Development of Whey Protein Based Edible Films with pH-controlled Release for Active Packaging

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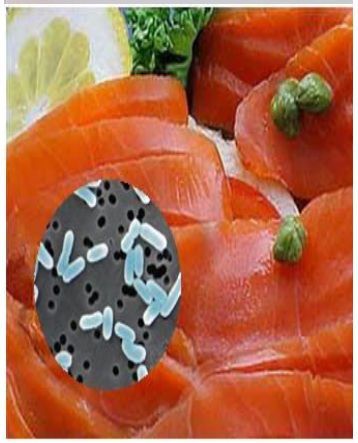
Food Safety and Packaging



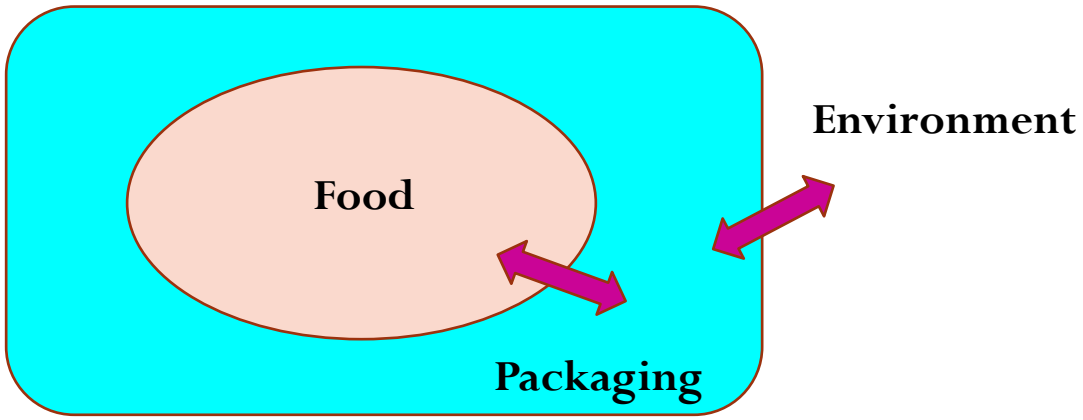
- Microorganisms
- Chemicals
- O_2
- Moisture
- Light

Functional Properties of Packaging Materials

Better shelf-life and quality

Active and Antimicrobial Packaging

A packaging system releases active/antimicrobial compounds on the food surface to delay microbial growth.



- Inhibit pathogenic bacteria
- Control spoilage
- Use minimum amounts of active compounds

→

✓Extend shelf life

✓ Safe and High quality foods

Controlled Release Packaging (CRP) System

Innovative form of active packaging where antimicrobial and antioxidant compounds incorporated into a polymer and relase in a controlled manner.

