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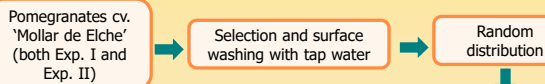
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INTRODUCTION

The autochthonous pomegranate (*Punica granatum* L.) cultivar 'Mollar de Elche' is the predominant cultivar in Spain. Although with lower external red color, it has soft seeds and outstanding organoleptic properties. Weight loss, chilling injury, and fungal decay are the main factors affecting postharvest quality and limiting the cold storage of pomegranate fruit.

The **OBJECTIVES** of this research were to extend the storage life of fresh entire 'Mollar de Elche' pomegranates using edible coatings (ECs) amended with GRAS (generally recognized as safe) salts as antifungal agents and combining them with modified atmosphere packaging (MAP) technology. Composite ECs were based on the hydrocolloid hydroxypropyl methylcellulose formulated with the lipids beeswax, carnauba wax, or glycerol monostearate as hydrophobic components, and potassium bicarbonate or sodium benzoate as antifungal ingredients.

MATERIALS AND METHODS



EDIBLE COATING PREPARATION

- Hydrocolloid (2%): hydroxypropyl methylcellulose (HPMC)
- Lipid: beeswax (BW, 0.8%), carnauba wax (CW, 0.8%) or glycerol monostearate (GMS, 0.44%)
- Plasticizer (0.4%): glycerol + Emulsifier (0.4 or 0.86%)
- GRAS salt (2%): sodium benzoate (SB) or potassium bicarbonate (PBC)
- Total solids: 5.6%
- Heating + Homogenization (Ultra-Turrax)

EXPERIMENT I

Treatments (ECs)

- CONTROL (Uncoated)
- HPMC-BW-SB
- HPMC-BW-PBC
- HPMC-CW-SB
- HPMC-CW-PBC
- HPMC-GMS-SB
- HPMC-GMS-PBC

EXPERIMENT II (Figure 1)

Treatments (ECs + MAP)

- CONTROL (Uncoated)
- HPMC-CW-SB
- HPMC-CW-SB + MAP (Xtend® bags)
- HPMC-BW-SB + MAP
- Uncoated + MAP
- FLUDIOXONIL (Fungicide, 0.6 g/L)

INCUBATION

7 and 14 days at 20°C

COLD STORAGE

4 and 8 weeks at 5°C, 90% RH + 1 week at 20°C (Shelf life)

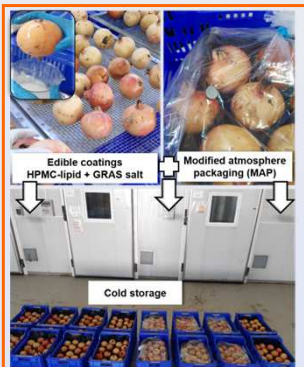


Figure 1. Experimental procedure for Experiment II.

Fruit quality assessment

- Weight loss; Rind color; CO₂ and O₂ concentrations (MAP)
- Juice quality: SSC, TA, pH, MI (maturity index)
- Ethanol and acetaldehyde contents
- External and internal decay
- Physiological disorders
- Sensory evaluation

RESULTS

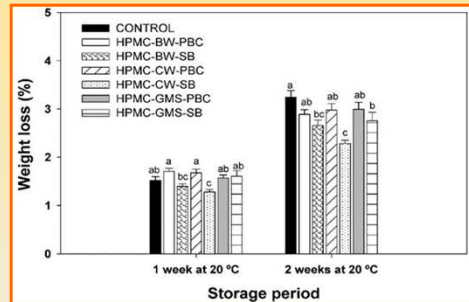


Figure 2. Experiment I. Weight loss of 'Mollar de Elche' pomegranates coated with HPMC coatings amended with antifungal GRAS salts. For each storage period, columns with different letters indicate significant differences among treatments according to Fisher's protected LSD test ($P < 0.05$) applied after an ANOVA.

Figure 3. Experiment II. Weight loss of 'Mollar de Elche' pomegranates treated with HPMC coatings amended with antifungal GRAS salts alone or in combination with MAP for 8 and 15 weeks at 5°C and 90% RH followed by a shelf-life period of 1 week at 20°C. For each storage period, columns with different letters indicate significant differences among treatments according to Fisher's protected LSD test ($P < 0.05$) applied after an ANOVA.

