

Characterization of sustainable biomaterials for infrastructure durability Yucatan, México.

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Abstract. The research work discusses the use of sustainable biomaterials in cement mortars as a method to obtain durability in the infrastructure of the Yucatan region. The natural product comes from the organic extraction of the bark of *Albizia tomentosa*, a native tree. Characterization of the extract by NMR revealed the presence of phenols such as epicatechin and carbohydrates such as sucrose. Other physicochemical techniques were employed for cement and aggregates to determine their mineralogical composition (XRD) and elemental analysis (SEM-EDS). The organic extract was applied at a concentration of 5 mg/ml during the hydration and curing processes of the mixture, then the electrical resistivity, capillary water absorption and ultrasonic propagation velocity properties of the cement mortars were measured and compared with the reference mortar, at a curing time of 7, 28 and 96 days. The results showed that the use of the tested biomaterial can improve the durability of concrete structures.

Keywords: Biomaterials, Durability, Cement mortar.

1 Introduction and methodology.

Cement is the most widely used material in the construction sector worldwide, however, each Portland clinker manufactured ton of cement is responsible for high energy consumption and emission from 0.7 to 0.8 tons of CO₂, approximately. This work looks for the sustainability of concrete through the incorporation of organic additives coming from the Yucatan regional flora, with plenty of interesting molecules, to obtain an environmentally friendly construction material. The natural product was extracted from the bark of the *Albizia tomentosa* tree by maceration in water and was added to the cement mortars to perform the durability tests: electrical resistivity, propagation of ultrasound velocity and water absorption by capillarity, besides NMR, DRX and SEM. The objective was to discuss the potential use of sustainable biomaterials in cement mortars as a method to obtain durability for the infrastructure of the Yucatan region.

2 Results, discussion and conclusion.

XRD results show the mineralogical composition of the cement: mainly calcite, followed by 3CaO·SiO₂, also known as C3S, which form hydration products. Also, less abundant phases of CaSO₄, an inductor of hydration, and Ca₃SiO₅, form of C3S, were found, as well as traces of dolomite (CaMg(CO₃)₂) and goethite (FeO(OH)); for the aggregates, only calcite was observed, these results were confirmed by EDS. Fig. 1a shows the ¹H-NMR spectrum of the organic extract, where characteristic signals of the flavonoid epicatechin were detected in the aromatic region (6.00 – 7.50 ppm, circle). Also, broad resonances are observed, suggesting the presence of tannins, which are known to enhance the properties of the mortar. Furthermore, signals in the region from 3.00 – 5.00 ppm were assigned to the sucrose. As well known, the resistivity and ultrasonic propagation velocity of the control cement mortar is related to the continuous hydration reaction of the cement, i.e. the presence of tricalcium silicate confirmed by XRD, and improves with increasing curing times (7, 28 and 96 days). For the biomaterials the electrical resistivity (kΩ·cm) and ultrasonic propagation velocity (m/s) value at 7 days were 12.44 ± 0.015 and 1006 ± 12 at 28 days 15.75 ± 0.002 and 1056 ± 5, and at 96 days were 22.40 ± 0.004 and 1345 ± 6 respectively, which are higher than that of control. The tannins and sucrose present in the extract at a concentration of 5 mg/ml probably helped to decrease the formation of cracks, as result of tannins polymerization, leading to an increase in molecular size, thus filling micro cracks produced during the hydration of cement and enhancing their properties. This behavior is observed in the capillary water absorption curves showing lower absorption in the biomaterials at 96 days of curing (Fig 1b).

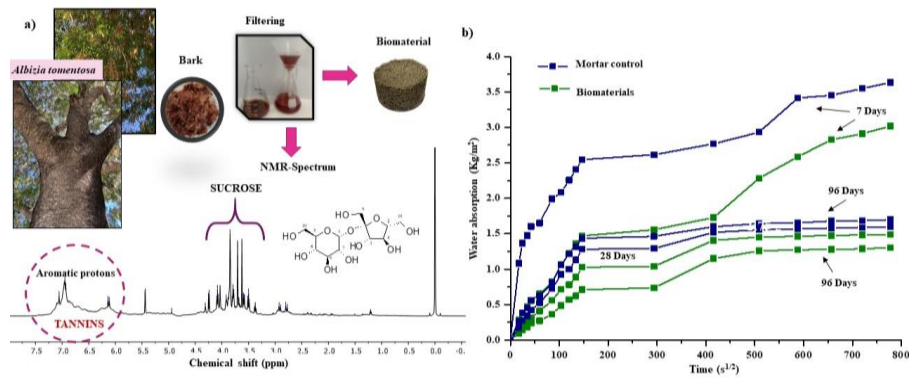


Fig. 1. a) HNMR spectrum of the organic extract and b) comparison curves of water absorption.

References

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