



UNIVERSITY OF GHANA

Evaluation of biodegradation of diesel and engine oil in a Rhodic kandiustalf (soil) amended with biochar and its effect on the vertical flow of groundwater

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Introduction

- Petroleum oil and its various derivatives are the primary energy sources for industrialization and everyday life.
- The primary groups of petroleum hydrocarbons (PHCs) of environmental significance are aromatic hydrocarbons, PAHs, and petrol additives.
- Due to these chemical constituents, the spillage of petroleum into the environment creates a significant environmental risk (Trindade et al., 2005).
- The amount of oil spilled worldwide was approximately 10,000 metric tons in 2024 (Statista Research Department, 2025).
- Figure 1. Conceptual model of the evolution of PHC contaminants in the environment (Balseiro-Romero et al., 2018).
- Figure 2. The combined action of biochar and soil microbes to promote the biodegradation of PAHs (Kong et al., 2018).

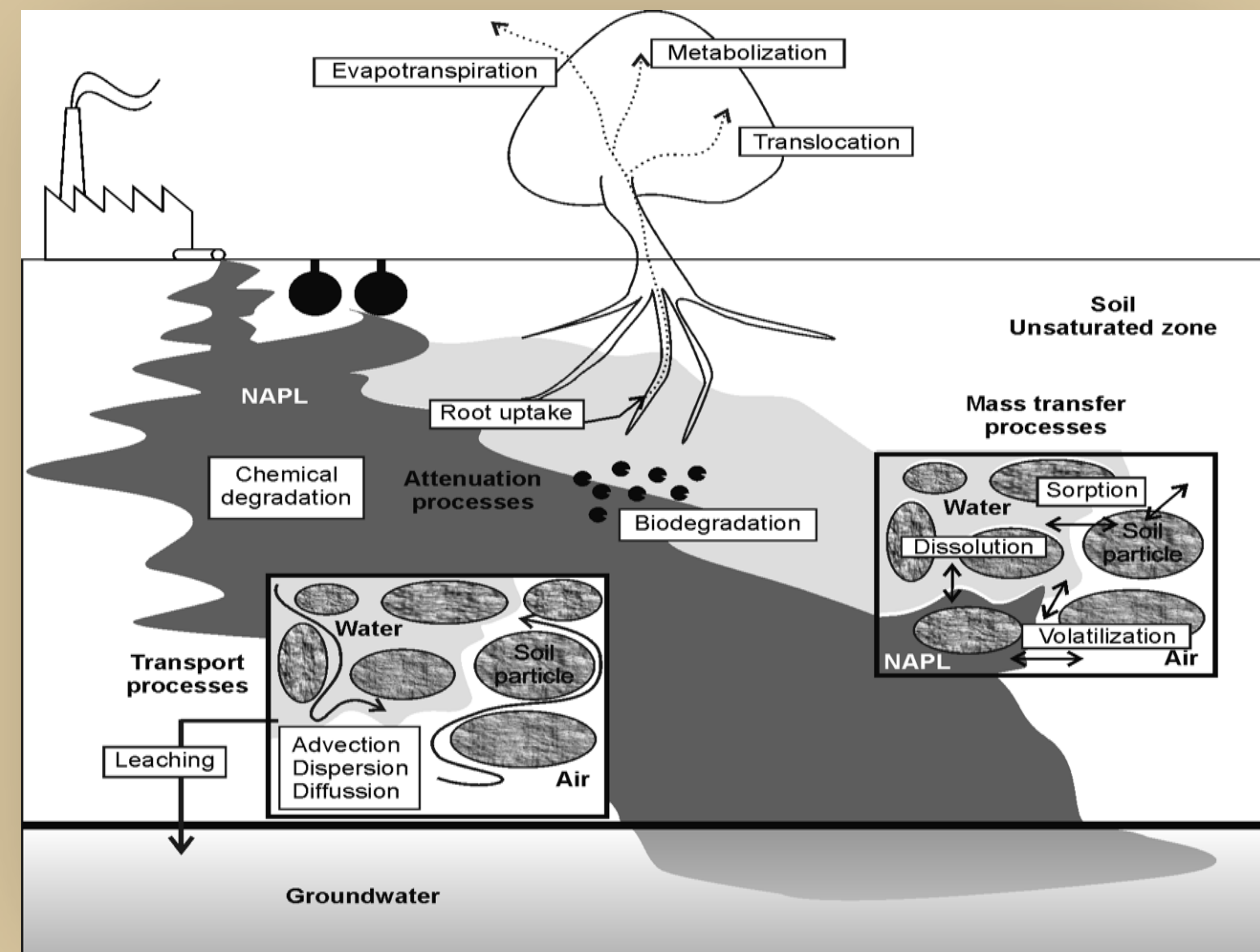


Figure 1

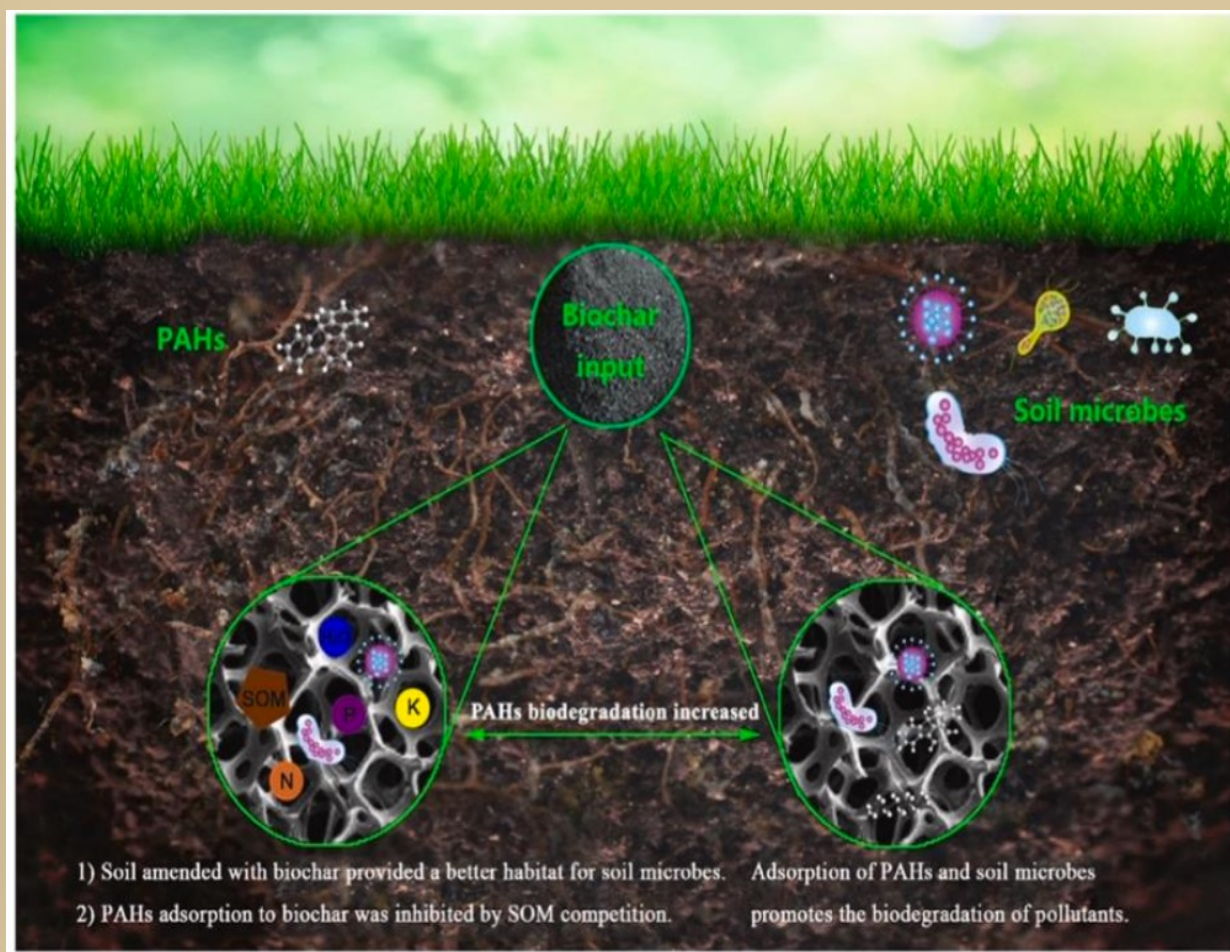


Figure 2

Objective

The specific objectives of this study were to:

- evaluate CO₂ emission from an oil-contaminated soil amended with biochar.
- evaluate the quantity of oil degraded in an oil-contaminated soil amended with biochar.
- investigate the vertical flow of water in an oil-contaminated soil amended with biochar.

