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Determination of the Proximate Composition of Some Arable Crops Cultivated on Crude Oil Polluted Soil Following Remediation with Leaf Litters and Hydrogen Peroxide

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ABSTRACT

Studies to determine the proximate composition of common bean (*Phaseolus vulgaris*), cucumber(*Cucumissativus*) and Garden egg (*Solanummelongena*) on crude oil polluted soil following remediation with leaf litters and hydrogen peroxide was carried out in Agricultural research farm in Rivers State University, Port Harcourt. The experiment was arranged in a randomised complete block design with various levels of pollutions.The experiment had 14 treatments and 5 replicates: T1:100ml Crude Oil (C/O) + 100mlHydrogen peroxide(H_2O_2), T2:100ml C/O + 100g Leaf litter (L/L), T3:200ml C/O + 200ml H_2O_2,T4:200ml C/O + 200g l/l, T5:300ml C/O + 300ml H_2O_2, T6:300ml C/O + 300g L/L, T7:400ml C/O+400ml H_2O_2, T8:400ml C/O + 400g L/L, T9:500ml C/O + 500ml H_2O_2, T10:500ml C/O + 500g L/L,T11:no pollution + 500ml H_2O_2, T12:no pollution + 500g L/L, T13:500ml C/O + no amendment and T14: (no pollution and no amendment) was used as control. Results of Proximate analyses after harvest showed high moisture content in cucumber and garden-egg (86.4% and76.6% respectively) whereascommon beans were lower (7.9%); Common beans showed the highest ash content (2.3g) in T14 (control) while the other treatments were below 2.0g. Common beans had the highest lipid, protein, carbohydrate and fibre contents among the three crops while the least was observed in cucumber. Common beans performed better in leaf litter soils than in H_2O_2, while cucumber and garden-egg had poor yield in both leaf litter and H_2O_2remediated soils.

Key words: Proximate, Pollution, Crude oil, remediation Leaf litter, hydrogen peroxide, arable crops.

Introduction

Pollution is the production and the release through human activities of any substance into the environment in quantities that are harmful to man and other living things or in some way reduce the quality of human life and substances which make the environment impure are called pollutants (Ndukwu*et al*., 2012, Chuku and Ochekwu, 2018). Ochekwu and Eneh 2012 stated that crude oil can be mineral oil or hydrocarbon mainly composed of hydrogen, carbon, oxygen and some trace elements. Crude oil pollution on soils makes it unsatisfactory for plant growth, metabolic functions such as transpiration and translocation. The effects of crude oil deposits on soil mostly interferes with the chlorophyll content, lending to the impairment of plant's photosynthetic capacity. Other possible morphological changes brought about by crude oil in soils where plants are cultivated include stunted growth, leaf burning, leaf chlorosis, leaf fold or curl, seizure in leaf growth and leaf abscission (Ochekwu and Eneh, 2012). Certain species of plants are usually more susceptible to oil pollution than others. Plants with rhizomes or underground storage organ tend to be more resistant than annuals and otherplants.Crude Oil pollution incidents leave the environment with some negative impacts onagriculture and human health.Successful usage and soil management is required for sustainable agriculture. Crude oil pollution produces toxic effect on living organisms in whichever form and wherever they occur (Adenipekun*et al.,* 2009). Odejimi, and Oghalu (2006) described plants as "the first victims of oil spill on land / terrestrial ecosystem". This pollution according to Agbogidi and Ejemete (2005) is due mainly to accidental discharge, human error, sabotage, transportation and other natural causes. Pollution of agricultural soil has in turn significantly affected the growth performance of plants. Agbogidi (2010) reported that contamination of soil with crude oil significantly reduced biomass accumulation in *Jatrophacurcas*when compared to seedlings grown in uncontaminated subplots. She also observed a negative interaction between crude oil polluted soil and weight gain in the plants.

*Solanummelongena*provide protein, vitamins and minerals but low in sodium, calories and fat. It contains a large quantity of water and good for balancing diets that are heavy in protein and starches. It is high in fibre and provides additional nutrients such as potassium, magnesium, folic acid, vitamin B6 and A. It is rich in reducing sugars, anthocyanin, phenols, glycol-alkaloids, dry matter and amide proteins.

