International Journal of Scholarly Research in
Science and Technology
Journal homepage: https://srrjournals.com/ijsrst/
ISSN: 2961-3337 (Online)

(RESEARCH ARTICLE)

Check for updates

Bioremediation of crude oil spillage using *Cisuss populnea* leave as bio-sorbent

Joel Tari Honda [1], I. I. Nkafamiya [2] and P.M. Dass [2,*]

[1] *National Center for Technology Management (NACETEM), Modibbo Adama University (MAU) Yola, Adamawa State, Nigeria.*
[2] *Department of Chemistry, Modibbo Adama University Yola, P.M.B. 2076, Adamawa State, Nigeria.*

International Journal of Scholarly Research in Science and Technology, 2023, 02(02), 022–029

Publication history: Received on 11 March 2023; revised on 04 May 2023; accepted on 07 May 2023

Article DOI: https://doi.org/10.56781/ijsrst.2023.2.2.0018

Abstract

The total petroleum hydrocarbon concentration decrease at the initial and final bioremediation across different variable of *cisuss populnea* leave biosorbent. 25 g of soil was weighed into different plate, contaminated with about 10 ml of crude oil, the plate was labeled as BI, CI DI, BF, CF and DF (leave) across 3 g, 6 g, and 9 g variables and A (soil and crude oil mixture) as control for initial and final bioremediation. 1 g of each contaminated soil sample was extracted using mechanical shaker at room temperature and the extracts were analyzed using GC/MS the results showed that the initial treatment of leave biosorbent were 706.4482 ppm, 544.2509 ppm, 347.75909 ppm respectively. After 4 weeks of biodegradation, the concentration decreases to 310.4318 ppm, 117.8105 ppm, 60.05455pmm and control 757.39864 ppm respectively. The Total removal efficiencies of Total petroleum hydrocarbon were 56.2%, 78.4%, and 82.7% for the treatments of 3 g, 6 g, and 9 g of leaves sorbent

Keywords: Bioremediation; Crude oil; *Cissus populnea;* Leave

1 Introduction

Crude oil is a naturally occurring liquid with a complex mixture of organic molecules, mostly hydrocarbon with different chemical and physical properties (Agunobi *et al.,* 2014).

Oil exploitation has increased the rate of environmental degradation and has perpetuated food insecurity as a result of death of fish and crops as well as loss of farm lands and viable rivers for fishing activities leading to loss of livelihood. There is no doubt that the disastrous effect of oil spill impedes agricultural productivity and fishing to be specific, which in the long-run has an adverse consequence on the economic life of the inhabitants of this region Paul (2015).

Furthermore, studying the prospects and challenges of environmental impact of oil exploration in the Niger Delta region of Nigeria and the remediation of contaminated lands in the region, argues that resolving the technical dilemma of the clean-up mechanism and identifying social impediments will be the key success driver of the United Nations Environmental Program action plan, which was recently adopted by the government of Nigeria for the clean-up of the Niger Delta. The study further recommends that bioremediation should be adopted considering its low greenhouse effect and the reduced cost burden on the weak and overstretched economy of Nigeria (Osuagwu and Olaifa, 2018). Bioremediation is a process of using living organism to remedy environment problems such as contaminated soil and water, some micro-organism in the soil and water naturally feed on some hazardous substances' certain chemicals, that are harmful to people and the environment. Plants source can be used to clean up soil and water environment as presented by Choron (2010). However, the exploration and exploitation activities of crude oil comes with diverse negative effects on the environment and indigenous people leaving in the areas of the crude oil activities, such as those in the Niger Delta region. One of these notable and severe effects is the oil spillage (Chebbi, 2001 and 2000).

