Antifungal Edible Coatings for Postharvest Disease Control and Quality Maintenance of Fresh Fruits

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Centre de Tecnologia Postcollita (CTP)

Outline

- Introduction
- Natural antifungal edible coatings
- Synthetic antifungal edible coatings
  - Coating matrixes
  - Antifungal ingredients
- Evaluation of antifungal edible coatings
  - Preparation of emulsions
  - In vivo disease control ability
  - Effects on fruit quality and physiological behavior

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ALTERNATIVE FUNGICIDE-FREE STRATEGIES TO CONTROL POSTHARVEST DECAY

Alternative postharvest antifungal treatments

- Physical treatments
- Biological treatments
- Low-toxicity or low-risk chemical treatments
  - Natural compounds
  - Food additives and GRAS compounds
  - Disease resistance inducers
  - **Antifungal edible coatings**

Antifungal edible coatings

- Edible coatings: regulation of physiological responses of fresh produce during postharvest storage
  - Regulation of water vapor exchange: fruit transpiration
  - Regulation of gaseous exchange (CO_2, O_2): fruit respiration

- Antifungal edible coatings
  - Increased functionality: double function (physiological, pathological)
  - Replace conventional postharvest waxes formulated with synthetic chemical fungicides

Antifungal edible coatings

- Natural: Chitosan, *Aloe* spp. gels,...
- Synthetic: composite films and coatings
  - Hydrocolloid and lipid matrixes formulated with antifungal ingredients

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Chitosan

- Edible natural biopolymer with antimicrobial activity
- Deacetylated derivative from chitin (exoskeletons of crustaceans)
- Approved as basic substance
- Tested alone or amended with other antifungal ingredients (mostly essential oils)
- Chitosan-based nanoemulsions and nanocomposites also obtained
- Mono or multilayer applications

Aloe spp. gels

- *Aloe vera* is the most important species
- Gel obtained from extracts of leaf pulp
- Coating properties and proved antifungal activity
- Tested alone or in combination with other antifungal ingredients (essentials oils, …)

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Types of coating matrixes

- Hydrocolloids
  - Polysaccharides: HPMC, CMC, gums, starch, pectins,…
  - Proteins: whey, casein, pea, soy,…
- Lipids: natural waxes, mono-, di-glicerids, fatty acids,…
- Composite: hydrocolloids + lipids

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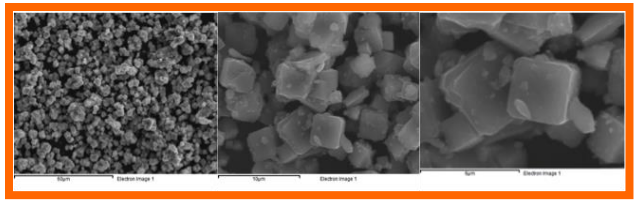
- Composite: hydrocolloids + lipids
- Minor ingredients: emulsifiers, plasticizers,…
- Specific carriers of antifungal ingredients
  - Through impregnation or encapsulation
  - Zeolites, β-cyclodextrin, lecithin, Arabic gum,…

