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EFFECTS OF CASSAVA MILL EFFLUENT ON PHYSICOCHEMICAL PROPERTIES OF GARDEN SOIL – EZIOBODO, IMO STATE, NIGERIA.

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ABSTRACT

An assessment of the Effect of Cassava Effluent on Farmland Soil was made. Two soil samples were collected; one from a farmland polluted with cassava effluent and, another as an unpolluted sample – free from cassava effluent pollution. The physiochemical analyses were carried out to investigate the effects of the cassava effluent on soil properties. Results showed that unpolluted soil sample was normal, while the polluted soil sample showed elevated pH value 9.0 and other soil chemical properties Such as manganese (0.50mg/l), Lead (0.08mg/l) Cadmium 0.61mg/l), Nitrate (11mg/l), Sulphate (18.60mg/), Organic Matter (3.70%) and Conductivity (223 us/cm) with the presence of cyanide compared to the unpolluted sample. Enlightenment campaign, detoxifying cassava effluent in accordance with environmental safety Standard, appropriate method(s) of environmental friendly disposal of both solid and cassava wastewater are recommended for safe and healthy environment.

Keywords: Cassava (Manihot spp), effluent, pollution, soil, wastewater, environment

1.0 INTRODUCTION

Manihot esculenta (crantz), Synonymous with Manihot utilissima (cassava) belong to the family “Euphorbiaceae”. It is native to South America and is extensively cultivated in the tropical and subtropical regions of the world for its edible starchy tuberous root and are harvested between 7 to 13 Months based on the cultivars planted (Cooke, 1985); Taye, 1994). The tubers are quite rich in carbohydrates (85-90%) with very small amount of protein (1.3%) in addition to cyanogenic gloucoside (Nwabueze and Odunsi, 2007; Oyewole and Afolani, 2001). As a major source of carbohydrate in the world with Africa being the largest centre of production (Claude and Denis, 1990). Annual cassava production in Africa is about 84 million tones, with Nigeria being the highest with 30 million tonnes, Democratic Republic of Congo with 16.8 million tones, Tanzania with 5.7 million tones, Mozambique with 5.3 million tones and Madagascar with 2.4 million tones (Nweke, 1992). Cassava has diverse uses depending on the community. The edible tubers are processed into various forms which include Chips, pellets, cakes, and flour. The flour could be fried to produce gari or steeped in water to ferment to produce foofoo when cooked (Oyewole and Udunfa, 1992). In Nigeria, nearly every community depends on it as a source of food. The reliance on cassava as source of food and exposure to goitrogenic effects of thoicyanate has been identified as being responsible for the endemic goiters in Akoko area of South Western Nigeria (Akindahausi, et al.; 1998).

Wastewater from cassava processing is released into the environment probably farm land or even water body without proper or any treatment at all in most rural areas where cassava is processed. This has been identified as a source of pollution.

2.0 LITERATURE REVIEW

According to Narayanan (2009), soil is the unconsolidated to or superficial layer of Earth's crust lying below any aerial vegetation and undecomposed dead organic remains, and extending down to the limits to which it affects the plants growing about its surface. Beneath the soil, lie the sub soil and unweathered rocks. Soils commonly become stratified into layers or horizons, at different depths. The layers of soil at different depths show different compositions and natures.

Soil pollution deals primarily with topsoil and aquifers. Soil is a thin veneer that covers most of the Earth's land surface. Though its volume and mass are very small, in comparison to the lithosphere, it is of vast importance to man. Soil fulfills a wide range of inter – related functions.

(1) It forms a crucial link between the atmosphere, geology, water resources and land use.
(2) It acts as a reservoir of carbon, which is a key factor in determining concentrations of green house gases;
(3) Regulates the flow of water from rainfall to water bodies, aquifers, vegetation and the atmosphere;
(4) Acts as the medium for vegetation, crops and forests and plays a major role in determining the nature and distribution of life;
(5) Forms the basis for terrestrial ecosystems.

