BY-PRODUCT VALORIZATION TO DEVELOP AN ACTIVE PACKAGING:
Antimicrobial and antioxidant properties

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INTRODUCTION

The Directive 2008/98/EC is a legal framework for treating waste in the EU; the main objective is to reduce waste production following a hierarchy waste model that is comprised of different steps: the first one is for preventing waste thanks to a proper waste management, the next is the re-utilization of by-products to minimize it or, if possible, avoid their release in the environment, then the recycling path, the recovery strategies, and the final disposal [1]. A way to valorize by-products when reach in bioactive compounds can be its re-use for developing active bioplastic packaging. Orange peel (OP) represents almost 60% of the orange by-product during juice processing and are enriched of flavonoids, phenolics acid, carotenoids, essential oils, lignin, cellulose, and hemicellulose [2]. The objective of the present work was to develop active PP and PLA based films by incorporation OP extract. Antimicrobial and antioxidant capacity of the extracts and films were investigated to evaluate future food packaging application.

1 MATERIALS AND METHODS

1.1 Orange peel extract preparation and characterization

Orange (*Citrus sinensis*, var. Valencia) peel extract was produced by Bio Base Europe Pilot Plant (BBEPP), Belgium, and supplied frozen. Further concentration and drying strategy applied through spray-drying (Büchi Mini Spay dryer B-290) was used where 250 mL aliquots of OPE were sprayed and recovered content was collected into 50 mL polyethylene tubes and stored at - 20 °C before use. Spray-Dried Orange Peel Extract (SD-OPE) was assessed for its antioxidant content by radical scavenging assays, ABTS and DPPH assay, [3, 4]; the Ferric Reducing Ability of Plasma (FRAP) assay and for its Total Phenolic Content (TPC) by the Folin Ciocalteu reagent assay [5]. Results expressed are the mean ± standard deviation of three replications.

1.2 Film preparation

To produce the monolayer active films, PP Isplen PR230C1E (Repsol) and PLA Luminy® LX175 (TOTAL Corbion) were employed as polymeric base materials. Additionally, two different microporous additives were used (Accurel XP 100 and Accurel XP 951B, Evonik, Germany) for PP and PLA active films, respectively, to facilitate the incorporation and the retention of the active compounds into the polymeric matrix. The film processing was carried out by using a co-rotating twin screw extruder, to obtain films where the final theoretical concentration of active orange peel extract (OPE) was 5% (w/w).

1.3 Antimicrobial and antioxidant activity of the film

The antimicrobial activity of the processed films against different types of microorganisms (*Listeria monocytogenes, Escherichia coli, Saccharomyces cerevisiae* and *Aspergillus niger*) was analyzed by *in vitro* tests in vapor phase. *E coli* and *L. innocua* were inoculated in plate count agar at 37ºC for 24h whereas *S. cerevisiae* and *A. niger* were inoculated in Potato Dextrose Agar at 25ºC for 3

and 5 days, respectively. The free radical scavenging capacity of PP and PLA active films was evaluated using DPPH and ABTS method [4]. Each film (100 mg) was immersed in 5 ml of methanol for 24h. Results were expressed as percentace of inhibition. All assays were performed in triplicate and results expressed are the mean ± standard deviation.

2 RESULTS

2.1 TPC and Antioxidant content of the SD-OPE

Results from TPC and antioxidant assessment of SD-OPE reveal high TPC content and overall high antioxidant content from ABTS and FRAP assay.

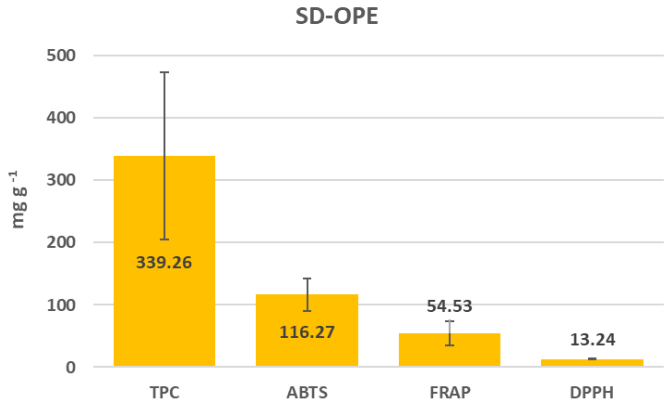

Fig. 1 – TPC and antioxidant content of SD-OPE.
TPC, FRAP, DPPH: gallic acid equivalent mg / g of spray-dried orange peel extract (GA equ mg / g SD-OPE); ABTS: trolox equivalent mg / g of spray-dried orange peel extract (TROLOX equ mg / g SD-OPE)

The lower antioxidant content revealed by DPPH assay (Fig. performed in an organic solvent (methanol) instead of water, suggest that the antioxidant content of SD-OPE is more available when dissolved in water.

2.2 Antimicrobial and antioxidant activity of the film

The results obtained, show that the active films did not inhibit the growth of the tested microorganisms, so that they do not present antimicrobial activity against the representative microorganisms for the group of Gram(+) and Gram(-) bacteria, yeasts and moulds. However, both PP and PLA active films exhibited inhibition towards the DPPH (8,78±0,02 % and 8±2 %) and ABTS free radical (8,17±0,01 % and 20±4 %).

3 ACKNOWLEDGMENT

This work was supported by European union's H2020 R&I program (no. 817936)

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