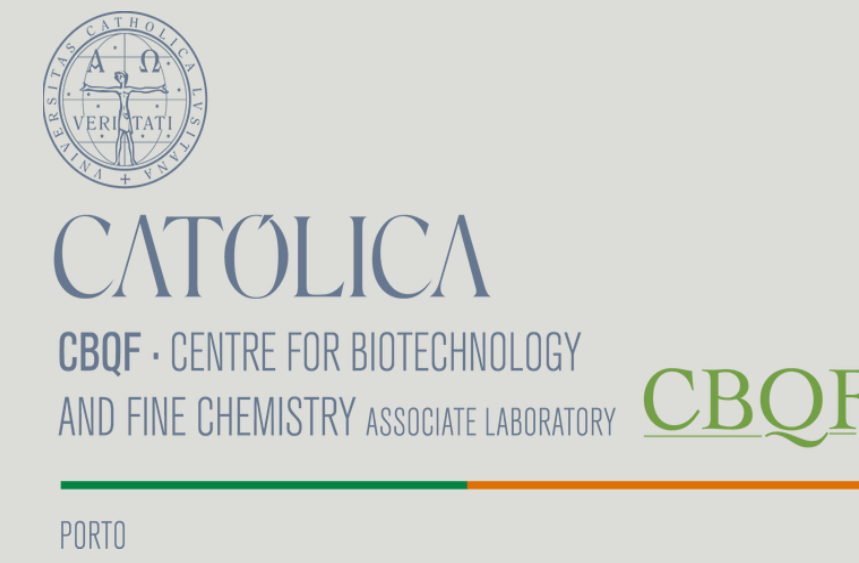


Exploring the Power of Lemon Co-Products: Potential Application in Edible Coatings

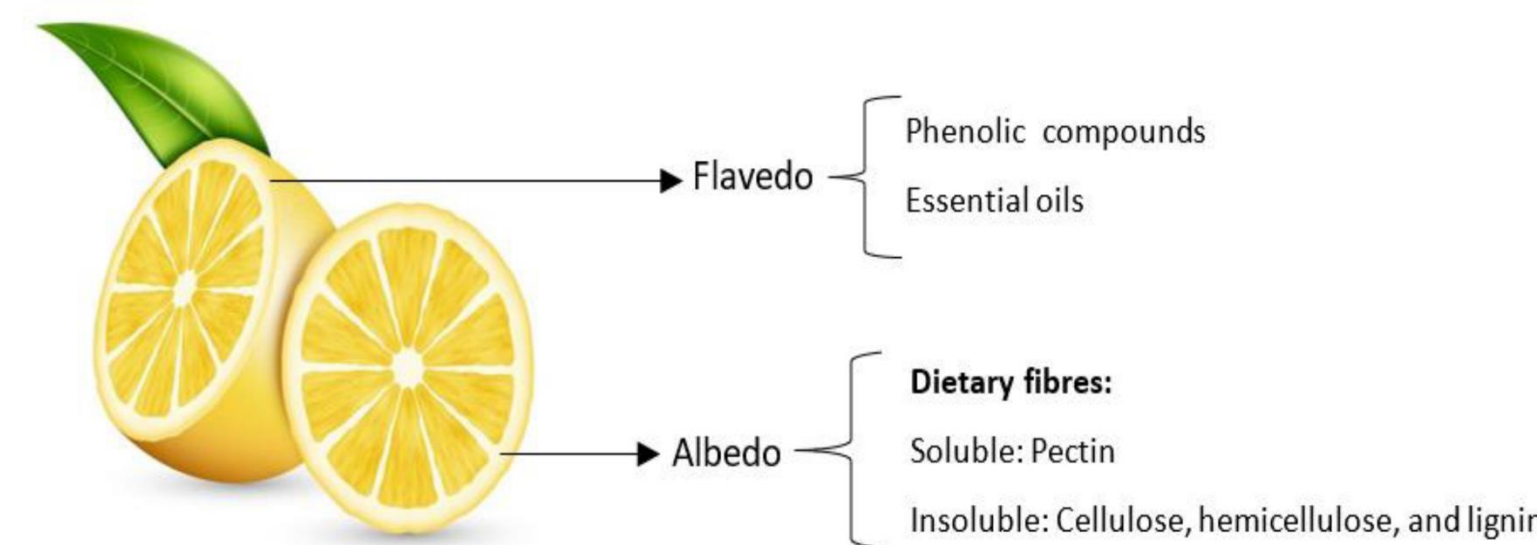
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Introduction