Phaseolus vulgaris, also known as the common bean and green bean, among other names, is an herbaceous annual plant grown worldwide for its edible dry seeds or unripe fruit (both commonly called beans). Beans are rich source of protein and carbohydrates, as well as being a good source of vitamin B complex such as niacin, riboflavin, folic acid and thiamine. It also provides iron, copper, zinc, phosphorus, potassium, magnesium. calcium, and has furthermore, hashigh fibre content It is also an excellent source of polyunsaturated fatty acids (Duke and Ayensa, 1985).

Cucumissativus is a good source of phytonutrients (plant chemicals that have protective or disease preventive properties) such as flavonoids, lignins and triterpenes, which have antioxidant, anti-inflamatory and anti-cancer benefits, according to Worlds Healthiest Foods (USDA, 2018). Cucumbers are naturally low in calories, carbohydrates, sodium, fat and cholesterol and 95% water content.

This study therefore investigated the proximate analysis of common bean, cucumber and garden egg in a soil polluted with crude oil after remediating with leaf litters and hydrogen peroxide.

MATERIALS AND METHODS

Experimental site

The research was carried out in an Agricultural Farm located in Rivers State University, Port Harcourt, Nigeria with latitude 4.7923 and longitude of 6.9825. The study site is characterized by tropical monsoon climate with mean annual temperature of 32.15^{0}C, 66%humidity and 0.9948 atmospheric pressure, while, the soil is usually sandy or loamy.

Experimental Design

Randomised experimental block design was used for the study. The experiment was in 3 blocks for each plant. Block 1; 10kg of soil was used with 100, 200, 300, 400 and 500mls of crude oil remediatedwith leaf litter (100,200,300,400,500g) and hydrogen peroxide (100,200,300,400 and 500mls) with 10kg of unpolluted soils that served as the control. The same experiment was replicated for blocks 2 and 3 respectively.A total of 420 experimental bags each filled with 10kg of soil were used for the whole study. A total of 70 experimental bags were used for each plant which was replicated 2 times for the three test crops.

Materials used for the research

Planting Materials

Treated seeds of garden egg (*Solanummelongena*), beans (*Phaseolus vulgaris*) and cucumber (*Cucumissativus*) were the planting materials used for the study. They were obtained from Agricultural Development Programme (ADP), Rumuokoro, Port Harcourt, Rivers State, Nigeria.

Crude Oil collection

Crude oil (100 litres) was procured from the Port Harcourt Refinery, Eleme, Rivers State, which was then applied as a pollutant on the weighed 10kg of agricultural soil.

Remediating Agents: Leaf Litter and Hydrogen Peroxide

The organic fertilizer used was *Terminalia catappa*(leaf litter) while the inorganic fertilizer was Hydrogen peroxide (H_2O_2). The *Terminalia catappa*was obtained from a site in the Rivers StateUniversity while the hydrogen peroxide was obtained from the departmental laboratory. The leaf litters were gathered in very large quantities, dried in the University of Port Harcourt green house and analysed before use.

Treatment applied

T1 = 100ml crude oil + 100ml H_20_2
T2 = 100ml crude oil + 100g leaf litter
T3 = 200ml crude oil + 200ml H_20_2
T4 = 200ml crude oil + 200g leaf litter
T5 = 300ml crude oil + 300ml H_20_2
T6 = 300ml crude oil + 300g leaf litter
T7 = 400ml crude oil + 400ml H_20_2
T8 = 400ml crude oil + 400g leaf litter
T9 = 500ml crude oil + 500ml H_20_2
T10 = 500ml crude oil + 500g leaf litter
T11 = No pollution + 500ml H_20_2
T12 = No pollution + 500g leaf litter
T13 = 500ml crude oil + no amendment
T14 = Control

Proximate analysis of the test crops

The recommended method of association of analytical chemists (AOAC, 1990) was used for the determination of protein, ash and lipid. Harvested fruits of *Solanummelongena, Phaseolusvulgaris* and *Cucumissativus*were washed, diced and a portion of the fresh samples was taken from each sample and used for moisture content determination, while the rest samples were dried, pulverized and used for the determination of crude protein, lipid, ash content and carbohydrate.

Determination of moisture content

Two grams of the fresh sample of *Solanummelongena, Phaseolus vulgaris* and *Cucumis sativus*were placed in the crucible and heated at 105ºC until a constant weight was attained. The moisture content of the three samples were calculated as loss in weight of the original sample and expressed as percentage moisture content (FAO, 1980).