Materials and Methods

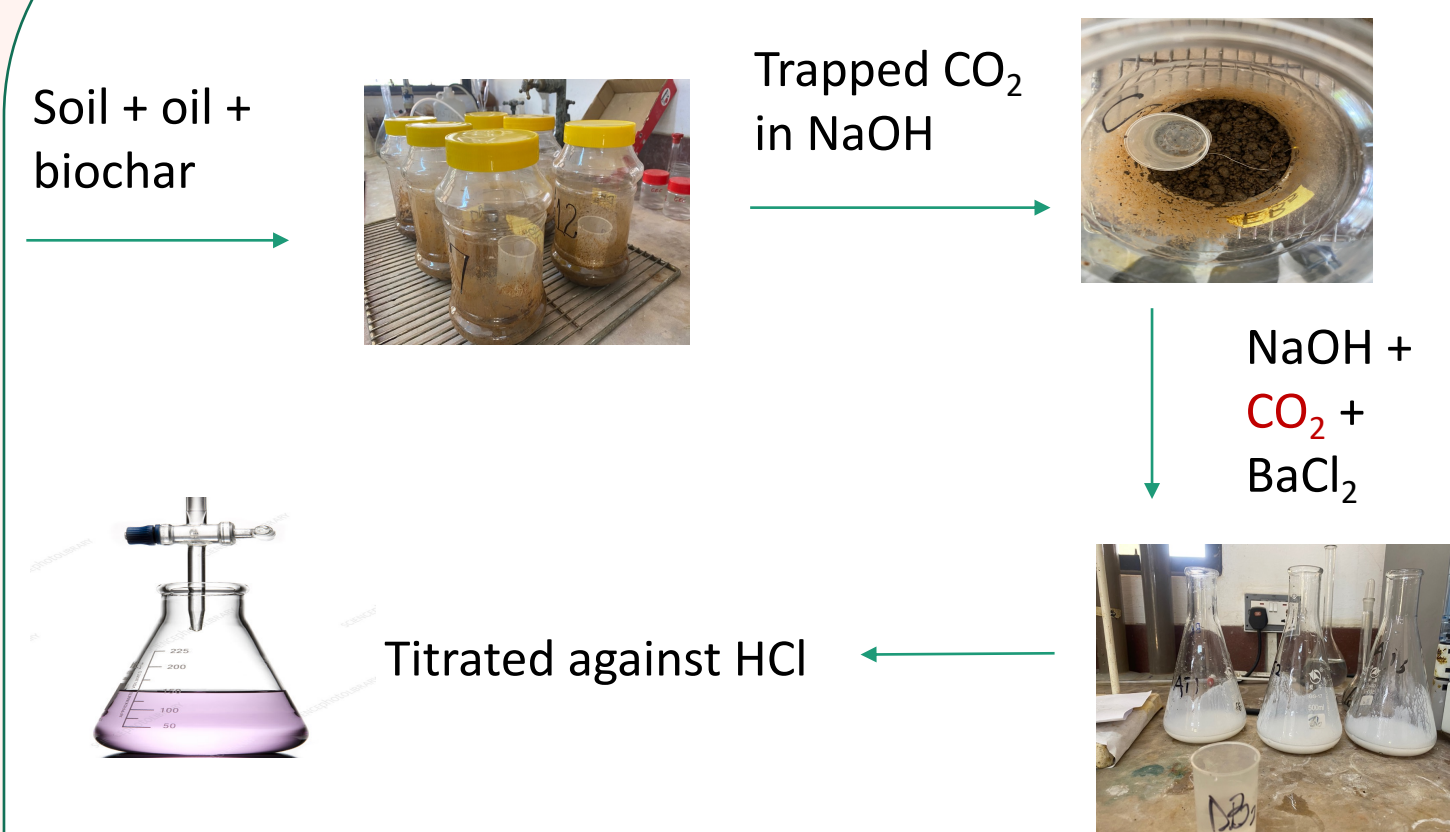


Figure 3. Semantic representation of the CO₂ emission experiment

The cumulative C mineralized during the aerobic incubation study was fitted to the first-order exponential to estimate the labile mineralizable C (C_i) with its respective turnover rate (k) and R².
 $C_m = C_i (1 - e^{-kt})$

