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Development of More Sustainable Solutions for Food Packaging

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State of the Art

The food packaging industry predominantly uses synthetic polymers due to their advantageous properties and cost efficiency. However, these materials significantly contribute to plastic pollution and environmental harm, and conventional packaging lacks active functionalities to enhance food preservation, leading to increased food waste (Ahmed et al., 2022). This research project aims to develop biobased active packaging from agrifood waste to improve the sustainability of materials and extend food shelf life. Key challenges include identifying suitable residual biomasses for fillers in biopolymers and incorporating natural antioxidant and antimicrobial compounds into packaging materials (Duguma et al., 2023). Compatibility and stability within biopolymer matrices such as PLA, PHA, PBS, and PVA are critical to success (Ozkan et al., 2019).

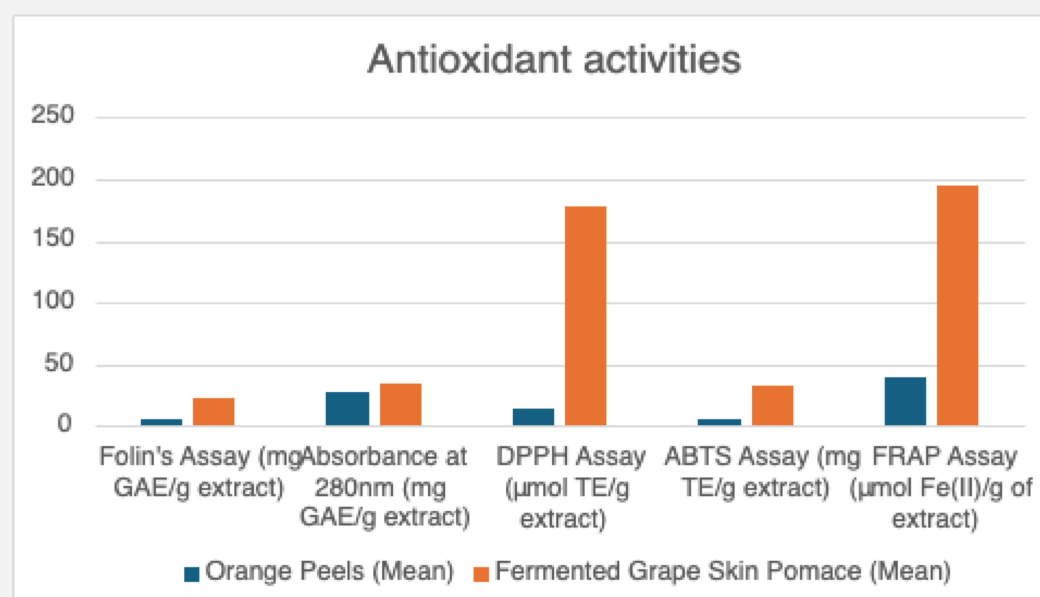
The development process involves using various analytical techniques, including encapsulation, metabolomics, differential scanning calorimetry (DSC), and mechanical testing, to optimise the material properties. Ensuring that these biobased films meet industry standards is crucial for commercialisation. Additionally, compliance with European food contact regulations is a significant hurdle, requiring extensive testing to prevent harmful compound migration and adhering to EFSA and FDA standards (Misra & Pathak, 2023). The materials developed through the Ecosister project will be tested on food products to validate their ability to extend shelf life without compromising quality, with collaborations from industrial partners essential for scaling production.

PhD Objectives

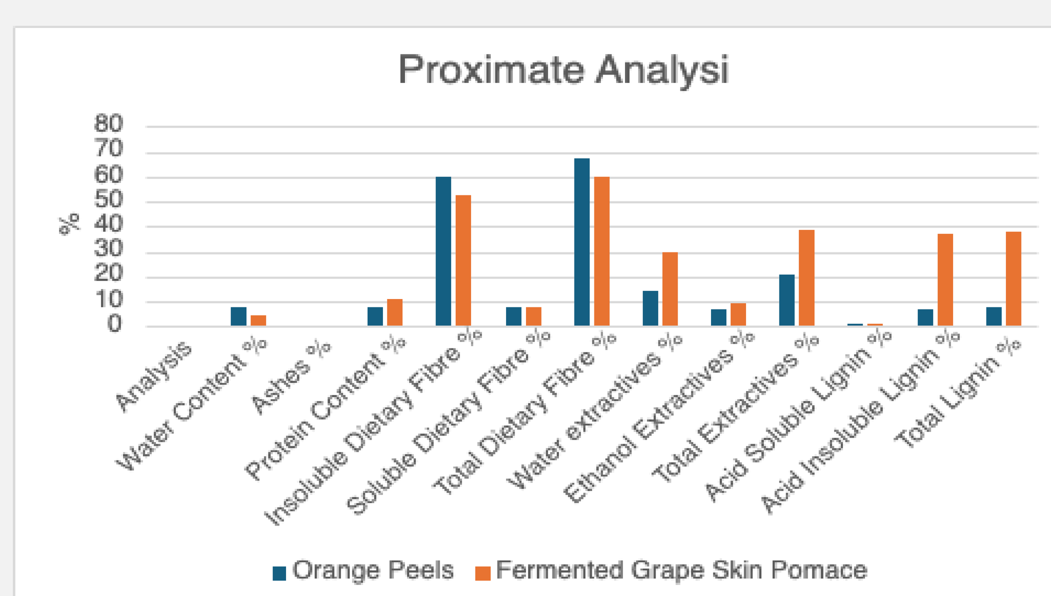
1. Identify suitable natural antioxidant and antimicrobial compounds from agrifood waste.
2. Assess the selected active films' mechanical strength, flexibility, and barrier properties to ensure they meet food packaging industry standards.
3. Develop formulations by incorporating natural compounds into biobased polymers.
4. Evaluate the films' mechanical, physical, antimicrobial, and antioxidant properties using advanced DSC, SEM, and FTIR techniques.
5. Test the antimicrobial and antioxidant efficacy of the packaging materials.
6. Conduct food contact compliance tests and assess performance in real food systems for shelf-life extension.

