Hemicellulose-chitosan Nanocomposite Coating for Postharvest-life Extension of Papaya (*Carica papaya* L.)

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Outline

1. Introduction
    a. Objective of the research
    b. Scope of the research
2. Research findings
    a. Nanocomposite coating
    b. Postharvest-life extension of papaya
3. Status
4. Acknowledgement

Introduction

General objective:

To prepare nanocomposite coatings derived from food processing and agricultural wastes and apply these to high-value Philippine fruits to extend their postharvest-life

Introduction continued

Challenges

- ✓ preparation & characterization of the coating
- ✓ extension of fruit shelf-life

Introduction continued

Significance

- ✓ improvement of fruit/vegetable quality
- ✓ extension of fruit shelf-life
- ✓ develop high value products

Introduction continued

Composition of Coating

matrix + filler + others

mango

bell pepper

papaya

Introduction continued

Desired Properties of Coating for postharvest-life extension

- Alter the physiology of fruits
- Edible
- Biodegradable
- Nontoxic

Introduction continued

Composition of Edible Coating

- galactomannans – collagen blends (Lima et al., 2010)
- galactomannans-glycerol blends (Cerquira et al., 2009)
- glyoxal crosslinked galactoglucomannans (Mikkonen et al., 2012).

Composition of Edible Coating

✓ hemicellulose + chitosan
(Sumalapao and Sabularse, 2011
Yanos, Hernandez and Sabularse, 2013)

✓ pectin + gelatin + cellulose
(Mallari, Hernandez and Sabularse, 2013)

Introduction continued

- **Hemicelluloses**

noncellulosic polysaccharides associated with cellulose and lignin in plant cell walls.

xylans, xyloglucans, glucuronoxylans, arabinoxylans, mannans, glucomannans and galactomannans

Introduction continued

- **Chitosan**

  deacetylated chitin

Chitin

natural carbohydrate polymer of N-acetyl-D-glucosamine, linked by β-1,4 bond

Introduction continued

Nano

Greek word *nannos*, meaning 'dwarf'

"One-billionth" - 10^{-9}

- ✓ nanosecond
- ✓ nanometer (nm)

Nanoparticles

particulate dispersions or solid particles
size range: 10 – 1000 nm
(Mohanraj and Chen, 2006)

Nanocomposites

polymers with nanoparticles that have enhanced properties (Downing-Perrault, 2005)

Hemicellulose nanocomposites

- Glucomannan composite films with cellulose nanowhiskers (Mikkonen et al., 2010)
- Xylan-rich hemicelluloses film with cellulose nanofibers (Peng et al., 2011)
- Sulfonated cellulose nanowhiskers reinforced xylan films (Saxena and Ragauskas, 2009)