Soil is generally composed of sand, silt and clay particles, organic matter (humus), water and air space. Sand and other mineral parts of the soil result from the weathering of rocks. Soil itself is more complex than an assemblage of clay minerals. It is a vital part of our environment, and an essential resource for life. Its formation takes place over long periods and so it is effectively a non – renewable source. The type and characteristics of the soil in an area make a key contribution to the landscape and agro – ecosystem, and affecting human habitat, wildlife, agriculture and suitability for development (Narayanan, 2009).

Soil is a complex assemblage of clay minerals, detrital materials such as quartz, humus and organic compounds, water, trapped gases and living organisms. The average composition of the Earth's crust, with respect to major components, is (wt. percent): Oxygen 46.6, Silicon 27.7, aluminum 8.3, iron 5, calcium 3.63, magnesium 2.09, Sodium 2.83, and Potassium 2.59. During the weathering process the feldspars and other silicate minerals are broken up by natural elements like water, heat and sunlight, releasing chemical compounds, which include bases, silica and oxide of iron (Fe_2O_3) and aluminum (Al_2O_3). Percolation of water for a long time through the fine products of weathering results in the leaching of relatively soluble bases, alkaline earths (Ca and Mg) and some silica.

Soil quality is a measure of the ability of a soil to carry out particular ecological functions, such as medium for plant growth, regulator of water supplies, recycler of raw materials, habitat for soil organisms, and engineering medium. Soil quality reflects a combination of chemical, physical and biological properties. Some of these properties are relatively unchangeable, inherent properties that help define a particular type of soil. Soil texture and mineral make up are examples. Other soil properties, such as structure and organic matter content, can significantly be changed by management. These more changeable soil properties can indicate the status of a soil's quality relative to its potential, in much the same way that the turbidity or oxygen content indicates the water – quality status of a river.

While protecting soil quality must be the first priority, it is often necessary to attempt to restore the quality of soils that have already been degraded. Some soils have sufficient resilience to recover from minor degradation if left to revegetate on their own. In other cases, more effort is required to restore degraded soils. Organic and inorganic amendments may have to be applied, vegetation may have to be planted, physical alterations by tillage or grading may have to be made, or contaminants may have to be removed. As societies around the world assess the damage already done to their natural and agricultural ecosystems, the science of restoration ecology has rapidly evolved to guide managers in restoring plant and animal communities, to their former levels of diversity and productivity. The job of the soil restoration, an essential part of these efforts, requires in depth knowledge of all aspects of the soil system (Nyle and Ray, 2002).

Cassava processing, especially in areas where the industry is highly concentrated, is regarded as polluting and a burden on natural resources. Some forms of processing, particularly for starch, have developed beyond traditional methods and are now water intensive yet often sited in areas of water scarcity. By its nature, cassava processing for starch extraction produces large amount of effluent high in organic content. If untreated, this may be displayed in the form of stagnant effluent ponds from which strong odours emanate. Other forms of processing, despite not requiring water, generate very visible dust waste. As a consequence of the visual display of pollution, cassava is often perceived by local populations as contributing significantly to environmental damage and water deficit. Yet despite this notion, supported mainly by the visual display of pollution, few systematic impact studies have been conducted.

Annual cassava production in Africa is about 84 million tonnes, mainly in Nigeria (30), the Democratic Republic of Congo (16.8), Ghana (7.1) Tanzania (5.7) Mozambique (5.3) and Madagascar (2.4). Cassava is primarily produced by small scale farmers and processed at the family – or villages – level. Despite small scale operation, cassava production in Africa is highly commercialized, with as much as 45% of the total output marketed (Nweke, 1992). A great diversity of products is derived from cassava. The most representative are gari in West Africa, Chickwangue in Central Africa, and a tap and Ugali in East Africa.

