SUPPLEMENTARY FILE

Hydrochar from *Sargassum muticum*: A Sustainable Approach for High-Capacity Removal of Rhodamine B Dye

D. Spagnuolo[a], D. Iannazzo[b], T. Len [c], A. M. Balu Balu [c], M. Morabito[a], G. Genovese [a], C. Espro[b] and V. Bressi[b,c]*

[a]*Department of Chemical, Biological, Pharmaceutical and Environmental Sciences, University of Messina, Viale F. Stagno d'Alcontres 31, 98166 Messina, (Italy)*

[b] *Department of Engineering, University of Messina, Contrada di Dio–Vill. S. Agata, I-98166 Messina, (Italy)*

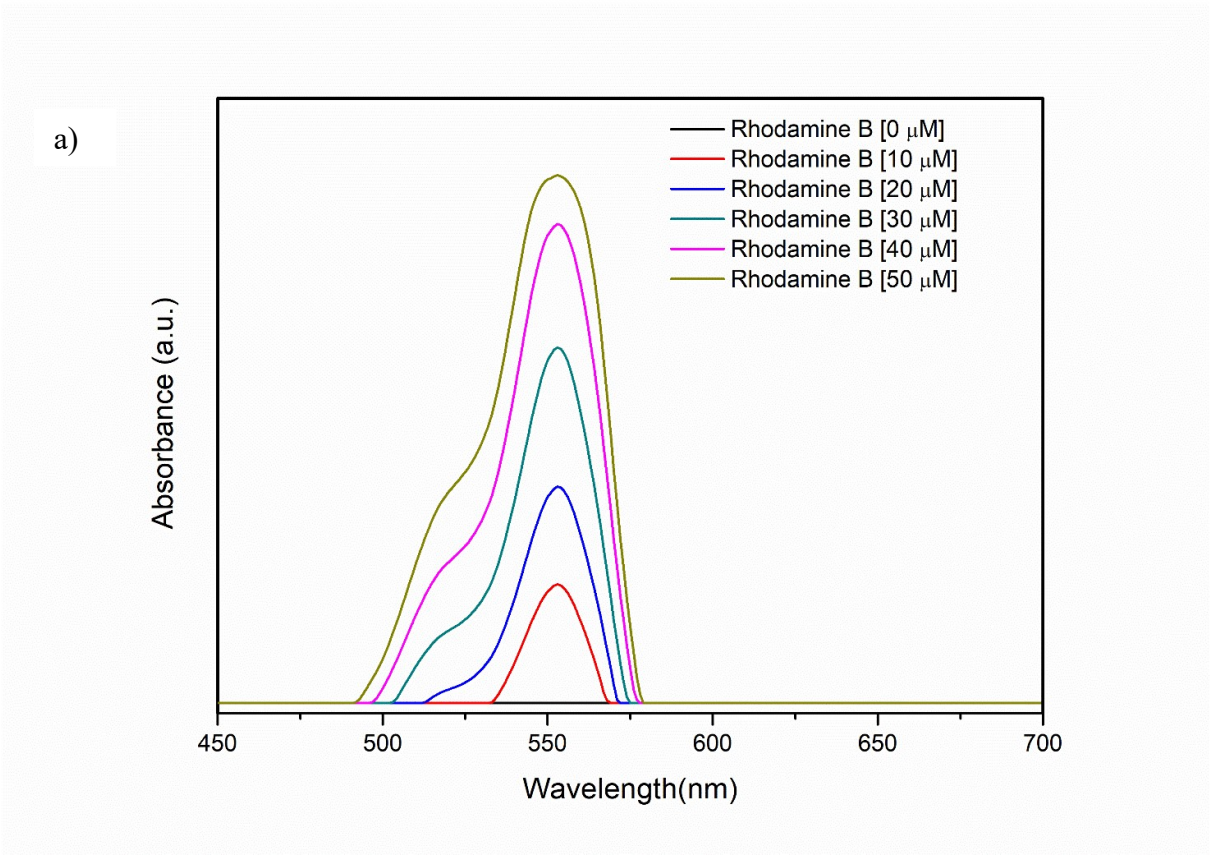
[c]*Department of Organic Chemistry, University of Córdoba, Campus de Rabanales, Marie Curie (C-3), Ctra Nnal IV-A, Km 396, Cordoba, (Spain)*

*Corresponding Author; E-mail Address: viviana.bressi@unime.it

Figure **S1**. Underwater belt of *Sargassum muticum* (*Phaeophyceae, Ochrophyta*) on a quay in Venice Lagoon (Italy).

