DETERMINATION OF PHYSICAL AND CHEMICAL PROPERTIES OF TERMITE HILL SOIL

BY

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DECLARATION

I hereby declare that this Project is a record of a research work that was undertaken and written by me. It has not been presented before for any degree or diploma or certificate at any University of Institution. Information derived from personal communications, published and unpublished works of others were duly referenced in the text.

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CERTIFICATION

This project entitled 'Determination of the physical and chemical properties of termite hill by Habila Yakubu 'meets the regulations governing the award of the degree of Bachelor of Engineering (B.ENG.) of the Federal University of Technology, Minna, and it is approved for its contribution to scientific knowledge and literary presentation.

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DEDICATION

I dedicate this project work to Alpha and Omega the sustainer of my life, who has kept me this far. May his name be praised.

ACKNOWLEDGEMENTS

I return all glory and praises to God Almighty, for giving me the inspiration during the writing of this project; it would have failed if not of his constant love.

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ABSTRACT

The physical and chemical properties of termite hill soil was determined in the laboratory by collecting three different samples of termite hill soil A,B and C from different sites.Soil samples serving as control was also collected near each of the termite hill soil.After the soil analysis , the organic matter and nitrogen content in the termite hill soil was higher than that of the soil in it's surrounding.The termite hill organic matter content was,3.24%,1.33% and2.25% for sample A,B and C respectively.While it's nitrogen content for sample A,B and C was,0.80%,1.10% and 2.80% respectively.The physical analysis of termite hill soil shows that it is mostly sandy clay especially ,samples A and B with textural class for sand ,silt and clay as; (45.12%,11.28%,43.60) and (49.12%,7.28%,43.60%).It has a relatively high bulk density of; 2.832% ,1.961% and 1.973% for sample A,B and C, which shows that it is a sub soil.The results has shown that termite hill soil has more soil nutrients than it's surrounding soil .From the above parameters obtained,termite hill soil ca n be used for Agricultural practices like growing of crops and could also be recommended as a construction material if it's organic matter content is reduced.This is because it is a subsoil which is good for construction of structures like silos, rural roads and bricks.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of the Study .

Termite is an insect also known as the white ant of the order *isoptera*. They are found throughout the country from sea level to 600ft (1800m). Termite are soft bodies and medium sized, they live in colonies with a caste system comprising the three types of functional individuals: steriles, workers and soldiers. There are about 1600 species of termites (McGraw Hill, 1982) but some of the common kind of species found in tropical and savanna ecosystem is: *Macrotermes M goliath*, *M-bellicosus* and *M-natalensis*.

The size of the mound (termite hill) ,which may be anything up to 5m high and 20m broad depends largely on the kind of soil type, depth of the soil and climatic condition(McGrawHill,1882).Termite play important role in the decomposition process in savannah and tropical ecosystem, and the physical and chemical properties has tremendeous effects on the soils

1.2 Properties under Consideration

Some of the physical properties to be considered are; porosity, bulk density, particle density and soil texture. These properties, have help the soil rigidity supporting power, moisture retention capacity, ease of root penetration, plasticity, aeration and retention of plant nutrient. It is therefore, important to note the extent to which these characteristic can be manipulated for maximum benefit.

While some of the chemical properties to be considered are; soil pH, soil macro and micro elements, cation exchange, soil organic matter, available phosphorus, organic carbon and nitrogen content. These properties are responsible for the regularities and peculiarities in general changes of chemical composition of the soil(Olaitan *et al.*, 1984).

1.3 The Building Process

Each species of termite build it's own mound in a slightly different way, but as the shape of a mound depend upon the nature of the subsoil and climate, if the condition are not favourable for particular shape of mound, a species will build accordingly hence, one may find a mound built by *M-bellicosus* superficially resembling the *M-goliath* type and vise versa. During the building process, a worker termite fills it mouth with clay which there becomes mixed with saliva and select a grain of sand which it carries in it's mandible placing the sand grain in position the termite squirts the wet clay round and kneads it with it's head and mandibles. Contrary to the statement made by (Marrais, 1938) and (Graisse, 1950) that termites dig down as far as water table in order to obtain moisture.

1.4 Soil for Building

Result have shown that termite mound are build from subsoil and that termites do not directly altered or affect the chemical characteristics of soil with the possible exception of base exchange capacity and total exchangeable bases . The physical measurement have confirmed that termites mound are heap of subsoil but have shown and altered soil structure. The main factors affecting the composition of mould soil were found to be the nature of the nearby soil and the environment of the mound sand (Olaitan *et al.*, 1984).

1.5 Objectives

i. To determine the physical and chemical properties of termite hill soil

ii. To used the properties obtained to provide solution for better agricultural practices or cultivation of soils affected by termites.

1.6 Justification

The determination of physical and chemical properties of termite hill is an attempt to create some meaningful data that can be used to solve problem encountered by rural farmers during soil cultivation and this data generated, will help in the ultilisation of such soil for improved crop production and there by, reduce the cost of fertilizer input and this will increase the farmers financial status.

1.7 Scope of the Study

Some physical and chemical properties of relevant industrial properties have been selected for study within the scope of this project.

the physical environment of which the soil constitutes only one component. Other factors may include the underlying geology, are hydrology, the relief or topography, the plant and animal population and the results of human activity, both past and present (Nyle *et al*, 1999).