* Corresponding author: Joel Tari Honda

The spilling of crude oil could be on water or land depending on the location of the source. When crude oil spillage occurred on water environment, it results to the formation of oil layer which then spreads round the surface of the water from the point source under the influence of several factors such as wind, current or gravity (Owonaro *et al.,* (2019). Various causes of oil spills have been identified which are traceable to the advances and pursuit for development through industrialization, resulting to continuous exploration and exploitation of crude oil (Dimitrakis *et al.,* 2011). The notable causes of oil spill on water bodies are outlined such as: subsea pipelines leak caused by corrosion or equipment failure e.g. (flange leaks), subsea blowouts due to drilling operations, industrial waste water discharges, oil spill caused by the accidental collision of oil tankers and indiscriminate dumping of ballast water from ships. In Africa, most significantly Nigeria, pipeline Vandalization, crude oil bunkering/theft and sabotage increase the amount of oil spills that occur in this part of the world. Either in deep or coastal waters, it is impossible to completely stop oil spill.

When spill occurs, a significant proportion of the ecosystem that supports major fisheries and numerous endemics and migrating populations of fish, reptiles, birds, marine mammals, plankton and various sensitive benthic communities is adversely affected and damaged. An oil spill accident is regarded as a kind of disaster because it causes not only fatal destruction of the marine environment but also enormous cost is incurred to prevent the disaster from escalating, and compensations paid for damages. Also wild life, harbor facilities, vessels and health of mankind are seriously affected and contaminated.

2 Material and methods

2.1 Plant Sampling and Sample Preparation

Cissus populnea plants obtain from Michika Local Government Area of Adamawa State; Nigeria was used in this study. Fresh leave, of matured plants of *Cissus populnea* grown in highland Michika was collected. The crude oil was collected from NNPC, Jimeta yola and the soil sample was collected from the premises of faculty of agriculture Moddibo Adama University yola. The plant samples collected was freed from twigs and extraneous matter by sifting the Soil, grit, sand and dirt were removed. The sample was rapidly and thoroughly washed under tap water, rinsed with distilled water and then air dried at room temperature for 15 days. The samples (leave) was ground in an industrial blender (LO 4.0Visa) and sieved to obtain a powder with known particle size (25lm). After preparation, the material was placed in sealed plastic vials to be used as biosorbent**.**

2.2 Study the total petroleum hydrocarbon concentration decrease at the initial and final bioremediation across different variable.

2.2.1 Soil sampling and Analysis

The topsoil samples from the premises of the faculty of agriculture Modibbo Adam university, yola were taken from 0.3metres deep using an auger machine into polypropylene bags, free from hydrocarbon contamination. This process is called augering. The soil samples were taken for immediate physio-chemical analysis the soil samples were determined by the method of Association of Analytical Chemists (1990).

2.3 Soil preparation

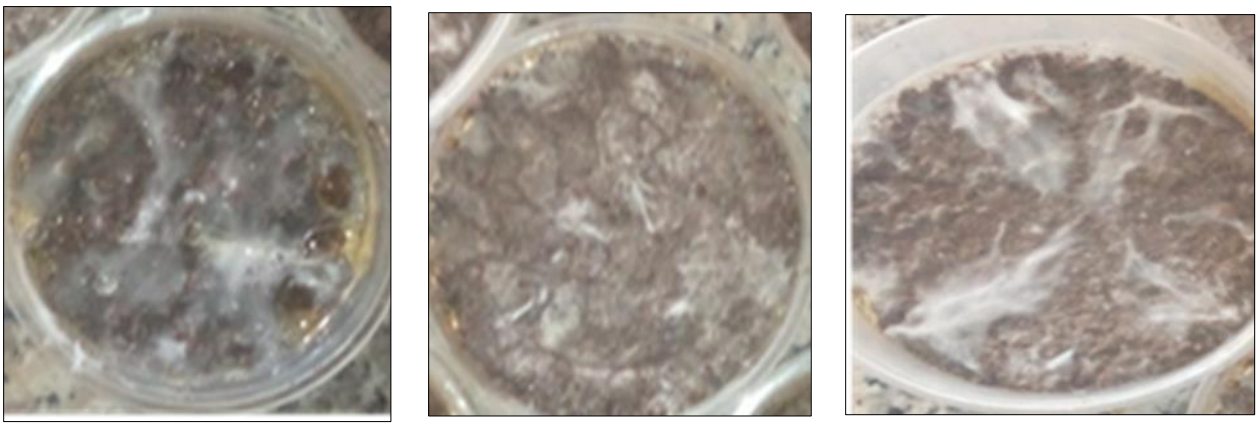
Approximately 25 g of soil was weighed into different plate, contaminated with about 10 ml of crude oil, the plate was labeled as BI, CI, DI and BF, CF DF (leave), across 3 g, 6 g, and 9 g variables and A (soil crude oil mixture) as control for initial and final bioremediation. The pH and humidity was adjusted to 6.5-8.5 so as to maintain a favorable condition for biodegradation using calcium hydroxide solution. After four weeks the final remediation was analyzed (Adams *et al.,* 2017).

