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Corn pith as insulating biomaterial: from biomass fractionation to composite production

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Considering the over-exploitation of fossil resources and the release of greenhouse gas into the atmosphere, the development of a plant biorefinery is a major challenge for the next years in order to produce biomolecules, bioenergy and biomaterials. The conversion of lignocellulosic biomass coming from forest residuals, crop residues, and energy crops present a special interest as it is not actually competing with food applications. In this context the present work focuses on an agricultural by product, the corn stalk which is composed of two main anatomical parts: the pith, the inner part constituted of some vascular bundles dispersed in large parenchyma cells, and the rind, composed of closely spaced vascular bundles embedded in small-diameter parenchyma tissue. The alveolar structure observed in the pith is similar to the structure of expanded polystyrene and could explain the insulating properties observed in composites prepared from crop pith like sunflower and corn^[1, 2]. One of the challenges to produce crop bio-based insulating boards at large scale is obtaining the pith by a mechanical and scalable method. Dry fractionation processes, which exhibit strong arguments of sustainability (no water consumption or drying of effluents), allowed dissociating plant structures at the relevant scale (0.5-4mm). In this work, firstly a dry fractionation diagram was developed at the kilogram scale in order to separate the rind from the pith of corn stem internode while preserving pith alveolated structure. Coarse grinding, based on shear as main mechanical stress, allowed dissociating both anatomical parts of the stem. They have been further separated based on their difference in apparent density using a gravimetric table. About 41% of the initial pith was recovered in fractions containing more than 92% of pith and with particles size higher than 1mm. Insulating composites were then produced with two fractions of corn pith and alginate as binder (Figure 1). The thermal conductivity is 0.046 W/mK (Fig1a), and 0.052 W/mK (Fig. 1b). This collaborative work highlights that dry fractionation preserves initial pith structure and the bio-based composited exhibit thermal conductivities in the range of conventional insulating materials.

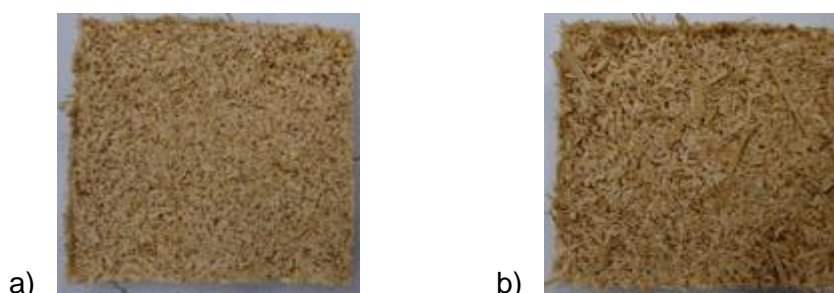


Figure 1. Bio-based insulating corn-alginate composites made from two corn pith fractions

[1] N. Mati-Baouche N., H. De Baynast, A. Lebert, S. Sun, C. Lopez-Mingo, P. Leclaire & P. Michaud. *Ind. Crops. Prod.*, **58** (2014) 244-250.

[2] M. Palumbo, A.M. Lacasta, N. Holcroft, A. Shea & P. Walker, P. *Construction and Building Materials*, **124** (2016), 269-275..