IMPACT OF GARBAGE DISPOSAL ON SOIL TEXTURE, POROSITY AND CATION EXCHANGE CAPACITY IN GWADAN GWAJI TOWN, KEBBI STATE, NIGERIA

Zainab Lawal Gwandu [1]
Email: zainablawalgwandu@gmail.com
Sagir Muhammad [2]
1: Department of Education Foundation, Kampala International University, Uganda
2: Department of Science Education, Kebbi State University of Science and Technology, Aliero

ABSTRACT

This paper reports on a survey of Impact of Garbage Disposal on the Soil Texture, Porosity and Cation Exchange Capacity in Gwadan Gwaji town, in particular the soil texture; and the porosity, organic carbon, the soil cation exchange capacity and the phosphorus in the soil in Gwadan Gwaji town, in Kebbi state, Nigeria. The findings were that garbage disposal has an impact on the soil composition in Gwadan Gwaji, given the fact that as chemicals agents in the garbage continue to interact with the soil, the composition of the soil in question changes its content over time. Therefore, there is need to gazette garbage disposal grounds, and take precautionary measures to ensure that the effects of garbage on the soil are minimized.

Keywords: Garbage Disposal; Soil Texture; Porosity; Cation Exchange Capacity

Introduction

Garbage disposal is a serious problem in Nigeria and the countries of the developing world at large, where indiscriminate disposal is evident today. Disposal sites contain paper, food waste, leaves and vegetable waste, ashes among others. The soil has traditionally been an important medium of organic waste disposal (Marshal et al. 1999), and the soil is the primary recipient of solid waste (Myles and Ray, 1999).

These wastes end up interacting with the soil system thereby changing the physical and chemical properties. According to Anikwe (2000), garbage amended soil has a high content of organic matter. Soil organic matter increases the degree of aggregation and aggregate stability (Mbagwu and Piccolo, 1990). According to Anikwe and Nwobodo (2001), garbage increases nitrogen, Ph, caution exchange capacity, percentage base saturation and organic matter.

Garbage disposal in Gwadan Gwaji is done in such a haphazard manner; garbage is dumped alongside the roads, street alleys, in uncompleted buildings and in bushy areas. Garbage is also dumped on unused land, in gardens, pits and in drainage channels. This has a potentially dangerous impact on the soils where the garbage is dumped. The effect of garbage disposal on soil was analyzed by examining soil samples from various dumpsites for the texture and structure of the soil, to show how the interaction of garbage with soils changes its composition and properties.

Research hypotheses

The study was guided by the following hypotheses:

1. The disposal of garbage has no significant impact on soil texture in Gwadan Gwaji town, in Kebbi state, Nigeria.
2. The disposal of garbage has no significant impact on the porosity, organic carbon and the soil C.E.C in the soil in Gwadan Gwaji town, in Kebbi state, Nigeria.

Method

The study was conducted following soil samples obtained from various sites within Gwadan Gwaji. Soil samples were obtained from three different natural dumping sites. Soil samples were also collected from a forth site, which was the control area, a place with no garbage disposal activity. Samples from all the sites were collected in Ziploc bags and transported to the laboratory for analysis. The results obtained from laboratory tests on the soil samples were used to assess the chemical properties in the garbage and their interaction with the various soils in the dumpsites. Cluster Analysis (CA) and Factor analysis (FA): CA was performed to classify elements of different sources on the basis of their similarities using dendrograms and to identify relatively groups of variables with similar properties. FA was employed on the variables that are correlated to isolate or determine specific factors that are associated with the various soil compositions.

Findings

The study was carried out based on two specific objectives: to examine the soil texture; and to assess the porosity, organic content, the soil C.E.C and the phosphorus in the soil in Gwadan Gwaji town, in Kebbi state, Nigeria. The study used four different sample sites, labeled as the control site, site A, site B and site C, to collect soil samples for the study.

