**RESIDUALEFFECT OF TOTAL HYDROCARBON FROM SPENT OIL CONTAMINATED SOIL ON PLANT (*Telfairia occidentalis*) ELEMENTAL COMPOSITION AND MODULATION**

**A RESEARCH PROJECT**

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**SUBMITTED TO:**

**DEPARTMENT OF GENETICS AND BIOTECHNOLOGY**

**FACULTY OF BIOLOGICAL SCIENCES**

**AKWA IBOM STATE UNIVERSITY**

**IKOT AKPADEN CAMPUS.**

**IN PARTIAL FULFILLMENT OF REQUIREMENT FOR THE AWARD OF BACHELOR OF SCIENCE (B. Sc) IN GENETICS AND BIOTECHNOLOGY**

**OCTOBER, 2022**

**DECLARATION**

This project is authentic work carried out by; **JOHNNY, MFONISO ADEN** with the Registration Number: **AK17/NAS/BIO/067** in partial fulfillment of the requirement for the award of Bachelor of Science (B. Sc) in Genetics and Biotechnology.

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**CERTIFICATION**

This is to certify that this research work “residual effect of total hydrocarbon from spent oil contaminated soil on plant **(*Telfairia occidentalis*)** elemental composition and modulation” is the original copy of research carried out by; **JOHNNY, MFONISO ADEN** with the Registration Number: **AK17/NAS/BIO/067** in the Department of Genetics and Biotechnology, Faculty of Biological Sciences Akwa Ibom State University, Ikot Akpaden, under the supervision of Dr. Ifiok Uffia.

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**ACKNOWLEDGEMENT**

My heartfelt appreciation goes first to my supervisor Dr Ifiok Uffia for his careful supervision of the success of my work. This segment of the preference cannot be completed without acknowledging the effort of Mr. Ime Etim for his academic encouragement.

My warm arm of fellowship is extended to my friends and colleagues who contributed in their little way to the success of this work. I am also grateful for the assistance provided mainly, by Mr.Ekop Usen and his family, Engr. Aniekan James and his family, and Miss Nkese Usen. I am indebted to my mother and brother for their prayers and financial support during this work. My prayer for them is that God’s blessings should continue to abide with them.

Finally, I thank the Alpha and the Omega for guidance towards the successful delivery of this project.

**DEDICATION**

This work is dedicated to God Almighty and my beloved Mother.

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***ABSTRACT***

*The effect of spent car oil contaminated soil on Telfairia occidentalis elemental composition and growth performance was studied for four weeks. Measurement were made based on vine length, number of leaves and width and data obtained were subjected to multivariate statistical analysis.* specimen A (control) recorded 1.3 8.9±1.39cm and 13±0.00cm respectively. Specimen B and C shows no growth performance in the first week and there was significant (p<0.05) differences from two to four weeks in the specimens (A, B and C) which recorded; 4.16±1.20cm, 10.9±0.97cm, 12±0.00cm and 5.1±0.88cm, 8.4±0.37cm and 9.5±0.00cm respectively. The number of leaves in the three specimens were counted and specimen A(control) shows different in number of leaves that was different from the contaminated soil with car spent oil from first to forth weeks (table 4.1). The vine length was also measured and the effect of the spent oil on the growth performance was observed and recorded 3.67±1.38cm, 26.0±2.53cm, 48±2.53cm and 70.5±2.33cm in specimen A, and specimen B recorded, 0.67±0.005cm, 7.6±1.23cm, 18.4±3.45cm, 20±0.00cm and specimen C recorded 6.4±1.43cm, 17.6±1.08cm and 19.0±0.00cm respectively. There was significant (p>0.05) increased in the contaminated soil when NPK was added. The leaf width in week three when NPK was apply shows significant (p>0.05) increase that differs from the former as specimen B recorded 10.9±0.97cm and 12±0.00cm in week three and four. Specimen C recorded 8.4±0.37cm and 9.5±0.00cm respectively. *The total hydrocarbon content (THC) was determined based on Official Analytical method and there was a significant (p>0.005) increased in the contaminated soil with spent oil compared to the one without spent oil. This study has shown that contaminated soil with car spent oil has a pronounced effect on the growth and total hydrocarbon content on Telfairia occidentalis and that NPK has the potential of enhancing the growth of the plant and the hydrocarbon content.*

**CHAPTER ONE**

**INTRODUCTION**

* 1. **Background of study**

Spent engine oil refers to used motor oil collected from mechanical/automobile, workshops, garages, and industrial sources like hydraulics oil, turbine oils, process oil and metal working fluids (Olugboji and Ogunwole, 2008). Spent engine oil is a mixture of several different chemicals (Wang *et al.,* 2000), including low and high molecular weight (C15-C20) aliphatic hydrocarbons, aromatic hydrocarbons, polychlorinated biphenyls, lubricative additives, chlorodibenzofurans, decomposition products, heavy metal contaminants such as aluminum, chromium, tin, lead, manganese, nickel, and silicon that come from engine parts as they wear down (ATSDR, 1997). It is a non-volatile liquid and lubricant important in the maintenance of motor and internal combustion engines. When used or expired and drained out from automobile or generator engine during servicing is referred to as spent engine oil. Spent engine oil has constituted an important source of pollution in Nigeria due to its indiscriminate disposal into space, gutter, water drains and open vacant plots. According to Anoliefo and Vwioko (1995), contamination of open vacant plots and farmlands with petrol oils and grease is becoming more widespread problem than crude oil pollution especially in the urban areas. The impact of spent engine oil on contact with the soil ranged from depletion of nutrients especially Nitrogen (N) and Phosphorus (P), inhibition of microbial activities and degradation of soil physical properties (Amadi *et al.,*1993). Spent engine oil diffused into the soil on contact with the soil leading to the formation of waxy oily scum texture (Anoliefo and Vivioko, 1995). Oils in soil makes the soil condition unsatisfactorily for plants (De Jong, 1980), due to reduction in the level of available plant nutrients or a rise to toxic levels of heavy metals, such as Mn, Va, Pb, etc. (Udo and Fayemi, 1975). Anoliefo and Vivioko (1995), reported that spent engine oil polluted soil caused stunted growth in plant and the effect was more pronounced with tomato than sweet pepper. Petroleum and other organic petroleum-based products like gasoline, kerosene, diesel, and naphtha are in higher demand due to the expansion of industries that have been in the past and are still existing worldwide. In a natural state, this material consists of hundreds of thousands of distinct hydrocarbon compounds (Jeff, 2006). These crudes are transported through pipelines, exposed to environmental factors like weather, temperature variations, soil movement, and human activity. These factors can harm the pipelines, causing them to crack or break and contaminate the surrounding soil, endangering human health and the environment. One of Nigeria's most prevalent environmental pollutants/contaminants is crude oil products. There are some natural sources of oil contamination, but human activity is the leading cause. Underground gasoline storage tanks at motor fuel stations, heating oil tanks for homes and businesses, fuel distribution facilities, refineries, crude oil production sites and unintentional accidents are familiar sources of these items (Marinescu *et al.,* 2011). Most of these PHCs are considered high-grade pollutants for environmental remediation by the United States Environmental Protection Agency Act.

