of the above listed scientific evidences; to what extent is it certain that the net effects of termites on the soil profile are agriculturally beneficial? Therefore; this study aims at assessing the highlighted physical and chemical properties of termite mounds with a view towards the possibilities of harvesting them as organic fertilisers on the rain fed upland arable farmlands.

Materials and Methods

Location and Morphological Characteristics

The location of the concentrated Termiteria are the Termite mounds under study. They are approximately between latitudes 13° 04′ 05′ and 13° 06′ 09′ N; and longitudes 05° 13′ 11′ and 05° 15′ 18′E across Sokoto-Rima River Valley, East of Kwakwalawa village in Dundaye District of

Wammako Local Government Area in Sokoto State. The termite mounds were indeed found within the *fadama* land of rivers Sokoto and Rima on grass plains while some of the Termite mounds were leaned on tree (See plates 1 and II). This location is agreeing to the general characteristics of where termite mounds are commonly found as succinctly described by Young (1976).

> *"Termites mounds have a marked effect on vegetation pattern, often they are sites of tree growth on grassy plains with predominantly hydromorphic soils. It varies in heights from one metre up to a maximum in macro terms Spp of nine metres. Approximately circular in plan and vary in shape between species. Mounds can be constructed in few months and last 10 years to 50 years before been abandoned. Furthermore, its frequencies spatially varies from one per ha to 500 per ha and may occupy 5% ground surface" (Young, 1976)*

In the study area, the termite mounds have akin characteristics as succinctly described by Young (1976). The Table I and Plates I and II refers to the measurements and shapes of the mounds that were generally conical with circular plans.

Plate I: ***Termite Mound across Sokoto –Rima Valley Lean on a Tree***

Table I Morphological Characteristics and Spatial Coverage of Termitarium

Termite Mounds Serial Number	Suffix for the parts measured	Circumference of the part measured (metre)	Mean values of the circumference (metre)	Heights of the termite mounds (metres)	Ground surface occupied in area (M^2)	Volume of the mounds in (M^3)
Termite mound (TM1)	U	1.41	1.83	1.05	0.43	0.19
	M	1.74				
	B	2.32				
TM2	U	1.42	1.85	0.93	0.42	0.13
	M	1.83				
	B	2.31				
TM3	U	0.95	1.44	0.90	0.35	0.10
	M	1.23				
	B	2.13				
TM4	U	1.02	2.29	1.29	0.86	0.37
	M	2.54				
	B	3.30				
TM5	U	1.02	1.90	0.99	0.72	0.24
	M	1.67				

	B	3.01				
TM6	U	1.44	1.55	1.23	0.35	0.14
	M	2.09				
	B	2.13				

Sources: Field work, 2012. TM- Termite mound, U- Upper, M- Middle, and B- Below

The data in Table I, reveals a consensus conical shape of increasing circumference from the upper part of the mound through the middle to the base that generally have wider base. This supports the observations made by the authors that the mounds have conical shapes. The mound that had the smallest upper circumference was TM (30.95 m) and the widest upper circumference was TM6 (1.44 m). TM3 had the smallest (1.23 m) circumference at the middle slope while TM4 had the widest of (2.54 m.) The base has a recorded 3.30 m in TM4 and the smallest was 2.13 m inTM3 and TM6. The maximum height 1.29 m was recorded on the fourth termite mound (TM4), with the shortest 0.90 m in TM3. In this case, there are records of termite domes that were less than one metre height. In respect of the circumferences of the mounds, TM4 still had the longest base of 3.30 m followed by TM5 with 3.0lm and the least were TM2 and TM6 with records of 2.13 m each. The value of the middle circumferences taken should that TM4 is the longest (2.54 m) followed by TM6 (2.09m) and the least value of 1.23 m was recorded against TM3. As regards the upper parts of the mounds (Table I), TM3 had a record of 0.95m which was the shortest and the longest is 1 .44 mtrs recorded on TM6. The general observation was that the height and the circumferences had positive correlation on each of the mounds but when compared to each other, the relationship was not perfect to have warranted conclusion that once a mound is taller, it should have the widest base than the shorter one. The area covered by each dome was further indicated in the Table I where the TM4 covered the largest area of $0.86m^2$ followed by TM5 with a value of $0.72m^2$. The least studied area covered were observed in TM3 and TM6 with $0.35m^2$ each. In view of the typical small farm holding in the studied area, the area could be sufficient for arable farming if the mounds are harvested. In spite of the height of TM6, yet, it had the lowest area coverage due to its very low basal radius. Similar trend as observed in area was also obtained in volume where TM4 and TM5 recorded highest volume. However, TM3 was the only mound with smallest volume of 0.10 due to its low height when compared with other. The significance of having substantial volume of mound is tied to the possibilities of its utility as a source of manure on arable agricultural land in order to reduce application of inorganic fertiliser which is scarce and expensive.

