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Research Article

Physicochemical Characteristics of Soils and of Associated Roots of Cucurbits (*Lagenaria guineensis* and *Luffa aegyptica*) in Open Waste Dump Sites

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Abstract

Waste degradation process in waste dump involves not only biological process, but also interrelated physical and chemical processes. Plant roots are involved in the uptake of mineral nutrients and water for plant growth. This study aimed to determine the cation exchange capacity of soils by evaluation of physicochemical parameters including cations of soils and roots of Cucurbits in waste dumps. Results revealed soil pH ranged from 5.87 - 6.65. Values of phosphate ranged from 2.34 mg/kg to 20.2 mg/kg in the soils and from 45.1 to 127.5 mg/kg in the roots. Sulphate ranged from70.9 mg/kg to 269 mg/kg in the soils and from 348 to 581 mg/kg in the roots. Ammonium was negligible (<0.02 mg/kg) in the soil samples. Values of Aluminium ranged from 1,172 mg/kg to 2,952 mg/kg in the soils and from 1,197 mg/kg to 2.847 mg/kg in the roots. Exchangeable Cations of Calcium (Ca^{2+}) ranged from <0.10 to 129 mg/kg in the soils and from 618 to 6,163 mg/kg in the roots, while Magnesium (Mg^{2+}) ranged from 105 to 226 in the soils and from 917 to 1,563.5 mg/kg in the roots. Potassium (K^{+}) ranged from 114 to 643 mg/kg in the soils and from 3,515 to 10,050 mg/kg in the roots, while Sodium (Na^{+}) ranged from 906 to 1537 mg/kg in the soils and from 1,353 to 2,800 mg/kg in the roots. The roots removed metals from the soils and transferred to cucurbits. The values for cation exchange capacity (CEC) of the waste dump soil samples ranged from 13.0 Cmol/kg to 53.7 Cmol/kg and from 45.5 Cmol/kg to 87.1 Cmol/kg in the roots of cucurbits. Particle size density revealed the soils as sandy loam. The study revealed the nutrient status of waste dump soils and associated cucurbits and has ascertained the soil quality and the bioaccumulation of some ions by the roots of Cucurbits.

Keywords: Waste Dump Soil; Cucurbit; Cation Exchange Capacity; Ion Bioaccumulation; Magnesium; Potassium

Introduction

Urbanization, industrialization, social development and population increases and solid waste production are growing rapidly, making garbage pollution a serious problem [1]. Waste disposal poses threat to plants, animals and the soil. Physical and chemical hazards might be encountered at the waste site [2]. The composition of municipal solid waste in Port Harcourt is food waste, pa- per cardboard, faeces, screening residual, plastics, broken bottles, batteries, textiles, bones, glass, wood and leaves, ferrous metal, leather and rubber, non-ferrous metal, concrete, and ceramic and hazardous waste [3].

The soil has been considered convenient repositories for solid and liquid waste. However, while the production of waste is global, its management is not the same. In Rivers State and Nigeria as a whole, the mismanagement of waste has impacted negatively on motorable roads, drainage systems and immediate surroundings besides the proximity of dumpsites and untreated waste site to agricultural lands and drinking water sources thus resulting to socio- economic and health hazards including a general impact on the ecology of the environment [3].

Improper disposal of untreated municipal solid waste is not only harmful to human's health but also constitute a threat to ecological environment [1]. When waste is dumped on land, there is more or less a continued release of metals to be of great concern because of their toxic effects on organisms and ecosystem processes [4]. In particular contamination of soils may arise via land application of sewage sludge and fertilizers or from industrial sources. The generation and production of contaminants above the acceptable limit result in deleterious impact which is inhibition of nitrification that affects plants communities and this leads to photosynthetic drop that spreads throughout the ecosystem [5].

The root of plants are involved in the uptake of mineral nutrients and water for plant growth, but they also release a wide range of organic compounds in the surrounding soil [6]. The process of degradation of waste in waste dump involves not only biological process, but also interrelated physical and chemical processes. Whenever the physical or chemical environment is suddenly changed, the ecological functioning of the environment is also affected [7].

It is known that a major concern in applying municipal and industrial waste to Agricultural land is the enrichment of soils with metals such as Copper, Zinc, Cadmium Lead and Nickel [3]. Recently, a number of alternatives have been developed using plants, to clean up wastes [8]. These plants have been studied for their ability to remove metals from soils thereby treating waste - soil containing metal contamination [9]. Phytoremediation is used in absorbing, extracting, or neutralizing toxic compounds. Certain types of mustards and sunflowers can extract lead, arsenic, zinc, and other metals. Poplar trees can absorb and breakdown toxic organic chemicals. Reeds and other water-loving plants can filter water tainted with sewage, metals, or other contaminants [8]. Radioactive strontium and cesium have been extracted from soil near the Chernobyl nuclear power plant using common sunflowers [8].

One of the most important functions of soil is to provide nutrient to the root systems of plants, and to support their growth and development. Nutrient supply to plant roots is a very dynamic process. The interactions of numerous physical, chemical and biological properties in soils control plant nutrient availability [10].

Plant nutrients (cations and anions) are absorbed from the soil solution and release small quantities of ions (H^+, OH_3^-, and HCO^-) back to the solution [10].

During utilization of energy sources by macro and microphytes, complex organic materials are utilized, which results in the release of carbon dioxide and also the release of inorganic plant nutrients such as Nitrogen, Phosphorus and Sulphur [5]. When considering the problems of phytotoxicities and food chain transfer, knowledge of bioavailability becomes important. This is because it is desirable to estimate or even reduce the bioavailability of trace elements. Bioavailability is the possibility that micronutrients in soil environment will cause either positive or negative effect [11].

The Cucurbitaeceae family is a plant group with the most species widely used for bio-remediation as they grow commonly at waste dump sites. Many of the biophysical details are poorly understood, but in general, plant roots are designed to efficiently extract nutrients, water, and minerals from soil and ground water. The mechanisms involved may aid extraction of metallic and organic contaminants [8].

Africa's agricultural viability and food security depend heavily on its soil quality [12]. To understand the potential for feeding the world on a sustainable basis, we need to know how soil forms, how it is lost, and what we can do to protect and rebuild good agricultural soil. The cucurbitaceae plants, well associated with the waste dump site are important in the agricultural sector, equally important are their death, decomposition and recycling. That is to say that they can be used as fertilizers. Other economic importance of the cucurbits includes degradation in the environment, sales, medicine, and food [13].

