UNIVERSITÀ DEGLI STUDI DI PALERMO

PackLAB
UNIMI Food Packaging Laboratory

CHARACTERIZATION AND DEVELOPMENT OF DIFFERENT METHODS TO EXTEND SHELF LIFE OF FRESH CUT FRUIT

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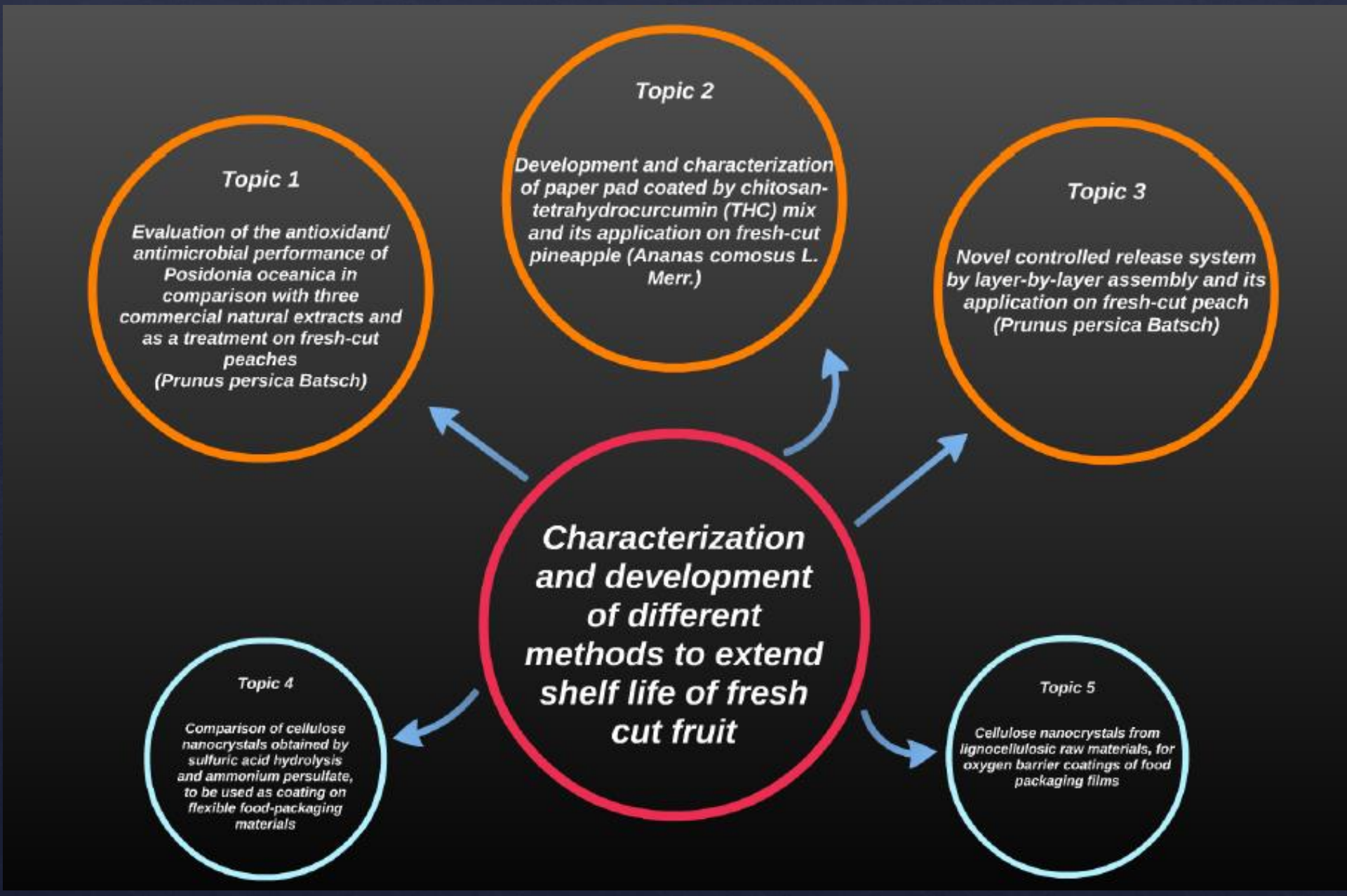

Topic 1
Evaluation of the antioxidant/ antimicrobial performance of Posidonia oceanica in comparison with three commercial natural extracts and as a treatment on fresh-cut peaches (Prunus persica Batsch)
Topic 2
Development and characterization of paper pad coated by chitosan-tetrahydrocurcumin (THC) mix and its application on fresh-cut pineapple (Ananas comosus L. Merr.)
Topic 3
Novel controlled release system by layer-by-layer assembly and its application on fresh-cut peach (Prunus persica Batsch)
Characterization and development of different methods to extend shelf life of fresh cut fruit
Topic 4
Comparison of cellulose nanocrystals obtained by sulfuric acid hydrolysis and ammonium persulfate, to be used as coating on flexible food-packaging materials
Topic 5
Cellulose nanocrystals from lignocellulosic raw materials, for oxygen barrier coatings of food packaging films

