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Electron Microscopy Characterization of Sargassum Spp. from the Mexican Caribbean for Application as a Bioconstruction Material

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Introduction

In recent years, the influx of *Sargassum* spp. on the coasts of the Mexican Caribbean has increased considerably [1–3], generating effects on the marine ecosystem and the tourism sector. Recently, various applications of these algae have been explored, for example energy production, biofertilizers and as a bio-construction material [1,4]. The thermal conductivity of *Sargassum* spp. is low, so it can be used as a bio-construction material for conventional houses, and increase energy efficiency in these constructions [4,5]. The characterization of *Sargassum* spp. by means of scanning electron microscopy is shown below, to show the identification of some compounds that justify their use as bio-construction material for houses.

Materials and methods

Sargassum spp. was collected from the coasts of Cancun, Mexico, washed with distilled water and dried until 88.5% was removed, which corresponds to the moisture level of materials such as sand and marine microorganisms. Characterization was performed using a Model Jeol JSM 7600F Scanning Electron Microscope (SEM) equipped with field emission. Semi-quantitative chemical analysis could be performed using Energy Dispersive X-Ray Spectroscopy (EDS). To demonstrate the use of *Sargassum* spp. as a bioconstruction material, the thermal behavior inside two houses of 5 mx 4 m and a height of 2.50 m was simulated using Solidworks ® and Energy 2D ® software: (a) one using a mixture of cement-*Sargassum* spp. (95-5%) with a thermal conductivity of 0.51 W/mK [4,5] and (b) another with concrete brick for conventional homes (100%), with a thermal conductivity of 0.78 W/mK [4,5].

Results and Discussion

Figure 1 shows the characterization by scanning electron microscopy of *Sargassum*spp, the morphology of the vesicles, stems and leaves is observed. As a result of the chemical analysis, different concentrations are identified, mainly of C, O, Ca, S and K. The large amount of C, Ca and O is associated with the presence of calcite that we have reported in previous investigations and that has been corroborated in scientific literature [1,6]. This compound can be visualized in the structures shown in Figure 1 (c). Calcite is one of the materials used in the manufacture of portland cement [7], and it can be used in mixtures with other construction materials. In addition, due to its high organic content, *Sargassum* spp. has low thermal conductivity, and can be used as a thermal insulation material in homes or for energy storage systems in buildings.

The simulation results show that a house with cement bricks and *Sargassum* spp. will maintain greater thermal insulation than one with conventional bricks (Figure 2). The simulation on Energy 2D shows that at a constant irradiance of 1000 w/m^2, 5% of *Sargassum* spp. reduces the surface temperature increase in the building blocks by more than two degrees and consequently reduces the transfer and thermal accumulation. inside the house (27 ° C for homes with *Sargassum* spp. and 30 ° C for conventional homes). In places like Cancun, Mexico, where high temperatures are registered, this material represents an interesting alternative. *Sargassum* spp. can be used as a bio-construction material, and its thermal properties provide stability for thermal comfort in homes; It is also a material with no added value and represents a waste that must be removed and used on the shores of the Mexican Caribbean.

Conclusions

Characterization by scanning electron microscopy shows the presence of some elements associated with calcite-type compounds, which are used in many cases for the manufacture of Portland cement; Furthermore, the high content of fibrous organic matter provides it with thermal properties, therefore it can be used as a bioconstruction material, generating added value and establishing a new application for these marine flakes that are abundant every year in the Mexican Caribbean.