Traditional processing techniques are flexible in their use of the different processing resources. Retting (soaking) is employed in humid regions (Central Africa), while in the dryer regions (Western Africa) a fermentation step is usually included. Cassava granules are commonly produced in areas of high population density, while chips and flour are more widely used in those with low population density (Nweke, 1992). In some regions, techniques for making chips and flour are water intensive; but in other areas, only sunshine is required. A major feature of cassava processing in Africa is that villages in each climatic zone concentrate on making products for which the zone is endowed with the necessary resources (Nweke, 1992). Cassava processing has many technological pathways adapted to the use of locally available processing resources. Where water for fermentation is scarce, heaping or stacking fermentation techniques are used.

3.0 MATERIALS AND METHODS

3.1 AREA OF STUDY

The farm land is located at Eziobodo, Owerri West Local Government Area, Imo State, Nigeria. It is located in globe by 4 ^{o} 45′N and 7^{o} 15′N latitude and 6^{o} 50′E and 7^{o} 25′E longitude with elevation of 88m above sea level. The area has the following geological characteristic:

Owerri lies entirely within coastal plain sandstones (Benin Formation) which have a thickness of about 800m. The Benin formation extends from the west across the Niger Delta and southward, beyond the present coastline. It is over 90 percent sandstone with minor shale intercalations in some places. It is coarse grained, gravely, locally fine grained, poorly sorted, sub-angular to well-rounded, and bears lignite streaks and wood fragments. The Benin formation is thus partly marine, partly deltaic, partly estuarine and partly lagoonal and fluviolacustrine in origin (Reyment, 1976). Its age ranges from Miocene to recent. The terrain of the area is characterized by two types of land forms: highly undulating ridges and nearly flat topography. Various structural units (point bars, channel fills, natural levees, back swamp deposits and oxbow fills) are identifiable within the formation indicating the variability of the shallow water depositional medium. The otherwise continuous body of the Benin formation is interrupted by the Afam clay member which consists mainly of clay with few intercalated sandstone bodies. Stratigraphically, the Benin formation is overlain by recent alluvium and recent sediments and underlain by the Agbada formation. Its outcrop lateral equivalent is probably the Ogwash - Uku-Asaba formation.

3.2 SAMPLE COLLECTION TECHNIQUE

Soil samples were collected using the transect survey (straight line) method. Soil samples (polluted and control) were collected at different points though, in the same farmland at depth of 10 to 15 centimeters using soil Auger. The samples were collected into different polythene bags and transported to Imo State Environmental Protection Agency (ISEPA) laboratory for physicochemical analysis.

3.3 PHYSICOCHEMICAL ANALYSIS OF THE SOIL SAMPLES

The polluted and control (unpolluted) soil samples were determined using standard method as prescribed by (AOAC, 2002). The soil samples were air-dried at 80^oC for elemental analysis. Ten grammes of each sample was weighed and digested in concentrated hydrochloric acid and tetraoxosulphate (VI) acid and thereafter diluted with 15ml of distilled water. Subsequently, the filtrate of each was analysed for chemical parameters such as the pH, Zinc, Copper, Cyanide, Manganese, Potassium, Iron Nitrate, Sulphate, Phosphate, Lead, Cadmium, Chromium, Sodium, Organic Matter and Conductivity. The results of the analysis were also recorded.

3.4 DETERMINATION OF SOIL PH

Soil pH in Water

Ten grammes (10g) of each sample was weighed and added into 25ml beaker. Ten milliters (10ml) of distilled water was thereafter, added and the solution was allowed to stand for 30 minutes and then stirred occasionally with a glass rod. The electrodes of the pH Meter were inserted into the partly settled suspension and then pH was measured.

3.5 GRAIN SIZE ANALYSIS

Hundred grammes (100g) of each soil sample was measured in a weighing balance and subjected to sieve analysis for 15 minutes. And the results were taken.

Computations

(i) Percentage on any sieve = $\frac{\text{Mass of soil retained}}{\text{Total soil mass}} \times 100$

(ii) Cumulative percentage retained on any sieve = sum of percentage retained on all coarser sieves

(iii) Percentage finer N = 100 – (cumulative percentage retained).