Parameters	*Sargassum muticum*	Ref.
C (% dry weight)	30.1; 31.4	(Milledge and Harvey 2016); (Robledo et al. 2021)
H (% dry weight)	4.2	(Milledge and Harvey 2016)
O (% dry weight)	28.1	(Milledge and Harvey 2016)
N (% dry weight)	3.6; 1.4	(Milledge and Harvey 2016); (Robledo et al. 2021)
S (% dry weight)	0.8	(Milledge and Harvey 2016)
Moisture (%)	87.91; 85.6	(Fouda et al. 2019); (Torres et al. 2021)
Dry matter (%)	12.09	(Fouda et al. 2019)
Ash (%)	20.68; 33.3; 17.2; 24	(Fouda et al. 2019); (Milledge and Harvey 2016); (Torres et al. 2021); (Robledo et al. 2021)
Carbohydrates (%)	24.79; 24	(Fouda et al. 2019); (Robledo et al. 2021)
Proteins (%)	5.31; 8.5; 10.4	(Fouda et al. 2019); (Torres et al. 2021); (Robledo et al. 2021)
Ammonia (mg/g dry weight)	3.13	(Fouda et al. 2019)
Fats (%)	0.12	(Fouda et al. 2019)
Kaempherol (ppm)	126.3	(Fouda et al. 2019)
Phenanthrene (ppm)	0.045	(Fouda et al. 2019)
Aluminum (mg/g dry weight)	0.366	(Fouda et al. 2019)
Boron (mg/g dry weight)	0.013	(Fouda et al. 2019)
Cadmium (mg/g dry weight)	< 0.001	(Fouda et al. 2019)
Calcium (mg/g dry weight); (g/kg)	15.256; 18.8	(Fouda et al. 2019); (Torres et al. 2021)
Chromium (mg/g dry weight)	0.005	(Fouda et al. 2019)
Cobalt (mg/g dry weight)	< 0.001	(Fouda et al. 2019)
Copper (mg/g dry weight)	0.003	(Fouda et al. 2019)
Iron (mg/g dry weight)	0.537	(Fouda et al. 2019)
Lead (mg/g dry weight)	0.001	(Fouda et al. 2019)
Magnesium (mg/g dry weight); (g/kg)	6.777; 7.5	(Fouda et al. 2019); (Torres et al. 2021)
Manganese (mg/g dry weight)	0.025	(Fouda et al. 2019)
Molybdenum (mg/g dry weight)	< 0.001	(Fouda et al. 2019)
Nickel (mg/g dry weight)	0.003	(Fouda et al. 2019)
Phosphor (mg/g dry weight)	0.4528	(Fouda et al. 2019)
Potassium (mg/g dry weight); (g/kg)	13; 23.3	(Fouda et al. 2019); (Torres et al. 2021)
Sodium (g/kg)	7.3	(Torres et al. 2021)
Vanadium (mg/g dry weight)	< 0.005	(Fouda et al. 2019)
Zinc (mg/g dry weight)	0.128	(Fouda et al. 2019)