The city of Port Harcourt does not have sanitary landfill but there are several dumpsites in Port Harcourt and its environs. These dump sites are usually surrounded by luxuriantly growing vegetation soil type and other environmental factors control the plant species or population at these dump sites. At the immediate vicinity of the dumpsite, free growing weeds including some Cucurbitaceae plants are abundant. Luxuriantly growing *Luffa aegyptica* and *Lagenaria guineensis* are easily identified by their characteristic cucumber - like fruit and green leaves.

In Nigeria, little information is available on the types of the physicochemical constituents of waste dump soils and associated roots of Cucurbits in waste dump sites [3]. There is therefore the need to determine the cation exchange capacity of the soils by evaluation of the physico-chemical parameters including cations, and heavy metals of the soil and the roots of Cucurbits (*Luffa aegyptica* and *Lagenaria guineensis*) found in waste dumps. It is also necessary to access the ability of plant roots to remove metals from their external environment and the involvement in metal transformation and transfer of metals to higher plants and even animals. The aim of the study is to evaluate the nutrient status of waste dump soils and associated plants (cucurbits) in order to ascertain the soil quality and the bioaccumulation of some ions by the roots of these Cucurbits.

Materials and Methods

Description of the study area

The study areas were the following; The first site is the Eagle Island, an island located South-West of Port Harcourt City. It is bounded on the East by Nkpolu-Oroworukwo (at the University Science and Technology) and surrounded by Elechi creek. It has mangrove vegetation. It is both an industrial and Residential area. The sampling site was an abandoned or active dump located in the Eagle Island. The Eagle Island waste dump site is composed of paper products, cardboard materials, plastics, broken bottles, leaves, food wastes, feces, leather and rubber. It is a waste dump site used by Port Harcourt city council and Environmental Sanitation Authority for solid waste disposal. Most of the wastes disposed were mainly domestic and household wastes. The waste dump had an area of 4,355sq.m. Sampling stations were established on the waste dump site and were represented as stations A and B.

The second site is the Rugaraga, municipal waste dump site in a street located North-West of Port Harcourt City. It is a non-noisy street found after the transformer before reaching the Psychiatric hospital junction in Rumigbo. The sampling site was a borrow pit area used as a dump located immediately after the mechanic village found in the Rugaraga Street. It is a waste dump site used by the community in that area for solid waste disposal. The Rugaraga waste dump comprises of wooden products, batteries, textiles, bones glass, ferrous metal, ceramic and hazardous waste as reported for Port Harcourt waste dump site by Obire., *et al.* 2002. Most of the waste disposed are mainly domestic, household wastes, and of course industrial waste from the mechanic village. The waste dump had an area of 4,000sq.m approximately. Sampling stations were established on the waste dump site and were represented as stations C and D.

The Rugaraga Street is both an industrial and Residential area too. The sampling site has mangrove swamp vegetation with palm trees and plantain trees in the area, where there is a creek.

The third site is a vegetable garden located in Okarki Street in Borokiri layout, Port Harcourt. This area is located south of Port Harcourt city after Harold Wilson Drive. It is purely a Residential area and the garden has green vegetation more of garden vegetables. The Borokiri garden site contained the following waste, food waste and leaves or decomposing plant materials. The sampling site being vegetable garden is used by the Resident occupants to dump their kitchen waste. The dump area is small compared to the other two aforementioned sites. Sampling stations were established on the vegetable garden site and were represented as station E and F.

Collection and treatment of soil samples

Waste dump soil samples were collected from the two established stations on each dump site using standard method. At each sampling station, the surface debris was removed and subsurface soil dug to a depth of about 5cm were scooped from one foot square area into sterile duplicate sampling black polythene bags and approximately labeled. Twelve (12) soil samples, two from each study site, were aseptically collected on each sampling visit. Samples were collected seven times at biweekly intervals. The soil samples were appropriately labeled and placed in a cool box containing ice packs and immediately transported to the laboratory and treated within 24 hours after collection. A total of 84 waste dump site soil samples were collected during the sampling period in the Months of April to July. The soil samples were air dried to obtain fine soil particles [14].

Collection and treatment or processing of the cucurbit roots

Cucurbit root sample collection was also carried out biweekly during the study period. At each sampling station, the root of the desired cucurbit plant was dug out with the aid of a sterile hand trowel and inserted into sterile duplicate sampling black polythene bags and approximately labeled. Six (6) root samples, two from each sampling station were collected on each visit. The root samples were transported to the laboratory and processed within twenty four (24) hours after collection.

The root samples were processed by carrying out a thorough washing of parts of the root required, to remove all soil and most of the loose, decayed plant tissue, in which most of the saprophytes are present [15]. Several small sections (5-10mm square) from the margin of the tissue area were cut. These were placed in one of the surface

sterilant solutions (Clorox solution) making sure that the surface is wet. These were left for about 15 to 30 second and the sections were removed aseptically one by one for at least 5 to 10 second intervals, such that each of them has been surface sterilize for different times. The sections were dried on clean, sterile paper towels for different times [15].

Physico-Chemical Analysis of Soil Parameters
Particles Size Analysis (Hydrometer Method) [16]

Reagent: Sodium hexameta – Phosphate dispersing agent, 5% (calgon)

Procedure

About 51g of air dried fine texture soil was weighed into a 500ml dispersing cup. The cup is filled to within 5cm of the top with distilled water. 200ml of dispersing solution is added and allowed to soak for about 15 minutes. A baffle stirrer is inserted with the cup and the stirrer blade is lowered into the suspension. The contents are stirred for 10 minutes. The suspension in the cylinder is made up to 1130ml mark with distilled water. This is done with the hydrometer in the suspension. The hydrometer are removed, top of cylinder is covered with the hand and inverted several times. Cylinder is placed on a flat surface and the time is noted. After about ½ minute the hydrometer is slowly and carefully lowered into the suspension. At 40 seconds exactly, the hydrometer reading is taken. The hydrometer is removed and with the aid of a thermometer the temperature of the suspension is taken. At about 2 hours, replace the hydrometer inside the suspension and the reading is taken. Again the temperature of the suspension is taken.

