VIII SIMPÓSIO DO PAPAYA BRASILEIRO
Linhares - Espírito Santo
20 a 23 de setembro/ 2022

Tecnologias pós-colheita para extensão da vida de prateleira do mamão

Marcos David Ferreira
Embrapa Instrumentação
21/09/2022

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Ponto de Colheita vs. Danos físicos vs. Temperatura

- **Apresentação de Tecnologias**
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    - Embalagens
  - Tratamentos físicos
  - Microorganismos antagonistas

- **Conclusões e comentários finais**

Pesquisa Agropecuária Brasileira

Empresa Brasileira de Pesquisa Agropecuária (Embrapa)

MISSÃO

Viabilizar soluções de pesquisa, desenvolvimento e inovação para a sustentabilidade da agricultura, em benefício da sociedade brasileira.

PERFIL INSTITUCIONAL

- Fundada em 1973
- Vinculada ao Ministério da Agricultura, Pecuária e Abastecimento (Mapa)
- Quadro Funcional:
  - 8.042 Empregados
  - 2.232 Pesquisadores
  - 1.999 Doutores (PhD)

FoFonte referência: Embrapa/GGP

Pesquisa Agropecuária Brasileira

Empresa Brasileira de Pesquisa Agropecuária (Embrapa)

- **43** Unidades Descentralizadas (Centros de Pesquisa)
- **7** Unidades Centrais (Administrativas)

Embrapa Instrumentação

Embrapa Instrumentação

- **32 pesquisadores:**

- 9 físicos
- 7 engenheiros eletrônicos e eletricistas
- 4 engenheiros de materiais
- 3 químicos
- 3 engenheiros agrônomos
- 2 engenheiros químicos
- 1 engenheira de alimentos
- 1 engenheiro mecânico
- 1 bioquímico farmacêutico
- 1 economista

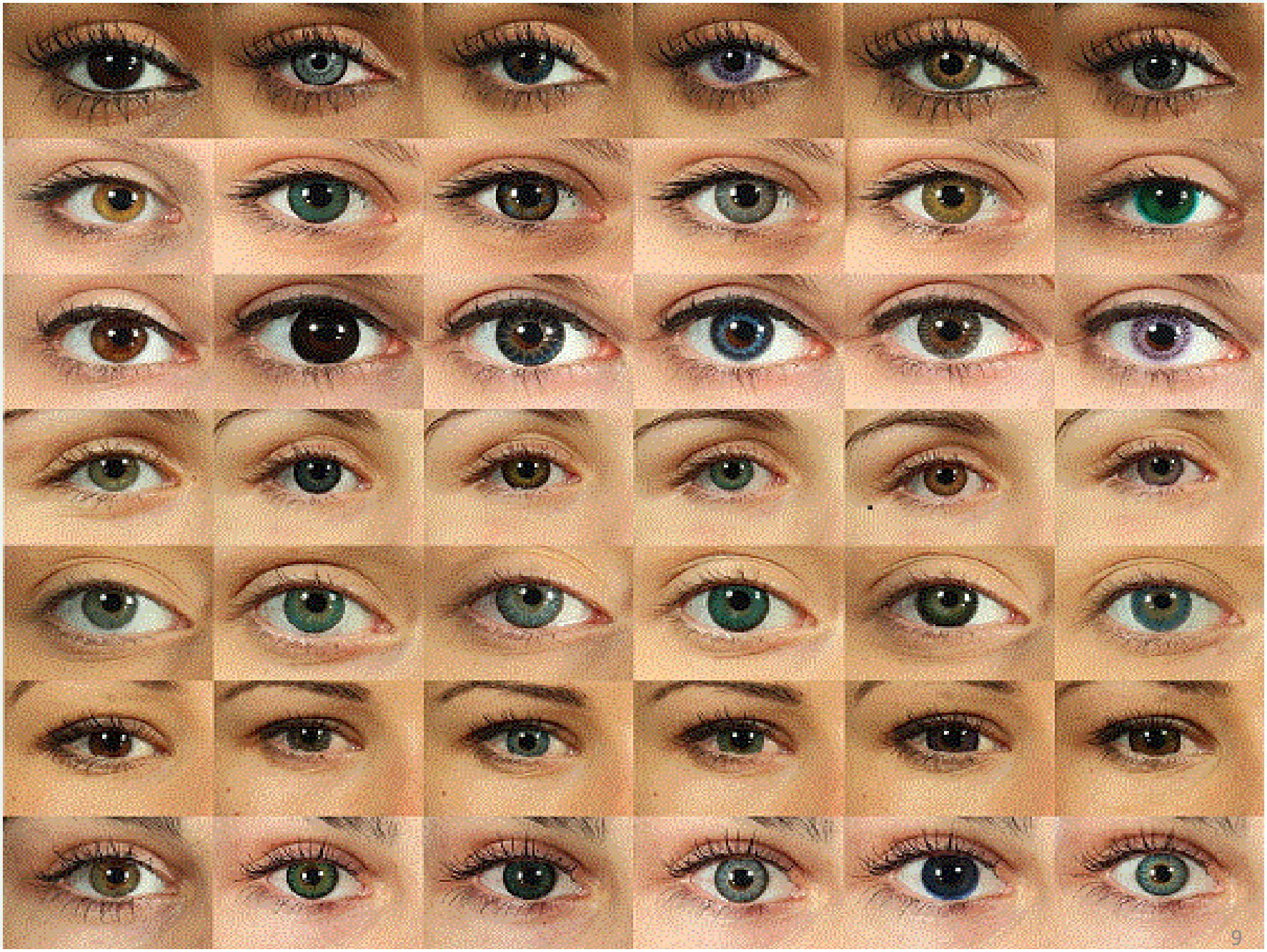
- **Total de 86 funcionários**
- **bolsistas nível médio, graduação, pós-graduação e pós-doc**
- **300 colaboradores: graduação, pós-graduação e pós-doutorado**

Linhas de Pesquisa

1. Automação e agricultura de precisão
2. Química e tecnologia da biomassa
3. Meio ambiente, manejo e conservação dos recursos naturais
4. Nanotecnologia aplicada ao agronegócio
5. **Instrumentação para pós-colheita**

Projetos

- 2023 participação de até 40% de projetos de inovação aberta com o setor produtivo
- Embrapa atual: 24%
- Embrapa Instrumentação: 70%



Agricultura Brasileira

Produção Agrícola Anual (em milhões de toneladas)

Grãos
244,9
(2020)

Frutas
43,6
(2020)

26.6% PIB
20,1% FT

Carnes
28,1
(2020)

Leite
35,4
(2020)

A agricultura brasileira é baseada em mais de 300 espécies de cultivos e envia ao mundo 350 tipos de produtos que chegam a 200 mercados do planeta.

Fonte: IBGE, Conab
Fonte referência: Embrapa/Sire (Novembro/2021)

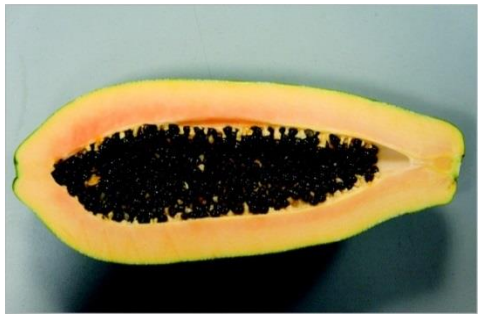
Como aumentar o tempo de prateleira?

- Boas práticas
- Ponto de Colheita vs Manuseio vs temperatura
- Danos físicos – Inimigo oculto

Tecnologias Pós-Colheita

Ponto de Colheita vs. Qualidade

- Cor da casca e polpa



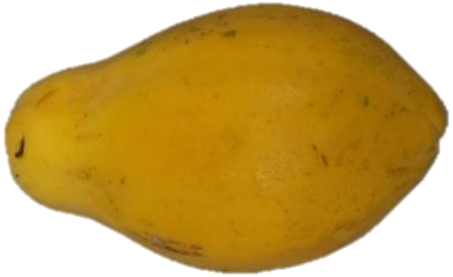
- Sabor

- Aparência & Preço

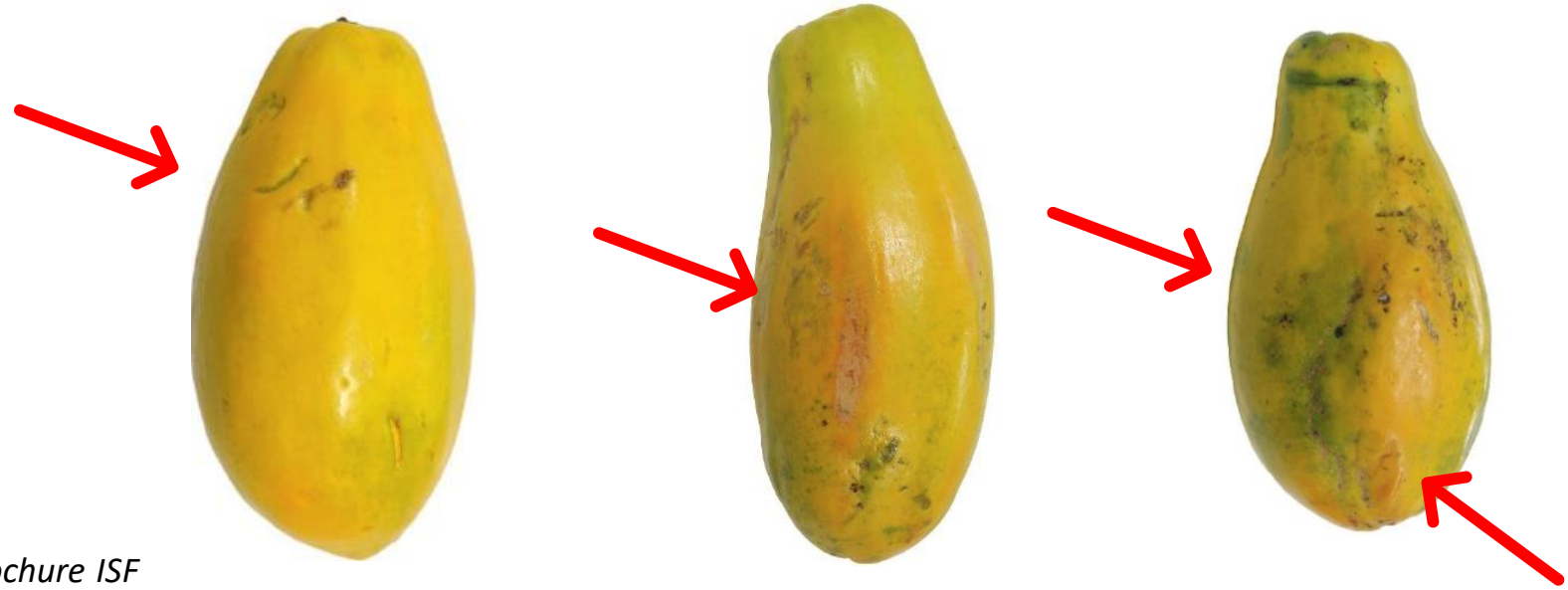
- Defeitos

Fonte: Ap. Fabiana Sasaki

Danos físicos



- **Frutos verdes**
- **Frutos Maduros**



Fonte: Brochure ISF

Danos físicos

Fonte: CEAGESP & Fabiana Sasaki

Embalagem

- Terminal da CEAGESP
- 6 horas para ser descarregado
- Perdas estimadas em torno de 20%

Fonte: Pereira et al., 2021

Fotos: Gabriel Bitencourt de Almeida

Embalagem

» De acordo com as exigências do mercado

Foto: Fabiana Fumi C. Sasaki

Foto: Patrícia Lígia Moraes

Temperatura

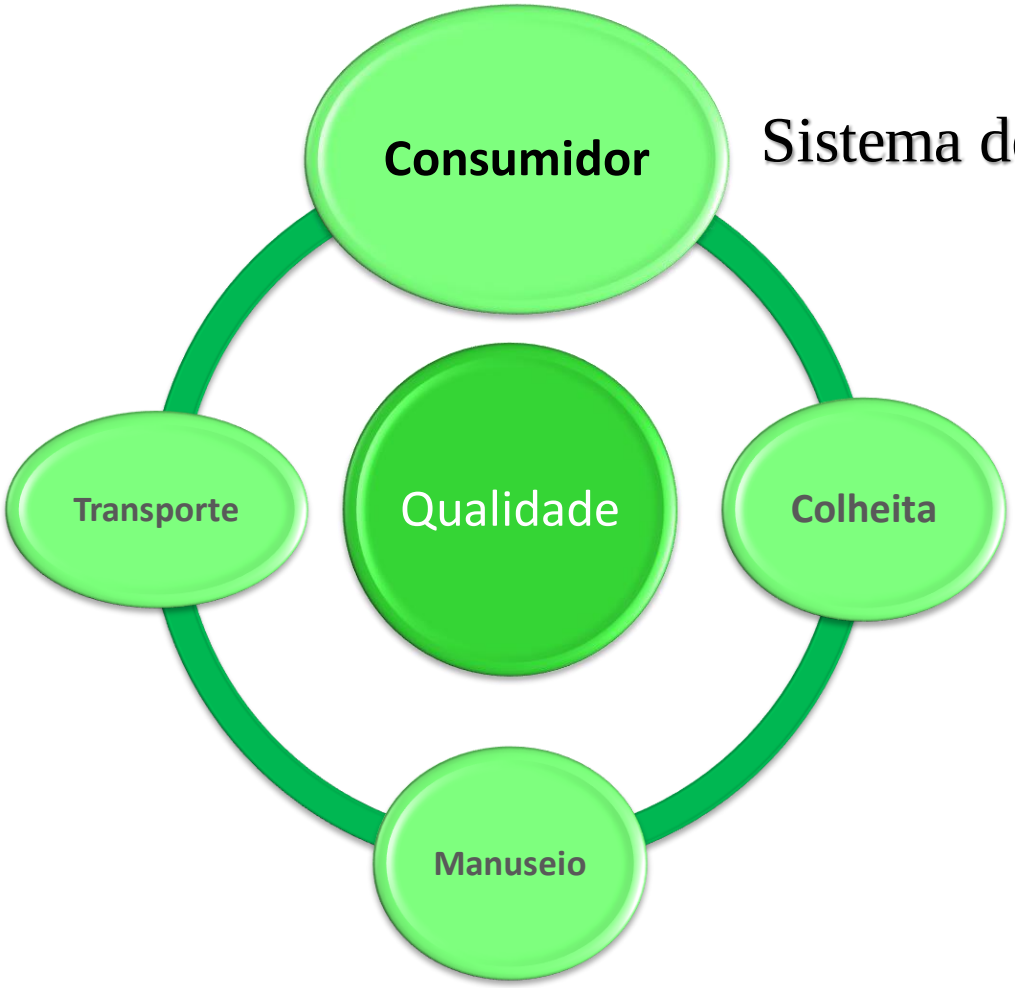
Ambiente

- Aumento da atividade respiratória
- Aumento de 4 a 5 vezes com aumento da temperatura de 10ºC a 30ºC

