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Alternatives for Fungal Textiles Made from Bread Waste that have the Properties of Leather

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Abstract

Two of the most pressing environmental issues on a global scale are food waste and fashion industry pollution. The feasibility of producing an alternative textile material with leather-like properties from fungal biomass cultivated on bread waste was investigated in order to alleviate the issues posed by food waste and contribute to sustainable fashion. In a submerged cultivation method, the filamentous fungus Rhizopus delemar was successfully grown on waste bread, and the fungal biomass was treated with chestnut wood's vegetable tannin. OM, SEM, and AFM showed how the tannin treatment affected the hyphae, while NMR and FTIR demonstrated that tannin interacts with fungal biomass. TGA analysis was used to measure thermal stability. Sheets of hyphae were prepared using the wet-laid method commonly used for papermaking. As a post-treatment, glycerol and/or a biobased binder were applied to some of the sheets. In total, three of the manufactured materials had characteristics similar to those of genuine leather. After being treated with glycerol alone, sheets made from untreated biomass had a tensile strength of 7.7 MPa and an elongation at break of 5%. Though sheets from untreated biomass and tannin treated biomass with both glycerol and fastener medicines prompted rigidities of 7.1 MPa and 6.9 MPa, and the stretching at break of 12% and 17%, individually. After the binder treatment, the sheet's increased hydrophobicity helped keep the sheet's absorbed glycerol inside, preserving its flexibility when moist. These results show that fungal sheets made from bread waste have a lot of potential as eco-friendly materials with leather-like properties.

Keywords: Environmental issues • Leather like properties • Eco friendly materials

Introduction

Bread waste valorisation has been explored to produce ethanol, lactic acid, protein, dye pigments, food, and feed. Furthermore, considering the availability and quantity of bread waste, the further production of marketable bioproducts, which have the potential to replace already commercialized alternatives, leads bread waste from a waste management challenge to an environmental and economic opportunity. As of 2021, the global food waste segment will account for 17% of the global food products available for retail and is associated with 8–10% of global greenhouse gas emissions. Conversely, the fashion industry is regarded as one of the most polluting. According to Quilleriet (2004), the fashion industry was responsible for the production of 92 million tonnes of waste and the emission of 1715 million tonnes of CO2 in 2015. Leather was the first clothing that humans wore. With more than USD 80 billion in annual trade, leather and leather products rank among the most widely traded goods worldwide. In 2020, the global market for leather goods was worth USD 394.12 billion, with an annual growth rate of 5.9%. Vegetable tanning uses secondary metabolites from plants that can bind and precipitate proteins in the animal hides or skins [1].

Natural leather with nine commercially available bio- and petrochemical-based leather alternatives. In terms of properties, none of the studied materials matched the quality of natural leather, and some of those materials contained environmentally harmful substances, mostly in the form of coatings or reinforcing layers. The hides are made up of multiple scales that are made to do different things in the animal's body. As a result, leather substitutes struggle to compete with natural leather because it exhibits a tightness gradient throughout its cross-section. However, fungal products have a promising future in biofabrication of leather-like materials that are both environmentally friendly to produce and decompose. This study started with the hypothesis that submerged cultivation of a zygomycete fungus, Rhizopus delemar, in a 1000 L airlift bioreactor could be used to create fungal textile materials with leather-like properties from bread waste [2].

Discussion

Currently, chrome tanning is the preferred process in the industry due to the softness of the material it produces, the low cost, and the quickness of the process. However, the effluent from these chrome tanneries contains chromium, chlorides, sulphides, sodium, and suspended solids in concentrations above the acceptable levels, which creates severe environmental issues Alternative and sustainable leather-like materials are highly sought after in light of the drawbacks of the leather industry and the growing demand for leather as a luxury material. Leather substitutes derived from biobased materials have progressed through a number of successful pathways, and some materials have already been commercialized as leather alternatives. Wearable fungal mycelium material, Piatex made with pineapple fibers as a raw material, and a material developed using fungal mycelium grown on sawdust and other organic substances that has been produced from collagen, the same protein found in animal hides, are some of the leather alternatives that are available on the market. Academic research on fungal leather substitutes is lacking, despite commercial knowledge of the subject; however, academics have only reported a few studies [3-5].

Conclusion

Cultivation on a scale of 1 L and 2 L, respectively, with synthetic medium serving as the substrate, was used to cultivate fungi and prepare sheets. To stabilize the fungal biomass's proteins, a vegetable tanning pretreatment was applied to the harvested biomass. After that, glycerol and biobased binder

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post-treatments were used to improve the material's mechanical performance, and fungal sheets were formed using the wet-laid technique. To the best of our knowledge, this is the first study to investigate vegetable tanning on filamentous fungi in order to develop textile alternatives with leather-like properties. Additionally, the aim of the study was to develop a biobased material free of harmful chemicals and energy-intensive processes.

Acknowledgement

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Conflict of Interest

None.

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