LINGKAR
Journal of Environmental Engineering
E-ISSN: 2986-8807, P-ISSN: 2746-2498
https://journal.ar-raniry.ac.id/index.php/lingkar/index

Published by
Dept. of Environmental Engineering
UIN Ar-raniry Banda Aceh, Indonesia

CHICKEN MANURE AS BIOSTIMULANT FOR TOTAL PETROLEUM HIDROCARBON (TPH) REMOVAL IN OIL CONTAMINATED SOIL

Arief Rahman [1*], Mudatstsir [1], Husnawati Yahya[1]
[1] Department of Environmental Engineering, UIN Ar-Raniry, Banda Aceh, Indonesia, 23111

*Corresponding Email: arief.rahman@ar-raniry.ac.id
DOI: 10.22373/ljee.v6i1.7985

Abstract

Oil contamination in the soil might cause degradation on the quality of the soil, which becomes a problem for the environment and the organisms in it, especially the plants. The plants will be unable to grow and develop properly in the degraded soil, which will give a severe negative impact to agricultural sector. Biostimulation can be a good solution in solving soil degradation problem, utilizing microorganisms and biostimulant. The objective of this study is to discover the potential of chicken manure as biostimulant for biostimulation process in the removal of total petroleum hidrocarbon (TPH) as one of the main properties in oil contaminant. In this study, the chicken manure as biostimulant were being mixed with the oil contaminated soil (400 gr), with variation of weight; W_1= 50; W_2= 100; W_3= 150; and W_4= 200 gr. Biostimulation process were being observed and analyzed every 7 days for 21 days, and being compared with the soil without biostimulant addition (control). The result shown that biostimulation process using chicken manure in this study can remove up to 66.67% of TPH, from 6% of to 2% (W_4 for 21 days), but still unable to fulfill the quality standard given, which is 1%. Based on the result of this research, it can be concluded that biostimulation using chicken manure as biostimulant can be utilized to remove TPH from oil contaminated soil, hence still need improvement to perform better.

Keywords: *Biostimulation, Biostimulant, Chicken manure, Total petroleum hidrocarbon (TPH), oil contaminated soil*

How to cite this article: *Rahman, A., Mudatstsir., and Yahya, H. 2025. "Chicken Manure as Biostimulant for Total Petroleum Hidrocarbon Removal in Oil Contaminated Soil." Lingkar: Journal of Environmental Engineering 6(1) : 1-10 : 10.22373/ljee.v6i1.7985*

1. Introduction

Soil degradation has become one of the main problems that humanity must face in this modern time, caused by several factors including oil contamination. The

Manuscript received 23 May 2023; revised 31 May 2023; accepted 15 June 2025

degradation of soil quality will cause negative impacts on the environment and the organisms living in it, especially plants. Oil contaminant in the soil will disrupt physical and chemical process in the plant system, causing harmful effect like the supression on seeds germination, slow nutrients absorption, reduction of chlorophyll content, decreation of leave, root and stem size, and even leading to extiction (Novakovskiy et al., 2021). Although some species of plants has higher survivability in oil contaminated soil, like *Secale cereale* (Skrypnik, et al., 2021), remediation efforts must be conducted to remove the oil contaminants in contaminated soil, hence it can sustainably supporting the life in it.

As one of the main properties of oil, total petroleum hidrocarbon (TPH) can be observed to determine the contamination rate of oil contamination in the soil. According to Regulation of Ministry of Environment of Indonesia Republic No. 128 (2003), the standard value of TPH in the soil is 10,000 µg/g (1%). Remediation methods can be used to reduce the TPH value in the soil, including biostimulation method utilizing microorganisms. Biostimulation is a modification effort to the environment to create a favorable condition for microbial activity by adding nutrients, oxygen, adjusting the temperature and pH, etc. (Romantschuk et al., 2023). One of nutrients sources that can be added as biostimulant is the manure of animals, including chicken manure. Chicken manure contains macronutrients and micronutrients such as nitrogent, phosphorus, potassium, and calcium (Odales-Bernal et al., 2024), which are essential subtances to support microbials life (Bruslind, 2025). Since chicken manure can be found easily and highly abundance, the utilization of chicken manure can also become a prevention effort in poulty farm waste contamination.

