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In-depth study of bio-oil and biochar production from macroalgae *Sargassum* sp. *via* slow pyrolysis†

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Sargassum is undoubtedly one of the most predominant brown macroalgae, posing a significant disposal problem for coastal areas worldwide. The effective valorization of *Sargassum* sp. would be beneficial not only for environmental mitigation but also for producing high-value chemicals. However, the valorization of *Sargassum* sp. for bio-oil and biochar production *via* slow pyrolysis has not been well studied yet. Hence, this study aimed to conduct a comprehensive investigation into bio-oil and biochar production from *Sargassum* sp. *via* slow pyrolysis to provide valuable data for further valorization. A batch reactor was employed, and the pyrolysis of *Sargassum* sp. was conducted in a temperature range of 400–600 °C and with retention times of 10–50 min. The results showed significant compounds could be identified in bio-oil from *Sargassum* sp., including carboxylic acids, furan derivatives, aliphatic hydrocarbons, and *N*-aromatic compounds. Based on the ultimate analysis, the H/C and O/C atomic ratios of biochar were lower than the feedstock, reflecting the occurrence of dehydration and decarboxylation reactions throughout the pyrolysis. Biochar exhibited calorific values in the range of 23.12–25.89 MJ kg^{-1}, indicating it has more potential to be used as a solid fuel than low-ranked coals. Surface morphological analysis was performed by scanning electron microscopy (SEM) and showed a larger surface area in biochar than in the algal feedstock. Furthermore, a reaction model was deduced, and it was confirmed that the pyrolysis reaction obeyed the Arrhenius behaviour. Overall, the slow pyrolysis of *Sargassum* sp. provides an opportunity to obtain value-added chemicals and biochars, which could be further utilized for other applications.

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