Antimicrobial Effect of Orange Pomace and Derived Polyphenols on Common Food Pathogens

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Impact on California agriculture: California has over 270 thousand acreages for the production of 3.5 million citrus fruits annually, leading to $2 billion business. Most of the orange fruits are utilized for juice production, leaving behind a large amount of pomace wastes. With the constant food waste issue, it is becoming increasingly more important to find innovative solutions for reducing food waste and revalorizing the agri-food byproducts for value-added products. The under-utilized byproduct, orange pomace (OP), has the potential as natural antimicrobial ingredients for food and packaging applications.

Rational and introduction: One of the promising qualities about orange pomace (OP) is the presence of phenolic compounds including flavonoids and essential oils which may have strong antimicrobial properties. Some of the most prevalent phenolic compounds are the flavanones hesperidin and naringin as well as the essential oil limonene. The naturally occurring flavanones can be further modified using enzymatic treatment or fermentation to cleave the glycosidic bond and form the aglycones hesperetin and naringenin.

Experimental approach: This study is aimed to examine the potential antimicrobial effects of polyphenols found in orange pomace waste. Crude extracts and modified forms of these compounds were evaluated to determine if chemical or enzymatic transformations improved antimicrobial effects. The orange pomace powder prepared in the lab and its derived polyphenolic compounds naringin, naringenin, hesperidin, hesperetin, and limonene were tested against a variety of pathogenic and food spoilage organisms using minimum inhibitory concentration (MIC) tests. The concentration at which the microbial growth was inhibited was recorded and compared to positive controls containing only the solvent that was used to solubilize the polyphenol compound in the culture medium.

Major conclusion: Results show that the modified polyphenols have a stronger antimicrobial effect than the naturally occurring forms, specifically, naringenin and hesperetin, the aglycone part of its naturally occurring flavanone glycosides naringin and hesperidin after the removal of the sugar moiety, seemed to present stronger antimicrobial effect against certain bacteria. Nevertheless, the natural occurring polyphenols and even the orange powder without separation/extraction could exhibit some desirable antimicrobial effect. For example, OP powder showed a strong inhibitory effect on *Staphylococcus aureus* and *Listeria monocytogenes* with MIC at 0.761 mg/mL and 0.227 mg/mL, respectively, which resembled that of limonene, hesperidin, and naringenin, indicating possible synergistic effects from multiple phenolic compounds present in the matrix material. Overall, naringenin significantly inhibited *Staphylococcus aureus* and *Listeria monocytogenes*, and also showed slight effect on *Salmonella enteritidis*. Limonene clearly inhibited *Staphylococcus aureus* and *Listeria monocytogenes*. Hesperidin showed slight inhibitory effect on *Staphylococcus aureus*. There was no clear inhibitory effect on *E. coli* and *Pseudomonas aeruginosa* by any tested phenolics nor the OP powder. The results from this project will greatly support ongoing studies, where orange pomace is utilized as food-grade processing aids and packaging additives for a variety of food and packaging applications, especially for extended shelf life based on its potential antimicrobial effects.

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