Calculation

Let H_1 and H_2 be the hydrometer reading, T_1 and T_2 be the temperature (ºC) at 40 seconds and 2 hours respectively. Let TºC be the calibration temperature of the hydrometer (given that calibration temperature of hydrometer is 20ºC).

$$\% \text{ (Silt + Clay)} + (H_1 + 0.3\,(T_1 - T) - 2.0) \times \frac{100}{50}$$

$$\% \text{ Clay} = (H_2 + 0.3\,(T_2 - T) - 2.0) \times \frac{100}{50}$$

% Sand = 100% - (Silt + clay).

Available Phosphorus (Bray and Kurtz) [17]
Reagent

1N Ammonium Fluoride (NH_4F), prepared by dissolving 3.7g of NH_4F in distilled water and solution dilution to 100ml. 0.5N HCl, prepared by diluting 20 2ml of conc. HCl in 50ml of distilled water. Extracting solution (0.03N) NH_4F and 0.025 N HC1), prepared by adding 15ml of 1.0N NH_4F and 25 ml of 0.5N HCl to 460ml of distilled water.

Reagent A

Add 12g of ammonium molybdate $(NH_4)6\ Mo_7O_{24}.\ 4H_2O$ in 250ml distilled water. Dissolve 0.2908g of Potassium antimony tartarate $(K_2Sb_2(C_4H_2O_6)_2$ in 100ml of distilled water. Prepare 5N H_2SO_4 by diluting 148ml conc. H_2SO_4 with about 100ml of distilled water. Mix solutions (a) (b) and (c) together in a 2 litre volumetric flask and make up-to mark with distilled water.

Reagent B

(a) Dissolve 1.056g of ascorbic acid in 200ml of reagent A and mix.

Standard P stock solution

(a) 0.4393g of oven-dried KH_2PO_4 in distilled water and made up to 1litre in a volumetric flask. This solution contains 100ppm phosphorus. 5ml of 100ppm P is introduced into a 100ml volumetric flask and made up to 100ml Mark. This solution contains 5ppm.

(b) A standard solution of phosphorus which contains 0,0.1,0.2,04,0.6,0.8 and 1.0ppm of phosphorus is prepared by diluting 1,2,4,6,8 and 10 of 5ppm of stock to 50ml. Each of the standards prepared contains 10ml of Reagent B and is allowed to develop for 15 minutes and the absorbance of the standards measured in a spectrophotometer at 660µm. A standard curve is drawn by plotting absorbance against concentration in a graph sheet. Then absorbance of the sample containing the soil extract is measured and P concentration is determined from the standard curve.

Calculation

Let the concentration of P in the diluted soil extract be Y ppm.

P concentration in the undiluted extract = $\frac{50y}{10}$ ppm

Amount of the P in the 20ml undiluted extract = $\frac{50y}{10} \times 20\mu g$.

This is present in 2.85g soil

Therefore, 1g soil contain $\frac{50y}{10} \times \frac{20\mu g}{2.85}$

Therefore, available P in the soil = $\frac{50y}{10} \times \frac{20}{2.85}$ ppm

Exchangeable Cations
Reagents

(a) Ammonium acetate, 1N 228ml of glacial acetic acid (99.5%) is diluted with distilled water to 2litres.

(b) 276ml of concentrated NH_4OH or acetic acid to 7. The solution is made up to 4litres.

(c) Buffer solution, 67.5g of NH_4Cl is Standard EDTA solution, 1.8613g of disodium ethylene-aminetetractate is dissolved in distilled water and the solution is diluted to a volume of 1 litre. The solution is 0.005m.

(d) Standard calcium solution 0.5004g of special low magnesium "reagent – grade $CaCO_3$ (dried at 150ºC)" is dissolved to a volume of 1 litre. This solution is 0.005m.

(e) Cyanide solution, 1g of Potassium cyanide (KCN) is dissolved in 100ml of distilled water.

(f) Hydroxylamine hydrochloride solution, 5g of (NH_2OHHC1) is dissolved in 100ml of distilled water.

(g) Potassium ferrocyanide solution, 4g of reagent grade $K_4Fe(CN)_6.3H_2O$ is dissolved in 100ml of distilled water.

(h) Triethanolamine, reagent grade.

(i) Eriochrome Black T indicator, 0.2g of EBT is dissolved in 50ml of methanol.

(j) Calcein indicator, 20mg of calcien is dissolved in 50ml of methanol.

(k) Sodium hydroxide (NaOH), 10% solution.

Procedure:

(a) 10g of air dried soil sample is weighed into a container; 100ml of neutral, IN NH_4OAc is added and shaked for 30minutes in a mechanical shaker.
(b) The suspension is allowed to stand over-night.
(c) The following day the suspension is filtered with Whatman filter paper No. 42. The leachate is saved for the determination of exchangeable bases.

Determination of Ca^{2+} Plus Mg^{2+} in Extracts

(a) 25m1 of the NH_4OAc extract is introduced into conical flask with the aid of a pipette. The volume is made up to 150ml with distilled water.

(b) 15ml buffer solution, 10 drops each KNC, NH_2OH, HC1, $K_4Fe(CN)_6$, triethanolamine ($C_6H_{15}NO_3$), are added.
(c) Few minutes are allowed for the reaction to take place and 10 drops of EBT (Eriochrome Black T) is added.
(d) The solution is titrated with EDTA (Disodium ethylene diamine tetracetate). At the end point, color changed from wine-red to purplish blue. Blank is prepared with distilled water and titrated.

Standardization of EDTA, using Ca standard and Calcein indicator

(a) 25m1 of Ca standard is introduced with 25ml conical flask and the volume made up to 150ml with distilled water.
(b) 10drops wash of KCN. $NH_2O.HCl$ and triethanolamine are added. 30m1 of 10% NaOH is added, 10drops of calcein indicator is added.
(c) The solution titrated with EDTA. At the end-point, color changed from red to blue. Blank is prepared without Ca standard but with distilled water and titrated in the same manner.

Calculation

M moles of (Ca + Mg) in 25ml extract = ml of EDTA in EBT titration of sample- ml of EDTA in EBT titration of blank.

$xX = X_1$

Where X = Concentration of EDTA
x = Sign of multiplication

M moles of Ca in 25ml extract = (m1 of EDTA in calcein titration of sample – m1 of EDTA in calcein titration of Blank).

