

Supplementary data

Article

Potential of Coccolithophore Microalgae as Fillers in Starch-Based Films for Active and Sustainable Food Packaging

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Supplementary Table S1. Elemental analysis and protein estimation from freeze-dried biomass of *E. huxleyi* (EHUX) and *C. pseudoroscoffensis* (CP) microalgae.

Samples	%C	%H	%N	%S	%CHNS	Protein (N × 4.78) ^c
<i>E. huxleyi</i> (EHUX)	27.3 ± 0.5	3.7 ± 0.1	3.4 ± 0.0	<i>t</i>	34.4 ± 0.6	16.1 ± 0.1
EHUX (other batch) ^a	20.3 ± 0.2	4.3 ± 0.1	3.2 ± 0.0	1.3 ± 0.3	29.0 ± 0.6	15.3 ± 0.1
<i>C. pseudoroscoffensis</i> (CP)	21.3 ± 0.2	2.9 ± 0.1	2.3 ± 0.1	<i>t</i>	26.5 ± 0.2	11.2 ± 0.3
CP (other batch) ^b	22.6 ± 0.3	3.4 ± 0.2	2.4 ± 0.1	<i>t</i>	28.5 ± 0.6	11.6 ± 0.4

t, traces (<0.5%); ^aData from other batch of *E. huxleyi* biomass produced under the same culture conditions [1]; ^bData from other batch of *C. pseudoroscoffensis* biomass produced under the same culture conditions [2]; ^cNitrogen-to-protein conversion (4.78) proposed for microalgae [3].

Supplementary Table S2. TGA values at the second stage of thermal decomposition of starch films (control) and starch-based films containing 20% of commercial CaCO₃, *E. huxleyi* (EHUX) or *C. pseudoroscoffensis* (CP)

Samples	T _{max} (°C)	Remaining ash (%)
Starch (control)	295.8	8.0
Starch+CaCO ₃ 20%	302.7	19.7
Starch+EHUX 20%	251.4	18.6
Starch+CP 20%	278.8	12.5