Determination of protein content

The crude protein was determined using micro-Kjeldah method as described by AOAC.2000.

$$\%N\ (wet) = \frac{(A-B)\times 1.4007 \times 100}{\text{Weight of sample}}$$

Where:

A= volume (ml) standardHCl normality of standardHCl
B= volume (ml) standardNaOH normality of standard NaOH

Determination of Crude Lipid

This estimation was performed using the Soxhlet extraction method. Ten grammes of the powdery form of *Solanummelongena, Phaseolus vulgaris* and *Cucumissativus*were weighed and wrapped with a filter paper and placed in a thimble. The thimble was covered with cotton wool and placed in the extraction column that was connected to a condenser. 200ml of n-
Hexane was used to extract the lipid (A.O.A.C., 1990).

Determination of Ash Content

This was done using the method of A.O.A.C (1990). The total ash content of a substance is the percentage of inorganic residue remaining after the organic matter has been ignited. Two grammes (2g) of the pulverized *Solanummelongena, Phaseolus vulgaris* and *Cucumissativus* samples was placed in a crucible and ignited in a muffle furnace at 550ºC for 6 hours. It was then cooled in a desiccator and weighed at room temperature to get the weight of the ash.

Determination of crude fibre content

Crude fibre feed. dry matter inorganic matter(ash) and residue ash were treated with excess concentrated HCl. Extracted acid soluble ash and acid insoluble ash produced organic matter loss inweight due to ashing in furnace. Crude protein and ether extract portion are made soluble in petroleum ether. Carbohydrates and the residue after boiling with weak acid and weak alkali is dried and the residue left is ignited and the difference in weight is crude fibre.

Determination ofcarbohydrate content

The carbohydrate content was determined by subtracting the summed up percentage compositions of moisture, protein, lipid, fibre and ash contents from 100%(Otitoju, 2009).

RESULTS AND DISCUSSION

Moisture Content

The results of proximate analysis showed that cucumber had the highest moisture content on T12 (86.5 ± 0.4%) than all the other treatments, followed by garden egg which was also high in moisture content on T12 (76.5 ± 0.5%), whereas common beans that had yield in all the treatments had the least moisture content with the highest seen in T12 (8.3 ± 0.2%) which are all within the range covered by USDA (2018). This implies that the effect of crude oil pollution on the soil does not have an adverse effect on the moisture content of common beans, whilst cucumber and garden egg had no yield on the polluted soils. The low moisture content of common beans is an implication that beans are less susceptible to spoilage by microorganisms, during storage, hence can be stored for a relatively long period of time when compared to the other fruits.The moisture content analysis showed that cucumber had the highest moisture content among the three crops which was seen in the unpolluted and leaf litter amended soil (T12), while that of garden egg was higher than common beans. Common bean having yield on all the treatments could be as a result of the fact that it is capable to phytoremediate polluted soil because of its nitrogen fixing ability. The moisture content was observed to have decreased on the unpolluted soil (control) to values that were lower than that of the polluted and amended soils (Figure 1).