2.3 The Major Component of Soil

Organic material in various stages of decomposition includes:-

1. Humus
2. Mineral particles
3. Air
4. Water

The organic material and mineral particle are intimately associated in the top soil. If the organic material is removed or mineral particles can be divided up conveniently according to the diameter of the particles.

Clay less than	0.002mm in diameter
Silt between	0.002 – 0.02mm in diameter
Sand between	0.02 – 2.00mm in diameter

Source: (Nyle *et al.*, 1999)

2.4 Mineral Soil Compared to Organic Soil

The term mineral soil denotes a soil which consists of predominantly mineral of inorganic matter. The organic mater is rarely more than 10%, most and which is accumulated in the top 30cm. The majority of soil are alike and when the term soil is used, it is usually this category that is being referred to. Virtually all cultivatable soil in the tropic are mineral soils.

In contrast to mineral soils, organic soil contain about 70-95% of organic matter and this high organic matter content characteristic the whole profile. Organic soil are not formed through the normal soil forming processes, described in the next section, but through accumulation of vegetative matter in swamps mashes and bogs. Peat deposits are common in the cool temperate region of the world because of low temperature permits only a minimum of microbial activity which results in the accumulation of organic matter. Organic soil are rare in the tropics because the temperatures are high throughout the year and this accelerates microbial decomposition or mineralization of organic matter. One example of tropical organic soil is the extensive peat soil of Rwanda. We will only concern ourselves with mineral soil in our subsequent discussion. (MC Graw-Hill, 1982).

2.5 Surface and Subsoil

When used without any specific qualifications, the terms surface soil, arable layer or topsoil generally refer to the top 15 to 20cm of the soil. In an undisturbed state or when subjected to only minimum tillage, as is often the case in most parts of tropical Africa, the surface layer of tropical mineral soil is usually darker than the layer below it. The dark colour is due to the presence of organic matter. The amount will vary from less than 1% to about 6% in most cultivable soils of the tropics. In general, savannah soils have lower levels of organic matter than those often encountered in the humid tropics. (Olaitan *et al.*,1984).

The surface soil is usually the most critical layer, it is the zone most often subjected to annual cultivation for arable crops and usually it is the richest in available plant nutrients.

Investigation or discussion on soil fertility or productivity is usually centered on surface soils and in fact the everyday usage of the word soil is commonly taken to mean surface soil. Below the surface layer or top soil is the subsoil the latter is almost always lower in organic matter than the surface layer and so the soil colour may and often does, change quite markedly. Generally, subsoil colours are more striking and show greater variation. The red, brown, yellow or brownish yellow colours of soil, are mainly dependable on the amount and form of iron present. Most soils of the tropics are freely drained i.e. water percolates through the soil easily and so the soil is adequately aerated. For this reason, the iron is oxidized to reddish iron (iii) (ferric) oxide. (Olaitan *et al.*, 1984). A red soil is thus an indication of adequate drainage and aeration. Red soils are therefore, often found on upland sites and upper slopes. On lower slopes or depressions where the soil are not so well drained, the iron occurs in a hydrated form thus impart brown or yellow colour to the soil. In very poorly drained soil such as low land rice soils, the shortage of oxygen brings about which encourages reduction and formation of compounds which give predominant grey colours to the soils. This condition is commonly found in the seasonally flooded *fadama* soil of valley bottoms in the West African savannah and in the *dambo* soil of east and central Africa.

The productivity of soil is influenced greatly by the nature and properties of the subsoil, especially when dealing with deep-rooted annual crop such as cocoa, and rubber which can absorb water and nutrients at depth of up to five metres. (Olaitan *et al.*, 1984)

2.6 Rock Weathering

This is the disintegration of rocks which is due to the action of exogenic (or exterior) forces. These forces include; rainfall, frost, solar radiation, wind, living organism and the atmosphere the result of this weathering is the formation of soils and the degree of rate of disintegration varies according to the vegetation and climate prevailing in the area concerned. These are three major processes of weathering physical, chemical and biological (Anthony *et al.*, 1986).

2.7 Physical Weathering

This is the mechanical disintegration of rocks without any change in their chemical composition. Physical weathering is most important in arid and semi-arid areas where the rocks are exposed and it may be as a result of::

1 Disintegration to Change in Temperature

Extreme heat and cold in the day and night cause expansion and contraction of rock. Subsequently, the rock cracks. Different mineral in the rocks have different coefficient of expansion and so when the rock are heated, they crack because the minerals expand at different rates.

2 Expansion of Frozen Water in The Rock and Mineral Crevices

This is common in temperate areas and at high attitudes on the tropics. Water in crevices in the rock expands when it freezes and this force can break up the rock.

3 Expansion of Roots in The Rock Crevices

When plants grow in rock crevices, the root tend to expand and this put some force onto the rock which may then crack.

4 Disintegration of Root in The Rock and Minerals Crevices

Heating and cooling of the surface of the rock lead to weathering. The outer heated layers tend to put away from the cooler rock underneath a process known as exfoliation (Anthony *et al.*; 1986).

2.8 Chemical Weathering

Chemical weathering alters the composition of the rock, however, the process of chemical weathering include oxidation, reduction, hydration, hydrolysis, carbonation and solution (Anthony *et al.*; 1986).

2.8.1 Oxidation

Oxygen is an active element and it combines freely with many other element. In the process, oxygen combines with some other minerals.

