VALORIZATION OF ANCHOVY FISHBONE WASTES FOR THE PREPARATION OF BIOPOLYMERIC BASED GREEN COMPOSITES FOR FOOD PACKAGING APPLICATIONS

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Keywords: wastes valorization, natural filler, biopolymers, green composites, 3D-printing, sustainable packaging.

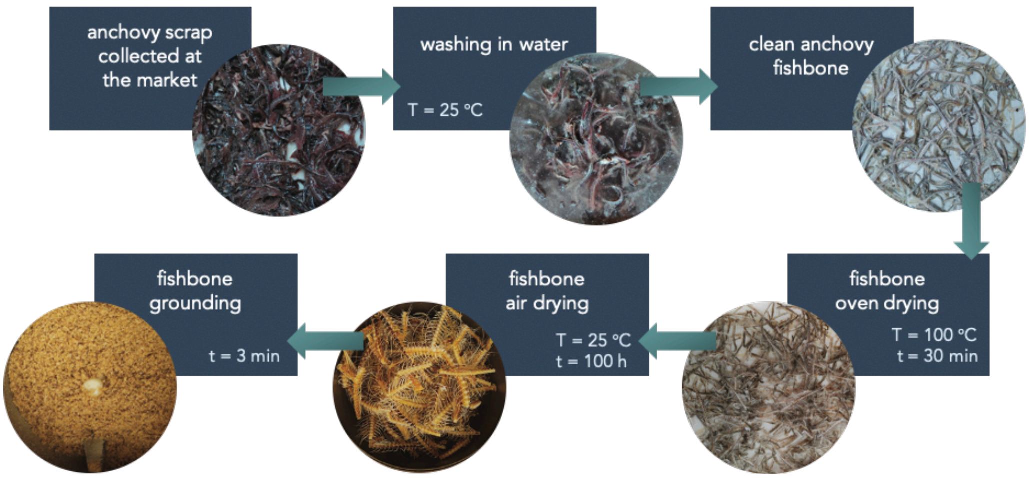
INTRODUCTION

The use of bio-based and biodegradable polymers has recently gained great interest, in order to replace traditional plastics reducing environmental impact caused by use of fossil sources and inappropriate disposal. However, biopolymers are generally more expensive than the traditional ones [1]. Replace a certain amount of bioplastic with natural scraps allow to decrease the amount of plastic needed lowering the final costs. Global use of fish products has recorded a huge increase over the last years. Consequently, also the amount of fish wastes produced and grossly discarded in markets has undergone a dramatic increase causing environmental and hygiene issue. Use of these scraps for the production of materials with higher added value would promote the implementation of circular bioeconomy, reducing waste production and solving environmental and hygiene issue related to them [2]. Combining biopolymers with animal waste could be an effective strategy in the view of producing food packaging decreasing the amount of bioplastic needed and, consequently, the cost of the final products. In this work, anchovy fishbone (EE), obtained by local market, were ground into powder and added to a biopolymeric matrix (Mater-Bi®) in order to produce a 3D-printed fish crate.

1. EXPERIMENTAL SECTION

1.1 Preparation of EE flour

Anchovy fishbone flour (EE) was obtained by anchovy scraps collected directly at "Ballarò" market (Palermo, Italy) following the process reported in Scheme 1.



Scheme 1. Schematic representation of anchovy fishbone flour preparation.

1.2 Processing of EE composites and 3D printing

Two different formulations were prepared by melt mixing 10 or 20 wt% of EE to Mater-Bi® (MB). The obtained blends were then extruded. The specimens were designed and printed using a Sharebot Next Generation (Italy) 3D printer (nozzle temperature = 160 °C).

2. RESULTS AND DISCUSSION

2.1 EE powder microbiological analysis

Viable count technique did not show the presence of any pathogenic bacterium or mold. Detectable levels of food contaminants were only detected among yeasts and TMM.