Table 1 Experimental Setup for Treatment of Crude oil contaminated soil

Sample no:	Treatment unit for initial remediation	Description
A BI,CI,and DI	Soil + crude oil Soil +Crude oil + leave sorbent Treatment unit for final remediation	Control Bioremediation
BF,CF,and DF	Soil +Crude oil + leave sorbent	Bioremediation

A control BI 3 g leave CI 6 g leave DI 9 g leave

Figure 1 Contaminated Soil of A, BI, CI and DI for Initial Bioremediation



BF 3 g leave CF 6 g leave DF 9 g leave

Figure 2 Contaminated Soil of A, BF, CF and DF for final Bioremediation

2.4 Extraction using mechanical shaking method

During mechanical shaking, 1 g of each contaminated soil sample was placed in conical flask and mixed with 10 ml of n hexane and covered with Aluminum foil paper to prevent loss of solvent. The mixture was shaken for 30 min, and then filtered using paper filters. The final volume of the extracts was taken and stored in clean small bottles. A sample of the extract was then withdrawn with automated gas tight syringe of the auto-sampler and analyzed by direct injection into the Gas chromatography/mass spectroscopy (GC/MS preset at specific condition. The filtrates were analyzed using GC/MS Agilent Technologies 7890A. The Analysis was allowed to run and data were quantified at the end of the analysis(Oludele et al., 2021).

3 Results and discussion

3.1 Total petroleum hydrocarbon concentration decrease at the initial and final bioremediation of 3 g, 6 g, and 9 g of leave, biosorbent

In this study we consider and compared the total petroleum hydrocarbon (TPH) decrease in concentration for initial and final remediation. After adding the biosorbents of *cissus populnea* plant for leave, on the stimulated processed contaminated soil at different variables of 3 g, 6 g, 9 g and control respectively.

3.2 *Cisuss populnea* Leave biosorbents Treatments

In the figure 4.20 it was observed that at the initial remediation of leave biosorbent the Total petroleum hydrocarbon (TPH) concentration were 706.4482 ppm, 544.2509 ppm, 347.75909 ppm and control 757.39864 ppm at 3 g, 6 g and 9 g leave sorbent respectively. After 4 weeks of biodegradation, the concentration decreases to 310.4318 ppm, 117.8105 ppm, 60.05455pmm and control 757.39864 ppm respectively. The Total removal efficiencies of Total petroleum

hydrocarbon were 56.2%, 78.4%, and 82.7% for the treatments of 3 g, 6 g, and 9 g of leaves sorbent. This results shows decrease in concentration of Total petroleum hydrocarbon with increase in biosorbent and the higher the grams of the sorbents the lower the concentration of Total petroleum hydrocarbon decreases but comparatively the final remediation of leave biosorbents shows higher removal perhaps that could be due to their surface area, porosity and the extent of biodegradation process.