*Telfairia occidentalis* is a valuable commercial crop grown in urban and peri-urban areas in Nigeria and across the lowland humid tropics of West Africa. It belongs to the family cucurbitaceae. It is a tropical vine grown primarily for the leaves and edible seed (Fagbemi *et al.,* 2005). In addition, the plant can be used to treat anemia, convulsion, high blood pressure, high blood cholesterol, anthritis, liver problems and inflammatory condition (Oguntola, 2011). The fruit is fluted as it can be seen from the shape of the gourd. It is from this morphology it derives its name-fluted pumpkin. There is hardly any home in Nigeria where *Telfairia occidentalis* is not consumed in daily meals due to its health restoration value. The young leaves are sliced and stored in a bottle to which coconut water and salt are added. This is used for the treatment of convulsion in ethno medicine (Gbile, 1986). The roots are used as rodenticide and ordeal poison (Gill, 1992). The leaves contain essential oils, vitamins; root contains cucubitacine, sesquiterpene, lactones (Iwu, 1983). In addition, diets that are rich in leaves and seeds of fluted pumpkin have been found to increase haemotological indices, improved sperm quality, reduced blood glucose levels, arrest cancers and prevent the upset andropauce (Muanya, 2012). In this study, fluted pumpkin was used to access the productive of soil polluted with spent engine oil and amended with organic fertilizer. The cumulative concentrations of PHCs in ecological media are usually measured as Total Petroleum hydrocarbons (TPHs), with carbon numbers generally ranging from C10 to C40 (*Grifoni et al.,* 2020). However, the downward migration of diesel and gasoline fuels through the soil profile is limited due to the physical properties of the energy which will be adsorbed in the organic-rich surface soil, causing an impediment to downward migration (Adam and Duncan, 2002). Nonetheless, methods have been developed to find and locate the leak when it is minor (Arifin *et al.,*2015). Detecting HC contamination in the soil through changes in the vegetation cover pattern can indirectly detect leaks in pipelines. According to (Smith *et al.,* 2004; Emengini *et al.,* 2013a, 2013b), the presence of HC in the soil can have a variety of physiological impacts on plants, including reduced growth and leaf chlorosis, which can alter how much light is reflected, transmitted, and absorbed by leaves and the canopy. In the recent light of the research on the effect of crude oil on plants, it was observed that crude oil has a synergistic impact on soil physiochemical properties, which affects the performance of the plants and results in the unavailability of nutrients to the plants, as such there is need to evaluate the growth performance and Total Hydrocarbon Content (THC) on the affected plant (Odejegba and Sadig, 2004).

* 1. **Problem Statement**

The disposal of spent oil into open vacant plots and farms, gutters and water drains is an environmental risk (Odjegba and Sadiq, 2002) since it is liquid, it easily leaches into the environment and eventually pollutes either water or soil (Olugboji and Ogunwole, 2008). This factors have been studied to affect the growth performance and increased the heavy metal contents of plants one of which is fluted pumpkin (*Telfairia occidentalis).* Although some heavy metals at low concentrations are essential micronutrients for plants, but at high concentrations they may cause metabolic disorders and become growth inhibitors for most of the plant species (Fernandes and Henriques, 1991). This work investigates the residualeffect of total hydrocarbon from spent oil contaminated soil on plant (*telfairia occidentalis*) elemental composition and modulation.

* 1. **Justification**

In recent years, the effect of spent oil on both animals and plants in the environment has been reportedly increased and its effects on plant’s yield is inevitable. Fluted pumpkin (*Telfairia occidentalis* Hook F.)*,* is a vegetative crop belonging to the family Cucurbitaceae, native to West Africa but occurs mostly in its cultivated form in various parts of southern Nigeria (Odoemena, 1991). It is obvious that plants are known to respond differently to their environment right from germination and at their different stages of growth, therefore it becomes necessary to study what the effect of disposal of spent oil into the environment will have on the growth and performance of crops with time. In view of the above, this research was therefore carried out to evaluate the residualeffect of total hydrocarbon from spent oil contaminated soil on plant (*telfairia occidentalis*) elemental composition and modulation.

**1.4 Aims and Objectives of the study**

This work aims to determine the residual effect of total hydrocarbon from spent oil contaminated soil on plant (*telfairia occidentalis*) elemental composition and modulation

The aim of the study was accomplished through the following objectives:

* Evaluate the effect of spent oil contaminated soil treated with NPK on the growth and modulation of ***Telfairia occidentalis***
* Analyze the residual effects of the Petroleum hydrocarbon on the germinated ***Telfairia occidentalis***
* Assess the effect of the Total Hydrocarbon Content on a contaminated soil with spent oil, treated with NPK on *Telfairia occidentalis*.

**CHAPTER TWO**

**LITERATURE REVIEW**

**2.1 Brief history**

Crude oil is one of the essential mineral resources which aids in boosting a country’s economy and is a significant source of Petroleum and Petroleum products. Due to the pursuit of economic growth and development, industries have created many problems in refining this crude oil. In countries like Nigeria, the effect is evident because of damage to the pipelines. Contamination of water, air, and land (soil) suffer from these actions of attempting to boost the country’s economy. Over the years, studies have been made to remediate these dangers created by the quest to help the county’s economy.

**2.2 Crude oil polluted soils**

Crude oil spill occurs on the earth’s surface at oil production, transportation, and storage. Soil contaminated with oil (crude oil-contaminated soil) is dangerous for human health, ﬂora, and fauna. Therefore, one of the actual problems for the normal functioning of biological and ecological systems in the regions with oil production is eﬃcient remediation and utilization of crude oil-contaminated soil. The most important genetic soil characteristics are disturbed at oil contamination: content and composition of humus, nitrogen, phosphorous, and other chemical elements vary; soil adsorption capacity is reduced, density is increased, aeration and water penetration are reduced, and plant available moisture content is decreased (Valeyev, 2004). The presence of oil and refined petroleum products in the soil can lead to toxic effects on plants and soil microorganisms and acts as a source of ground water contamination (Scott, 2003). Petroleum hydrocarbon contamination of soil occurs through extraction, accidents, pipeline, raptures, consumption and refining (Scott, 2003). Most of the crude oil reservoirs and oil refineries in Nigeria are located in areas with agricultural activities and urban areas in the Niger Delta. It is believed according to UN reports, that an average riverine dweller of the Niger Delta is exposed to polluted air, polluted water and polluted food, hence facing health hazard resulting to reduced life expectancy (UN Report, 2001). Consequently, the remediation of soil impacted by oil production and transport is not only of importance considering environmental problems but also for the preservation of agricultural productivity and human health. Chemical and physical methods applied for remediation of petroleum-contaminated soils such as thermal treatment, soil washing, solidification and stabilization are expensive, disruptive to the environment and involved high-energy consumption (Kaimi *et al.,* 2007). Therefore, natural remediation techniques have been developed to provide more environmentally friendly and cost effective cleanup of sites impacted by petroleum spills (Alkorta and Garbisu, 2001). Natural self -puriﬁcation of natural objects from oil contamination is a time-consuming process. Therefore, short-time eﬃcient artiﬁcial methods are required for puriﬁcation. At present, the following methods are known for remediation of crude oil-contaminated soil: biological, chemical, thermal, ultrasound, and mechanical (Kapustin, 2008). The purpose of most of remediation methods mentioned above is to extract oil from crude oil-contaminated soil. As a rule, these methods are expensive. This paper suggests a method for the neutralization of crude oil-contaminated soil with the use of neutralizer produced on the basis of a sodium humate, and the possibility is shown for the use of the neutralized soil in road construction.

