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BIOSTIMULANT AND PHYTODEFENSE APPLICATIONS OF POLYSACCHARIDE AND POLYPHENOL EXTRACTS FROM WASTE VEGETABLE BIOMASS

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SPOKE 8 - CIRCULAR ECONOMY IN AGRICULTURE THROUGH WASTE VALORIZATION AND RECYCLING
WP 8.1 – Producing New Products To Upgrade Waste Value
TASK 8.1.1 – Valorization of the waste by green chemistry to obtain high value molecules or new products

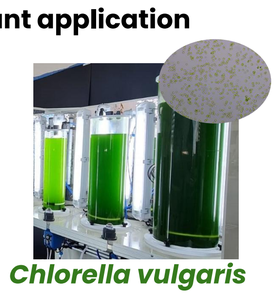
INTRODUCTION

The extraction of polysaccharides and polyphenols from waste vegetable biomass presents promising opportunities in agriculture, particularly in the development of new biostimulants and phytodefense agents. Polysaccharides extracted from microalgae can improve plant growth by boosting nutrient uptake and water retention, while also stimulating root development, leading to more resilient plants (Mutale Joan 2020; Puglisi 2020). Similarly, polyphenols, which are abundant in vegetable wastes, exhibit strong antioxidant properties that play a crucial role in plant defense mechanisms. For instance, polyphenols extracted from chestnut spiny burns (Esposito 2019), when applied to crops, can trigger the plants innate immune response, enhancing resistance to pathogens and environmental stressors such as drought and extreme temperatures. These natural extracts can reduce the need for synthetic inputs, minimize waste, and promote sustainability in agriculture.