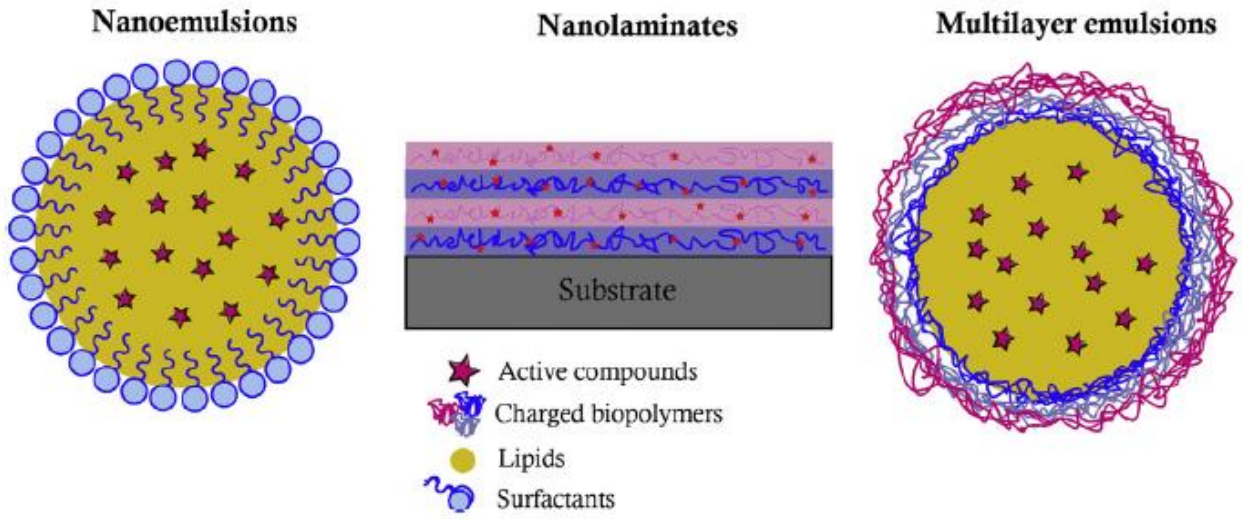


Antifungal ingredients: Types

- Food additives and GRAS salts (Na, K, NH_4,…)
  - Organic salts: sorbates, benzoates, paraben, silicates,…
  - Inorganic salts: bicarbonates, carbonates,…
- Natural compounds: essential oils, plant extracts,…
- Antifungal proteins and peptides
  - Bacteriocins, lysozyme, nisin,…
- Metal-based nanoparticles
  - Metals: Ag, Au,…
  - Oxides: ZnO, SiO_2, TiO_2, Al_2O_3, Fe_3O_4, Fe_2O_3,…
- Biocontrol agents: antagonistic microorganisms

Antifungal ingredients: Incorporation

- Amended, imbibed
- Impregnation of solid particles
- Microencapsulated or nanoencapsulated
- Multilayer nanolaminates: layer by layer technique



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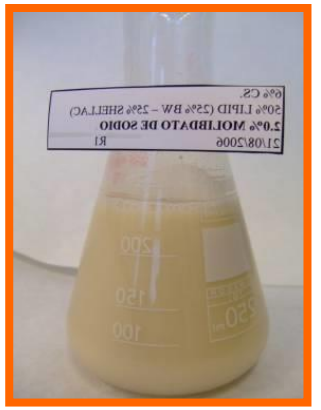
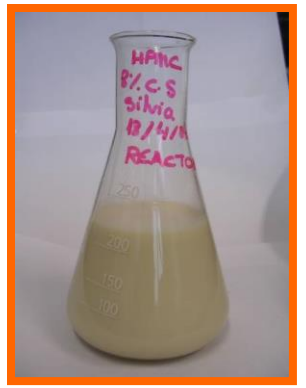
Preparation of emulsions

- Incorporation of antifungal ingredients at selected concentrations into hydrocolloid-lipid composite emulsions
- Example: emulsions prepared with:
  - Aqueous solution HPMC
  - Lipid: beeswax (BW)
  - Glycerol (plasticizer)
  - Oleic acid (emulsifier)
  - Tween 80 (wetting agent)
  - Total SC = 6-10% wb
- Samples homogenized (Ultra-Turrax)

  (98ºC; 1 min 12,000 rpm; 3 min 22,000 rpm)

  25 min cooled under agitation





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In vivo disease control ability

Curative activity

Fresh fruit samples

Selection, washing, and random distribution

Inoculation

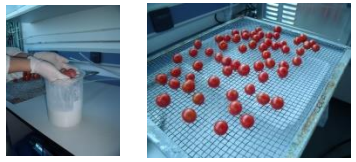
Spore suspensions
- 10^4-10^6 spores/mL
- 1-3 wounds/fruit

EDIBLE COATINGS FORMULATION

Selected antifungal ingredient and concent.

Emulsions containing
- Composite matrix
- Antifungal ing

EDIBLE COATINGS APPLICATION
- **Curative activity:** 2-24 h after fungal inoculation
- **Application by immersion for up to 30 s or in waxing equipment**
- **Drained on a mesh screen and allowed to air-dry**



Control treatment:
Inoculated but uncoated fruit

Incubation
4-15 days at 20-25ºC

Evaluation
After incubation period
- **INCIDENCE** % infected wounds
- **SEVERITY** Lesion diameter

Disease reduction with respect to control fruit

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Effects on fruit quality and physiological behavior

Cold storage

Initial quality
(at harvest)

Treatment with selected antifungal coatings

Cold storage
15-60 days at 0, 5ºC, 90-95% RH
+
Shelf life
3-7 days at 20ºC

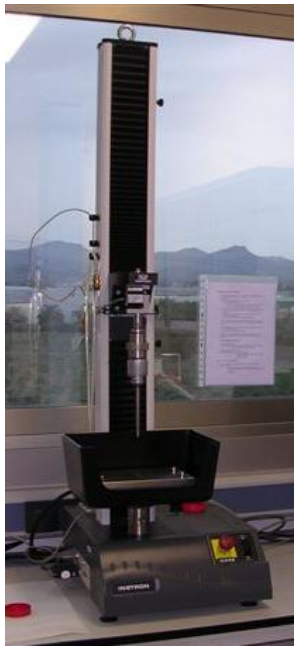
Quality evaluations

Physico-chemical attributes

- **Weight loss (WL, %)**
- **Peel color (Minolta)**
- **Fruit firmness (% of deformation, Instron)**
- **Internal quality: SSC, TA, pH**
- **Respiration rate**
- **Ethanol and acetaldehyde contents (GC)**
- **Bioactive compounds (HPLC)**

Sensory attributes

- **Flavor, off-flavors**
- **Fruit external aspect**



Funding

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Guest Editors

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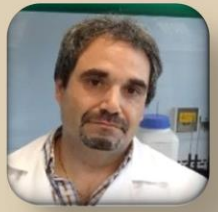

Deadline

20 May 2024

Special Issue

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Invitation to submit

Thanks for your attention!!

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