**2.3 Petroleum based hydrocarbon plant**

Petroleum based hydrocarbon plant are plant that have excessive intake of hydrocarbon and have the tendency to exhibit the material of crude oil compound in their nutrient. Crude oil is a raw natural resource that is extracted from the earth into products such as gasoline and other petroleum products. It is composed of hydrocarbon deposits and other organic materials that were formed from the remains of animals and plants hat lived millions of years ago. Hydrocarbon plants are plants that follow certain metabolic pathway that produce hydrocarbon product similar to petroleum.

**2.4 Petroleum hydrocarbon residue and effects on contaminated soils**

The soil is a fundamental and irreplaceable natural resource, which provides an essential, link between the components (air, bedrock, water, and biota) that make up our environment; these components interact with each other to provide essential needs like food, fuel, and fiber to support the organism (DEFRA, 2009). Soil contaminated by petroleum hydrocarbons is a serious worldwide environmental problem that has been attracting public attention over the past decades. Human activities are one of the major factors that contribute to the spill of hydrocarbons through agriculture or industrial products. Although petroleum is one of the dominant energy sources to maintain the economic and social development of a country, petroleum has become one of the most important types of organic pollutant and is caused by the main leakage of underground storage tanks and accidental spills during transportation and disposal. Total petroleum hydrocarbons in the presence of soil have a negative impact on human health and the development of plant growth. With the expanding of the soil contaminated by petroleum hydrocarbons effort have been made to remediate total petroleum hydrocarbons contamination in soil. Spills, leaks and other environmental factors associated with petroleum products cause hazards to human health. Chemicals involved are petroleum hydrocarbons, polycyclic aromatic hydrocarbons (PAHs), solvents, pesticides, lead, and other heavy metals (USEPA, 2011). Contaminants can enter the soil from the point source (industrial and households) and diffuse source (mobilization and transportation by floodwaters) that can have long-term implications for the quality and functioning of soils as well as human health and food quality (DEFRA, 2009).

Natural gas, crude oil, tars, and asphalt are types of petroleum hydrocarbons (Frick, 1999). The word petroleum means “rock oil” or “oil from the earth” (USEPA, 2011). Petroleum used in our daily life plays a vital role in our modern society. It is the main energy source for heating, transportation, and manufacturing, but acts as a raw material for plastic and synthetic rubber. Total Petroleum Hydrocarbons (TPHs) are used to describe mixtures of organic compounds found in or derived from crude oil that has the potential to be most toxic (CCME, 2001).

It’s made up of hydrogen and carbon but may also contain sulfur, nitrogen, heavy metals, and oxygen compounds. Most products that contain total petroleum hydrocarbons (TPHs) can burn easily. Some are clear or light colored liquids that evaporate easily, and others are thick, dark liquids or semi-solids that do not evaporate (CCME, 2001) and many of these products (gasoline, kerosene etc.) have oily odors. Modern society uses so many petroleum-based products (for example gasoline, kerosene, fuel oil, mineral oil, and asphalt), widespread environmental contaminants (CCME, 2001).

**2.5 Spent oil**

Spent Oil (a synthetic lubricant used in automobile engines, generators and other machines) is one of the very dangerous sources of pollution. Once motor oil is drained from an engine, it is no longer clean because it has picked up materials, dirt particles, and other chemicals during engine operation. This lubricating oil is now classified as used-oil. According to the United State Environmental Protection Agency, Used -oil is defined as any oil that has been refined from crude oil or any synthetic oil that has been used and as a result of such use, is contaminated by physical or chemical impurities (US EPA, 2000). Ministry of Environment and Forest also defined used -oil as oil derived from crude oil or Mixtures containing synthetic oil including used engine oil, gear oil, hydraulic oil, turbine oil, compressor oil, industrial gear oil, heat transfer oil, transformer oil, spent oil and their tank bottom sludge which are suitable for re-refining (MEF, 2008). Used motor oil is also found to contain a number of additional components from engine wears; this includes iron, steel, copper, lead, zinc, barium, cadmium, sulfur, water, and ash. Because of the contaminants it contains, used motor oil disposal can be more environmentally damaging than crude oil pollution (US EPA, 2000). These contaminants may cause both short-term and long-term effects if they are allowed to enter the environment (US EPA, 2000). Just one gallon of used -oil can make one million gallons of fresh water unfit for human consumption (US EPA, 1996). It takes only 50 to 100ppm of oil to foul the sewage treatment process if it is disposed of in a sewer drain (US EPA, 1996).

Studies have shown that generally, five litres of oil can cover a small lake (US EPA, 2000). Causing: BOD depletion through the oil film formed on the water surface, dead of plants and animals that come in contact with it through its toxic effects, and also contamination of drinking water sources. Hazards from used-oil contaminated water range from mild symptoms of toxic compounds in the liver of organisms to complete impairment of body functions and eventually death of the organism (Noln *et al.,*2002). Safe collection and subsequent handling of used-oil is necessary to ensure environmental safety. Unfortunately, Nigeria lacks proper used-oil disposal methods, unlike other developed countries (Osibanjo, 2004). In most developed countries, used- oil are recovered and recycled. Some uses of used-oil include: Direct use as fuel, Re-refining of used-oils to fuel oil and Regeneration of used-oils to base oil (Kristensen, 2006).

**2.5 Composition of spent oil**

The most important consideration in engine oil is the reduction of friction and control of wears (Jilner, 1997) where viscosity is the primary factor performance which was obtained by blending base stock or base oil with various compositions of various additives. So achieving the right viscosity relies on selecting the right base stocks and blending recycled oil with performance additives to enhance functional performance. The advanced refinery technologies specifically the lube processing, is a sophisticated refining technique e.g. Hydro treating/hydro cracking is introduced to convert the undesirable components of the base stocks. United State Environmental Protection Agency noticed that, the base stocks used in the formulation of this engine oil are either of crude petroleum or synthetic origin. Crude petroleum base oils are obtained by refining crude. While synthetic on the other hand is those products made from petroleum or vegetable feed stock and are often “tailor made” for specific application.

**2.6 Bioremediation of polluted soil**

Bioremediation is usually accomplished “in-situ”, but polluted soil may also be excavated and hauled to a treatment site where such techniques as high temperature compositing may be used to destroy the organic contaminations in the soil. The use of bioremediation technology that assists the naturally occurring microbial populations in breaking down chemicals is called biostimulation. Usually, the soil naturally contains some bacteria or other microorganism that can degrade specific contaminants. However, the rate of natural degradation may be far too slow to be very effective (Brady and Weil, 2002). Brady and Weil (2002) reported further that both growth rate and metabolic rate of organisms capable of using contaminants as sources of carbon are often limited by insufficient mineral nutrients, especially nitrogen and phosphorus. Therefore, nutrients and oxygen are often added to speed up the process.