Table **S1**. Chemical composition of *Sargassum muticum.*



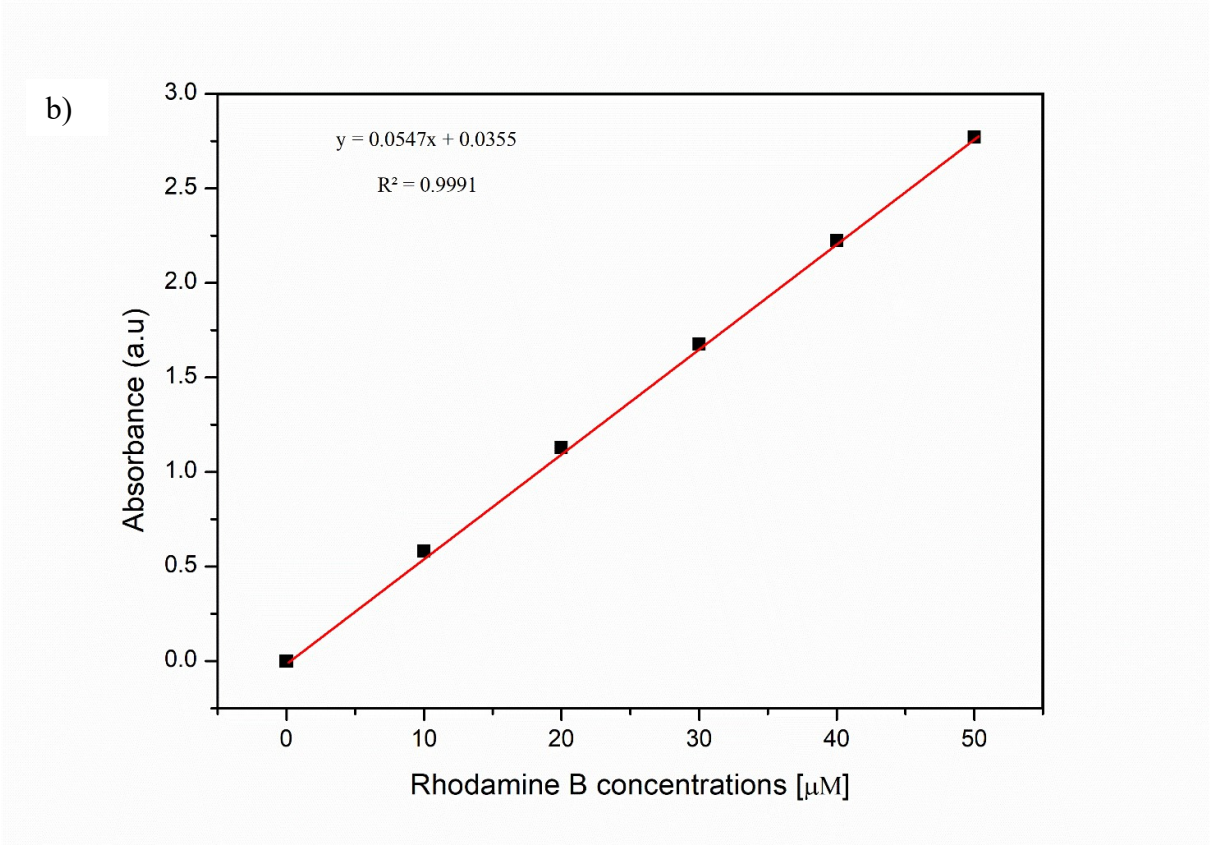


Figure **S2**. a) UV-Vis spectra of Rhodamine B solutions at different concentrations and b) calibration curve based on Beer's-Lambert law, sd ≤ 1.

