NATURAL HYDROGEL BASED ON RENEWABLE MATERIALS TO IMPROVE SOIL QUALITY AND PLANT GROWTH

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Introduction

- This work describes a new type of natural biopolymeric material based on acid whey and cellulose derivatives as a soil conditioner for sustainable agricultural application to improve soil quality and plant growth.
- Acid whey, a by-product of the dairy industry, has been used as the main component of CMC/HEC-based hydrogel to replace the water commonly used for the hydrogel synthesis → a solution to exploit the overproduction of dairy by-products, thereby reducing the associated pollution. Moreover, acid whey can also serve as a valuable source of nutrients for plants.
- Final hydrogel composite was blended by poly(lactic acid) to ensure the stability of the hydrogel in the soil for a longer time.

Results

Fig. 1: Effect of hydrogel amendment on water retention capacity (WRC) in soil (HPLA0-hydrogel without PLA; HPLA20-hydrogel mixed with 20% PLA w/w).

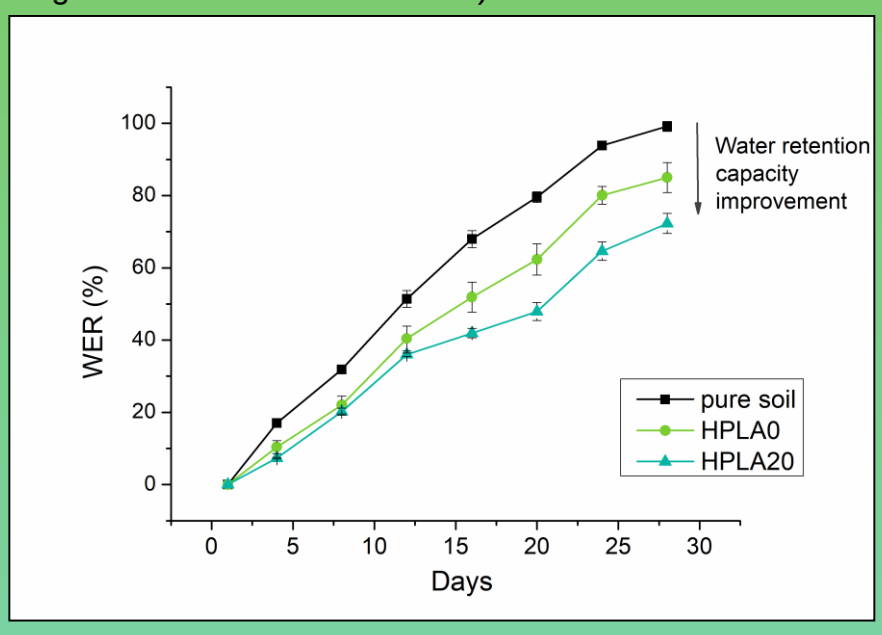


Fig. 2: Effect of PLA addition on hydrogel biodegradability after 20 days in soil (A- hydrogel before degradation; B- HPLA0; C-HPLA10, D-HPLA20).