Bioremediation is used extensively to break down petroleum constituents, including the more resistant polynuclear aromatic hydrocarbons (PAHs) as well as several synthetic compounds such as polychlorinated biphenyls (PCBs) and trichloroethylene (TCE). Generally, Nyer and Skladany (1993) have reported four major ways to remediate soils contaminated with hydrocarbons as follows: excavation and off-site disposal land fill, in-situ soil venting, in-situ biodegradation and above ground or in-situ chemical oxidation. Excavation of site soils may result in the loss of the volatile compounds present. As these soils are exposed to the atmosphere, petroleum products with high vapour pressures and low boiling points tend to volatilize. According to Nadim *et al.,* (2000) in-situ soil venting is to move air past the contaminated soils and transfer the organic from the liquid phase to vapour phase. This technique, Nadim *et al.,* (2000), described as soil vapour extraction (SVE) which could also be referred to as in-situ clean-up process to remove volatile and some semi-volatile organic compounds (VOCs). This mass transfer process would effectively remove the hydrocarbons from the soil (Nyer and Skladany, 1993). According to Nyer and Skladany (1993), chemical oxidation relied on the use of hydrogen peroxide. On the other hand, when dealing with petroleum-contaminated soils, one can measure the concentration of individual petroleum constituents or the total petroleum hydrocarbon (TPH) concentration. Furthermore, analytic test procedures normally used to assess soil contaminated by petroleum products are petroleum hydrocarbons and heavy metals determination (Massoud *et al.,*1996; Kelly and Tata, 1998). However, Kelly and Tata (1998) and Amadi *et al.,* (1996) pointed out that the degree of soil contamination by petroleum hydrocarbons and heavy metal could impact soil ecosystems sufficiently to result in significant losses in soil quality.

The increase in the consumption of petroleum fractions has led to the rapid increase in the pollution of soil by used motor oil (UMO). The environment (soil and water) is highly contaminated with hydrocarbons by the disposal of used oils (engine oil, diesel or jet fuels). The disposal of used and unused lubricating oil into gutters, water drains, and land are common practice in Nigeria, especially by motor mechanics. This discharge contributes to soil pollution in Nigeria and makes up a larger percentage of polluted ground in the world (Macura and Kune, 1976).). Pollution of soils with petroleum hydrocarbons is a widespread environmental problem and a growing concern in many countries, especially in Asia and African continents especially in industrialized and oil producing countries. In the developing countries with poor regulatory policies on the environment, the problem is very severe.

**2.7 Effect of Automobile oil on physical and chemical properties of soil**

Amadi *et al.,* (1996) reported the effect of heavy and moderate oil spill on soil properties of rainforest ecosystem in Nigeria after 17 years of oil spillage. They found that the pH status of the soils in contaminated zones varied from acidic (4.0) to near neutral (6.0) levels. Furthermore, the organic carbon content of the soils decreased from 3.6% at the heavy impact (HI) zones to 2.8% at the moderate impact (MI) zones. Total nitrogen (N) in the HI and MI zones differed by a fraction of 0.10%. Available phosphorus (P) was higher at the MI than HI zones, while cation exchange capacity (CEC) decreased from a mean of 6.48 at the HI zones to 4.46 at the MI zones. The residual oil content at the HI zones showed persistence of high level of oil, about 788 times higher than the biogenic threshold level for most tropical soils, inspite of the time lapse between spill and the time of investigation. Their findings indicate that although organic C, total N, C/N ratio, available P, exchangeable K and CEC were higher at the MI than HI zones, the treatment effects were, nevertheless, not significant. Amadi *et al.,* (1996) concluded that indiscriminate disposal of oily wastes or spill might lead to formation of oily scum. As a result, oily scum on soil surface would impede O2 and water availability to biota, and anaerobic condition created in the subsoil would aid the persistence of the oil. Similarly, Udo *et al.,* (1984) discovered that soil properties usually underwent considerable changes following pollution by oil. These changes, amongst others, included increase in water holding capacity, loss of soil structure, exclusion of air which introduced reducing conditions and the production of hydrogen sulphide. Diana *et al.,* (2004) noted that hydrocarbon oil contaminated soils had significantly higher pH values and C: N ratios, and lower total nitrogen and available phosphorus than uncontaminated soils. They attributed the higher C: N ratio in contaminated soil to lower nitrogen rather than higher carbon. Similar findings were reported by Diana *et al.,* (2004) who noted that electrical conductivity (EC), total carbon, available potassium were significantly lower in contaminated soils relative to uncontaminated soils. They further reported that total petroleum hydrocarbons were low (49 to 64μg/g) and pointed out that the plots with the highest concentration of hydrocarbons also had the highest C: N ratios. Ogboghodo *et al.,* (2001) noted that land degradation due to oil pollution could lead to alteration of the physico-chemical properties of the soil such as soil structure, reduction in soil permeability, surface sealing, compaction and decrease in macro-pores. They further pointed out that infiltration rate, and hydraulic conductivity were affected by oil pollution. Odu (1981) observed that oil pollution had less effect on soil physical properties such as texture than on the chemical properties. Total nitrogen, organic carbon, exchangeable acidity, phosphorus, exchangeable cations, carbon-nitrogen ratio and percentage base saturation of soil were reduced by oil pollution (Ogboghodo *et al.,*2001). However, Asuquo *et al.,* (2001) observed that organic carbon, total nitrogen, soil pH, redox potential and hydrocarbon contents of soil increased with crude oil contamination. They also noted that hydraulic conductivity increased with oil contamination of the soil.

***2.7.1 Effect of Automobile oil on crop development***

Nwankwo (1989) reported that the effect of oil on seed germination had been shown to be inhibitory. Inhibitory is variously associated with tar-mat induced loss of viability (Rowell, 1977) or unfavourable soil conditions (Anoliefo and Vwioko, 1995). De Jong (1980) reported that oils in soil created unsatisfactory condition, probably due to insufficient aeration of the soil caused by displacement of air or the demand for oxygen by activities of micro-organisms (Gudin and Syratt, 1975). Naegele (1974) observed that plants responded differently to pollution effect due to an innate genetic response of the plant system as modified by environmental influences. Oil penetrates and accumulates in plant thereby causing damage to all membranes and leakage of cell contents (Baker, 1970). The growth of cereals is adversely affected in oil polluted soil causing chlorosis of leaves and plant dehydration (Udo and Fayemi, 1975). Amadi *et al.,* (1993) in a greenhouse study on maize germination in oil-polluted soils corroborated the findings of Udo and Fayemi (1975), and Mc Gill and Nybory (1975) that increasing the concentration of oil beyond 3% in soil reduced the percentage germination, by oil coating on seed surfaces thereby affecting physiological functions within the seed. However, by decreasing the soil bulk density with sawdust, in this experiment, the soil volume available for contact with oil was reduced. Consequently, the degree of inhibition of the physiological functions was reduced. Rowell (1977) reported that oil exerts adverse effect on soil condition and this was supported by Baker (1970) who noted adverse effect of oil on microorganisms and plants. Conversely, only a few beneficial effects of well-degraded oil on soil biota have been reported (Mc Gill, 1980). A few investigators have examined the effect of post-oil spill rehabilitation measures on rate of soil recovery and crop improvement (Amadi *et al.,*1993; Too good *et al.,*1977). In all cases of oil pollution of soil ecosystem, N and P were observed to be limiting to both biodegradations of oil and crop development (Amadi *et al.,*.1993). Germination of seeds is grossly affected by oil pollution (Udo and Fayemi, 1975). Udo and Fayemi (1975) maintained that seeds planted in oil-polluted soils generally absorbed the oil and got destroyed. Contaminated plots had significantly lower total vegetation cover and litter than uncontaminated plots (Diana *et al.,*2004). Diana *et al.,* (2004) reported that at seven sites, total vegetation cover on contaminated plots was significantly lower than on uncontaminated ones, the average being about 43 % on contaminated and 58 % on uncontaminated plots. All contaminated plots had significantly more bare ground than uncontaminated ones, about 44 % compared with 6 % respectively (Diana *et al.,*2004).

