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Recovered organic acids from cranberry juice deacidification as a natural strategy for fresh-cut lettuce preservation within a circular economy framework

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Introduction

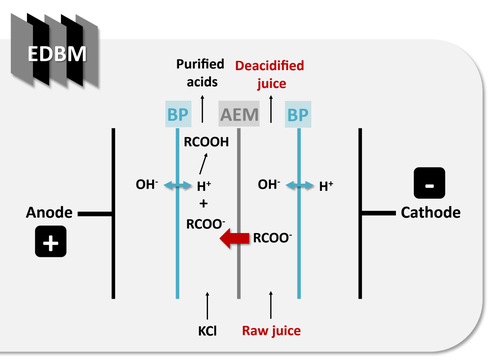
- **Fresh produce** are increasingly being consumed, but maintaining their **microbial safety** is still a **big challenge** in the food industry[1]
- **Leafy greens** are considered the commodity group of **greatest concern** from a **microbiological safety perspective** (FAO/WHO)[2]
- ***E. coli*** contamination is frequently reported : **60 outbreaks** linked to **leafy vegetables** consumptions from **2009 - 2018 (Canada + US)**[3]
- **Sodium hypochlorite (SH)** remains the **gold standard sanitizer** used for fresh produce washing but **natural alternatives** are needed[4]
- Recently, **cranberry juice** was **deacidified** using EDBM (electrodialysis with bipolar membranes), generating a coproduct in the form of **organic acids recovery solutions (OARs)** with **promising antimicrobial potential** that remain unexplored

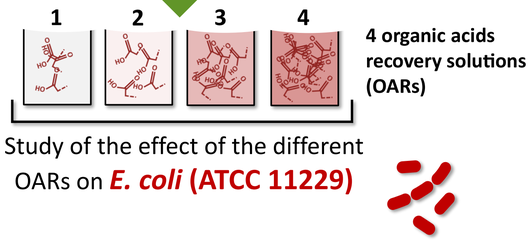
Objectives

To evaluate the **antibacterial effect** of the **OARs** on ***E. coli*** and their possible use for **fresh-cut lettuce preservation** as **alternative to conventional sanitizers**

Materials and methods

Cranberry juice deacidification

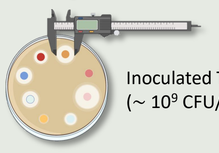




Study of the effect of the different OARs on ***E. coli*** **(ATCC 11229)**

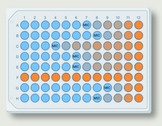
In vitro

Agar well diffusion test



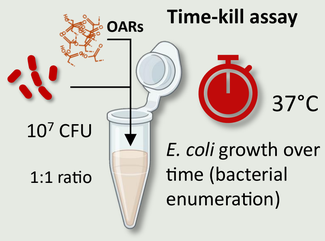
Inhibition diameters (mm)

Microdilution method

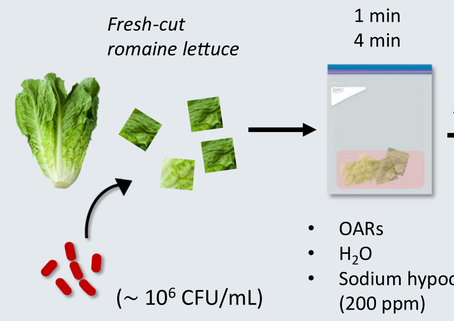


- MIC (mg/mL)
- MBC (mg/mL)

Time-kill assay



In situ



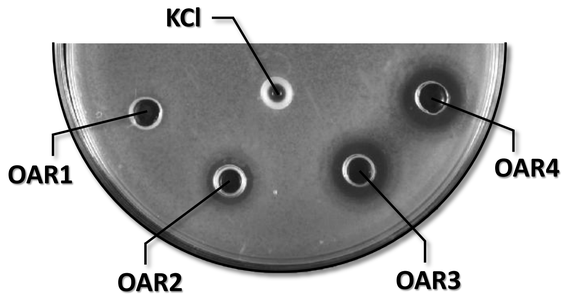
Analyses :