INTRODUCTION

QUALITY DECAY

Mechanical shock

+

Enzymatic oxidation

+

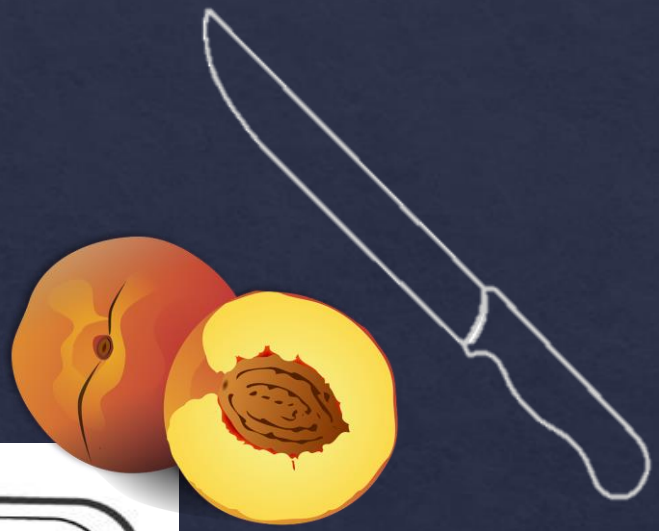
Microbiological spoilage

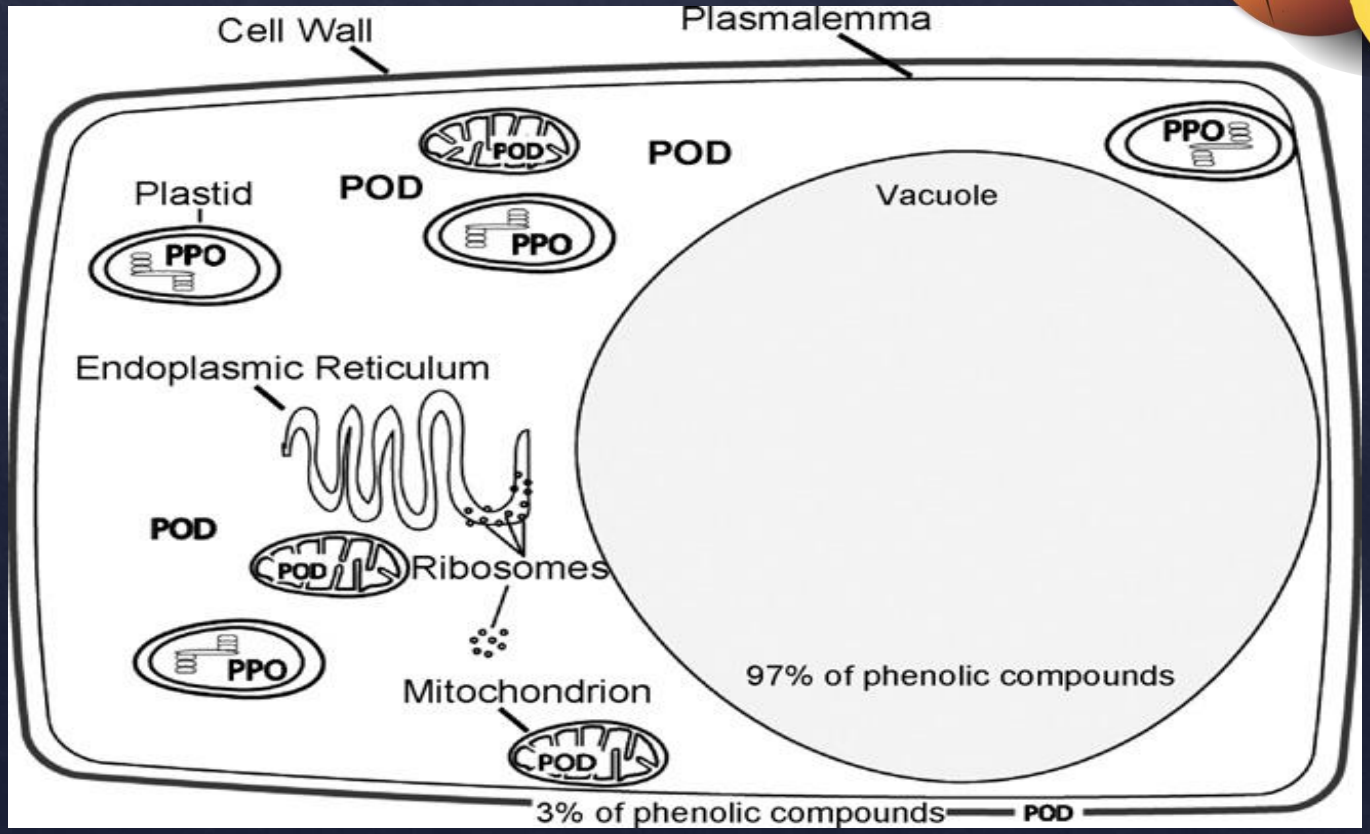
=

Increase of fruit senescence

INTRODUCTION

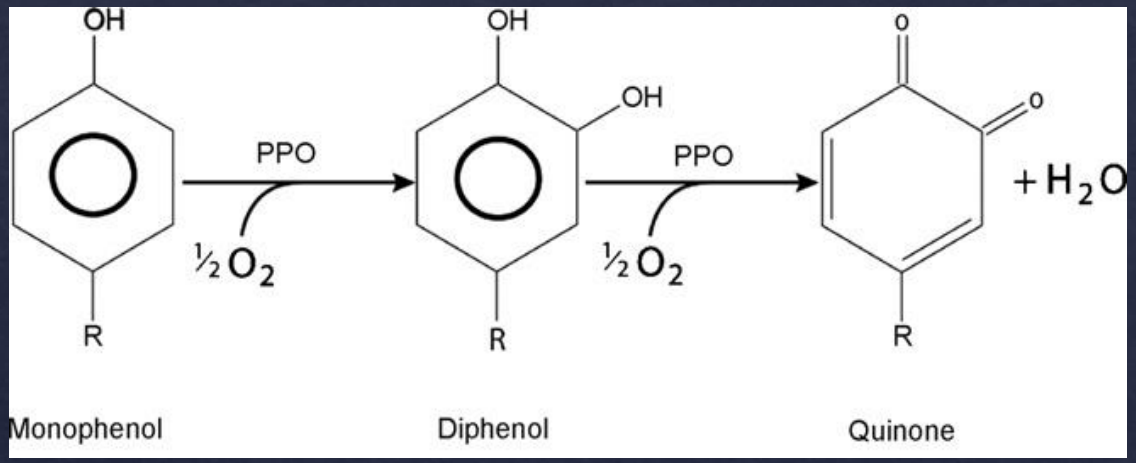
CUTTING PROCESS TRIGGERS THE FRUIT DECAY





Localization of phenolic compounds and phenolic oxidizing enzymes (PPO: polyphel oxidase; POD: phenol peroxidase). (Toivonen & Brummel, 2008).

INTRODUCTION



Mechanism for polyphenol oxidase action (PPO) on monophenols and Diphenols. (Toivonen & Brummel, 2008).

PRODUCT APPEARANCE INFLUENCES CONSUMER CHOICE

WHICH SOLUTION ?

THE ACTIVE PACKAGING

"Packaging in
which subsidiary constituents have been deliberately included in or on either the packaging material or the package headspace to enhance the performance of the package system"
(Robertson, 2006)

OBJECTIVES

Control of enzymatic browning	• Good visual appearance
Control of microbiological growth	•Shelf-life extension
Valorization of natural compounds	• Use of nutraceuticals food

TOPIC 1

P. oceanica EXTRACT

GREEN TEA TANNIN

TOPIC 2

TETRAHYDROCURCUMIN *(THC)*

CHITOSAN

TOPIC 3

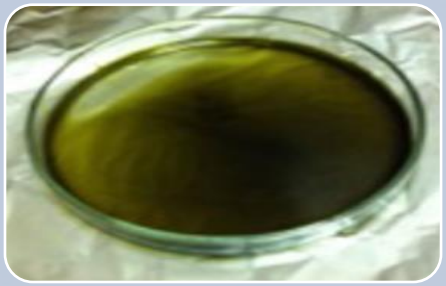
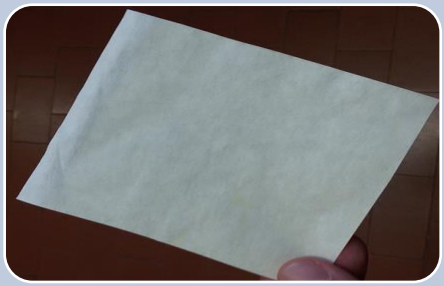
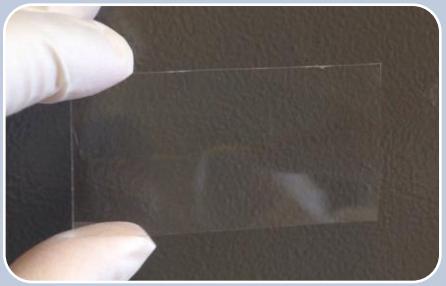
CHITOSAN

ALGINATE

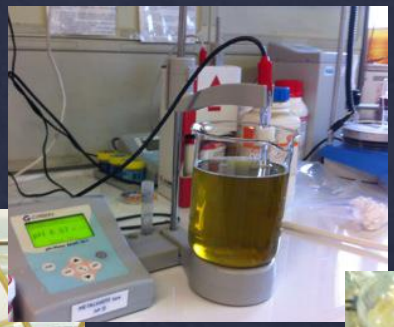
GREEN TEA TANNIN

HOW to deliver
antioxidant/antimicrobial substances on fruit

?

TOPIC 1	TOPIC 2	TOPIC 3
		
DIPPING	COATING	LAYER-BY-LAYER

TOPIC 1 – MATH&METH



2% (w/v) of P.oceanica

P.oceanica and green tea extracts applied on peach by dipping

1% (w/v) of Tea tannin

TOPIC 1 – MATH&METH

ANALYSIS CARRIED OUT

- TPI (mg GAE/g extract)
- Antioxidant activity (mg/L EC_{50})
- Total soluble solids (%)
- Titratable acidity (g/l of citric acid)

ON *P.oceanica* EXTRACT AND PEACHES

- Color
- Total aerobial count
- Yeasts & moulds
- Enterobacteriaceae & Pseudomonas

