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Abstract

Multifunctional Bacterial Cellulose–Chitosan Tape: An Innovative Substitute for PVC †

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Abstract: Synthetic polymers, generically named plastics, are manufactured from non-renewable sources, such as fossil fuels [1]. In 2020, 367 million metric tons of plastic were produced worldwide, and, only in 2018, global plastic waste volume reached 342.6 million metric tons [2,3]. One of the most used plastics is polyvinyl chloride (PVC), which is not environmentally friendly. The goal of this study was to achieve an eco-friendly substitute for PVC tapes while mimicking their properties and applications. In this way, bacterial cellulose (BC) and chitosan (CH) tapes in different concentrations, 1% and 2%, were developed. Mechanical properties, thickness, bonds between BC and CH and degradation tests were assessed in water and under different temperatures. Mechanical testing showed that the combination of the two polymers resulted in better mechanical performances when compared to BC tape (8.52 ± 1.11 MPa); this may be related to the stronger chemical bonds created between the BC and CH. In addition, BC–CH at 1% revealed closer values of strength compared to PVC tapes (703.19 ± 16.18 MPa and 516.92 ± 22.0 MPa, respectively). Moreover, with the present study we were able to conclude that the incorporation of CH increases tape porosity. Interestingly, higher porosities (BC and CH at 2%) resulted in better mechanical properties upon tensile testing (1344 ± 52.87 MPa). Upon contact with water, the BC–CH mixture at 1% proved to be more resistant and not mechanically affected over time, like PCV tape. Thermally, both tapes with CH revealed to be more resistant than the PVC tape. However, the BC–CH tape at 1% was the most stable over time at all temperatures tested. This preliminary study opens new possibilities to the use of these tapes in sport areas, packaging and pharmaceutical or biomedical fields.

Keywords: bacterial cellulose; chitosan; ecological footprint; PVC substitute; mechanical properties; degradation assay

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References

1. Chamas, A.; Moon, H.; Zheng, J.; Qiu, Y.; Tabassum, T.; Jang, J.H.; Abu-Omar, M.; Scott, S.L.; Suh, S. Degradation Rates of Plastics in the Environment. *ACS Sustain. Chem. Eng.* **2020**, *8*, 3494–3511. [CrossRef]
2. Annual Production of Plastics Worldwide from 1950 to 2020 | Statista. 2022. Available online: https://www.statista.com/statistics/282732/global-production-of-plastics-since-1950/ (accessed on 26 January 2022).
3. Distribution of Plastic Waste Treatment Worldwide in 2018, by Method. 2022. Available online: https://www.statista.com/statistics/1271029/global-plastic-waste-treatment-by-sector/ (accessed on 26 January 2022).