Supplementing food antimicrobials in commercial edible coatings to enhance the safety and extend the shelf-life of stone fruit

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Summary

Edible coatings can preserve stone fruits but are not effective against foodborne pathogens. The project goal is to supplement food antimicrobials in commercial stone fruit coatings to enhance safety and extend the shelf-life of stone fruits. The minimum inhibitory concentration (MIC), minimum bactericidal concentration (MBC), and antimicrobial interactions were determined at pH 5.0–7.0 for lauric arginate (LAE), organic acids, and parabens. LAE was the most efficacious against both *Listeria monocytogenes* Scott A and *Salmonella* Enteritidis, with MIC and MBC of 50 ppm or lower, while increasing the pH led to higher MIC and MBC for the other antimicrobials. At a certain pH, LAE showed synergistic activities with other antimicrobials. Findings will be used to select antimicrobials for incorporation in coatings to treat stone fruits.

Objectives

1. Characterize the physical, mechanical, and antimicrobial properties of films casted from commercial stone-fruit coatings supplemented with food antimicrobials.
2. Evaluate the reduction of inoculated pathogens, native yeasts, and molds/fungi, as well as the quality of stone fruits after coating and during storage.

Methods

Figure 1 presents an overview of the project. LAE, methylparaben/propylparaben (2:1, w:w), sorbic acid, benzoic acid, and propionic acid were tested against *Listeria monocytogenes* Scott A and *Salmonella enterica* serovar Enteritidis ATCC H4267 in tryptic soy broth adjusted to pH 5.0–7.0. The microbroth dilution method was used to determine the MIC, defined as the lowest concentration with no changes in the optical density (OD; <0.05) at 630 nm after 24 h. The MBC was determined as the lowest concentration at which there was no growth after spread plating the wells with OD <0.05 (**Figure 2**). The checkerboard assay was used to determine interactions between antimicrobials based on the fractional inhibitory concentration Index (FICI):

$$FICI = \frac{\text{MIC of A in combination with B}}{\text{MIC of A alone}} + \frac{\text{MIC of B in combination with A}}{\text{MIC of B alone}}$$

Results to Date

The MICs and MBCs of antimicrobials at pH 5.0–7.0 are presented in **Tables 1** and **2**. The most effective antimicrobial was LAE, followed by sorbic acid, parabens, benzoic acid, and propionic acid. For LAE, the MIC and MBC decreased with an increase in pH, while it was the opposite for the other antimicrobials. The FICI of LAE combined with other antimicrobials is shown in **Table 3**. Synergism against *L. monocytogenes* was observed for LAE and parabens at all pH values, while it was either additive or indifferent for LAE and other combinations. For *Salmonella* Enteritidis, LAE manifested synergistic effects with other antimicrobials at pH 6.0 only, while it was either additive or indifferent at pH 5.0 and pH 7.0.

Benefits to the Industry

The project benefits the produce industry by improving the safety and extending the shelf life of stone fruits, thereby reducing the risk of contamination and possible product recall. The results of this study can be adopted by the stone fruit industry and can be extended to other fresh produce. Therefore, the findings are valuable for the safety and sustainability of agricultural products susceptible to foodborne outbreaks.