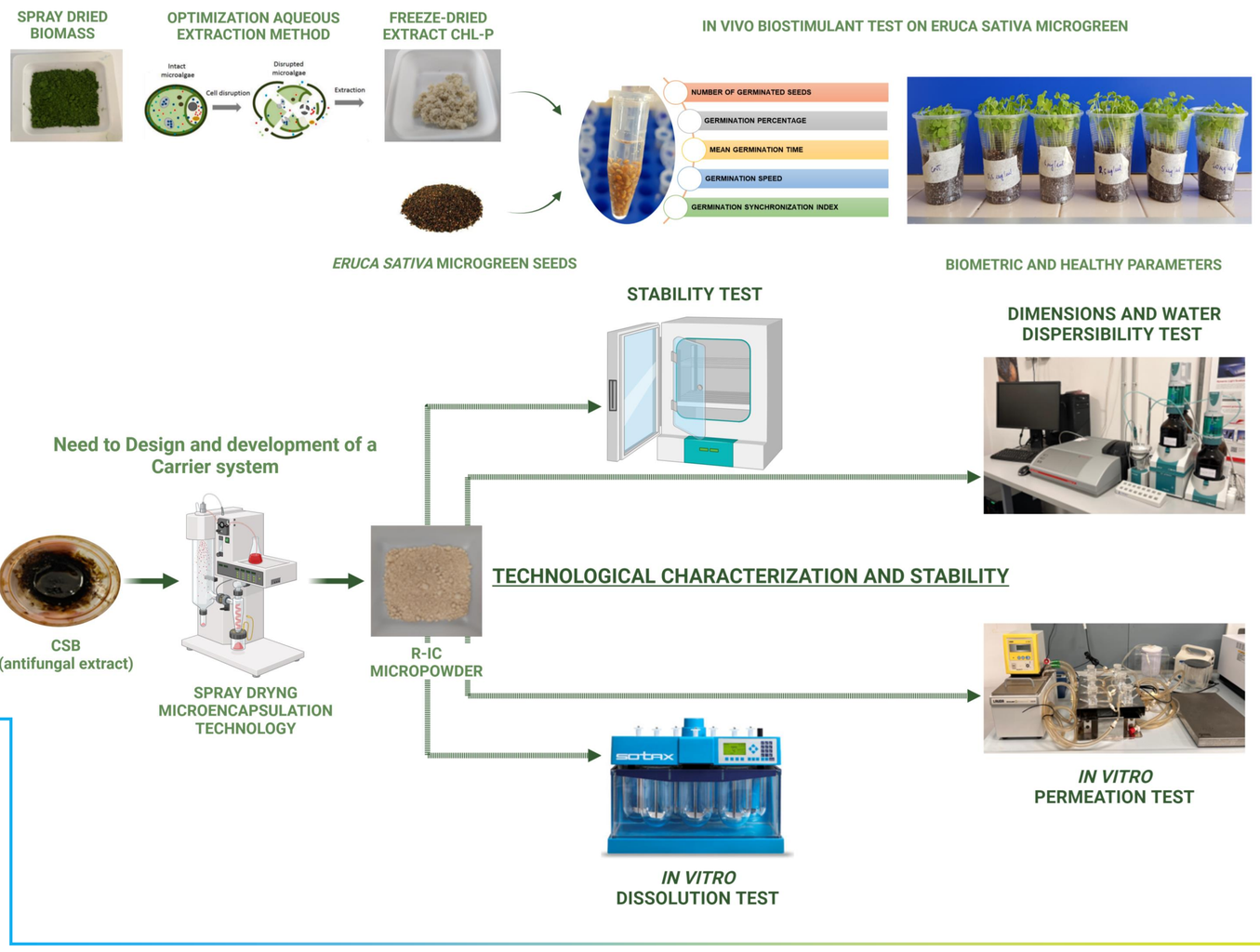
WORKFLOW

Product 1 – *Chlorella vulgaris* extract for biostimulant application

Optimizing the extraction method for the intracellular polysaccharide fraction (CHL-P) from *Chlorella vulgaris* residual dry biomass and evaluating its biostimulant effect through in vivo assays on *Eruca sativa* microgreen, as described by El-Naggar et al., 2020.



Chlorella vulgaris



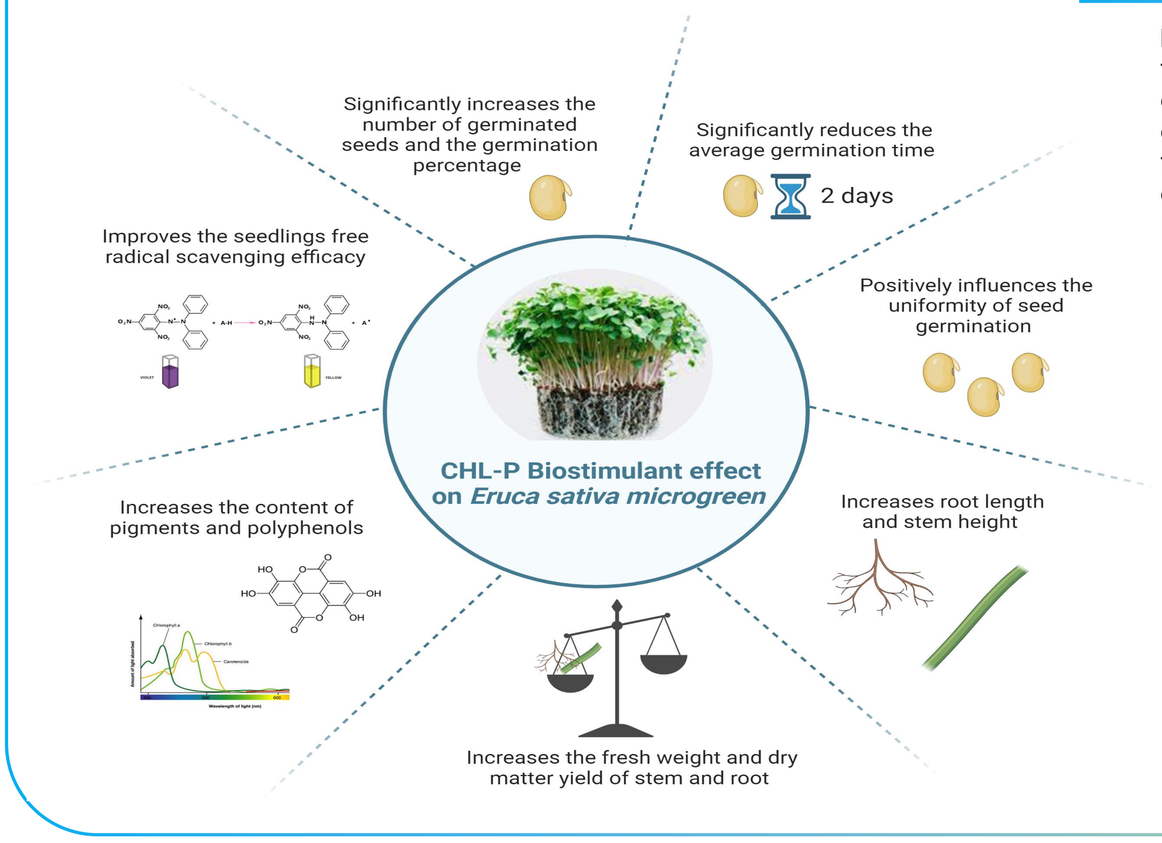
Product 2 – Chestnut spiny burs microparticulate powder for phytodenfense application