4.0 RESULTS AND DISCUSSION

4.1 RESULTS

Table 4.1: CHEMICAL ANALYSIS

S/NO	PARAMETERS	POLLUTED	UNPOLLUTED
1	Temperature (^{o}C)	28.6	26.4
2	PH	9.0	8.0
3	Nitrate (mg/l)	11	7.50
4	Sulphate (mg/l)	18.60	4.30
5	Phosphate (mg/l)	16.23	37.12
6	Iron (mg/l)	0.20	0.20
7	Copper (mg/l)	14.20	49.88
8	Manganese (mg/l)	0.50	<0.01
9	Zinc (mg/l)	0.12	0.01
10	Lead (mg/l)	0.08	<0.001
11	Cadmium (mg/l)	0.61	0.05
12	Chromium (mg/l)	0.01	<0.01
13	Cyanide (mg/l)	0.02	0.01
14	Potassium (mg/l)	0.72	0.54
15	Sodium (mg/l)	4.24	3.36
16	Organic Matter (%)	3.7	2.8
17	Conductivity (us/cm)	223	94

Table 4.2: GRAIN SIZE DISTRIBUTION ANALYSIS FOR POLLUTED SAMPLE

IS Sieve No	Particle size (mm)	Mass of soil retained (g)	Percentage retained (%)	Cumulative percentage retained (%)	Percentage finer (%)
2.0mm	2.0	2.10	2.10	2.10	97.90
1.18mm	1.18	3.70	3.70	5.80	94.20
600µm	0.60	21.60	21.60	27.40	72.60
425µm	0.425	21.20	21.20	48.60	51.40
300µm	0.30	18.90	18.90	67.50	32.50
212µm	0.212	15.60	15.6S0	83.10	16.90
150µm	0.15	8.00	8.00	91.10	8.90
63µm	0.063	4.60	4.60	95.70	4.30

Table 4.3: GRAIN SIZE DISTRIBUTION ANALYSIS FOR CONTROL SAMPLE

IS Sieve No	Particle size (mm)	Mass of soil retained (g)	Percentage retained (%)	Cumulative percentage retained (%)	Percentage finer (%)
2.0mm	2.0	1.60	1.60	1.60	98.40
1.18mm	1.18	3.70	3.70	5.30	94.70
600µm	0.60	19.40	19.40	24.70	75.30
425µm	0.425	18.50	18.50	43.20	56.80
300µm	0.30	18.20	18.20	61.40	38.60
212µm	0.212	14.30	14.30	75.70	24.30
150µm	0.15	8.10	8.10	83.80	16.20
63µm	0.063	4.80	4.80	88.60	11.40

