

Development of New Competitive and Sustainable Bio-Based Plastics

NowPack
New BioBased-Film for Packaging

Natural extract formulations and encapsulation for the different final food applications

NEWPACK project is based on the production of PHB-PLA blends for food packaging applications. Mixing PLA with PHB potentially leads to materials with interesting physical, thermal and mechanical properties.

In the literature, it is reported that the addition of PHB significantly improved the crystallinity, crystallization rate and barrier properties of PLA. However, PHB-PLA blends present some disadvantages like brittleness, low barrier properties and both low antioxidant and antimicrobial activity.

For this reason, different commercial natural extracts were identified and characterized in terms of antimicrobial and antioxidant properties, in order to select the best ones to be either extruded into PLA-PHB films or applied as coatings.

Natural extracts can be obtained starting from vegetables, fruits or agricultural residues, using different extraction techniques. In almost all the literature works, these extraction processes are not studied from the point of view of economic sustainability because the focus of the works was mainly the evaluation of antioxidant and antimicrobial power of the final extracts. For instance, the natural extracts of grapefruit are widely studied in scientific literature, but it is impossible to find commercial products available in large amounts and affordable prices.

Based on the state of the art about antimicrobial and antioxidant extracts and on NEWPACK goal of using additives recovered from agri-food residues, 6 food grade commercial extracts from citrus fruits and one from olive leaf were selected, plus a rosmarinus extract and a thymus essential oil as reference extracts. Also, grape skin extracts are available on the market but typically produced from red grapes.

They have not been selected for the present project because of the typical red/purple color. Then, the selected extracts were characterized for moisture content, color, thermal stability, solubility, total phenolic content (Folin assay), antioxidant capacity (FRAP, ABTS assay) and antimicrobial activity (**Figure 1**).

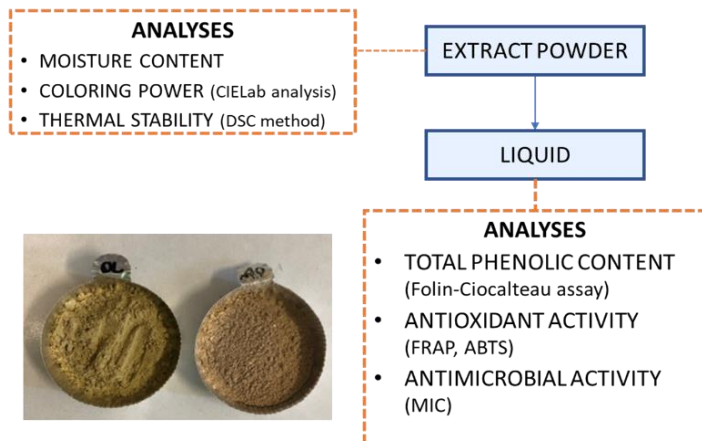
It is important to underline that solubility problems were encountered since the OL is not fully soluble in water (about 80 %), while all the citrus extracts require solubilization in NaOH (at least 0.5%) which made difficult the set of the antimicrobial tests.

Based on the results obtained for antioxidant activity and on the first results obtained for antimicrobial activity (inhibition to *E. coli*), the most promising natural extract (OL and one citrus extract) have been selected for the development of coating formulations.

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Extracts characterization



Selected food and pathogenic microorganisms

| RIBEREBRO products | ARGAL products | PATHOGENIC MICROORGANISMS |
|--|---|---|
|  WHOLE MUSHROOM |  SLICED CURED HAM | <i>Listeria monocytogenes</i> <i>Escherichia coli</i> <i>Salmonella spp.</i> <i>Pseudomonas aeruginosa</i> <i>Staphylococcus aureus</i> |
|  MIX OF FRESH VEGETABLES |  READY TO EAT RUSSIAN SALAD | |
|  MIX OF PASTEURISED GREEN BEANS |  SLICED VEGAN SAUSAGES | |
| | | <i>Aspergillus niger</i> <i>Aspergillus flavus</i> |

Figure 1: Analytical methods applied for extracts characterization & list of the selected food and pathogenic microorganisms to test antimicrobial activity of the extracts in the NewPack project

Moreover, thermal stability of the extracts suggest they could be used directly into the polymer blend before extrusion if the working temperature is maintained below 200°C. For this reason, to increase the thermal stability of the natural extracts, some preliminary spray drying encapsulation trials were carried out using beta-cyclodextrins as carrier materials.

However, the encapsulation did not appear to increase thermal stability of neither the citrus, nor the olive leaf extract. In addition, preliminary trials with a different encapsulation technique (prilling by vibration) were also conducted on one citrus extract. In this case, encapsulated citrus extracts in Na-alginate revealed higher thermal stability.

The antimicrobial activity tests of the extracts are under completion to evaluate effect against all the selected microorganisms. This could eventually lead to selection of a different citrus extract. However, this is not going to impair future activities regarding production of active coatings, since all the citrus extracts are quite similar for thermal stability and NaOH solubility.

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