Methods

There were a total of 30 Termite mounds on a nearly straight line between the first gate of the permanent site of Usmanu Danfodiyo University, Sokoto to Kwakwalawa village before the second gate into the University. The Termite mounds were systematically sampled at every fifth mound. The first mound was randomly chosen between the range of five that had been chosen as interval of every sample. Thus, the 2nd mound was firstly sampled and the subsequent samples were 7th, 12th, 17th, 22nd and 27th; making a total of six mounds that were sampled and studied. Each of the mounds morphological dimensions were taken (height, circumferences of the base, the middle and the near apex portion). The tools used for the exercise were hoe, trowel, measuring tape and camera. In addition to the soil samples of the mounds taken, soil samples of the immediate upland soils farmlands were also collected for similar physical and chemical properties determination for comparison.

Besides the morphological measurements of the mounds taken on the field, the soil samples' colour with Munsell soil colour chart when dry and moist; the structure; extent of abundance, diameter, continuity and distribution of pores within the mound's soil samples as well as the morphology of individual pores were examined. Surface stoniness and any rock outcrops were also looked for around the mounds. The rest of the soil properties which include soil texture, pH, and exchangeable bases, especially (calcium, magnesium, sodium and potassium) were analysed in the laboratory in accordance with the procedure described by Page, *et al*, (1982). Others were nitrate, nitrogen and phosphorous tested with the use of LaMoTTE. Soil testing Kit of model STH Series combination soil outfit used based on its instructional procedure of Nitrate Test and phosphorous reagents on the soil extract with eventual matching of the colour development of the sample with their respective colour charts on the field. The ground surface occupied by the Termite mounds was also been calculated using menstruation area formulae (Table1). The results were presented by descriptive statistics.

Results and Discussion

The Soil Colour

The Table 2 refers to the soils colours common with the sampled termite mounds soils and the rain fed upland farm soils. In respect of the former, more than 66% of the soil samples when dried were dark yellow brown; the rest were brown and yellowish brown. When the soils were wetted, 50% of the samples with dark yellowish brown turned to dark brown; while the balance of 50% by

25% each turned to yellowish brown and brown respectively. The yellowish brown and brown colours when dried turned dark yellowish brown and yellowish brown respectively.

The rain fed upland farm soils were strongly brown when dried and yet of the same colour when wetted, except a sample that turned to dark yellow brown. In as much as colours are often indicators to humus content and chemical nature of iron compounds present in soils, the termite mounds soils' colour with dominance of dark yellowish brown and brown colour indicates higher amount of humus content than the upland soils. However, both soils as regards their colours indicates existence of iron. This condition of higher amount of humus and iron contents makes the termitaria mound soils suitable as additives to upland soils.

Table 2: Soil Colour of Upland Farmlands and Termite Mounds

Soil Sample codes	Colour when dry	Colour when wet
Up1F1	7.5YR/5/6 (Strong Brown)	7.5YR/5/6 (Strong Brown)
Up1F2	7.5YR/5/6 (Strong Brown)	7.5YR/5/6 (Strong Brown)
Up1F3	7.5YR/5/6 (Strong Brown)	7.5YR/5/6 (Strong Brown)
TM1	10YR/4/3 (Dark Yellowish Brown)	10YR/3/3 (Dark Brown)
TM2	10YR/4/4 (Dark Yellowish Brown)	10YR/5/6 (Yellowish Brown)
TM3	10YR/4/4 (Dark Yellowish Brown)	10YR/3/4 (Dark YellowishBrown)
TM4	10YR/4/3 (Dark Yellowish Brown)	10YR/4/3 (Dark YellowishBrown)
TM5	10YR/5/3 (Brown)	10YR/5/4 (Yellowish Brown)
TM6	10YR/4/4 (Dark Yellowish Brown)	10YR/5/4 (Brown)

Source: Author's Field work, 2012 key: TM Termite mound UPLF = upland farm

Soil Structure

The termite mounds soils were well structured, strong grade with durable peds that were evident of undisplaced soil, adhere weakly to one another, withstand displacement and become separated when soil is disturbed. The form was angular blocky, blocky or polyhedrons arranged around a point, plane of curved surfaces that were casts of moulds formed faces of the surrounding peds. The soil was stable and slightly compact in consistency, because the lump could be crushed into fragments with moderate pressure. Furthermore, surface stoniness and any rock outcrops around the mounds were absent.