For example

$C + 0_2 \longrightarrow CO_2$ 2.0

Carbon + oxygencarbondioxide

$4FeC0_3 + 0_2 \longrightarrow 2Fe_20_3 + 4C0_2$ 2.1

Iron (ii) + oxygen → iron oxide + carbon

(haemetite) + dioxide

(Olaitan *et al.*, 1984).

Some other minerals which contain iron (ii) (ferrous) can be oxidized. These are olivine, hornblende, augite and biotite.

2.8.2 Reduction

This takes place when the supply of oxygen is limited. It is the common in the process of rock decay.

Fe_20_3 + H_20 ⟶ Fe_20_3+ H_20 2.2

Iron (ii) oxide or + water ⟶hydrated iron oxide or geothete

(red) (yellow)

Silica or quartz, aluminum oxide (Al_20_3), aluminosilicates and organic materials can also become hydrated (Anthony *et al.*; 1986).

2.8.4 Hydrolysis

The metallic cations of many compounds are replaced by hydrogen (H^+) ions from water. This leads to the disintegration of certain minerals. Silicates frequently become hydrated

$CaSiO_3 + 2H_20 \longrightarrow H_2SiO_3 + Ca(OH)_2$ 2.3

Calcium Silicate + water ⟶ Silicic acid + Calcium hydroxide

(Olaitan *et al.*, 1984).

2.9 Biological Weathering

In the early stages of mineral decomposition, lichen, fungi and bacteria undoubtedly play major role. Lichen grow on the rock and gradually decomposes the minerals on the surface layers. Trees have root which pass through the crevices in the rock and as these grown and increase in size, the rock cracks (Foth,1990).

Worms, insect and other small animals help to modify the chemical and physical properties of the soil. The continuous borrowing of earthworms and insect will establish drainage channels in the soil, earth worms also help in the decomposition of the soil because they eat it and as it passes through their gut some breakdown of minerals occurs.

2.10 The Relationship between Rock and Soil

Weathered rocks give rise to parent material and this is regarded as the first step in soil development. Pronounced difference in climate result in pronounced differences in soil even when the parent maternal are identical. In relative small region of uniform climate, however, the nature of are parent material is probably more important than any other single factors in determining the characteristics and productivity of a soil. Parent material is the unconsolidated mass from which the soil profile develops it is not the bed rock itself. (Foth, 1990).

In other words, the influence of parent material on soil characteristics is most pronounced in mature soil. Soil derived from rocks with a low calcium content e.g. quartzite or *leptite* support a poor forest-Granite and gneiss content contain some calcium and produce good soil for crop production. The basic igneous rocks, *gabbro* diorite and basalt together with the calcerous sedimentary rocks have the highest calcium content and often give rise to productive soil which supports good vegetation (Nyle *et al.*, 1999).

The nature of the parent materials has a bearing on the type of soil which result and on the rate of profile development. The soil texture and nutrient content are both influenced by the nature of the parent materials. Thus we can conclude that the parent material influences both the physical and chemical properties of the soil.

2.11 Rock Weathering and Soil Formation

How is soil formed? What gives soil the characteristics which disintegrate from other soil.

When a farmer cut through natural vegetation and begin to cultivate the soil it undergoes certain change. To some extent continues to change as long as it is in use. The soil is therefore changed and modified by human interferences and influence. One important observation is that colour of the soil often differs from place to place. These differences are the result of differences in certain soil forming factor which are::

1. Parent rock maternal
2. Living matter that is plant and animals
3. Past and present climate of the area.
4. Topography or relief.
5. Human influence

2.12 Physical Properties of Soil

The physical properties of soil determine, to a large extent their production capacity. The degree of aeration, moisture content and depth of penetration are directly related to the physical attribute of the soil. Some important physical properties of soil are texture, structure, colour, temperature and aeration (Moscow., 1986).

2.12.1 Properties of Sand, Silt and Clay

2.12.2 Sand

The individual particles can be seen with the naked eye e.g sandy soil are well aeration and have good drainage, but they will not hold water or nutrients. Coarse and particles have a drainage of 2.0 to 0.2mm and fine sand particle range in size from 0.2 to 0.02mm.

2.12.3 Silt

Silt particle range in size from 0.02mm to 0.002mm and they can be seen by using a microscope compared with sand, silt contains less silica (S_10_2) and more of the cation important in plant nutrition. The physical properties of silt are intermediate between sand and clay. Tropical soils contain less silt than soils in temperate regions.

2.12.4 Clay

The individual particles of clay can not be seen with naked eye since they are less than 0.002mm in diameter. Clay particle contain oxygen, silicon, aluminum and iron. When fine clays are shaken up solids and liquid are called colloids. Clay colloids are important because they can hold nutrients on their surface in a form which is readily available to plants. They are also spongy and can hold water better than sand. Unfortunately, clay soil also has a tendency to become water logged and to be partly aerated. Clay is sticky when wet and may form very hard lumps or clods when dry (Mosow, 1986).

2.13 Soil Texture

Soil texture is determined by the size of the soil particles: It refers to the proportion of sand, silt and clay in a soil. In a more general way, texture may be used top describe how the soil feels or behaves under cultivation. Soil texture may be determined by various methods(Singh,1989).

Table 2.0 Simplified Key for Identification of Soil Classes by Texture

A	Air dried	Moist	Boil class
	Single grained loose	Gritty no ribbon	Sand
Aggregated		Gritty no ribbon	Sand loam
		Intermediate no ribbon	Loam
		Smooth no ribbon	Silt loam
Aggregated	Moderate pressure to break aggregates	Gritty medium ribbon	Sandy clay loam
		Intermediate gritty/smooth medium ribbon	Clay loam
		Smooth medium ribbon	Silty clay loam
	Aggregated can not be crushed with finger	Smooth good ribbon	Silty clay
		Gritty good ribbon	Sand clay

Source: (Singh, 1989).

