Multilayer structures to improve the barrier properties of egg white protein films for the packaging of fresh fruits and vegetables

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INTRODUCTION and OBJECTIVE

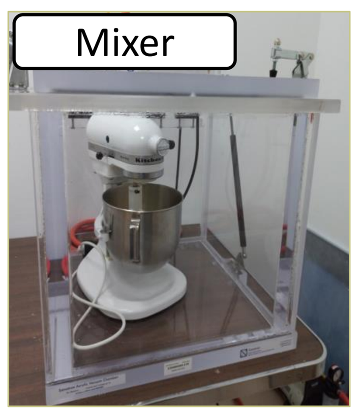
Modified atmosphere packaging (MAP) is a technology used to extend the self-life of fruits and vegetables. This technology consists in modifying the in-package gas composition. Most of these packages are made from petroleum-based polymers and the research community is focusing on finding biodegradable packaging materials. Proteins-based polymers could be an alternative (Hernandez-Izquierdo y Krochta, 2008), but some, like egg white protein films (EWP), are very sensitive to water due to their hydrophilic nature and have poor water vapor barrier capacity (Pranata et al., 2019). Multilayer structures with hydrophobic materials could be an alternative to solve this drawback. For these reason, the aim of this work was to evaluate the effect of adding layers of zein or beeswax on the barrier properties of EWP films and assess their applicability to the packaging of fresh fruits and vegetables.

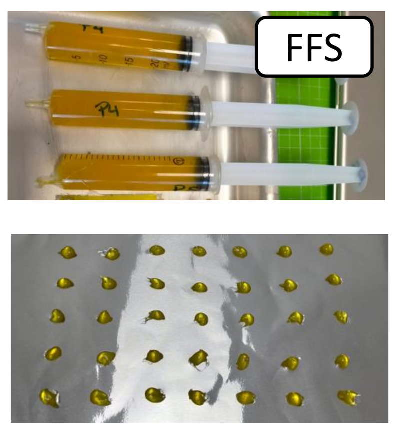
MATERIALS AND METHODS

1.- FILMS PRODUCTION

Mixing → Stabilization → Compression molding → Film extraction → Coating or layering → Bags forming → Product packaging

- Mixing: EWP:GLY:H_2O (1:0.5:0.5 w/w)
- Stabilization: 24 h / 5°C
- Compression molding: 1st cycle: 130°C at 150 bars; 2nd cycle: 20°C at 150 bars

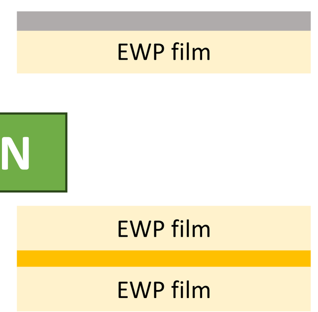




Hydrophobic compounds

BEESWAX (BW) — Applied as a coating

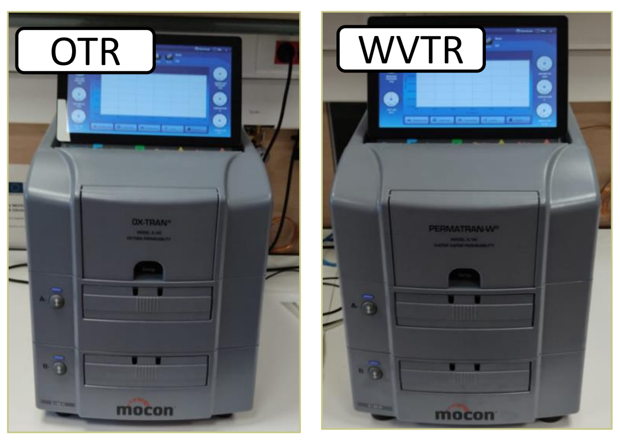
ZEIN — Multilayer structure



Bags: CONTROL (macroperforated) · EWP · EWP + BW · EWP + ZEIN · PLA · OPP

2.- FILMS CHARACTERIZATION

- Oxygen Transmission Rate (OTR): Mocon OX-TRAN 2/22
- Water Vapour Transmission Rate (WVTR): Mocon PERMATRAN-W 3/34
- Opacity: Spectrophotometer Libra S22 - Biochrom



3.- FRESH PRODUCT PACKAGING

CELERY — Fresh-cut, 14 days / 5°C

CHERRY TOMATO — Fresh, 21 days / 5°C

→ weight loss (%)