$XY = Y_1$

M moles of MG in 25m1 extract = moles of (Ca + Mg)

M moles of Ca = X_1-Y_1

Therefore moles of Ca in 100ml extract = $\frac{100}{25}Y_1$

And in M moles of Mg in 100ml extract = $\frac{100}{25}Y_1 (X_1-Y_1)$

These are present in 20g soil.

Therefore 100g soil contain $\frac{100}{25}Y_1 \times \frac{100}{20} \times 2meqCa$

$\frac{100}{25}(X_1 - Y_1) \times \frac{100}{20}\ 2meqMg$

Values obtained are the exchangeable Ca and Mg in 100g soil.

Exchangeable Na^+ and K^+ (Air – Natural Gas Flame)

Reagent

(a) 100ppm Na (prepared by dissolving 0,254g dried NaCl in water and diluting to 1 litre).
(b) 100 ppm K (prepared by dissolving 0.191g dried Kc1 in water and diluting to 1 litre).
(c) In NH_4OAc for extraction as Ca and Mg.

Procedure

(a) Prepare 0,4,10.14 and 20ppm standards of Na by pipetting 0,2,5,7, and 10ml of 100ppm stock solution, of the element into 50ml volumetric flasks and diluting the solution to 50ml with NH_4OAc solution.
(b) 10ml of NH_4OAc extract is diluted to 50ml with NH_4OAc solution.
(c) Sodium filter is inserted into the instrument (flame photometer).
(d) The flame photometer is calibrated by setting the meter needle to zero by aspirating 0ppm standards and by setting the meter needle to 100% emission with the highest concentration of standard.
(e) The rest of the standards are aspirated one by one and the emission reading recorded. A calibration curve is prepared by plotting emission reading against concentration of standards.
(f) The NH_4OAc extract (diluted and undiluted) is aspirated in the flame photometer, the concentration of the extract is determined from the meter readings and calibration curve.

Exchangeable K

The procedure for determination of exchangeable K^+ is similar to that of Na^+ except that the filter corresponding to the element need to be used.

Calculations

The calculation procedure for Na and K are the same. Let the concentration of Na in the undiluted NH_4OAc extracted be C ppm, concentration of Na in the diluted NH_4OAc extracted.= $\frac{50}{10}$ xC

Therefore, amount of Na in the 100ml undiluted extract

$= \frac{50}{10} \times C \times 100mg$

$= \frac{50}{10} \times C \times \frac{100mg}{10^3}$

$= \frac{C \times 50 \times 100meq}{10 \times 10^3 \times 28}$

Exchangeable Ammonium and Nitrate (Steam Distillation Method)

(a) Magnesium oxide is heated in an electric muffle furnace at 600-700ºC for 2 hours, cooled in a desiccators containing potassium hydroxide and stored in a tightly stopped bottle.
(b) Devarda's alloy prepared by ball-milling a good quality alloy until the product will pass through a 100 – mesh sieve.
(c) Sulfamic acid (NH_2SO_3H) purified by crystallization from hot water. 2g of the purified reagent is dissolved in 100ml distilled water. The solution is stored in a refrigerator.
(d) Sulphuric acid 0.005N.
(e) Potassium chloride 2N, prepared by dissolving 149 KCl in 1 litre of water.

Procedure

Ammonium (NH_4^+)

(a) 10g of soil is shaked with 100ml 2N KCl in a 250m1 conical flask for 1 hour and filtered using Whatman No, 42 filter paper.

(b) The distillation apparatus is flushed with steam for a few minutes.

(c) 5m1 H_3BO_3 (Boric acid) indicator is added to a 50ml conical flask and placed under the condenser of the distillation apparatus so that the end of condenser is above the surface of H_3BO_3.

(d) 10ml of the soil extract is introduced into the distillation flask, 0,2g MgO is added and the flask is attached to the steam distillation apparatus.

(e) Distillation is commenced by closing the stock lock on the steam by pass tube.

(f) When the distillate has reached 35ml mark in the conical flask, distillation is stopped by opening the stock lock on the steam by pass tube.

(g) Then the end of condenser is rinsed and the rinsate collected in the conical flask. The distillate is titrated with 0.005N H_2SO_4 from a micro burette. At end-point, the colour change is from green to faint pink.

A blank determination is carried out with the reagent without the soil extract.

Nitrate (NO_4)

(a) The sample left over from the previous distillation is allowed to cool and 0,2g of Devarda's alloy is added.

(b) 5ml boric acid indicator (H_3BO_3) is introduced into a conical flask and placed under the condenser of the distillation apparatus so that the end of the condenser is about 4cm above the surface of the boric acid (H_3BO_3).

(c) When the distillate reaches 35ml mark in the conical flask, distillation is stopped by opening the stopcock on the steam by pass tube.

(d) Then, the end of the condenser is rinsed and the rinsate collected in the conical flask.

(e) The distillate is titrated using 0.005N H_2SO_4 from a micro burette. The color change is from green to faint pink at end point.

(Ammonium + Nitrate) – N

The procedure is the same as above but to 10ml soil extract is added 1ml of sulfamic acid (To destroy NO_2) the flask is swirled before addition of MgO and Devarda's alloy. Distillation is commenced as above and also titration.

Calculations

Let the burette readings for soil extract and blank be V_1 and V_2 ml respectively and the normality of H_2SO_4 be N. Meq of NH_4^+ in the distillate

$$= N (V_1 – V_2)$$
$$= N (V_1-V_2) \times 14mgN.$$

This is present in 10ml of extract. Therefore,
100ml extract contain

$$\frac{100}{10} \times N (V_1-V_2) \times \frac{14}{10} mgN \text{ as } NH_4^+$$

This is present in 10g of soil

Therefore, 1g soil has

$$\frac{100}{10} \times N (V_1 – V_2) \times \frac{14}{10} \times 10^3 ppm$$

Calculations for NO_3^- is similar to that for NH_4^+

pH of the Soil

1. Buffer pH 7.0: - 3.387g potassium dihydrogen phosphate (KH_2PO_4) and 3.533g disodium hydrogen phosphate (Na_2HPO_4) were dissolved in 500ml of distilled water and made up of to 1 litre.
2. Buffer pH 10.0: - 2.092g sodium bicarbonate ($NaHCO_3$) and 2.640g sodium carbonate (Na_2CO_3) were dissolved in distilled H_2O and made up to 1 litre.
3. 0.39 N standard solution of KCl: 29.0g of dried A.R. grade KCl was dissolved in distilled H_2O and diluted to 1 litre. This solution should give a conductivity of 50ms/cm.
4. Anhydrous Na sulphite, Na_2SO_3. $7H_2O$: 1gram of $Na_2SO_3.7H_2O$ was dissolved in 500ml distilled water. Reading should fall below 0.1 mg/l dissolved oxygen.