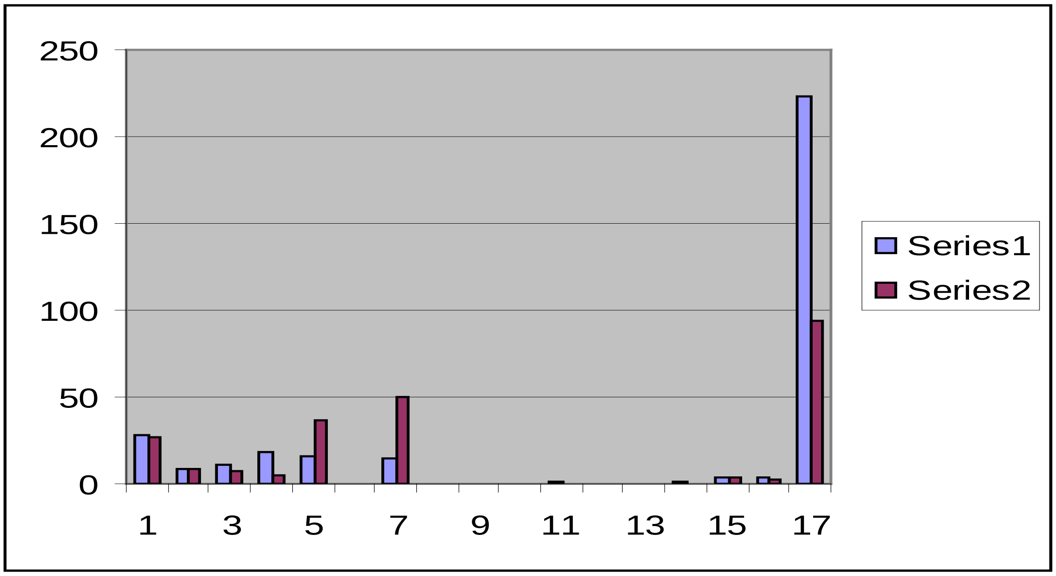

FIGURE 4.1 COMPARISON OF POLLUTED SOIL SAMPLE WITH THE UNPOLLUTED SOIL SAMPLE

Series 1 are parameters for polluted soil sample.
Series 1 are parameters for unpolluted soil sample