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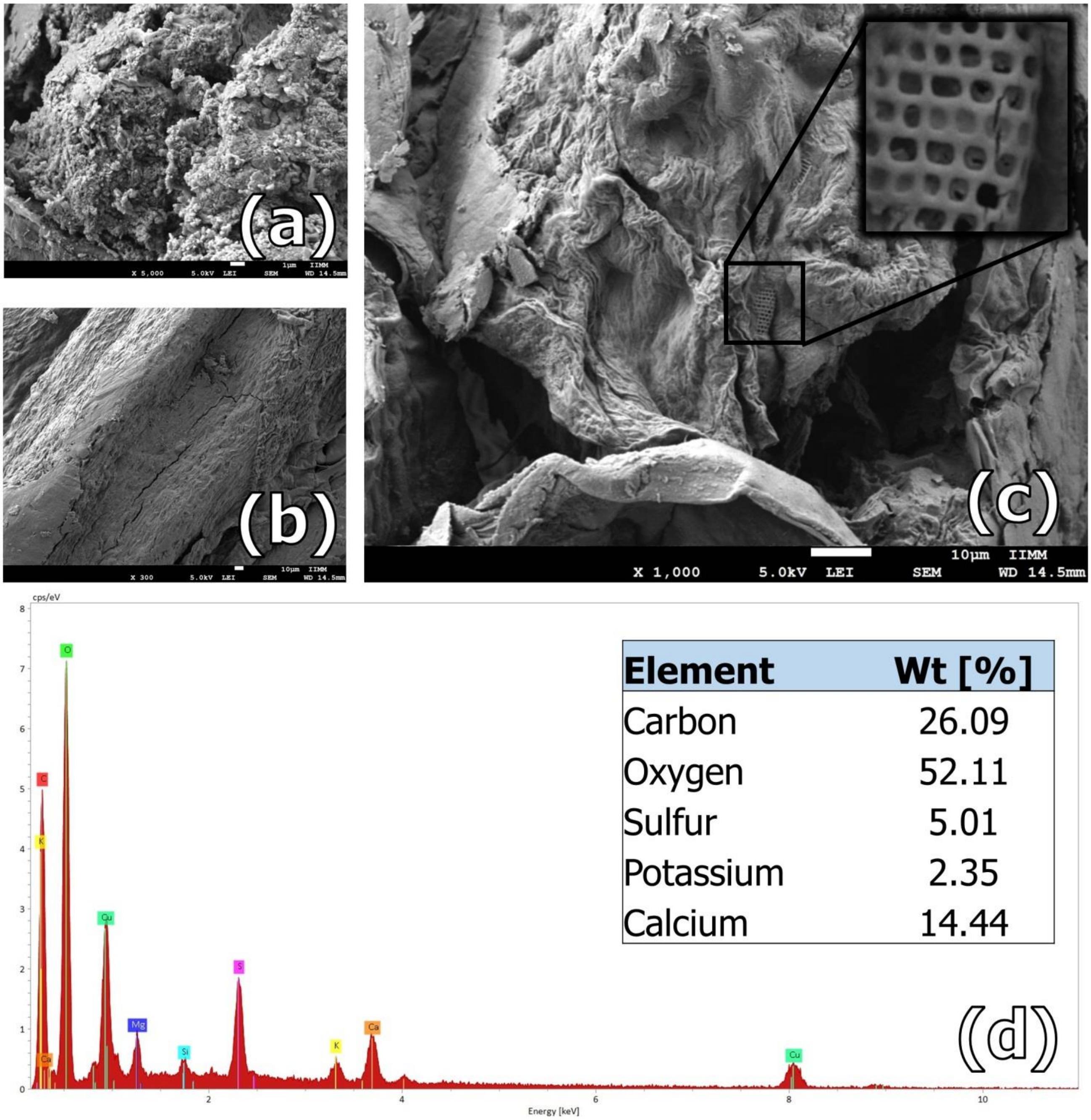

Element	Wt [%]
Carbon	26.09
Oxygen	52.11
Sulfur	5.01
Potassium	2.35
Calcium	14.44

Figure 1. Figure 1. SEM Sargassum spp.: (a) vesicles (b) thallus (c) leaves and thallus (d) EDS

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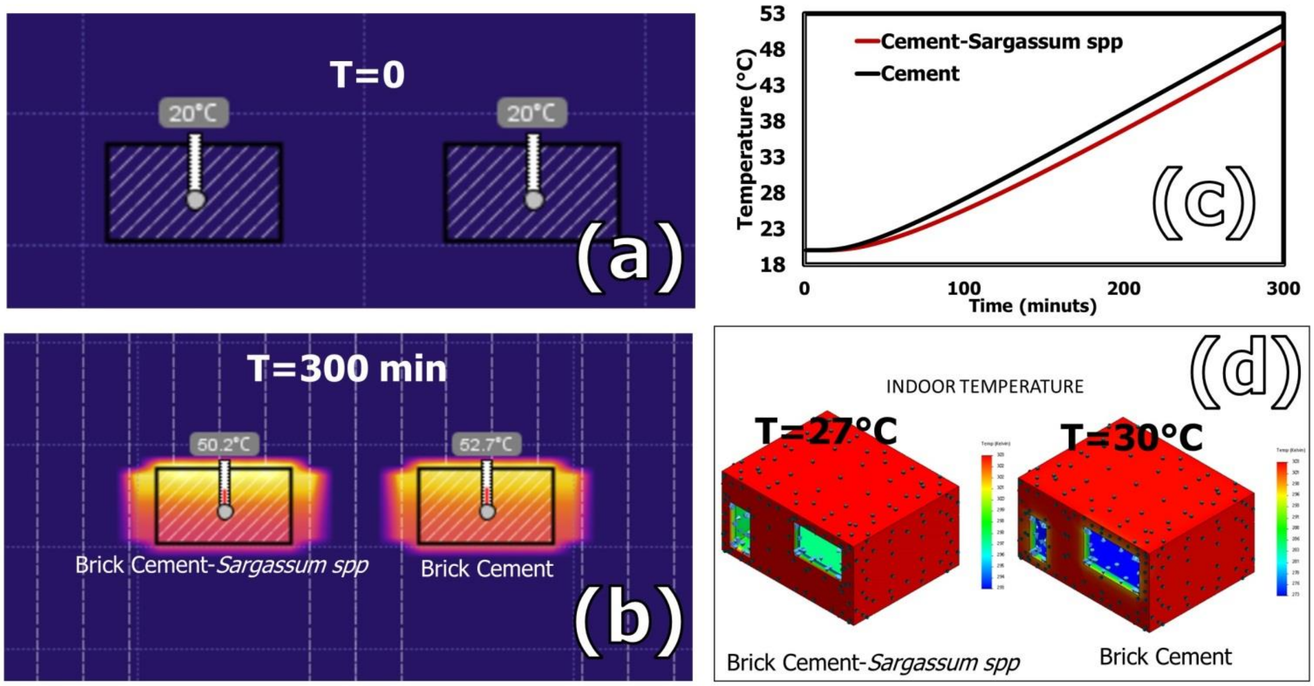

Figure 2. Figure 2. Thermal simulation in bricks: (a) ambient temperature (t = 0) (b) 300 minutes (c) temperature increase during the simulation (d) Simulation in houses.

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