Determination of the Soil Texture

The study aimed to assess the soil texture of the soil in the different sample sites in Gwadan Gwaji town, Kebbi state in northern Nigeria. In order to achieve this, the hydrometer method of soil mechanical analysis (sand, silt and clay) was used.

Apparatus:

1. Multi-mix machine with baffled “milkshake” cups
2. Glass cylinders of approximately one liter capacity for containing soil suspension during settling
3. Special hydrometers for measuring density of soil suspension

Reagent:

Sodium hexameta-phosphate dispersing agent - 5%

Procedure:

Weigh 51g of air-dry soil which has been passed through a 2mm sieve and transfer it to a “milkshake” mix cup (a 51g air-dry sample represents approximately 50.0g of oven-dry soil). If the soil is estimated to contain 75% or more sand, 101.0g of soil are used. Add 50cc of 5.0% sodium hexametaphosphate along with 100cc of distilled water. Mix with a stirring rod and let the sample set for 30 minutes.

Stir the soil suspension for 15 minutes with the multimix machine. Transfer the suspension from the cup to the glass cylinder. With the hydrometer in the suspension, add distilled water to the lower blue line. The volume will then be 1130cc. use the upper line (1250cc) when 100g are used. Remove the hydrometer cover top of the cylinder with the hand and invert several times until all the soil is in suspension. Place the cylinder on a flat surface and note the time. Slide slowly in the suspension until the hydrometer is taken at 40 seconds after the cylinder is set down. Remove the hydrometer and record the temperature of suspension with a thermometer.

After the first hydrometer reading, let the suspension stand for 3 hours and then take the second reading. Also take the temperature of the suspension. The first reading measures the percentage of silt and clay in the suspension. The second reading indicates the percentage of 2 micron (total clay in the suspension). Results are corrected to a temperature of 63^0 Fahrenheit. For every degree over 68^0 add 0.2 to the hydrometer reading before computation and for under 68^0 subtract 0.2 from the hydrometer reading.

Samples calculation:

Given:

1a – Hydrometer reading at 40 seconds, H_1
1b – Temperature reading at 40 seconds, T_1
2a – Hydrometer reading at 3 hours, H_2
2b – Temperature reading at 3 hours, T_2
3 – Temperature correction to be added to the hydrometer reading = 0.2, where T = degrees Fahrenheit
4 – Silt correction to be added to the hydrometer reading = -2.0

Calculations to show the individual and arithmetic average percentage for each soil texture:

A – SAND = $100[H_1+0.2(T_1-68)-2.0]^2$

B – CLAY = $[H_2+0.2(T_2-68)-2.0]^2$

C – SILT = 100-[%sand+%clay)

Table 1: Showing the Impact of Garbage Disposal on Soil Texture

Sample site	Hydrometer reading at 40 sec (H1)	Temp. reading at 3 sec. (T1)	Hydrometer reading at 3 hrs. (H2)	Temp. reading at 3 hrs. (T2)	Percentage of Sand	Percentage of Silt	Percentage of Clay
Control site	5	25	2	25	91.2	5.9	2.9
Site A	5	25	2	25	91.2	5.9	2.9
Site B	6	25	3	25	89.2	5.9	4.9
Site C	7	25	4	25	87.3	5.8	6.4

Table 1 indicates the impact of garbage disposal on soil texture within four different sites in Gwadan Gwaji. Where the control site had 91.2% of sand, 5.9% of silt and 2.9% of clay. Site A had 91.2% of sand, 5.9% of silt and 2.9% of clay. Site B had 89.2% of sand, 5.9% of silt and 4.9% of clay, whereas site C had 87.3% of sand, 5.8% of silt and 6.9% of clay.

The above results revealed that in site B and C, there is an impact of garbage disposal on the soil texture which reduces the percentage of sand and increases the percentage of silt and clay in the soil when compared with the control site. This implies that over time, garbage disposal has an impact on the soil texture by increasing the concentration of silt and clay in the soil.