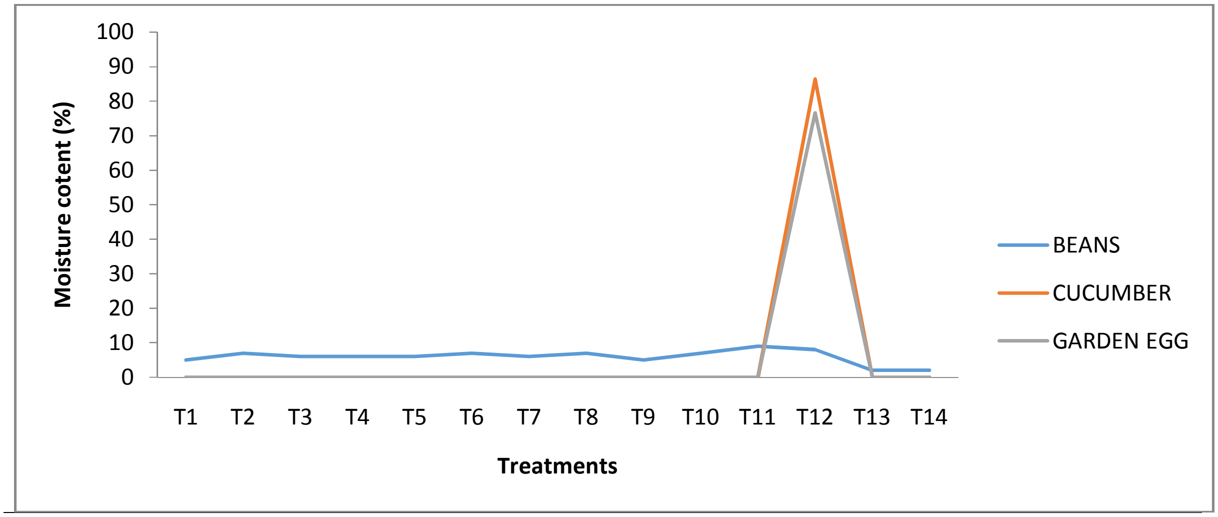

Figure 1: Moisture content of common beans, cucumber and garden egg on crude oil polluted Soil following remediation with leaf litter and hydrogen peroxide**.**

Ash Content

The result of proximate analysis showed that common beans, cucumber and garden egg were all in the range of 1.2 – 1.8 % and this is in line withAbulude*et al* (2004). Ash content decreased in the plants probably due to the effect of petroleum hydrocarbon on the plant. Though, the test plants are generally low in ash in unpolluted soils (Figure 2).

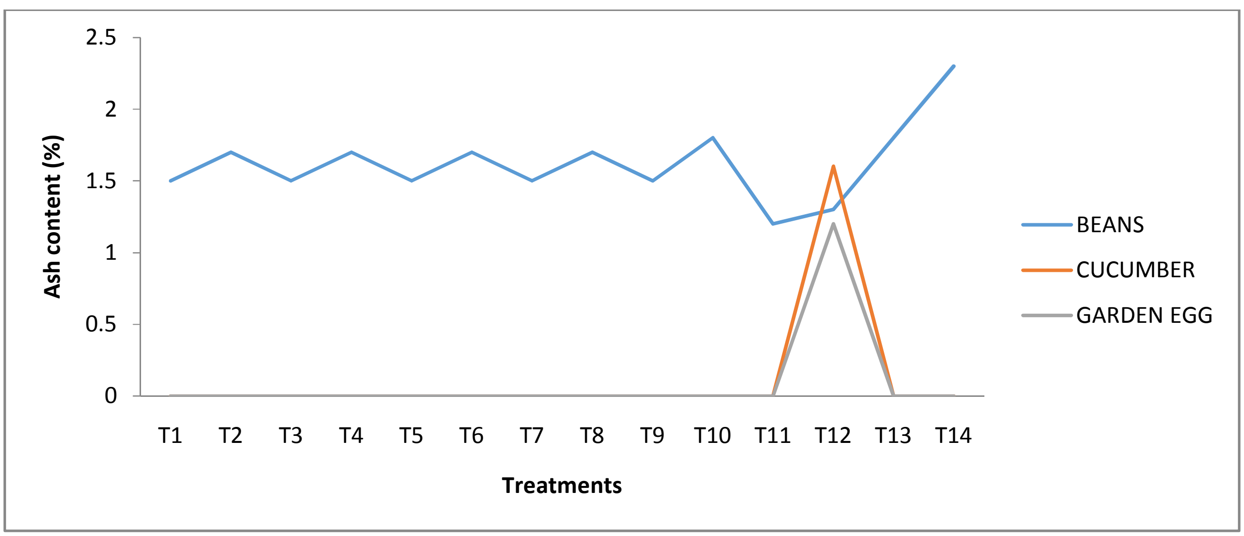

Figure2: Ash content of common beans, cucumber and garden egg on crude oil polluted Soil following remediation with leaf litter and hydrogen peroxide**.**

Lipid Content

Lipids play important roles in diet as important energy source and also aid the transportation of fat soluble vitamins (A, D, E and K). The result of proximate analysis showed that common beans cucumber and garden egg were generally low in lipid which had lipid content within the ranges set by USDA (2018). Common bean had the highest lipid content in T11 and T14 (1.2 ± 0.02 and 1.24 ± 0.03), cucumber had a value of (0.5 ± 0.1) and garden egg had a value of (1.1 ± 0.6). Low lipid content will not allow these fruits to contribute significantly as a source of non-visible oil to the diet in which they may be present (Figure 3).The lipid content of all the samples was generally low which was in agreement with Inobeme*et al.,*(2014) and USDA (2018).