Phosphate

Reagent

a. Standard phosphate solution 0.2195g anhydrous KH_2PO_4 was dissolved in distilled H_2O and diluted to 1 litre 1 ml = 0.05mg PO_4 –P.

b. Aqueous solution of phenolphthalein indicator 5g phenolphthate disodium salt was dissolved in distilled H_2O and diluted to 1 litre.

c. Strong acid solution 300ml concentrated H_2SO_4 was when cool, 4.0ml concentrated HNO_3 was added and diluted to 1 litre.

d. Stannous chloride reagent: 2.5g of fresh $SnCl_2.2H_2O$ was dissolved in 100ml glycerol, heated in water bath and stirred with a glass rod to hasten dissolution.

Sulphate

Reagent

a. Standard sulphate solution :0.1479g of anhydrous Na_2SO_4 was dissolved in distilled H_2O and diluted to 1 litre in a volumetric flask 1ml = 0.100Mg SO_4^{2-}

b. Buffer solution :30g magnesium chloride ($MgCl_2.6H_2O$), 5g Sodium acetate ($CH_3COONa.3H_2O$), 1.0g potassium nitrate (KNO_3) and 20ml acetic acid (CH_3COOH) (99%) were dissolved in 500ml distilled H_2O and make up to 1 litre.

c. Barium chloride ($Bacl_2$) crystals: $Bacl_2.2H_2O$ crystals were grinded to about 20 to 30 mesh.

d. Extracting solution :0.0164M potassium chihydrogen phosphate (KH_2PO_4) :2.2319g of KH_2PO_4 was dissolved in distilled H_2O and diluted to 1 litre in volumetric flask.

e. 50% V/V acetic acid :500ml of the concentrated acid of 99.93% purity was measured into about 400ml distilled H_2O in a 1 litre flask and diluted to the mark to distilled H_2O.

f. Ortho-phosphoric acid with specific gravity of 1.75.

g. Cum acacia, 0.5% V/V : prepared fresh by dissolving 0.5g gum acacia in 100ml warm H_2O.

Preparation of Standard Solution for Calibration Curve (Soil)

a. 0.00ml, 5.00ml, 10.00ml, 15.00ml and 20.00ml of the standard sulphate solution was measured into separate 50ml volumetric flask and diluted to about half of the container to distilled water.
b. 5.00ml of 50% acetic acid and 1.00ml of H_3PO_4 were added and swirl to mix.
c. It was diluted to about ¾ of the flask to distilled H_2O and mixed again.
d. 1.00g of $BaCl_2.2H_2O$ crystals was added without mixing and left to stand for 10 minutes.
e. The flask was inverted for 10 times and allowed to stand for 10 minutes.
f. 1.0ml of 0.5% gum acacia solution was added and make up to 50ml mark with distilled H_2O.
g. The solution was inverted several times more and allowed to stand for 1 hour.
h. The turbidity was measured as absorbance at 470nm wavelength using the 10mm cell in the UV/ visible spectrometer using vision 3.0 software.
i. This solution contained sulphate ion concentration of 0.00, 0.01, 0.02, 0.03 and 0.04 mg/ml respectively.

On completion of the calibration sun for both soil and root, the software automatically plotted the measured absorbance of the standard against the known values for the standards entered. The correlation coefficient for the standard curves was 0.990. 2 standards and a calibration blank were analysed to check the reliability of the calibration curve.

Preparation of Standard Solution for Calibration curve (Root)

a. 0.00ml, 10.00ml, 20.00ml, 30.00ml and 40.00ml of the standard sulphate solution were measured into separate 100ml volumetric flask.
b. Diluted to about ½ of the container with distilled H_2O.
c. 20ml of the buffer solution A was added and mixed in stirring apparatus.
d. While stirring a spoonful of $BaCl_2$ crystals was added and diluted with distilled water to the 100ml mark.
e. Stirred at K speed for 1 minute.
f. After stirring, the solution was poured immediately into 10mm cell and turbidity measured within 5 minutes at 420nm.
g. These solutions contained sulphate ion concentration of 0.00, 10.00, 20.00, 30.00 and 40.00 mg/l respectively.

Exchangeable Cations in Soil and Root

Reagent

a. Reagent water prepared by distillation
b. Concentrated HCl
c. Concentrated HNO_2
d. Standard solution of each metal for calibration curve.
e. Barium stock solution 1.779g of $BaCl_2$. H_2O was dissolved in 50ml of concentrated HCl and about 700ml of distilled water. The solution was diluted to 1 litre with distilled water to obtain a concentration of 1000 mg/l.
f. Vanadium stock solution: 2.2296g of NH_3 meta – vanadate NH_4VO_3 was dissolved in 800ml of distilled water. 10ml concentrated HNO_3 was added and diluted to 1 litre with distilled water to obtain a concentration of 1000mg/l.
g. Stock Q.C solution of each metal: 1000 mg/l standard from ACCU standard Europe was used.
h. Hydrogen peroxide solution, 30%.
i. Calcium stock solution B: 54.66g calcium chloride hexahydrate ($CaCl_2.6H_2O$) was dissolved in 500ml of distilled water. The solution was diluted to 1 litre with distilled H_2O. 1ml of this solution contains 10mg of calcium.
k. Potassium stock solution 19.07g of KCl was dissolved in 700ml of water. The solution was diluted to 1 litre with distilled H_2O. 1ml of this solution contains 10mg of K.
l. Sodium solution: 25.14g of NaCl was dissolved in 500ml of distilled H_2O and made up to 1 litre. 1ml of this solution contains 10mg of Na.

In order to ensure that metals are not introduced into the sample during preliminary treatment, all glassware as volumetric flask, beaker and funnel were soaked with 10% HCl over night and rinsed with distilled water.

Results

The results of the Physico-chemical constituents of waste dump soils and of roots samples of associated Cucurbits from the study locations are presented in Table 1. The particle size density (PSD) of the waste dump soils are also presented in Table 1.