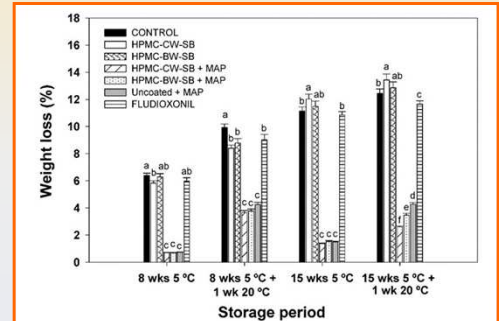


Table 1. Experiment II. Juice quality of 'Mollar de Elche' pomegranates at harvest and after treatment with HPMC antifungal edible coatings and/or MAP, followed by storage at 5°C and 90% RH plus a shelf-life period of 1 week at 20°C. For each storage time, means in columns with different letters are significantly different by Fisher's protected LSD test ($P < 0.05$) applied after an ANOVA.

| Treatments | Juice quality | | | | | | |
|-----------------|------------------|--------------------|---------------|----------------|-------------------------|--------------------|-----------------|
| | SSC (°Brix) | TA (% citric acid) | pH | MI | Acetaldehyde (mg/100ml) | Ethanol (mg/100ml) | |
| All harvest | 15.90 ± 0.03 | 0.23 ± 0.01 | 4.16 ± 0.05 | 69.13 ± 0.58 | 0.18 ± 0.03 | 0.52 ± 0.10 | |
| 8 weeks at 5°C | CONTROL | 15.15 ± 0.10 b | 0.18 ± 0.00 b | 5.10 ± 0.02 a | 82.88 ± 0.95 b | 0.23 ± 0.02 a | 1.69 ± 0.25 c |
| | HPMC-CW-SB | 15.28 ± 0.12 b | 0.18 ± 0.00 b | 5.10 ± 0.04 a | 83.03 ± 0.43 b | 0.27 ± 0.02 a | 1.63 ± 0.31 c |
| | HPMC-BW-SB | 15.92 ± 0.22 ab | 0.18 ± 0.00 b | 5.08 ± 0.03 a | 90.58 ± 2.63 a | 0.21 ± 0.02 a | 0.85 ± 0.34 c |
| | HPMC-CW-SB + MAP | 16.42 ± 0.41 a | 0.18 ± 0.00 b | 5.01 ± 0.04 ab | 90.82 ± 1.95 a | 0.09 ± 0.04 b | 4.33 ± 0.79 a |
| 1 week at 20°C | HPMC-BW-SB + MAP | 15.15 ± 0.13 b | 0.18 ± 0.00 b | 4.93 ± 0.01 bc | 84.36 ± 2.59 ab | 0.23 ± 0.02 a | 3.22 ± 1.05 ab |
| | Uncoated + MAP | 15.77 ± 0.47 ab | 0.20 ± 0.01 a | 4.87 ± 0.04 cd | 80.40 ± 3.92 b | 0.21 ± 0.02 a | 1.83 ± 0.10 bc |
| | FLUDIOXONIL | 15.52 ± 0.13 b | 0.20 ± 0.00 a | 4.79 ± 0.01 d | 78.60 ± 0.73 b | 0.25 ± 0.02 a | 1.44 ± 0.11 c |
| 15 weeks at 5°C | CONTROL | 15.07 ± 0.25 a | 0.17 ± 0.01 a | 4.71 ± 0.02 a | 86.95 ± 4.17 a | 3.06 ± 0.12 cd | 27.37 ± 0.85 bc |
| | HPMC-CW-SB | 15.10 ± 0.05 a | 0.17 ± 0.01 a | 4.80 ± 0.05 a | 90.99 ± 2.43 a | 3.88 ± 0.06 ab | 26.22 ± 0.28 cd |
| | HPMC-BW-SB | 15.17 ± 0.07 a | 0.18 ± 0.01 a | 4.71 ± 0.09 a | 84.48 ± 2.92 a | 4.28 ± 0.35 a | 30.55 ± 1.23 b |
| | HPMC-CW-SB + MAP | 15.33 ± 0.12 a | 0.16 ± 0.01 a | 4.87 ± 0.03 a | 93.58 ± 3.54 a | 2.77 ± 0.23 cd | 23.24 ± 1.77 de |
| 1 week at 20°C | HPMC-BW-SB + MAP | 14.67 ± 0.32 a | 0.16 ± 0.01 a | 4.91 ± 0.06 a | 92.85 ± 3.36 a | 3.45 ± 0.23 bc | 21.31 ± 0.83 e |
| | Uncoated + MAP | 15.23 ± 0.27 a | 0.16 ± 0.00 a | 4.75 ± 0.08 a | 92.76 ± 2.12 a | 2.53 ± 0.07 d | 29.74 ± 3.04 bc |
| | FLUDIOXONIL | 15.07 ± 0.15 a | 0.17 ± 0.00 a | 4.86 ± 0.05 a | 89.37 ± 2.76 a | 3.81 ± 0.38 ab | 35.61 ± 0.92 a |

CONCLUSIONS

- HPMC-BW-SB coatings reduced the development of pomegranate latent infections caused by *Botrytis cinerea* and wound infections caused by *Penicillium* spp.
- MAP bags were effective to preserve freshness, prevent fruit shriveling and rind browning, and reduce fungal decay, thus extending storage life of pomegranates.
- The combination HPMC-BW-SB + MAP was the most promising treatment as it reduced weight loss and decay, without negatively affecting the fruit physicochemical and sensory quality.