Determination of Porosity in the Soil

The study was also aimed at assessing the porosity of the soil. In the lab, it was realized that the determination of soil porosity requires two procedures, that is; the determination of bulk density and particle density of the soil samples, and this gives the porosity of the soil.

Materials:

1. Core sampler
2. Pyconometer bottle/volumetric flask
3. Mittler balance
4. Dry oven
5. Distilled water
6. Amyl alcohol
7. Beaker 350mg

Therefore Porosity $= 1 - \frac{bd}{pd} \times 100$ = porosity gmc^3

Where: bd – Bulk density
Pd – Particle density

Procedures for Determining the Bulk Density

Weigh the soil in a core sampler to take the measurement of each soil sample. Place the beaker on the mittler balance to take the weight of the soil. Then add distilled water into the beaker containing the soil. Weigh it again then transfer the soil sample from the beaker into a can. Dry it in the oven at 1.0^{o}C for 24 hours. Use the mittler balance again to take the reading. This procedure is carried out for all the four samples of the soil. Bulk density can be calculated using the formula:

Bulk density $= \frac{\text{Dry weight of the soil} \quad \text{gcm}^3}{\text{Volume of the core sampler}}$

Table 2: Showing the Bulk Density of the Sampling Soils

Sample site	Empty can (W1)	Sample weight (W2)	Sample dry (W3)	W3 – W1 (127.4)
Control site	25.4	20.84	208.1g	1.43
Site A	25.4	192.5	191.6g	1.30
Site B	25.4	210.7	210.3g	1.45
Site C	25.4	212.2	211.6g	1.44

The results in table 2 show the bulk density of the soil in different sample sites, where there is a very significant increase in the sample weight from 20.84 in the control site to 192.5 in site A, followed by a slight increase to 210.7 in site B and then further to 212.2 in site C. These results indicate that garbage disposal increases the bulk density of the soil significantly as compared to the control site.

Procedure for Determining Particle Density

Weigh the pycnometer bottle or volumetric flask of a known weight of bottle (wb) = 61.08g. Fill the bottle to mark the volume flask (vb=100ml). While for the pycnometer, u fill it with sample soil of 30g and distilled water of 100ml and cock it. Weigh the bottle with water i.e. wbw = 160.65g.

Pour out the water in the pycnometer bottle then transfer the soil sample from the bottle into the can and dry it in the oven. After drying it, then place it again on the mittler balance to take the reading. From this the data for particle density can be calculated using the formula:

$$\text{Particle density (dw)} = \frac{wbw - wb}{vb} = dw\ 0.952$$

Where: wbw – weight of bottle + water
wb - weight of bottle
vb - volume of the bottle

Table 3: Showing the Particle Density of the Soil Sample

Sample site	**Empty bottle**	**Empty bottle + water**	**Soil and water**	**Final result**
Control site	18.5	42.3	48.7	2.64gcm^3
Site A	18.5	42.3	48.4	2.44gcm^3
Site B	18.5	42.3	48.6	2.57gcm^3
Site C	18.5	42.3	48.7	2.8gcm^3

In table 3, measures of the particle density show a slight reduction in the level of soil and water from 48.7 in the control site to 48.4 in site A. This reduction is also reflected in the final results where there is a reduction from 2.64gcm^3 in the control site to 2.44 gcm^3 in site A. However, this reduction is reversed as site B shows an increased in the soil and water to 48.6 and final result of 2.57 gcm^3. The same increased is seen further in site C with a soil and water level of 48.7 and a final result of 2.8 gcm^3. This shows that particle density initially drops when garbage is first disposed of in the soil, but gradually increases with time.