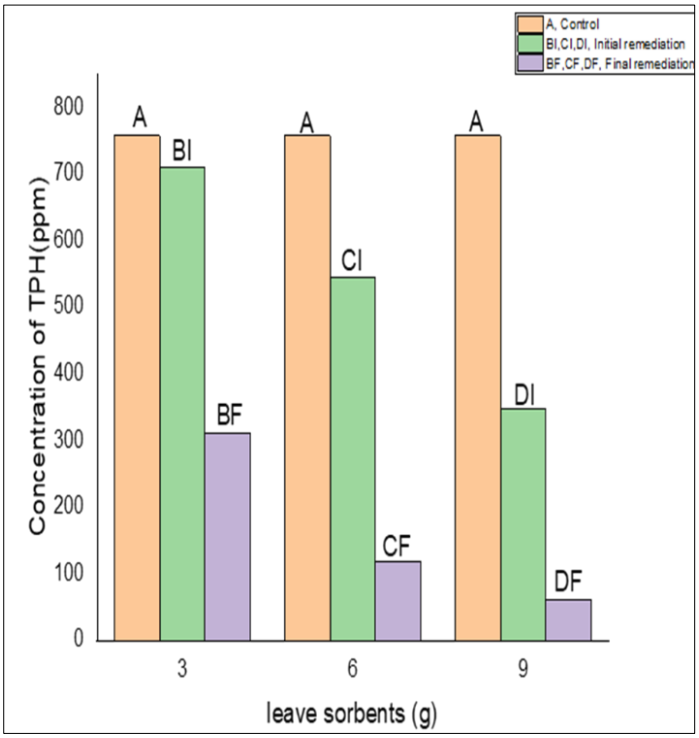


Figure 3 Effect of removal of crude oil from contaminated soil by leave sorbent on plate for initial and final remediation at 36 ℃ for 4 weeks

3.3 MS spectra of 3 g, 6 g and 9 g *Cissus populnea* leave.

The MS spectra of *Cissus populnea* leave biosorbent has been depicted in fig 4-6 which indicated that the concentration of Total Petroleum Hydrocarbon (TPH) was high at the initial remediation time. Figure 7-9 After 4 weeks of biodegradation, the chromatographic profiles of this fraction had a different pattern which indicated lower concentration of Total Petroleum Hydrocarbon (TPH) at 3 g, 6 g and 9 g of leave biosorbents. This results shows that the *Cissus populnea* leave biosorbent is capable of removing the Total Petroleum Hydrocarbons (TPH) from the soil.