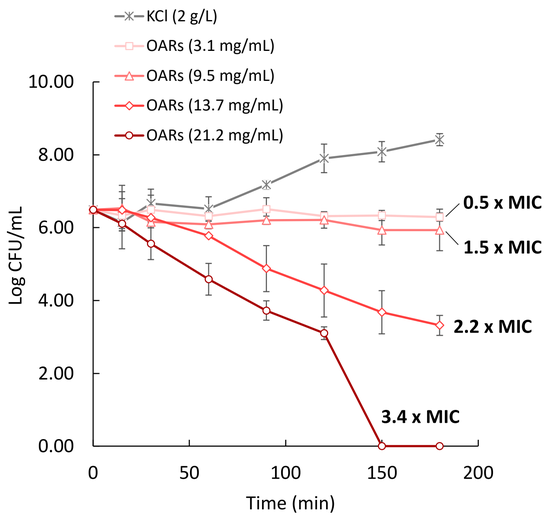
- **Microbial enumeration**
  Serial dilution (1:10) in peptone water and surface plating on Petrifilm® *E. coli*/Coliform
- **Quality parameters**
  Texture
  Weight
  Color

Results and discussions

Organic acids recovery solutions (OARs) composition and *in vitro* evaluation

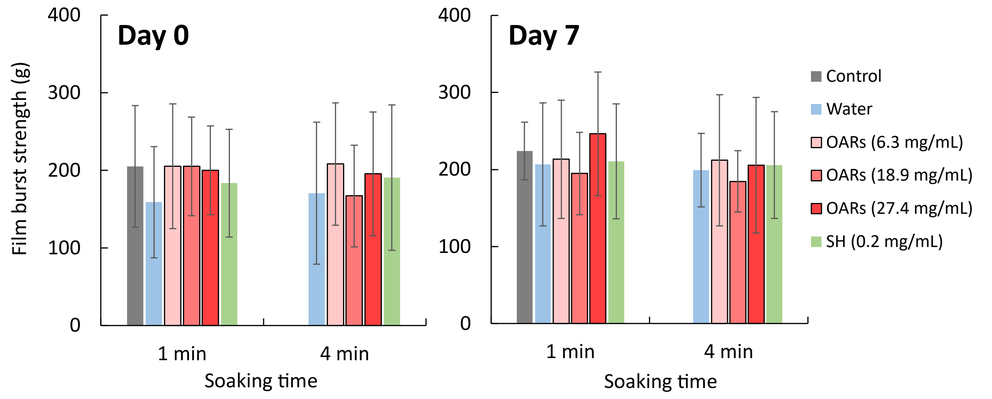
	Organic acids recovery solutions (OARs)			
	OAR1	OAR2	OAR3	OAR4
pH	2.15	2.24	2.26	2.16
Organic acids (mg/mL)	6.3	18.9	27.4	42.3
Citric	3.2	8.0	11.7	18.1
Malic	2.7	9.3	12.1	20.0
Quinic	0.3	1.3	3.0	3.1
Succinic	0.1	0.2	0.3	0.8
Ascorbic	0.0	0.1	0.3	0.3
Minerals (mg/mL)	1.31	1.33	1.75	2.21
Proanthocyanidins (PACs) (mg/mL)	0.00	0.00	0.04	0.02
Anthocyanins (mg/mL)	0.00	0.01	0.03	0.02

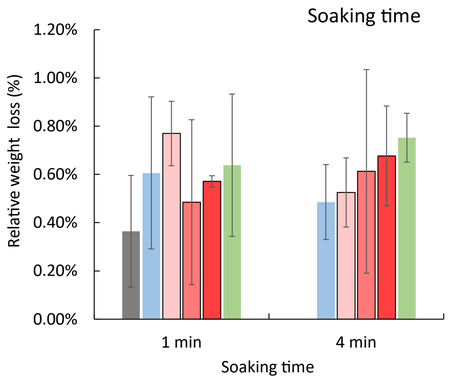




- **Inhibition** correlated with **OAs concentration** ($r = 0.927$, $p < 0.001$)
- Averaged **MIC = 6.3 ± 0.5 mg/mL**
- **MBC/MIC ratio** < 4 → bactericidal character
- **Bactericidal** effect in a **concentration-dependent** manner above a specific **threshold concentration**

