A multiphysics approach to optimize modified atmospheres for packaging of respiring food products

Final Report Summary - MULTIMAP (A multiphysics approach to optimize modified atmospheres for packaging of respiring food products)

Modified atmosphere packaging (MAP) has proven to be an attractive alternative for extending the shelf-life of various food products. The design of MAP for fruits and vegetables is a complex task that requires the understanding of the dynamic interactions between the product and the package. The development of new bio-based materials and their adaptation to several products are the current major challenges in package design. Bio-materials are water-sensitive, and some of their properties, such as permeability, can be influenced by ambient humidity. In addition, prediction models of headspace evolution must be developed for these novel materials. In the multiMAP project, new protein-based materials were developed, characterised, improved, and validated for fresh and fresh-cut fruits and vegetables, and new
prediction models were developed for bio-based materials and microperforated packages. Several high-quality research papers from this multiMAP project are being published in top journals and presented in international conferences.

The first objective of the multiMAP project was the development of novel materials, with a focus on the suitability of bio-based and biodegradable nanocomposites and foamed materials for MAP applications. Polylactic acid (PLA), which is commercially available, and protein-based films, which are currently in the research and development phase, were evaluated. Furthermore, these materials were compared with petroleum-based materials as low density polyethylene (LDPE) and polyamide (PA6). Their permeability in various temperature and humidity conditions was investigated, and the results revealed the weak barrier properties of protein-based materials. Different solutions were proposed to improve material performance, and high-potential materials were developed by adding nanoparticles, increasing material crosslinking, and incorporating additional layers.

The second objective of the multiMAP project was to evaluate the suitability of the developed materials for packaging fruits and vegetables and to compare the packaging performance of these products with those of commercially available bio-based materials. Headspace gas and vapour composition in the packages was monitored, and the produce was subjected to physicochemical and sensory analyses at different time points. The results indicated that PLA pouches help maintain the quality of packaged products and that protein-based materials do not. Nevertheless, several technological advances made during the multiMAP project drastically improved the performance of protein-based materials, resulting in the development of suitable packaging for storing whole and fresh-cut fruits and vegetables, such as whole blueberries and fresh-cut celery.

The third objective of the multiMAP project was to develop computational fluid dynamics models to predict headspace evolution in the developed produce packages. In the final year of the project, gas transport through bio-based and microperforated materials was investigated through different approaches. Numerous factors and parameters were used in our models, increasing complexity and thus rendering multiphysics model implementation the only possible analysis method. Finally, overcoming the drawbacks of previous models, we developed models to predict the atmosphere evolution inside packages with high precision and accuracy. These models would be useful in the produce industry for increasing the shelf life of packaged products and minimising plastic use.

Updated information of multiMAP project, pictures and diagrams can be found in the following link:

www.jaimegb.com/multimap

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