Refrigerada

- Diversas recomendações
- Frutos verdes mais sensíveis ao frio
- 10ºC a 13ºC/16 ºC

Qualidade Pós-Colheita



Sistema de comercialização

Perecíveis

Tecnologias Pós-Colheita

Tecnologias Pós-Colheita

Mercado Interno vs. Mercado Externo

- 96% da produção do mamão destina-se ao mercado interno
- Brasil – terceira posição no mercado de exportações mundiais.
- Exportação aérea – 95,3% (2018)

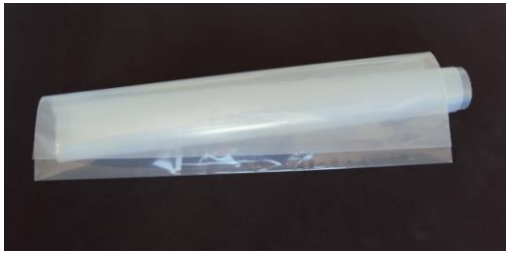
Tecnologias a serem apresentadas

- **Nanotecnologia**
  - Revestimentos comestíveis c/OEs
  - Nanossensores
  - Filmes aditivados
- **Tratamentos Físicos**
- **Microrganismos Antagonistas**

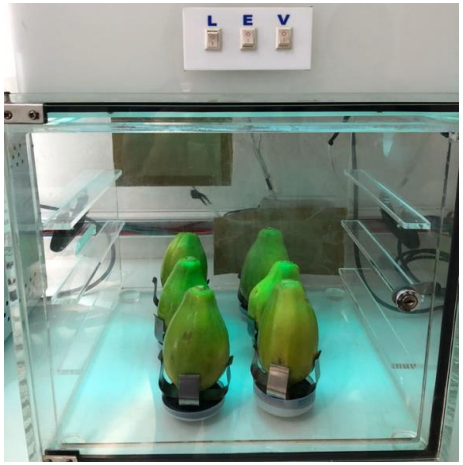
Projeto Saúde-Mamão
Rede Nanotecnologia Embrapa

Tecnologias

Nanotecnologia



Tratamentos Físicos



Microrganismos antagonistas

O que é Nanotecnologia?

Nanotecnologia

Rede Agro Nano

Iniciou em 2006
158 pesquisadores
53 centros de pesquisa e universidades

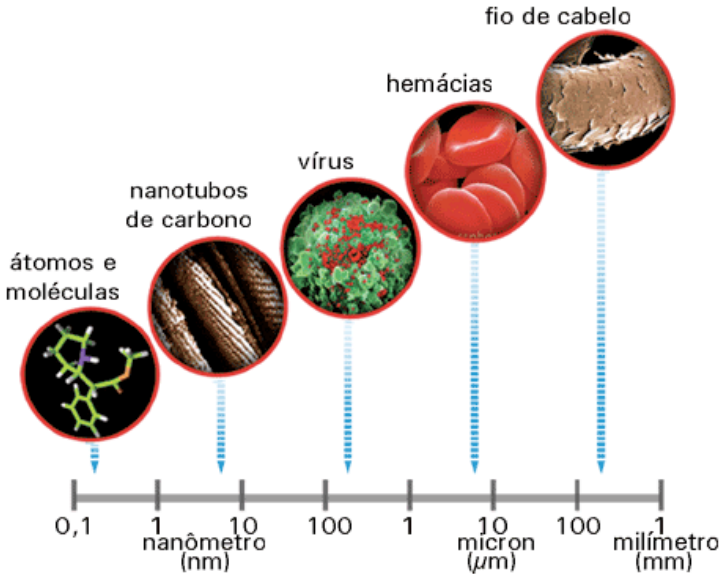
Embrapa

Laboratório Nacional de Nanotecnologia para o Agronegócio - LNNA

2009

2013

Nanotecnologia Aplicada ao Agronegócio



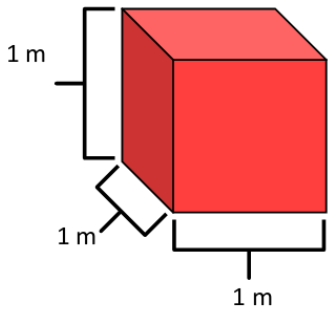
Crédito: Prof. Dr. Henrique Toma (USP, Brazil)

- Desenvolvimento de sensores e biossensores;
- Processamento de filmes nanoestruturados para embalagens e conservação de alimentos;
- Desenvolvimento de bionanocompósitos;
- Novos materiais e processos em nanotecnologia e suas aplicações no agronegócio;
- Estudo dos aspectos de segurança em nanotecnologia;
- Plano de transferência de tecnologia.

Nanoescala: 10^{-9} m ou um bilionésimo de metro

Propriedade Dependente da Área Superficial

Aresta = 1 m

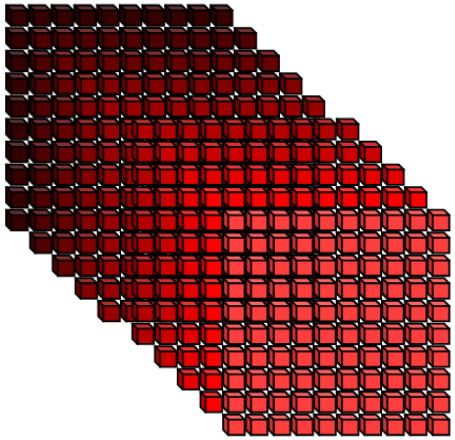


Para 1 cubo:

Volume = 1 m x 1 m x 1 m = 1 m^3

Área de superfície = 6 x $(1\ m)^2$ = 6 m^2

Aresta = 0,1 m



Para 1000 cubos:

Volume = (0,1 m x 0,1 m x 0,1 m) x 1000 = 1 m^3

Área de superfície = 6 x $(0,1\ m)^2$ x 1000 = 60 m^2

Revestimentos comestíveis

Revestimentos Comestíveis

No que consistem as coberturas comestíveis?

São compostos naturais, de origem vegetal ou animal, normalmente com estruturas poliméricas, com ou não grupos funcionais ativos.

Revestimentos Comestíveis

Quais as características desejadas de um revestimento?

- Altera as trocas gasosas, perdas de água e rancificação

Conservação da qualidade da fruta que vêm do campo

- Retardar o amadurecimento e mantendo cor, sabor e aroma.
- Preservar a coloração, perda de nutrientes e textura
- Elevar resistência reduzindo danos mecânicos – machucaduras
- Atividade antimicrobiana
- Minimizar infestações por microrganismos (embalagens ativas)
- Consistir em uma tecnologia simples e economicamente viável

Revestimentos Comestíveis

- Revestimentos comestíveis, aditivos, glaceantes, são regulados pela RDC nº 8/2013 **<u>Lista positiva.</u>**
- GRAS – Geralmente Reconhecido como Seguro - FDA- Órgãos Internacionais.
- Escala nano
- Origem vegetal "Plant-based"

Revestimentos – Ação

foods

MDPI

Review

Nanoemulsions as Edible Coatings: A Potential Strategy for Fresh Fruits and Vegetables Preservation

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Abstract: Fresh fruits and vegetables are perishable commodities requiring technologies to extend their postharvest shelf life. Edible coatings have been used as a strategy to preserve fresh fruits and vegetables in addition to cold storage and/or controlled atmosphere. In recent years, nanotechnology has emerged as a new strategy for improving coating properties. Coatings based on plant-source nanoemulsions in general have a better water barrier, and better mechanical, optical, and microstructural properties in comparison with coatings based on conventional emulsions. When antimicrobial and antioxidant compounds are incorporated into the coatings, nanocoatings enable the gradual and controlled release of those compounds over the food storage period better than conventional emulsions, hence increasing their bioactivity, extending shelf life, and improving nutritional produce quality. The main goal of this review is to update the available information on the use of nanoemulsions as coatings for preserving fresh fruits and vegetables, pointing to a prospective view and future applications.

Keywords: nanotechnology; wax coating; natural antimicrobials; essential oils; nanocoatings; post-harvest; bioactive compounds; quality; preservation methods; nanomaterials

check for updates

Citation: de Oliveira Filho, J.G.; Miranda, M.; Ferreira, M.D.; Plotto, A. Nanoemulsions as Edible Coatings: A Potential Strategy for Fresh Fruits and Vegetables Preservation. *Foods* **2021**, *10*, 2438. https://doi.org/10.3390/foods10102438

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1. Introduction

Fruits and vegetables are important sources of minerals, vitamins, and fibers, which are essential for human's well-being, and their consumption has been associated with several beneficial effects on human health. The demand for those benefits has considerably increased over the years due to consumer preference for natural products and changes in lifestyle [1]. In this sense, fruits and vegetables are an important component of the human diet.

After they are harvested, fruits and vegetables continue the respiration process, consuming O_2 and releasing CO_2 and water. Consequently, lipids, proteins, organic acids, and carbohydrates are metabolized and energy replacement is compromised, as the vegetable or fruit is separated from the mother plant [2]. Over time, quality characteristics such as color, flavor, weight, nutritional value, and bioactive compounds continue to deteriorate as a result of senescence [3]. The water released during the respiration process plays an important role in the postharvest quality of fresh fruits and vegetables and can result in loss of nutritional value, soft texture, sagging, wrinkling, and withering [4].

Although waxes were used to preserve citrus fruit in ancient China, it was not until the twentieth century that edible coatings based on emulsions were developed to preserve the quality of fresh fruits and vegetables [5]. These emulsions are typically formulated from oils (vegetable- or animal-derived), waxes (paraffin, carnauba wax, candelilla, or beeswax), and resins (shellac or wood rosin). Furthermore, polymer-based coating solutions can have additional functionality when formulated with plant essential oils having antimicrobial

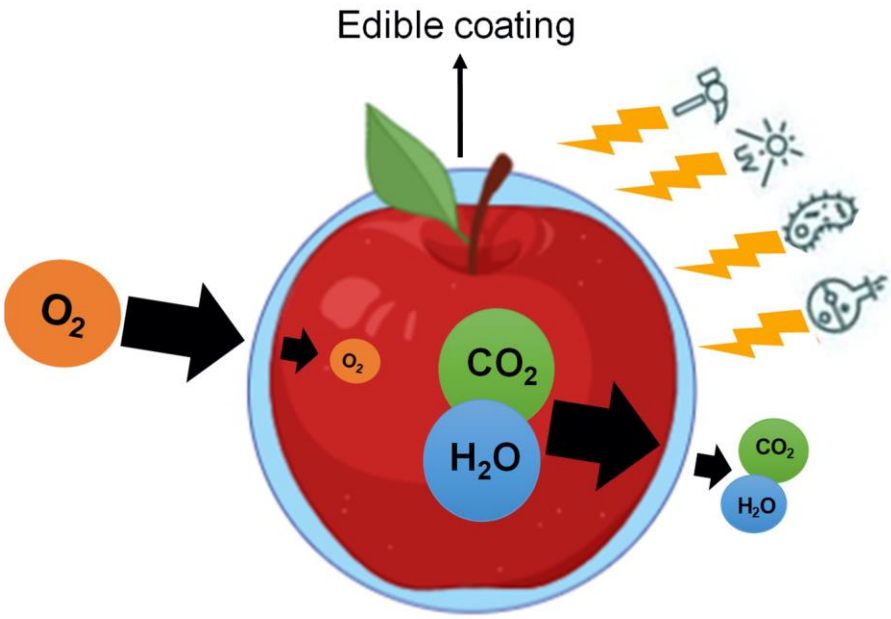
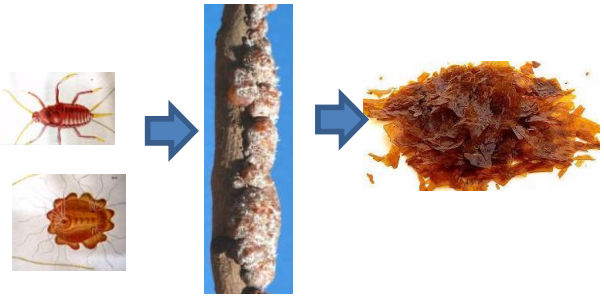


Figure 2. Main functions of edible coatings on fruits and vegetables.