SAMPLES WERE ANALYZED AFTER 0, 3, 5 AND 7 D

TOPIC 1 – RESULTS

Total aerobic count (TAC), Pseudomonas and Total yeast and
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for each
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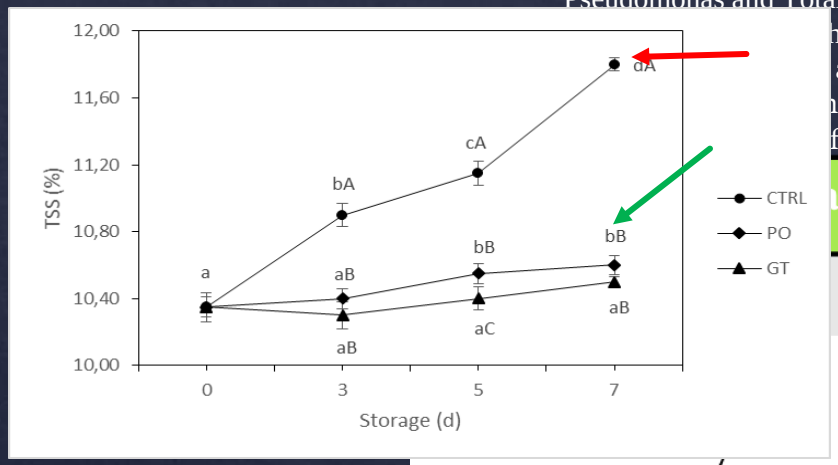
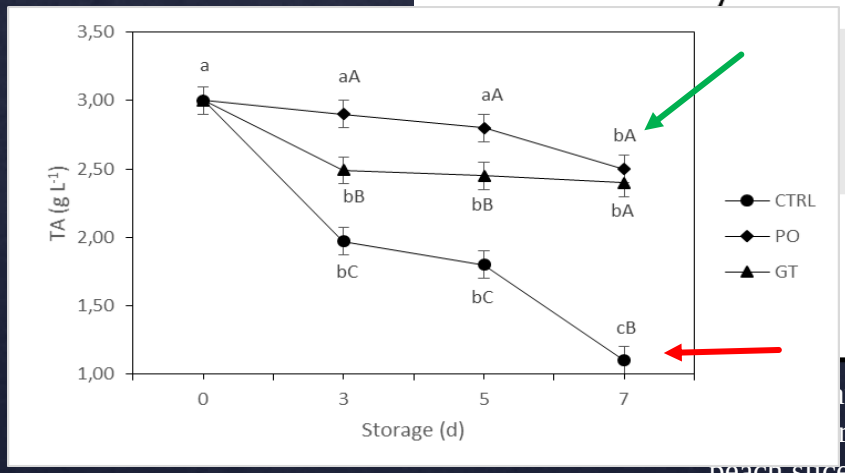
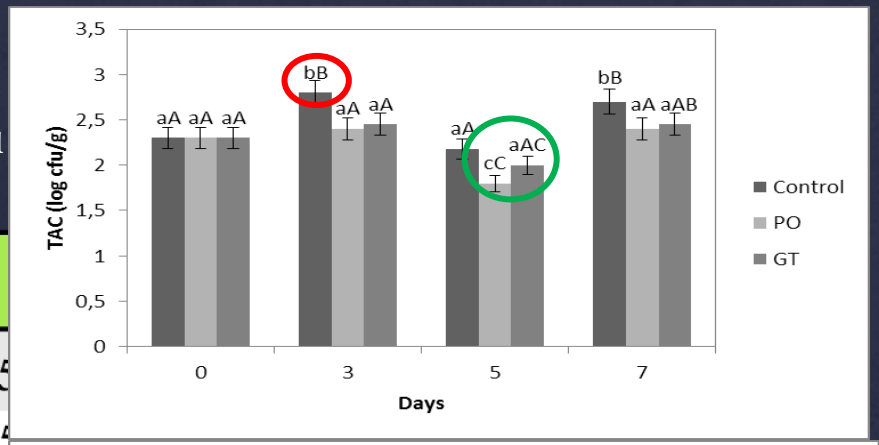
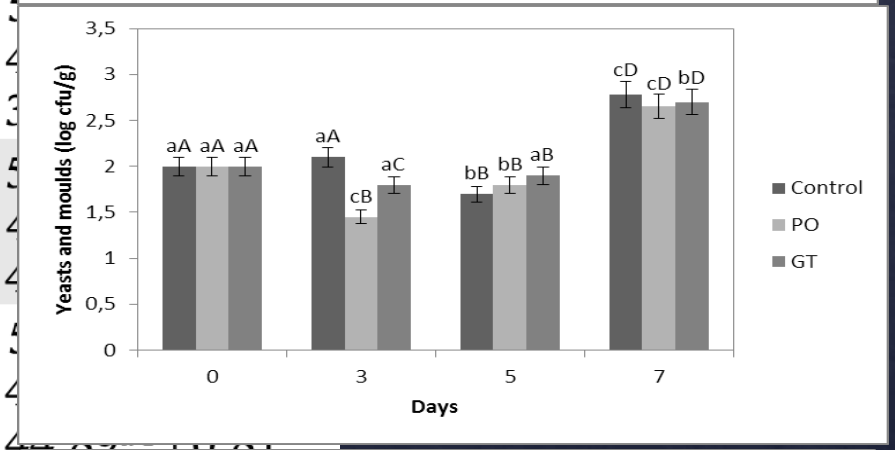
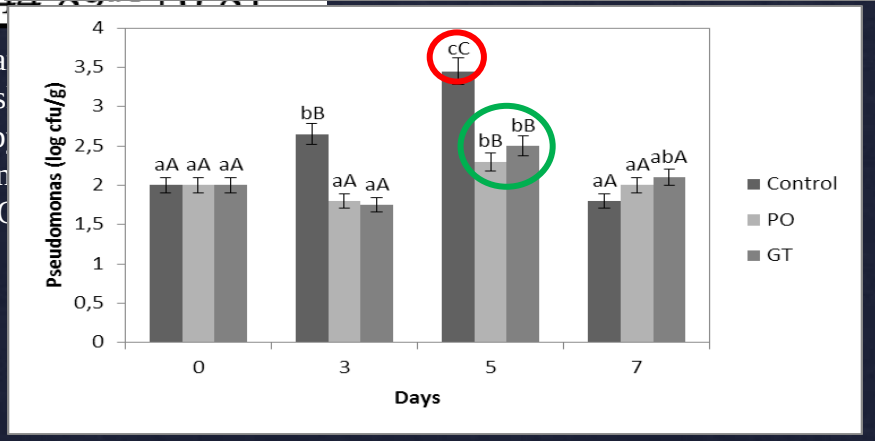




Evolution of total soluble solids and titratable acidity (g L^{-1}) in peach (*Prunus persica*) cv. Rich May slices treated with *P. oceanica* (PO), Green Tea (GT) and untreated (CTRL).







TOPIC 1 – CONCLUSIONS

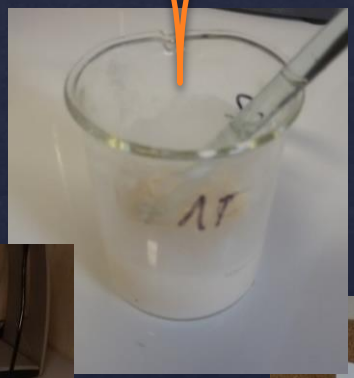
Evaluation of the antioxidant/antimicrobial performance of *Posidonia oceanica* in comparison with three commercial natural extracts and as a treatment on fresh-cut peaches (*Prunus persica* Batsch)

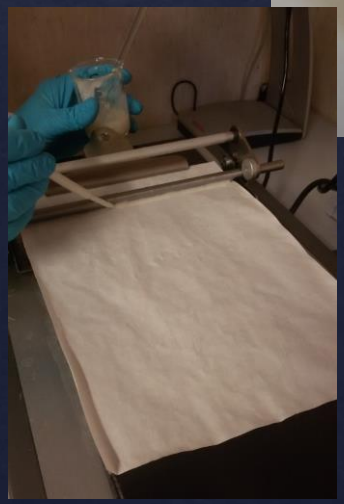
1. **GOOD ANTIMICROBIAL ACTIVITY**
2. **LESS FRUIT COLOR DECAY**
3. **KEEPING OF POMOLOGICAL TRAITS**

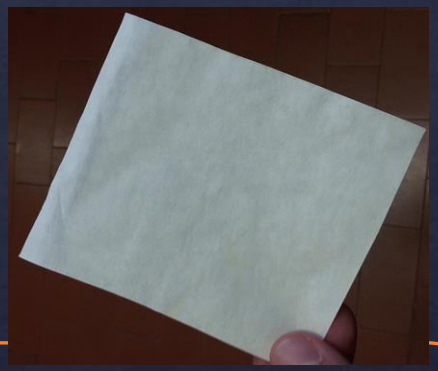
TOPIC 2 – MATH&METH

10% (w/v) of THC

3% (w/v) of CHITOSAN







Tetrahydrocurcumin and chitosan powders were mixed and coated on paper

TOPIC 2 – MATH&METH

ANALYSIS CARRIED OUT ON PINEAPPLE

- Weight loss (g)
- Total soluble solids (%brix)
- Titratable acidity (g/l of citric acid)
- pH
- Color
- Browning Potential (Abs)
- Total phenolic content (mg GAE/100 g of FW)
- Microbiological count (TAC+Y&M)