Procedure for determining soil porosity

Table 4: Showing the Soil Porosity

Sample site	**Bulk density**	**Particle density**	**Porosity**
Control site	1.43	2.64	54.16
Site A	1.30	2.44	53.28
Site B	1.45	2.57	56.42
Site C	1.44	2.30	51.43

The results in table 4 show the porosity of the soil in the different sample sites. The bulk and particle density show an initial drop from 1.43 and 2.64 in the control site respectively to 1.30 and 2.44 in site A respectively. These results are then increased to 1.45 and 2.57 bulk and particle density respectively in site B before dropping again to 1.44 and 2.30 respectively in site C. The porosity also follows the same pattern, where it initially drops from 54.16 in the control site to 53.28 in site A, before increasing to 56.42 in site B, and then dropping again to 51.43 in site C. These results show that there is a fluctuating level of soil porosity in the soil where garbage has been disposed of over time.

Table 5: Showing Summation of the Porosity and Texture Content in the Soil

Sample site	**Bulk density (gcm^3)**	**Particle density (gcm^3)**	**Porosity (%)**	**Texture**
Control site	1.43	2.64	54.16	Sand
Site A	1.30	2.44	53.28	Sand
Site B	1.45	2.57	56.42	Sand
Site C	1.44	2.30	51.43	Sand

Table 5 shows a summation of the results on the porosity and soil texture content. The porosity in the control site is shown to be at 54.16%, and in site A it's at 53.28%. Site B shows a porosity of 56.42% and site C shows a porosity of 51.43%. With the porosity in all sites being above 50%, the texture of the soil in all the sample sites was judged to sand. This therefore shows that whereas garbage disposal increases the concentration of slit and clay in the soil, the increase in the concentration is not significant enough to alter the general texture content on the soil.

Determination of the Soil pH

Apparatus:

Glass-electrode pH meter

Materials:

- 0.01M calcium chloride
- Distilled water
- 1N potassium chloride

Procedure:

Soil in H_2O (1:1 soil to water ratio)

1. Weigh 20g of air-dry soil (passed in a 2mm sieve) into a 50-ml beaker. Add 20 ml of distilled water and allow it to stand for 30 minutes and stirring occasionally with a glass rod.
2. Insert the electrodes of the pH meter into the partly settled suspension and measure the pH. Do not stir the suspension during measurement
3. Report the result as "soil pH measured in water"

Soil pH in 0.01M $CaCl_2$

1. Prepare a 1:2 (soil:0.01M $CaCl_2$) suspension (10g of soil and 20ml of solution).
2. Let the suspension stand for about 30 minutes and stir occasionally with a glass rod
3. Measure pH and report result as "soil pH measured in 0.01M $CaCl_2$"

Table 6: Showing the Soil pH

Sample site	Soil pH 1:1 ratio	E.C/ms (mill siemens) 1:5 ratio	Temperature (^oC)
Control site	4.74	0.28	24.6
Site A	6.72	0.09	24.6
Site B	7.67	0.33	24.5
Site C	8.03	0.87	24.5

Table 6 shows the results on the soil pH, where the E.C reduces from 0.28 in the control site, to 0.09 in site A, before increasing to 0.33 in site B and further to 0.87 in site C. the temperature remains constant at 24.6 ^oC and slightly drops to 24.5^oC in site B and C. There is a steady increase in the soil pH itself from 4.74 in the control site to 6.72 in site A, to 7.67 in site B and further to 8.03 in site C. This implies that garbage disposal gradually decreases the concentration of soil pH in the soil over time.

Determination of Organic Carbon in the Soil by Walkley-Black Method

Apparatus:

Burettes, 50ml or 25ml

Materials:

1. Potassium dichromate ($K_2Cr_2O_7$) 1N – dissolve 49.04 of $K_2Cr_2O_7$ in distilled water and dilute to 1 liter
2. H_2SO_4 conc. If chloride (Cl) is present in the soil add Ag_2SO_4 to the acid at the rate of 15g per liter
3. O-phosphoric acid (H_3PO_4), conc.
4. O-phenanthroline-ferrous complex 0.025M (Ferroin).
5. Barium diphenylamine sulropate (0.16%)

6. Ferrous sulfate (0.5N) – dissolve 140g of $FeSO_27H_20$ in water; add 15ml conc. H_2SO_4 cool and dilute to 1 liter. Standardize this reagent daily, or each time before using for organic C determination by titrating against 10ml $1NK_2Cr_20_7$.