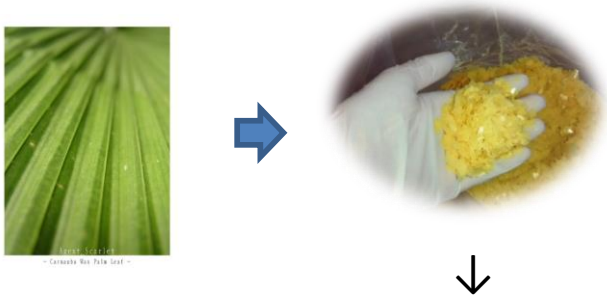
Um exemplo:

Goma Laca



Barreira ao gás e redução da troca gasosa

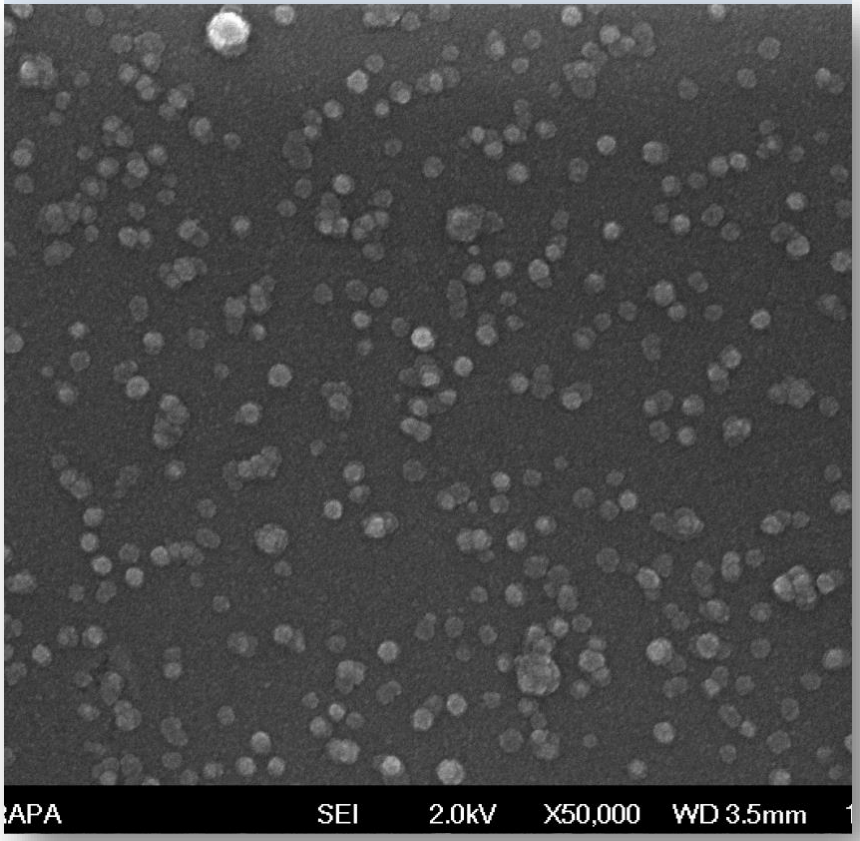
Carnaúba



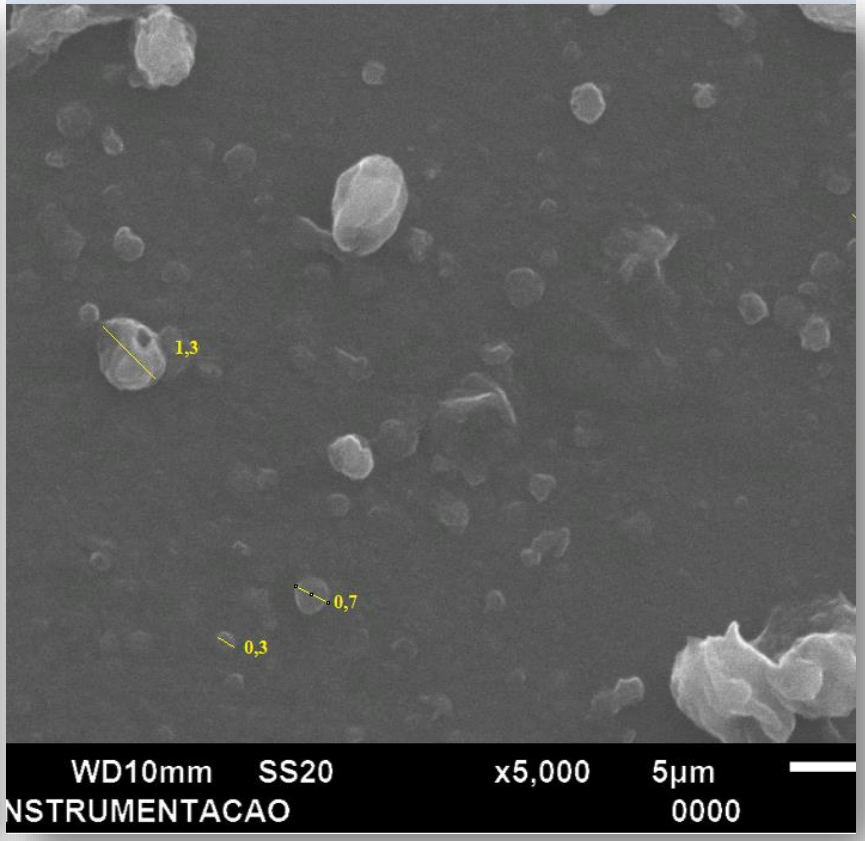
Barreira a perda de água

Nanotecnologia & Revestimentos Comestíveis

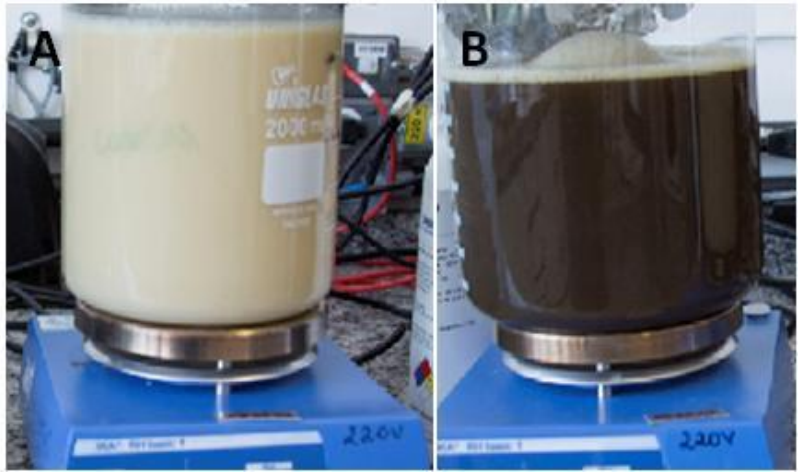
Nanoemulsão Carnaúba



Convencional



Nanoemulsão de cera de carnaúba



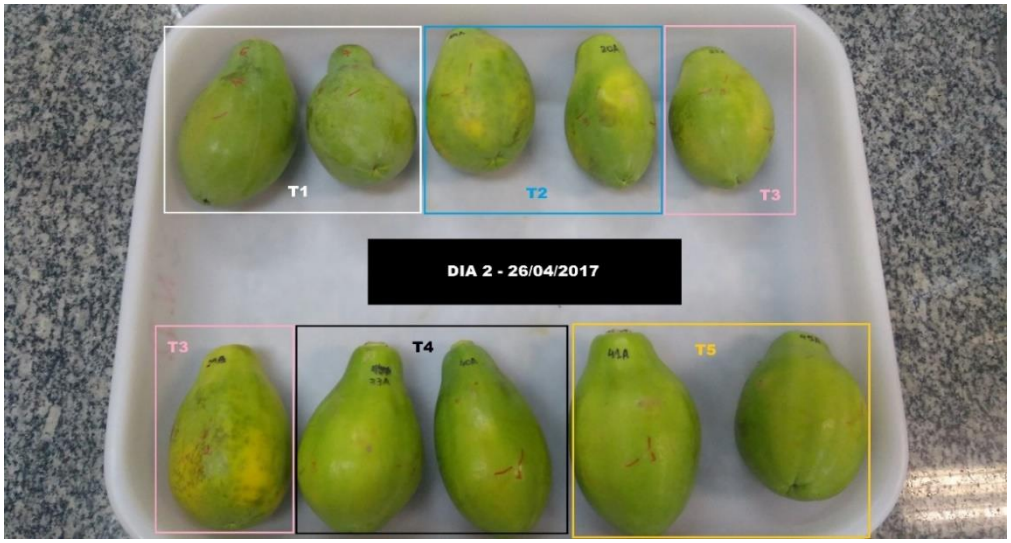
7 dias a 24 ºC

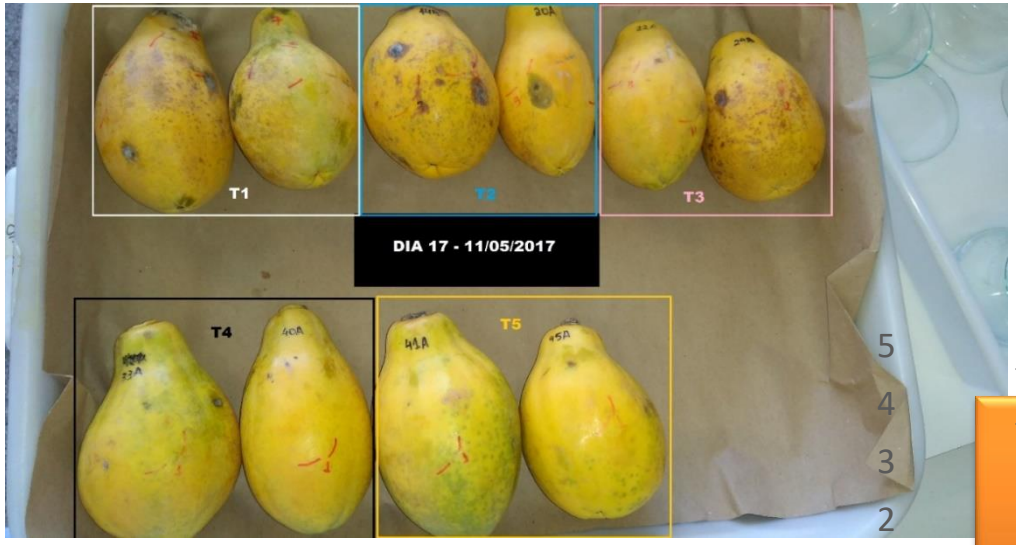
Controle

Nano 9%

Nano 18%

Nanoemulsão a base de carnaúba para manutenção da qualidade pós-colheita de mamões





Fotos: Natália M. Zucchini

T1- controle

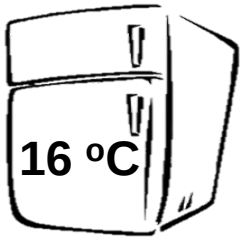
(sem revestimento)

T2- cera 4,5% (v/v)

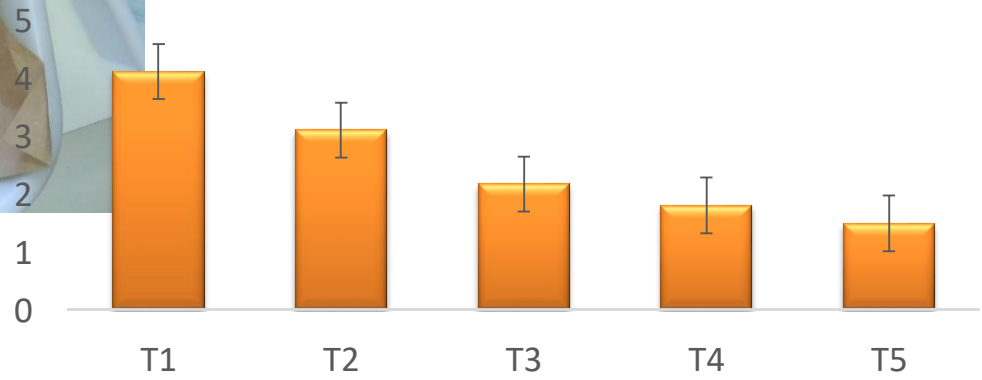
T3- cera 9,0% (v/v)

T4- cera 13,5% (v/v)

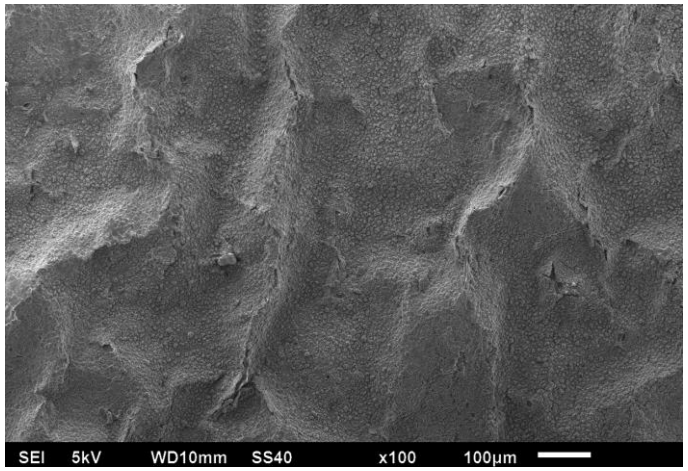
T5- cera 18,0% (v/v)