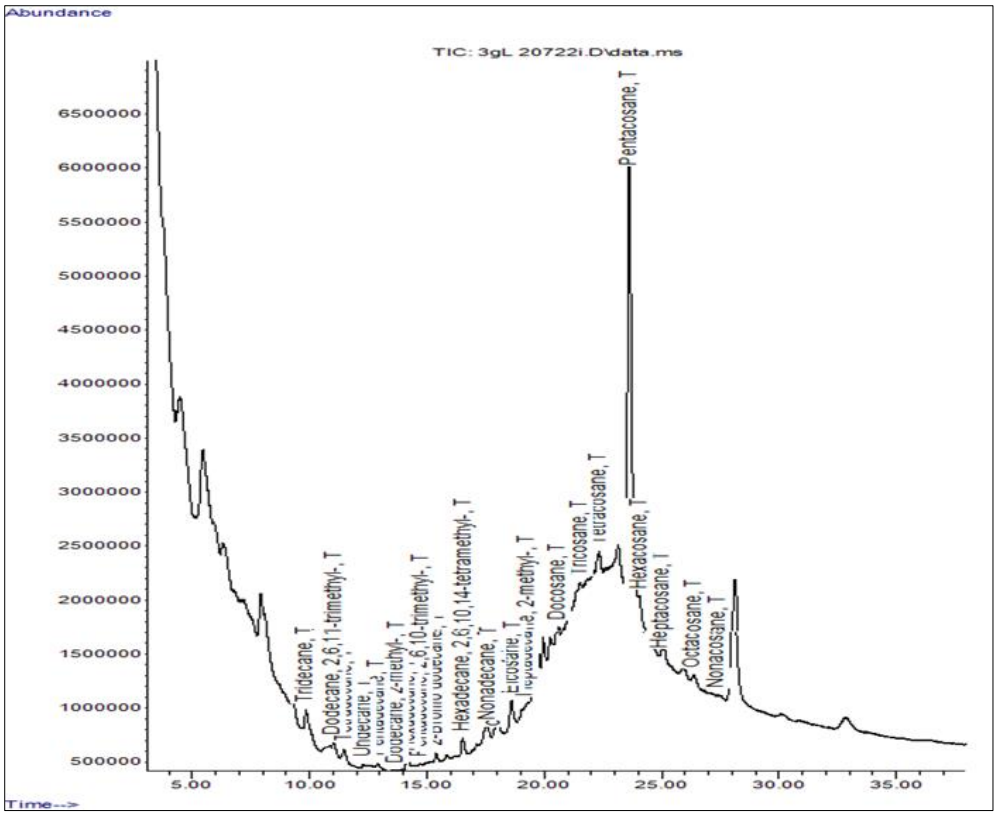


Figure 4 MS Spectra of 3 g leave for initial Bioremediation

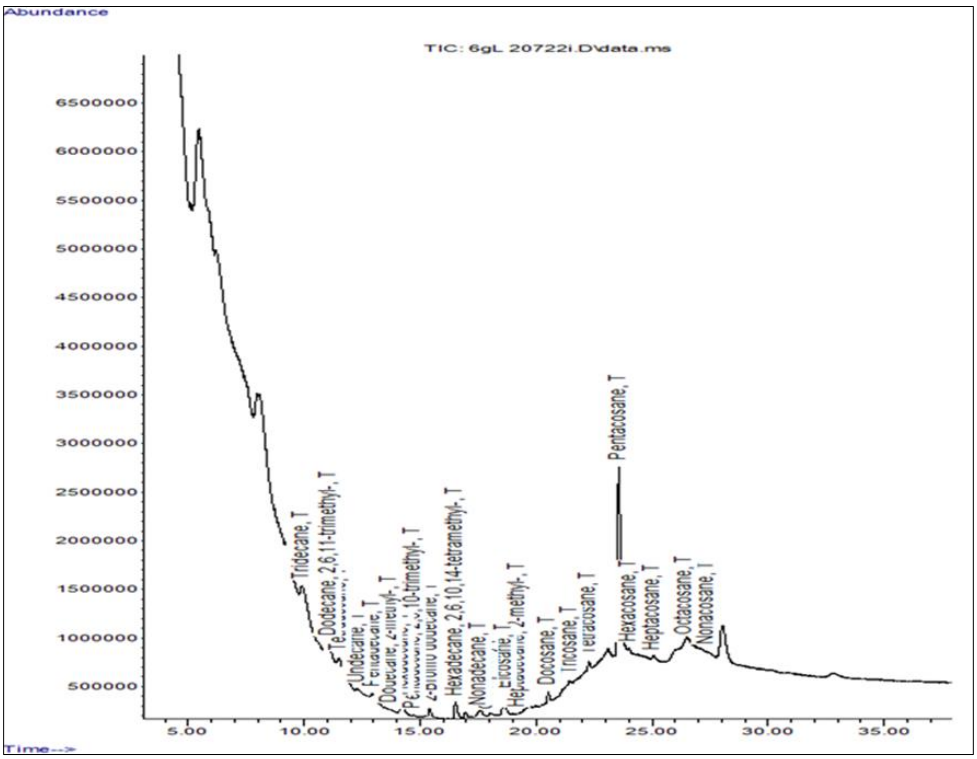


Figure 5 MS Spectra of 6 g leave for initial Bioremediation

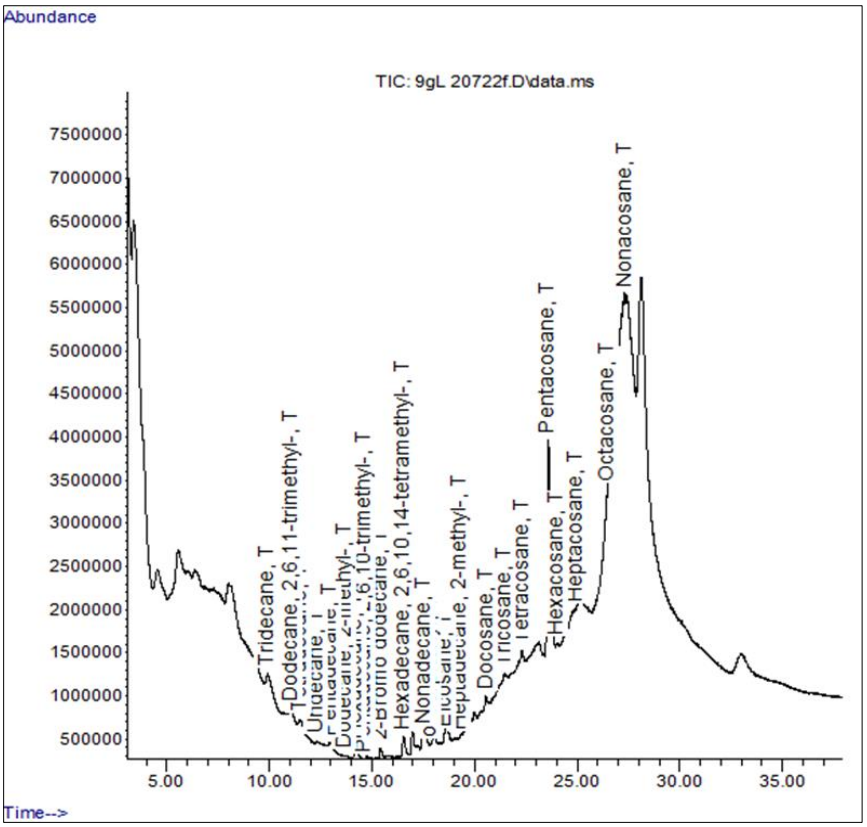


Figure 6 MS Spectra of 9g leave for initial Bioremediation

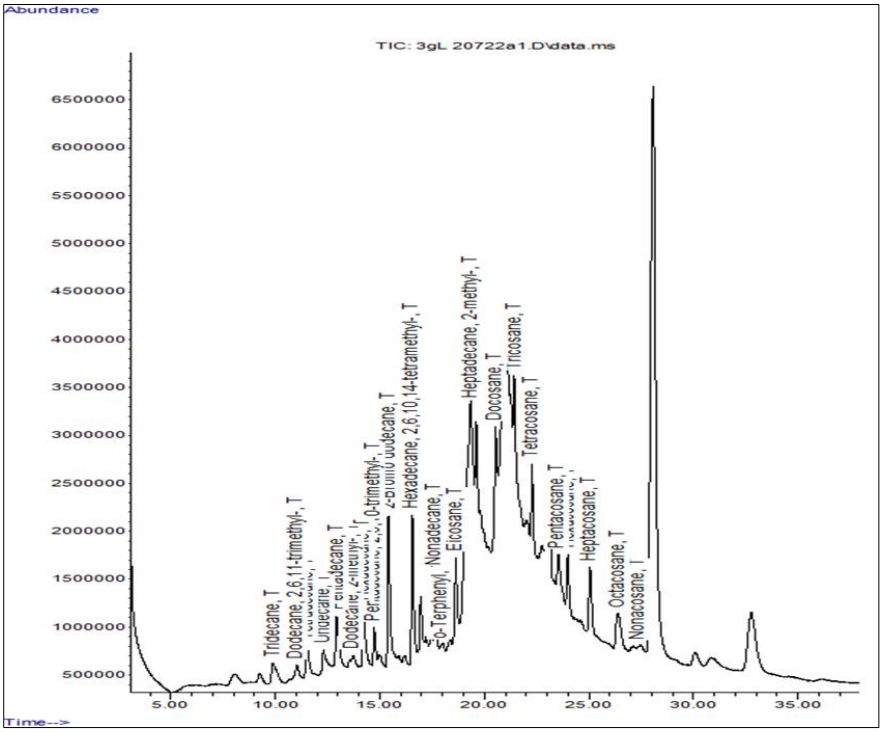


Figure 7 MS Spectra of 3 g leave for final Bioremediation

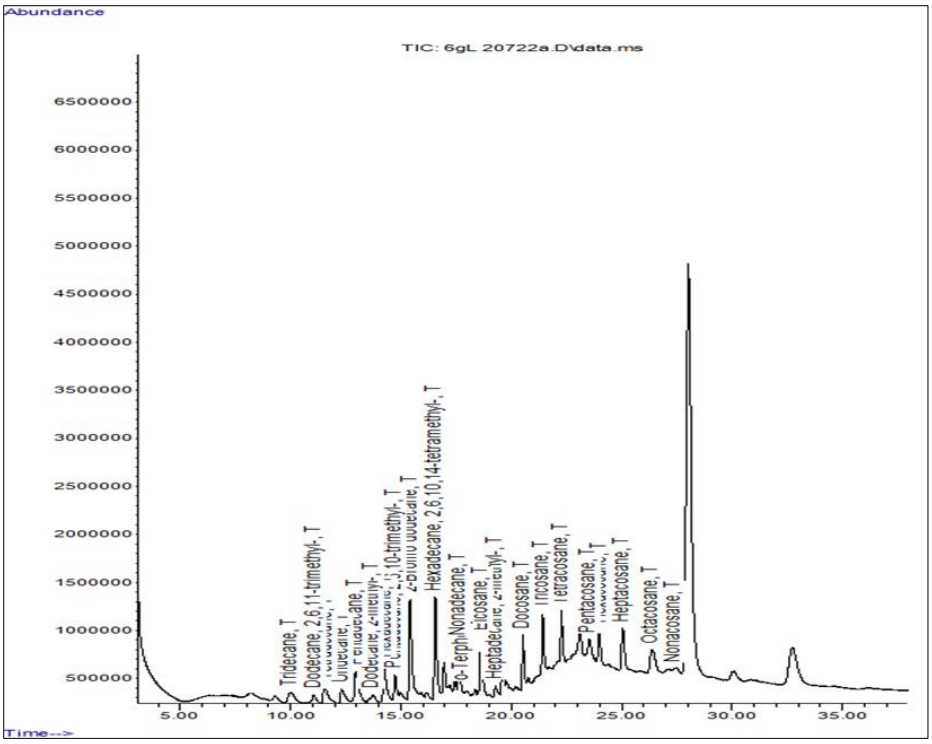


Figure 8 MS Spectra of 6 g leave for final Bioremediation

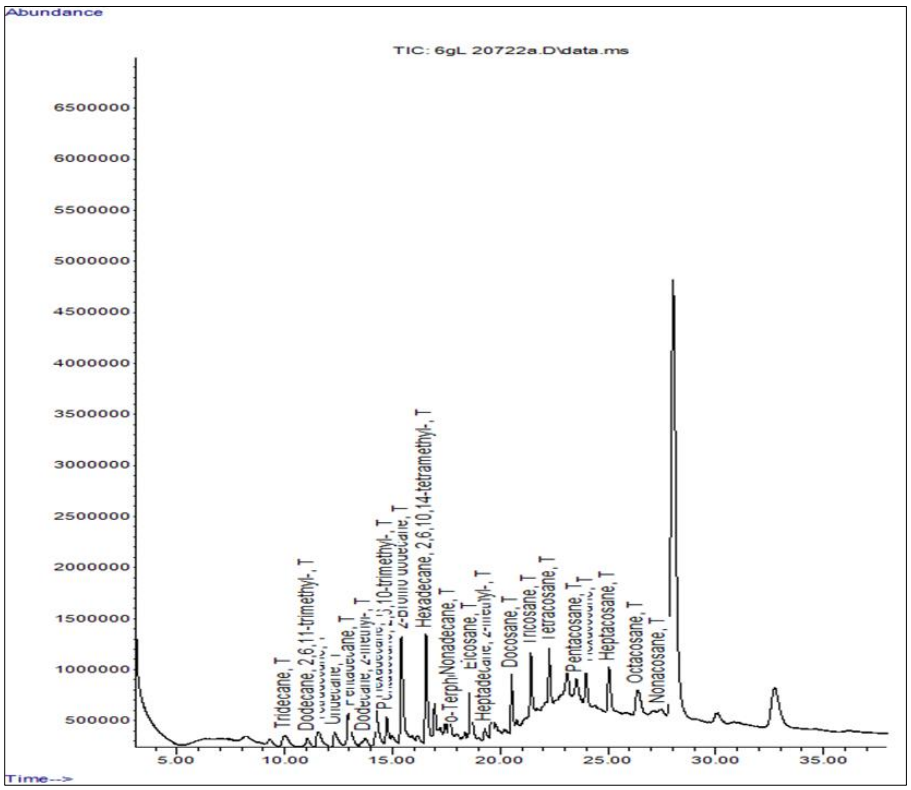


Figure 9 MS Spectra of 9g leave for final Bioremediation

4 Conclusion

In these research work of bioremediation of crude oil spillage using *Cisuss populnea* leave, as biosorbent for remediation of crude oil spillage in contaminated soil.

The leave biosorbent have demonstrated capacity to remove total petroleum hydrocarbon (TPH) concentration in contaminated soil both at the initial and final remediation after four weeks of