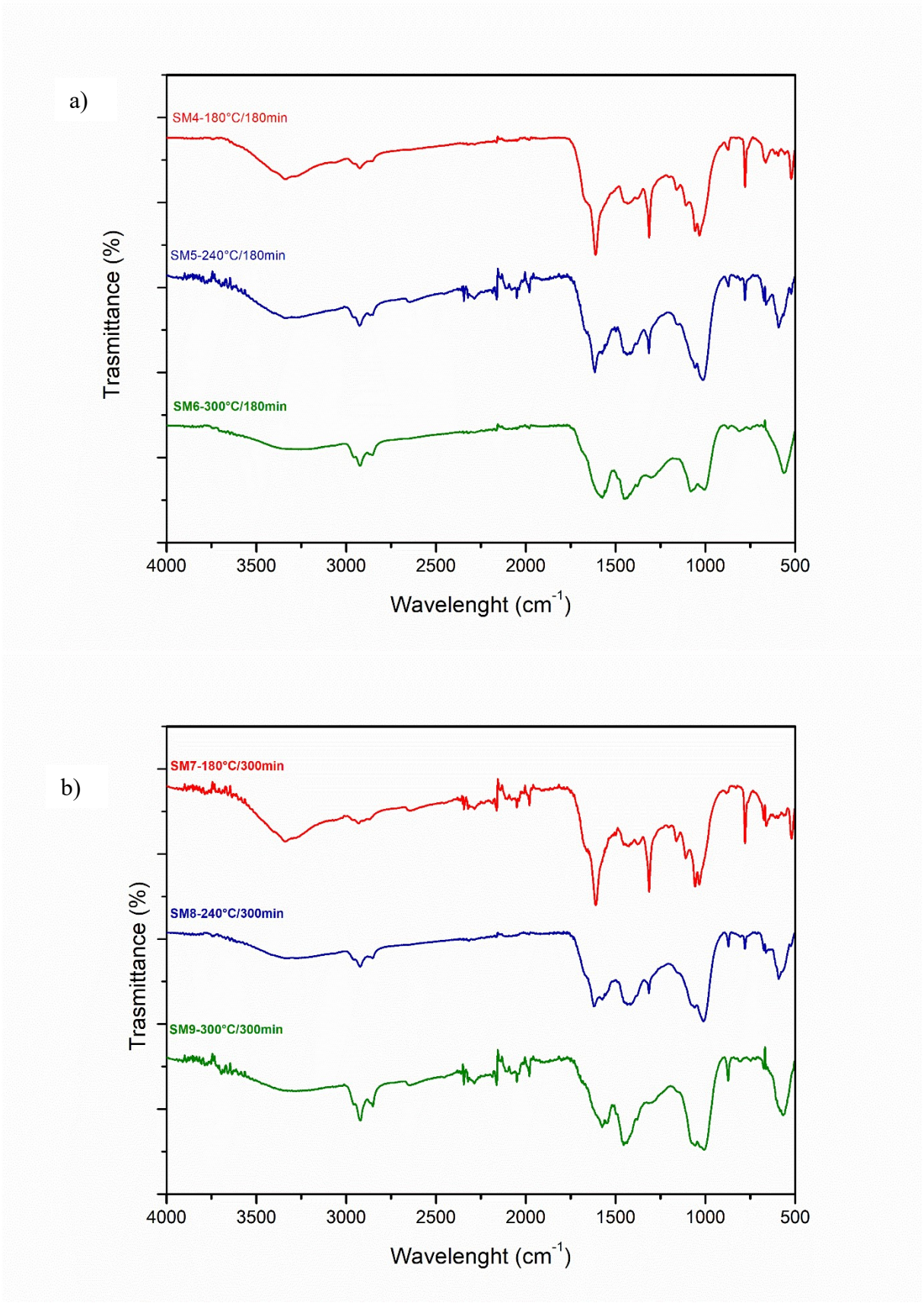


Figure **S3.** FT-IR spectra of Hydrochar obtained from the hydrothermal process of algae at three different reaction temperatures (180 ° C, 240 ° C, 300 ° C) and reaction times: a) 180 min, and b) 300 min.

