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Improving Soil with Biopolymer Hydrogel: Better Soil Quality and Water Retention

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This study focuses on the development and evaluation of biodegradable polymer hydrogels to enhance soil quality, water retention, and irrigation efficiency in arid regions such as Oman.

Three novel hydrogels were formulated using sodium alginate derived from brown seaweed: one with pure alginate, the second enriched with an extract from a local aromatic plant, and the third incorpo biochar rating powder. These were compared against a Russian hydrogel and a Saudi commercial hydrogel. Laboratory analyses included water absorption, thermal stability (TGA), functional group characterization (FTIR), soil pH and EC measurements, and microbial compatibility. Soil moisture retention was evaluated using pressure plate extractions at six pressure levels (0.5 to 15 bars), both with and without soil, followed by RETC modeling. A pot experiment simulated realistic conditions, with sealed pots irrigated from below to assess capillary rise and CO_2 emissions using the SKY8000-M4-X gas analyzer.

Results showed that the alginate-aromatic hydrogel based had the highest water-holding capacity, especially in soil-amended samples, though its water absorption rate was lower than commercial alternatives. Preliminary gas emission data revealed reduced CO_2 release in hydrogel-treated soils, indicating improved moisture retention and possible suppression of

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microbial respiration. Daily pot weight monitoring confirmed slower water loss where the new hydrogels were applied.

These findings demonstrate the effectiveness of locally developed biodegradable hydrogels in improving soil water dynamics and reducing environmental stress, offering a sustainable solution for agriculture in arid climates. Further field trials are planned to validate long-term performance and scalability.

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