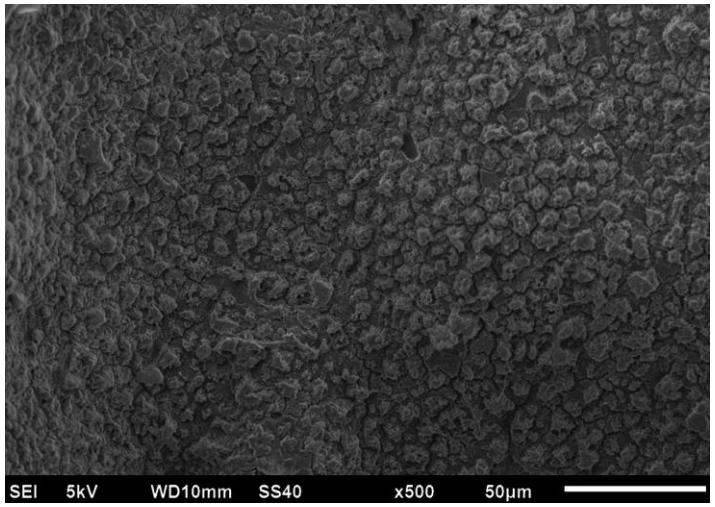


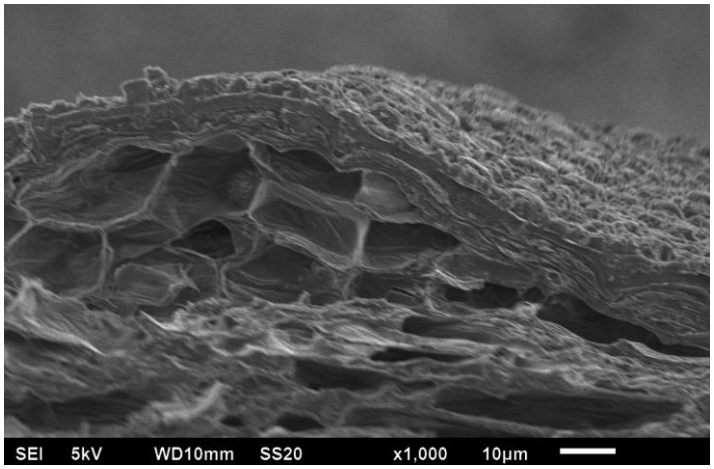
Perda de massa (%)

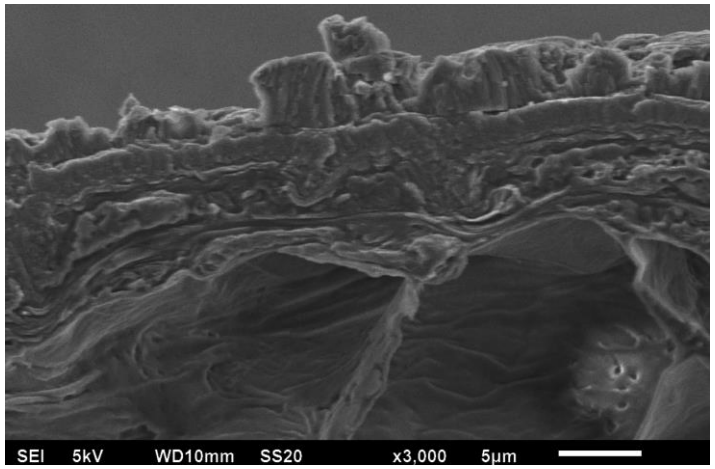


Casca do mamão









Em tomate...

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Research article

Carnauba wax nanoemulsion applied as an edible coating on fresh tomato for postharvest quality evaluation

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GRAS-ingredients
Copernicia prunifera
Emerging processing technologies
Sustainable chemistry

ABSTRACT

Edible coatings to extend the shelf life and preserve the quality of fruit and vegetables are highly demanded nowadays. Recently, plant-based edible coatings have gained importance in the context of sustainability, which in combination with suitable top-down process can render "greener" nanoemulsions with optimized properties. Herein we developed a carnauba wax nanoemulsion (CWN) by using a high-pressure processing to be applied as an edible coating for fruit and vegetables. The as-developed nanoemulsion properties were compared to conventional carnauba wax emulsion (CWM), where CWN showed particle size diameter of 44 nm and narrow distribution, while CWM displayed larger particles and wider size distribution (from 200 to 1700 nm). For assessment of the postharvest quality, cv. 'Debora' tomatoes, employed here as a model, were coated with CWN or CWM, at concentrations of 9 and 18%, and then compared to uncoated fruit during storage at 23 °C for 15 days. Evaluation of fruit quality, including sugar, acids, pH, water vapor loss, firmness, gloss, color, ethylene and respiratory activity, were assessed at every 3 days, while sensory test were carried out at the end of storage. Uncoated tomatoes presented the highest water loss values, meanwhile, firmness, ethylene, and respiratory activity were not largely modified by the coatings during storage. Tomatoes coated with the CWN exhibited the highest instrumental gloss and were preferred by consumers in sensory evaluations, indicating the potential of the as-developed carnauba wax green nanoemulsion for postharvest applications.

1. Introduction

Fruit and vegetables play an essential function in human's nutrition, as they are rich sources of vitamins, minerals, fiber, and phytochemicals, reducing some disease risks and promoting health (Angelino et al., 2019). However, the relative short lifetime of fruit can be an obstacle to their widespread consumption while intensifying food losses. Therefore, novel technologies that can at the same time extend the shelf life while improving fruits appearance are important nowadays for inducing healthy food consumption and decrease food loss. In this context, edible coatings for fruits and vegetables are of utmost importance (Maringgal et al., 2020; Nor and Ding, 2020). They should be safe for consumers and follow countries' legislation, such as the Brazilian Health Regulatory Agency (ANVISA, 2013) in Brazil, and international recommendations, including those of the Food and Drug Administration (FDA), Codex Alimentarius Commission (CODEX – INS 903, 1995) and European Union -E903 (EFSA, 2012).

Current commercial coating emulsions for fruit and vegetable are usually made up of different components, including polyethylene wax, shellac, beeswax, morpholine and candelilla, which many times are combined with carnauba wax (Bai and Plotto, 2011; Puttalingamma, 2014; Kumar and Kapur, 2016; De Freitas et al., 2019). Such a mix of components allows the coating to achieve proper permeability while increasing gloss, which is an important parameter for the consumer's purchase decision (Bai and Plotto 2011). It is important that the ingredients employed are Generally Recognized as Safe (GRAS),

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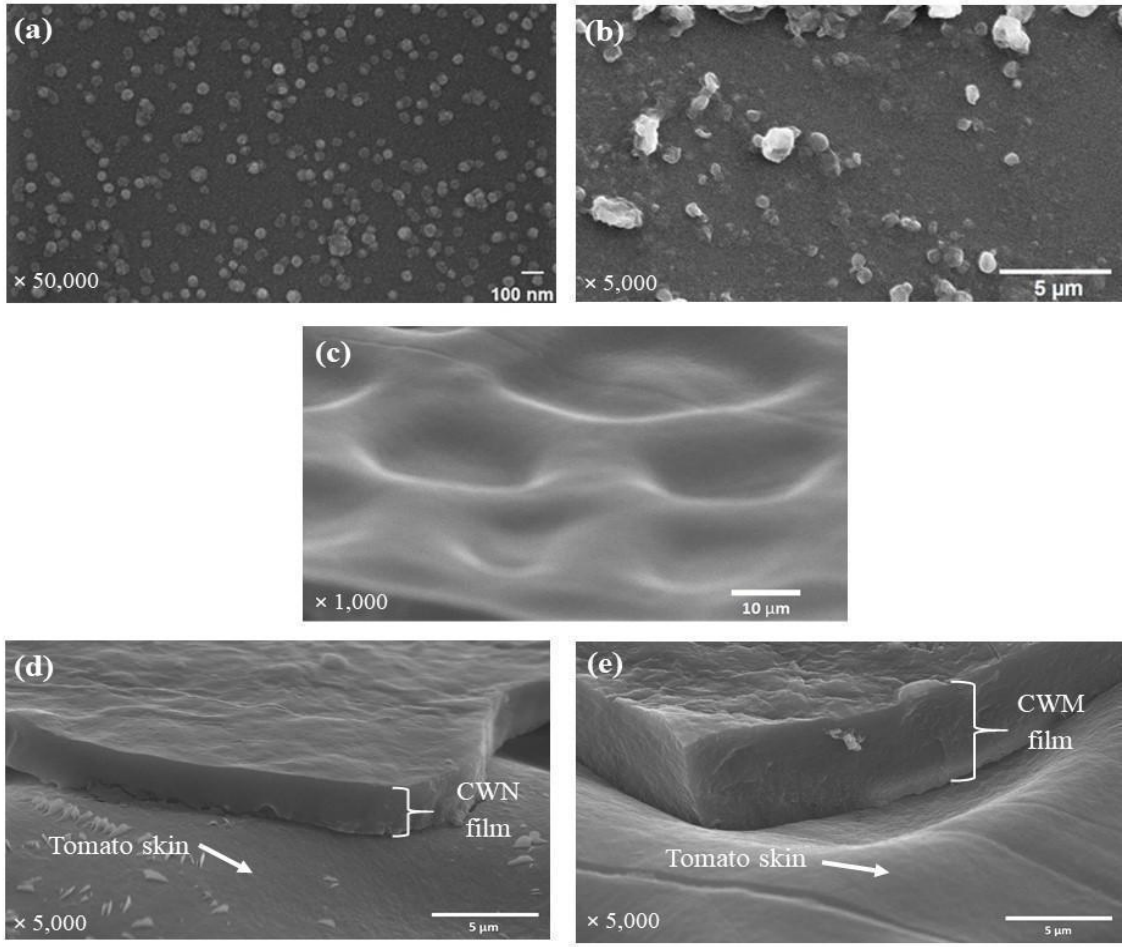


Figure 1. Field emission gun scanning electron microscopy (FEG-SEM) of diluted (1:1000) carnauba wax nanoemulsion-CWN18%
(a) and conventional emulsion 18% **(b)** on silicon wafer. Electronic micrography of uncoated tomato surface **(c)**, CWN18%-coated
(b) tomato **(d)**, and CWM18%-coated tomato **(e)**.

Effect of Surface Roughness on Retention and Removal of Escherichia coli O157:H7 on Surfaces of Selected Fruits

Outras frutas

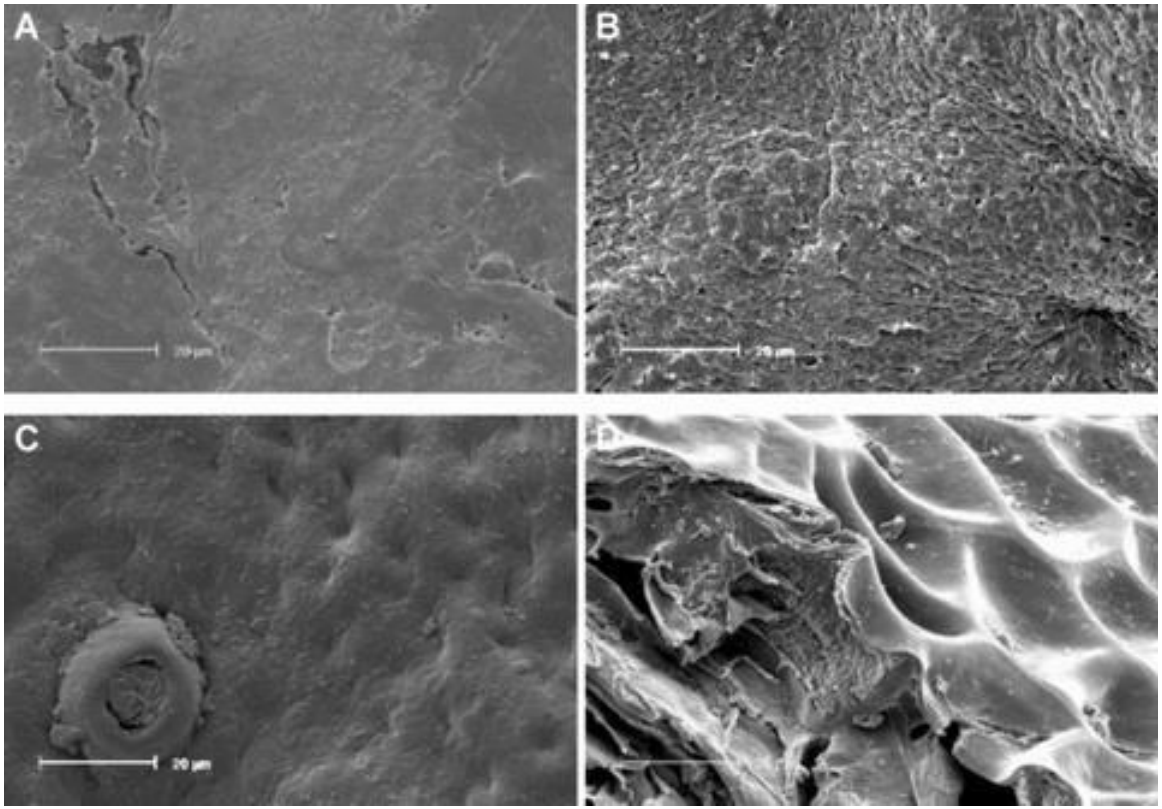
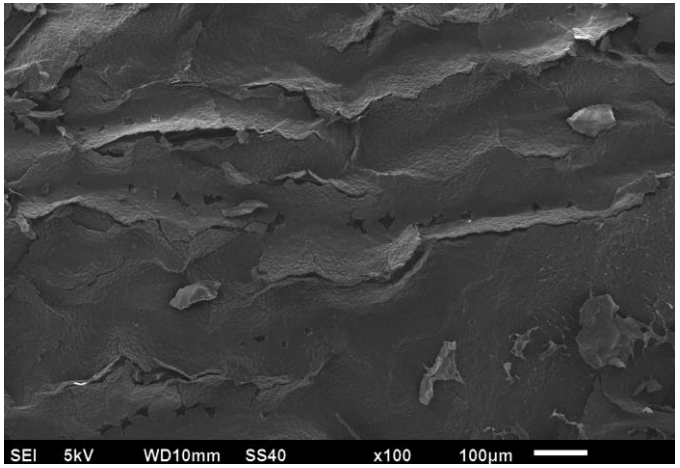
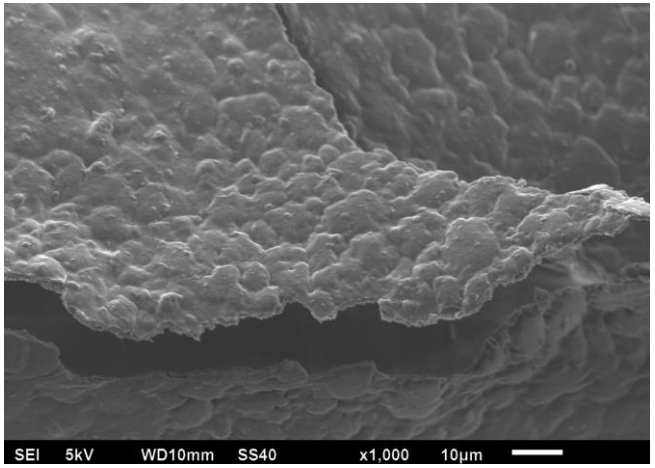


