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REVIEWER'S REPORT

Manuscript No.: IJAR-53842 Date: 15-09-2025

Title: Chemical Functionalization and cross-linking of biochar from cow dung for use as supper absorbent mulch substrate for agricultural purpose

Recommendation:
Accept as it is

Rating	Excel.	Good	Fair	Poor
Originality		√		
Techn. Quality	√			
Clarity		√		
Significance	√			

Reviewer Name: Dr. Manju M **Date:** 15-09-2025

Reviewer's Comment for Publication.

1. The study presents an innovative use of cow dung biochar as super absorbent mulch, addressing water scarcity in agriculture.
2. Chemical functionalization and cross-linking were successfully confirmed by FTIR, enhancing moisture and nutrient retention.
3. Field trials in a semi-arid area showed improved crop yields and growth in mulched plots versus non-mulched.
4. The approach is promising for sustainable farming in arid regions and deserves further research and scaling.

Detailed Reviewer's Report

1. Background and Rationale

Water scarcity significantly affects agricultural productivity, particularly in arid and semi-arid areas. Traditional irrigation and mulching techniques are either labor-intensive or inefficient in long-term moisture retention. Thus, there is a pressing need for improved mulching materials that are both sustainable and effective in conserving water and nutrients.

2. Objective of the Study

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The main goal of the study was to develop and test a super absorbent mulch substrate derived from cow dung biochar, chemically modified to enhance its water-holding and nutrient retention capacity, ultimately improving crop yields in water-limited environments.

3. Biochar Preparation

Cow dung was collected from a cattle farm in Thika, Kiambu County, and converted into biochar through pyrolysis (burning under limited oxygen supply). This process produced a porous carbon-rich material suitable for chemical modification and agricultural application.

4. Chemical Functionalization

The biochar was functionalized using:

- Ethan-1,2-diol
- Glycerol
- Phosphoricacid

  These agents introduced hydrophilic functional groups such as hydroxyls and phosphates to improve the biochar's affinity for water.

5. Cross-Linking for Super Absorbency

Cross-linking agents used included:

- Phosphoric acid
- Citric acid
- Urea

  These compounds facilitated the formation of a polymer-like network, enhancing the swelling capacity and water retention of the modified biochar, creating a gel-like structure when wet.

6. FTIR Characterization

Fourier Transform Infrared Spectroscopy (FTIR) was used to confirm successful modification. Notable absorption peaks included:

- –OH (3350.73 cm^{-1})
- P–OH (788.87 cm^{-1})
- P=O (1279.5 cm^{-1})
- C–N (1045.23 cm^{-1})
- N–H (1622.80 cm^{-1})
- C–H (2919.68 cm^{-1})
- C=O(1602.5cm^{-1})

  These indicate the successful incorporation of functional groups that contribute to water absorption and nutrient binding.

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7. Field Experiment and Design

Field trials were conducted in Makuyu ward, Murang'a County, using maize and Calliandra calothyrsus. A randomized block design was employed to compare mulched and non-mulched plots. Parameters monitored included watering frequency, plant growth, and yield.

8. Results and Observations

- Mulched plots exhibited significantly higher water retention and reduced irrigation frequency.
- Improved nutrient retention and soil moisture levels were noted.
- Crop yields and biomass production were higher in mulched plots compared to controls.
- The swelling test confirmed strong cross-linking and absorbency of the mulch.

9. Conclusion and Recommendations

The modified biochar mulch proved effective in conserving moisture and boosting crop productivity in semi-arid conditions. It is a sustainable, low-cost solution with significant potential for scaling in dryland farming systems. Further research is recommended for long-term performance, soil health impacts, and economic viability across diverse crops and regions.

10. Applications

- **Water Conservation in Agriculture:** The modified biochar mulch retains moisture effectively, reducing irrigation frequency in arid and semi-arid regions.
- **Soil Nutrient Management:** It enhances nutrient retention in the root zone, minimizing leaching and improving soil fertility over time.
- **Crop Yield Improvement:** By maintaining consistent soil moisture and nutrients, it supports healthier plant growth and increases overall crop productivity.