In the previous study conducted by Oghoje & Ukpebor (2020), biostimulant derived from chicken manure was utilized to treat 5% and 10% of TPH levels, with % of removal 84% and 80% respectively in 168 days using 20% of biostimulant-soil ratio. In another study conducted by Osadebe & Nkoro (2024), chicken manure can reduce 96.83% of 5% TPH level of oil contaminated soil in 60 days, using 10% of biostimulant-soil ratio. The study conducted by Okpanachi, et al. (2025) shows that chicken manure can reduce 67,08% of 10% of TPH level in 40 days, using 10% of biostimulant-soil ratio. Based on the result of conducted studies, It is shown that chicken manure has a good potential to be utilized as biostimulant for treating oil contaminated soil.

The objective of this research is to discover the potential of chicken manure as biostimulant in TPH removal for treating oil contaminated soil. In this research several variations of biostimulant-soil ratio up to 50% was being used to discover the influence to the remediation rate of oil contaminated soil for 21 days.

2. Methodology

2.1 Field Study

In this experiment, the chicken manure was taken (800 gr) at a poultry farm located at Jaya Baru Subdistrict, Banda Aceh City, Aceh Province, Indonesia. After being taken, the chicken manure was being dried under sunlight exposure for a week (≈63 hours of sunlight exposure). The oil contaminated soil was taken (2 kg) at Rajawali Servis motorcycle repair shop which is located at Jaya Baru Subdisctrict, Banda Aceh City, Aceh

Manuscript received 23 May 2023; revised 31 May 2023; accepted 15 June 2025

Province, Indonesia. The TPH value of the oil contaminated soil sample in this research is 6%, which is not fulfilled the quality standard given by the regulation (Regulation of Ministry of Environmental of Indonesian Republic No. 128, 2003), hence it needs to be treated with a proper treatment. Oil contaminated soil before treatment is shown by **Figure 1**.

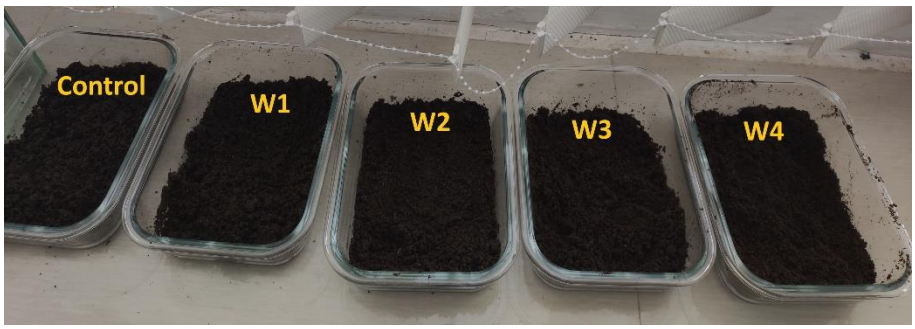

Figure. 1. Oil Contaminated soils in container before treatment (from left to right: control, W_1, W_2, W_3, and W_4

2.2. Experiment Set-Up

The experiment in this research was being conducted by using 5 set of biostimulation containers, with 20 in length, 6 cm in width, and 7 cm in height. Each container was being filled with oil contaminated soil mixed with biostimulant, 4 cm in thickness. Biostimulation container design is shown by **Figure 2**.

