Emulsifying Properties of White Chlorella Biomass and Its Fractions after Cell Disruption by High-Pressure Homogenization

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Microalgae have emerged as a promising source of nutritional, economical, and sustainable proteins. *Chlorella* stands out for its high content of proteins, vitamins, and minerals [1]. White chlorophyll-deficient allow wider use in food applications [2]. Microalgal biomass has mostly been incorporated into pre-stabilized emulsions to assess its influence on the overall system [3]. Studies on emulsifying capacity mainly focused on isolated proteins, whose extraction compromises native functionality [4]. However, the functional valorization of the whole biomass as an emulsifying ingredient, and the understanding of soluble and insoluble fraction in emulsion stability, remain limited.

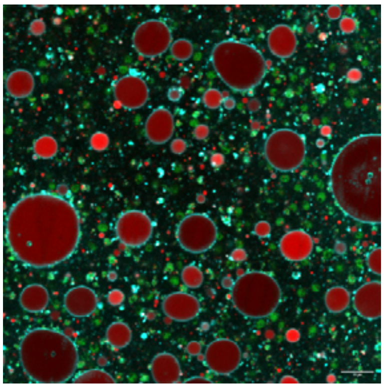
This study investigated the emulsifying potential of white *Chlorella* biomass suspension, after High-pressure homogenization (HPH) disruption. Fractions (total, soluble and insoluble) were characterized for composition and particle size. Oil-in-water emulsions were formulated using either the whole total biomass (TB), the soluble (S) or the insoluble (I) fractions, to evaluate their individual stabilizing properties. A control emulsion was also formulated with hydrated and homogenized intact cells. Emulsion stability was monitored over 10 days and microstructure analysed by Confocal Laser Scanning Microscopy. Results were compared with a intact cells control emulsion.

Intact-cell suspensions formed emulsions, likely due to soluble compounds and cell overloading but showed rapid creaming, coalescence, and sedimentation. TB emulsions remained the most homogeneous system showing minimal destabilization (creaming or coalescence) and no visual sedimentation by day 10. TB and S emulsions initially exhibited similar droplet sizes (1–20 µm). S emulsion underwent rapid creaming and progressive coalescence from day 0 to 10. I emulsion displayed larger initial droplets (10–100 µm), similar to control, yet greater resistance to destabilization, suggesting steric and structural stabilization by cell debris. Microscopy revealed phospholipids adsorption at the oil–water interface and a loose network of particulate fragments around droplets, limiting aggregation.

Overall, disrupted biomass emulsions showed higher stability than those with intact cells, highlighting complementary roles of amphiphilic compounds and particles. The soluble fraction provides fast adsorption but weak strength, while the insoluble fraction offers steric stability without full coverage. Their combination yields the most stable emulsions. Future work will explore how HPH parameters influence disruption and macromolecule release to optimize emulsifying properties for sustainable food applications.

Keywords:

microalgae, biomass valorization, oil-in-water emulsion, cell disruption, high-pressure homogenization, microstructure



Confocal microscopy image of an emulsion formulated with the disrupted total biomass of white Chlorella, stained with specific markers (objective ×100; scale bar = 10 µm). Phospholipids are shown in blue, neutral lipids in red, and proteins in green.

References:

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