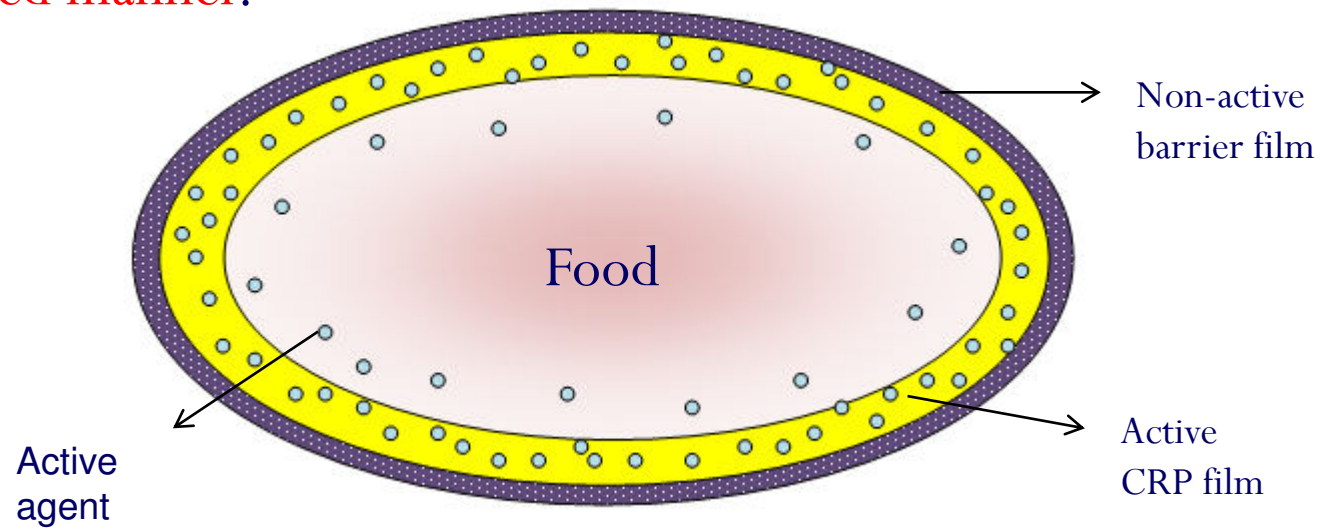
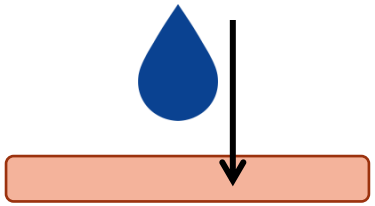
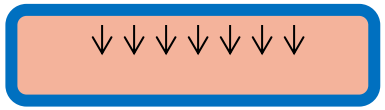


Figure 1. CRP System

Controlled Release

- Direct addition of antimicrobials
  - Excessive use !
  - Neutralization !
- Antimicrobial sprays or dips
  - Diffusion into center of food !

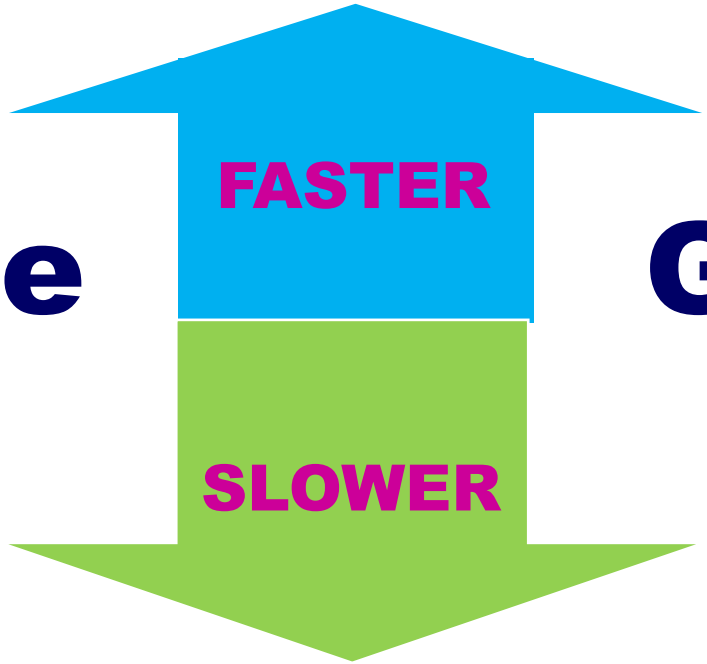




Controlled release antimicrobial packaging

- ✓ Prevent too high / too low concentration of active substances at food surface
- ✓ Prevent sensorial or toxicological problems (use lower amounts of active agent)

Diffusion into Food !



Release Rate

Growth Rate

Microbial Spoilage!

pH-Controlled Release in WPI films

- pH-triggering mechanism for controlled release of lysozyme from WPI films

- Can be triggered by adjusting the pH of food when antimicrobial activity is needed
  - Before cold storage
  - After freezing-thawing
  - Before transportation and market display