Procedures:

a) Take a representative sample and grid to pass through a 0.5mm sieve.
b) Weigh out soil samples in duplicate and transfer to 250ml Erlenmeyer flasks (1.00g should be used if the organic C content is between 1 and 3%; 2.00g if it's less than 1%)
c) Pipatte 10ml or $1NK_2Cr_20_7$ solution accurately into each flask and swirl gently disperse the soil.
d) Add rapidly 20ml conc. H_2SO_4 using an automatic pipette, directing the stream into the suspension. Immediately swirl the flask gently until soil and reagents are mixed, then swirl more vigorously for one minute. Rotate beaker again and allow the flask to stand on a sheet of asbestos for about 30 minutes
e) Add 100ml of distilled water after standing for 30 minutes
f) Add 3-4 drops of indicator and titrate with 0.5N ferrous sulfate solution. As this end point is approached, the solution takes on a greenish cast and then turns to dark green. At this point, add the ferrous sulfate drop by drop until the color changes sharply from blue to red (maroon color) in reflected light against a white background
g) Make the blank titration in the same manner, but without soil (steps 3, 4, 5 and 6) to standardize the dichromate
h) Calculate the results according to the following formula:

$$\% \text{ organic C in soil (air-dry)} = \frac{(\text{me K2Cr207} - \text{me FeSO4}) \times 0.003 \times 100 \times (f)}{\text{G of air-dry soil}}$$

Where:
Correction factor (f) = 1.33
Me – Normality of solution x ml of solution used
% organic matter in soil = % organic C x 1.729

Table 7: Showing the Organic Carbon in the Soil

Sample site	Titration volume	Final result (%)
Control site	25.7	1.14%
Site A	17.9	0.42%
Site B	20.1	0.02%
Site C	24.5	0.90%

The results in table 7 above show the concentration of organic carbon in the soil when exposed to garbage. The results show that the titration volume initially drops from 25.7 in the control site to 17.9 in site A, and then an increase to 20.1 in site B and a further increase to 24.5 in site C. The final results also show a significant drop from 1.14% in the control site to 0.42% in site A, and an even further drop to 0.02% in site B, before a significant increase to 0.90% is realized in site C. This shows that when garbage is disposed of in the soil, the organic carbon content in the soil falls significantly, before it starts to increase again over time.

Determination of Nitrogen in the Soil

Procedure:

1. Put 2g of soil in a microjalder flask/microjalder digestion tube, then put a catalyst, i.e., digested tablet in the tube, then add concentrated saturated acid 10ml in the tube where the 2g of soil and catalyst are.
2. Then put it in the digestion block/heater, leave it for 1 hour to digest. After 1 hour, remove it from the heater and allow it to cool. After cooling, add 50ml of distilled water into a microjalder digestion tube.
3. After that, then put 20ml of boric acid into a conical flask, add 10ml of the digested solution. Put it in a microjalder machine to titrate and take the reading.

Table 8: showing the Nitrogen in the Soil

Sample site	**Titration volume**	**Final result (%)**
Control site	1.0	0.035%
Site A	2.4	0.084%
Site B	1.6	0.056%
Site C	1.3	0.046%

The results in table 8 show the level of nitrogen in the soil before and after garbage disposal. The results indicate a significant initial increase of more than 100% in the nitrogen levels from 1.0 titration volume and 0.035% final result in the control site to 2.4 titration and 0.084 final result in site A. However, the readings in site B and C show a reduction to 1.6 and 1.3 titration and 0.056% and 0.046% final results respectively. This shows that garbage disposal significantly increases the level of nitrogen in the soil in the initial stages, but that this increase starts to diminish with time as the chemicals in the garbage are absorbed in the soil.

Cation Exchange Capacity (C.E.C) of the Soil

The cation exchange capacity is defined as the sum of total exchangeable cations held in a soil, and is expressed as milliequivan=lent per 100g soil on an oven-dry weight basis. There are various methods used in determining the C.E.C, but for this study, the titration method was used.