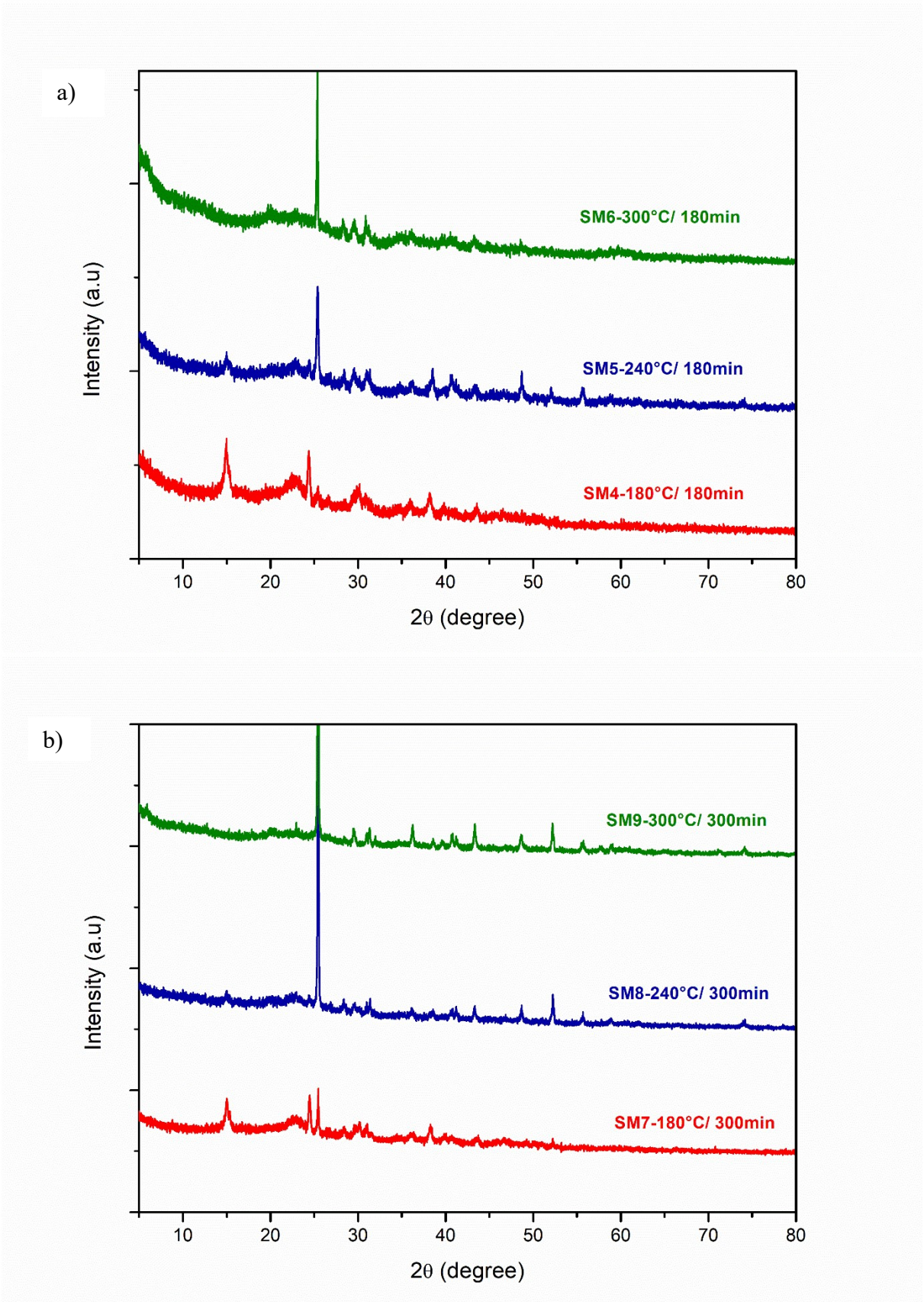


Figure **S4.** XRD spectra of Hydrochar obtained from the hydrothermal process of algae at three different reaction temperatures (180 °C, 240 °C, 300 °C) and reaction times: a) 180 min, and b) 300 min.