2.14 Soil Texture Classification

Exact identification of soil texture is complicated by the dissimilar size limits for particle diameter set by different countries and organization. These are summarized in table 2.1 in this project, the international system is used.

Table 2.1 The Universal Classification \of Soil Texture

Soil fraction		International scale	US department of agriculture	British standard institution
Soil fraction			Particles in mm	
and	course	2 - 02	2 - 0.05	2 – 0.06
	fine	0.2 - 0.002		
Silt		0.02 – 0.002		0.06 – 0.002
Clay		Less than 0.002	Less than 0.002	Less than 0.002

Source: (G. Lombin, 1984).

2.15 Bulk Density

A second important mass measurement of soil is bulk density (Db) which is defined as the mass of a unit volume of dry soil. This volume includes both solids and pores. A careful study should make clear the distinction between particles and bulk density. Both expression of density use only the mass of the solid in a soil, therefore, any water present is excluded from consideration (Brady *et al.*, 1999).

There are several methods of determining soil bulk density by obtaining a known volume of soil, drying it to remove the water and weighing the dry mass. A special corning instrument can obtain a sample of known volume surface soils, perhaps the simplest method is to dig a small hole collect all the excavated soil, and then line the hole with plastic film and fill it completely with a measured volume of water. Still another method involves coating a clod of soil with a water proof film the volume of the odd-shaped clod is determined by its buoyancy when suspended in water. The formula for calculating bulk density is given below.

(Nyle *et al.*, 1999).

$$\text{Bulk Density} = \frac{\textit{Weight of oven dry soil}}{\textit{Volume of soil (solids+pore)}}$$

2.16 Chemical Properties of Soil

Soil, as a natural body is characterized by certain composition of chemical elements in its mineral part. The elements appear in soil as various compounds of different solubility and mobility. These properties are responsible for the regularities and peculiarities in general changes of the chemical composition of soils and of the distribution of compounds, forming the soil mass, through out the profile. (Eyre , 1968).

The following are some of the chemical properties of soil and they include cation exchange, soil pH, calcium carbonate content, phosphorus content, potassium content, magnesium content, nitrogen content etc.

2.17 Soil Colloids

The colloidal fraction of the soil consist of an inorganic portion the clays and an organic component-humus. Clay is of two types, the silicate clay and the hydrous oxide clays. (Bohn, 1979). Silicate clays are most common in temperate region whilst hydrous oxide clays are characteristics of tropical and subtropical soils. Clay particle are extremely fine and therefore, they have a large external surface area. In some cases the plate-like crystal units that make up each particle form a large internal surface area too. Organic colloids have no internal surfaces and the external surface area is dependent on how finely divided the particle are (Bohn, 1979).

2.18 Electronegative Charges on Soil Colloids and their Cation Adsorption Properties

The minute soil colloid particle or *micelle* is it inorganic or organic carries a negative charge and consequently thousand of positively charged ions (cation) are drawn to each colloidal crystal by electrostatic attraction. An electrical double layer is thus established with colloidal particle forming the inner layer of a large anion and the described cation which surround the anion constituting the outer layer. In humid tropical soils the exchange complex is dominated in order by H^+ ca^{2+}. Mg^{2+}, Al^+. Because of the preponderance of H^+ and Ca^{2+} ions in the exchange complex the clays of humid region are usually described as having calcium, hydrogen complex. In the humid tropical environment, H^+ ions may displace metallic ions giving rise in acid hydrogen saturated clay. Acid clay are calcium aluminum clays in an arid region which hardly experiences any leaching or where drainage is impeded, alkaline salt may accumulate and adsorbed Na^+ ions may equal or even exceed those complex.(Nyle *et al.*,1999).

2.19 Cation Exchange

The absorbed cations on the exchange complex cannot be leached out easily, but they can be replaced because of the ionic competition for negative sites. This ionic competition exits because there are large numbers of ions present. Replacement of one cation by another on the exchange complex is called cation exchange. Factors that control cation exchange in soils include the relative concentration of the ion involved, the number of charges on the ion and the speed of movement or activity of the ion. The greater the number of charges an ion carries the more efficient it is in replacing others on the exchange complex(Olaitan *et al.*, 1984) replacing others on the exchange complex the speed of movement of an ion is essentially a function of its size. Hydrated ions, for instance are usually less active than non-hydrated ions of the same species. The replaceability senses of the common cations in soils is AL>Ca>Mg>k>Na; and the ion exchange is a chemical equivalence basis. Thus, when an ammonium fertilizer, e.g. $(NH_4)SO_4$, or potash fertilizer e.g. kcl, is added to the soil, the NH_4^+, or k^+ ions will replace other cation on the cation exchange complex and these will go into soil solution takes place on the surfaces of clay and humic colloids as well as on the surface of plant roots.

Under natural conditions the process of cation exchange accounts for the fact that calcium and, to lesser extent potassium, magnesium and sodium are lost by leaching. At the same time aluminum and hydrogen ions, both of which enhance soil acidity increase. This explains in part why soil in humid region tends to become acid rather quickly, (Jury , 1972).