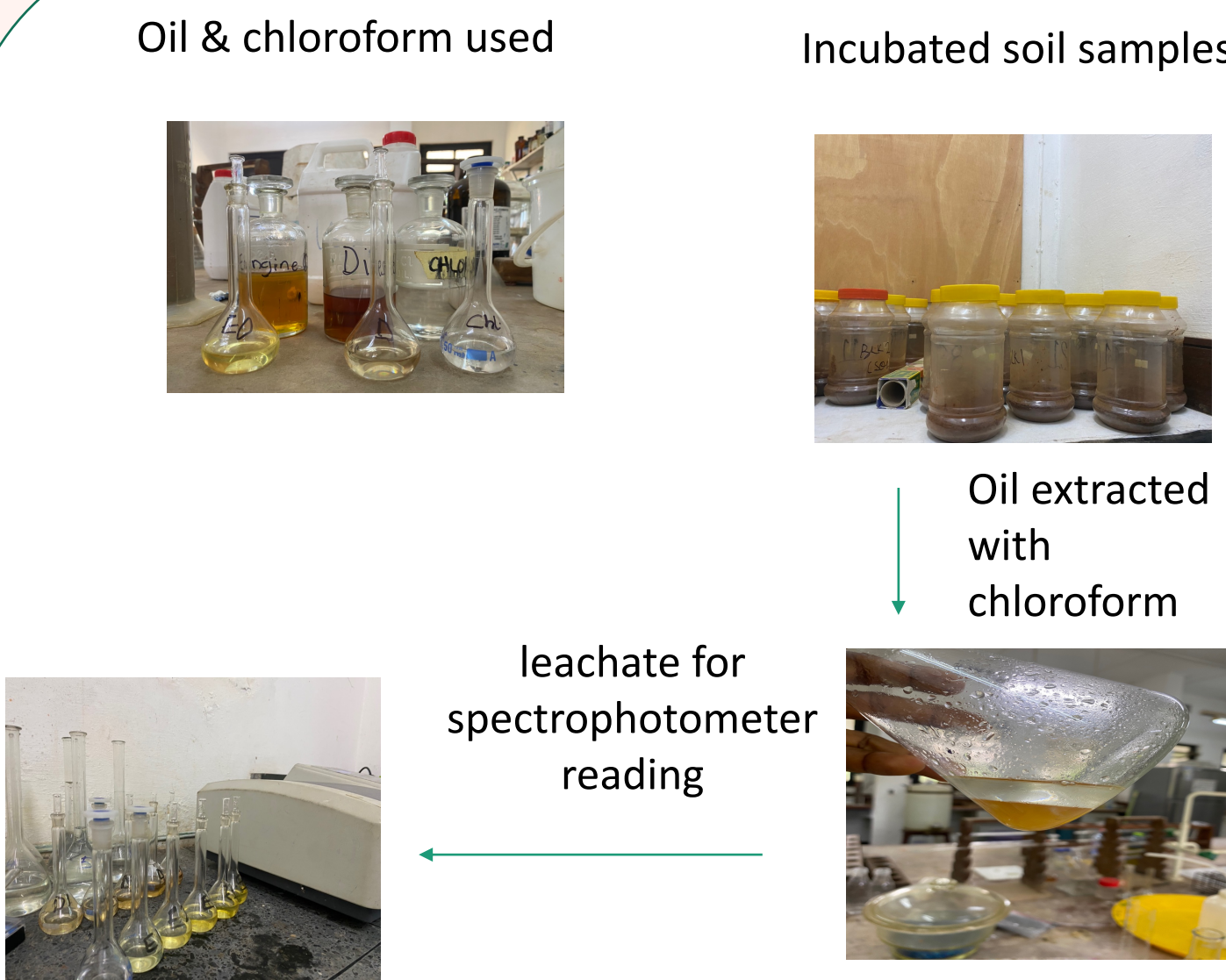


Figure 4. Semantic representation of the oil degradation experiment



Figure 5. Semantic representation of water flow in a soil system

Results and Discussion cont.

