Reviewer's comments

Title

- Simplify and clarify: "Recent Advances in Biostimulation for Remediating TPH-Contaminated Soils: A Comprehensive Review".
- Consider shortening or simplifying: e.g., "Progress in Biostimulation-Based Remediation of TPH-Contaminated Soils."

Abstract

- Suggest a **graphical abstract** for better visibility.
- Use structured format: *Background, Methods, Results, Conclusion*.
- Reduce repetition and wordiness.

Rewritten Abstract (example):

Background. Petroleum pollution in soils is a major environmental concern globally. Biostimulation, a form of bioremediation that enhances native microbial degradation via nutrient amendment, is gaining attention for its sustainability and cost-effectiveness.

Methods. This review consolidates research from 2000 to 2024, analyzing biostimulant types, mechanisms, microbial responses, and field-scale applications using data from 276 peer-reviewed articles.

Results. Organic amendments, mineral nutrients, and biochar enhance microbial TPH degradation through nutrient supplementation, soil improvement, and stimulation of functional genes. Combined treatments consistently outperform single-agent applications.

Conclusion. Biostimulation is a scalable, eco-friendly remediation strategy for petroleum-contaminated soils. Optimizing nutrient balance, biostimulant synergy, and real-time monitoring are key to field success.

1. Introduction

- Separate long paragraphs for clarity.
- Highlight novelty of this review versus past works. Clarify the novelty of the review, what gap it fills (e.g., "Compared to previous reviews, this work uniquely emphasizes…").

- Emphasize how **this review is distinct from earlier works** (e.g., includes emerging technologies like nanomaterials, GEMs, AI sensors).
- Add more recent references on biostimulation.

  https://doi.org/10.1016/j.seares.2022.102268

  https://doi.org/10.1016/j.marpolbul.2021.112863

  https://www.mdpi.com/1660-4601/18/5/2226

2.1 Improvement of the Nutritional Environment

- Rephrase for clarity, e.g., "Microorganisms require balanced C/N/P ratios for optimal hydrocarbon degradation."
- Remove redundant mentions of C/N/P ratios.

2.2 Improve the Physical and Chemical Properties of Soil

- Improve transitions between examples.
- Ensure cited studies clearly support claims.

2.3 Increase Microbial Diversity

- Strengthen focus on functional gene activation.

3.1.1 Agricultural Residue

- Better organize content into subgroups.
- Remove repetitive phrasing (e.g., “swine factory wastewater…” repeated).

3.1.2 Domestic Waste-Based Nutrient Additives

- Improve grammar for clarity.
- Cite examples more clearly.

3.1.3 Composting

- Emphasize compost's dual benefits: nutrient supply and microbial activation.

3.1.4 Mineral Fertilizers

- Clarify when and why mineral fertilizers are best used in combination.

3.2.1 Biochar Remediation Alone

- Clarify difference between nutrient amendment vs. sorption.

3.2.2 to 3.2.4 Combined Remediation Strategies

- Improve flow of logic.
- Merge similar findings to avoid excessive detail.

3.3.1 Restoration by Plants Alone

- Shorten long sentences.
- Clarify mechanisms of rhizoremediation.

3.3.2–3.3.4 Combined Restoration Approaches

- Add tables showing effectiveness comparisons.
- Merge overlapping content.

3.4 Summary of Biostimulant Applications

- Combine Table 5, 6, and 7 into one comprehensive summary.
- Ensure table headings include treatment duration, TPH degradation %, and soil type.

3.5 Emerging Technologies

- Add subheadings: *Nanotechnology, Genetically Engineered Microbes (GEMs), AI-Based Monitoring*.
- Add references from 2022–2024 on biosensor systems.

4.1 Engineering Applications and Policy-Relevant Considerations

- Include case examples.
- Add brief SWOT (Strengths–Weaknesses–Opportunities–Threats) analysis for field-scale biostimulation.

4.2 Spatial and Regional Variability

- Consider adding a map or visual summary of region-specific biostimulants.
- Clearly explain implications for future field trials.

5. Summary and Outlook of the Biostimulation Approach

- Present summary as bullet points for clarity:
    - Biostimulation is sustainable and scalable.
    - Synergistic applications outperform single treatments.

- Future work should focus on standardization and real-time monitoring.

5.1 Future Research Directions

- Highlight 4 clear areas:
  - Standardized C:N:P ratios
  - In-situ monitoring systems
  - Cross-disciplinary collaboration
  - Predictive modeling using AI

6. Conclusion

- Slightly shorten for impact.
- Include a final sentence on global importance and scalability.

Rewritten Closing Sentence:

With ongoing refinement, biostimulation can become a cornerstone in the global remediation of petroleum-contaminated soils.

Acknowledgements & Competing Interests

Suggestions:

- Ensure funding sources and any affiliations are disclosed if applicable.

References

- Standardize formatting per journal guidelines (PeerJ: APA style).
- Include DOIs for all references.
- Remove duplicate entries or incomplete citations.
- Ensure all in-text citations match those in the list.

Figures & Tables:

- Ensure **caption consistency**.
- Add **units, treatment durations, and soil types** in all comparative tables.
- Ensure tables are properly formatted in final submission (many placeholder tables are referenced but not inserted).

Grammar & Style:

- Rephrase run-on sentences.
- Example:

“Biostimulation can enhance the proliferation and growth of microorganisms…” Consider breaking up or simplifying.

“The pristine environment plants themselves in some petroleum contaminated areas are sufficient…” Consider rewording for clarity.

“The use of aged refuse as soil amendment brings beneficial petroleum-degrading bacteria…” . “brings” can be “introduces” or “enhances presence of…”