Introduction cont

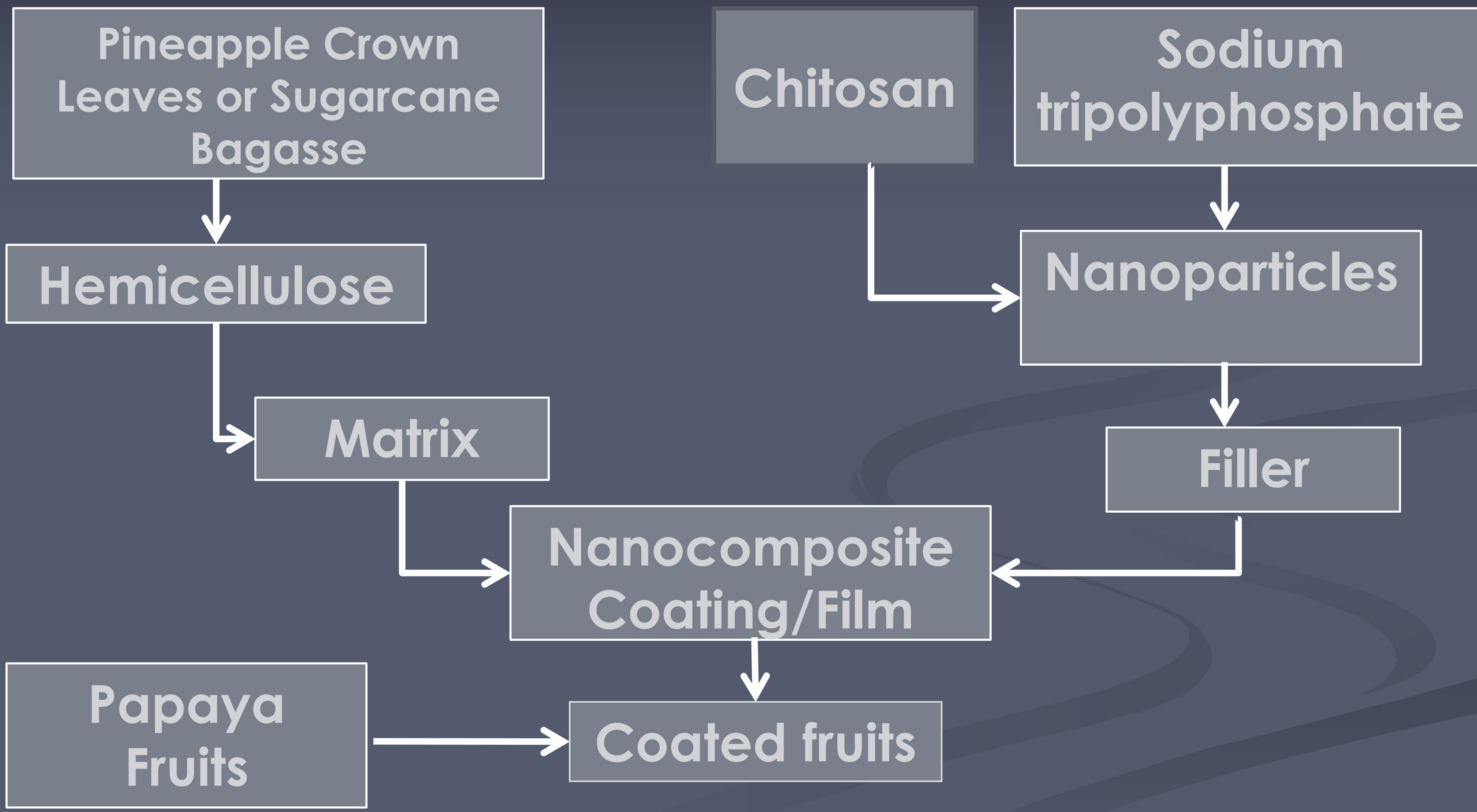
matrix + filler + others

hemicellulose
chitosan polyphosphate
additives

Why papaya fruits?

- ✓ Top export winner of the Philippines *(Serrano, 2004)*
- ✓ Philippines ranks 10 world wide in terms of production in 2007, contributing 1.78% (164,234 MT) and its economic contribution is increasing *(Lustria et al., 2009)*
- ✓ Part of the Industry Strategic Plan, targeted yield increase from 18.26 MT/ha to 24.30 MT/ha in 2016 and to 35.58 MT/ha in 2020.
- ✓ A good model in studying climacteric fruits.

Project Overview



Major findings (potential products)

1. hemicellulose extracted from pineapple crown leaves
2. chitosan/polyphosphate nanoparticles prepared
3. film with different mechanical, physico-chemical and barrier properties
4. Coating extended the shelf life of Sinta and Red Lady papaya

Source of Hemicellulose

Pineapple crown leaves

Hemicellulose from PCL

Major findings (continued)

chitosan/polyphosphate nanoparticles

117 nm TEM (Sumalapao and Sabularse, 2011)