2.20 Cation Exchange Equation

Many different equations have been proposed to model cation exchange reactions. Common features of these model are that key assume the mineral surface has a constant total (CEC) at a given pH and that the exchange reaction is considered to be stoichemetric and reaction is the mass action equation which describe Na^{2+} exchange as follows (Bohn *et al.*, 1979).

$$Ca \times + 2N_a^+ \rightleftarrows 2Na \times C_a^{2+}$$

Where X represents the exchange phase of the cation. The equilibrium reaction coefficient for the reaction is therefore

$$K_k = \frac{(Nax)^2 (Ca^{2+})}{(ca \times)(N_a^+)}$$

2.21 Anion Exchange and Adsorption

In general, colloids low cation exchange are high in anion exchange some of the cation, such as iron have hydroxyl (OH^-) concentration that can be exchanged with sulphate (So_4^{2-}) phosphate ($H_2PO_4^-$ and HPO_4) and, molybdate ($M_O O_4^{2-}$) ions (Jury , 1972).

Soil high in hydrous oxide clays (oxides of iron and aluminum) and amorpous clays, such as *alophane*, are particularly high in anion exchange. This explains why tropical soils are known to fix considerable quantities of phosphate and sulphate. Work done at the institute for agricultural research at *Samaru* in Nigeria has shown that most of the West African savannah soils fix plenty of sulphate (Jury , 1972).

2.22 Soil pH

Soil pH can be determined using the glass electrode technique or a colorimtric pH indicator. The glass electrode is used in nearly all soil testing laboratories for line determination of soil pH. It can also be used effectively and reliably for field-work.

Colorimetric indicators are most useful for testing soil in the field and are also used in some testing laboratories when used properly, they give approximate but satisfactory results. A soil indicator kit contain a solution of two dyes mixed together so that a range of colours is obtained for the various hydrogen ion concentration in soils, use of such a kit gives a rapid field estimate of pH within 0.2 a unit from pH 4.0 to 8.0. (Eyre , 1968).

2.23 Alkaline Soils

Alkaline soils have a greater concentration of hydroxyl ions than hydrogen ions. These soils are formed as a result of the chemical reaction between carbonate of calcium, magnesium, sodium. potassium and hydroxyl ion. For example sodium carbonate (Na_2 Co_3) is readily hydrolyzed to form sodium hydroxide.

$$Na_2CO_3 + H_2O \longrightarrow 2NaOH + CO_2$$

Sodium Carbonate + water $\longrightarrow$ sodium hydroxide +Carbon Dioxide

This will eventually raise the pH value of the soil to 8.5 or above. Sodium hydroxide is corrosive to plant tissue the sodium ion are absorbed by the colloidal complex and this slows up the development of root and water absorption (Anthony *et al.*, 1986).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Materials

The materials used for these tests are samples of termite hill soil and ordinary soil (serving as control) obtained from three locations in Niger state, Nigeria. These locations are: *Gidan-Kwanu* sample (A) *Kata-Eregi* sample (B) and *Barkin-Salle* sample (C).

3.1.1 Termite Hill Soil

Termite hill soil was collected in three locations in Niger state, Nigeria

3.1.2 Soil

The soil samples were collected close to each of the three samples of the respective termite hill soil i.e. A, B and C.

3.1.3 Identification of Test

The laboratory tests carried out on the soil sample of termite hill and the ordinary soil are the physical and the chemical properties test. The physical property tests include: soil texture, bulk density, particle density, and porosity while the chemical property tests includes: soil pH, organic matter content, organic carbon content, available phosphorous and exchangeable cations (Na^+, k^+, ca^{2+} and mg^{2+}).

3.1.4 Methods

3.1.5 Determination of Soil Texture

Apparatus:

(i) Soil hydrometer,

(ii) Plunger,

(iii)Sedimentary cylinder,

(iv) Bottle.

(iv)Stop clock,

(v) Thermometer,

(vi)Weighing balance

Reagent: Distilled water, sodium hexametaphosphate (Na_6PO_4) i.e. 5% calgon solution

Procedure: 50g of 2mm of sieved soil was weighed accurately into a bottle, 100ml of distilled water was added into the soil sample. 50ml of 5% calgon solution or hexametaphosphate (Na_6PO_4) was added and sample was shaken on a flask shaker for one hour, then the samples were also fragmented further using motorize mechanical shaker. The sample was quantitatively transferred into a sedimentation cylinder and made up to 1 litre marked with distilled water. The sample was disturbed by using a plunger for proper soil suspension. The hydrometer reading was taken by immersing the hydrometer into the sample and the used to determine the reading. the temperature was taken to measure the percentage of silt and clay in suspension while the 2 hrs reading without disturb was taken to measure the percentage of clay in suspension. A blank sample was also prepared but without soil and the reading also obtained.

3.1.6 Determination of Bulk Density

Procedure: (Non stony soils)

1. The clod soil was excavated
2. The clod was air-dried, a thin thread was tied round it and weighed (Ws)
3. The air dried clod was dipped in a paraffin and melted at (60^0c) to water proofed it.
4. The coated clod was weighed (Wsp) and the weight of the paraffin coating was calculated (Wp).
5. Where (Wp = Wsp - Ws)

6. The clod was suspended from the balance arm which was submerged in a beaker of water. The weight was recorded (Wspw). The clod is discarded it it leaks.