The rain fed upland farm soils on the other hand, were structured and of single grain with no observable aggregation or orderly arrangement of natural lines of weaknesses. The degree of cohesion was separating non-coherent, i.e., loose in consistency.

Comparatively, it was evident that the termite mounds soils' structures were superior to upland farm soils' in terms of structure. This makes it suitable as additives to the upland soils in order to raise the quality of the soil structure which improves the soils stability, water holding capacity, well aerated pore spaces for crop production with consequence of raising its fertility.

Table 3: Soil Texture of Upland farmlands and Termite mounds

Soil sample codes	Sand (%)	Silt (%)	Clay (%)	Texture
Up1F1	97.50	1.80	0.70	Sand
Up1F2	95.40	3.70	0.90	Sand
Up1F3	97.90	1.70	0.70	Sand
TM1	76.19	19.04	4.76	Loamy sand
TM2	60.00	32.00	8.00	Sandy loam
TM3	57.69	30.76	11.53	Sandy loam
TM4	60.00	36.00	4.00	Sandy loam
TM5	34.78	60.87	4.36	Silt loam
TM6	70.83	20.83	8.33	Sandy loam

Source: Author's Field work, 2012 key: TM Termite mound UPLF = upland farm

The Chemical Properties

In Table 4, the average results of the pH, phosphorous, nitrate, nitrogen, cation exchange capacity, magnesium, calcium, sodium and potassium contents of termite mounds and upland soils for comparison are shown. The average pH of the soils of the termite mounds ranged between7.14 to 8.84 (slight to strong alkalinity) whereas the upland soils have 6.41 to 6.50 (moderate acidity). This quality also makes the mounds soils relevant to be harnessed as additive to the upland soils in order to raise their pH to the levels that is tolerate able to most crops. Indeed, the mounds soils in this respect could serve as additional source of liming the upland soils which would improve its productivity.

Further closury examination of Table 4 shows that, termite mounds soils have almost 1000% of CEC, 600% of K, 500% of Mg, 400% of Ca, 300% of Na and very high nitrate nitrogen and phosphorous than the upland soils. These very high exchangeable cations, CEC nitrate nitrogen and phosphorus content in the termite mounds soils than the upland farm soils, qualifies it as additives to the upland farm soils because it will improve its soil structure and generally raise its fertility status. Other benefits could include savings in procuring high quantity of inorganic fertiliser by the farmers with attendant less production cost and more profits by the farmers. Beyond economic advantage is the aspect of food security and good health in the light of high quality organic food that becomes more readily available to the populace.

Table 4: Soil Chemical Properties of Termite Mounds and Upland Farmlands

Soil sample codes	K (Cmol/ Kg)	Na (Cmol/ Kg)	Ca (Cmol/ Kg)	Mg (Cmol/ Kg)	CEC (Cmol/ Kg)	Nitrate nitrogen (mg/kg)	P(mg/ kg)	pH
TM1	32.67	16	3.4	3.97	21.40	30	75	7.97
TM2	58.33	11.33	1.97	4.5	34.40	20	75	8.59
TM3	37.67	13.67	1.40	4.13	26.13	10	75	8.75
TM4	16.33	15.67	1.87	5.4	33.33	50	100	7.14
TM5	31.33	23.00	1.50	4.43	30.7	20	50	7.74
TM6	58.33	19.00	1.47	18.6	30.47	10	75	7.92
μ	39.11	16.61	1.94	6.88	29.36	23.33	75	8.84
Up1F1	6.05	5.04	0.50	1.30	3.00	3.15	26.00	6.49
Up1F2	6.0	5.00	0.50	1.40	3.20	3.50	26.00	6.41
UP1F3	7.0	5.04	0.60	1.40	3.40	4.00	25.00	6.50
μ	6.35	5.02	0.53	1.03	3.21	3.55	25.66	6.46

Source: Author's Field work, 2011. Key: TM Termite mound UPLF = upland farms

Conclusion

In the light of the result obtained, the physical and chemical properties of the termite mounds soils have been shown to have very high fertility status than the upland soils. Consequently, instead of leaving the termite mounds unutilised and occupying the already in shortage prime arable farmlands; and in view of low level income disposition of our peasant farmers with attendant inability to procure sufficient inorganic fertiliser coupled with clamour for organic food production. It is, therefore, recommended that the termite mounds soils be harnessed in addition to other organic fertilisers to raise the low fertility status of the upland farms. The termite mounds should be crushed and worked into the upland soils by the farmers. This mound is an additional cheaper source of organic fertiliser within the neighbourhood of the farmers farmland. It requires only transportation cost, unfortunately, the farmers do not harvest them, therefore, the need to enlighten the farmers of its usefulness is quite imperative.

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