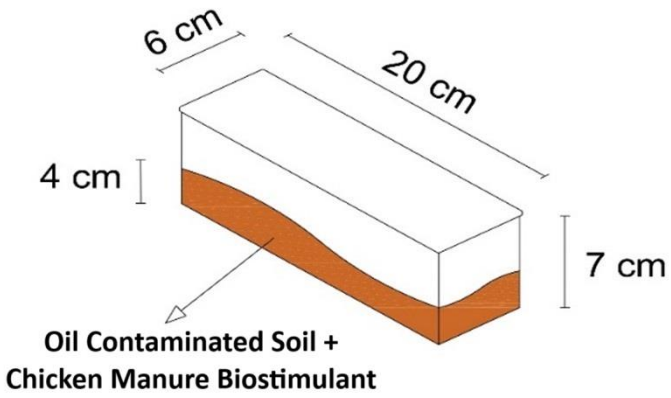

Figure. 2. Biostimulant Container Design

Oil contaminated soil was being mixed with biostimulant in several ratio, with variation of biostimulant; W_1 = 50 gr; W_2 = 100 gr; W_3 = 150 gr; and W_4 = 200 gr, along with oil contaminated soil without biostimulant addition as control media. Each variation of biostimulant was being mixed with 400 gr of oil contaminated soil, generating ratio of biostimulant-soil (B/S); 12.5%; 25%; 37.5%; and 50%. After the mixture for each variation was being filled into each container, the biostimulation containers was being placed at dry environment with room temperature of 31°C. During

Manuscript received 23 May 2023; revised 31 May 2023; accepted 15 June 2025

the experiment process, once every 7 days for 21 days, soil measurement was being conducted. After the measurement, 25 mL of aquadest was added to maintain the soil moisture and the soil was being stirred to maintain its homogeneity. The experiment design for this research is shown by **Table 1**.

Table 1. Experiment Design

Oil contaminated soil (gr)	Biostimulant Variations (gr)	B/S ratio (%)	Measurement
400	0 (control)	-	Day 0, 7, 14, and 21
	50	12.5	
	100	25	
	150	37.5	
	200	50	

2.3. Analytical Methods

In this study, After being collected, the data was being analyzed. The percentage of TPH was being determined by using gravimetry principle, with formula as follows:

$$TPH\left(\%\,\frac{b}{b}\right) = \frac{W_0 - W_e}{W_s} \times 100\% \quad (1)$$

Where W_0 is the weight of vial before extraction, W_e is the weight of vial after extraction, and W_s is the weight of sample of soil that being extracted. TPH percentage was being calculated for each weight variation of biostimulant (W_1, W_2, W_3, and W_4), and also for soil without biostimulat addition (control).

The performance of chicken manure biostimulant in treating oil contaminated soil was being determined by computing the percentage of removal, using an equation as follows:

$$R(\%) = \frac{TPH_0 - TPH_e}{TPH_0} \times 100\% \quad (2)$$

Where R is removal percentage, C_0 is TPH level before treatment, and C_e is TPH level after treatment. R was being calculated for each variation of in the experiment.

Manuscript received 23 May 2023; revised 31 May 2023; accepted 15 June 2025

3. *Result and Discussion*

After the experiment has conducted, determination of the performance of chicken manure as biostimulant in TPH removal for oil contaminated soil can be done by analythical methods. Each variation (C, W_1, W_2, W_3, and W_4) on each measurement day (day 0, 7, 14, and 21) conduced the data of TPH levels. The result of TPH removal treatment is shown by **Table 2** and TPH removal rate is shown by **Figure 2**.

Table 2. The result of TPH measurements

Biostimulant Variation (gr)	TPH (%)				
	C	W_1	W_2	W_3	W_4
0	6	6	6	6	6
7	5.8	5	4.8	4.2	4
14	5.8	4.8	4.2	3.8	3.2
21	5.6	4.6	3.6	2.2	2