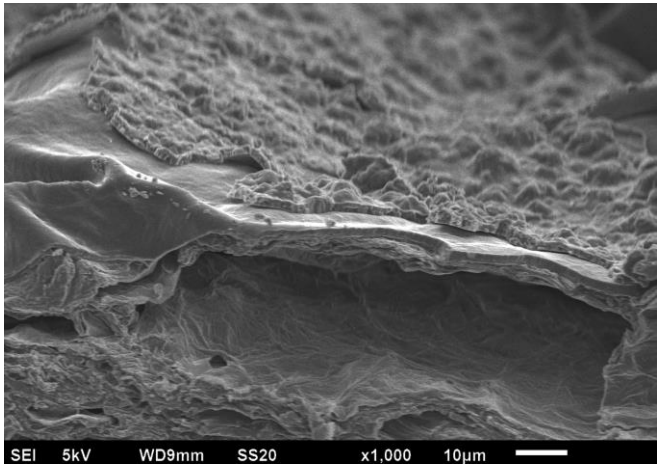
Figure 3 --- ESEM images of the surface topography of selected fruits at high magnification (×2400): (A) apple, (B) avocado, (C) orange, and (D) cantaloupe.

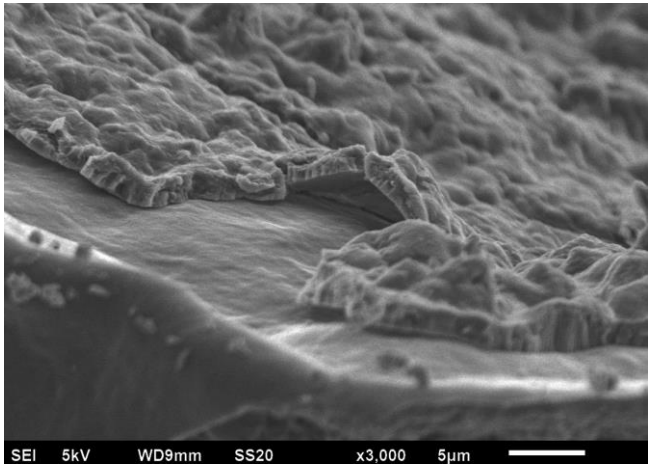
Journal of Food Science, Volume: 74, Issue: 1, Pages: E8-E15, First published: 21 January 2009, DOI: (10.1111/j.1750-3841.2008.00998.x)

Nanoemulsão de cera de carnaúba aplicada no mamão

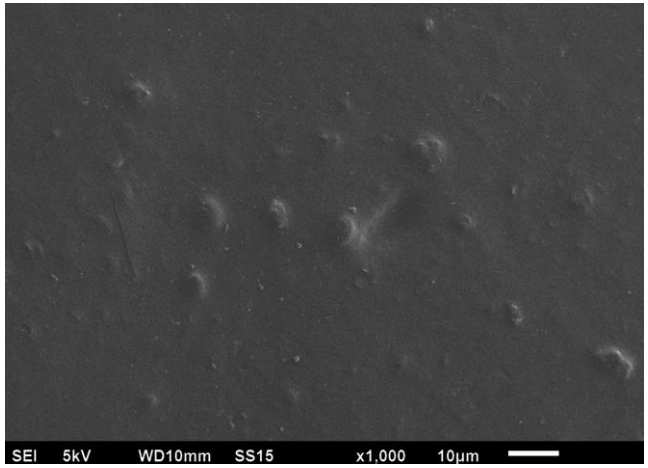


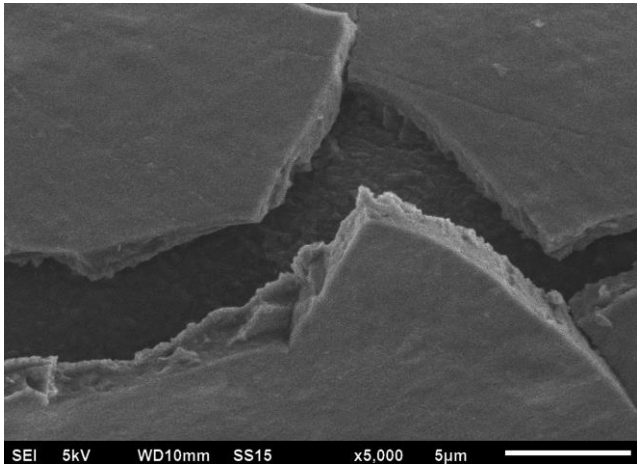


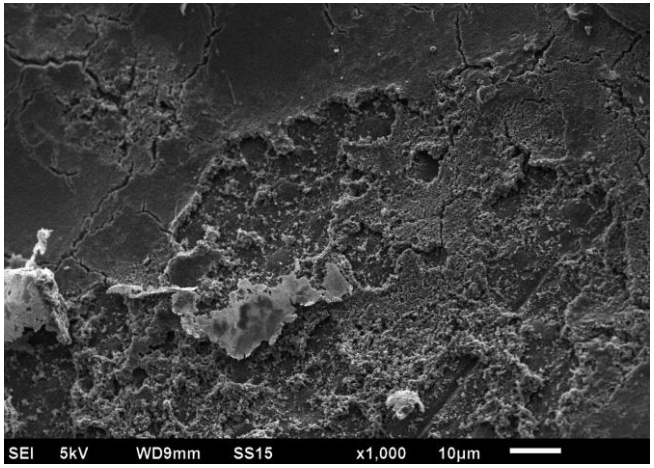


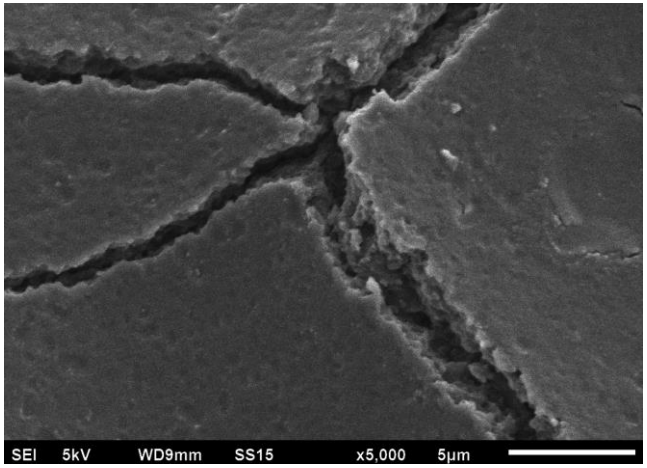


Outras emulsões – revestimentos – Micro/Convencional









Outras publicações...

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Nano- and micro-sized carnauba wax emulsions-based coatings incorporated with ginger essential oil and hydroxypropyl methylcellulose on papaya: Preservation of quality and delay of post-harvest fruit decay

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[b] São Paulo State University (Unesp), School of Pharmaceutical Sciences, Araraquara, SP, Brazil
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ARTICLE INFO

Keywords:
Carica papaya L.
Edible coatings
Postharvest quality
Disease control
Volatile compounds

ABSTRACT

Carnauba wax nano and micro-sized emulsions and hydroxypropyl methylcellulose coatings, alone or combined with ginger essential oils (GEO) were applied on papayas and evaluated under several storage conditions. In a first experiment, storage parameters were: 6 days at 22 °C, and 9 days at 13 °C followed by 5 days at 22 °C. In a second experiment, storage was: 5 days at 22 °C, and 10 days at 16 °C followed by 3 days at 22 °C. Coating effects were dependent on storage conditions. While fruits were in cold storage, there were few changes; however, at 22 °C, the differences between coatings became more evident. Nanoemulsions maintained papaya quality during storage by retarding firmness loss, color changes, and reducing respiration rates, resulting in delayed ripening. GEO exhibited some positive effect on fungal disease control. Nanoemulsion-based coatings improved shelf life by reducing weight loss, color development, and slowing ripening of papaya fruit.

1. Introduction

Papaya (*Carica papaya* L.) is a native fruit of tropical America and is disseminated throughout the tropics. India is the largest global producer of papaya (5.9 million tons), followed by Brazil with a production of 1.1 million tons (FAO, 2022). According to Secex (Brazilian's Secretariat of Foreign Trade), the Brazilian exportation of papaya fruit has increased annually, having reached 43.6 thousand tons by 2019 (CONAB, 2021).

Papaya, however, is a fragile, highly perishable fruit with a post-harvest life of up to four weeks (Pérez-Carrillo & Yahia, 2004). Due to its thin skin, papaya fruit is very susceptible to mechanical damage and postharvest injuries. Additionally, the high volume of water in the mesocarp renders the fruit susceptible to microorganism attack and other physiological disorders (Singh & Rao, 2011).

Estimations of fruit postharvest losses are approximately 30 to 60 percent in both developed and developing countries (FAO, 2019), and additionally, intense fruit handling may reduce the overall quality (Miranda et al 2015). The application of coatings has been considered a valuable strategy in providing additional protection to intact or fresh-cut fruit by forming a semipermeable barrier that lowers water vapor permeability and inhibits microbial adherence and growth. Several types of materials have been proposed as suitable to coat fruits, each having advantages and disadvantages in their applications (Marín et al., 2021).

Particularly, hydrophobic compounds such as carnauba wax, lipid-based formulations, and more hydrophilic biopolymers such as chitosan, starch and cellulose salt derivatives, or their combinations (composites), have been extensively evaluated as protective edible films and coatings (Formiga et al., 2019; Zambrano-Zaragoza et al., 2020; Arroyo et al., 2020; Pestana, et al., 2021). Among the composite edible coatings, for example, chitosan and carnauba wax composite coating with oregano essential oil, was effective in reducing water loss and micro-organism decay on cucumbers (Gutiérrez-Pacheco et al., 2020). Chitosan and beeswax-pollen grains coating applied on pears resulted in

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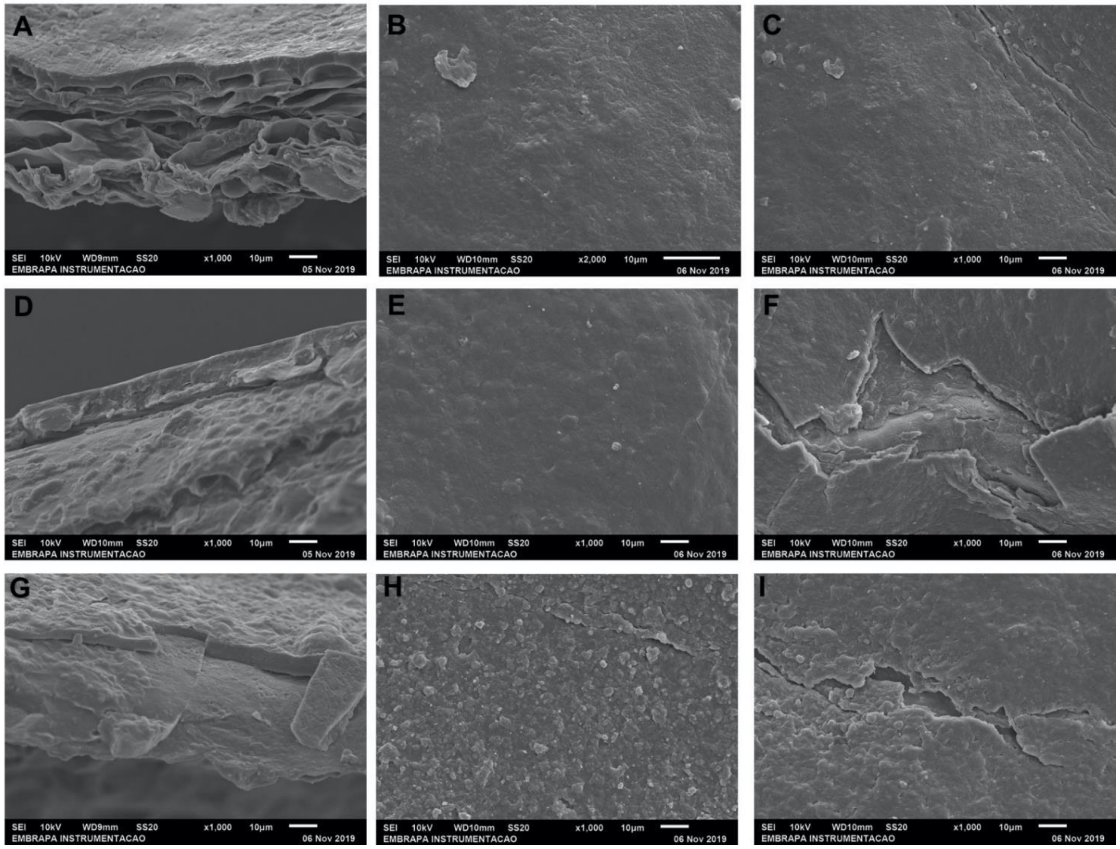


Figure 2. Field emission gun scanning electron microscopy (FEG-SEM) of papaya skin uncoated (A, B and C) and coated with Nano 18% (D, E and F) and Nano 9% (G, H and I).