biodegradation. However, long-term biodegradation with increase in biosorbent need to be performed to ascertain 100% removal of total petroleum hydrocarbon in the contaminated soil.

Compliance with ethical standards

Acknowledgments

We are grateful to the entire Staff of Chemistry Department Modibbo Adama University, Yola for their support during the course of this research work. Special thanks also go to Dr Mohammed Yahaya Fululu and his team, Abti American University, Yola for their technical support and assistance in GC/MS analysis.

Disclosure of conflict of interest

The authors declare that they have no conflict of interest.

References

[1] Adams F.V, A. Niyomugabo, O.P. Sylvester (2017). International conference on sustainable Material processing and Manufacturing SMPM, 23-25 kruger National park. Bioremediation of crude oil contaminated soil using Agricultural Wastes Department of Petroleum Chemistry American University of Nigeria, yola, 640001 Nigeria.

[2] Agu, M. O. (2010). Evaluation of Some Properties of Violet Plant *(Securidaca Longepedunculata) Roots* as a Surfactant. Federal University of Technology, Yola. M.Tech. Thesis, 1-80.

[3] Agunobi, K.N., Obienusi, E.A., Onuoha, D.C., (2014), An investigation of the pattern and environmental impact of oil spillage in etche local Government area of Rivers State, Nigeria. Journal of Natural Sciences Research 14(16), 124-137.

[4] Chebbi, R., 2000. Inertia-gravity spreading of oil on water. Journal of Chemical Engineering Science 55(21), 49534960.

[5] Chebbi, R., 2001. Viscous-gravity spreading of oil on water. American Institute of Chemical Engineers Journal 47(2), 288-294. Clark

[6] Chorom (2010). "Bioremediation of crude oil. Polluted soil by application of Fertilizers" Iranian j. Environ. Sci. Engine. Res.7 (4): 347-366.

[7] Dimitrakis, I.P., Psaltaki, M., Markatos, N., 2011. 3-D oil spill modelling, natural dispersion and the spreading of oilwater emulsions in the water column. Global NEST Journal 13(4), 325-338.

[8] D. Owonaro, J. G.Akpa and C. P.Ukpaka. Development of predictive model for crude oil dispersion in coastal water. Current Science Perspectives 5(1) (2019) 6- 13.

[9] Oludele, O. E., Wyse, M. E., Odeniyi, O. K., Ali, P. O., & Kugbogbenmowei, M. (2021). *Bioremediation of Crude Oil Contaminated Soil Using Cow Dung*. https://doi.org/10.18483/ijSci.2427

[10] Nagati, V. B., Alwala, J. Koyyati, R., Donda, M. R., Banala, R. and Padiaya, P. R. M. (2012). Green Synthesis of Plant Medicated Silver nanoparticles using with aniasomnifera Leaf extract and Evaluation of their Antimicrobial Activity. *Asia Pacific Journal of Tropical Biomedicine,* 1-5.

[11] Osuagwu ES, Olaifa E (2018) Effects of oil spills on fish production in the Niger Delta. PLoS ONE 13(10): e0205114. https://doi.org/10.1371/journal.pone.0205114

[12] Paul I. A. (2015) A Historical Perspective of Petroleum on Nigeria's Economic Crisis Since Independence: Global of Human-Social Science and Economics 15(2), 17–24.