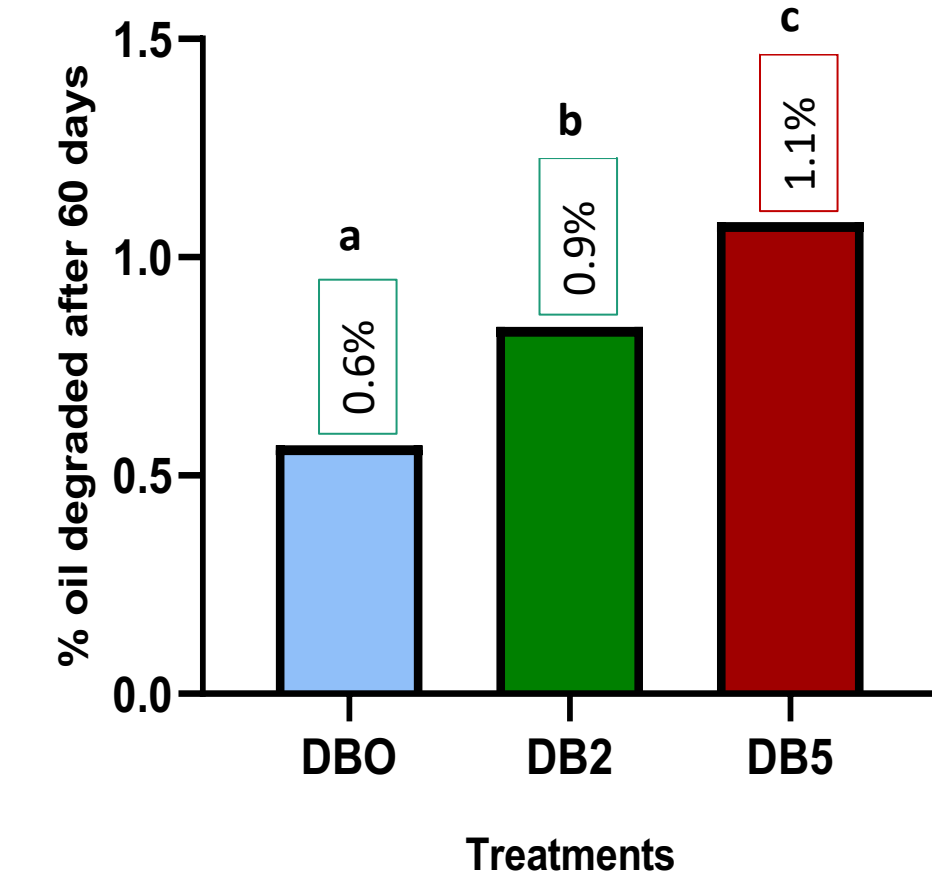


Figure 8. Percentage diesel degraded

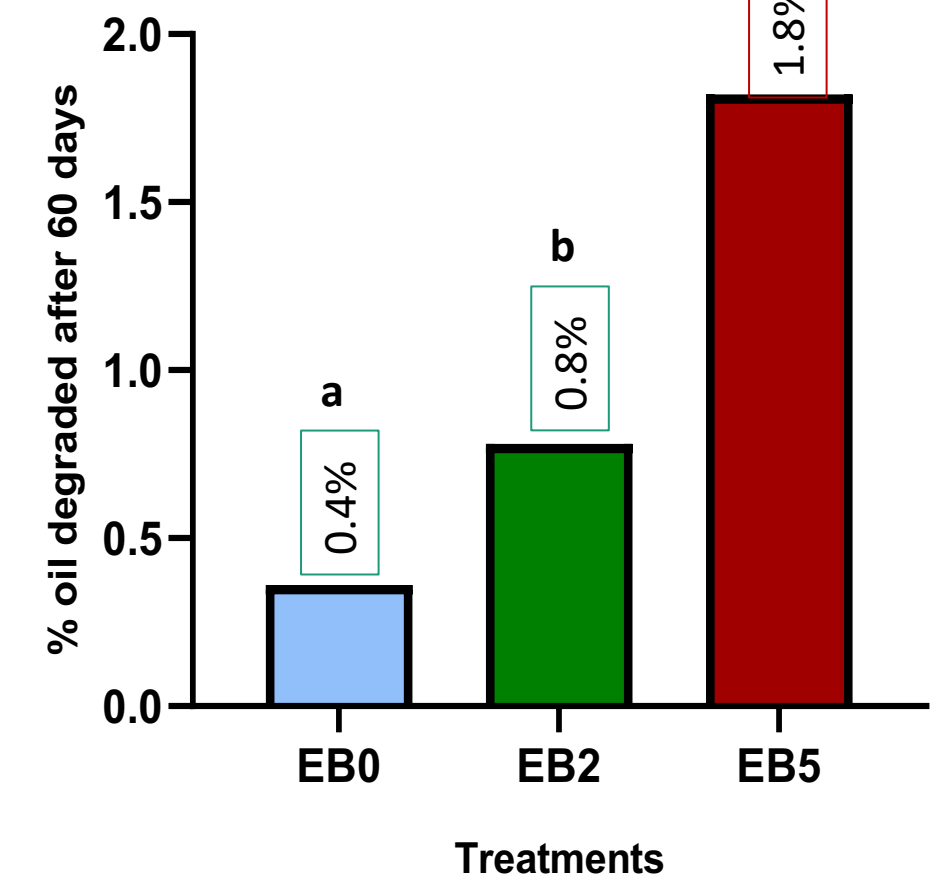


Figure 9. Percentage engine oil degraded

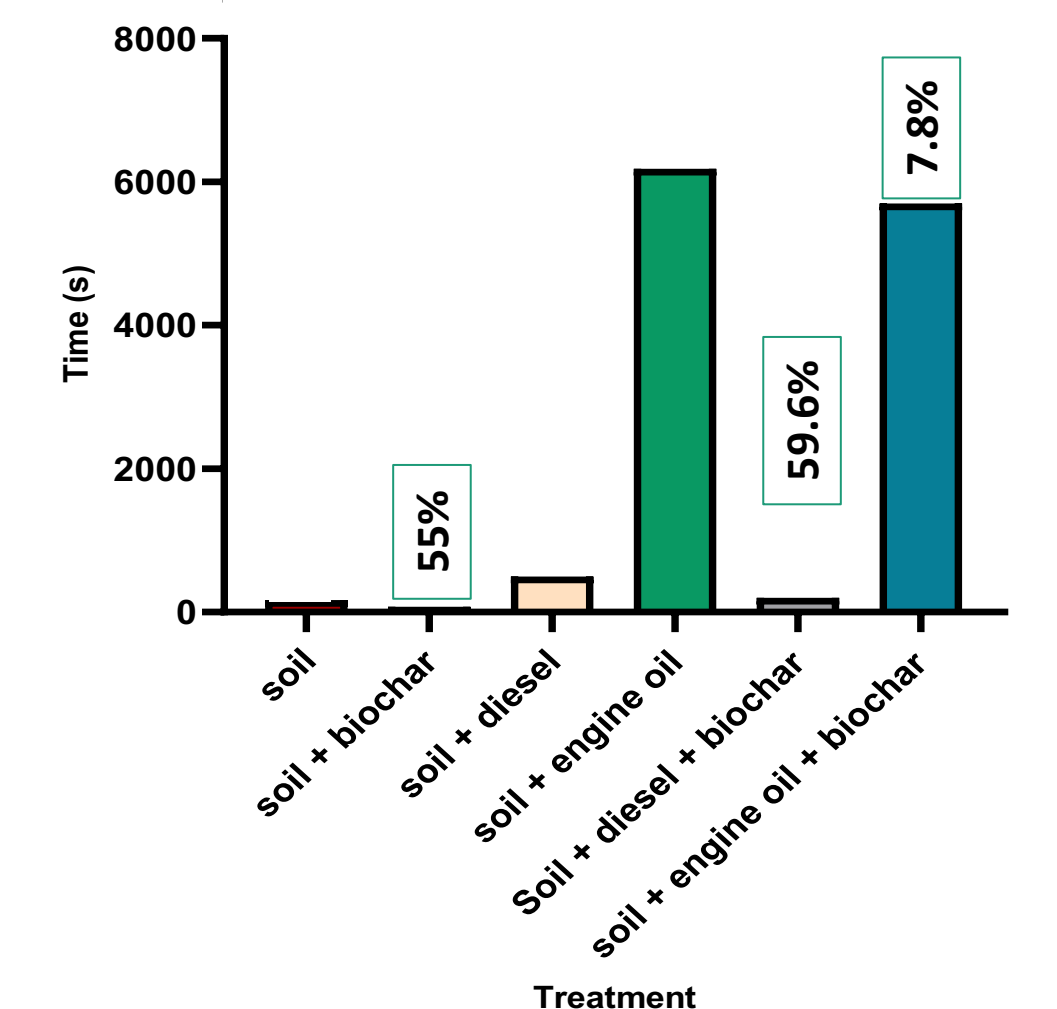


Figure 10. Time at which first drop of effluent was recorded

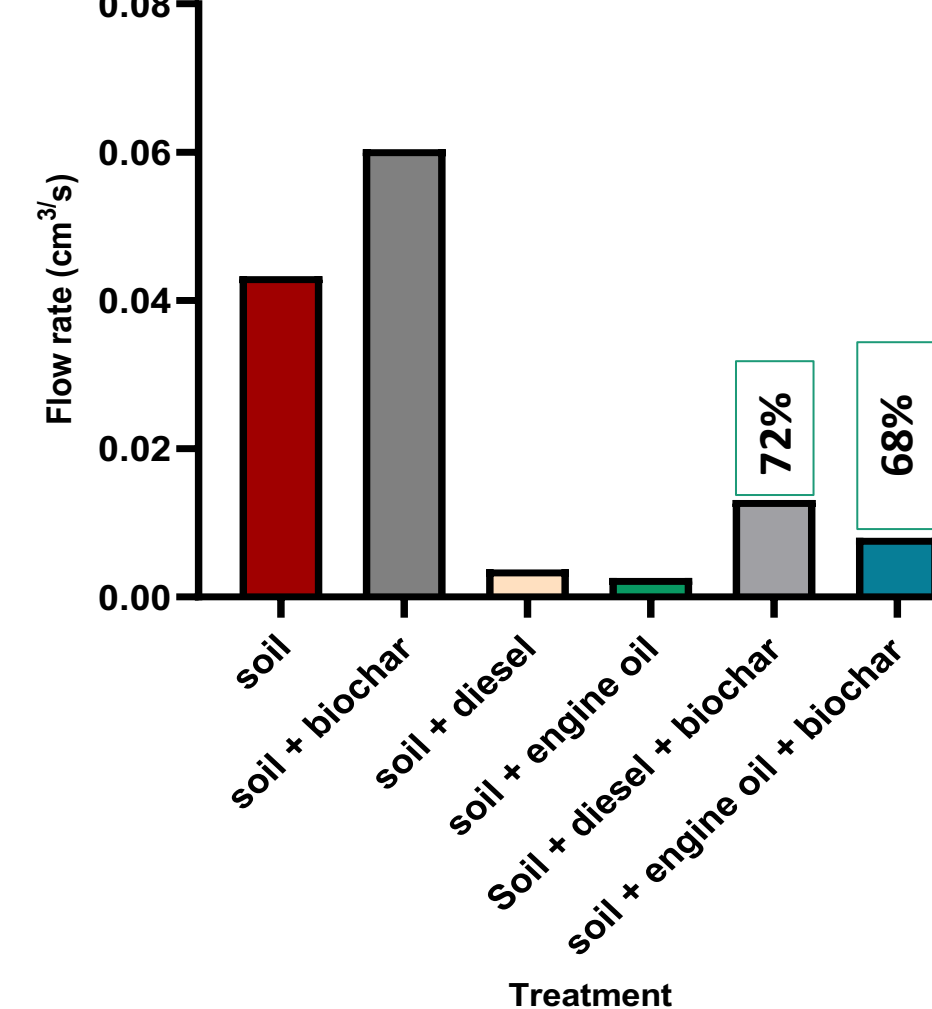


Figure 11. Influence of biochar on Flow rate

Results and Discussion

Table 1. Kinetics of C mineralization

Treatment	C _i (mg/kg)	K (day ⁻¹)	R ²
DB0	141.1	1.09	0.995
DB2	172.97	1.02	0.995
DB5	149.93	0.88	0.993
EB0	142.63	0.93	0.996
EB2	200.23	0.95	0.996
EB5	231.57	0.89	0.995