Spray-dried microparticulate formulation (R-IC) containing a polyphenol-rich extract from *Chestnut spiny burs* (CSB) was developed as a potential agricultural phyto-defense product.

Chestnut spiny burs

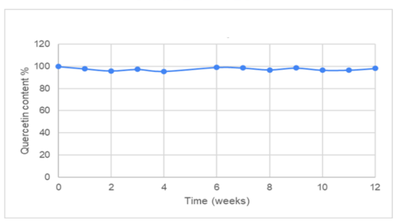
RESULTS

Product 1 -The CHL-P extract, derived with a high yield (>19%), demonstrated significant biostimulant effects on Eruca sativa microgreens, improving biometric parameters, chlorophyll, carotenoids and polyphenols content and antioxidant activity at concentrations of 0.5–1 mg/ml.

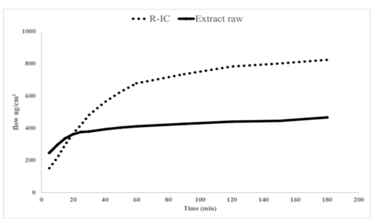


Product 2 - The microparticulate powder form is able to enhance stability with a retention of functional content (97%) over time under controlled storage conditions as well as to lead to an easy dispersibility in water with a colloidal suspension formation (d_{50} < 1 µm). The effectiveness of foliar-applied agrochemicals largely depends on cuticular permeation, which is influenced by the retention time and dissolution rate of active compounds. R-IC microparticles showed enhanced *in vitro* water dissolution (55% to 88%) and improved permeation which was two-fold higher than the raw extract.

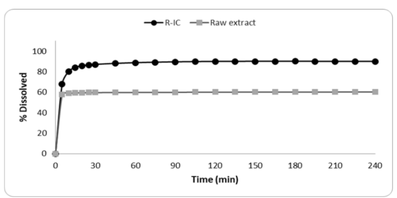
STABILITY TEST



PERMEATION TEST



DISSOLUTION TEST



DIMENSIONS AND WATER DISPERSIBILITY TEST

Time ($t_0 - t_4$ weeks under storage conditions)	D_{50} µm	Standard deviation	Poli Dispersity index %
T_0	0.4466	± 0.0011	2.7
T_1	0.4345	± 0.0097	4.6
T_2	0.4918	± 0.0820	3.5
T_3	0.5511	± 0.0870	2.8
T_4	0.5491	± 0.0885	2.6

FINAL REMARKS

By integrating our findings into agricultural practices, we align with circular economy principles, enhancing crop yield and resilience through innovative, eco-friendly approaches. Specifically, we will validate the effect of CHL-P (product 1) on other plant models to support its functionality as a novel biostimulant in agriculture. Additionally, we will strengthen the phytodefense activity of R-IC (product 2) through in vivo tests on *Lactuca sativa*.

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