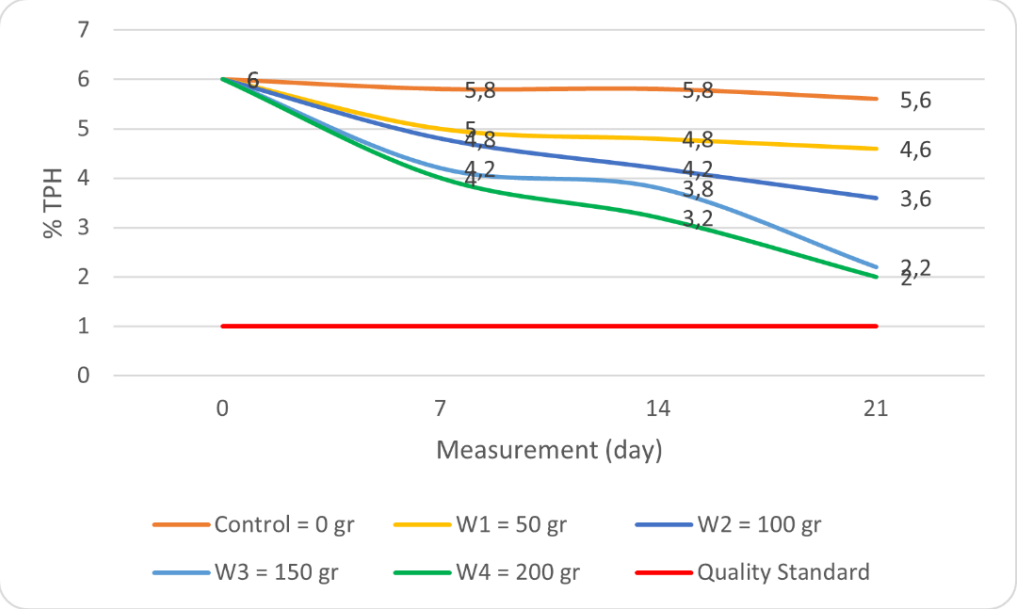

Figure 2. TPH Removal Rate

From **Table 2**, it is shown that TPH levels was decreased over time by the time given in this experiment for all variations, with the higher result was achieved by variation W_4 with 200 gr of biostimulant weight (50% of B/S ratio) in 21 days, which is from 6% to 2%. The decreation of TPH level caused by degradation process by microorganisms in the mixture of soil-biostimulant, where higher amount of biostimulant provides higher nutrients, hence it is able to support the activity of

***Lingkar**: Journal of Environmental Engineering Vol. 6 No. 1, June (2025)*
Manuscript received 23 May 2023; revised 31 May 2023; accepted 15 June 2025

microorganisms in the degradation process. Moreover, since animal manure such as chicken manure contains microorganism such as *Bacillus* and *Pseudomonas* (Zhang, et al., 2018) the addition of chicken manure as biostimulant into the soil also can increase the number of microorganisms that can degrade TPH levels (Abena, et al., 2019).

From **Figure 2**, it proved that the higher B/S ratio not only can achieved highest result of TPH degradation, but also can achieved higher removal rate over time. Variation W_4 at 14th day (3.2%) preceded the removal rate of W_1 and W_2 at 21st day (4.6 and 3.6 respectively). Longer time will be needed along with the higher level of TPH, not only from the amount but also from the toxicity that will inhibit the growth and the activity of microorganisms.

From the data of TPH measurement for each measurement day, TPH removal percentages was determined to discover the performance of chicken manure biostimulant. TPH removal percentages for this experiment is shown by **Table 3** and oil contaminated soil in each container after treatment are shown by **Figure 3**.

Table 3. TPH Removal Percentages

Biostimulant Variation (gr)	TPH Removal (%)				
	C	W_1	W_2	W_3	W_4
0	-	-	-	-	-
7	3.33	16.67	20	30	33.33
14	3.33	20	30	36.67	46.67
21	6.67	23.33	40	63.33	66.67

Figure 3. Oil Contaminated soil in each container after treatment (from left to right: control, W_1, W_2, W_3, and W_4)

From **Table 3**, it is shown that variation W_4 is able to reach the highest TPH removal percentage, which is 66.67% in 21 days, followed by W_3, W_2, and W_1, which are 63.33%, 40%, and 23.33% respectively. It is also shown that the oil contaminated soil without addition of biostimulant is unable to reach a high removal percentage. After 21 day of treatment, TPH level in control media only decreased by 6.67%. Without enough

Manuscript received 23 May 2023; revised 31 May 2023; accepted 15 June 2025

nutrients and enough population of degradator microbiota, TPH degradation rate will be slow and takes longer amount of time.

The result of this experiment is in accordance with the previous researches, using chicken manure and the other animal derived manure as biostimulant for treating oil contaminated soil. The comparison between COD removal in this research and the other researches is shown by **Table 4**.