Starch



Starch + CaCO₃ 2.5%



Starch + CaCO₃ 5%



Starch + CaCO₃ 10%



Starch + EHUX 2.5%



Starch + EHUX 5%



Starch + EHUX 10%



Starch + CP 2.5%



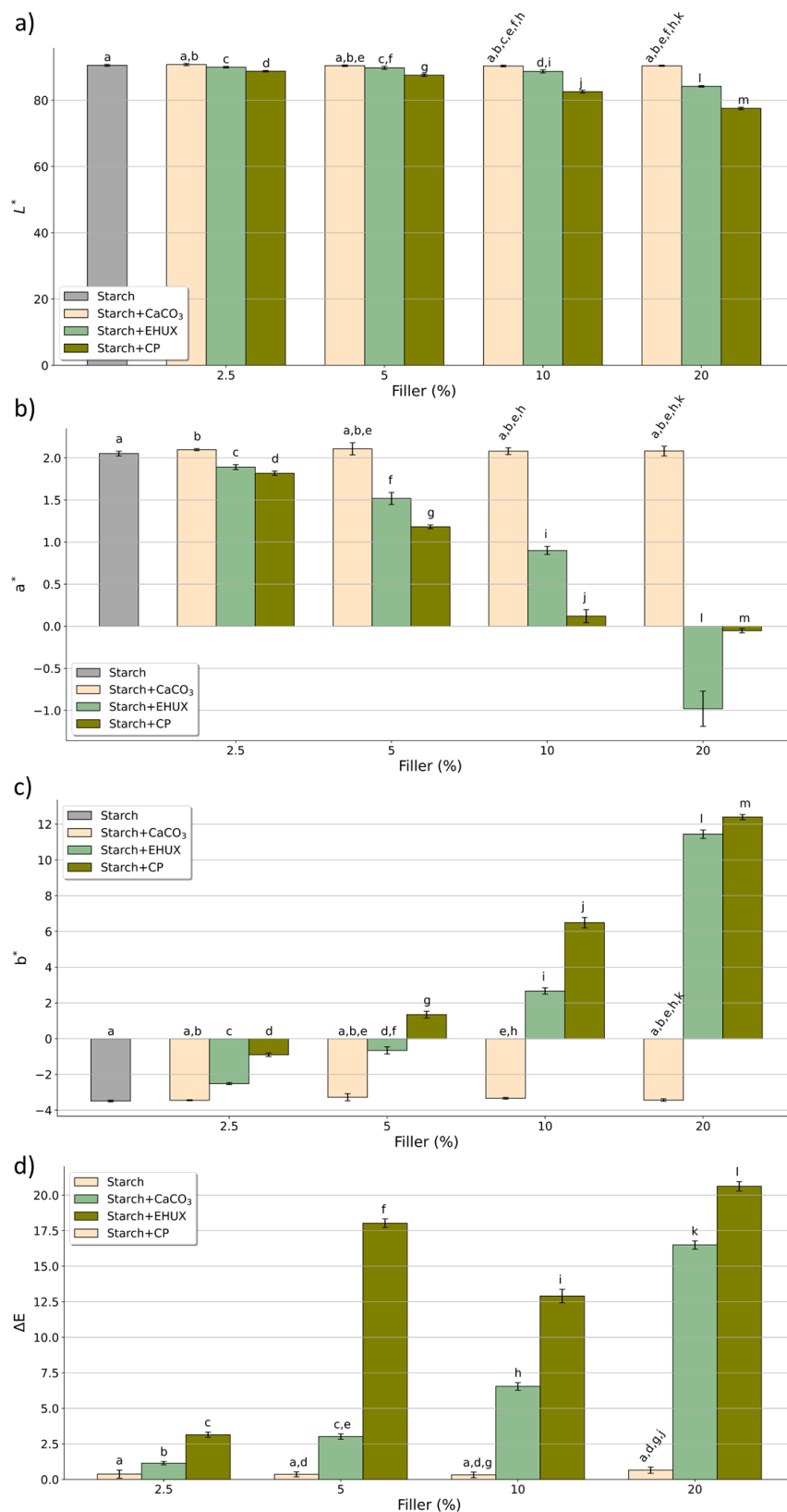
Starch + CP 5%



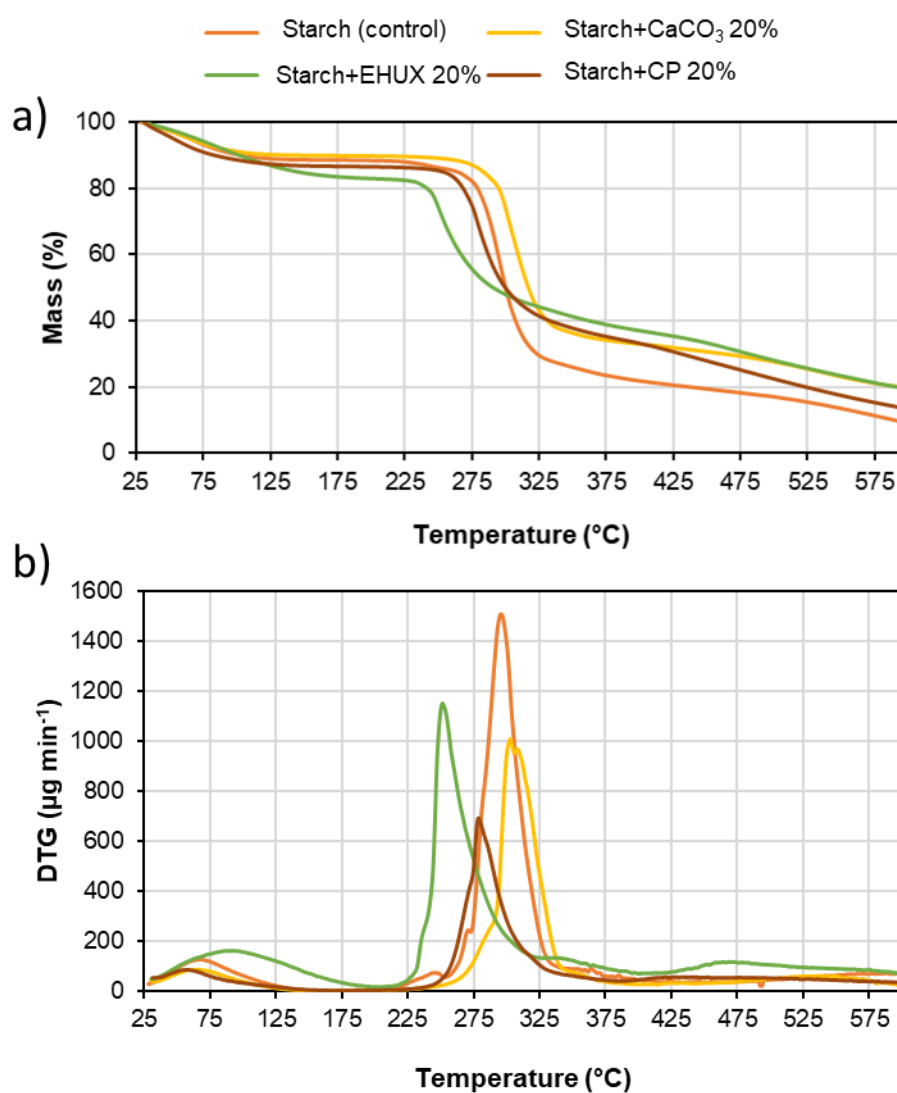
Starch + CP 10%



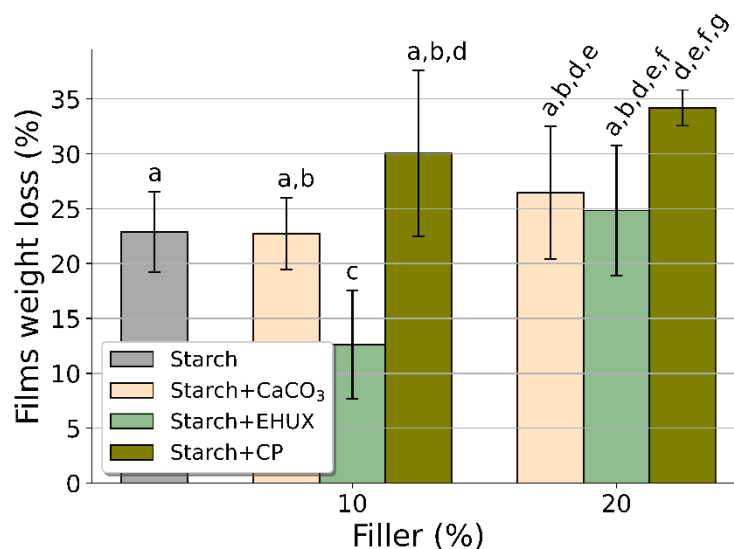
Supplementary Figure S1. Real images of starch-based films without and with 2.5, 5, and 10% (w/w of dry starch weight) of commercial CaCO₃, *E. huxleyi* (EHUX) and *C. pseudoroscoffensis* (CP) biomass.



Supplementary Figure S2. Values (mean \pm standard deviation) for lightness (L^*), red-green (a^*), yellow-blue (b^*), and total colour variation (ΔE) of pristine starch films (control) and starch-based films containing commercial CaCO₃, *E. huxleyi* (EHUX) or *C. pseudoroscoffensis* (CP) at different percentages (2.5, 5, 10 and 20% w/w). Different letters between each condition indicate significant differences (Student's t-test; $p < 0.05$).



Supplementary Figure S3. a) TGA curves and b) first derivatives of starch films (control) and starch-based films containing 20% of commercial CaCO₃, *E. huxleyi* (EHUX) or *C. pseudoroscoffensis* (CP).



Supplementary Figure S4. Weight loss percentage observed after immersion in water for 8 days of pristine starch films (control) and starch-based films containing commercial CaCO₃, *E. huxleyi* (EHUX) or *C. pseudoroscoffensis* (CP) at different percentages (10 and 20% w/w). Different letters between each condition indicate significant differences (Student's t-test; $p < 0.05$).

References:

- [1] S.S. Aveiro, T. Melo, A. Figueiredo, P. Domingues, H. Pereira, I.B. Maia, J. Silva, M.R. Domingues, C. Nunes, A.S.P. Moreira, The polar lipidome of cultured *Emiliania huxleyi*: A source of bioactive lipids with relevance for biotechnological applications, *Biomolecules* 10 (2020) 1434.
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- [3] S.O. Lourenço, E. Barbarino, P.L. Lavín, U.M. Lanfer Marquez, E. Aidar, Distribution of intracellular nitrogen in marine microalgae: Calculation of new nitrogen-to-protein conversion factors, *Eur. J. Phycol.* 39 (2004) 17-32.