Procedure:

1. Weigh 5g of air-dry soil in a 250ml Erlenmeyer flask. Add 20ml of $1NNH_4OA_c$ solution and shake well on a shaker for half an hour or more. Standing for 24 hours with occasional shaking by hand also serves the same purpose.

2. Filter the saturated soil on a Suchner funnel. Wash with another 20ml volume of NH_4OA_c using 50ml for each washing. Save filtrate plus washings in a 250ml volumetric flask (this will be used for determination of exchangeable bases in another experiment after making to the volume).
3. Wash soil residue on Suchner funnel with two 50ml portions of methyl alcohol.
4. Transfer washed-soil plus filter paper in another Erlenmeyer flask. Add 20ml KC1 and shake on a shaker for 30 minutes.
5. Filter on Suchner funnel, wash two times with 50ml portions of the KC1 solution. The total volume of filtrate plus washings should not exceed 400ml.
6. Transfer the filtrate into a 800ml Kjeldahl flask and set on the distillation rack.
7. Add 20ml NaOH from the side arm and receive the distillate in 20ml boric acid solution plus a few drops of the mixed indicator contained in a 250ml Erlenmeyer flask kept under the delivery tube. Continue distillation until $2/3^{rd}$ of the content is distilled.
8. Titrate the distillate with standard O-1M HCL solution.
9. Run a blank containing 400ml KCL solution only.
10. Calculate the C.E.C as follows:

$$\text{C.E.C} = \frac{\text{ml of H2SO4 x normality of H2SO4 x 100}}{\text{Oven-dry weight of soil}} \quad \text{m.e./100g of soil}$$

Determination of Sodium (Na) by Flame Photometer Reading

<u>Materials:</u>

1. Soil extract (neutral normal ammonium acetate extract from experiment on C.E.C.
2. Standard Na stack solution – dissolve 2.542g of NaC1 (dried at 110oC) in distilled water and dilute to 1 liter. This solution contains 100ppm Na.

<u>Procedure:</u>

1. Set the flame photometer for Na by inserting appropriate filter (589 mu wavelength)
2. Set the instrument to 100 percent transmittance by feeding 25mmp Na solution
3. Run the soil extract
4. Calculate the amount of Na present in the soil as milli-equivalent per 100g oven-dry weight of the soil by getting Na concentration in the extract from the standard curve. Make sure that you have considered all dilutions in making calculations.

Table 9: Showing the Sodium (Na) in the Soil

Sample site	Flame photometer reading	Na reading/atomic number
Control site	11	0.48cmol/kg
Site A	13	0.57cmol/kg
Site B	24	1.04cmol/kg
Site C	47	2.04cmol/kg

The results in table 9 above show a steady increase in the level of sodium concentration in the soil. From the frame photometer reading of 11 and Na reading of 0.48cmol/kg in the control site, these results increase to frame photometer reading of 13 and Na reading of 0.57cmol/kg in site A, and then increases to a frame photometer reading of 24 and Na reading of 1.04cmol/kg in site B. The results further increase to 47 frame photometer reading and 2.04cmol/kg Na reading in Site C. These results show that there is a steady increase in the concentration of sodium in the soil upon contact with the soil, as there an increase in both the frame photometer and Na readings in site A, B and C in relation to the control site.

Determination of Potassium (k) by Flame Photometer Reading

Materials:

1. Soil extract (neutral normal ammonium acetate extract from experiment on C.E.C.
2. Standard K stack solution – dissolve 0.9533g of dried KC1 in distilled water and dilute to solution to 500ml in a volumetric flask, and mix it. This solution contains 1000ppm K. from here prepare K standard solutions by pipetting suitable aliquete such that the final solutions range in concentration from 0 – 25ppm K.