Edible Films and Antimicrobials

Whey Protein Isolate

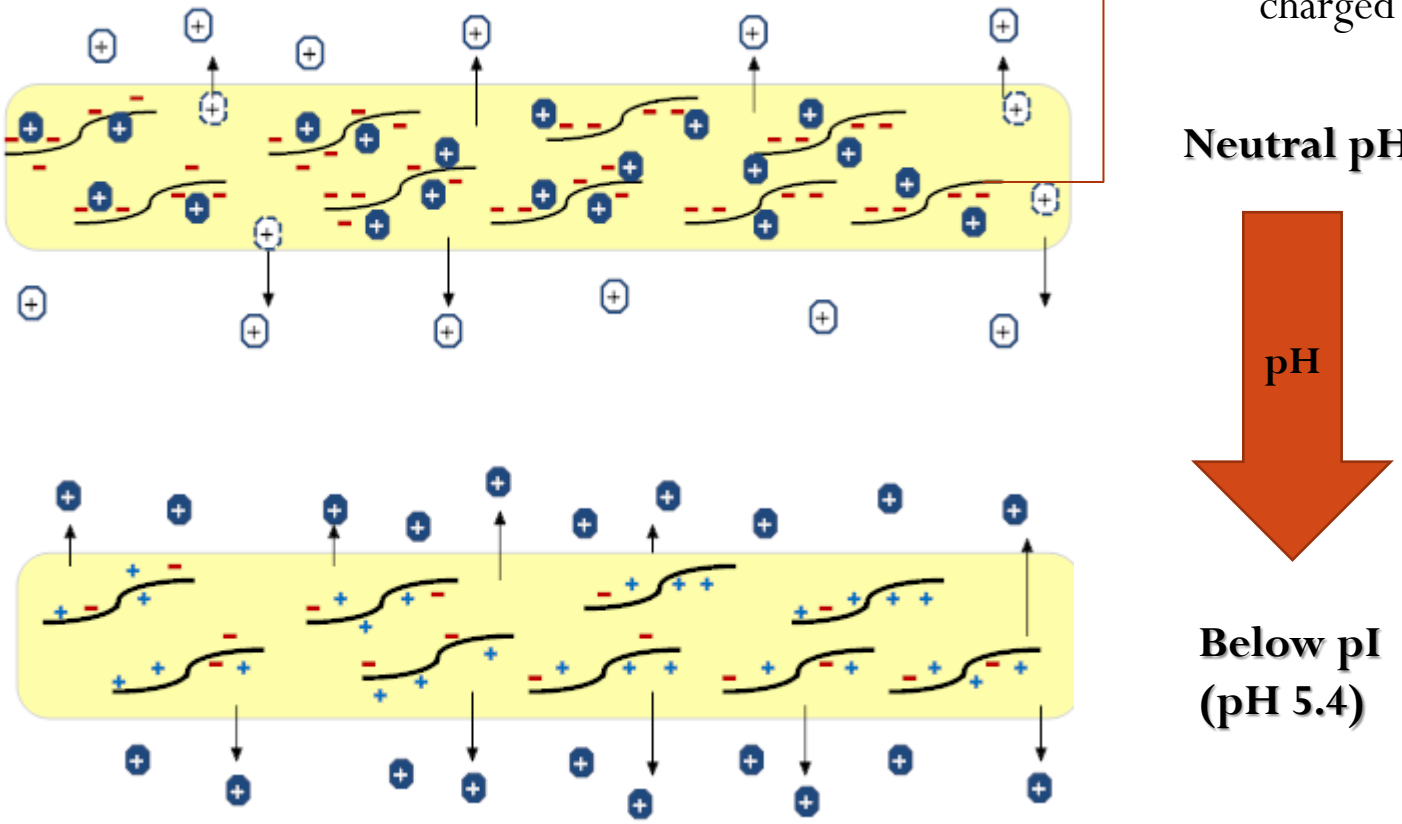
- 20% of milk proteins
- pI ≈ 5.4
- One of the most commonly used biodegradable film material
- Forms transparent brittle films
- Good O_2, CO_2, lipid and aroma barrier properties

Lysozyme

- Hydrolases
- pI ≈ 9,2
- Molecular weight ≈ 14.7 kDa
- Found in tears, mucus, egg white
- One of the most frequently used biopreservative
- Antimicrobial activity mainly on gram-positive bacteria