7. The clod was break-opened, and a subsample of the soil was taken and the moisture content determined.

8. Ws was corrected to it oven dried mass

$$W_{dry} = \frac{W_s \times weight\ of\ subsample\ afterdryingz}{weight\ of\ subsample\ before\ draying}$$

Calculation:

$$Bulk\ density\,(gcm^{-3}) = \left(W_{dryg}\right)/\left[\left(W_{spg} - W_{spwg}/Dwcm^{2}\right) - (Wpg/Dpcm^{3})\right]$$

Where Dw = density of water at temperature of determination (1.0) and Dp = density of paraffin wax

3.1.7 Determination of The Particle Density of a Given Soil Using Pychnometer Bottle

Apparatus

1. Pychnometer bottle
2. Hot plate
3. Electronic weighting balance
4. Spatular

Reagent: Distilled Water

Procedure: The pychnometer bottle was weighed impty 10g of 2mm sieve soil was weighed and transferred into the pycnometer bottle, the bottle and soil was weighed, the bottle and the soil was half filled with water and boiled on a hot plate to expelled the entrapped air. Boiling was continued for the next 10 minutes, the bottle and soil was then filled with water and the lid inserted into it. The bottle, soil and water was then weighed; the entire sample was discharged and the bottle was then filled with only water and weighted, the density of water at the observed temperature was taken. Particle density was calculated with the formulae below

Wa = weight of bottle

Ws = weight of bottle + soil

Wsw = weight of bottle + water

Ww = weight of bottle + soil + water

dw =density of water at observed temperature

ρb = bulk density

ρp = particle density

Fa = % porosity

$$\rho p = \frac{dw(ws - wa)}{(w_s - w_a) - (wsw - ww)}$$

Where $\% \, porosity = fa = 1 - \frac{pb}{pp} \times \frac{100}{1}$

3.1.8 Determination of Soil pH

Apparatus:

Glass-electrode pH meter

Reagents:

-0.01M calcium chloride

-Distilled water

- 1 N potassium chloride

Procedure

(Soil pH in H_20 (1:1 soil to water ratio))

1. 20g of air-dried soil was passed through 2-mm sieve into a 50-ml beaker, and 20ml of distilled water was added and allowed to stand for 30 minutes, and stirred occasionally with glass rod

2. The electrode of pH meter was inserted pH in the partly settled suspension and the pH reading measured. The suspension was not stirred.

3. The result was recorded as pH measured in water.(soil pH in 0.01M $cacl_2$)

1. 1:2 (soil: 0.01m $CaCl_2$) suspension (10g of soil and 20ml of solution)

2. The suspension was allowed to stand for 30 minutes and stirred occasionally with a glass rod

3. The pH value was measured and the result was recorded as pH in 0.01M $CaCl_2$

3.1.9 Determination of Available Phosphorus (Bray No 1 Method)

Apparatus:

1. Centrifuge
2. Mechanical shaker
3. 20ml test-tube
4. B and L spectronic 1 liter (stored in polyethylene bottle)

Procedure:

1. 1g of air-dried soil sample was passed through a 2mm sieve and was inserted into 15ml centrifuge tube with 7ml extracting solution added.

2. The sample was shaken for 1 minute on a mechanical shaker and centrifuged the suspension at 200rpm for 15 minutes.

3. 2ml of supernatant was pipette into 20ml test tube

4. 5ml of distilled water and 2ml of ammonium molybdate solution was added.

5. The content was mixed properly and 1ml of $SnCl_2.H_20$ dilute solution and mixed

6. The percentage of transmittance on the electro photometer at 660 mu-wave length was measured after 5 minutes but not later than 20 minutes

3.2.0 Determination of Organic Matter in Soil (walkley-black method)

Apparatus:

1. Burettes, 50ml or 25ml

Procedure:

1. A representative sample was grounded and passed through 0.5mm sieve

2. The soil sample was weighed in duplicate and transferred to 250ml Erlenmeyer flask (1.00g should be used if the organic carbon is between 1 and 3% 2.00g if it is less than 1%).

3. 10ml of 1$\underline{N}$ $K_2Cr_20_7$ solution was pipette accurately into each flask and swirled gently to disperse the soil.

4. Concentrated 20ml of H_2S0_4 was added using automatic pipette. Then the stream was directed into the suspension. The flask was swirled immediately in order to mix the reagent, the swirling continues vigorously for one minutes then the beaker was rotated and allowed to stand on asbestos for about 30 minutes.

5. 100ml of distilled water was added after it stood for 30 minutes

6. 3-4 drops of indicator was added and titrated with 0.5N ferrous sulfate solution. As the end point was approached, the solution takes on a greenish cast and then changes to dart green. At this point, ferrous sulfate was added drop by drop, until the colour changes sharply from blue to red (Maroon colour) in reflected light against a white back ground.

7. Blank titration was made in the same manner but without soil. (3, 4, 5 and 6 was stepped to standardize the dichromate)

8. The result was calculated with the formula.

% organic carbon in soil

$$= \frac{(me\,K_2Cr_20 - -me\,FeSO_4 \times 0.003 \times 100(F)}{g\ of\ air-dry\ soil}$$

Correction factor F = 1.33

me = Normality of solution x ml of solution used percentage organic matter in soil = percentage organic carbon x 1.729

9. % organic carbon may also be expressed on oven-dry basis after correction for moisture content in air-dry soil.