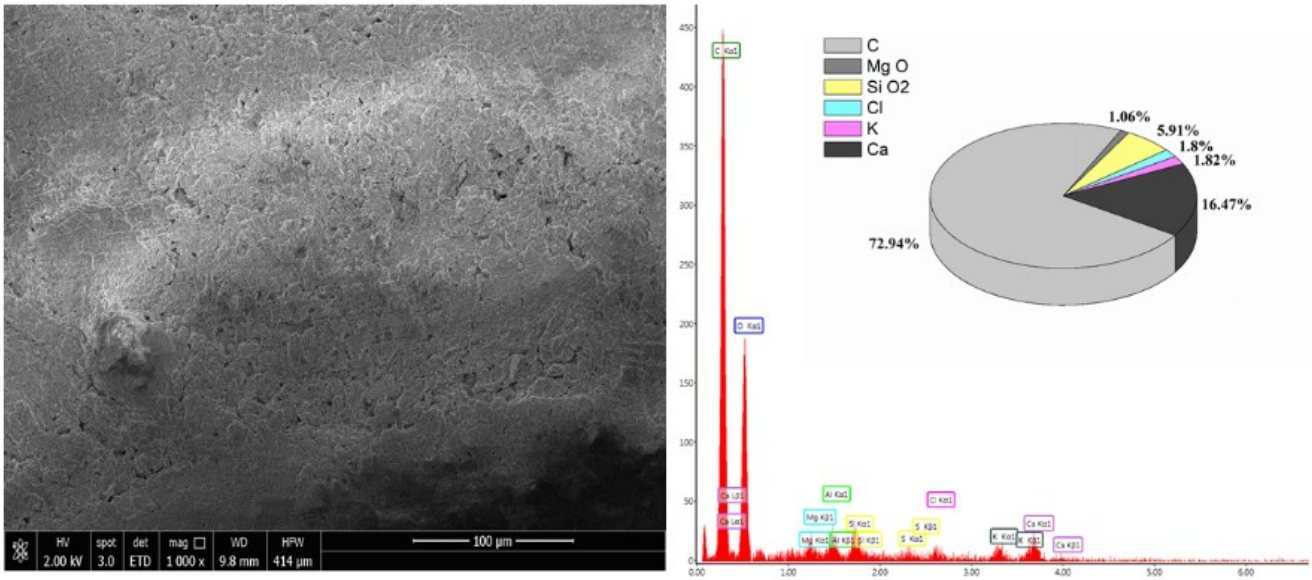


Figure **S5.** SEM image of sample SM1-$HC_{180–60}$ and relative EDX spectrum.

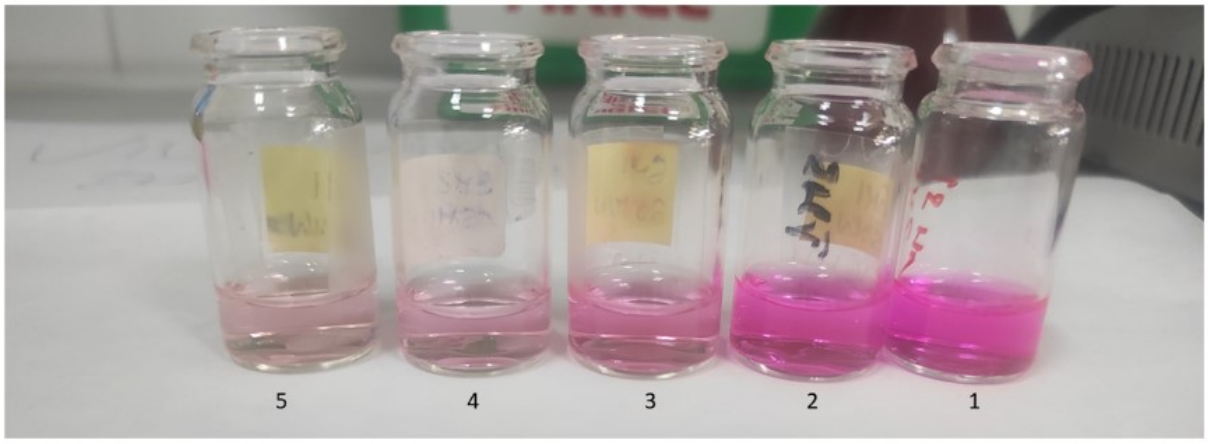


Figure **S6.** Impact of contact time by hydrochar SM2 in Rhodamine B solution evaluated 1) immediately, 2) after 5 min, 3) after 15 min, 4) after 30 min, and 5) after 60 min.