Aplicação de cera

Fotos: Fabiana Fumi C. Sasaki

Adição de óleos essenciais

Capim-limão
(*Cymbopogon citratus*)

Alecrim pimenta
(*Lippia sidoides*)

Manjericão
(*Ocimum micrathum*)

Alfavaca cravo
(*Ocimum gratissimum*)

Óregano
(*Origanun vulgare*)

Palmarosa
(*Cymbopogon martini*)

Cravo em folhas
(*Sysygium aromaticum*)

Hortelã-verde
(*Mentha spicata*)

Hortelã-pimenta
(Mentha piperita)

Ação antimicrobiana

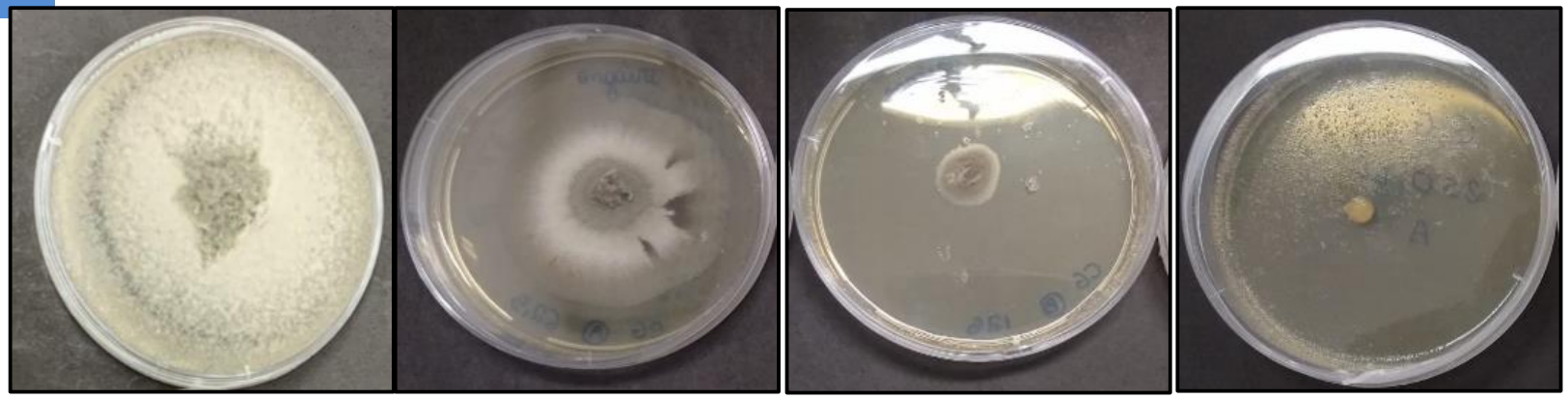
- **Fungos Fitopatogênicos**

  Colletorichum gloeosporioides
  Fusarium solani
  Lasiodiplodia theobromae
  Penicillium expansum
  Alternaria alternata
  Rhizopus stolonifer
  Botrytis cinerea

- **Bactérias fitopatogênicas e patogênicas ao homem**

Colletotrichum gloesporioides

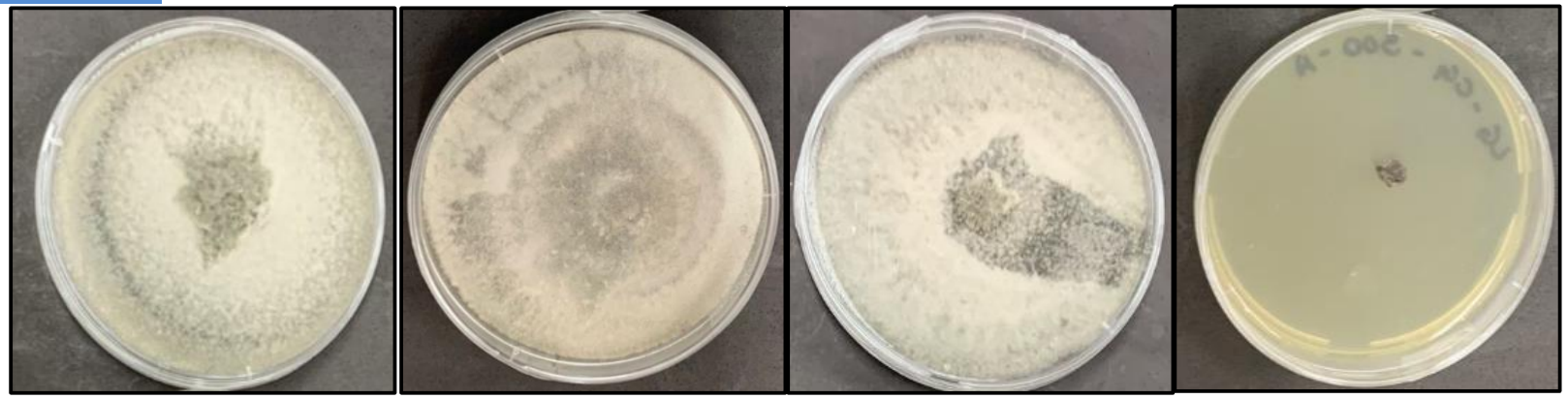
Orégano



Controle | 62,5 uL/L | 125 uL/L | 250 uL/L

125 < MIC ≤ 250

Capim Limão



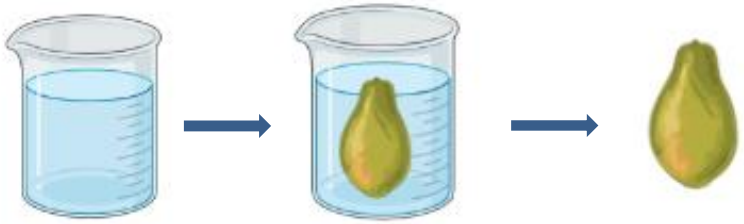
Controle | 62,5 uL/L | 250 uL/L | 500 uL/L

250 < MIC ≤ 500

Efeito da Nanoemulsão de cera de carnaúba associada ao óleo essencial de hortelã livre e encapsulado na conservação de frutos de mamão

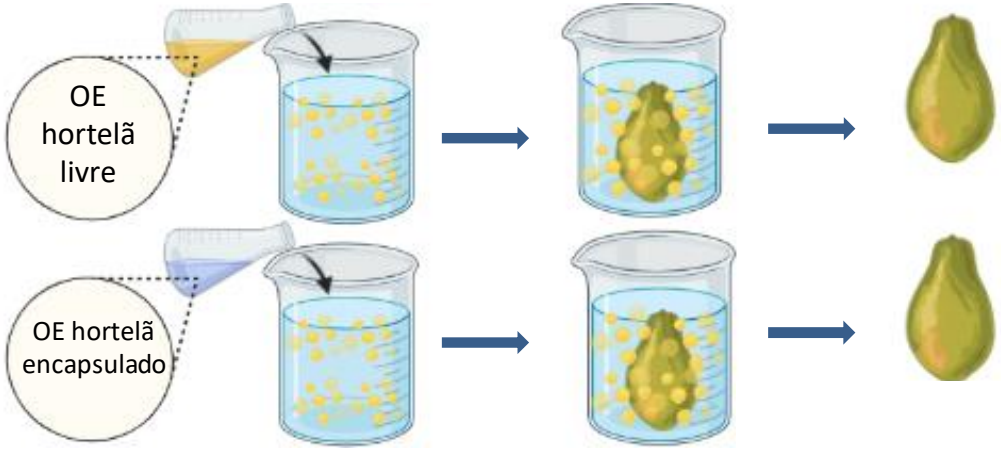
Tratamentos:

Água (Controle)