3.2.1 Determination of Exchangeable Cation (Ca^{+}, Mg^{2+}, K^{+}, N_a^{+})

Apparatus:

1. Centrifuge
2. 100-ml volumetric flask
3. Flame photo meter
4. Absorption spectrophotometer

Procedure:

1. 5g of sample was added to 30ml of 1 N NH_4OAC and shaken on a mechanical shaker for 2 hours.

2. The supernatant was carefully decanted into a 100ml volume flask. Centrifuge (2.000rpm for 5-10 minutes)

3. 30ml of NH_4 OAC solution was added and shaken for 30 minute. The supernatant was centrifuged and transferred into the volumetric flask

4. Step 3 was repeated and the supernatant was transferred into same volumetric flask

5. NH_4OAC solution was made up to mark

6. $K^+ . N_a^+ \ and \ Ca^{2+}$ was determine on an atomic absorption spectrometer.

7. A standard curve was prepared within the range of $0 - \mu gp/m/(or\ ppmp)$

8. The optical density (O.D) of standard solution was plotted against the μgp/ml(or ppmp) and the content of extractable phosphorus in the soil calculated.

3.2.2 Determination of Nitrogen-content regular (macro)-Kjeldahi method)

Apparatus:

1. Macro-kjeldahl digestion-distillation apparatus
2. Macro-kjeldahi flask 500ml and 750ml

Procedure:

1. 5 to 10g of soil sample was weighed which contained about 10mg of N (was grounded and air-dried to pass through 0.5mm sieve) in a dried 500ml macro-kjedahl flask 20ml of distilled water was added; the flask was swirled for few minutes then allow to stand for 30 minutes.

2. 1 tablet of mercury catalyst was added (or 1g of the $K_2SO_4 - H_20$ mixture catalyst) and 10g of K_2SO_4. Then 30ml of concentrated H_2SO_4 was added through an automatic pipette.

3. The flask was heated cautiously at low heat. The digestion stand. The water was removed and frothing ceased, the heat was increased until the digest clears. The mixture was boiled for hours and the heating was regulated during boiling so that the H_2SO_4 condenses about half way up the neck of low flask.

4. The flask was allowed to cool slowly and 100ml of water was added to the flask.

5. The digest was carefully transferred into another clean macro-kjeldahl flask (750ml). The sand particles bumping during kjeldahl distillation. The residue was washed with 59ml of distilled water four times and transferred the aliquot into the same flask.

6. 50ml of H_3BO_3 indicator solution was added into 500ml Erlenmeyer flask which was then placed under condenser of the distillation apparatus. The end of the condenser was about 4cm above the surface of the H_3BO_3 solution.

7. 750ml of kjeldahl flask was attached to the distilled apparatus. 150ml of 10 N NaOH was poured through the distilation flask, opening the funnel, stop clock and distillation commences.

8. The condenser was cooled (below 30^0c) to allow sufficient cold water to flow and regulate heat to minimize frothing and prevent suck-back.

9. 150ml distillate was collected and the distillation was stopped.

10. NH_4-N in the distillate was determined by titrating with 0.01*N* standard HCl (or H_2SO_4), using a 25ml burette graduated at 0.1ml. The colour change at end point from green to pink.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSIONS

4.1.0 Bulk Density

From table 4.0 the bulk densities for termite hill soil samples A, B and C are: 2.232g/cm^3, 1.961g/cm^3 and 1.973gcm^3. And the bulk densities for the soil (control) samples in table 4.1 are: 1.804g/cm^3. 1.712g/cm^3 and 1.914g/cm^3. This result shows that, bulk density increase with depth. since there was an increase with value obtained from the soil. The difference was as a result of unequal depths of the two soils. Termite hill are usually subsoil and therefore has higher bulk densities.

4.1.1 Particle Density

The particle densities for the termite hill soil in table 4.0 are 2.832/cm^3, 2.646g/cm^3 and 3.333g/cm^3 while one soil (control) samples A. B and C in table 4.1 are 3.690g/cm^3, 2.599g/cm^3 and 3.140g/cm^3 surface soil usually have lower particle densities than that of surface soil. For these reason, termite hill soil recorded higher particle densities because it is subsoil.

4.1.2 Percentage Porosity

Normally, porosity decreases down the depth as a result of decrease in pore space. Termite hill soil sample in table 4.0 porosities are 21.19%, 25.89% and 40.80% while the soil (control) samples A, B and C in table 4.1 porosities are; 37.58%, 36.82 and 53.62%. The decrease in the value of the porosities for termite hill soil shows that it is a sub soil.

4.1.3 Percentage Sand, Silt and Clay (Texture)

Textural class of termite hill soil where mostly sandy clay. This is because termite, dig downs to a considerable depth to obtain its soil for building. The dominant soil proportion soil in termite hill is mostly clayey. From table 4.1, the percentage sand, silt and clay for sample A, B and C soil are (55.68%, 5.28%, 31.04%), (49.68%, 5.28%, 45.04%) and (63.69%, 5.28%, 31.04%) while the termite hill soil are, (45.12%, 11.28%, 43.60%), (33.12%, 37.28%, 29.60% and (49.12%, 7.28%, 43.60%)

4.1.4 Soil pH

There was differences between the termite hill soil and soil (control) in table 4.2 and 4.3, As a result of termite activities on the soil. The soil control (0.01M) $CaCl_2$. The termite hill soil for the corresponding sample where 6.21 and 5.03 in (0.01M) $CaCl_2$. soil PH in (H_20) when recorded the values for (soil) (control) and termite hill soilas: 6.75, 6.05, 7.21 and 5.79, 6.05, 7.38 respectively.