**2.8 Fluted Pumpkin (*Telfairia occidentalis Hook. F*.)**

The fluted pumpkin (*Telfairia occidentalis Hook. F*.) belongs to the family cucurbitaceae, which consists of 90 genera and 750 species (Irvine, 1969; Purseglove, 1984). It is one of the most widely cultivated leafy vegetables in southern Nigeria (Odiaka *et al.,*2008). Asiegbu (1987) reported protein and oil contents of the seed at 30.1 and 47%, respectively. He also reported that the essential amino acid content compared favourably with those of important legumes such as soybean and groundnut. The plant could also find potential use in medicine since the roots and older leaf extract contain compounds such as resins, alkaloids and saponins (Akubue *et al.,*1980). It could also be exploited as a cover crop along with melon (Colocynthis vulgaris) in vegetable farms of Okra (Abelmoschus esculentus) and Pepper (Capsicum annum) (Akobundu, 1987). One characteristic feature of fluted pumpkin is its exhibition of the polyembryonic trait. Different forms of polyembryony have been reported to occur in *T.occidentalis* (Odiyi, 2003). The author suggested that the occurrence of polyembryony is natural and that multiple seedlings were observed to develop in two areas of the seeds of the crop. The occurrence of multiple embryos in the embryonic axis and cotyledons makes it possible to obtain more plants from one seed as suggested by Esiaba (1982). This may help to overcome shortage of planting materials However, the seedlings are likely to be similar in all respects because of the post-zygotic and post-germinal nature of the emerging embryos (Odiyi, 2003).

In addition, seedlings emerging from the cotyledons can serve as substitutes where zygotic embryos or seedlings are poorly developed or damaged during germination. (Guo *et al.,*2006) reported that polyembryony and male/female sterility are two reproductive difficulties that have greatly hampered the improvement of Citrus by conventional sexual breeding. (Sedgely and Griffing 1989) reported that polyembryony is under genetic control in some fruit tree crops. For instance, in Irvingia gabonensis, the level of polyembryony was found to differ among accessions collected worldwide. Accessions that showed polyembryony in Ibadan also showed high levels of polyembryony in M’Balmayo, Onne and Ibadan, indicating that it is probably an inherited characteristic in the accessions exhibiting this trait. Assessment of six kernels from a polyembryonic fruit was about equivalent to the weight of the single kernel of normal fruit from the same accession. Therefore, from a production point of view, there seems to be little reason to select for this characteristic.

**2.8.1 Origin and Distribution of Fluted Pumpkin *(Telfairia occidentalis)***

Fluted pumpkin *(Telferia occidentalis)* is traditionally used by an estimated 30 to 35 million people and this plant is indigenous to the people in Nigeria, including the Efik, Ibibio, and Urhobo (Aderi *et al.,*2011). Common names for the plant include fluted gourd, fluted pumpkin, ugu (in the Igbo language), and Ikong-ubong (in the Efik and Ibibio languages). However, it is predominantly used by the Igbo ethnic group, who continue to cultivate the gourd for food sources and traditional medicines (Oyekunle and Abosede, 2012). Fluted pumpkin was an asset to international food trades of the Igbo ethnic group (Ogbonna, 2009). Fluted pumpkin *(Telfairia occidentalis)* is a tropical vine grown in West Africa as a leaf vegetable and for its edible seeds (Aderi *et al.,*2011). *Telferia occidentalis* is a member of the family *Cucurbitaceae* and is indigenous to southern Nigeria (Aderi *et al.,*2011; Odiaka and Schippers, 2004). The fluted gourd grows in many nations of West Africa, but is mainly cultivated in south-eastern Nigeria and it is used primarily in soups and herbal medicines (Okon *et al.,*2004). Although the fruit is inedible, the seeds produced by the gourd are high in protein and fat, and can, therefore, contribute to a well-balanced diet. The plant is a drought-tolerant, dioecious perennial that is usually grown trellised (Okokoh, 2005). Fluted pumpkin also occurs in the forest zone of West and Central Africa, most frequently in Benin, Ghana and Cameroon. Although the plant is rare in Uganda, and absent in the rest of East Africa. It has been suggested that it originated in south-east Nigeria and was distributed by the Igbos, who have cultivated this crop since time immemorial (Odiaka, 2001). It is, however, equally possible that fluted pumpkin was originally wild throughout its current range, but that wild plants have been harvested to local extinction and are now replaced by cultivated forms.

**2.8.2 Nutritional and Proximate Composition of Fluted Pumpkin *(Telfairia occidentalis)***

Fluted pumpkin *(Telfairia occidentalis)* is nutritious and comprises of different compound and minerals. It proximate composition is anchored on different parts of the plant; the leaves and seed (Nyong *et al.,*2021). Additionally, it proximate composition of either the leaves or seeds shows large variations as a function of cultivar, plant age, ecological conditions and cultural practices (Nyong *et al.,*2021). The composition of the leaves is comparable to that of other dark green leafy vegetables. The leaf composition per 100 g edible portion include: moisture 86.4 g, energy 147 kJ (47 kcal), protein 2.9 g, fat 1.8 g, carbohydrate 7.0 g, fibre 1.7g (Ehiagbnare, 2008). The high content of mineral nutrients, especially of Mg, Fe and K, carotene and vitamin C make the leaves potentially useful as food supplements (Ehiagbnare, 2008). Young leaves contain the anti-nutrients cyanide at 60 mg per 100 g dry matter and tannins at 41 mg per 100 g dry matter, but their concentrations are below toxic levels and may not affect the bioavailability of the minerals (Aletor *et al.,*2002). Young leaves should be well cooked to remove the potential toxic effects before consumption (Aletor *et al.,*2002; Ehiagbnare, 2008). Akwaowo *et al.,*2002 concluded that the composition of the seed per 100 g edible portion is: water 6.2 g, energy 2280 kJ (543 kcal), protein 20.5 g, fat 45.0 g, carbohydrate 23.5 g, fibre 2.2 g, Ca 84 mg, P 572 mg. Other sources recorded a protein content of 28–37% and an oil content of 42–56% of the dry matter (Aletor *et al.,*2002). The mineral content of the seed is reported to be high (Akwaowo *et al.,*2002). The seeds are high in essential amino acids (except lysine) and can be compared with soya bean meal with 95% biological value. The fruit pulp has a protein content of about 1.0% (Nyong *et al.,*2021). Considered an “oil seed”, the fluted gourd is high in oil (30%) (Nyong *et al.,*2021). Shoots of *Telferia occidentalis* contains high levels of potassium and iron, while seeds are composed of 27% crude proteins and 53% fats (Oboh, and Akinhahuns, 2004). The leaves contain a high amount of antioxidants and hepatoprotective and antimicrobial properties (Oboh, and Akinhahuns, 2004). The main constituents of the seed oil are oleic acid (37%), stearic and palmitic acid (both 21%), linoleic acid (15%) (Giami, 2003). Giami (2003) reported that fermenting fluted pumpkin seeds for seven days increased crude protein and in vitro protein digestibility while decreasing the levels of two anti-nutrients, polypherol and phytic acids.