WPI films

- **Whey protein film (WPI)**
- **WPI – Oleic acid blend film (9% oleic acid)**
- **WPI – Beeswax composite film (30% beeswax)**



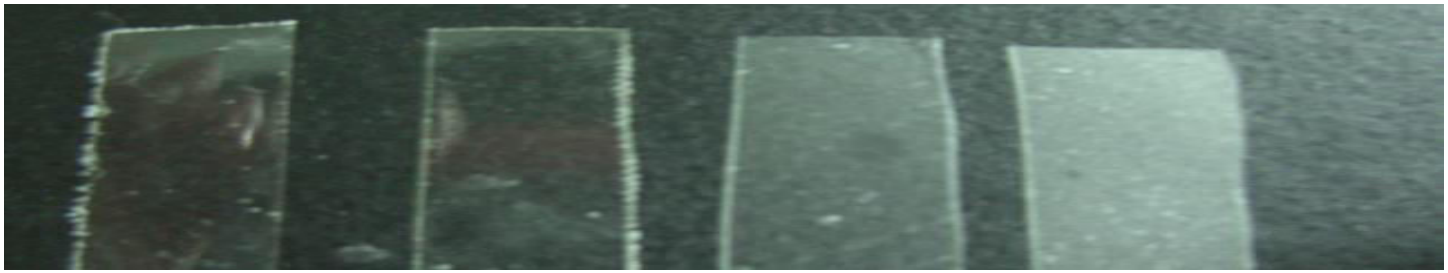
Potential Application

- Activation of Lyz based antilisterial activity
- *Listeria monocytogenes* - Smoked fish processing (Smoked salmon)
  - MAP → lost after opening the pack
  - Vacuum packaging has no absolute effect on *L. Monocytogenes*

pH-triggered release system can be employed as a hurdle to reduce the risk, especially during the storage of remaining food after the first consumption.