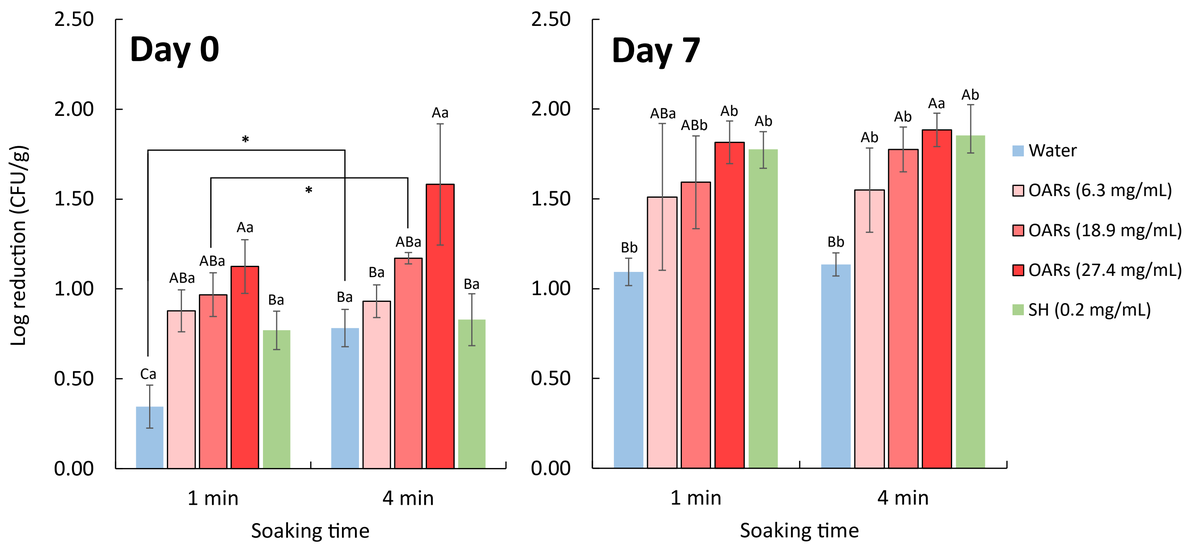
Lettuce quality parameters





- **No significant differences** between treatments (day 0 and day 7)
- **No significant effect** of **treatment time** and **storage duration**
- **OARs preserved** quality parameters similarly to H_2O or SH

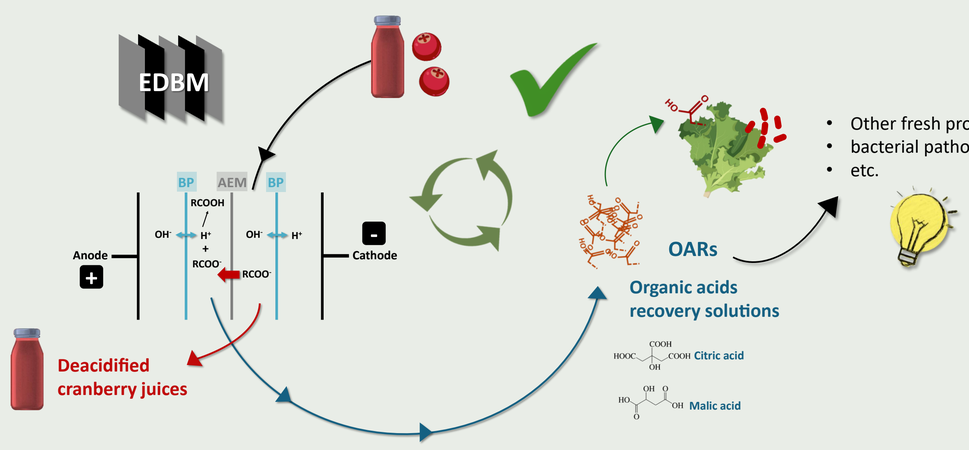
E. coli inactivation in lettuce



- Regardless of soaking time, **greater reduction on day 0 using OARs than H_2O or SH**
- **Positive linear relationship** ($r^2 > 0.93$) on day 0 : **organic acids concentration - log reduction**
- No significant effect of **treatment time** on day 0 → **1 min can already achieve great efficacy**
- 7-days storage → **effect of temperature (4°C)** on decreased *E. coli* viability
- **Additional reduction during storage** differs according to treatments → possible **effect of residual compounds** (OAs/SH)

Conclusions

- ***E. coli*** (ATCC 11229) inhibition **increased by organic acids concentration** in the OARs
- **1.1 – 1.9 times log reduction improvement with OARs** vs SH on fresh-cut lettuce
- About **2 log of *E. coli* inactivated** after a 7-day refrigerated storage (4°C) using OARs
- OARs had **no detrimental effect** on lettuce quality parameters
- **Innovative circular economy approach** was proposed to promote fresh produce safety



Acknowledgments

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References

[1] Callejón *et al.*, 2015, Foodborne Pathog. Dis., 12(1), 32-38.
[2] FAO/WHO, 2008, Microbiological risk assessment series.
[3] Coulombe *et al.*, 2020, J. Food Prot., 83(8), 1444-1462.
[4] Ölmez *et al.*, 2009, LWT-Food Sci. and Technol., 42(3), 686-693.