9th World Congress on **Biopolymers & Bioplastics**

August 26-27, 2019 | London, UK

Raw protein hydrolysates from tanning industry in blends with Polybutylene succinate adipate (PBSA) for agricultural applications

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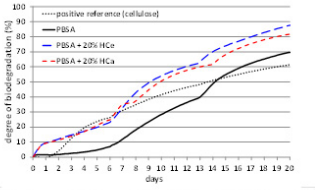
In this study, thermoplastic blends based on poly (butylene succinate-co-adipate) (PBSA) and different raw hydrolyzed collagens (HCs), byproducts of the tannery industry, were investigated for the production of biodegradable items for applications in agriculture. The used HCs were obtained by alkaline (HCa) and enzymatic (HCe) hydrolysis of the solid wastes generated during the phase of shaving in the tanning process. PBSA/HC blends, containing 5-20 wt% of HC, were produced by melting extrusion and characterized in terms of processability by blow film extrusion/injection molding and thermal/rheological properties. In view of their potential use in agriculture, the ultimate aerobic biodegradability of films (thickness 300 micron) was evaluated under controlled composting conditions, according to the UNI EN ISO 14855-1; dog-bone specimens, produced by injection molding, were also subjected to a disintegration test carried out in compost under curing at room temperature, according to the UNI EN 14045. The blown films, produced up to 20 wt% of HCa, resulted flexible with satisfactory tensile properties and excellent tear resistance, due to its good compatibility with the polymeric matrix and plasticizing effect. While, the HCe behaved as filler, due to the poor interfacial matrix/HC interactions with consequent continuous decrease of the tensile properties with increasing HCe loading. All the blends up to 20 wt.% HCa and HCe resulted suitable for the injection molding obtaining molded specimens with good tensile properties, in particular those containing HCa. Both HCs improved the biodegradation rate of the blends studied, with even higher rates than cellulose. The results obtained encourage the use of the raw collagen hydrolysates derived from the tannery industry in the production of thermoplastic blends to obtain compostable/biodegradable films or molded products with N-fertilizing properties for applications in agriculture (mulch) and plant nurseries.

Tensile dog-bone specimens of PBSA and PBSA/HCs

Disintegration test in compost



Ultimate aerobic biodegradability of PBSA and PBSA/HC blends under controlled composting conditions (UNI EN ISO 14855-1).

Recent Publications

1. Seggiani M, Gigante V, Cinelli P, Coltelli B, Sandroni M, Anguillesi I, Lazzeri A (2019) Processing and mechanical performance of polybutylene succinate adipate (PBSA) and raw hydrolyzed collagen thermoplastic blends. Polymer Testing. 77:105900.
2. Cinelli P, Seggiani M, Mallegni N, Gigante V and Lazzeri A (2019) Processability and degradability of PHA-based composites in terrestrial environments. International Journal Molecular Science 20(2):284-297.
3. Seggiani M, Cinelli P, Balestri E, Mallegni N, Stefanelli E, Rossi A, Lardicci C, Lazzeri A (2018) Novel sustainable composites based on Poly(hydroxybutyrate-co-hydroxyvalerate) and seagrass beach-CAST fibers: performance and degradability in marine environments. Materials 11:772-787.

4. Seggiani M, Altieri R, Puccini M, Stefanelli E, Esposito A, Castellani F, Stanzione V and Vitolo S (2018) Polycaprolactone-collagen Hhydrolysate thermoplastic blends: processability and biodegradability/compostability. Polymer Degradation and Stability 150:13-24.
5. Seggiani M, Cinelli P, Mallegni N, Balestri E, Puccini M, Vitolo S, Lardicci C and Lazzeri A (2017) New bio-composites based on polyhydroxyalkanoates and Posidonia oceanica fibres for applications in a marine environment. Materials 10(4):326-338.

Biography

Maurizia Seggiani is Full Professor of Principles of Chemistry for Applied Technologies at the University of Pisa, Italy. Her research activities are focused on analysis/optimization of chemical processes regarding the waste management (treatment/recovery/valorisation of industrial solid/liquid/gaseous effluents), biomass gasification, development and application of solid adsorbents for carbon capture at high temperature and also, recently, development of thermoplastic biodegradable/compostable composites for applications in agriculture/marine environments. In the last years, she has been coordinator of research projects concerning the development, processing and validation of bio-composites based on PCL, PHAs and PBSA and industrial byproducts (collagen hydrolysate) and natural waste fibers for different applications..

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