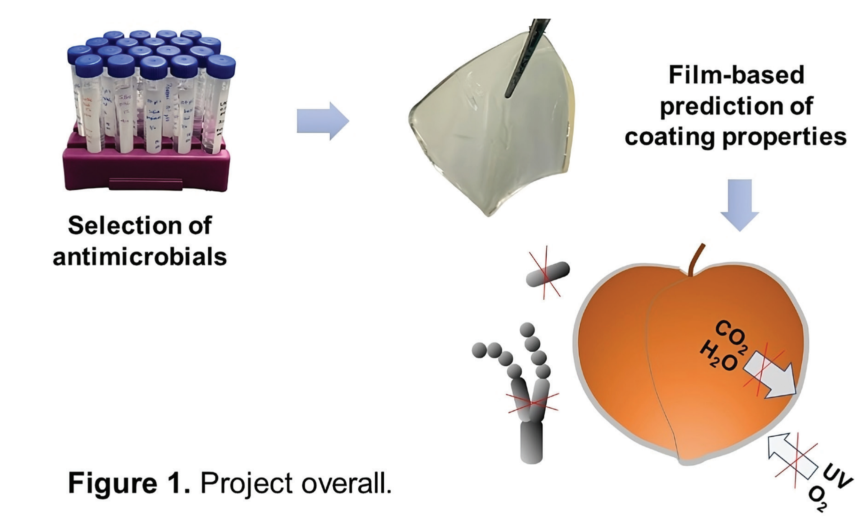

Figure 1. Project overall.

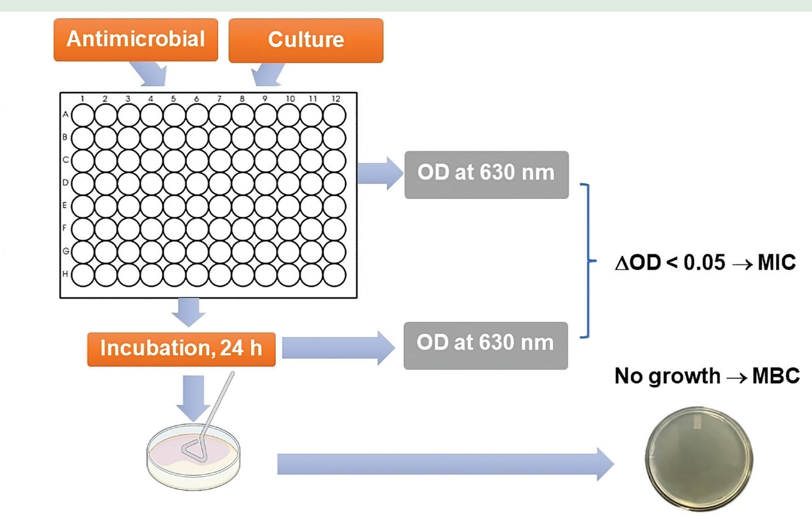

Figure 2. Method to determine MIC and MBC.

Table 1. MIC and MBC (ppm) of individual antimicrobials against *Listeria monocytogenes* Scott A at pH 5.0-7.0.

pH	Sorbic acid		Benzoic acid		Propionic acid		Methyl/Propyl-paraben (2:1)		Lauric arginate	
	MIC	MBC	MIC	MBC	MIC	MBC	MIC	MBC	MIC	MBC
5.0	100	400	200	800	200	1560	1560	3125	45	>50
6.0	400	3000	3125	12500	6000	16000	3125	6250	25	50
7.0	1500	4000	12500	30000	8000	>50000	6250	12500	20	30

Table 2. MIC and MBC (ppm) of individual antimicrobials against *Salmonella* Enteritidis at pH 5.0-7.0.

pH	Sorbic acid		Benzoic acid		Propionic acid		Methyl/Propyl-paraben (2:1)		Lauric arginate	
	MIC	MBC	MIC	MBC	MIC	MBC	MIC	MBC	MIC	MBC
5.0	200	400	200	800	200	1560	800	1560	45	50
6.0	400	1500	3125	6250	6000	16000	1560	3120	25	35
7.0	1500	4000	12500	25000	50000	>50000	1560	3120	20	25

Table 3. Fractional inhibitory concentration index (FICI) and the interaction mode of lauric arginate with different antimicrobials against *Listeria monocytogenes* Scott A and *Salmonella* Enteritidis.

Bacteria	pH	With parabens		With sorbic acid		With benzoate	
		FICI	Mode*	FICI	Mode*	FICI	Mode*
L. monocytogenes	5.0	0.75	PS	1.25	I	1.25	I
	6.0	0.5	S	1.25	I	1	A
	7.0	0.5	S	1	A	1.25	I
S. Enteritidis	5.0	1	A	1	A	1	A
	6.0	0.5	S	0.75	S	0.75	S
	7.0	1.25	I	1.25	I	1	A

*PS: partially synergistic; S: synergistic; A: additive; I: indifferent.