Procedure:

1. Set the flame photometer for K by inserting appropriate filter (768 mu wavelength)
2. Set the instrument to 100 percent transmittance by feeding 25mmp K solution
3. Run all the standard solutions and prepare standard curve by plotting transmittance readings against concentration of standard K solution
4. Run the soil extract
5. Calculate the amount of K present in the soil as milli-equivalent per 100g oven-dry weight of the soil by getting K concentration in the extract from the standard curve. Make sure that you have considered all dilutions in making calculations.

Table 10: Showing the Potassium (K) in the Soil

Sample site	Flame photometer reading	k reading/atomic number
Control site	19	0.49cmol/kg
Site A	27	0.69cmol/kg
Site B	13	3.33cmol/kg
Site C	24	6.15cmol/kg

Table 10 above shows the potassium levels in the soil before and after garbage disposal has taken place. The flame photometer readings are varying in all the sample sites where the control site gives a reading of 19, and 27 for site A, 13 for site B and 24 for site C. However, the K readings show a steady increase in the level of potassium concentration from 0.49cmol/kg at the control site, to 0.69cmol/kg in site A, which increases by more than 70% to 3.33cmol/kg in site B, and then almost doubles to 6.15cmol/kg in site C. This shows that the level of potassium concentration in the soil increases at a significant rate over time in sites where garbage is disposed off in the soil.

Discussions Conclusions and Recommendations

The study aimed to examine the soil texture and porosity, as well as soil pH, organic carbon, Nitrogen, the cation exchange capacity and the phosphorus in the soil. The results of the study are discussed as follows;

Impact of Garbage Disposal on Soil Texture

On the impact of garbage disposal on soil texture within four different sites in Gwadan Gwaji, the results show that the control site had 91.2% of sand, 5.9% of silt and 2.9% of clay. Site A had 91.2% of sand, 5.9% of silt and 2.9% of clay. Site B had 89.2% of sand, 5.9% of silt and 4.9% of clay, whereas site C had 87.3% of sand, 5.8% of silt and 6.9% of clay. The results revealed that in site B and C, there is an impact of garbage disposal on the soil texture which reduces the percentage of sand and increases the percentage of silt and clay in the soil when compared with the control site, implying that over time, garbage disposal has an impact on the soil texture by increasing the concentration of silt and clay in the soil.

This is in line with the findings of Oades (1993), who found out that when the organic matter content of a soil exceeds 20 to 35% (on a dry weight basis) it is considered organic soil material, and the soil is called an organic soil, consisting of: peat (organic material in which the plant parts are still recognizable), muck (highly decomposed organic material in which no plant parts are recognizable) and mucky peat (decomposition is intermediate between muck and peat).

Impact of Garbage Disposal on the Porosity of the Soil

When determining the soil porosity, it was realized that two procedures are required, that is; the determination of bulk density and particle density of the soil samples. And from the results of the tests, it was revealed that the bulk density was such that there was a very significant increase in the sample weight from 20.84 in the control site to 192.5 in site A, followed by a slight increase to 210.7 in site B and then further to 212.2 in site C, indicating that garbage disposal increases the bulk density of the soil significantly as compared to the control site.

On the particle density, the results revealed that there was a slight reduction in the level of soil and water from 48.7 in the control site to 48.4 in site A. This reduction is also reflected in the final results where there is a reduction from 2.64gcm^3 in the control site to 2.44 gcm^3 in site A. However, this reduction is reversed as site B shows an increased in the soil and water to 48.6 and final result of 2.57 gcm^3. The same increased is seen further in site C with a soil and water level of 48.7 and a final result of 2.8 gcm^3. This shows that particle density initially drops when garbage is first disposed off in the soil, but gradually increases with time.

The impact of garbage disposal on the cation exchange capacity

The study concluded that generally, garbage disposal increases the concentration of sodium, potassium, calcium, magnesium and phosphorus in the soil. Therefore, this meant that as the garbage comes into contact with the soil, the chemical concentration in the soil increases rapidly initially, but that the concentration becomes gradual over time. The researcher thus concluded from the above results that garbage disposal impacts on the chemical composition of the soil over time.