***2.8.3 Economic Importance of Fluted Pumpkin (Telfairia occidentalis)***

Fluted Pumpkin *(Telfairia occidentalis)* leaves, stems, and seeds, have high food value and provide a source of food, oil and raw material for a variety of products (Akwaowo *et al.,*2002, Giami *et al.,*2003). Fluted pumpkin *(Telfairia occidentalis)* occurs in the forest zone of West and Central Africa, most frequently in Benin, Nigeria and Cameroon (Odiaka and Schippers, 2004 and Aderi *et al.,*2011;). It is a popular vegetable all over Nigeria. In Nigeria, fluted pumpkin is cultivated mostly by the Igbos and Ibibios who live in the Southeastern/ Niger Delta parts of the country and who relish it as a pot herb, the Igbos in their ‘Ofe ugu’, and the Ibibios in their ‘Edikan ikong’ soups (Willie and Ameachi, 2017). The leaves are used solely or in combination with the leaves, fruits or seeds of other plants species, it is cooked with leaves of water leaf *(Talinum triangulare),* African Gnetum *(Gnetum africanum),* immature fruits of okra *(Abelmoschus esculentus),* seeds of Dika *(Irvingia gaboneensis)* and seeds of Egusi melon *(Cucumeropsis mannii Naud.)* in preparing soups used in eating starchy roots, tubers and cereals (Willie and Ameachi, 2017). The oil rich seeds maybe eaten boiled, roasted or fermented and are high in essential amino acids (except lysine and methionine) and can be compared with soybean meal, with 95% biological value (Schippers, 2004; Aderi *et al.,*2011; Odiaka and Nyong *et al.,*2021).

The fluted gourd has been traditionally used by indigenous tribes as a blood tonic, likely due to its high protein content (Aletor *et al.,*2002). Flour produced from the seeds can be used for high-protein breads (Akwaowo *et al.,*2002; Giami, 2004;). Furthermore, *Telferia occidentalis* leaves is prepared for herbal medicine, it is used to treat sudden attack of convulsion, malaria, and anaemia; it also plays a vital and protective role in cardiovascular diseases (Nwanna and Oboh, 2007; Okokon *et al.,*2007).

Conclusively, aside from it utilization as food sources, it is also a major source of income, measure of employment for producers and sources of revenue for the government (Odoiaka *et al.,*2008).

The incidence of cardiovascular, digestive diseases, diabetes and cancer imposed the need to adopt and introduce into the human diet plant products with increased bioactive properties, which have in their composition considerable amounts of antioxidants, polyphenols, fiber, vitamins, micro- and macro elements. Among such vegetable products is pumpkin. In recent decades, has been increased the interest for the pumpkin, with more and more studies being carried out on it, which confirms the indisputable value for food and human health (Kulaitienė *et al.,*2018). Pumpkin is a seasonal crop and belongs to *Cucurbitaceae* family which includes gourds, melons and squashes also (Saboo *et al.,*2013). It is cultivated around the world and used differently depending on the area and traditions. Sweet and aromatic, highly perishable or storable for months with little change in quality, pumpkins are, with few exceptions, prized for their delicious flesh that may be consumed crude or processed, and the seeds may be used for vegetable oil and protein (McCreight, 2017). It has many culinary uses either fresh or as an ingredient in pies, soups, stews and bread (Ratnayake *et al.,*2004). Pumpkin flesh is an exceptional raw material for jams, marmalades, purees (Santos *et al.,*2017), sterilized cans, juices, nectars, fermented beverages, pickles, chips, powders, teas, bioactive compound extracts, food dye. Pumpkin seeds, although underused, are of particular interest due to their chemical composition, therapeutic and industrial properties. They are used to produce oil, in bakery, consumed as a snack.

**CHAPTER THREE**

**MATERIALS AND METHOD**S

**3.1 STUDY AREA**

The planting of the *Telfairia occidentalis* seed was carried out at Genetics and Biotechnology department, Ikot Akpaden in Mkpat Enin L.G.A, Akwa Ibom State with latitude of 4037’38’’N and a longitude of 70 46’23’’ E and the samples were taken to Biochemistry department in University of Uyo for determination of Total Hydrocarbon contents.

**3.2 MATERIALS**

Atomic Absorption Spectrophotometer, *Telfairia occidentalis* seed and leaves, car spent oil, weighing balance, measuring tape, paper tape, perforated thermoplastic bucket, NHCl, distilled water and filter paper.

**3.3 SAMPLE COLLECTION AND PROCESSING**

The *Telfairia occidentalis* seeds were obtained from Ikot Akpaden market, in Mkpat Enin while the spent engine oil from car was obtained from petrol engine that were five years and above at different mechanic workshops in Ikot Akpaden, Mkpat Enin, Akwa Ibom State and the oil was pour into two perforated bucket with loamy soil and label B and C while the bucket without the spent oil was labeled A and was used as the control.

**3.4 SOIL PREPARATION AND TREATMENT FOR PLANT MATERIALS**

A perforated thermoplastic bucket with a loamy soil was used without the addition of spent oil as specimen (A) which was the control. 200ml of the car spent oil was mixed with the loamy soil in a perforated thermoplastic bucket label (B) and 100ml of spent oil was also mixed with a loamy soil and label (C). the two specimens (B and C) were allowed for 5 days before planting the fluted pumpkin seed.



**Figure 1:** *Telfairia occidentalis* **seed planted in soil without spent oil Specimen A**

A plant in a pot

Description automatically generated with medium confidence

**Figure 2:** *Telfairia occidentalis* **seed planted in contaminated soil with 200ml of spent car oil Specimen B**

**A picture containing outdoor, dirt

Description automatically generated**

**Figure 3: *Telfairia occidentalis* seed planted in contaminated soil with 100ml of spent car oil Specimen C.**

***3.4.1 Measurement of Vine Length, width of leaves and Number of leaves of Telfairia occidentalis***

The number of leaves for each specimen, which comprises of the ***Telfairia occidentalis*** planted on a normal soil (specimen A), the one planted on a contaminated soil with 200ml of car spent oil (specimen B) and the one with 100ml of contaminated car spent oil (specimen C), were counted by Andrew, (2021) method while the length of vine was measured using measuring tape by placing the tape on the vine from the bottom to the apex of the plant and reading was recorded in centimeters (cm) and the same method was used to measure the width of the leaf. The number of leaves, width of leaves and length of vine were reported in weeks (WikiHow, 2022).

**3.5 Determination of Total Hydrocarbon**

**3.5.1 Digestion of Samples (Dry digestion)**

The three samples from each specimen were oven dried at a temperature of 550C and the dried samples were later grounded into a powder then weighted into a crucible of about 1g. The powder was ash in a furnace at a temperature of about 500 to 7000C for 2 hours. The samples were removed from the furnace and allowed to cooled, after cooling, leaching was carried out of about 5ml of NHCl then a volume of 20cm3 was obtained with the aid of distilled H2O (AOAC, 2004). An Atomic Absorption Spectrophotometer (UNICAM) was used to determine the concentration level of heavy metals in all the specimens (Pearson, 2003).

**3.6 Experimental Analysis**

All the data obtain was expressed as mean ± standard deviation and analyzed using One Way Analysis of Variance (ANOVA). Significant means was separated by applying Duncan multiple range post hoc test as outlined by Duncan (1955).