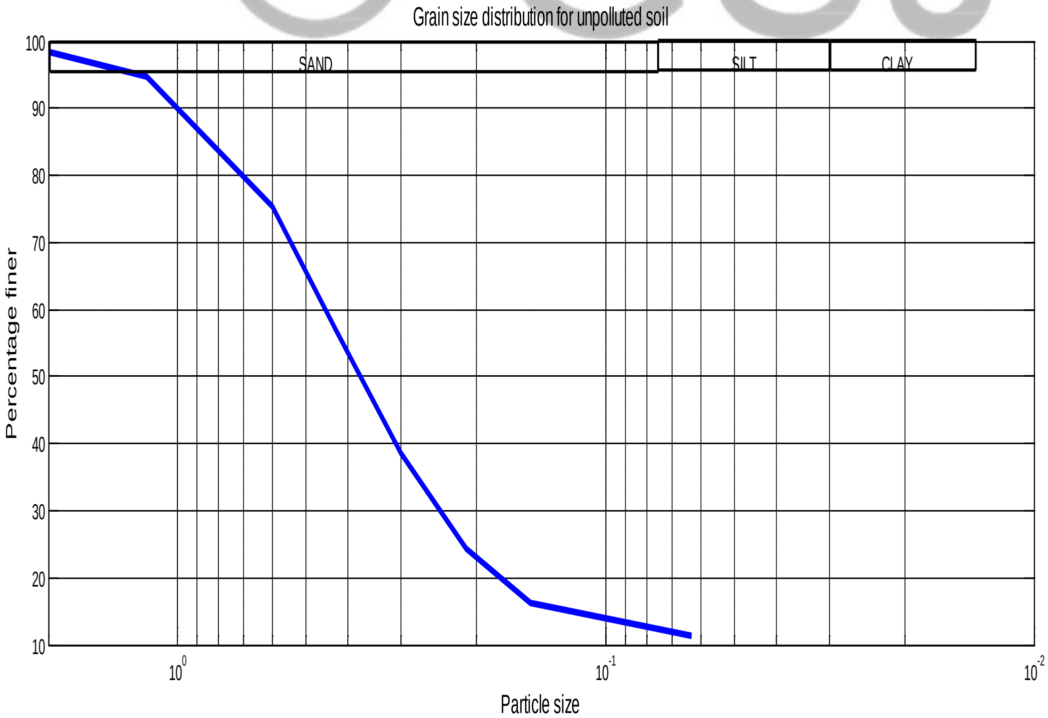

FIGURE 4.2 GRAIN SIZE DISDTRIBUTION OF UNPOLLUTED SOIL SAMPLE

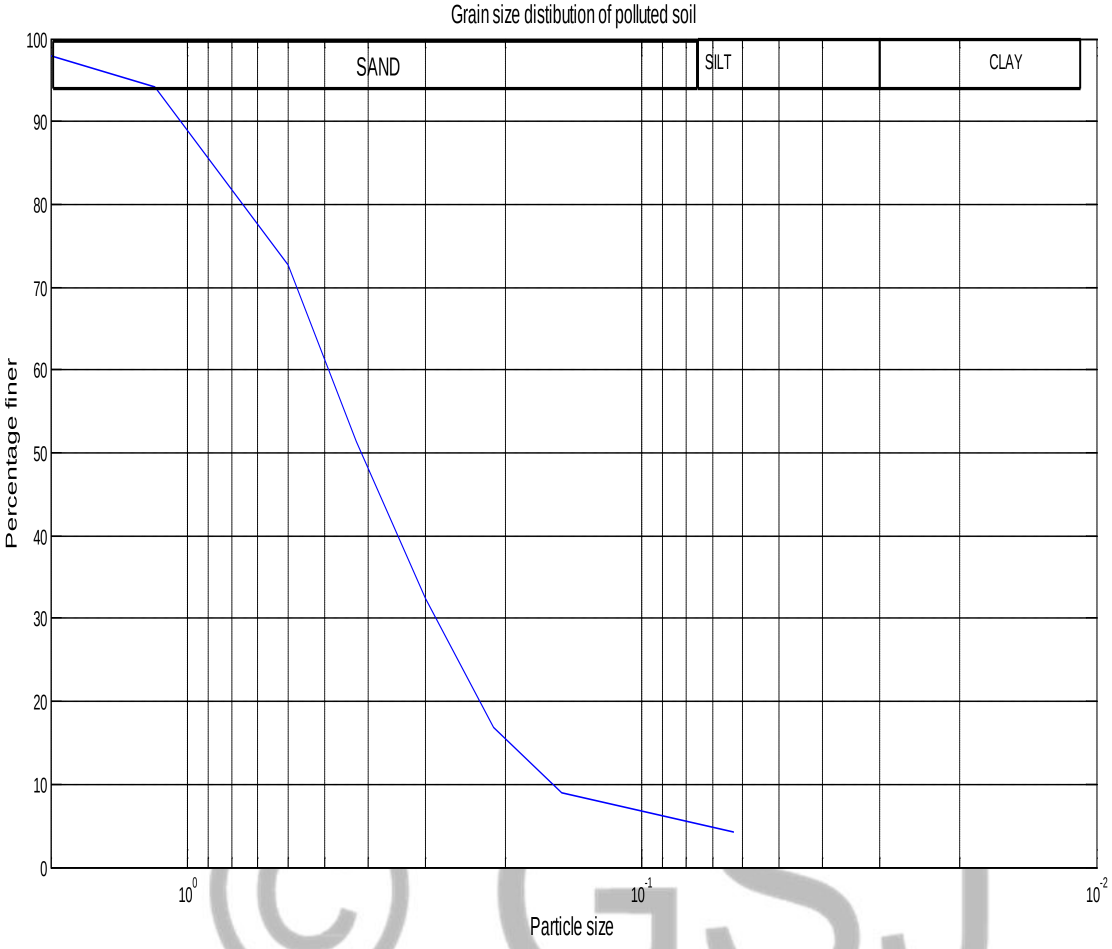

FIGURE 4.3 GRAIN SIZE DISTRIBUTION OF POLLUTED SOILL SAMPL

4.2 DISCUSSION

The table 4.1 showed elevated pH (9.0) in the polluted soil sample which indicates high alkalinity comparing with the unpolluted soil sample (8.0), which is near neutral value. Soil pH is one of the most important soil properties which determine the species, availability, survival, and growth organisms in the soil thereby affecting nutrients availability. Generally, soil falling between pH of 6.5 to 8.0 is suitable for most of the common crops. Soil with such pH range is rich in nutrients due to the availability of soil organisms to break down organic and inorganic materials in the soil to support plant growth. At elevated pH, most microorganisms become dormant (inactive).The same table (4.1) showed elevated value of some parameters (nutrients) in the polluted soil sample. Such parameters include Nitrate (11mg/l), Sulphate (18.60mg/), Organic Matter (3.70%) and Conductivity (223 us/cm) compared to the unpolluted sample. This means that the soil polluted with cassava effluent can reduce population and proliferation of soil microorganisms to make nutrients available for plant absorption. The table also showed reduction in concentration of copper in the polluted soil sample (14.20mg/l). Also, the table showed elevated values of heavy metals such as manganese (0.5mg/l), lead (0.08mg/l), cadmium (0.61mg/l) and chromium (0.01mg/l). This implies that cassava effluent contained and introduced heavy metals or caused increased concentrations of heavy metals in the soil. Such elements are toxic to plants and last long in soil due elevated pH. Cadmium recorded 0.61Mg/L on the soil sample and its control recorded 0.05Mg/L while WHO permissible limit is 0.003Mg/L- 0.05Mg/L. The soil is also polluted with cadmium. Cadmium is a highly mobile element that can easily be transported through the shoots of plants and uniformly distributed throughout the affected plant (Baker et al., 2000; Sekaraet et al., 2005). When it is exposed to human, it causes diarrhea, severe vomiting, bone fracture, reproductive failure, damage of central nervous system, stomach pains and damage of DNA in addition to cancer development (Otiet et al., 2013 and Ogbonna et al., 2015).

The table showed elevated concentration of cyanide. And since such soil contains varying concentration of heavy metals, cyanide forms complexes with zinc and hydrogen to form an acidic complex in higher concentrations. Such acidic complexes are called hydrogen cyanide acid.