Table 4. Comparison of biostimulants and treatment duration to % removal of TPH in oil contaminated soil

No.	Biostimulant	% Removal of TPH	Treatment duration (days)	Reference
1	Cow manure	86.66	30	Yahya, et al. (2025)
2	Chicken manure	84	168	Oghoje & Ukpebor (2020)
3	Chicken manure	96.83	60	Osadebe & Nkoro (2024)
4	Chicken manure	67.08	40	Okpanachi, et al. (2025)
5	Cow manure	60.19	14	Okafor, et al. (2025)
6	Cow manure	72.5	28	Sutthicharoen et al. (2023)
7	Sheep Manure	88.8	30	Yahya et al. (2023)
8	Chicken Manure	66.67	21	The result of this study

Based on **Table 4**, compared to the previous researches using biostimulant derived from chicken manure and the other animal manure (cow and sheep) for treating oil contaminated soil, the result given by this research can be considered as good, with relatively short duration of treatment. The results show that animal manure can acts as biostimulant to treat oil contaminated soil, increasing the quality of the soils to enhance its capability to support the life in it.

4. Conclusion

The result showing that chicken manure as biostimulant can reduce the TPH level in the oil contaminated soil. The highest removal given by variation W_4 (200 gr), reducing TPH level from 6% to 2% in 21 days, with removal percentage 66.67%. Nevertheless,

Manuscript received 23 May 2023; revised 31 May 2023; accepted 15 June 2025

chicken manure still unable to fulfill the quality standard given, which is 1%. Hence, the improvement still needed to optimize the efficacy of treatment. Improvement can be done by prolong the duration of the treatment, using higher ratio of biostimulant-soil, mix the chicken manure biostimulant with the other nutriens source (e.g., composts, bioenzyme, the manure of another animal, etc.), using bioaugmentation to add certain microorganism that can degrade the contaminant more effectively, etc. Overall, it can be concluded that chicken manure can be an alternative biostimulant to treat oil contaminant in the soil.

5. Acknowledgments

The researcher would like to express gratitude to Science & Technology Faculty of UIN Ar-Raniry Banda Aceh who gave permit to use the laboratory, ensured this research to be conducted.

REFERENCES

Abena, Marie Thérèse Bidja, Tongtong Li, Shah, Muhammad Naeem Shah, and Weihong Zhong. "Biodegradation of Total Petroleum Hydrocarbons (TPH) in Highly Contaminated Soils by Natural Attenuation and Bioaugmentation." *Chemosphere*. 234 (2019): 864-874. https://doi.org/10.1016/j.chemosphere.2019.06.111.

Bruslind, Linda. 2025. *Microbiology*. Oregon State University. Libretexts.

Novakovskiy, A.B., Kanev, V. A., Markarova, M. Y. "Long-term Dynamics of plant communities after biological remediation of oil-contaminated soils in far north." *Scientific Reports*. (2021) 11:4888. https://doi.org/10.1038/s41598-021-84226-5.

Odales-Bernal, Leyanet, Yasmani Alba Reyes, Wendy L. Duharte, Lisbet Mailin López Gonzáles, Edelbis López-Dávilla, Ernesto L. Barrera, and Frederik Ronsse. (2024) "Energy and Nutrient Potential of Chicken Manure: Case Study of Mechanized and Traditional Farms." *Afinidad IQS: Jounal of Chemical Engineering Theoritical and Applied Chemistry* (2024) Vol. 81, No. 604. https://doi.org/10.55815/432101.

Oghoje, U. S. & Ukpebor, J. E. (2020) The Effect and Efficacy of Chicken Manure Digestates on Bioremediation of Petroleum Hydrocarbons Polluted Soils. Nigerian Research Journal of Chemical Sciences. Vol. 8, Issue 1, 2020. https://www.researchgate.net/publication/341626371_The_Effects_and_Efficacy_of_Chicken_Manure_Digestates_on_Bioremediation_of_Petroleum_Hydrocarbons_Polluted_Soils/link/5f4f52ab458515e96d22b637/download?_tp=eyJjb250ZXh0Ijp7InBhZ2UiOiJwdWJsaWNhdGlvbiIsInByZXZpb3VzUGFnZSI6bnVsbH19.