**CHAPTER FOUR**

**RESULTS AND DISCUSSION**

**4.1 Effect of contaminated soil with spent oil on growth performance (vine length(cm), number of leaves and leaf width) of *Telfairia occidentalis* from week 1 – 4**

Table 4.1 shows effect of contaminated soil with spent engine oil on the growth performance of *Telfairia occidentalis.* the plant which was planted on the 24th of June 2022 and was nurtured until the 01st of July 2022, all the data were recorded and analyzed. There was a significant (p<0.05) different on the leaf width in the three specimens, as specimen A (control) recorded 1.3 8.9±1.39cm and 13±0.00cm respectively. Specimen B and C shows no growth performance in the first week and there was significant (p<0.05) differences from two to four weeks 4.16±1.20cm, 10.9±0.97cm, 12±0.00cm and 5.1±0.88cm 8.4±0.37 and 9.5±0.00cm respectively. The number of leaves in the three specimens were counted and specimen A shows different in numbers of leaves that was different from the contaminated soil with car spent oil from first to forth weeks (table 4.1). the vine length was also measured and the effect of the spent oil on the growth performance was observed and recorded 3.67±1.38cm, 26.0±2.53cm, 48±2.53cm and 70.5±2.33cm in specimen A, and specimen B and C recorded, 0.67±0.005cm, 7.6±1.23cm, 18.4±3.45cm, 20±0.00cm and specimen C recorded 6.4c±1.43cm, 17.6±1.08cm and 19.0±0.00cm respectively.The differences and the delayed in the growth performance (leaf width) of the specimens contaminated with different quantity of spent car oil could be as the effect of the spent oil quantity, soil nutrient and the amount of heavy metals present in the soil which may depressed the germination of the plant. This result coincides with the work of Vwioko and Fashemi (2005) who reported a positive response of plant seed germination to 1 % spent engine oil. The authors reported stimulation of germination at 1 % w/w spent engine oil in soil for *Ricinus communis* while germination in higher concentrations (2, 3, 4, 5 and 6 % w/w) exhibited depression. However, the increase in the number of leaves in the soil contaminated with 100ml of spent car oil may be attributed to the lower quantity and the differences in the nutrient composition of the soil as low quantity of spent oil may have much effect in reducing or depressing the growth performance of the plant (Odu 1981). The differences in the vine length of the three specimens may be attributed to the present of the heavy metals in the soil as the spent oil possess the potential of lowering the heavy metals content in the soil. This is in agreement with the work of *Ndukwu, et al., (2015)* who reported that spent oil can enhance the reduction of heavy metals and trace elements in the soil.

**4.1.2 Effect of spent oil contaminated soil treated with NPK on the growth and modulation of *Telfairia occidentalis***

NPK was introduced into the contaminated soil with car spent oil of different quantity in week three and there was a different in the growth performance of the specimens as compared to the weeks without NPK. NPK fertilizer helps to boost and remediate the growth performance of the plant. The leaf width in week three when NPK was apply shows significant (p>0.05) increase that differs from the former as specimen B recorded 10.9±0.97 and 12±0.00cm in week three and four respectively. Specimen C recorded 8.4±0.37cm and 9.5±0.00cm respectively. There was a boost in growth performance of ***Telfairia occidentalis*** when NPK was added to the contaminated soil with different quantity of car spent oil. This may be as a result of the inorganic matter present in the NPK which aid in boosting the growth performance of the two contaminated soil with different quantity of spent car oil. This result coincides with the work of Anoliefo and Vwioko (2005) and Sharifi *et al.,* (2007) who separately reported growth enhancement (fertilizer effect) at 1 % spent auto-engine oil contamination when compared to the control, for various plant species as the percentage in fertilizer application can aid the germination in the contaminated soil with low spent oil. There was also increase in the number of leaves and the vine length in the contaminated soil. This could be as the result of NPK remediating the contaminated soil and help in increasing the organic matter in the soil and the quantity of the spent oil can affect the growth performance of the plant (Vwioko and Fashemi 2005).

**Table 4.1: Effect of contaminated soil with spent oil, treated with NPK on growth performance of *Telfaria occidentalis* on their vine length(cm), number of leaves and leaf width (cm)**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Weeks** | **Specimen A(control)** | | | **Specimen B** | | | **Specimen C** | | |
|  | **LW** | **NL** | **VL** | **LW** | **NL** | **VL** | **LW** | **NL** | **VL** |
| **1** | **1.3c** | **1.00d±0.58** | **3.67d±1.38** | **0.00d±0.00** | **0.3d±0.12** | **0.67d±0.005** | **-** | **-** | **-** |
| **2** | **8.9b±1.39** | **3.6c±0.25** | **26.0c±2.53** | **4.16c±1.20** | **2.00c±0.31** | **7.6c±1.23** | **5.1c±0.88** | **2.4c±0.40** | **6.4c±1.43** |
| **3** | **13ab±0.00** | **9.2b±0.58** | **48b±2.53** | **10.9b±0.97** | **6.8b±0.38** | **18.4b±3.45** | **8.4b±0.37** | **7.6b±0.25** | **17.6b±1.08** |
| **4** | **13ab±0.00** | **13.5a±0.29** | **70.5a±2.33** | **12a±0.00** | **8.25a±0.25** | **20a±0.00** | **9.5a±0.00** | **8.25a±0.25** | **19.0a±0.00** |

**\*LW – Leaf Width; NL – Number of Leaves; VL – Vine length \*a-c =Means with different superscripts in a column are significantly different at p<0.05. \*specimen A – soil without car spent oil \*specimen B – 200ml of spent car oil \*specimen C 100ml of car spent oil**

**4.2. The Total Hydrocarbon Content on a contaminated soil with car spent oil, treated with NPK on *Telfairia occidentalis* plant**

The total Hydrocarbon content in the three specimens of ***Telfairia occidentalis*** planted in a soil with contaminated spent oil from different quantity of car spent oil were obtained as shown in Table 4.2. The result obtained shows that there was a significant decrease (p<0.05) in the total hydrocarbon content in specimen A (control) which recorded 86.092± 0.327mg/100kg while the total hydrocarbon content in specimen B (contaminated soil with 200ml of car spent oil) and specimen C (contaminated soil with 100ml of spent car oil) were significantly higher (p>0.05) than the control as they recorded, 213.678 ± 0.199mg/100kg and 335.287 ± 0.514mg/100kg of total hydrocarbon respectively. It was observed that specimen C which was contaminated with 100ml of spent car oil demonstrated high hydrocarbon content than specimen B with 200ml of car spent oil. The different in the total hydrocarbon content in the two contaminated specimens may be as a result of increase in quantity of the spent engine oil as specimen B which was contaminated with 200ml of car spent oil was lower than specimen C which was contaminated with 100ml of car spent oil. This result is in support of the research result obtained by Njoku *et al.,* (2009) who reported the decrease in the total hydrocarbon content of plant contaminated with spent engine oil to their quantity and their ability to reduce the level of crude oil in oil contaminated soil during early germination.