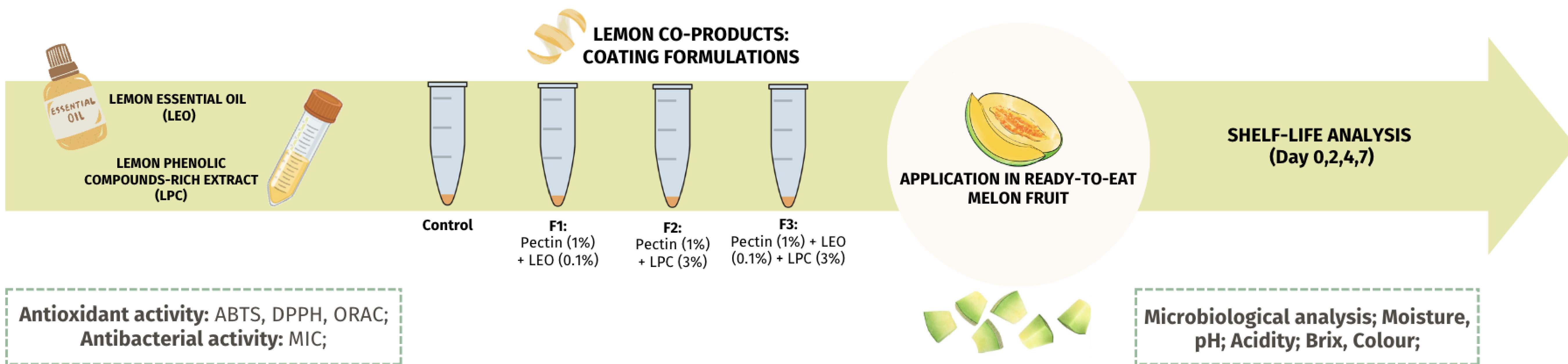
Citrus is one of the most widely cultivated fruit crops and among the most consumed products in the Mediterranean area. In 2019, the annual production of different citrus fruits was approximately 143 thousand tonnes, with lemons and limes accounting for around 20 thousand tonnes ^[1]. Industrial processes exploit only 45% of the total fruit weight, which generates a significant amount of waste, including peel (flavedo: 27%), pulp (albedo and endocarp: 26%), and seeds (2%). Lemon by-products contain significant amounts of bioactive compounds, which are associated with food preservation properties, such as antimicrobial and antioxidant activities ^[2]. Furthermore, these by-products, which are often discarded as waste in the environment, can be used to produce new ingredients, such as essential oil (LEO), lemon phenolic compounds-rich extract (LPC) and pectin (Lp), being an opportunity for the food industry to promote the zero-waste concept.



Objectives

✓To understand the preservative potential of LEO and LPC for use in edible coatings aimed at extending fruit shelf life, their antioxidant activity was assessed using ABTS, DPPH, and ORAC assays, while antibacterial properties were determined through the minimal inhibitory concentration (MIC) test. The main objective was to incorporate these functional ingredients into lemon pectin (Lp)-based coating formulations and assess their effectiveness over a 7-day storage period by monitoring microbiological parameters, moisture content, pH, acidity, °Brix, and colour.