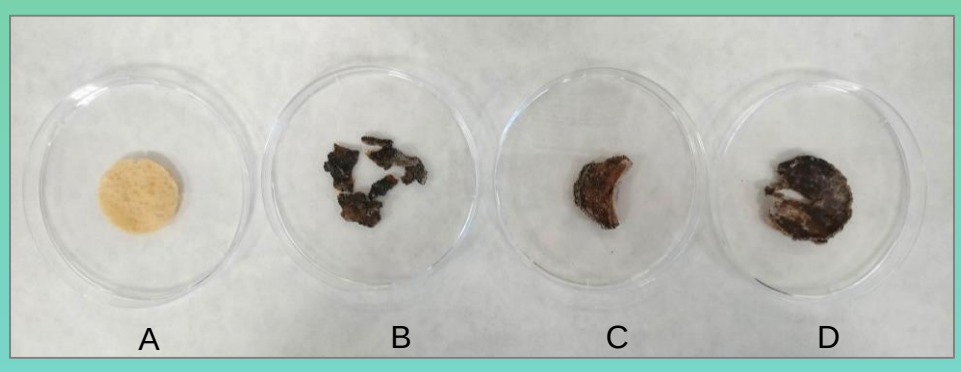
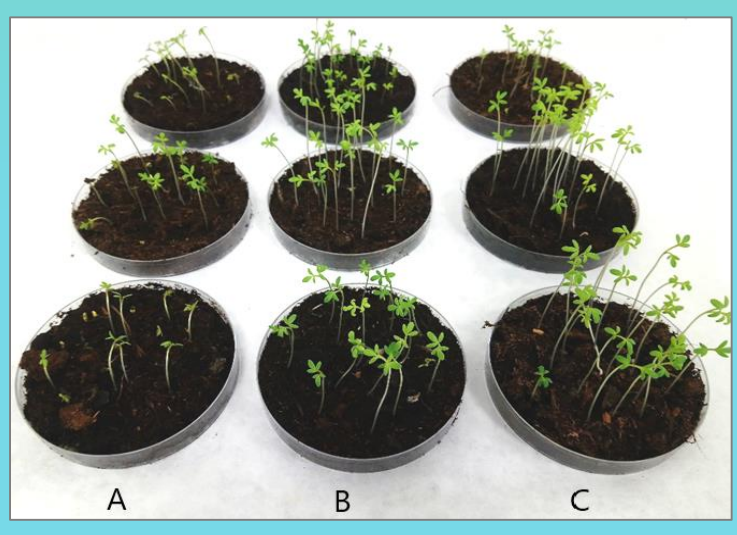
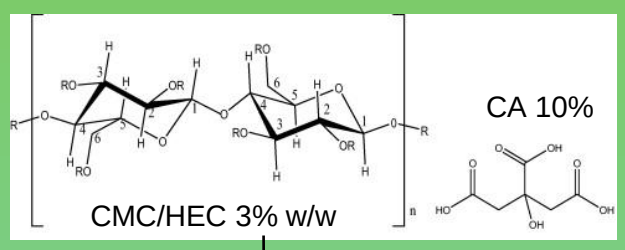


Fig. 3: Effect of hydrogel application on plant growth (*Lepidium sativum*):A) control soil without hydrogel, B) soil with 1% HPLA10, C) soil with 2% of HLPA10.

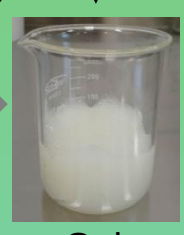


Experimental



Acid whey

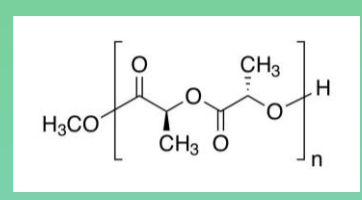
22 °C
4h



Gel

60 °C
24h

Xerogel



PLA (5-20 %)

HPLA0 - HPLA20

- Absorption capacity (Swelling ratio, SR)

$$SR\ (\%) = \frac{Ws - Wd}{Wd} \times 100$$

- Water retention capacity in soil (Water evaporation rate, WER)

$$WER\ (\%) = \frac{Mi - Mt}{50} \times 100$$

Biodegradability - Soil burial test (Weight loss, WL)

$$WL\ (\%) = \frac{Wi - Wf}{Wi} \times 100$$

- Gas chromatography

Effect of hydrogel application on soil quality and plant growth of *Raphanus sativus* and *Lepidium sativum*

Conclusions

- The novel hydrogel demonstrates considerable biodegradability (approx. 40 days) with a high water absorption capacity of 450-600%, which can improves water retention in soil by 30%.
- Introduction of PLA to the hydrogel extended time of biodegradation by 25 %.
- The tests performed on the vegetable species suggest that novel hydrogel has beneficial effect for their growth and may contribute to the increasing their survival rate during drought conditions.
- The results demonstrate the potential of use of acid whey in the development of a soil conditioners which can help to improve soil quality.
- The whey/polysaccharide/PLA – based hydrogel is promising alternative to commercial hydrogels based on synthetic polymers to enhance water and fertilizers use efficiencies in soil.

Acknowledgments

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