RESULTS

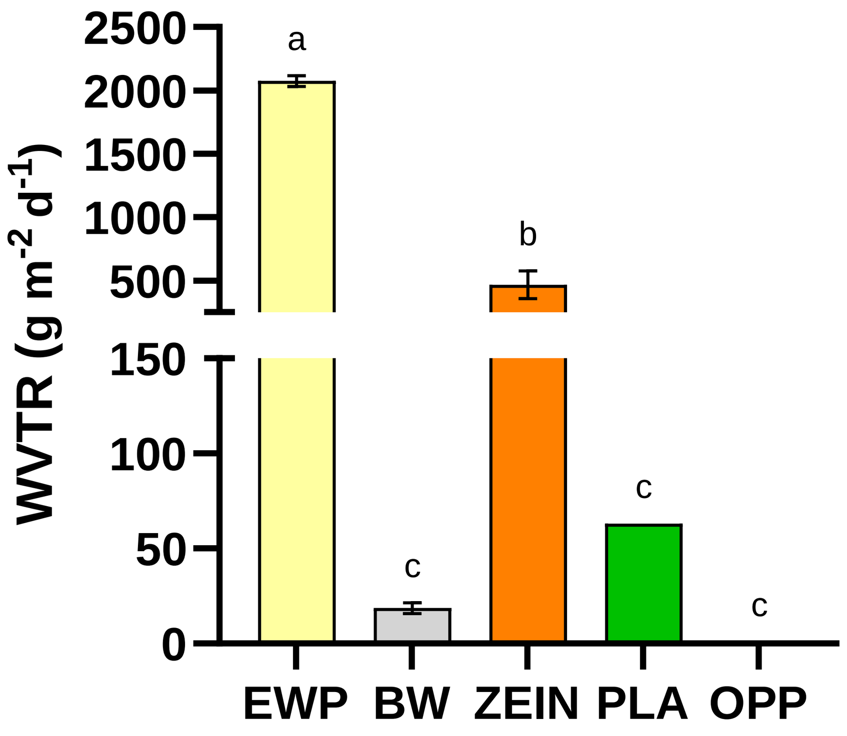


Figure 1 . Water Vapour Transmission Rate (WVTR) of EWP film, EWP film with beeswax coating (BW), EWP multilayer film with zein (ZEIN), PLA and OPP films. (Measurements realized at 23°C and 90% RH).

Opacity	
EWP	1.63 ± 0.12
BW	6.68 ± 1.24
ZEIN	1.02 ± 0.10
PLA	0.93 ± 0.08
OPP	1.09 ± 0.06

Table 1 . Opacity of EWP film, EWP film with beeswax coating(BW) and EWP multilayer film with zein (ZEIN), PLA and OPP films.

Due to the hydrophobicity of the materials used, the EWP films with beeswax coating and the multilayer EWP films with zein showed a significant reduction in WVTR compared to uncoated EWP films (Figure 1). The films coated with beeswax had even lower WVTR than PLA films, but these films are much more permeable to water vapour than the commercial OPP films. Transparency of the films was assessed by calculating the opacity of the films (Table 1). It was observed that the EWP films with beeswax coating had the highest opacity value, while the remaining values were close to 1.

Fresh-cut celery packaged in EWP bags experienced high weight loss (almost 70 %). The addition of zein (multilayer) or beeswax (coating), while reducing this weight loss, did not bring it closer to that of commercial films. In the images of celery (Figure 3), pronounced dehydration is observed in the control samples and those packaged in EWP bags. A similar trend was observed for cherry tomatoes, although in this case, the weight losses in EWP bags coated with beeswax approached those of PLA (Figure 4). None of the biodegradable bags tested (protein-based or PLA) yielded data comparable to those of OPP.

Figure 3. Scanned images of fresh-cut celery packaged in bags made of EWP and commercial films, after 14 days of storage at 5 °C.

