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ID657 | From Waste to Bioactives: Green Extraction of Natural Antioxidants and Antimicrobials from Tomato By-products

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Background: Global tomato production reached 192 million tons in 2023. Industrial processing generates around 25% by-products (peels, seeds, pulp), often discarded, yet rich in phenolics (e.g. quercetin, lutein), carotenoids (e.g. lycopene, β -carotene), fiber and proteins. With growing demand for sustainable, biodegradable, and clean-label packaging materials, there is increasing interest in using natural bioactive compounds to replace synthetic additives [1]. The NOVAPACK project explores the potential of tomato by-products as sources of antioxidants and antimicrobials and pigments for use in active edible packaging, thereby supporting circular economy goals and reducing environmental impact.

Methods: Tomato by-products were characterized in terms of proximal composition, and bioactive compounds were extracted using environmentally friendly, food-safe solvents: ethanol/water, citric acid, lactic acid, and ascorbic acid (HCl as reference). Extracts were analyzed using HPLC to determine the levels of carotenoid and phenolic compounds. FTIR spectroscopy was used to identify functional groups. Antioxidant capacity was tested with DPPH and ABTS assays. Antimicrobial effectiveness was evaluated against pathogens such as *E. coli*, *B. cereus*, *S. aureus* and *Salmonella* spp.

Results: Tomato by-products showed proteins ($20.50 \pm 0.20\%$), total dietary fiber ($65.89 \pm 2.25\%$) and ash ($2.96 \pm 0.09\%$). Ethanol/water extracts yielded higher quercetin concentrations, while acidic solvents improved phenolic compounds diversity extracting rutin and naringenin. Carotenoids were efficiently recovered, yielding a total carotenoid content reaching $2.24 \pm 0.03\%$, which played an important role in the observed antioxidant activity. FTIR analysis revealed hydroxyl and aromatic C=C groups, confirming the presence of phenolics and carotenoids. Antioxidant assays showed strong radical-scavenging activity, and antimicrobial tests indicated effective inhibition of the referred foodborne pathogens, with growth suppression at concentrations ranging from 0.01 % to 1 % w/v, with further optimization being still performed.

Conclusions: This study highlights tomato by-products as sources of natural antioxidants and antimicrobials for active packaging. Green extraction methods exhibit strong potential, especially when applied within Mediterranean agrosystems. Findings support bio-based packaging that improves food safety, shelf-life, and waste valorization, aligning with NOVAPACK goals.