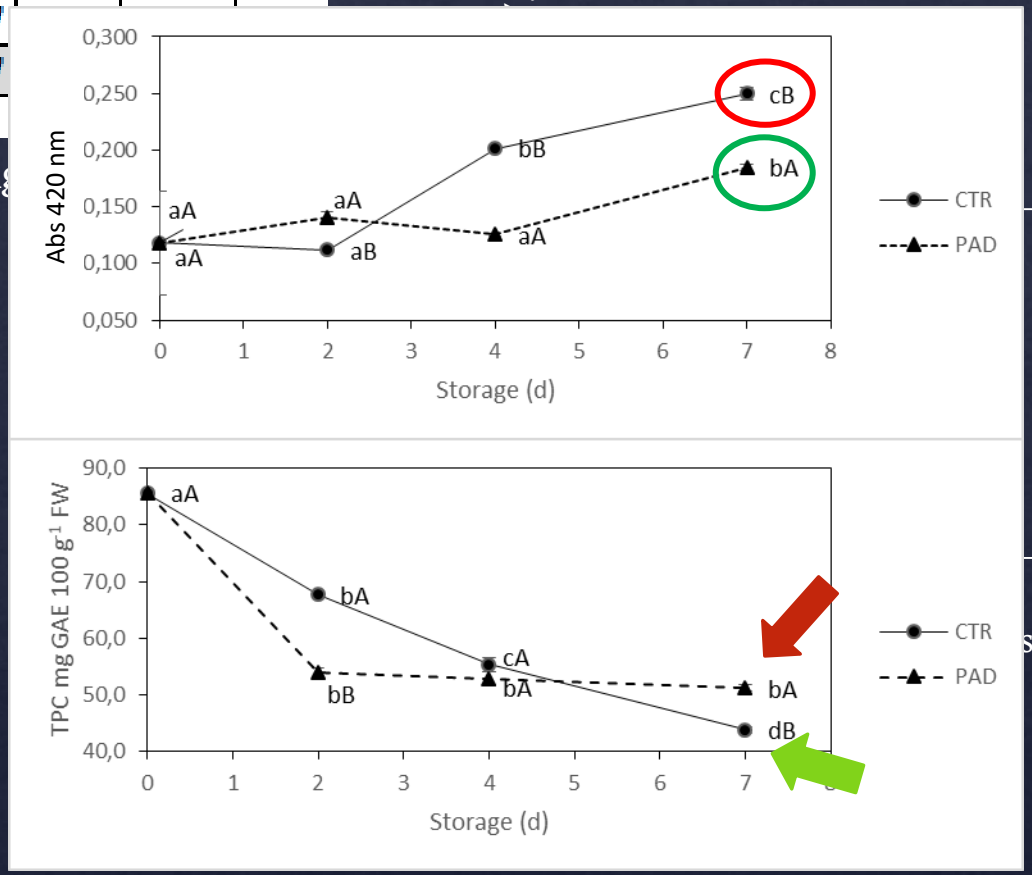
SAMPLES WERE ANALYZED AT THE DAYS 0, 2, 4 AND 7 OF STORAGE

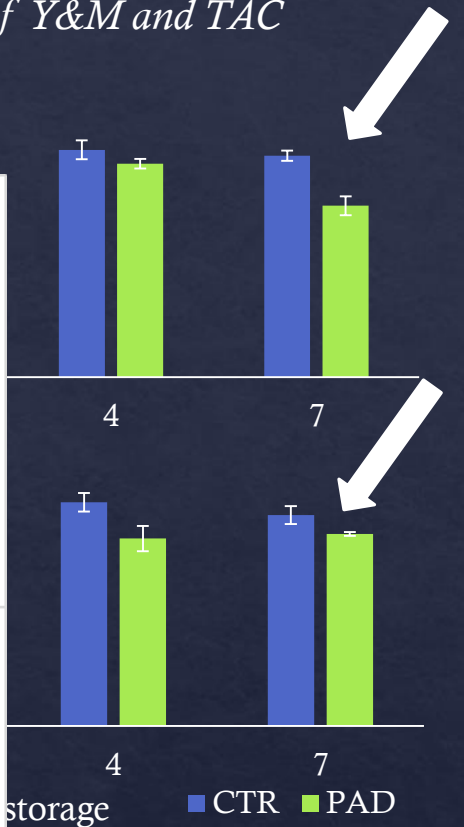
TOPIC 2 – RESULTS

	Days of storage			
	0	2	4	7
CTR	-	1,97		
PAD	-	1,57		

Evolution of ΔE during

Time course of Y&M and TAC

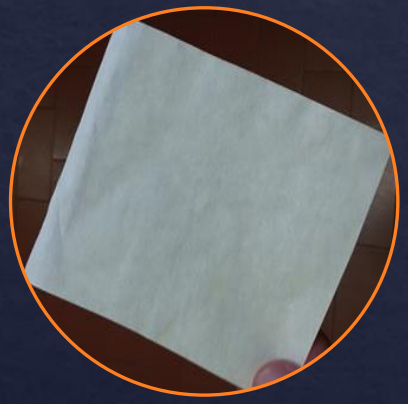




Evolution of Browning Potential (BP) (A) and Total Polyphenol Contents (TPC) (mg GAE/100 g of fresh fruit) (B) of pineapple slices treated by paper pad (PAD) and untreated (CTR). Data are means ± SD. Minor and capital letters show significant differences ($p \leq 0.05$) for each treatment and among treatments for each storage time, respectively.

TOPIC 2 – CONCLUSIONS

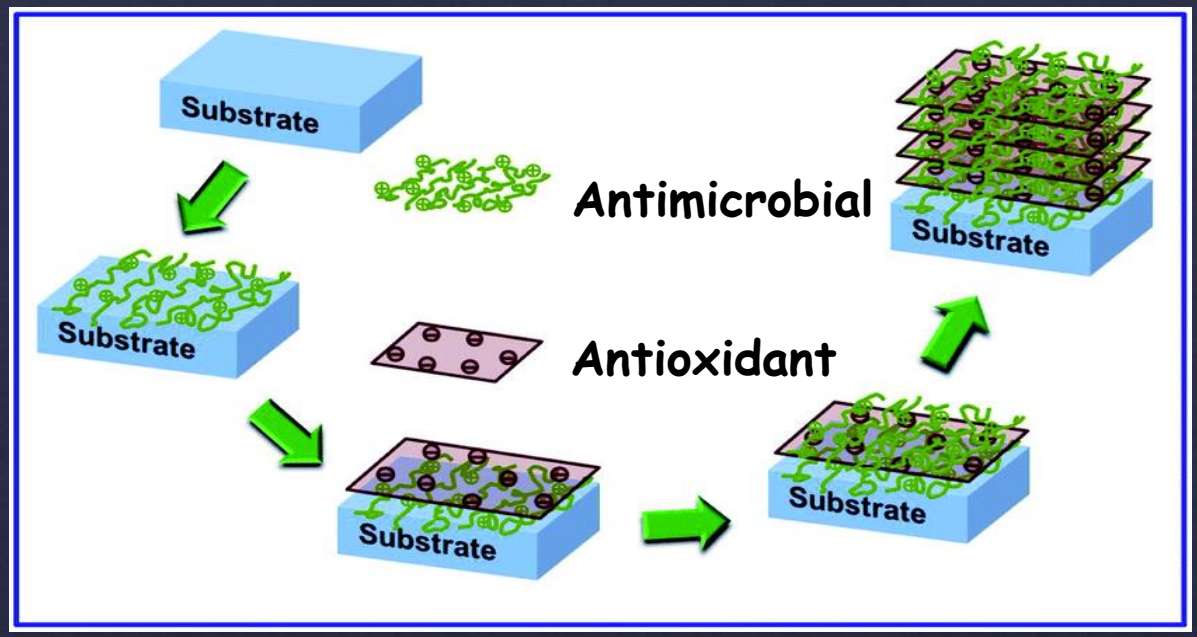
Characterization of paper pad coated with chitosan-tetrahydrocurcumin (THC) mix and its application on fresh-cut pineapple (*Ananas comosus* L. Merr)



1. **BROWNING REDUCTION**
2. **INHIBITION OF MICROBIAL GROWTH**
3. **POSSIBLE SHELF-LIFE INCRESE**

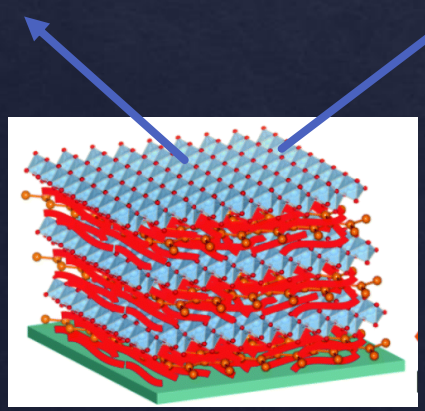
TOPIC 3 – *IN VITRO* MATH&METH

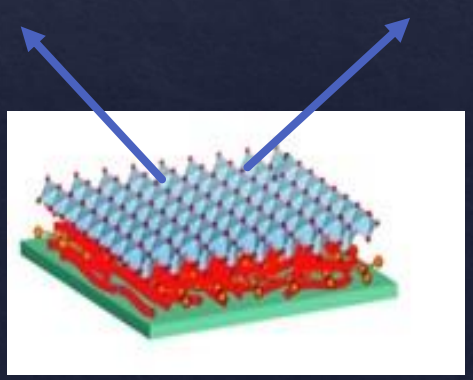
Layer-by-layer technique for bottom-up nano-fabrication