Nanoemulsão+OE hortelã livre

Nanoemulsão+OE hortelã encapsulado



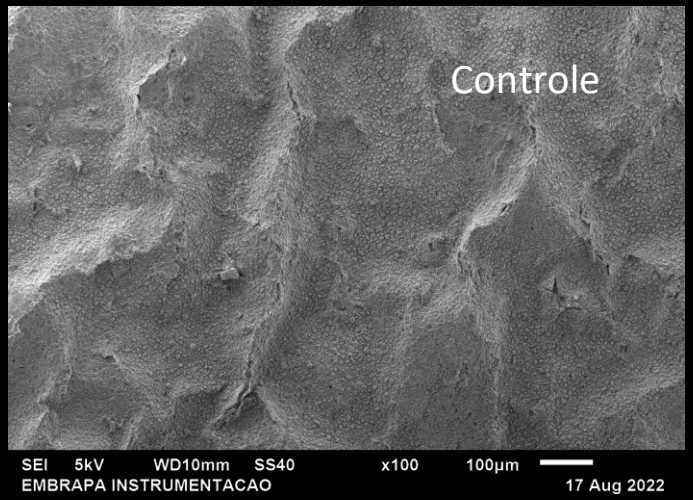
Após 16 dias de armazenamento à 16 °C

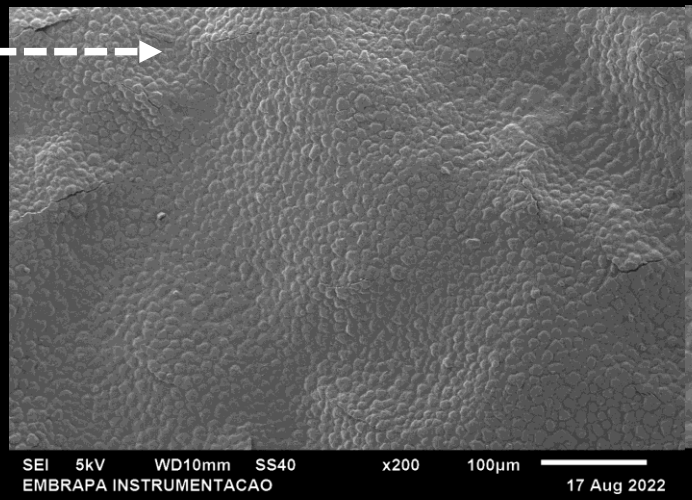
Controle

Nanoemulsão+OE de hortelã livre

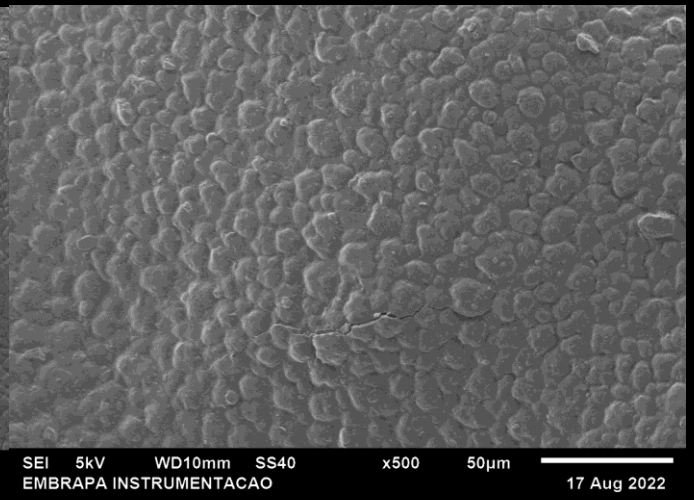
Nanoemulsão+OE de hortelã encapsulado

MEV-Superfície



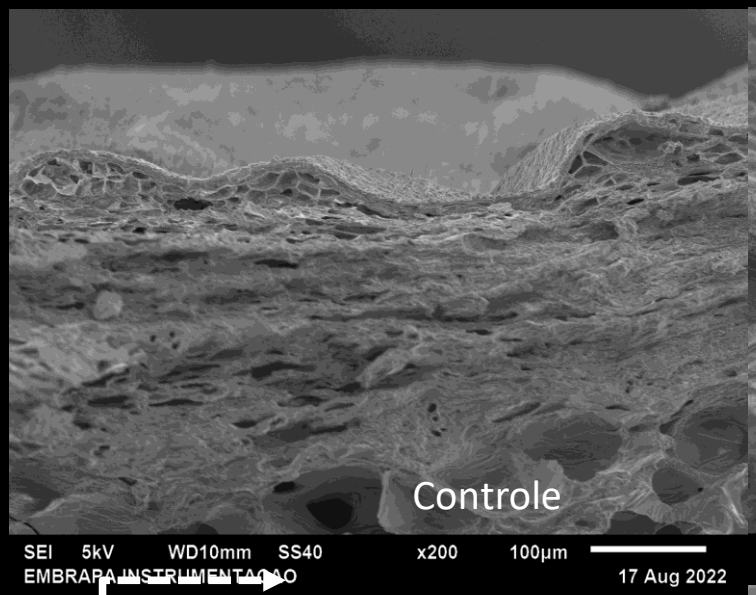


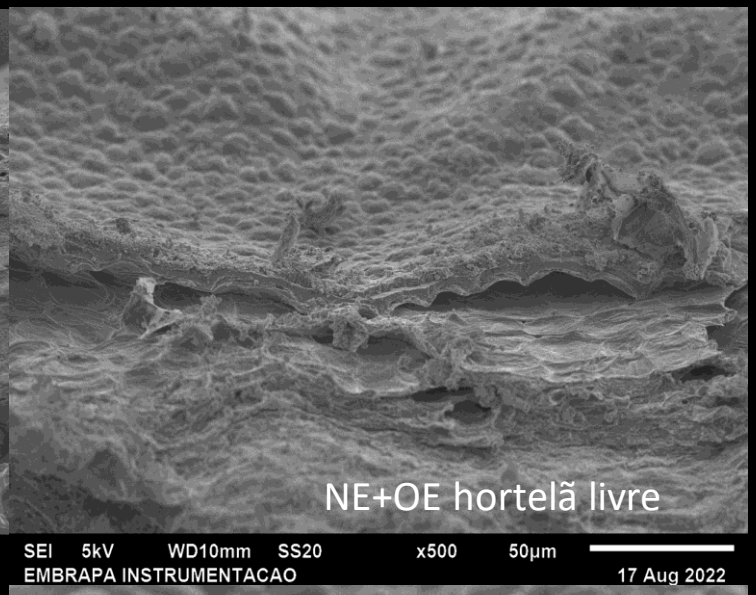
NE+OE hortelã livre



NE+OE hortelã encapsulado

MEV-Fratura


Controle
SEI 5kV WD10mm SS40 x200 100µm
EMBRAPA INSTRUMENTACAO
17 Aug 2022


NE+OE hortelã livre
SEI 5kV WD10mm SS20 x500 50µm
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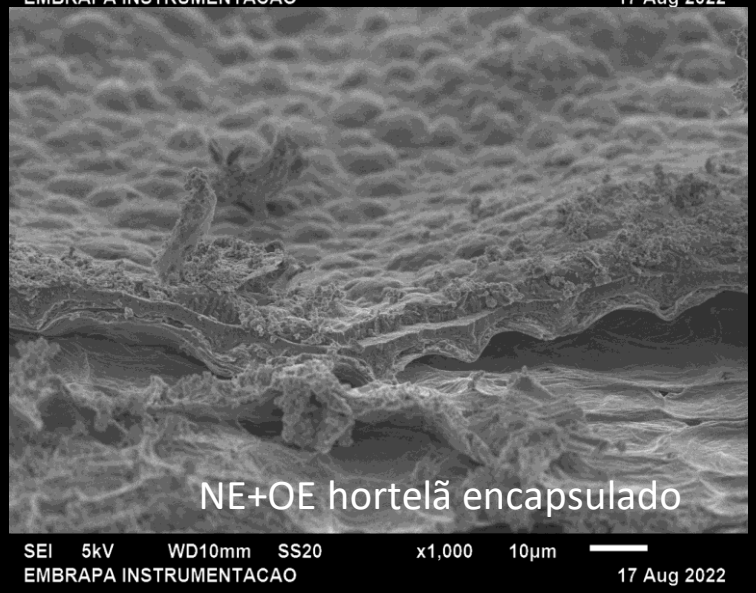
NE+OE hortelã encapsulado
SEI 5kV WD10mm SS20 x1,000 10µm
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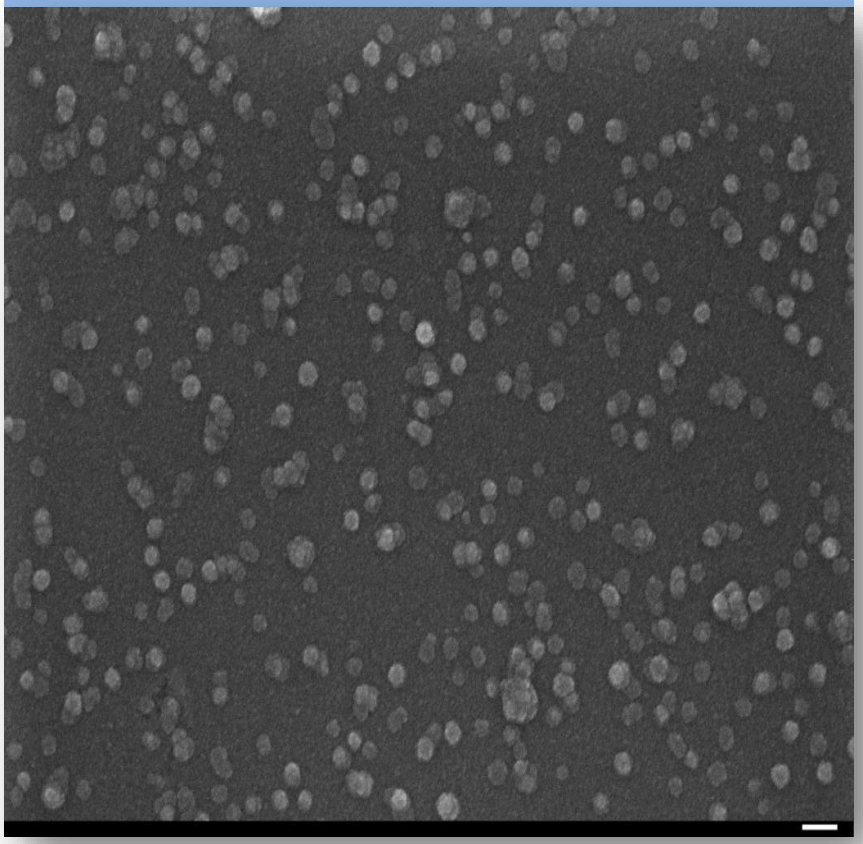
17 Aug 2022

Nanoemulsão

Sintética, Controle e Nanoemulsão

Nanoemulsão



Tanwax C18 NANO
Empresa: QGP Tanquímica

Nanoemulsão de cera de carnaúba integra lançamento nacional de portfólio da AgroFresh

Início / Notícias / Nanoemulsão de cera de carnaúba...

Rastreabilidade e Sensor de maturação de frutas
Empresa: Siena Company

SIENA
company

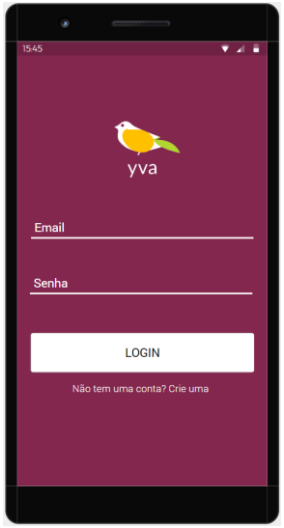
Sensor de maturação de frutas com nanotecnologia, com sistema de rastreabilidade para frutas e hortaliças.

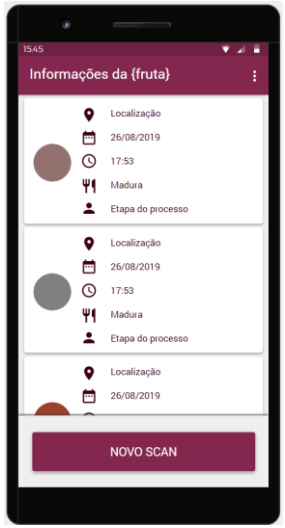
Embrapa

Sensor YVA

Embalagem com nanosensor + Aplicativo de rastreabilidade

+

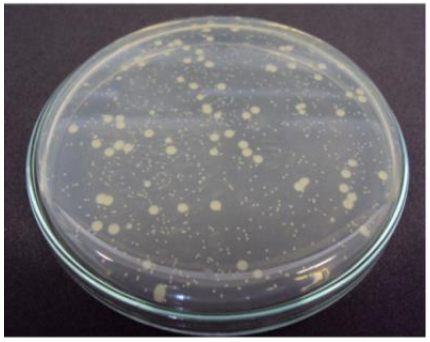




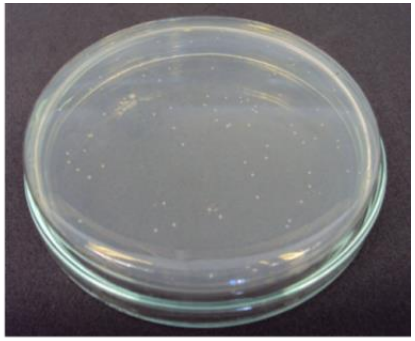
Embalagens

Filmes PEBD

Filmes PEBD + NPAg



Controle (PEBD)



Filme de PEBD + NPAg

Embalagens com PVC aditivado com Nanopartícula de Prata

Postharvest quality of papaya fruit wrapped with polyvinyl chloride film added with silver

K.S. Sapelli[1], K.R. Borba[2], M. Miranda[2], P.C. Spricigo[3,4], J.D. Bresolin[5], M.M. Foschini[5], D.S. Correa[3,5] and M.D. Ferreira[3,5]

[1]Universidade Estadual do Centro-Oeste, Departamento de Agronomia, Guarapuava, Brazil; [2]Universidade Estadual Paulista (UNESP), Faculdade de Ciências Farmacêuticas, Araraquara, Brazil; [3]PPGBiotec, Centro de Ciências Exatas e Tecnologia, Universidade Federal de São Carlos (UFSCar), São Carlos, Brazil; [4]Departamento de Produção Vegetal, Escola Superior de Agricultura "Luiz de Queiroz", Universidade de São Paulo, Piracicaba, Brazil; [5]Embrapa Instrumentação, São Carlos-SP, Brazil.

Abstract

The main goal of this research was to evaluate the postharvest quality during storage of papaya wrapped with polyvinyl chloride containing silver. Fourier Transform Infrared Spectroscopy, scanning electron microscopy and atomic absorption spectroscopy were employed for the film characterization. For the postharvest experiments, unwrapped fruits were compared to individually wrapped ones in both conventional polyvinyl chloride film and polyvinyl chloride film containing silver and stored under two conditions (10 days at 15°C, and 2 days at 22°C to simulate market conditions). The physicochemical analyzes, including soluble solids, titratable acidity, ratio, pH, ascorbic acid, weight loss, firmness and color were performed every two days of storage, while microbiological analyzes were performed on the 1st and 10th day of storage. Sensory analysis was carried on the last day of storage. Physicochemical analyses showed that fruits wrapped with polyvinyl chloride films presented a lower weight loss compared to than unwrapped fruits. These results were in accordance with sensory analysis. More importantly, papaya wrapped with polyvinyl chloride film containing silver kept papaya peel green for longer time causing a delay in ripening, indicating its potential to extend postharvest shelf-life of papaya and reduce postharvest losses.

Keywords: PVC, microorganism, color, ripening, smart packing, *Carica papaya*

INTRODUCTION

Papaya is a climacteric fruit, highly perishable, presenting a soft pulp with low resistance to damages and decays. Diseases and losses during storage and marketing are major problems found on papaya conservation (Bautista-Baños et al., 2013). The papaya postharvest losses of papaya are considered very high, and can achieve levels over 75% (Paull et al., 1997). Accordingly, the fruit may not reach its consumers as a result of postharvest losses. Film packaging can be an alternative to keep and extend fruits shelf-life. The most common plastic materials used for fruit packaging are the low-density polyethylene (LDPE) and polyvinyl chloride (PVC) (Marconcini, 2017). These films present distinct features depending on the film composition and processing variables (Sandhya, 2010) and have been used for postharvest application (Becaro et al., 2016; Dias et al., 2011; Donglu et al., 2016). More recently, nanotechnology based-approaches have gained prominence for post-harvest application. For instance, to improve film characteristics, nanoparticles and other materials have been employed to improve film characteristics, such as permeability, antimicrobial properties, etc. (Becaro et al., 2015; De Moura et al., 2012; Duncan, 2011; Guo et al., 2013). Silver has been studied as an important polymeric film addictive, mainly as for antimicrobial use (Becaro et al., 2015; Anh et al., 2016). However, silver has been pointed to be an inhibitor of ethylene action (Vinod et al., 2009).

Therefore, the main goal of this research was to evaluate the postharvest quality during storage of papaya fruits wrapped with PVC containing silver and compare them with unwrapped fruits and fruits wrapped with PVC without silver.

Acta Hortic. 1325. ISHS 2021. DOI 10.17660/ActaHortic.2021.1325.38
Proc. V Int. Symp. on Postharvest Pathology: From Consumer to Laboratory - Sustainable Approaches to Managing Postharvest Pathogens
Eds.: M.H. Jijakli et al.

Completando...

- Físico
  - Térmico
  - Ozônio
  - Luz UV-C
- Microorganismos antagonistas

Tratamento Térmico + Ozônio

Resultado

Scientia Horticulturae 257 (2019) 108722

Contents lists available at ScienceDirect

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journal homepage: www.elsevier.com/locate/scihorti

Ozonated water combined with heat treatment to control the stem-end rot of papaya

Daniel Terao*, Kátia de Lima Nechet, Rosa Toyoko Shiraishi Frighetto, Fabiana Fumi Cerqueira Sasaki

Embrapa Meio Ambiente, Rodovia SP-340, km 127, 5 Tanquinho Velho, Caixa Postal: 69, Jaguariúna, 13820-000, Brazil

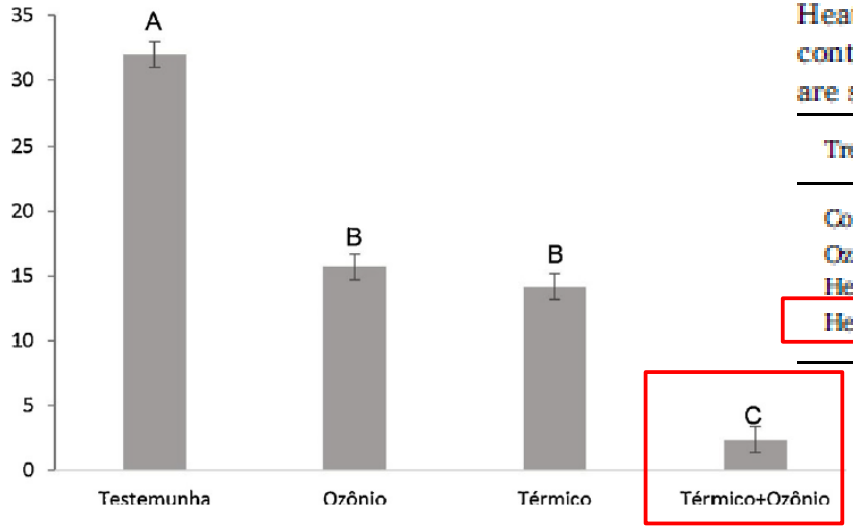

Fig. 3. Effect of Peduncle Heat treatment (70 °C/15 s), Ozone treatment (3 mg of O_3 L^{-1} during 5 min), and the combination of Heat with Ozone treatment on Area Under the Disease Progress Curve (AUDPC) of stem-end rot in papaya cultivar 'THB', during 15 days of storage (10 ± 2 °C during 7 days and in room condition at 23 ± 2 °C during 8 days). Means followed by different letters are significantly different at $P = 0.05$ according to Tukey's test.