Preliminary Results

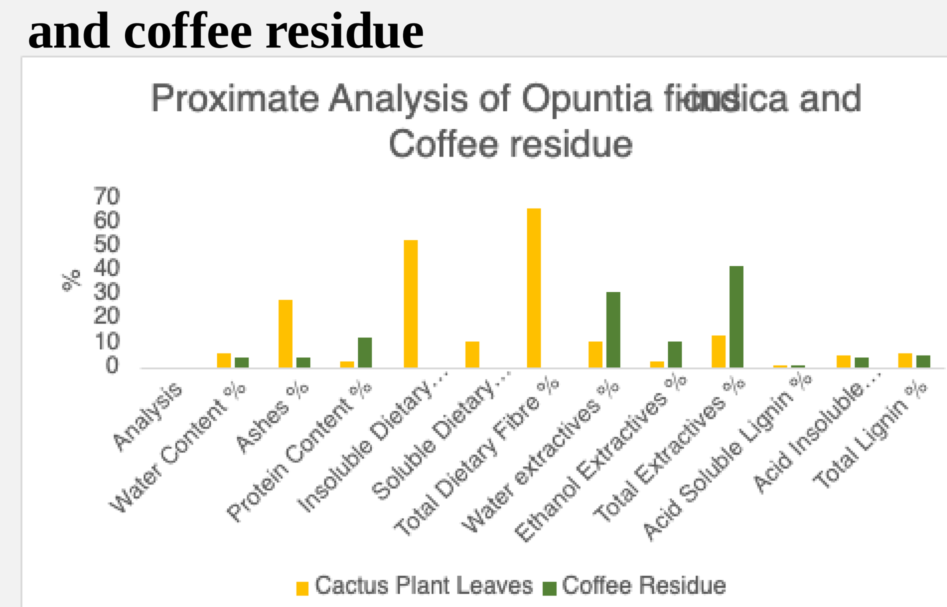
Orange Peels and Fermented grape skin Powders



Both materials orange peels and fermented grape pomace skin powders offer valuable antioxidant properties that can enhance the performance of bioplastics by improving their oxidative stability. The high phenolic content and antioxidant activity in grape skin pomace, in particular, make it an attractive candidate for reinforcing bioplastics, potentially extending their durability and lifespan. Orange peels, while showing lower antioxidant levels, are still a viable option due to their availability and sustainable nature. Incorporating these agricultural byproducts into bioplastics not only leverages their functional benefits but also contributes to waste reduction and sustainability in material production. Further research and development could optimize their integration and performance in bioplastic formulations.



Opuntia ficus-indica (cactus plant leaves) and coffee residue



Based on these results, Opuntia ficus-indica (cactus plant leaves) and coffee residue demonstrate ideal properties for incorporation as fillers in bioplastics. The high content of dietary fiber, particularly in cactus leaves, can improve the mechanical properties of bioplastics by enhancing their tensile strength and durability. Additionally, both materials contain substantial levels of water and ethanol extractives, which could contribute antioxidant properties, enhancing the stability and resistance of bioplastics to degradation. Coffee residue's notable lignin content provides rigidity and structural support, making it a valuable reinforcement agent. Moreover, the low ash and protein content in both materials reduces the risk of unwanted interactions in the polymer matrix, ensuring better compatibility. These attributes highlight the potential of these natural materials to improve the performance and sustainability of bioplastic composites.

Conclusion and Future Perspectives

The results from the selected biomasses show strong potential for developing bioplastics for active packaging. The next phase will involve using advanced techniques to incorporate these bio-based fillers and evaluate the mechanical strength, flexibility, and barrier properties of the films to meet food packaging standards. Additionally, the bioplastics will be tested in real food matrices for compliance and shelf-life extension. Collaboration with industry partners from material identification to commercialization will ensure a rapid transition from lab-scale innovation to market-ready, sustainable packaging solutions. Thanks to project ECOSISTER for the network and collaboration with industrial experts.

Referrences

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