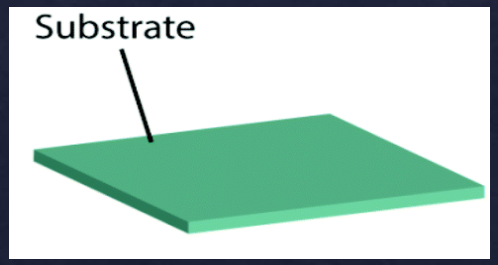


Layer-by-layer release:

gradual & alternate





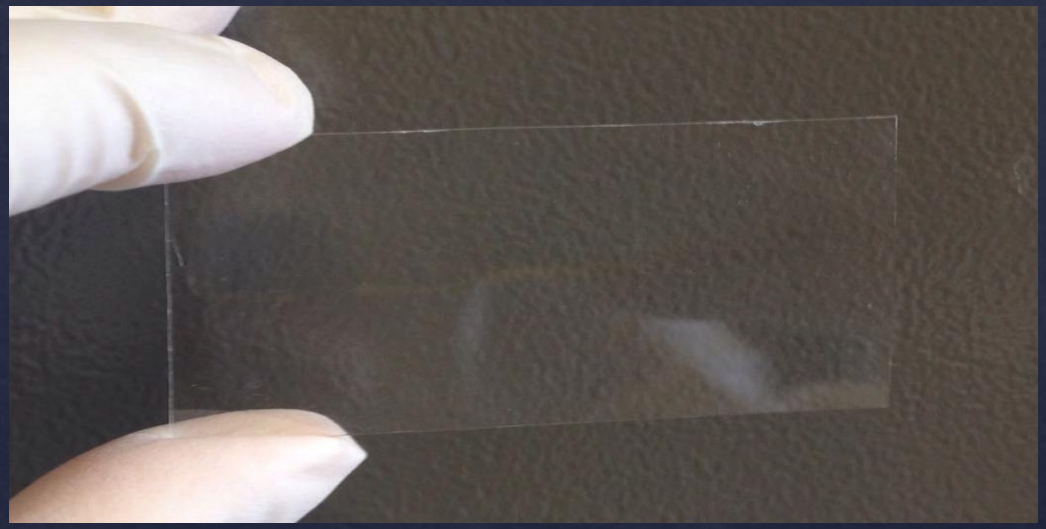


The layers are dissolved by food matrix

TOPIC 3 – *IN VITRO* MATH&METH

ON STRIPS
- OCA
- FTIR
- FTIC-Chitosan assembly

CRS strip



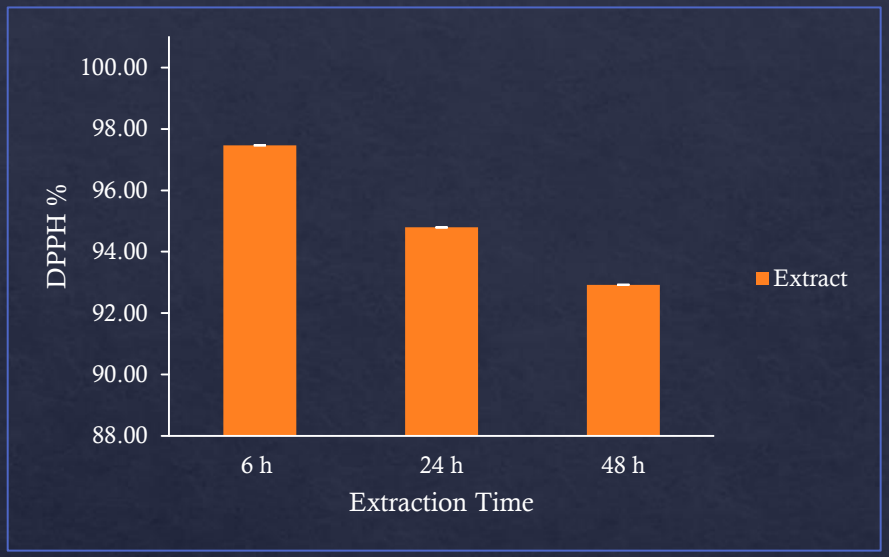
Citric acid solution (pH 3,8)

Extraction under stirring for

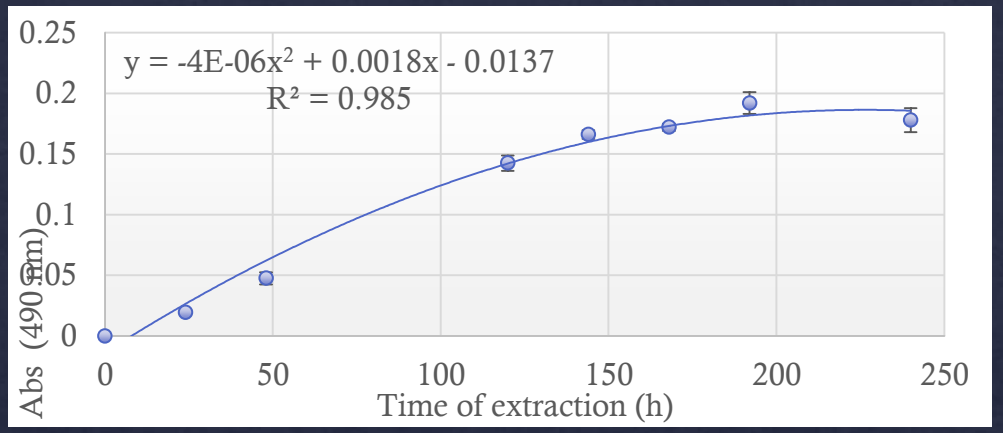
6 h ***24 h*** ***48 h***

ON STRIPS EXTRACT
- UV-VIS SPECTROPHOTOMETRY
- ANTIOXIDANT ASSAY
- MICROBIOLOGICAL TEST
- HPLC

TOPIC 3 – *IN VITRO* RESULTS



Antioxidant assay of LbL extract expressed as percentage of DPPH decay.



Kinetics of FITC-CHIT release over 244 hours of extraction (10 days).

P. chrysogenum, after 6 d of incubation

Inhibition halo of 48 h extract

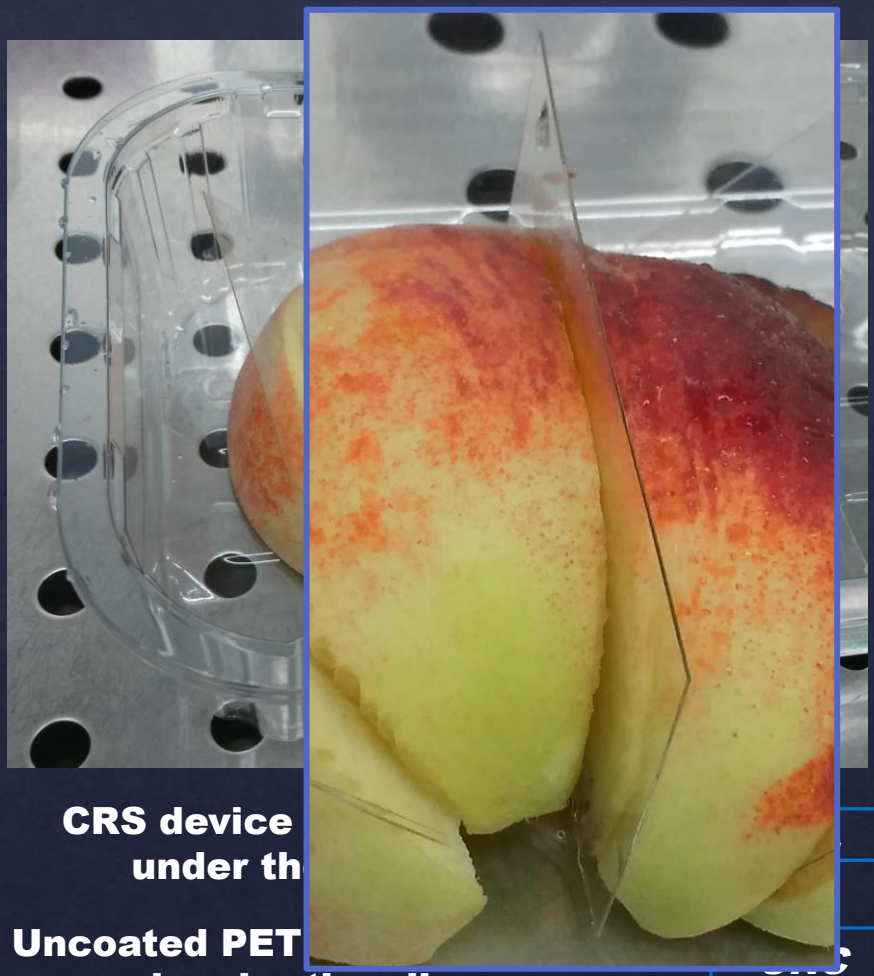
TOPIC 3 – *IN VITRO* RESULTS

1. **Migration of chitosan and polyphenols were modulated by time**
2. **Chitosan inhibited fungal growth**
3. **Polyphenols carried out its antioxidant capacities**

