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Air Impingement Drying of Macroalgae *Sargassum muticum*: effects of the Temperature and the Air-Drying Velocity on the Drying Kinetics

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1. Introduction

The brown alga *Sargassum*, which is an invasive species, causes public health troubles because of their massive groundings on beaches. About 10 000 wet tonnes of seaweeds have been grounded on beaches of Caribbean islands daily¹. One of the main issues to overcome the recovery of this raw material is the seasonal nature of groundings. In this context, the goal of this work is to add value to this alga biomass through the development of a biorefinery to use the resource for longer periods. Owing to their high moisture content, this raw material should be stabilized before being used as biorefinery input. The drying aims to obtain a stabilized product available the entire year. Thermal drying is a complex process and energy intensive. Therefore, modern drying technology focuses on energy saving and on the quality of the product. Air impingement technology aims to enhance the hot air-drying process. Thanks to this technology, the air impingement dryer permits to decrease the drying time and the temperature levels².

2. Methods

A prototype of air impingement dryer designed by CIMS company (Sablé-sur-Sarthe, France) was used. The alga *Sargassum muticum* was dried in different conditions. The experiments (quadruplicate) were carried out at four moderate temperatures (40, 50, 60 and 70 °C) at 35 m s⁻¹ and at the constant temperature of 40 °C at five air-drying velocities (7, 14, 21, 28 and 35 m s⁻¹).

3. Results and discussion

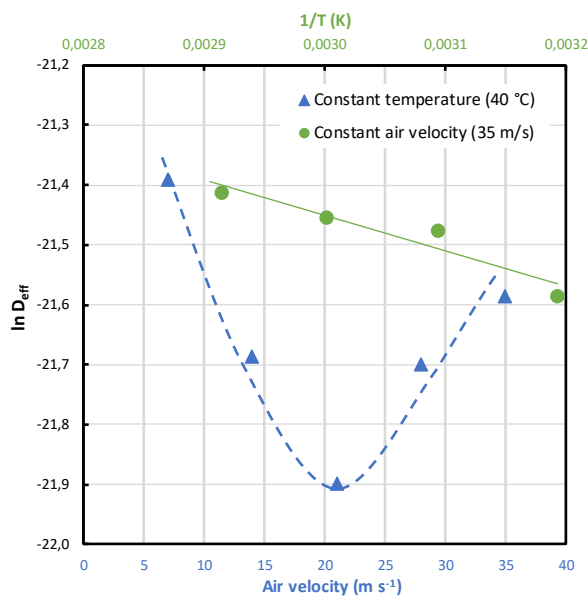


Fig. 1. $\ln D_{\text{eff}}$ vs air velocity at 40 °C and temperature at 35 m s⁻¹ (marks: data; solid line: Arrhenius model for temperature; dotted line: eyes guideline for air velocity)

4. Conclusion

This study shows that the apparent moisture diffusivity decreases with the drying temperature and depends on the air velocity (Fig. 1). The lower value of D_{eff} is found at 21 m s⁻¹, which may be attributed to a crusting phenomenon at high air velocity. This hypothesis is under investigation through rehydration kinetics of the dried algae.

References

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- [2] V. Boy, W. Ben Khalifa, L. Drévillon, Y. Lemée, T. Lendormi, J.-L. Lanoisellé, Air impingement and intermittent drying: application to apple and to mango, *Canadian Journal of Chemical Engineering* 99 (1), 120-134, 2021.

To reach a moisture content of 10 % (wet basis), the drying time, which decreases with the temperature, varied between 25 and 130 min.

The Fick's diffusional model was fitted to the drying kinetics and the model was applied to determine the apparent moisture diffusivity, D_{eff} . For all the conditions, D_{eff} varies between $3.09 \cdot 10^{-10}$ and $5.14 \cdot 10^{-10}$ m s⁻¹. Ten semi-empirical models were applied on the experimental data. The quality of the models was evaluated by four statistical parameters: the adjusted coefficient of determination (R^2), the residual sum of squares (RSS), the chi square (χ^2) and the root-mean-square-error (RMSE). At 40 °C and 35 m s⁻¹, the Henderson Pabis modified model best fits the experimental data ($R^2 > 0.99$; $\chi^2 = 5.32 \cdot 10^{-4}$; $\text{RSS} = 6.36 \cdot 10^{-3}$; $\text{RMSE} = 1.71 \cdot 10^{-2}$).