Manuscript received 23 May 2023; revised 31 May 2023; accepted 15 June 2025

Okafor, C. E., Nwabueze, O. P., Uzuegbu, C. P., Okeke, S. C., Okafor, R. C. (2025) Bioremediation Efficacy and Total Petroleum Hydrocarbon Reduction in Crude Oil Contaminated Soil Using Cow Dung. J. Appl. Sci. Environ. Manage. 29 (1): 555-561. https://doi.org/10.4314/jasem.v29i2.26.

Okpanachi, M. A., Egbeja, T. I., Onoja, E. A., Okpanachi, C. B., Joseph, E., and Shaibu, U. D. "Bioremediation Potentials of Poultry Manure in Crude Oil Poluuted Soil." *Journal of Global Ecology and Environment* (2025). Vol. 21, Issue 2, 28-36, 2025. https://doi.org/10.56557/jogee/2025/v21i29139.

Osadebe, Anwuli U. and Barisqua Q. Nkoro. "Bioremediation of Petroleum-Impacted Soil Using Poultry Manure." *Hibiscus: Journal of Environmental Microbiology and Toxicology* (2024). Volume 12, No. 2, 7-12. https://doi.org/10.54987/jemat.v12i2.1003.

Regulation of Ministry of Environment of Indonesia Republic (2003), Peraturan Menteri Lingkungan Hidup Nomor 128 Tahun 2003 Tentang Tata Cara dan Persyaratan Teknis Pengolahan Limbah Minyak Bumi dan Tanah Terkontaminasi Oleh Minyak Bumi Secara Biologis.

Romantschuk, Martin, Katariina Lahti-Leikas, Merja Kontro, Polina Galitskaya, Harri Talvenmäki, Suvi Simpanen, John A. Allen, and Aki Sinkkonen. "Bioremediation of Contaminated Soil and Groundwater by in situ biostimulation." *Front. Microbiol* (2023). 14:1258148. https://doi.org/10.3389/fmicb.2023.1258148.

Skrypnik, Liubov, Pavel Maslennikov, Anastasia Novikova, and Mikhail Kozhikin. "Effect of Crude Oil on Growth, Oxidative Stress and Response of Antioxidative System of Two Rye (*Secale cereale* L.) Varieties." *Plants* (2021) 10, 157. https://doi.org/10.3390/plants10010157.

Sutthicharoen, Saowalak, Jindawan Wibuloutai, Nuchnapa Prathumchai, and Supachai Sutticharoen. "Removal of Total Petroleum Hydrocarbons from Contaminated Soil Used Lubricating Oil by Surfactant: Triton X-100, and Cow Manure Amendments." *Burapha Science Journal* (2023). Volume 28 (No. 2). https://scijournal.buu.ac.th/index.php/sci/article/view/4491/4717.

Yahya, Husnawati, Abd. Mujahid Hamdan, Tuti Marlina, Yeggi Darnas, and T. Muhammad Ashari. "The Effectiveness of Cow Manure in Remediation of Top Soil Contaminated by Engine Oil Waste." *Cleaner Water Systems* 11 (2025) 100306. https://doi.org/10.1016/j.clwas.2025.100306.

Yahya, Husnawati, Syafrina Sari Lubis, and Maulida. "The Effect of Composting With The Addition of Sheep Manure on Decrease in Total Petroleum Hydrocarbon (TPH) Levels of Top Soil Polluted By Waste Oil." *Asian Journal of Management Entrepreneurship and Social Science* (2023). Volume 03, Issue 02. https://doi.org/10.63922/ajmesc.v3i02.416.

Zhang, Lili, Lijuan Li., Xiaoguang Pan, Zelu Shi, Xihong Feng, Bin Gong, Jian Li, and Lushan Wang. "Enhanced Growth and Activities of the Dominant Functional Microbiota of Chicken Manure Composts in the Presence of Maize Straw."

Manuscript received 23 May 2023; revised 31 May 2023; accepted 15 June 2025

Front. Microbiol (2018). 9: 1131. https://doi.org/10.1016/j.chemosphere.2019.06.111.

Manuscript received 23 May 2023; revised 31 May 2023; accepted 15 June 2025