All these characteristics allow the application on fresh-cut fruit

TOPIC 3 – *IN VIVO* MATH&METH

White-fleshed peach Cv "Alexandra"



CRS device under th

Uncoated PET and under the slices

Control sample → ***CTR***

Color **Firmness** **Weight loss**

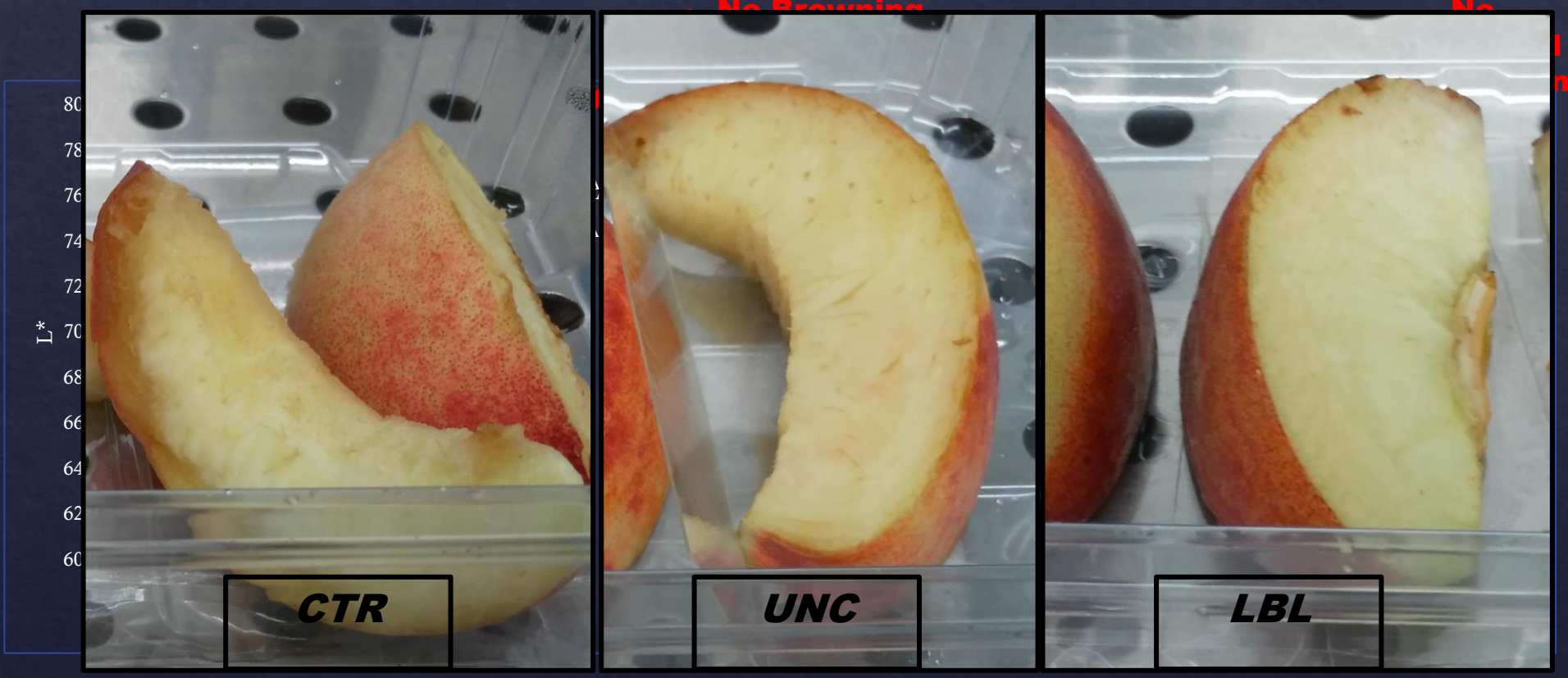
Titratable acidity

Total soluble solids

PPO activity

Total carotenoid content

TOPIC 3 – *IN VIVO* RESULTS



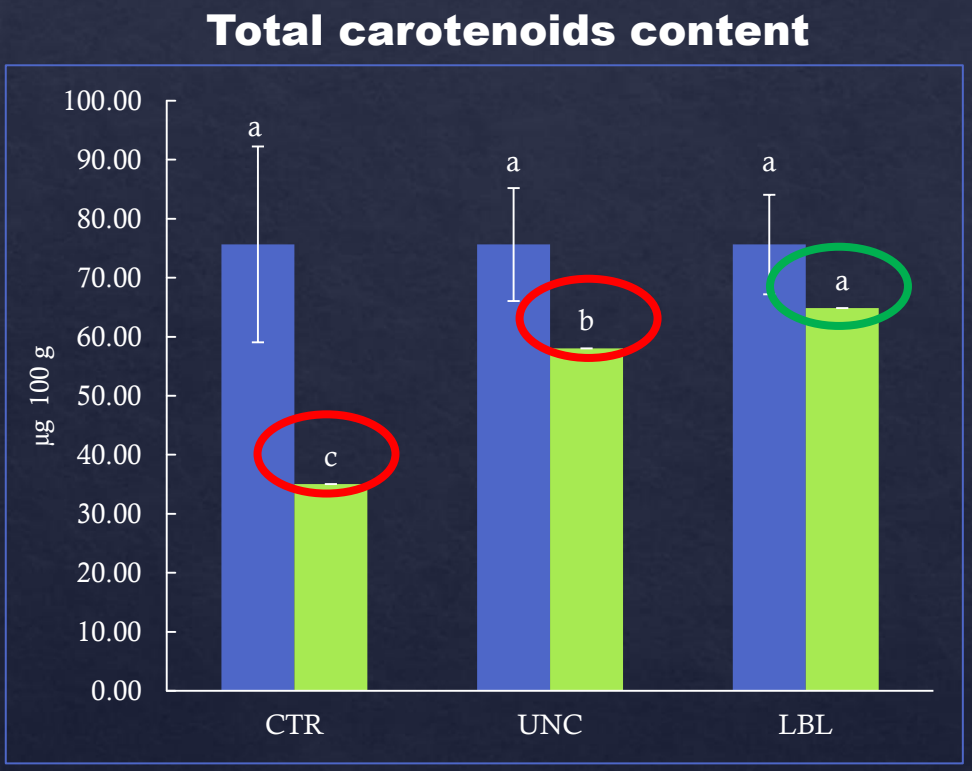
Lightness and a* parameter changes during storage of fresh cut peach slices treated of CRS (LBL), uncoated strips (UNC) and untreated (CTR). c