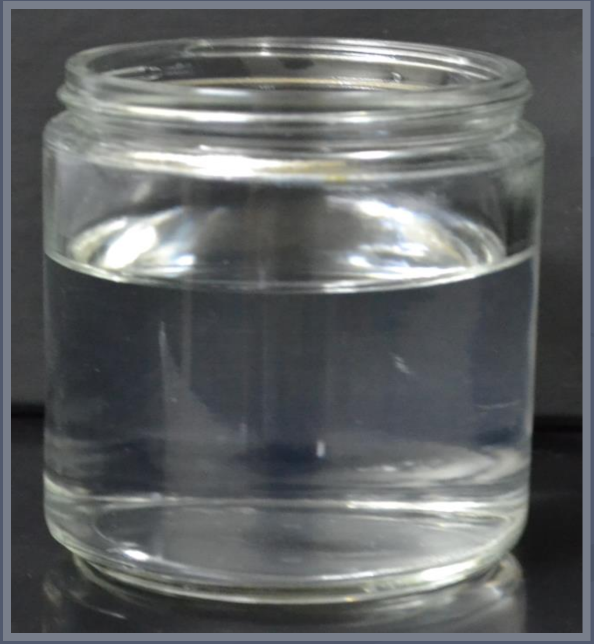
73.73 nm zeta sizer (Yanos et al., 2014)

53-64 nm zeta sizer (Yanos et al., 2014)

Major findings (continued)

chitosan/polyphosphate nanoparticles

117 nm ⟹ 73.73 nm ⟹ 53-64 nm



Nanocomposite Coating Formulation

Nanocomposite Film

Nanocomposite Coating Formulation

powder?

Major findings
(Sumalapao and Sabularse, 2011)

TYPE OF FILM	TENSILE STRENGTH AT BREAK (MPa)	ELONGATION AT BREAK (%)
hemicellulose only	0.0472±0.0045	3.6±0.5
hemicellulose + chitosan-polyphosphate nanoparticles	0.0540±0.0048	4.8±0.8
hemicellulose + chitosan-polyphosphate nanoparticles + additives	0.00000387 ±0.00000078	1.8±0.5

Methods of application of edible coatings

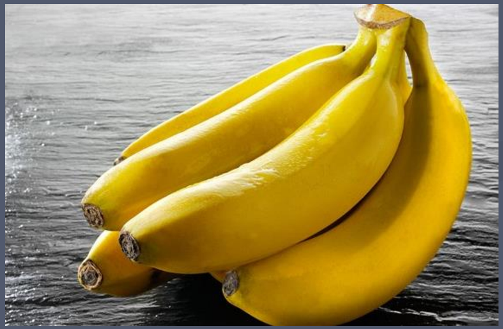
- Dipping

Source: Maqbool, 2012

- Brushing

Source: Dhanapal et al., 2012.

- Spraying



Source: Collins, 2012

Major findings

extended the shelf life of Sinta and Red Lady papaya

properties monitored

1. peel color
2. firmness
3. disease incidence and severity
4. shriveling
5. weight loss

Brief description of the scale used for fruit evaluation

property	scale	1	max
peel color	1 – 6	green	all yellow
firmness	1 - 4	very soft	firm
disease incidence & severity	1 - 5	none	>30%
shriveling	1 – 5	none	>50%
weight loss	1 - 5		