DB0, DB2 & DB5 represent soil + diesel + biochar at 0, 2, and 5%, respectively
EB0, EB2 & EB5 represent soil + engine oil + biochar at 0, 2, and 5%, respectively

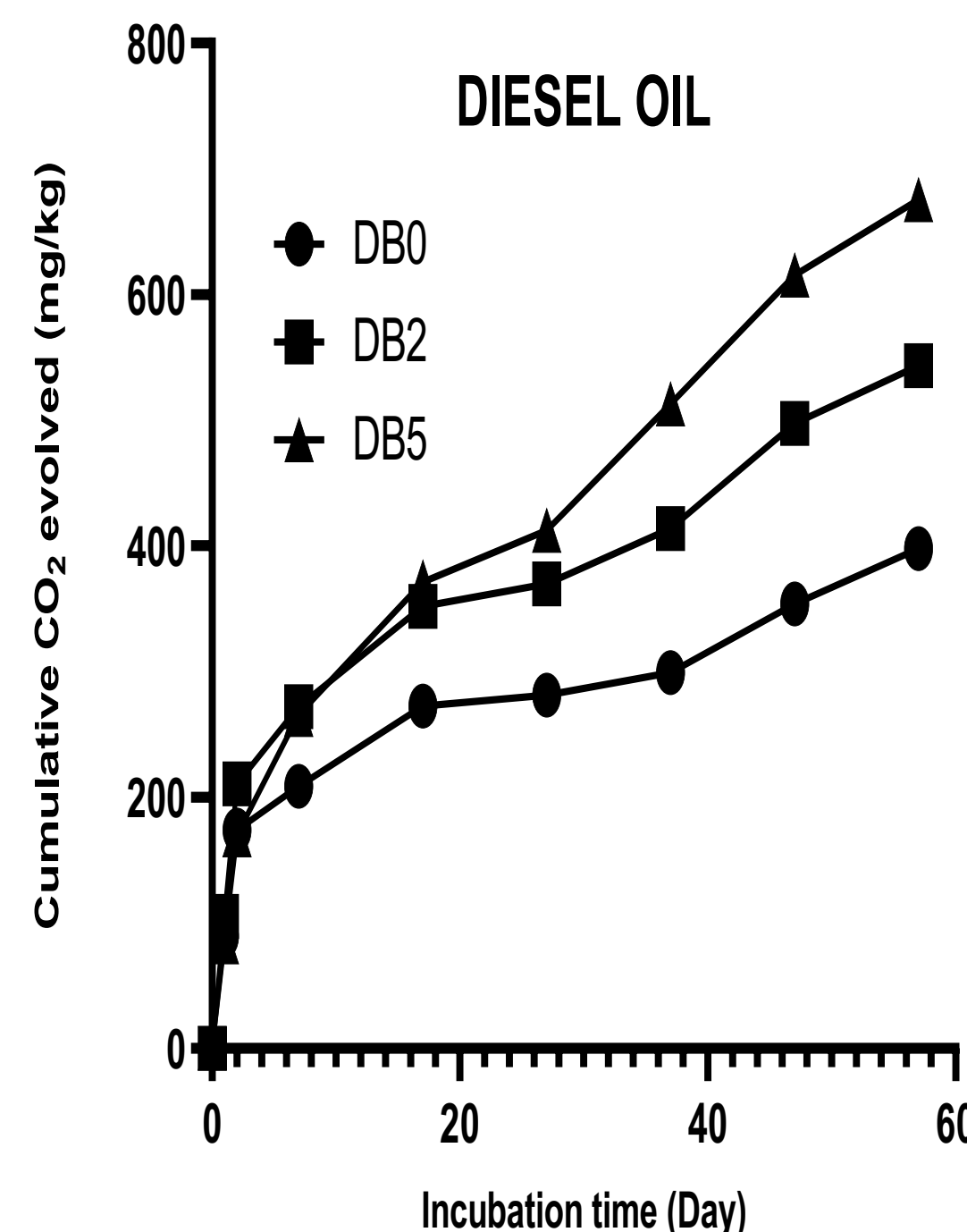


Figure 6. Cumulative CO₂ evolved in diesel-contaminated soil

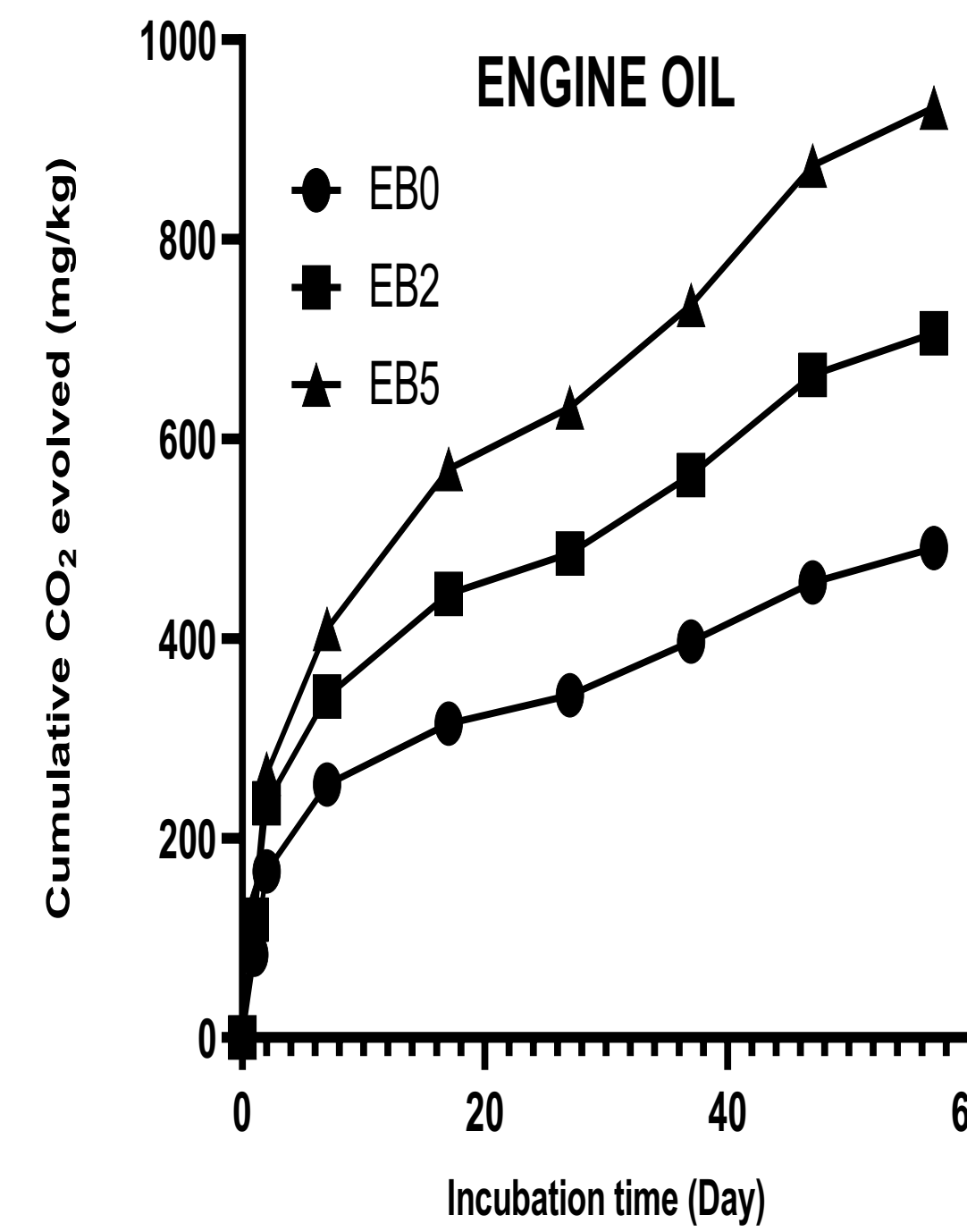


Figure 7. Cumulative CO₂ evolved in engine oil-contaminated soil

Conclusion

- CO₂ emission increased with increasing biochar application rates
- Application of biochar enhanced carbon mineralization
- Degradation of oil increased with increasing biochar application rates
- The amendment of the oil-contaminated soils with biochar improved the flow rate

Recommendation

Further research studies to investigate

- the effects of different biochar feedstocks and biochar sizes on CO₂ emission and oil degradation,
- the combined effect of biochar and other inorganic nutrient(s) and
- field experimentation are highly recommended.

Reference

- Balseiro-Romero M, Monterroso C, & Casares J.J. (2018). Environmental fate of petroleum hydrocarbons in soil: Review of multiphase transport, mass transfer, and natural attenuation processes. *Pedosphere*, 28(6), 833-847.
- Trindade O.P.V, Sobra G.L, Rizzo L.A.C, Leite F.S.G, & Soriano U.A. (2005). Bioremediation of a weathered and a recently oil-contaminated soils from Brazil: a comparison study. *Chemosphere*, 58, 515-522.
- Statista Research Department. (2025). Global oil tanker spills volumes 1970-2021.

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