Bioplastics for food packaging

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A two year research project at Ghent University (Department of Food Safety and Food Quality, Ghent, Belgium) has shown that bioplastics have a great potential as a packaging material for various types of food products (short, medium and long shelf life), including packaging under modified atmosphere (MAP). This research project, initiated by Pack4Food and funded by the Agency for Science and Technology (IWT, Brussels, Belgium), was led by Prof. Peter Ragaert and performed in close collaboration with different research institutes (Ghent University, University college Ghent, Packaging Centre, Belgian Packaging Institute and Flanders' Plastic Vision) and 22 companies.

Characterization of biobased materials

The project started with the characterization of multilayered biobased materials that were found on the market or that were laminated especially for this project. Different parameters important for food packaging materials, like barrier properties (Table 1), seal properties and mechanical properties, were collected (from technical sheet or by measurements at the Packaging Centre). The large variation in film characteristics of the different tested materials shows that for various types of food products a suitable biobased packaging material can be found.

Storage tests

Based on the characterization, different multilayered bioplastics were selected to pack different food products (short, medium and long shelf life) (Table 2). Several food products were packaged under modified atmosphere (mostly a mixture of N_2 and CO_2) which is a commonly used preservation technique in the food industry. The food products were analyzed for microbiological, chemical and sensorial parameters at certain times during their shelf life and the results were each time compared with their evolution in the conventionally packaged food products. Some examples of tested packages are shown in Figure 1a and 1b.

The results were mainly positive for the short and medium shelf life products, which were all MAP packed, except for the tomatoes, and stored at 4°C. All tested multilayered bioplastics showed sufficient barrier against O_2 and CO_2 to maintain the shelf life of the tested food products, as shown for ham sausage in Figure 2. For most other parameters, no differences between the biobased packages and the conventional packages were observed. Only for rumpsteak and ham sausage packed in trays, more loss in red or pink color was observed in the bioplastics packaging by the color measurements and these results were confirmed during the sensorial evaluations (performed at the respective food companies). This difference in color could be caused by different UV-transparency properties of the materials.

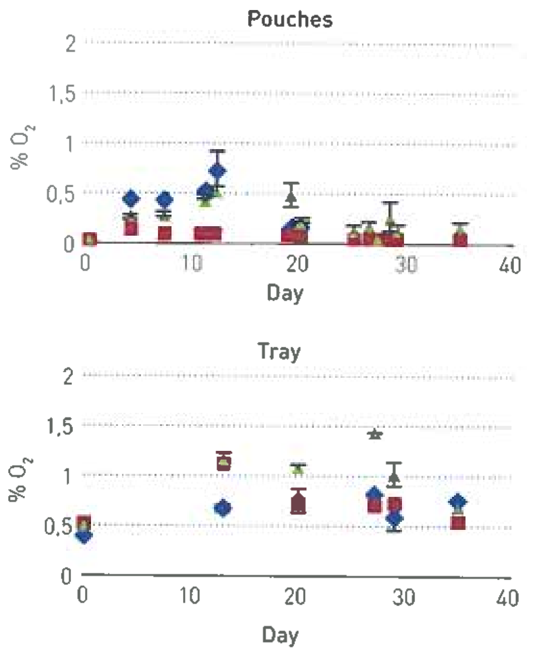

Fig 2: O_2 concentration during the shelf life of ham sausage packed in pouches made of Natureflex type 1 ■, Natureflex type 2 ▲ and in the reference package ◆ or packed in a PLA tray with a Paper/Alox/PLA topfilm ▲, a Natureflex type 1/PLA topfilm ■ and in the reference package ◆.