The results show that the pH values ranged from 5.87 – 6.65 at the various locations sampled. The Borokiri soil recorded the highest value followed by Eagle Island dump site soil and Rugaraga waste dump soil. The values of phosphate ranged from 2.34 mg/kg to 20.2 mg/kg in the waste dump soils and from 45.1 to 127.5 mg/kg in the roots of cucurbit plants. Values of sulphate ranged from70.9 mg/kg to 269 mg/kg in the soils and from 348 to 581 mg/kg in the roots of cucurbit plants.

The values of Ammonium was negligible and constant in all the waste dump soils with < 0.02 mg/kg and was not determined for the roots. Values of Aluminium ranged from 1,172 mg/kg to 2,952 mg/kg in the soils and from 1,197 mg/kg to 2.847 mg/kg in the roots. The results of the Exchangeable Cations of Calcium (Ca^{2+}) ranged from <0.10 to 129 in the soils and from 618 to 6,163 in the roots, while Magnesium (Mg^{2+}) ranged from 105 to 226 in the soils and from 917 to 1,563.5 in the roots. Potassium (K^+) ranged from 114 to 643 in the soils and from 3,515 to 10,050 in the roots, while Sodium (Na^+) ranged from 906 to 1537 in the soils and from 1,353 to 2,800 in the roots.

The values for cation exchange capacity (CEC) of the waste dump soil samples ranged from 13.0 Cmol/kg to 53.7 Cmol/kg and from 45.5 Cmol/kg to 87.1 Cmol/kg in the roots of cucurbits.

The results obtained for the particle size density (%) of the waste dump soils in Borokiri, Rugaraga and Eagle Island was 70%, 68 % and 82% respectively. The values of silt soil ranged from 13.2% to 17.0% with Rugaraga recording the lowest while Borokiri recorded the highest. The values of clay soil ranged from 4.80% to 16.2 Rugaraga waste dump soil recording the lowest while Eagle Island recorded the highest. The result of the particle soil density revealed that the Borokiri waste dump soil, the Rugaraga waste dump soil and the Eagle Island waste dump soil are all sandy loam soils.

Table 1: Physico-chemical constituents of soils and cucurbit roots from the study locations

S/N	Parameters	Waste Dump Location					
		Borokiri		Rugaraga		Eagle Island	
		Soil	Root *L. guineensis*	Soil	Root *L. aegyptica*	Soil	Root *L. aegyptica*
1.	pH	6.65	ND	5.87	ND	6.25	ND
2.	Phosphate (mg/kg)	18.4	127.5	20.2	78.2	2.34	45.1
3.	Sulphate (mg/kg)	96.0	348	70.9	393	269	581
4.	Ammonium (mg/kg)	<0.02	ND	<0.02	ND	<0.02	ND
5.	Aluminum (mg/kg)	2,452	2847	1,172	1,197	2,952	2,581
6.	Calcium (mg/kg)	129	1,728.5	2,580	6,163	<0.10	618
7.	Magnesium (mg/kg)	171	1,563.5	226	995	105	917
8.	Potassium (mg/kg)	114	10,050	178	3,515	643	4,681
9	Sodium (mg/kg)	914	2,800	906	1,353	1,537	2,596
10	Cation Exchange Capacity (Cmol/kg)	20.0	54.45	53.7	87.1	13.0	45.5
Particle Size Density (PSD)							
11	Sand (%)	70.0	ND	82.0	ND	68.0	ND
12	Silt (%)	17.0	ND	13.2	ND	15.8	ND
13	Clay (%)	13.0	ND	4.80	ND	16.2	ND

Note: ND = Not determined.

Discussion

The present investigation has revealed the physico-chemical constituents of soil and root samples of cucurbits from the various wastes dump sites. The study revealed the nutrient status of waste dump soils and associated cucurbits and has ascertained the soil quality and the bioaccumulation of some ions by the roots of Cucurbits.

The pH range of the sampled soils lies between 5.87 - 6.65. The results indicated that the sampled soils were slightly acidic. The pH values (5.87 - 6.25) reported here for the waste dump soils were in agreement with those reported by Tchobanglous., *et al.* [18] who stated that the initial pH of solid waste is between 5.0 and 7.0 for refuse which is about 3 days old. Although this study was not initiated intentionally at the outset of dumping of waste at the dump sites as to determine how long the waste had been in contact with the soil mass, but judging from the results, there is a likelihood that the sampling coincided within the 3 days of dumping. The pH value (6.65) of Borokiri garden site soil has a slight acidic condition which may be associated with the rate of respiration from plant roots and soil organisms which add more carbon- dioxide, thus making the soil solution slightly acidic (between 6.3 to 6.8) in the presence of H^+ ions that can exchange with mineral ions always present in the soil solution [19].

This present study has shown that the phosphate values ranged from 2.34 to 20.2 mg/kg and was highest in Rugaraga location and lowest in Eagle Island, while the sulphate value that ranged from 70.9 to 269 mg/kg was highest in Eagle Island and lowest in Rugaraga.

The high value recorded in phosphorus for the Rugaraga site might be possibly due to the increased microbial metabolism and biochemical heterogeneity of the soil microflora which must have led to the degradation of other waste materials in the soil which brought about an increase in some nutrient elements in these sites [20]. For instance, mineralization of nitrogenous compounds and transformation of phosphorus containing compounds in the soil environment have been reported by [11] and by Chaudhary., *et al.* [21].

Also, judging by the high phosphorus values recorded in the Rugaraga site, one can rightly say that the waste dump soil are rich in available phosphorus and could serve as a ready source of this nutrient for the enrichment of phosphorus deficient soils. Earlier researches [22] have shown that soil management practices such as the addition of organic matter to the soil may modify the amounts of available phosphorus in soils. They argued that organic materials that are generally returned to soils contain appreciable amounts of phosphorus. Various researchers [11,20] have reported that organic matter increases the phosphorus retention of soil. The findings in this study are in agreement with the latter.

The lowest values of phosphate in Eagle Island site could be associated its wash off by runoff waters and leaching [23]. Some of the waste dump soils are rich in available phosphorus and therefore could serve as a ready source of this nutrient for the enrichment of phosphorus deficient soils. Soil management practices such as the addition of organic matter to the soil may modify the amounts of available phosphorus in soil [24].