Major findings

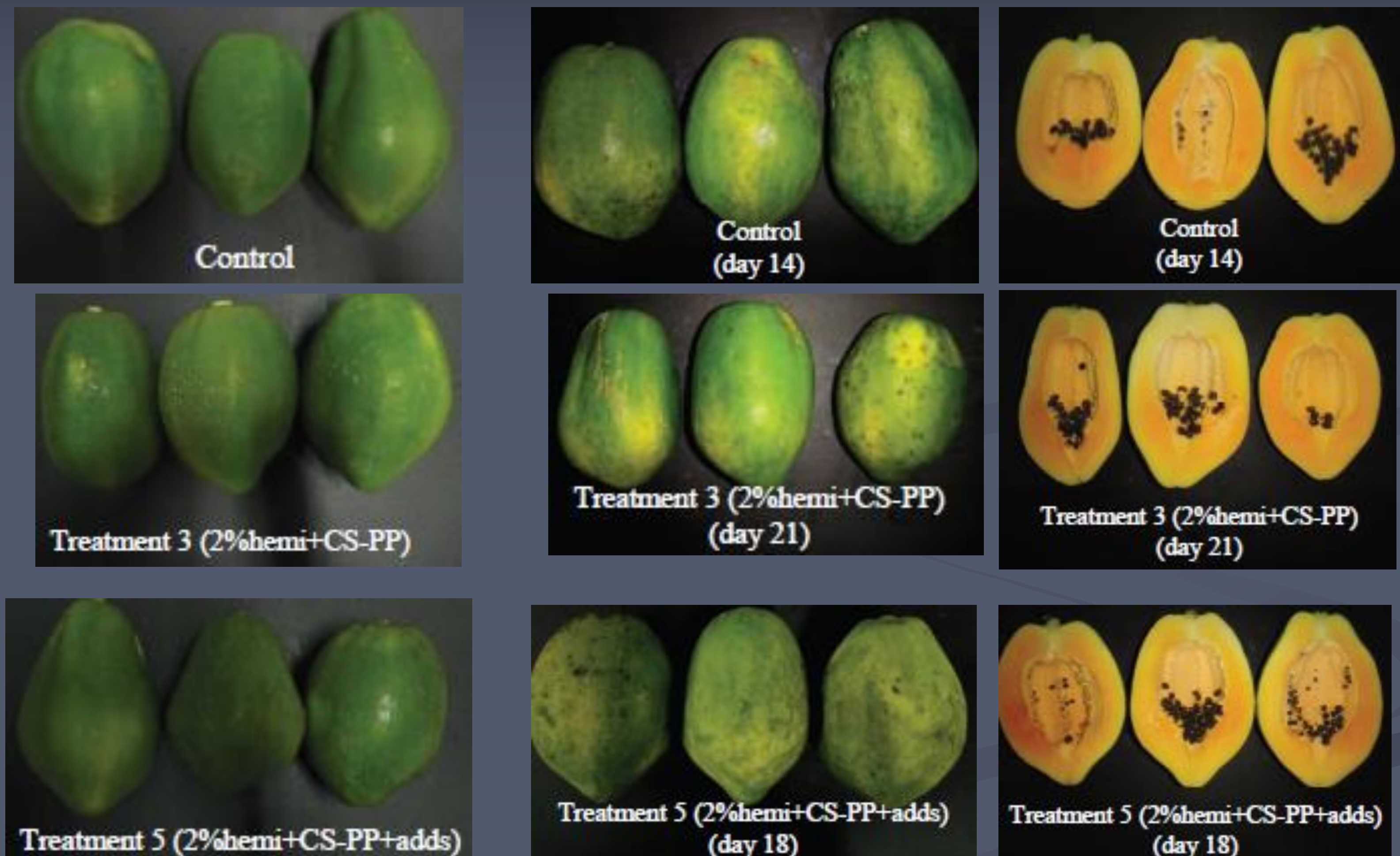
Extended the shelf life of Sinta papaya

T storage: 13 °C

RH: 83-93 %

Storage period: 30 days

Sinta fruits
breaker to more green than yellow



Sumalapao and Sabularse, 2011

Major findings

Extended shelf life
Red Lady papaya

T & H storage: ambient
Storage period: 12 days

Status

- optimization of conditions for the preparation and bench-scale production of a hemicellulose-chitosan nanocomposite coating

- more experiments on the evaluation of its performance in extending the shelf life of some high-value Philippine fruits including papaya

ACKNOWLEDGMENT

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DOST-PCIEERD

THANK YOU!