2.2 **EE composites filament printing process**

MB/EE10 composite filament was able to be 3D printed for FDM into flat (Figure 1a) or geometrically complex products (Figure 1b). The printing process proceeded smoothly and no clogging of the nozzle was observed. MB/EE20 cannot be printed for FDM. The filament is not strong enough to push itself inside the melting chamber but due to the voids present along its entire length.

Figure 1. Specimen 3D printed (a) and product with complex geometry printed with MB/EE10.

2.3 **Morphological analysis of EE 3D printed composites**

MB/EE10 exhibited relatively uniform filler dispersion with limited voids (Figure 2a). Moreover, EE particles appear well embedded in the polymeric matrices and a good interfacial adhesion between anchovy fishbone particles and the polymeric matrices can be noticed. Good adhesion between layers was achieved for samples printed with raster angle of ± 45° (Figure 2b).

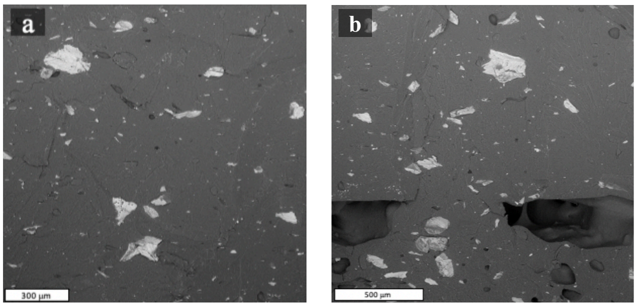


Figure 2. Cryo-fractured cross-section of 3D-printed MB/EE10.

2.4 **Mechanical properties of MB-EE 3D printed composites**

The addition of 10% of EE to MB lead to a decrease in E and TS but the ductility of the composite displayed a strong increase if compared with pure matrices, with EB value going from 55.6 to 258%, reasonably due to the presence of the oily phase in the filler that act as plasticizer (Figure 3). No flexural or impact fracture occurs either for MB or MB/EE10 due to their ductile behavior. However, a slight but statistically significant increase of EF can be noted when 10% of EE is added to MB.

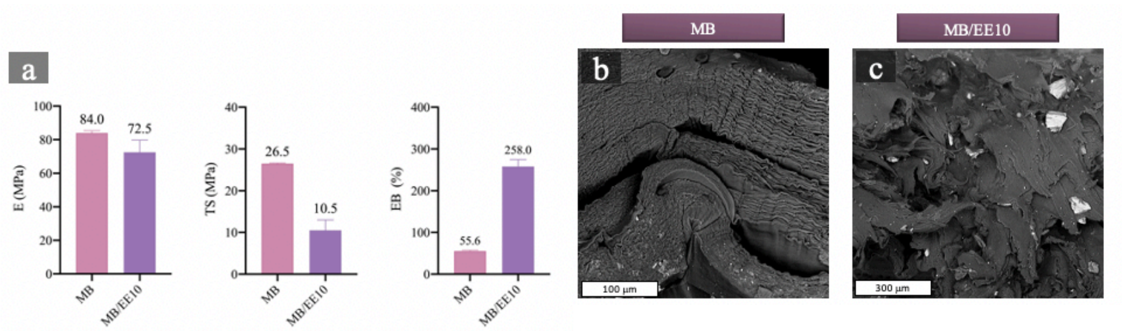


Figure 3. Elastic modulus (E), tensile strength (TS), and elongation at break (EB) of 3D-printed MB and MB/EE10 (a) and relative SEM micrograph of their fractured cross-section (b, c).

3. REFERENCE

[1] F.P. La Mantia, M. Ceraulo, P. Testa, M. Morreale "Biodegradable polymers for the production of nets for agricultural product packaging" Materials 14, 1-10 (2021).

[2] Scaffaro R, Citarrella MC, Gulino EF. Opuntia Ficus Indica based green composites for NPK fertilizer controlled release produced by compression molding and fused deposition modeling. Compos Part A Appl Sci Manuf 2022.