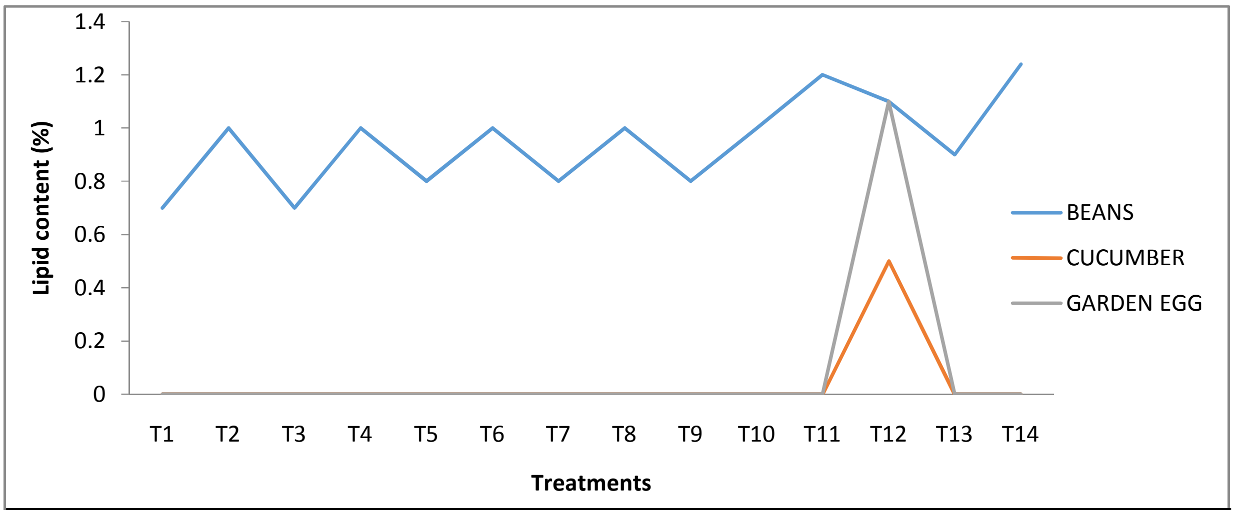

Figure3: Lipid content of common beans, cucumber and garden egg on crude oil polluted Soil following remediation with leaf litter and hydrogen peroxide**.**

Protein Content

Among the three samples common beans contains the highest percentage of protein (23.52%) USDA (2018) because legumes are known to have high amount of protein.On the otherhand, cucumber and garden egg are vegetables with very low protein content. The highest protein content was seen in T14 (control) with a value of 22.5 ± 0.2 which is within the ranges of bean protein content set by U.S.D.A. (2018). The results from the polluted and amended soils showed that there was a reduction in protein content due to the presence of petroleum hydrocarbons in the soil, whereas the unpolluted and amended soils and control recorded higher protein content (18.6 ± 0.2 – 22.5 ± 0.2). Cucumber and garden egg had low protein content of 0.17 ± 0.4 and 0.67 ± 0.5 respectively which is an implication that the presence of crude oil or its derivatives greatly alters the soil and as such, inhibits the production of protein by plants (Figure 4).The values of the unpolluted and remediated soils and the control had higher values of protein content which is an implication that crude oil adversely affected the production of protein by the plant thereby causing a reduction in the available protein. Besides, cucumber and garden egg naturally contains very little percentage of protein and can have minor changes in nutrient composition which might occur with season or environmental alteration as pollution.