Table 4.2 and 4.3 showed the grain size distribution of the soil samples and hence their textual class to be loamy– a combination of sand, silt and clay. This was made clear through the particle size range of 2.0mm to 0.063mm. Table 4.7 showed the gradation to be gap through the percentage finer of 97.90%, 94.20%, 72.60%, 51.40%, 32.50% 16.90% 8.90% and 4.30%. Comparing such percentage finer with that of the unpolluted sample (98.40%, 94.70%, 75.30%, 56.80%, 38.60%, 24.30% 16.20% and 11.40%), which is said to be well graded according to Indian soil classification. The gap gradation is as a result of the absence of microorganisms such as bacteria (*Bacillus sp.*) and fungi (*Rhizopus sp.*) in the polluted soil sample. Such microorganisms tend to maintain the soil structure through adequate pore spaces in soil and hence sufficient circulation of oxygen, water, and nutrients. The absence of such microorganisms, affect soil structure and texture negatively due to poor porosity in soil.

5.0 CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

The effect of cassava mill effluent on garden soil has proven to cause significant pollution to farm lands. Increase in soil pH has shown to affect the availability and distribution of soil nutrients and minerals and also causes displacement of soil microorganisms. Therefore, the absence of organisms like *Bacillus sp* in garden soil indicates strong pollution and displacement of healthy soil microorganisms. Such displacement affected physical parameters of the soil negatively. Such parameters are soil porosity, hydraulic conductivity and so on. The gradation was termed gap or poorly graded and hence no circulation of nutrients, oxygen and water. Furthermore, the elevated pH, increased the concentration of Nitrate, Sulphate, Organic matter and the presence of heavy metals in the soil proved the displacement of normal soil microorganisms such as Bacillus sp (Bacteria) and *Rhizopus sp.* (Fungi) by *Staphylococcus aureus* (Bacteria) and Candida sp (Fungi).

Therefore, I conclude elevated pH value, presence of heavy metals and insufficient pores on the soil to supply air (oxygen), water and nutrients to the plant cause death and performance plants.

5.2 RECOMMENDATION

- I strongly recommend that cassava effluents should be treated first before disposal or discharging either to nearby surface or farm land.
- Run-off from such farms should be checkmated to avoid the pollution of a nearby river which could lead to loss of aquatic life, aesthetic value and other physical parameters of such river.
- I also recommend that cassava effluent discharge from the mills should be highly controlled and regulated.
- Environmental awareness seminar is recommended to the public over the significant impact of cassava effluent on soil and surface water.

5.3 SUGGESTIONS FOR FURTHER STUDIES

I suggest that subsequent studies should focus on the following:

- The effect of cassava effluent on ground water and
- The effect of cassava effluent on surface water.

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