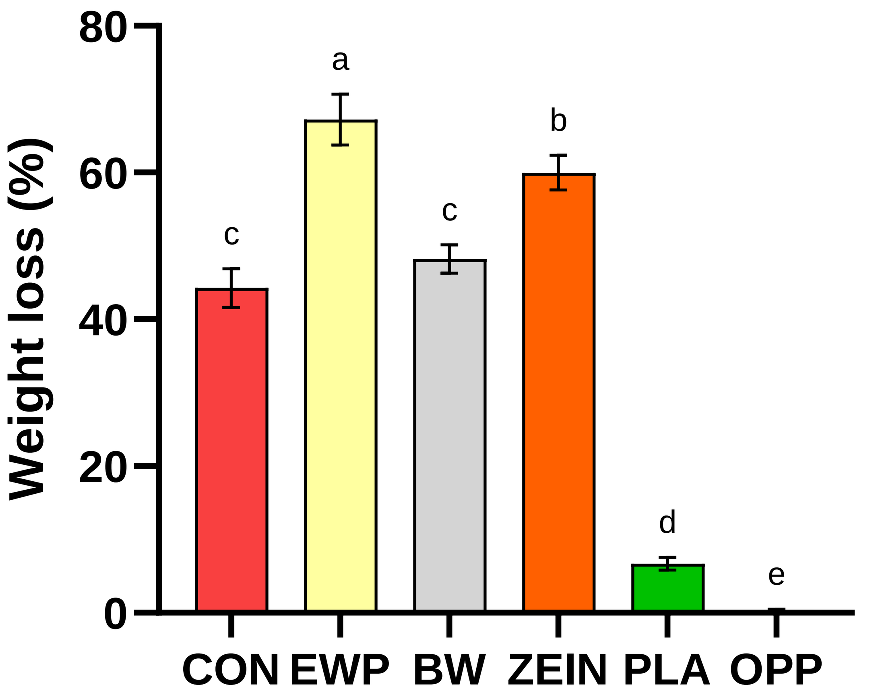


Figure 2. Weight loss of fresh-cut celery packed in bags of different materials after 14 days of storage at 5°C.

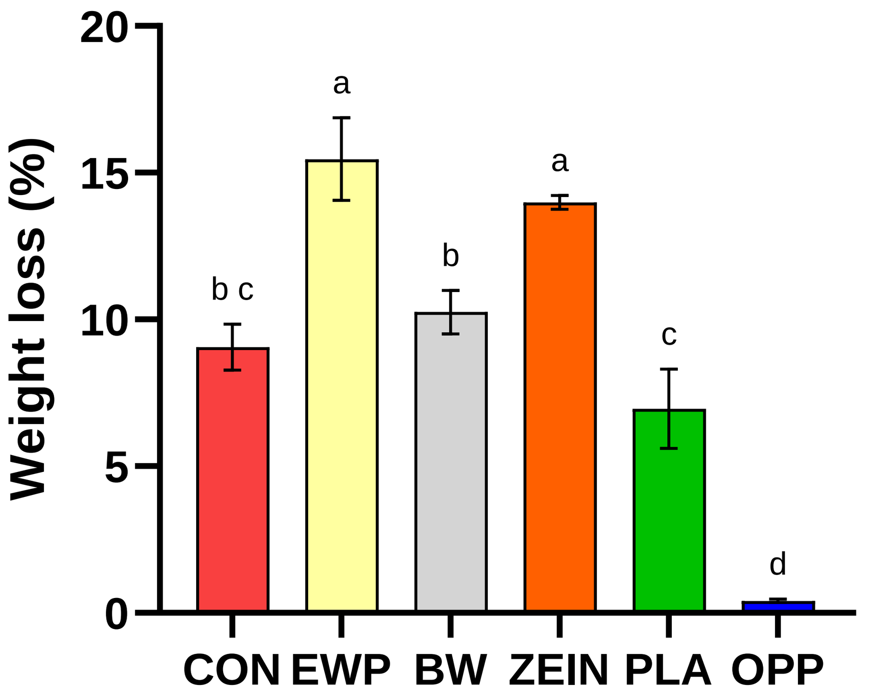


Figure 4. Weight loss of cherry tomatoes packed in bags of different materials after 21 days of storage at 5°C.

CONCLUSIONS

- The application of coatings or multilayer structures containing hydrophobic materials led to a decrease in the WVTR of the EWP films. Nevertheless, the use of beeswax as a coating resulted in an increase in the opacity of the EWP films.
- The use of EWP films for packaging fresh-cut celery resulted in marked dehydration and strong weight loss.
- For packaging cherry tomatoes, EWP film coated with beeswax is an alternative as the product exhibited behavior comparable to that of PLA films.
- Improvements in EWP films are required to obtain results comparable to those of OPP films.

REFERENCES

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