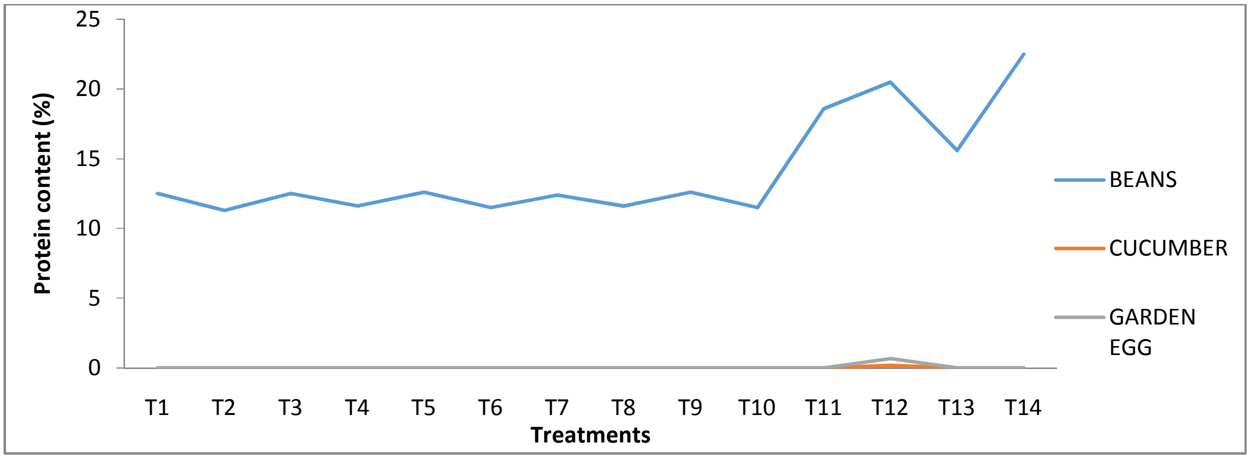

Figure 4: Protein content of common beans, cucumber and garden egg on crude oil polluted Soil following remediation with leaf litter and hydrogen peroxide**.**

Carbohydrate Content

Among the three samples cultivated and analysed for its proximate composition, common beans contain higher carbohydrate content. Carbohydrate content in beans on polluted soils showed a range of (11.5 ± 0.1 to 14.6 ± 0.2) which was very low and below the normal range by U.S.D.A. (2018) at 60.03 to 65g, which implies that petroleum hydrocarbon adversely affected the production of carbohydrate in the beans plants, while there was high percentage of carbohydrate on the remediated soils and the control at (50.4 ± 0.1 to 60.5 ± 0.1). The result showed that there is a difference in bean pods between the ones harvested from polluted soils, harvested from amended soils and harvested from the control soil (Figure 5). The range of carbohydrate content in cucumber and garden egg were 3.5 ± 0.2 and 4.3 ± 0.1). These values are low compared to common bean. However, due to the low carbohydrate and lipid contents and high moisture content in cucumber and garden egg, they would be desirable in making meals for diabetic patients. Mune*et al.,* (2008) reported that cowpea generally has higher protein content than carbohydrate. The reduction in carbohydrate percentage could be as a result of the presence of crude oil which affected the plant and limited the production and utilization of carbohydrate by the plant. The result for garden eggs and cucumber agrees with that of USDA (2018) that reported lower percentage of carbohydrate in cucumber and garden egg fruits.

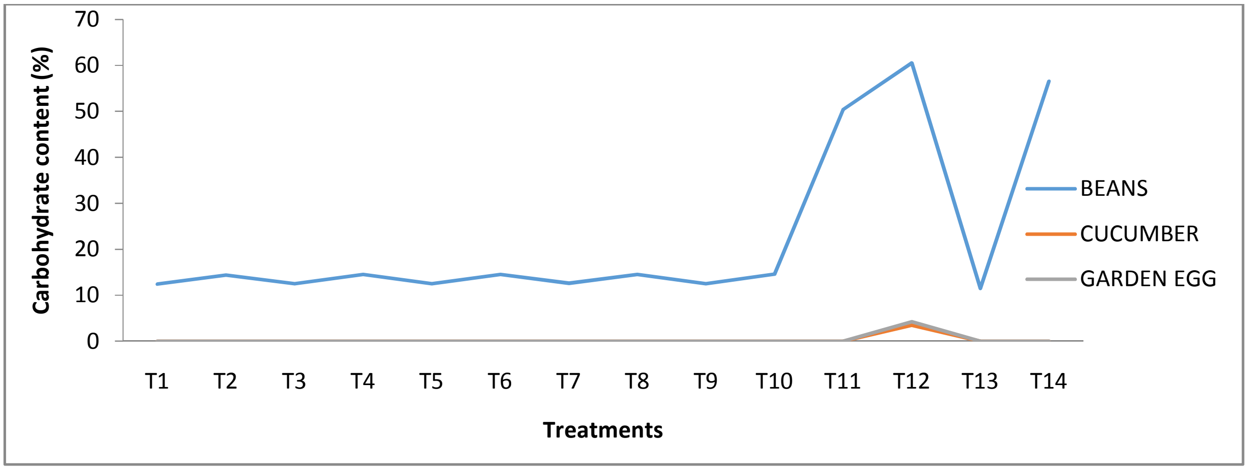

Figure 5: Carbohydrate content of common beans, cucumber and garden egg on crude oil polluted Soil following remediation with leaf litter and hydrogen peroxide**.**