4.1.5 Soil Organic Matter

The percentage organic matter content for the termite hill soil sample A, B andC are: 3.24%, 1.33% and 2.25% while the soil organic matter content A, B and C for soil sample A,B and C are: 0.91% , 0.52% and 1.9%respectively The organic content in termte hill soil is higher than that of soil(control).For this reason,the soil fertility of termite hill is increased..

4.1.6 Soil Organic Carbon

Organic carbon is a constituent's part of organic matter. Usually, organic matter availability in the soil depends on the amount of carbonaceous constituent present. The organic carbon content in the one termite hill soil are 1.88%, 0.77% and 1.31% for sample A,B and C. while the soil (control) organic carbon are 0.53%, 0.52% and 1.19%. The result shows a decrease in organic carbon content for each of the (soil) control, due to difference in organic matter level between the termite hill soil and soil (control).

4.1.7 Soil Nitrogen

Nitrogen content of the termite hill soil was observed to have increased when compared to the soil (control) close to the termite hill. The nitrogen content in termite hill soil in table 4.2 are 0.80%, 1.10% and 2.8% while the control (soil) A, B and C sample nitrogen content are:0.72%, 0.61% and 0.63% see table 4.3 organic matter level in the termite hill soil, since the two are directly proportional. These soils are very fertile for agricultural practices.

4.1.8 Soil available Phosphorus

Phosphorus is normally not readily available in most soils especially in tropical region. However, their availability depends mainly on the pH level of the soil and organic matter level. The phosphorus content of the termite hill soil sample A, B and C are 0.21, 0.14 and 0.16pm where the soil (control) samples are 0.22, 0.20 and 0.19 (ppm) respectively.

4.1.9 Exchange Cation

Termite hill soil samples were mostly neural this could be as a result of equal caution and anion in the soil, after the soil was initially the soil (control) where slightly acidic, the reasons for soil acidity is caused by displacement of the cautions with hydrogen ion (H^+).

Table 4.0 Test For Physical Properties of Termite Hill Soil

Libratory number	Sample description							
	Termite hill soil	Bulk density (g/cm^3)	Particle density (g/cm^3)	Porosity (%)	Sand (%)	Silt (%)	Clay (%)	Textural class
A	SSD-01	2.232	2.832	21.19	45.12	11.28	43.60	SC
B	SSD-02	1.961	2.646	25.89	33.12	37.28	29.60	SCL
C	SSD-03	1.973	3.333	40.80	49.12	7.28	43.60	SC

Where,SC=Sandy Clay,

SCL= Sandy Clay Loamy.

Table 4.1 Test For Physical Properties of Soil (Control)

Libratory number	Sample description							
	Control (soil)	Bulk density (g/cm^3)	Particle density (g/cm^3)	Porosity (%)	Sand (%)	Silt (%)	Clay (%)	Textura class
A	SSD-01	1.804	2.690	37.58	55.68	3.26	41.04	SC
B	SSD-02	1.712	2.599	36.83	49.68	5.28	45.04	SC
C	SSD-03	1.914	3.140	53.62	63.68	3.28	31.04	SCL

Where, SC=SandyClay

SCL=Sandy Clay Loamy

Table 4.2 Test For Chemical Properties of Termite Hill Soil

Laboratory number	Sample description	pH						Exchange Cation (cmo/kg^{-1})			
	Termite hill soil	1.26 $CaCl_2$ (0.01M)	1.26 H_20	O.M	O.C (%)	N	Avail P (ppm)	Na^+	K^+	Ca^{2+}	Mg^{2+}
A	SSD-01	6.21	6.75	3.24	1.88	0.80	0.21	5.50	2.40	6.40	6.72
B	SSD-02	5.03	6.05	1.33	7.00	1.10	0.14	7.00	2.40	6.20	4.6
C	SSD-03	6.34	7.21	2.25	1.31	2.80	0.16	5.40	2.30	7.52	1.12

Where: O.M = Organic Matter

O.C: = Organic Carbon

N = Nitrogen

P = Phosphorus

Table 4.3 Test For Chemical Properties of Soil (Control)

Laboratory number	Sample description	pH						Exchange cation (cmo/kg^{-1})			
	Termite hill soil	1.26 cacl$_2$ (0.01M)	1.26 H_20	O.M (%)	O.C (%)	N (%)	Avail P (ppm)	Na^+	K^+	Ca^{2+}	Mg^{2+}
A	SSD-01	4.29	5.79	0.91	0.53	0.72	0.22	5.52	0.77	3.04	4.32
B	SSD-02	4.54	6.05	0.52	0.30	0.61	0.20	0.69	0.26	3.20	1.44
C	SSD-03	6.30	7.38	1.19	0.69	0.63	0.19	0.61	0.31	3.36	1.12

Where: O.M = Organic Matter

O.C: = Organic Carbon

N = Nitrogen

P = Phosphorus

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

From the tests carried out, the properties of termite hill soil will improve the soil agricultural usage if it is used for soil cultivation, this was as a result of it's high organic matter content, high nitrogen content and soil pH concentration being changed from slightly acidic to neutral.

5.2 Recommendations

i. Termite hill soil can also be used as a farm construction material if the organic matter content can be treated since it is a sub soil the organic matter can be reduced by heating it in kiln to burn the plants and animals debris.

ii. Research should be carried out on how the termite can be encouraged to build more mound so that, it can be ultilised, since they are relatively scarce.

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