The low value of phosphate in *Luffa aegyptica* plant root of Eagle Island dump might be attributed to the fact that the element might be bound too tightly to clay humus complexes or is in a chemical form the roots of this plant cannot absorb despite its abundance in the soil [19]. The high phosphate value in *Lagenaria guineensis* plant root of Borokiri garden site might be an indication of rapid changes in microbial activities compared to the other two study locations [3].

Eagle Island site recorded the highest value for sulphate which might be due to the type of wastes and microorganism and microbial metabolism going on in this environment [19]. Soils have no analogous exchange system for some anions, such as sulphate and are therefore easily leached to lower soil horizons reducing its concentration [19]. This may account for the lowest sulphate value recorded in Rugaraga dump site. Sulphate values being highest in *Luffa aegyptica* root of Eagle Island dump than the other sites may be associated with the plants high efficiency in auto-utilization of the sulphate without depending on most bacteria. However, plants have been known to reduce sulfate themselves and do not depend on bacteria [19]. The low sulphate value recorded in *Lagenaria guineensis* plant root of Borokiri location may be due to lower availability of the element to the plant [9].

Ammonium and Aluminium were recorded in all the waste dump soils sampled. The levels ranged from < 0.02 to < 0.02 mg/kg and 0.043 - 0.109 Cmol/kg for Ammonium and Aluminum respectively. The present study has revealed that the value of ammonium is negligible (negative values) all throughout the dump sites, and the Aluminum value was recorded highest in Eagle Island dump site and lowest in Rugaraga waste dump site.

Ammonia is classified as a principal landfill gas produced from the decomposition of the organic fraction of municipal solid waste [18]. Then non-significant values of Ammonia all throughout the sampling sites may be a reflection of non extensive specific microbial (organotrophic and Nitrogen fixing bacteria) activities on the waste matter as well as the type of plants (non leguminous plant) and waste present at the dumpsite. The highest level recorded in Eagle Island site for Aluminium served as an indication of the accumulation role of the type of waste containing more of ferrous metal, burnt tyres and other Aluminum depositing waste materials dump in this site. This is seconded by the Borokiri garden site, which might be attributed to the fact that this site might be a dump and reclaimed site with high Aluminum contents, therefore the remnants of the degraded contents of the site should contain high level of Aluminum. The values (0.091 Cmol/kg and 0.109 Cmol/ kg) for the two sites tend to be higher than some previous records for some Nigerian ecosystem [25]. This high level of aluminum indicated environmental threat, since Aluminum has been identified as a toxic element, which does not breakdown easily in the environment, and thereby resulting to elevated levels found in the soils, water and air [26]. The low value of Aluminum in the Rugaraga waste dump did not agree with that observed by Ayolagha and Onwugbuta [27] which is > 0.043 Cmol/kg.

Aluminum has been rated as one of the toxic element especially at an acidic pH [26]. The results revealed that Aluminum level is higher in the *Lagenaria guineensis* plant root in Borokiri compared to other locations. This may be associated with the main components of the particles of soil surrounding the plant. The lower levels of the plant roots in Rugaraga dump as found in this study is not in agreement with that observed by Ayolagha and Onwugbuta [27] which is > 0.044 Cmol/kg.

From the results, the calcium, Magnesium, Potassium and Sodium values were recorded in all the sites as; <0.10 - 0.065 Cmol/kg, 0.004 -0.009 Cmol/kg, 0.003 - 0.017 Cmol/kg and 0.040 - 0.067 Cmol/kg respectively, Calcium values was highest in Rugaraga site and negligible (negative value) in Eagle Island site, Magnesium values was highest in Rugaraga site and lowest in Eagle Island site; Potassium value was highest in Eagle Island site and lowest in Borokiri garden site; and sodium value was highest in Eagle Island site and lowest in Rugaraga site.

Calcium, Magnesium, Potassium and Sodium are the dominant exchangeable bases [27]. The values of Calcium, Magnesium and Potassium throughout the three sampling sites were all lower than the standards on Environmental Pollution Control and Management in Rivers State [28]. This could be attributed to surface run- off and leaching. There was no similar pattern in the values of the exchangeable bases among all the waste dump sites. This has shown great diversity in the waste dumped in the various locations which affected the physico-chemical characteristics of the soils. The relatively high values of Calcium and Magnesium in Rugaraga soil could be associated with its high values of cation exchange capacity (CEC).

This is because CEC is important for maintaining adequate quantities of plant available calcium, magnesium and Potassium [29]. The low values recorded in the other locations may be attributed to a lower cation exchange capacity and to a higher leaching intensity in these locations which are features of sandy soils [30]. This explains the similar low value in the physicochemical parameters. In addition to this, a decrease in certain parameters could perhaps be on account of their mobility or their incorporation into microbial biomass and plant tissues through immobilization as rightly observed by Liu., *et al*. [31].

The high values of Potassium and Sodium as recorded in Eagle Island site indicates that the soil was not formed from the natural process of weathering of the underlying parent material, but rather from deposited particles like food items, faeces and saw dust. These findings is similar to that reported by Okoronkwo., *et al*. [20] that levels of elements in soils of abandoned waste dump site which might have introduced the high potassium value into the site. Potassium is among the major plant nutrients and their inadequate supply can have effect on the growth of plants. In Eagle Island dumpsite, there are good plant growths because of the availability of Potassium.

The values of Sodium recorded in this study tend to be lower than the acceptable limit 0.15 Cmol/kg as previously reported by Hayyat., *et al*. [32]. This may be attributed to higher leaching intensity taking place mainly in Borokiri garden site and Rugaraga dump site.

Many of the minerals essential for plant nutrition are the cations (Potassium, Magnesium, Calcium, and others) bound to clay humus complexes, but the roots can only obtain them when they become free ions in the soil solution [19]. They are freed by the same process of cation exchange involves in leaching.

Comparing the cucurbit plant roots in the sampling sites; the results showed that Magnesium, Potassium and Sodium values increased in the root of *Lagenaria guineensis* plant of Borokiri garden site at the pH of 6.05. Magnesium is an important nutrient with multiple functions like cofactor of enzymatic functions. Its deficiency will result in chlorosis showing up first in its older leaves because magnesium is a mobile element.

Potassium is the principal monovalent cation in plant tissues. It has a role in moving water from one compartment to another because cells actively transport ions, most commonly potassium (K^+) ions, and water flows by Osmosis. Calcium deficiency causes stunted root growth and dieback of growing plants. The results however indicated that much of the dead plant and animal material in Borokiri soil is rapidly decomposed by fungi that live partly inside and partly outside the living plant roots. As a result the nutrients that are released during decomposition are immediately absorbed by the plant [33].