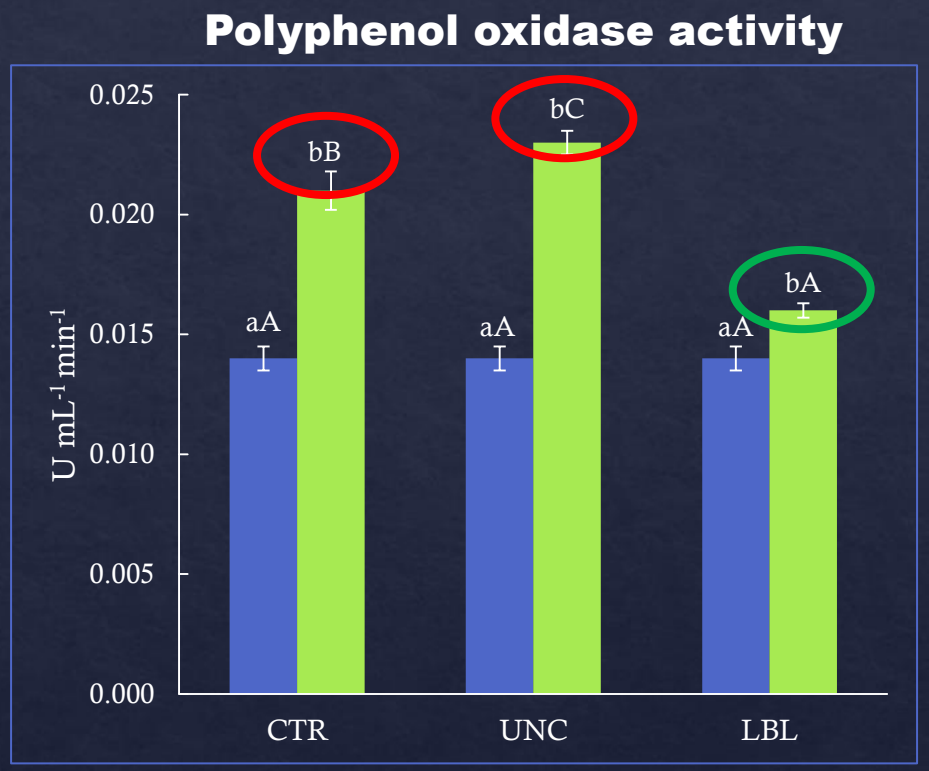
TOPIC 3 – *IN VIVO* RESULTS

	FIRMNESS kg cm^{-1}		WEIGHT LOSS %	TOTAL SOLUBLE SOLIDS %		TITRATABLE ACIDITY % of malic acid	
Time of storage	T0	T7	T7	T0	T7	T0	T7
CTR	3.97^{aA} ±0.46	4.08^{bA} ±0.73	5.22^{bB} ±0.09	8.25ns ±0.55	9.55ns ±0.02	0.808ns ±0.09	0.710ns ±0.02
UNC	3.97^{aA} ±0.46	4.86^{bB} ±1.33	2.48^{aB} ±0.68	8.25ns ±0.55	8.99ns ±0.59	0.808ns ±0.09	0.720ns ±0.06
LBL	3.97^{aA} ±0.46	5.89^{aB} ±1.54	2.50^{aB} ±0.70	8.25ns ±0.55	9.53ns ±0.01	0.808ns ±0.09	0.670ns ±0.08

Evolution of pomological traits of peach slices after 7 d of storage. of CRS (LBL), uncoated strips (UNC) and untreated (CTR). Data indicate ± SD. Capital and minor letters show significant differences ($p \leq 0.05$) for each treatment and among treatments for each storage time, respectively.

TOPIC 3 – *IN VIVO* RESULTS



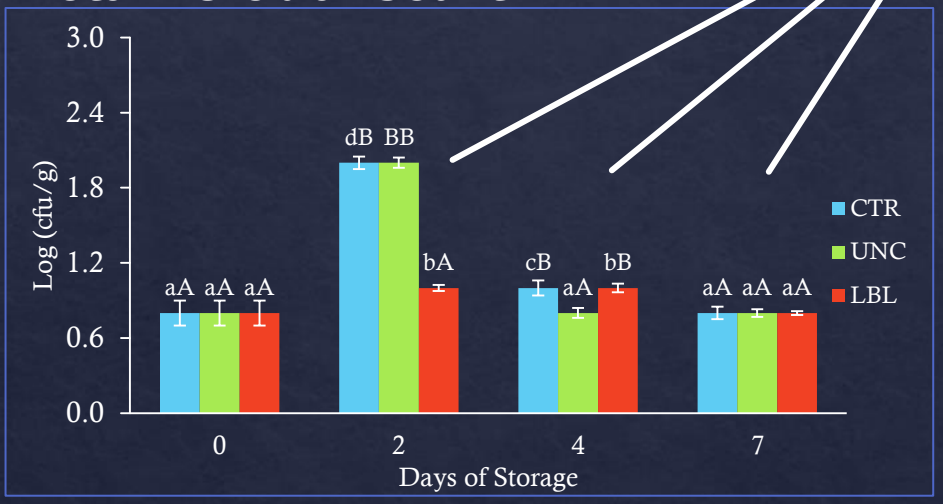


Evolution of total carotenoids and Polyphenol oxidase (PPO) of peach slices after 7 d of storage. of CRS (LBL), uncoated strips (UNC) and untreated (CTR). Data indicate ± SD. Minor and capital letters show significant differences ($p \leq 0.05$) for each treatment and among treatments for each storage time, respectively.

TOPIC 3 – *IN VIVO* RESULTS

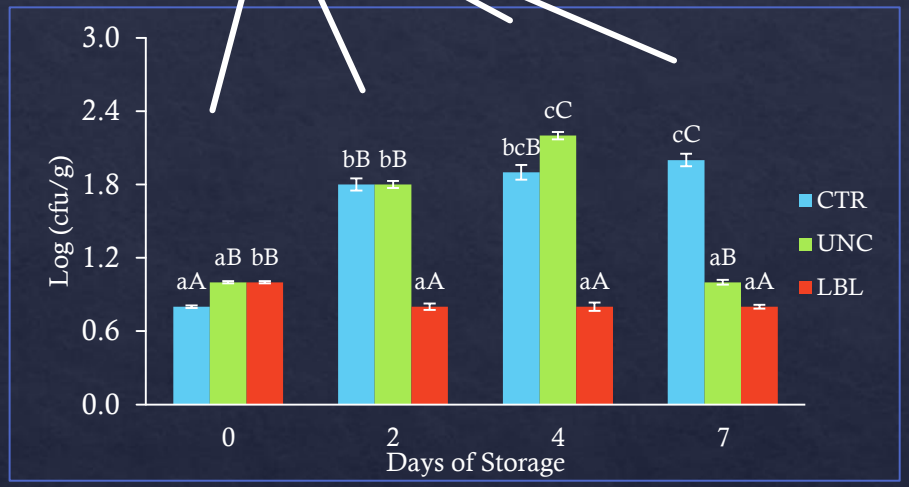
Remains constant

Total Aerobial Count

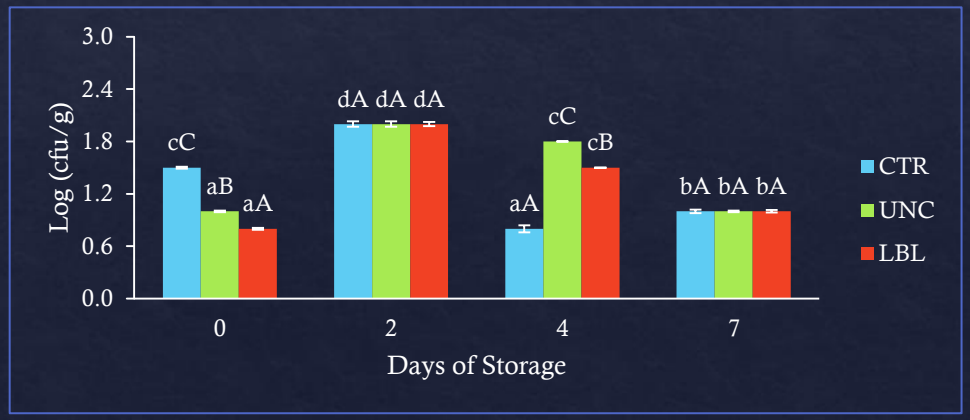


Remains constant

Psychrophiles



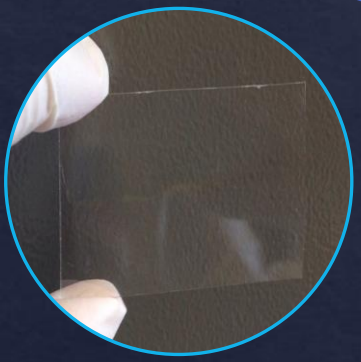
Yeasts & Moulds



Time course of Total Aerobic Count (TAC), yeasts and moulds and psychrophiles presence (log cfu/g peach. Data indicate ± SD. Minor and capital letters show significant differences ($p \leq 0.05$) for each treatment and among treatments for each storage time, respectively.