Cold smoked salmon

Produced WPI Films

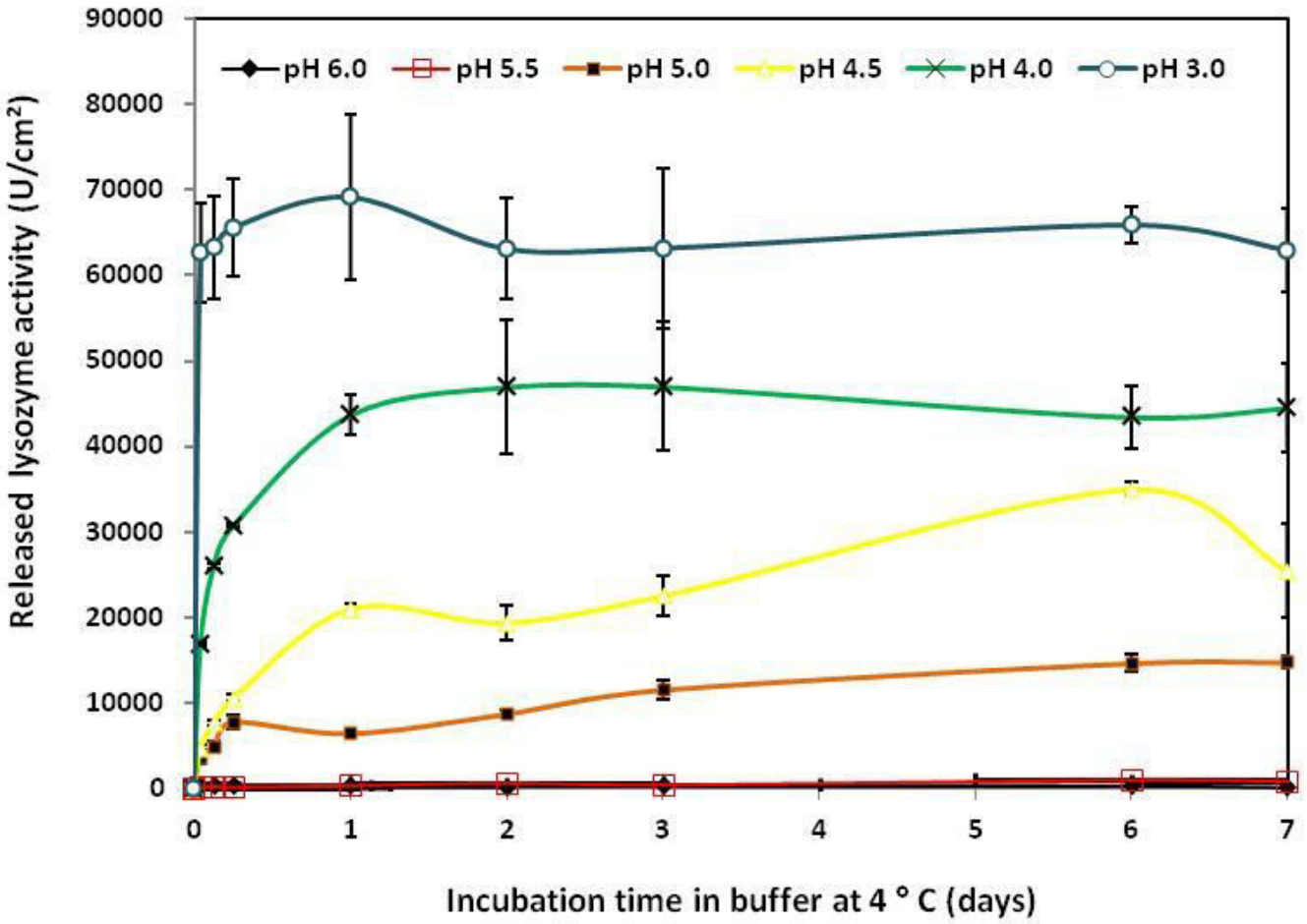


Control | LYS | LYS + Oleic acid (9%) | LYS + Beeswax (30%)

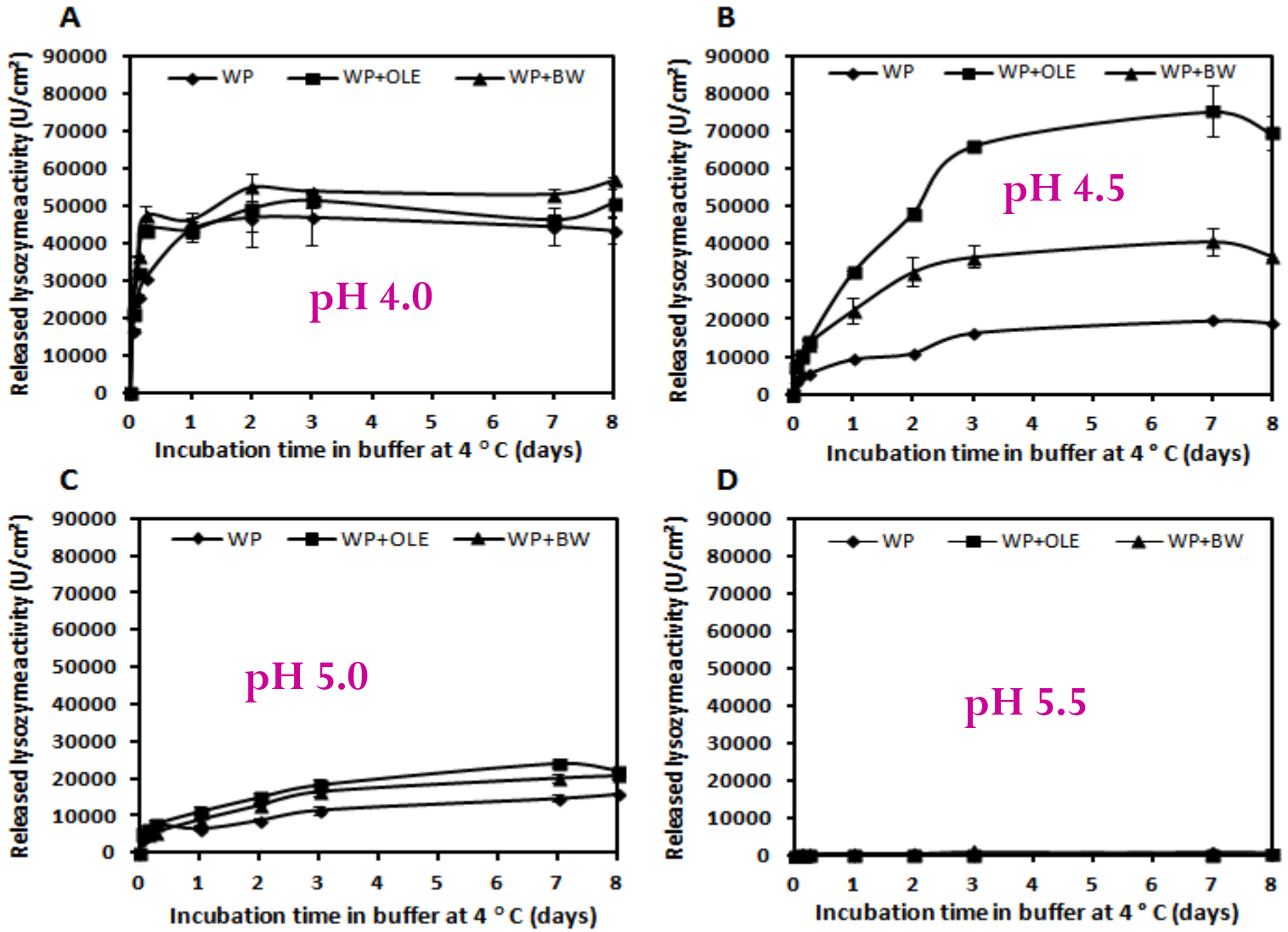
- Released LYS activity into buffer
- Released LYS activity on smoked salmon
- In-vitro antimicrobial activity of films
- Antimicrobial activiy of the films coated on smoked salmon
- Morphological properties