Methodology



Results

1. Preservative Potential of LEO, LPC and Synergy Effect

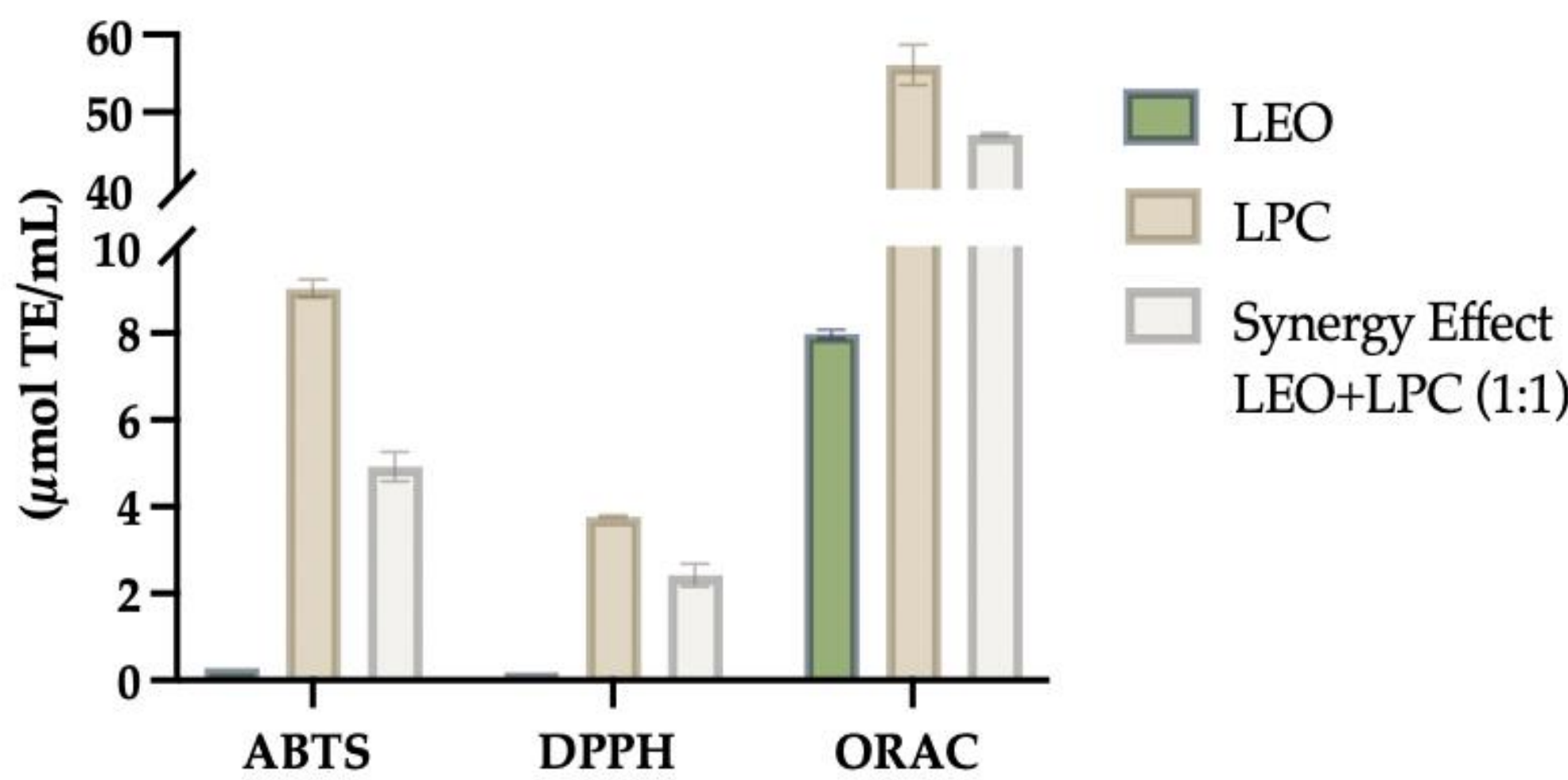


Figure 1. Antioxidant activity of lemon functional ingredients (LEO), (LPC) and the Synergy Effect (LEO+LPC; 1:1).

Table 1. Antibacterial activity (MIC) of lemon functional ingredients (LEO), (LPC) and the Synergy Effect (LEO+LPC; 1:1).

	LEO	LPC	Synergy Effect (LEO+LPC; 1:1)
MIC (μL/mL)			
<i>Escherichia coli</i>	31.25	125.0	62.5
<i>Staphylococcus aureus</i>	31.25	62.5	62.5
<i>Bacillus cereus</i>	62.5	125.0	125.0
<i>Pseudomonas aeruginosa</i>	62.5	31.25	62.5

2. Shelf Life Analysis of Lemon Edible Coatings

Table 2. Shelf life analysis (Moisture (%), pH, Acidity (g citric acid/100 mL), °Brix and Colour (L*)) of lemon edible coatings during the 7-day of storage.

	Control		F1		F2		F3	
	Day 0	Day 7	Day 0	Day 7	Day 0	Day 7	Day 0	Day 7
Moisture (%)	92.8 ± 0.8	91.2 ± 0.6	92.8 ± 0.8	92.0 ± 0.4	92.8 ± 0.8	92.1 ± 0.4	92.8 ± 0.8	92.1 ± 0.9
pH	7.2 ± 0.0	5.6 ± 0.0	7.2 ± 0.0	5.3 ± 0.0	7.1 ± 0.0	5.3 ± 0.0	7.1 ± 0.0	5.1 ± 0.0
Acidity (g citric acid/100 mL)	0.1 ± 0.0	0.3 ± 0.0	0.1 ± 0.0	0.2 ± 0.0	0.1 ± 0.0	0.2 ± 0.0	0.1 ± 0.0	0.2 ± 0.0
°Brix	7.8 ± 0.1	7.6 ± 0.1	7.8 ± 0.1	7.2 ± 0.1	7.2 ± 0.1	6.9 ± 0.1	7.8 ± 0.1	7.1 ± 0.1
Colour (L*)	63.2 ± 2.2	53.5 ± 7.3	67.5 ± 3.6	54.5 ± 6.2	66.9 ± 2.0	65.0 ± 2.7	68.5 ± 1.5	64.5 ± 3.2

Main Conclusions

- ✓ Based on these results, lemon co-products are rich in valuable bioactive compounds and represent a suitable matrix for extracting functional ingredients.
- ✓ The colour (L*) was positively influenced by the formulations containing LPC extract, providing stabilization during 7 days of storage.
- ✓ This strongly supports their valorisation in edible coating applications an innovative idea for extending the shelf life of melon fruit.

References

1. FAO Citrus Fruit Statistical Compendium 2020. 2021.
2. Magalhães, D.; Vilas-Boas, A.A.; Teixeira, P.; Pintado, M. Functional Ingredients and Additives from Lemon By-Products and Their Applications in Food Preservation: A Review. *Foods* 2023, Vol. 12, Page 1095 2023, 12, 1095, doi:10.3390/FOODS12051095.

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