Food product		Selected films
Short shelf life (storage under cooling)	Tomatoes	PLA tray + Multilayer PLA
	Rumpsteak	PLA tray + Natureflex type 1/PLA
Medium shelf life (storage under cooling)	Ham sausage Filet de Saxe	Natureflex type 1 Natureflex type 2 PLA tray + Natureflex type 1/PLA
	Ham sausage	PLA tray + Paper/AlOx/PLA
	French fries Grated cheese	Natureflex type 1 Natureflex type 2
Long shelf life (storage at room temperature)	Potato flakes	Skalax (Xylophane) Natureflex type 2
	Rice cakes Tortillachips	Cellophane /M/PLA Natureflex type 1 Natureflex type 2
	Speculoos	Cellophane /M/PLA Natureflex type 3 Natureflex type 4

Table 2: Overview selected food products and films

For the dry, long shelf life products, maintaining crispness is essential. Moisture barrier is very important for these food products, which were packed under air, except for the potato flakes, which were MAP packed, and stored at room temperature. Tortillachips and rice cakes maintained their crispness when they were packed in the biobased packaging during 6 or 12 months. Also no different lipid oxidation occurred compared to the conventional packaging. For potato flakes, no good sealed packages could be made from the Xylan based material (due to food product contamination on the sealing zone during filling), but the Natureflex™ film showed similar barrier properties as the conventional film. Furthermore, no difference in parameters was observed between both films. Because of the small packages, dry biscuits were immediately packed at the company itself. Small holes and micro leaks in the seal (due to the thickness of the film) caused to much moisture uptake by dry biscuits packed in the Natureflex type 3 film. Less moisture uptake was observed in the Natureflex type 4 film, but still the moisture barrier was insufficient to keep the biscuits crisp during the entire shelf life of 30 weeks.

Printability and migration tests

The Natureflex type 1 film (Fig. 3) was printed in the framework of a collaboration between Lima (organic food products) and Be_Natural (packaging consultant sustainable packaging). This packaging went commercial in 2012. Besides, a multilayer PLA film was printed at Vitra NV during the research project. The film could be printed without any problem and further testing showed good adhesion of the inks on the film surface. The PLA film seemed however receptive to solvents, which should be solved by applying other types of inks or adjusting the print design (no full surfaces). Global migration tests (10% and 95% ethanol) showed that all the tested multilayered biobased films did not exceed the limit of 10 mg/dm².

Case studies at food companies

Several bioplastics were selected to be tested in production environment at different participating companies in the project. On the vertical flow pack machines, only easily solvable problems were encountered (e.g. optimizing time-temperature settings) and good sealed packages could be made. On the horizontal flow pack machines, it was also possible to make sealed pouches, but some of the films seemed too brittle to be filled with a large amount of product.

Material	O_2 (cm³/m²·d) 23°C - 75% RH	H_2O (g/m²·d) 38°C - 90% RH
Natureflex type 1	9.9	10.1
Natureflex type 2	3.4	5.0
Ecoflex+Ecovio/Ecovio/Ecoflex+Ecovio	815.0	216.4
Metallised PLA	25.4	2.3
Cellophane /Metal/PLA	9.1	9.7
Paper/AlOx/PLA	45.7	6.0
Bioska (multilayer PLA)	617.6	275.1
Natureflex type 1/PLA	11.01	11.3
PHB/Ecoflex	142.1	80.6
Xylophane A (coated on paper)	3.7	24.3
PLA tray (Ingeo)	46.8	3.8

Table 1. Barrier properties of multilayered biobased plastics

In conclusion, this collaborative research project shows promising results for packing different food products in bioplastics without compromising the desired shelf-life. This also includes applications for MAP packaging. Moreover, some of the tested materials are already in use today. Examples are given in Fig. 3 (rice packaging - company Lima) and Fig. 4 (sliced meat packaging – company Ter Beke). Further attention however needs to be given to bioplastics materials for certain moisture sensitive food products in need of a high moisture barrier. Besides, the participating companies in the project mentioned issues such as current price and waste management options as important parameters in the decision and implementation process of companies whether or not to add bioplastics in their product portfolio.

www.foodscience.UGent.be
www.Pack4Food.be
www.iwt.be

Left Figure 1a. Ham sausage in PLA tray + Natureflex type 1-PLA
Right Figure 3. Rice packaging from company Lima (www.limafood.com)

Figure 1b. Tortillachips packed in reference (l) - natureflex type 2 (m) - Natureflex type 1 (r)

Figure 4. Sliced meat packaging from company Ter Beke (www.terbeke.com)