LYS Activity of the Films

- LYS release at different pHs

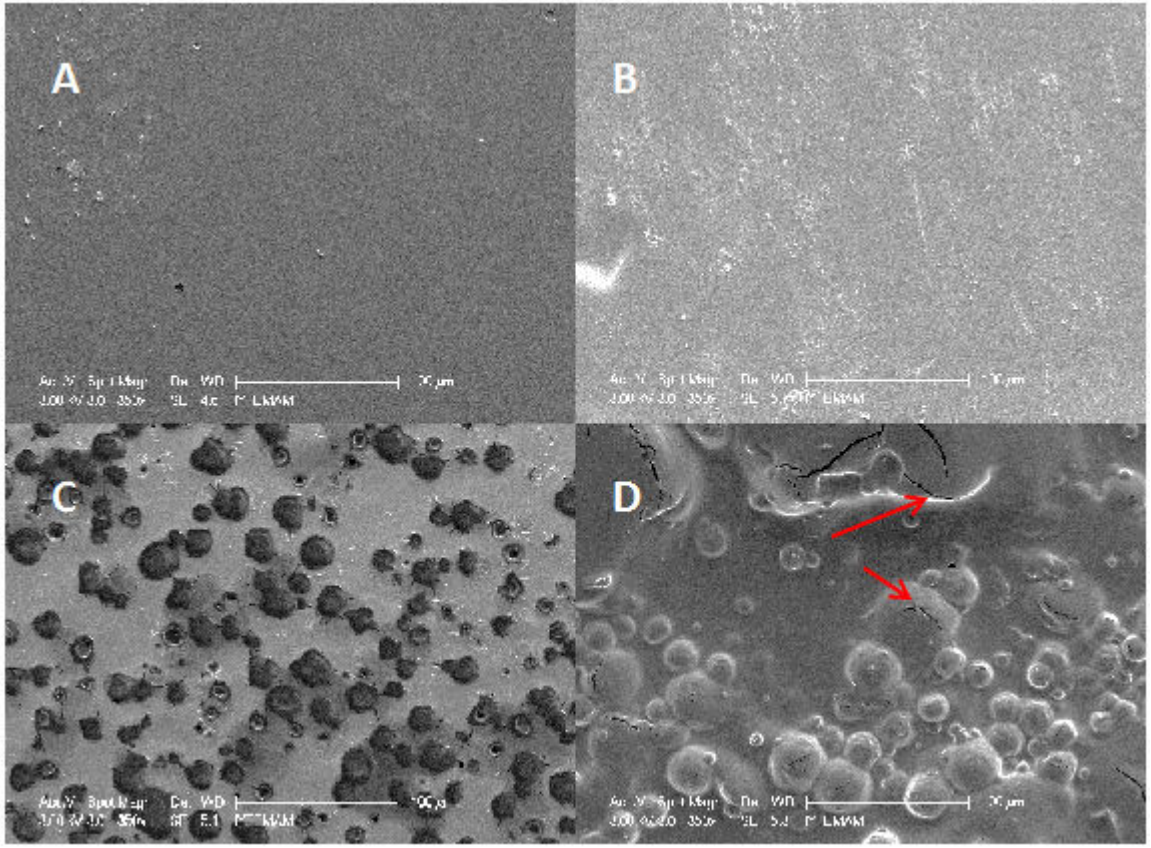


LYS Activity of the Composite and Blend Films



Film Morphology

Control WPI film

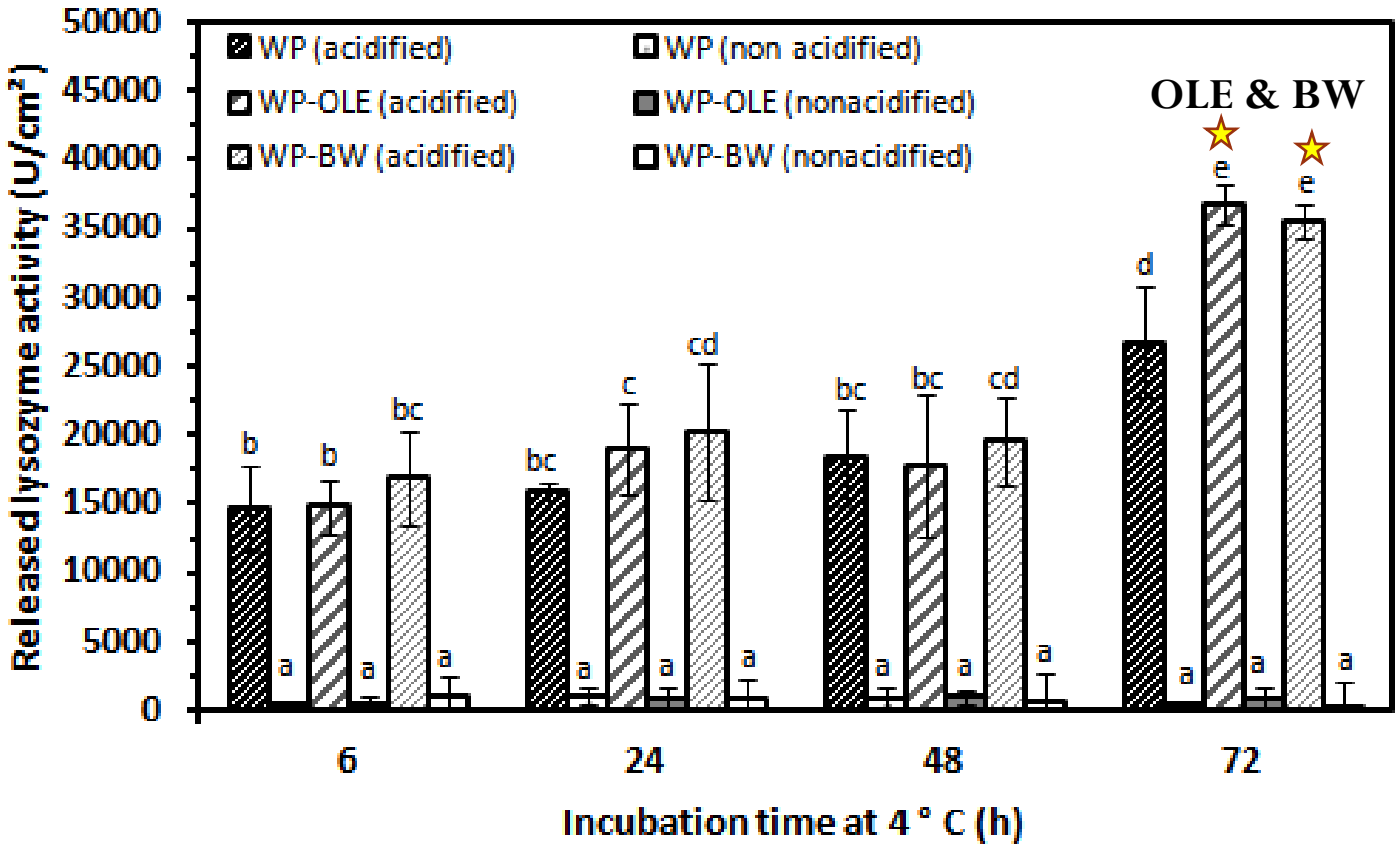


WPI + LYS

WPI + Oleic acid

WPI + bees wax

Release on Smoked Salmon



Antimicrobial Activity against L. innocua

Film composition				Average zone area (mm^2) at 4ºC	
LYZ (mg/c m^2)	OLE (%)[a]	BW (%)[a]	Acidification (5% citric acid)	24 h	48 h
-	-	-	-	Partial zones	Partial zones
-	-	-	+	Partial zones	Partial zones
0.7	-	-	-	51.7 ± 8.5[d]	63.5 ±13.9[c]
0.7	-	-	+	101.1 ± 15.3[c]	84.6 ± 22.5[b]
0.7	9	-	-	121.5 ± 14.9[b]	93.9 ± 17.4[b]
0.7	9	-	+	141.6 ± 26.6[a]	124.3 ± 32.7[a]
0.7	-	30	-	54.5 ± 7.4[d]	55.6 ± 11.04[c]
0.7	-	30	+	58.5 ± 21.2[d]	88.11 ± 55.6[c]

Antimicrobial Activity against *L. innocua*

L.innocua counts during storage at 4°C (log CFU/g)[a]				
Day 0	Day 1	Day 3	Day 5	Day 7
Uncoated				
$4.98 \pm 0.08^{a,A}$	$4.82 \pm 0.10^{ab,B}$	$4.82 \pm 0.10^{a,B}$	$4.80 \pm 0.11^{a,B}$	$4.83 \pm 0.13^{a,B}$