References

Agagu, O. K., (2009). Threats to the Nigerian environment: a call for positive action. Being a paper delivered at the 2009 Chief S.L. Edu Memorial Lecture, Nigerian Conservation Foundation, Lagos. 42pp Awake., 2002. Garbage will it Bury us? August 22, 83(16)

Arshad MA, Lowery B, and Grossman B. (1996). Physical Tests for Monitoring Soil Quality. In: Doran JW, Jones AJ, editors. Methods for assessing soil quality. Madison, WI. p 123-41.

Aziegbe, F. I. (2007).: Sediment sources, redistribution and management in Ekpoma, Edo State, Nigeria Journal of Human Ecology.

Aziegbe, F.I. (2007b). Seasonality and Environmental Impact status of polythene (cellophane) generation and disposal in Benin City, Nigeria. Journal of Human Ecology, 2(2): 141-147.

Baker, R. (2002). "Ministerial Brief: Plastic Bag Levy." Website. Accessed November 22, 2005. http://sres.anu.edu.au/people/richard_baker/examples/briefing/minty/Minty.html

Carroll, Dorothy (2009). Ion exchange in clays and other minerals. Geological Society of America Bulletin 70 (6): 749-780

Charman, P.E.V.; Murphy, B.W. (2000). Soils, their properties and management (2nd edn ed.). Melbourne: Oxford University Press.

Dede, D. C., (2000). Urban solid waste generation disposal systems and pattern. Journal of Urban Development, 5(1): 66-79.

Diaz, L. et al. *Solid Waste Management, Volume 2.* UNEP/Earthprint, 2006.

Donahue, Miller, Shickluna (2007). Soils: an introduction to soils and plant growth (4 ed.). Inglewood Cliffs, New Jersey 07632: Prentice- Hall.

EduGreen. 2005. "Health Impacts of Water Pollution." Website. Accessed December 18, 2005. http://edugreen.teri.res.in/explore/water/health.htm

Edward J. M., James H. J.Jr, (1987). Hazardous Waste Management Engineering, published by Van Nostrand Reihold Company Inc. New York.

George, T., Hillary, B. and Samuel, A. V., (1993). Integrated Solid Waste Management. McGraw-Hill Inc., London, Pp. 46-47.

Graedel TE and Allenby BR (1995) *Industrial Ecology*. Prentice Hall, Englewood Cliffs, New Jersey.

Havlin, Tisdale, Beaton, Nelson (2011). Soil Fertility and Fertilizers. New Delhi: PHI.

Hempel CG (1966) *Philosophy of Natural Science*. Prentice Hall, Upper Saddle River, New Jersey. ISBN 0-13-663823-6.

Institute for Lifecycle Environmental Assessment. (1990). "Paper vs. Plastic Bags."

Lajeunesse, S. (2004). "Plastic Bags." *Chemical and Engineering News* 82(38): 51. Lane,

Matlack, A. (2001). *Introduction to Green Chemistry*. New York, NY: Marcel Dekker.

Miller, G. T. (2005). *Sustaining the Earth: An Integrated Approach*. Pacific Grove, CA: Thomson Brooks/Cole.

Nanda, H. S.(2011)."Impact of Municipal Solid Waste Disposal on Geotechnical Properties of Soil", Proceedings of Indian Geotechnical Conference December 15-17, Kochi. Paper NoL-183, pp. 715-716.

Oades, J.M., (1993). The role of biology in the formation, stabilization and degradation of soil structure. Geoderma, 56: 377-400.

Oades, J.M., (1984). Soil organic matter and structure stability: mechanisms and implications for management. Plant and Soil, 76: 319-337.

Obediah, C. U., (2001). The impact of waste disposal on soil biochemical activities. Environmental Analysis, 8(2): 86 – 105.

Odjugo, P. A. O., (2004). Polyethylene generation and disposal in Benin City, Nigeria. Benin Journal of Social Sciences.