The revealed pH of 6.5 values of some exchangeable cations, and good growth of plants in Borokiri is an indication and in agreement with [26] that most essential elements are available for optimum utilization and growth of plant at slightly acidic conditions, around pH 6.3 to 6.8. The lower levels recorded for Magnesium, Potassium and Sodium in *Luffa aegyptica* plant root of Eagle Island dump site and *Luffa aegyptica* plant root of Rugaraga dump site respectively, may be owing to changes in microbial metabolism [3] or they exist in forms that the plant root cannot efficiently absorb [19] Calcium high value in *Luffa aegyptica* plant root of Rugaraga dump site may be attributed to a complex process known as the mineral surface exchange reactions which selectively favours the availability of the Calcium plant nutrient to the *Luffa* plant root found in Rugaraga waste dump [10]. The reverse of this process could explain the reason behind the lower values of Calcium in other sites.

The results obtained for Cation Exchange Capacity (CEC) ranged from 13.0 - 53.7 Cmol/kg. The values at Borokiri and Eagle Island dump soils were within acceptable range of Cation Exchange Capacity of 10 - 30 Cmol/kg [34]. The CEC values at Rugaraga site was higher than the maximum level allowed for efficient capacity of a soil to hold plant nutrient [34]. This could be attributed to the type of waste dumped in Rugaraga dump site being higher in organic matter compared to that in Borokiri and Eagle Island. Because addition of organic matter or material will increase a soil's Cation Exchange Capacity and decreases through acidification and organic matter decomposition [10,29]. However, all the cucurbits plant root samples investigated showed low levels of exchangeable cations. The results were generally lower than the values set as standards by [28,34], except Potassium level in the *Lagenaria guineensis* plant root of Borokiri garden which is slightly higher (0.268 Cmol/kg) when compared with the standard (0.2 Cmol/kg) [28].

The Cation Exchange Capacity values ranged from 45.5 - 87.1 Coml/kg with the *Luffa aegyuptica* plant root of Rugaraga waste dump site having the highest value and *Laffa aegyptica* plant root of Eagle Island dump site having the lowest value. The higher value in the plant root of Rugaraga dump site is attributed to the fact that the waste dump soil surrounding the plant root contains higher organic matter than the other sites. Since organic matter has high cation exchange capacity, increasing the organic matter content of any soil will increase the cation exchange capacity [35]. However, the other plant root accumulated lower levels of cation exchange capacity due to organic matter content which are lower than that obtained in Rugaraga waste dump site.

The particle size analysis of the various soils sampled revealed that they were all sandy loam soils similar to the report of Akhtar., *et al*. [36]. The particles size density values ranged from 68.0% - 82.0%, 13.0% - 17.0% and 4.80% - 16.2% for sand in Eagle Island waste site and Borokiri garden site and clay in Rugaraga waste site and Eagle Island waste site. Clay serves as important reservoir for plant nutrients. The negatively charged surface of the clay particles attracts positively charged atoms (Cations) of such nutrient elements as Calcium, Potassium and Magnesium, Phosphorus, Zinc and iron [37]. These nutrients form a loose chemical bond with the clay particles. This process is called adsorption.

From the standpoint of soil fertility, adsorption is of fundamental importance because it prevents the leaching (removal) of nutrients from the soil by the action of water. Nutrient ions on clay particles are replaced by hydrogen ions the surface of the plant roots. The nutrient ions are then free to be taken in by the plant [38].

On the other hand, clay particles do not retain negatively charged nitrate (NO_3) or nitrite (NO_2) ions well. As a result, niters are easily leached from the soil by rainfall or washed away by run-off waters. The most desirable soil from an agricultural standpoint is loam, which is in the following proportions, sand, 30 to 50 percent, silt, 30 to 50 percent, and clay, 0 to 20 percent [36].

Soils from Eagle Island and Rugaraga are mangrove Swamp forest soil, precisely Saline Sands with Sand fraction quarter than 60% respectively. The sand fraction of Borokiri site is also greater than 60%.

Variations in particles size density indicate that sand is poorly sorted and the poor sorted nature of the various particle size indicate that these soils were not formed from the natural process of weathering of the underlying parent material, but rather from deposited particles [20].

Some members of the cucurbitaceae family are being envisaged for bioremediation [39]. The cucurbit plant growth is important in soil fertility, equally important are their plant death, decomposition, and recycling. These plants are constantly releasing leaves, branches, and other plant parts which enter the soil. These re- leased soluble materials create a residue sphere, an area between decaying plant material and the soil [40]. This has been described as a hot bed of microbial activity, which drives a wide range of microbiological processes. In anaerobic "hot sports" soluble plant materials support denitrification and possible genetic exchange processes. During ion exchange, nutrient elements such as potassium (K), Calcium (Ca), and Magnesium (Mg) are attracted to the negatively charged surface of the soil particle. The essential nutrient ions which play ultimate role in soil fertility are replaced by hydrogen ions from the root systems of the plants and then are absorbed by the plants [36].

Conclusion

The health hazard associated with the indiscriminate dumping of waste around residential areas and other ecologically sensitive areas such as rivers and streams and arable land cannot therefore be under- estimated. Nigeria should therefore direct her efforts towards not only treatment of waste before disposal but also cultivate the habit of incorporating plants such as cucurbits that can withstand toxic condition of these waste dump sites in the treatment of waste as to minimize the health hazards associated with dumping of waste.

The present study has revealed the presence of various cations and anions associated with waste dump soils and in the roots of associated Cucurbits. The increase and decrease in the amounts of some soil mineral were noted during the period of investigation. Such soil minerals include the Exchangeable Cations. Some of the waste dump soils are rich in available phosphorus and therefore could serve as a ready source of this nutrient for the enrichment of phosphorus deficient soils. Soil management practices such as the addition of organic matter to the soil may modify the amounts of available phosphorus in soil. The presence of cucurbits is beneficial to the soil fertility. This is owing to the fact solubilization of chemicals by microorganisms in the rhizosphere of the Cucurbits can enhance the uptake of nutrients and other elements or metals from the waste dump soils. Thus, cucurbit plants if properly harnessed can be used in Nigeria in accelerating the bioconversion of waste compost into organic fertilizer for use in gardening, agriculture and horticulture.

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