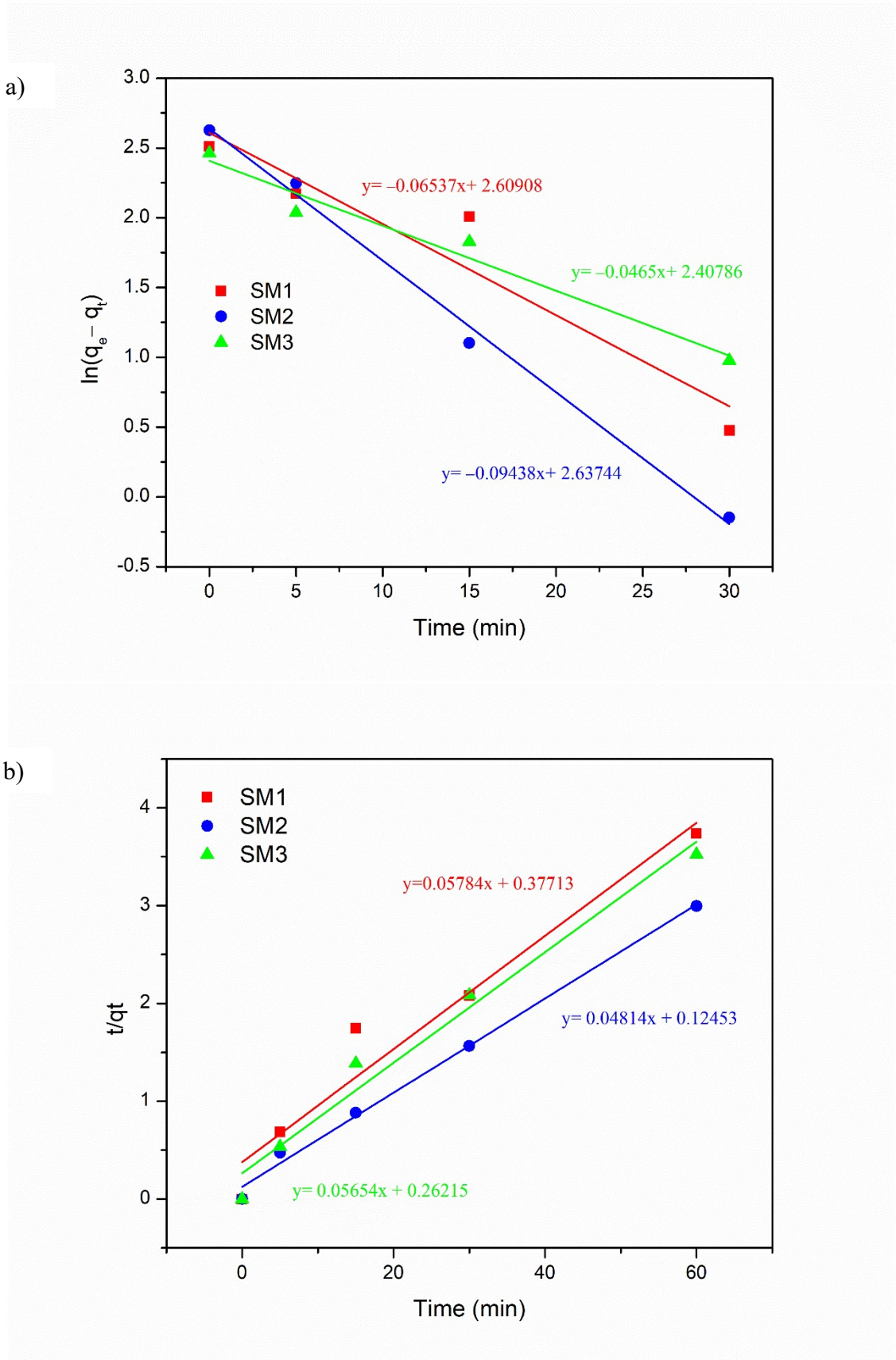


Figure **S7.** Kinetic of Rhodamine B adsorption by SM1, SM2, and SM3, fitted by a) pseudo-first order model and b) pseudo-second order model.

Fouda, W.A., Ibrahim, W.M., Ellamie, A.M. & Ramadan, G. 2019. Biochemical and mineral compositions of six brown seaweeds collected from Red Sea at Hurghada Coast. *INDIAN J. MAR. SCI.* 48:8.

Milledge, J.J. & Harvey, P.J. 2016. Ensilage and anaerobic digestion of Sargassum muticum. *J Appl Phycol*. 28:3021–30.

Robledo, D., Vázquez-Delfín, E., Freile-Pelegrín, Y., Vásquez-Elizondo, R.M., Qui-Minet, Z.N. & Salazar-Garibay, A. 2021. Challenges and Opportunities in Relation to Sargassum Events Along the Caribbean Sea. *Front. Mar. Sci.* 8:699664.

Torres, M.D., Flórez-Fernández, N. & Domínguez, H. 2021. Monitoring of the ultrasound assisted depolymerisation kinetics of fucoidans from Sargassum muticum depending on the rheology of the corresponding gels. *Journal of Food Engineering*. 294:110404.