Table 1
Effect of Heat treatment, Ozone treatment, and the combination of Heat + Ozone treatment during the Period of incubation and percentage of control of stem-rot in papaya 'cultivar THB'. Means followed by different letters are significantly different at $P = 0.05$ according to Tukey's test.

Treatments	Incubation Period	Control efficacy (%)
Control	10.08 a	
Ozone treatment	13.41 b	51
Heat treatment	14.66 b	55
Heat + Ozone	17.08 c	92.5

Embrapa

Radiação UV-C

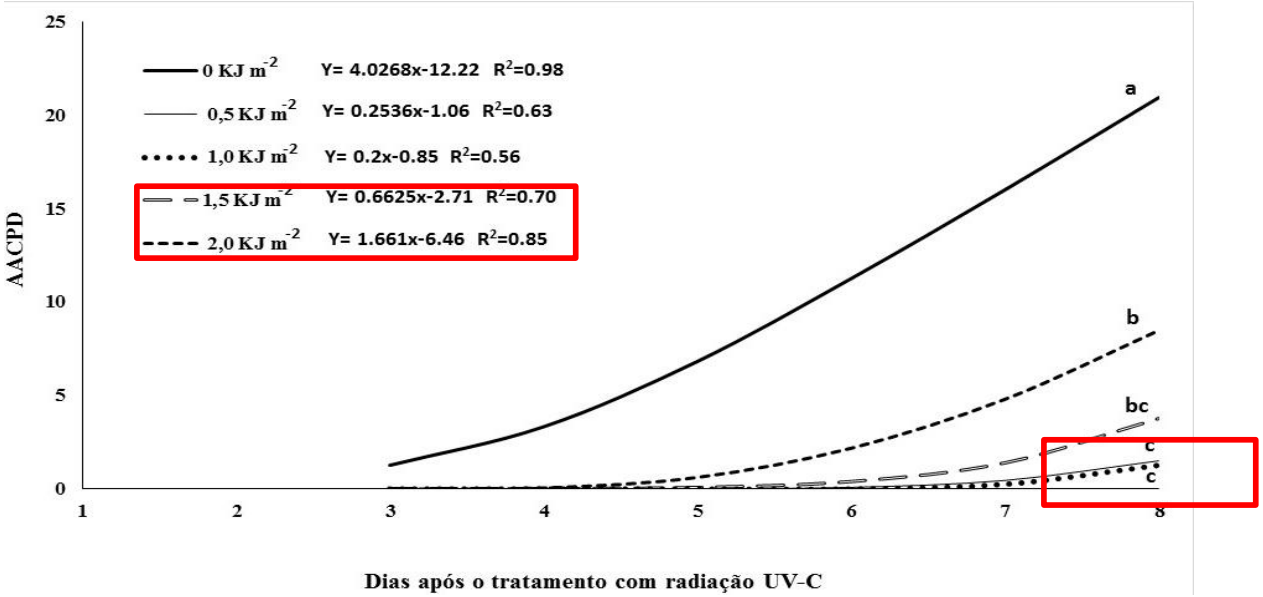

Figura 1 - Progresso da podridão peduncular de mamões tratados com diferentes doses de radiação UV-C e armazenados por sete dias a 10°C, seguido de oito dias a 22°C.

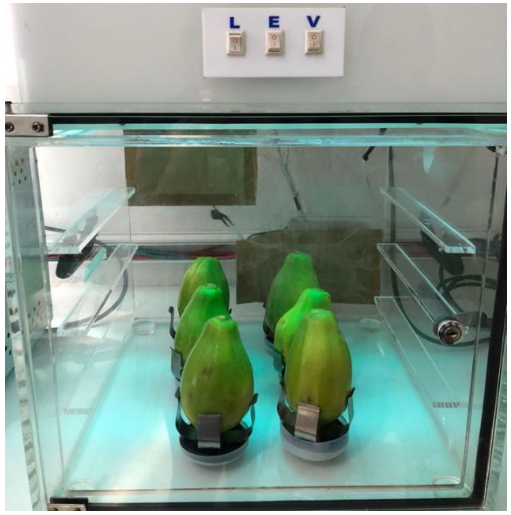

Foto: Daniel Terao

Tabela 1. Período de incubação da podridão peduncular em mamões tratados com diferentes doses de radiação UV-C e armazenados por sete dias a 10°C, seguido de oito dias a 22°C.

Dose UV-C	Período de incubação (dias)
2.0 KJ m^{-2}	7,5 a
1.5 KJ m^{-2}	7,3 ab
1.0 KJ m^{-2}	6,8 ab
0.5 KJ m^{-2}	6,0 b
0 (Testemunha)	2,6 c

Bactérias epífitas do mamão e formadoras de biofilmes para controle da antracnose do mamoeiro em pós-colheita

Biocontrole da antracnose em frutos de mamoeiro por bactérias epifíticas formadoras de biofilme

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RESUMO

Santos, L.A.L.; Silva, H.S.A.; Pinheiro, L.R.B.; Rocha, L.S.; Bragança, C.A.D; Silva, H.S.A. Biocontrole da antracnose em frutos de mamoeiro por bactérias epifíticas formadoras de biofilme. ***Summa Phytopathologica***, v.47, n.1, p.45-53, 2021.

A fim de se obter agentes de biocontrole para controle da antracnose em frutos de mamão em pós-colheita, buscou-se: i) selecionar bactérias epifíticas de mamoeiro antagonistas a *Colletotrichum brevizporum* pela produção de compostos antimicrobianos difusíveis e voláteis, quitinase e inibição da germinação de conídios; ii) quantificar a produção de biofilme pelos isolados selecionados; iii) obter uma concentração de bactérias que proporcionasse o controle da antracnose em discos de frutos; iv) avaliar a redução da severidade da doença em frutos de mamão. De 224 bactérias, 74 exibiram um mecanismo de ação contra o patógeno, 13 isolados dois mecanismos, quatro apresentaram três, e uma bactéria exibiu todos. Mediante a verificação da compatibilidade entre antagonistas, e a quantificação da formação de biofiolme, estabeleceram-se cinco "Mix" compostos por quatro isolados bacterianos. Em discos de frutos as bactérias foram avaliadas nas concentrações 10^4, 10^7 e 10^8 UFC mL^{-1}. À exceção do Mix 2, os demais reduziram significativamente a antracnose nos discos quando comparados ao controle. Os "Mix" 1, 3, 5, na concentração 10^8 UFC mL^{-1} exibiram melhor desempenho reduzindo a doença em até 75 %, 89,78 % e 90,8 %, respectivamente. Os Mix 3 e 5, na concentração de 108 UFC mL^{-1}, foram avaliados em frutos juntamente com o fungicida sintético Piraclostrobina. Não se verificou diferença significativa entre os Mix e o fungicida, que atingiu níveis de redução da doença superiores a 97 %, e as combinações com 98 %, frente ao controle não tratado.

Palavras-chave: *Carica papaya*. Controle biológico. *Colletotrichum brevizporum*.

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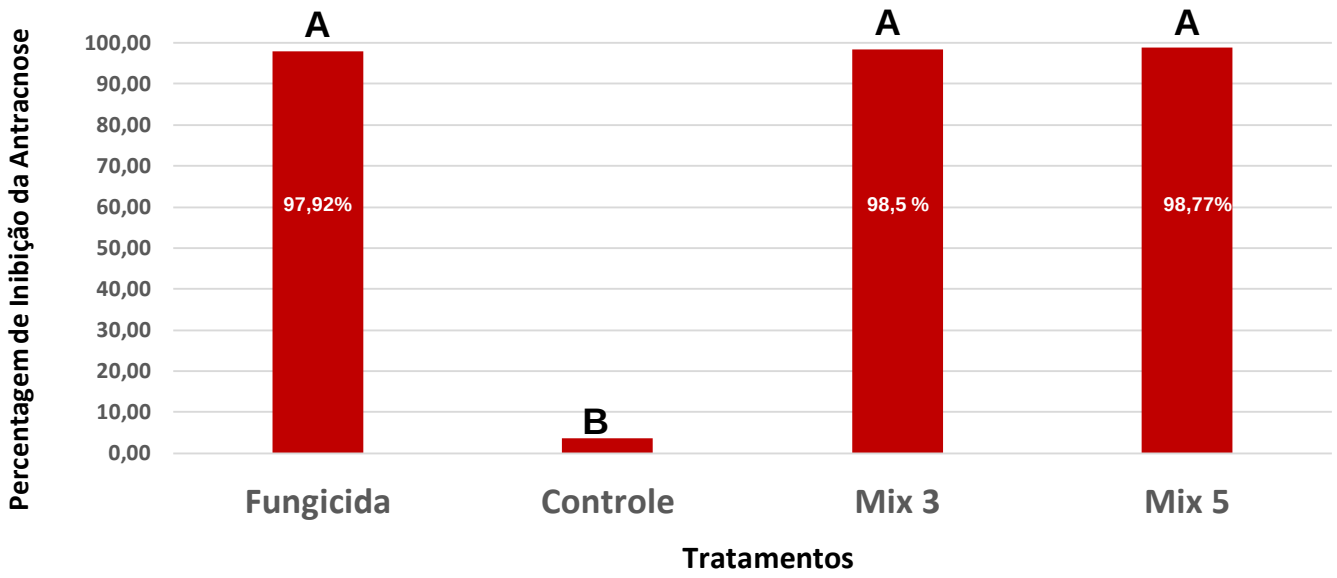
BACTÉRIAS EPIFÍTICAS COMO AGENTES DE BIOCONTROLE DA ANTRACNOSE DO MAMOEIRO EM PÓS-COLHEITA

LARYSSA ANDRADE DA LUZ SANTOS

Bactérias epífitas do mamão e formadoras de biofilmes para controle da antracnose do mamoeiro em pós-colheita



Avaliação da redução da antracnose em frutos inteiros

‘Tainung-1’

Controle | **Fungicida** | **Mix 3** | **Mix 5**

Fotos: Laryssa A. L. Santos

Embrapa

Avaliação da redução da antracnose em frutos inteiros – ‘Golden’

C/F S/F

Controle

C/F S/F

Fungicida

C/F S/F

Mix 3

C/F S/F

Mix 5

Fotos: Laryssa A. L. Santos

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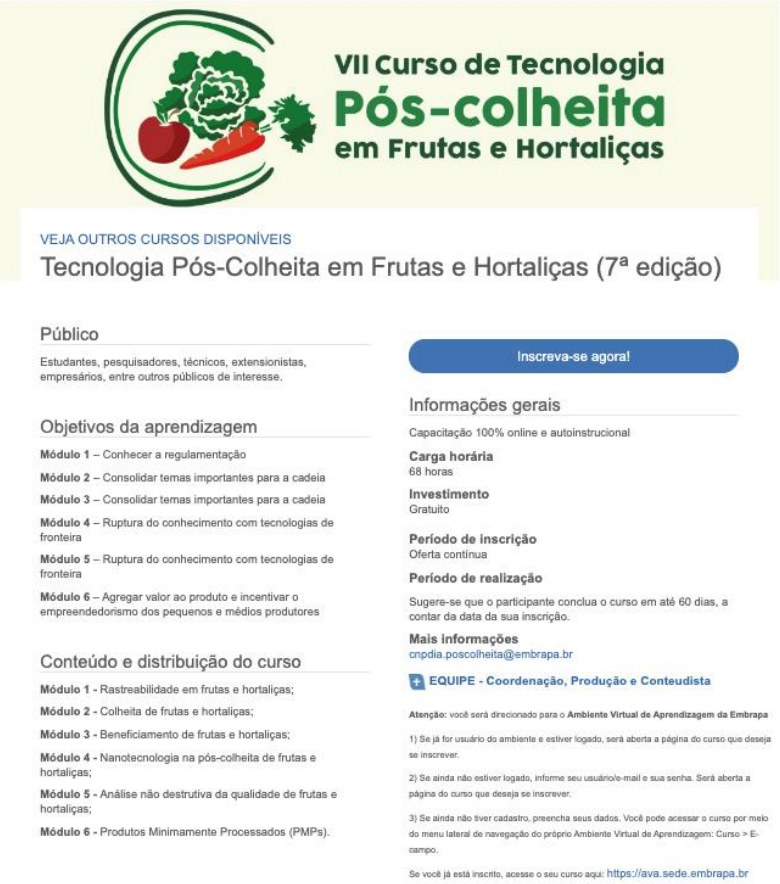

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