***4.2.1 Zinc (Zn) content***

The zinc (Zn) content in the three specimens was determined as shown in Table 4.2. the zinc(Zn) content obtained in specimen A (control) was significantly higher (p>0.05) than the Zinc content in specimen B (contaminated soil with 200ml of car spent oil) and specimen C (contaminated soil with 100ml of spent car oil) which recorded 1.163±0.002mg/100kg, 0.197 ± 0.003mg/100kg and 0.028± 0.002mg/100kg respectively. The significant decrease (p<0.05) in the zinc content of the contaminated soil may be as a result of spent engine oil which may deplete the level of the soil mineral elements. This observation is supported with the result obtained by Udo and OPuta (1984) that discovered that soil properties usually underwent considerable changes following pollution by oil. Similarly, Diana *et al.,* (2004) noted that hydrocarbon oil contaminated soils had significantly higher pH values and C: N ratios, and lower total nitrogen, Zinc and available phosphorus than uncontaminated soils. Similar findings were reported by Diana *et al.,* (2004) who noted that electrical conductivity (EC), total carbon, available potassium were significantly lower in contaminated soils relative to uncontaminated soils.

***4.2.2 Arsenic (As) content***

The Arsenic content of the ***Telfairia occidentalis*** in three specimens were determined as shown in table 4.2. The result obtained indicated that there was a significant decrease (p<0.05) in specimen A (control) compare to the Arsenic content in specimen B and specimen C respectively. Specimen A which was the control recorded 0.001 ± 0.000mg/100kg while specimen B(contaminated soil with 200ml of car spent oil) and specimen C (contaminated soil with 100ml of spent car oil) recorded 0.013 ± 0.002mg/100kg and 0.075± 0.001mg/100kg respectively.The increase in the Arsenic content in the two specimens planted in soil with contaminated spent oil from different vehicles may due to the reduction of the soil minerals as influenced by the spent oil. This is similar to the result obtained by Gebel, (1997) who attributed the decrease in Arsenic content in contaminated soil with crude oil to low organic nutrient in the soil and this may be as a result of oil spillage from the environment into the soil.

***4.2.3 Lead (Pb) content***

The Lead (pb) content of the ***Telfairia occidentalis*** were determined as shown in table 4.2. Specimen C which was a soil contaminated with 100ml of spent oil from car demonstrated higher level of Lead (Pb) content with 4.122± 0.002mg/100kg compare to specimen A (control) which recorded 0.137± 0.003mg/100kg and specimen B that recorded 1.974 ± 0.003mg/100kg. It was observed that there was a significant (p>0.05) increased in the Lead (Pb) content obtained in the two specimens contaminated with spent oil and that the lead (Pb) content increase with increase in the volume of the spent oil. This may be as a result of different environmental factors or geographical area where the three specimens were planted. Also the presence of heavy metals in the spent oil can affect the natural soil by increasing the heavy metals presence in the soil. This result is in line with the result obtained by Kayode *et al.,* (2009); Uhegbu *et al.,* (2012) who have respectively reported reductions or increase of heavy metals and exchangeable cations in soils treated with spent lubricant oil.

***4.2.4 Copper (Cu) content***

The copper (Cu) content in the three specimens was determined as shown in Table 4.2. the result obtained shows that the copper content present in specimen B was significantly higher (p>0.05) than specimen A (control) and specimen C respectively. The three specimens demonstrated the increase in the copper level in the order; specimen B > specimen C > specimen A as they recorded 3.610± 0.004mg/100kg, 1.448 ± 0.003mg/100kg and 0.245 ± 0.004mg/100kg respectively. However, the increase in the copper content observed in specimens contaminated with spent oil from different vehicles could be as a result of the increase in volume of the spent oil as the specimen with the highest volume of spent oil shows high copper content. This result is in agreement with the result reported by Enwezor *et al.,* (1989) and Landon, (1991) who observed high percentage in organic carbon, copper and nitrogen in the soil contaminated with spent oil compared to the control.

***4.2.5 Cadmium (Cd) content***

Table 4.2 shows the Cadmium content in the three specimens as the level of Cadmium was significantly (p>0.05) higher in the specimen contaminated with spent oils different from the control. Specimen C demonstrated high level of cadmium than specimen A and B as they recorded 0.157± 0.002mg/100kg, 0.001 ± 0.000mg/100kg and 0.039 ± 0.001mg/100kg respectively. The increase in the cadmium level in specimen C could be as a result of the spent oil or the heavy metals present in the spent oil as it was obtained from different region and quantity. Adweole *et al.,* (2008) reported heavy metals uptake by crops in their work and noted that these heavy metals were stored in crop parts and that there was significant difference in the heavy metals presence with difference in the spent oil level obtained from different regions and vehicles.

***4.2.6 Effect of contaminated soil treated with NPK on the hydrocarbon content of Telfairia occidentalis***

The result obtained in table 4.2 shows significant differences in the hydrocarbon content in the week three to four when NPK was added to the soil contaminated with different quantity of spent car oil. The result shows that the hydrocarbon content was reduced in week three and four when NPK was applied that differs from the one without NPK (Table 4.2). The decrease in the total hydrocarbon level in specimen B and C in from week 3 and 4 may be as a result of the effect during the application of NPK which may remediate the level of spent oil in the soil boost the organic matters in the soil. This result is coinciding with the work of Asuquo *et al.,* (2001) who observed decrease in hydrocarbon in contaminated soil following application of inorganic fertilizer in the soil.

**Table 4.2: The Elemental analytical results of Total Hydrocarbon content in mg/100g**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Specimens** | **Zinc**  **(Zn)** | **Arsenic**  **(As)** | **Lead**  **(Pb)** | **Copper**  **(Cu)** | **Cadmium**  **(Cd)** | **Total HC**  **(THC)** |
| **A** | **1.163a ± 0.002** | **0.001c ± 0.000** | **0.137c ± 0.003** | **0.245 c± 0.004** | **0.001c ± 0.000** | **86.092c ± 0.327** |
| **B** | **0.197b ± 0.003** | **0.013ab ± 0.002** | **1.974b ± 0.003** | **3.610a± 0.004** | **0.039b ± 0.001** | **213.678b ± 0.199** |
| **C** | **0.028c ± 0.002** | **0.075a ± 0.001** | **4.122a± 0.002** | **1.448b ± 0.003** | **0.157a± 0.002** | **335.287a ± 0.514** |

**\*Means with different superscripts in a column are significantly different at p<0.05**.

**\*Mean ± standard deviation of 3 determinants**

\***specimen A - *Telfairia occidentalis* seed planted in soil without spent oil (control)**

**\*specimen B - *Telfairia occidentalis* seed planted in contaminated soil with 200ml of spent car oil \*specimen C - *Telfairia occidentalis* seed planted in contaminated soil with 100ml of spent car oil**

**CHAPTER FIVE**

**CONCLUSION AND RECOMMENDATION**

**5.1 Conclusion**

This study has shown that spent car oil of different quantity on a contaminated soil of *Telfairia occidentalis* indicated significantly differences in the growth performance and the total hydrocarbon content on *Telfairia occidentalis* and consequently NPK shows helps in boosting the growth performance and reduces the hydrocarbon content of *Telfairia occidentalis*.

**5.2 Recommendation**

I therefore recommend thatpetroleum products should be properly disposed in the environment as it imposed side effects on both plant, animals and humans and there should be EPA (Environmental Protection Agency) in Nigeria to ensure that these products containing spent oil can be properly controlled. I recommend this study for further studies on the bioremediation methods to remediate the effect of this petroleum products in the environment.

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