TOPIC 3 – CONCLUSIONS

Novel controlled release system by layer-by-layer assembly and its application on fresh-cut peaches (*Prunus persica* Batsch)



1. **CAROTENOIDS AND COLOR WERE PRESERVED DURING STORAGE**
2. **PPO ACTION WAS SLOWED DOWN BY POLYPHENOLS**
3. **PSYCHROPHILES AND TAC WERE CONTROLLED BY CHITOSAN**
4. **DELAY OF FRUIT SENESCENCE**

FUTURE PERSPECTIVES OF LAYER-BY-LAYER DEVICE

- Tailoring of device according to the food characteristics
- Optimization using the most effective active substances
- Dossier required by EFSA for Active Packaging authorization

«WHAT FOR?» AWARD 2016

UNIVERSITÀ DEGLI STUDI DI PALERMO

PackLAB
UNIMI Food Packaging Laboratory

Portici (NA), September 16th, 2016

Italian Network of the PhD Courses in Food Science Technology & Biotechnology

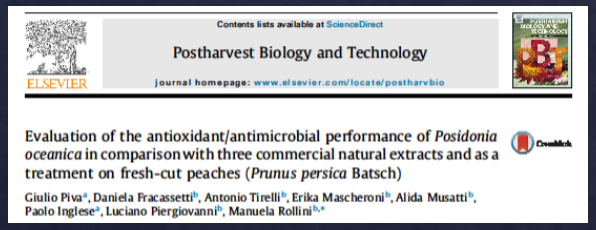
FEDERALIMENTARE
Federazione Italiana dell'Industria Alimentare

Acknowledgements

ACTIVITIES CARRIED OUT

- STAGE: 3 months at Grenoble INP (France).
- WORKSHOP: MATBIM 2015; SLIM 2015; ECPHS 2016.
- PREMIO «What for?» For the most effective presentation of the PhD thesis results.

DOCUMENTS

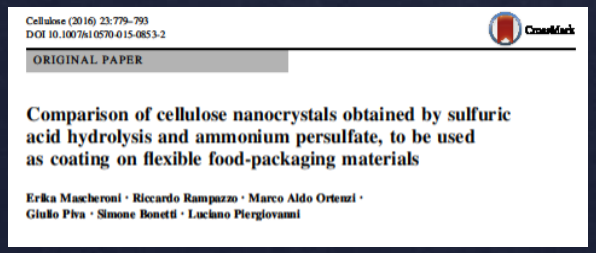

Contents lists available at ScienceDirect

Postharvest Biology and Technology

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

Evaluation of the antioxidant/antimicrobial performance of *Posidonia oceanica* in comparison with three commercial natural extracts and as a treatment on fresh-cut peaches (*Prunus persica* Batsch)

Giulio Piva[a], Daniela Fracassetti[b], Antonio Tirelli[b], Erika Mascheroni[b], Alida Musatti[b], Paolo Inglese[a], Luciano Piergiovanni[b], Manuela Rollini[b,*]


Cellulose (2016) 23:779–793
DOI 10.1007/s10570-015-0853-2

ORIGINAL PAPER

Comparison of cellulose nanocrystals obtained by sulfuric acid hydrolysis and ammonium persulfate, to be used as coating on flexible food-packaging materials

Erika Mascheroni · Riccardo Rampazzo · Marco Aldo Ortenzi · Giulio Piva · Simone Bonetti · Luciano Piergiovanni


3. 1
Protecting from Oxygen (and from other gases)

Luciano Piergiovanni, Riccardo Rampazzo, Giulio Piva

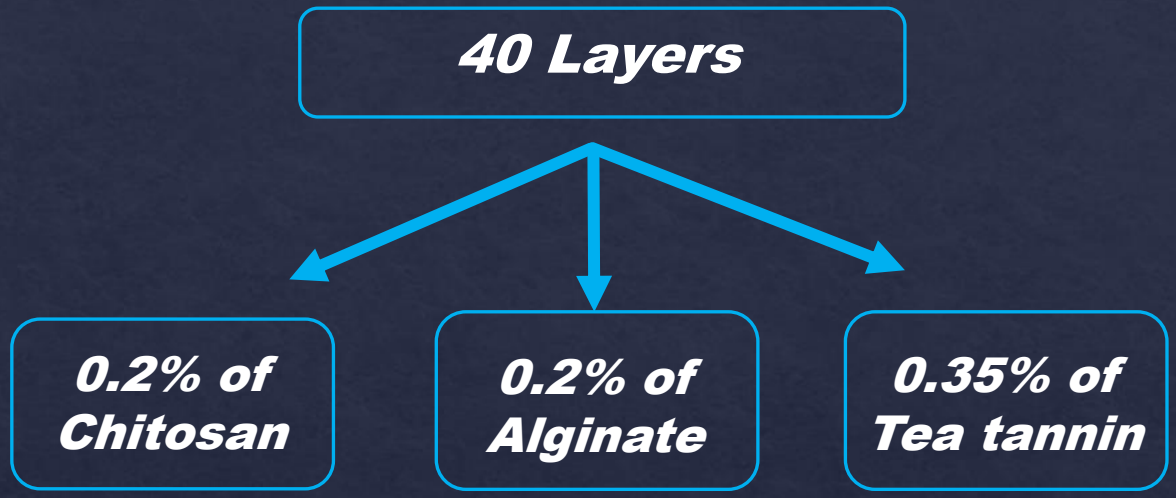
Biographies

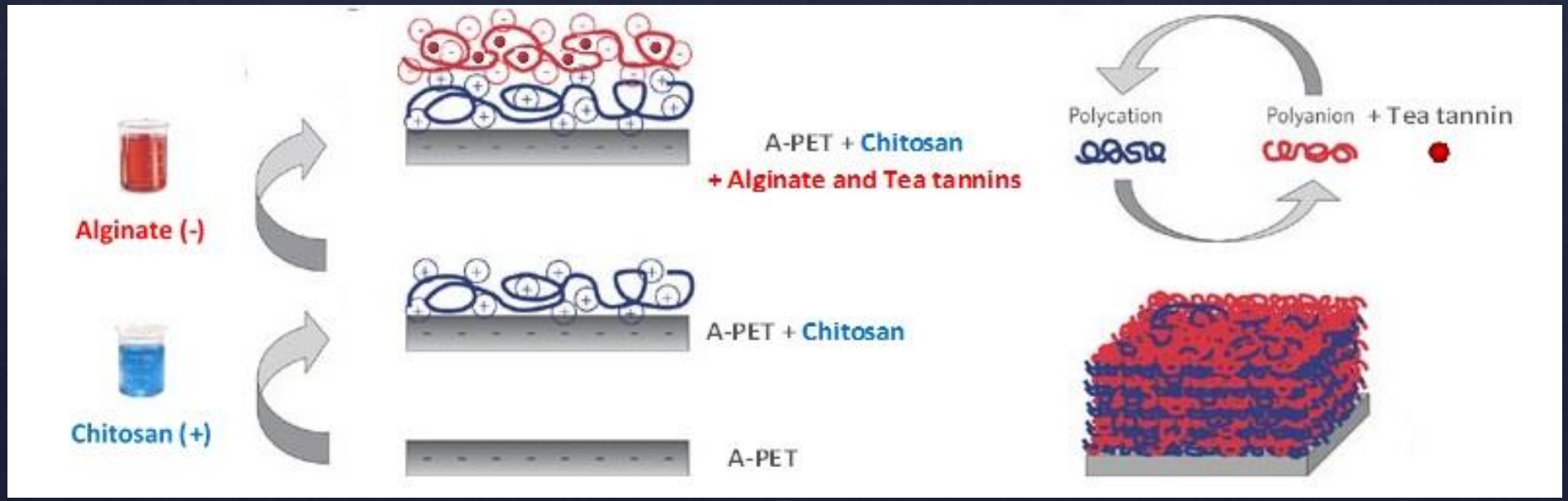
- **PIVA, G**., Rollini, M., Comà, V., Capretti, G., Mapelli, C., Piergiovanni, L. and Inglese, P. Development and characterization of a chitosan-tetrahydrocurcumin (THC) coated paper pad and application on fresh-cut pineapple (*Ananas comosus*). SUBMITTED TO Postharvest Biology and Technology.
- Rampazzo, R., Alkan, D., Ortenzi, M.A., Gazzotti, S., **PIVA, G**. and Piergiovanni, L. Cellulose nanocrystals from lignocellulosic raw materials, for oxygen barrier coatings of food packaging film. UNDER REVISION ON Packaging Technology and Science.

THANK YOU FOR YOUR KIND ATTENTION

TOPIC 3 – *IN VITRO* MATH&METH

Assembly of LbL





LbL assembly procedure