Fibre content

Crude fibre is primarily measured to comprehend indigestible parts in feeds and is consisted mainly of a part of lignin, pentosan, chitin in addition to cellulose. These compounds are collectively called fibre. Crude fibre clearly corresponds only to feeds of plant origin considering the component compounds. The average means of common beans, cucumber and garden egg from T1 to T10 were between 3.0 ± 2.0 to 10.0 ± 2.5. All these treatments had the remediating agents of leaf litters or hydrogen peroxide. T11, T12 and T14 were the highest in the mean fibre content of 25 ± 2.7 to 28 ± 2.2. T13 which had only pollution and no amendment were similar to T1 to T10. Hence, crude oil pollution affected the fibre content of common beans. Unlike the trend observed in common bean, the mean fibre content of cucumber and garden egg from T1 to T14 was between 3.0 ± 2.1 to 8.0 ± 2.4 (Figure 6).Atuanya (1987) observed that seeds grown in such soils failed to germinate and the ones that grew failed to bear fruits or produce yield as it was observed in the polluted and polluted and amended soils. Ekundayo*et al.,* (2001) also reported that germination of seeds planted in crude oil polluted soil may be delayed while percentage germination may also be significantly affected.

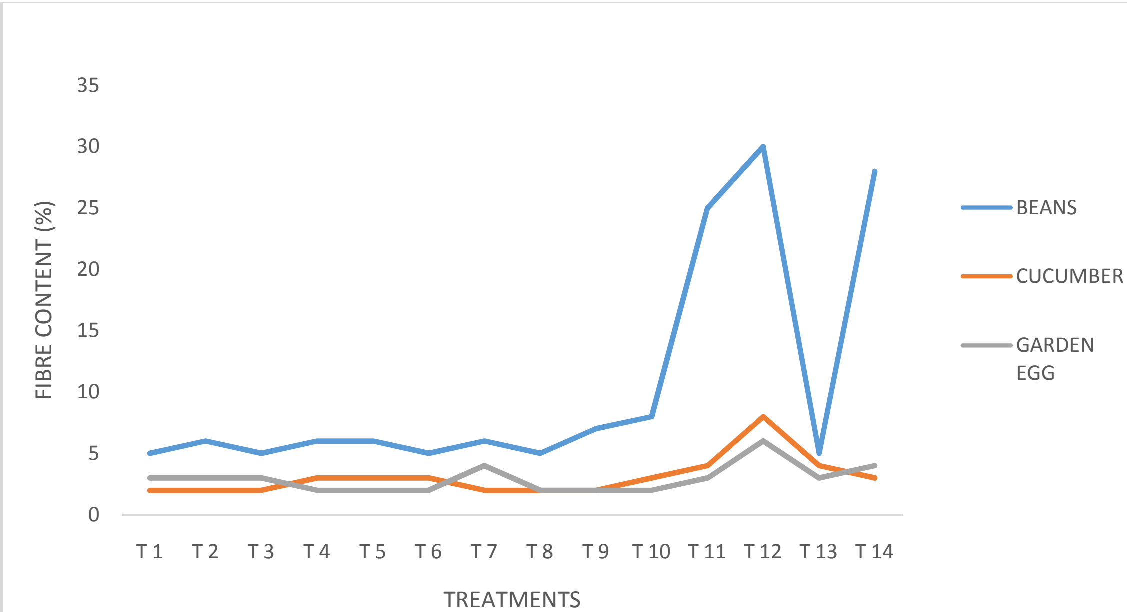

Figure 6:Fibre content of common beans, cucumber and garden egg on crude oil polluted Soil following remediation with leaf litter and hydrogen peroxide**.**

Conclusion

Proximate analysis represents the gross component that make up food and gives nutritional studies a more comprehensive and biochemically oriented dimension to analysis of food crops.

The study has given appreciable details of how crude oil and its derivatives affect the soil physico-chemical proterties, health status, nutritional components, vegetative and reproductive parameters of the arable plants. With the introduction of remediating agents of leaf litters and hydrogen peroxide to the soil, there was improvement in the soil status and by extension positively affected the proximate composition of common beans, cucumber and garden eggs. In all of these, crude oil pollution should be avoided on the environment especially agricultural soil because besides perturbation and destruction of the ecosystem, it also affects the health of humans on the food chain.

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