WPI/OLE (control)[b]				
$4.92 \pm 0.10^{a,A}$	$4.72 \pm 0.10^{bc,C}$	$4.73 \pm 0.08^{b,C}$	$4.78 \pm 0.09^{a,BC}$	$4.84 \pm 0.11^{a,B}$
WPI/OLE+LYS				
$4.92 \pm 0.08^{a,A}$	$4.68 \pm 0.07^{c,B}$	$4.69 \pm 0.15^{b,B}$	$4.74 \pm 0.12^{a,B}$	$4.49 \pm 0.12^{b,C}$
WPI/OLE (acidified)				
$4.97 \pm 0.04^{a,A}$	$4.84 \pm 0.11^{a,B}$	$4.77 \pm 0.13^{ab,B}$	$4.80 \pm 0.12^{a,B}$	$4.57 \pm 0.09^{b,C}$
WPI/OLE+LYS (acidified)				
$4.97 \pm 0.07^{a,A}$	$4.49 \pm 0.13^{d,B}$	$4.45 \pm 0.13^{c,BC}$	$4.27 \pm 0.19^{b,BC}$	$4.24 \pm 0.15^{c,C}$

Conclusion

- *LYS release mechanism based on acidification of the film was tested*
- *The films were successfully applied on smoked salmon slices*
- *Activation of edible films by consumer before consumption or after for the remaining part of the food is possible*
- *To optimize the concentration of LYS and increase the efficieny of film activity, further food applications are needed.*


thank
you!