

Current antimicrobials used for edible films and coatings development

Abstract

Edible films and coatings can act as carriers of different kind of antimicrobials. Their effectiveness depends on the nature and type of the hydrocolloid used in the structural matrix, the antimicrobial agent employed, the physiochemical characteristics of the product to be protected and its own interactions. This mini-review focuses on the three main groups of antimicrobials currently used for edible films and coatings development: essential oils, organic acids and bacteriocins. LAE®, ovotransferrin, lactoferrin or lactoperoxidase system are found among other minor antimicrobials not included in this mini-review.

Keywords: antimicrobial, essential oil, organic acid, bacteriocin, edible film, edible coating

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Introduction

There is a great variety of antimicrobials that can be incorporated to develop active edible films and coatings to minimize the risk of foodborne contamination by pathogens and inhibit the development of spoilers in the food industry. The most common antimicrobials used when developing edible films and coatings are essential oils, organic acids, and bacteriocins. As other minor antimicrobials we can cite LAE®, grape seed extracts, lysozyme, lactoferrin, ovotransferrin, and lactoperoxidase system among others. It is important to remark that when selecting the antimicrobial, it is fundamental to consider its effectiveness against the target but also

- i. Type of structural matrix
- ii. Antimicrobial concentration
- iii. Type of microorganism (bacteria, molds, yeasts)
- iv. Type of product over which it is applied and,
- v. All interactions

Essential oils

The specific composition of each Essential Oil (EO) and the structure and functional groups of its components play a key role in their degree of reactivity. The major EO components with antimicrobial effects include phenolic compounds, terpenes, aliphatic alcohols, acids, and isoflavonoids.¹⁻³ EOs from oregano, clove, tea tree, laurel, mastic thyme, cilantro and rosemary have a wide spectrum of antimicrobial activity against different potential spoilers or pathogenic bacteria such as *Listeria innocua*, *Staphylococcus aureus*, *Salmonella enteritidis*, and *Pseudomonas fragi*.⁴ Among them, in general, the group formed by the oregano and thyme EOs have been presented as the most active due to their high content on carvacrol and thymol characterized as having strong antimicrobial activity with a wide spectrum of action. Edible coatings incorporating EOs were effective in extending the shelf-life of different food products such as poultry,⁴ rainbow trout⁵ and peeled shrimps⁶ among others. Nevertheless, it would be necessary to take into account that their application can exceed the standard organoleptic acceptable levels and requires an exhaustive sensory study. In order to reduce this possible sensory impact two strategies should be considered

- i. The use of the isolated active compounds mainly responsible for the antimicrobial activity and
- ii. Lowering the initial antimicrobial concentration and controlling its release rate towards the food product while maintaining the effective dose where needed.

Organic acids and salts

Organic acids (OA) such as lactic (E-270), tartaric (E-334), acetic (E-260), malic (E-296), and citric (E-330) acids among others are widely used for food preservation. Potassium sorbate is the most widely used form of sorbic salt in food systems. The normal role of OAs in edible films and coatings formulations is their function as acidulants. Focusing on the function of edible films and coatings as carriers of antimicrobials, numerous studies report the development of successful formulations for food shelf-life extension.⁷⁻¹¹ However, we appreciate a high variation on the formulation efficacy obtained by the compounds included in the matrix, target microorganisms, and products.

Lactic acid bacteria and bacteriocins

Most Lactic Acid Bacteria (LAB) have a GRAS status given by the FDA, which makes them an appropriate natural preservative that can also be incorporated in edible films and coatings as an affective preservation technology.¹²⁻¹⁴ Bacteriocins are antibacterial peptides produced by lactic acid bacteria. Although some bacteriocins, such as pediocin PA-1 and lactacin 3147, have been developed for approval and use, the best known bacteriocin is nisin (E-234), which is recognized as GRAS by the FDA and it is commonly used as an additive in the conservation of cheese. The effectiveness of nisin-incorporated edible films and coatings is very sensitive to the final formulation of the system and has also been effective in different types of food products.^{7,8,15-18} A majority of studies point out that the most important factors influencing the antimicrobial effectiveness of nisin are those related to its concentration and the microbial target. Notwithstanding that, in order to achieve effective formulations, it is important to highlight the decisive influence that additives have on the final formulation, especially acidulants and EDTA.

Conclusion

Over the last decade, many research studies have been undertaken with the aim of developing new edible films and coatings that contain antimicrobial agents with activity against different foodborne pathogens and spoiling microbiota of food products. The final effectiveness of the formulations depends on the type and concentration of the antimicrobial but also on

- i. The type of structural matrix,
- ii. Target microorganism,
- iii. Type of product over which it is applied and,
- iv. All of their interactions

The most common antimicrobials currently used for edible films and coatings formulations are classified in three different groups: essential oils, organic acids, and bacteriocins.

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Conflict of interest

The author declares no conflict of interest.

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