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Tomato Peel Waste: a Powerful Source of Bio-based Polymer for Innovative Biomedical Devices

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Abstract

Italy is one of the world-leading processed tomato producers, the third one worldwide after California and China. In 2019 the National Association of the Canned Vegetable Industry (ANICAV) estimated that the tomato transformation campaign in Italy closed with a production of 4.8 Mtons of processed tomatoes and 91 thousand tons of waste composed of skin, seeds, and fiber (WTPC 2015). In the last decade, several routes have been covered for tomato waste valorization. Some of them involve the use of these waste in agriculture, as fertilizers or animal feeding (Abbeddou ,S. et al. 2015) or in second-generation biorefineries as biofuel (Hijosa-Valsero, M. et al. 2019). On the other hand, the biomedical sector is lacking of innovative bio-based and biodegradable polymers to involve in medical devices design. Tomato peel is composed by a tridimensional polymer named cutin, a repeated sequence of 10,16-dihydroxy hexadecanoic acid (10,16-diiHHDA) monomers (90% by weight). This unit has peculiar chemical features useful for the development of bio-based functional materials. The project CuToPro aims at recovering this secondary raw material for design new biomedical devices as nano-filtering face masks (nFFF) and Advanced Wound Dressings (AWD), but not limited to these. The tomato peel was purified through super critical carbon dioxide (sc-CO2), isolating an oleoresin rich in carotenoids. The latter constituting secondary high added-value impurities of the tomato peel to destinate to other markets. The depolymeritazion reaction, followed by a tailor-made purification, allowed to isolate 10,16-diHHDA in good amount (35%) and purity (>92%). The monomer was opportunely mixed/formulated with another bio-based polymer (PLA-PCL) and turned into micro and nano-ranged fibrous tissue by electrospinning. The fibers showed a smooth surface, they were free of defects and fibers were uniform in size and well interconnected. The hydrophobic nature of the monomer provides optimal water resistance maintaining high-water contact angle (112°). Furthermore: i) the antimicrobial tests showed an intrinsic antibacterial activity of the

monomer alone and formulated, against E. Coli and S. Aureus; ii) the cytotoxicity tests confirmed the biocompatibility of cutin based formulations. These experimental data reveal the high potential of cutin form tomato peel waste as innovative secondary raw material for biomedical devices.

Keywords: tomato peel, biomedical devices, supercritical fluid, circular economy

References

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