НАУЧНЫЙ ЖУРНАЛ
НАУКА И МИРОВОЗЗРЕНИЕ

УДК-54

LIQUID FOOD PACKAGING USING POMEGRANATE PEEL

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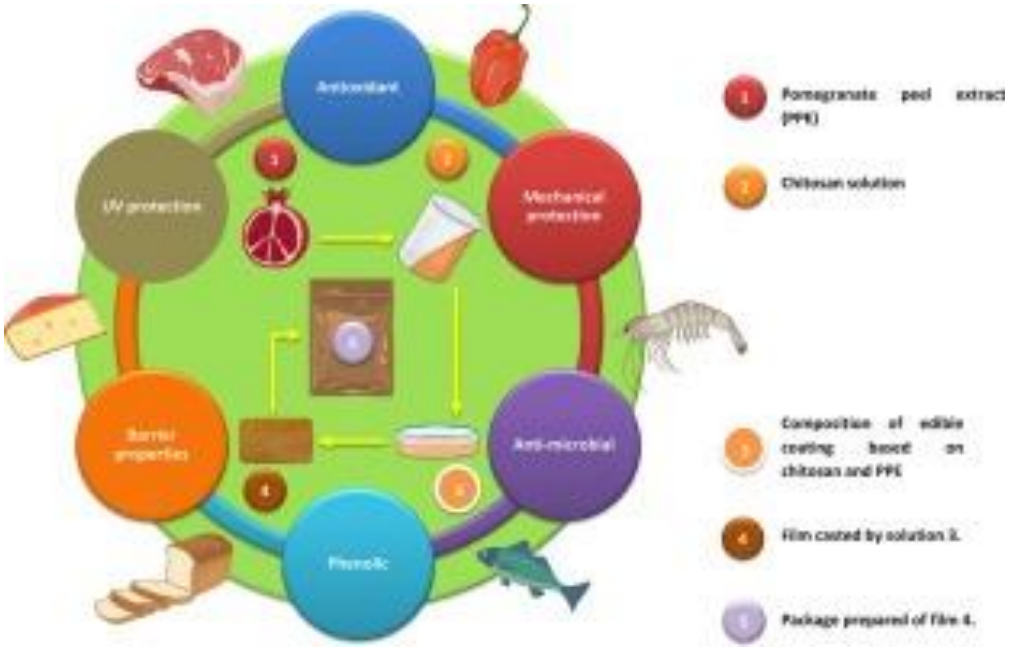
Abstract

The pomegranate (*Punica granatum* L.) fruit peel has been renowned for containing high amounts of bioactive phenolic and flavonoid compounds; however, it has been commonly deemed as an agricultural waste product. The present study comprehensively reviews the impact of pomegranate peel extract as an active addition to different edible packaging materials. This review provides an overview of the recent trends and advances in active edible packaging materials enriched with pomegranate peel and their technological properties. Recently, significant advances have been made to extend the shelf life of perishable food and control the release and transport of nutraceuticals and bioactive molecules by using pomegranate fruit and its underutilized components. Pomegranate peel extract within the edible matrix provide good compatibility between peel particles and the matrix, and can enhance structural, mechanical, and biochemical properties such as antioxidant and phenolic content as well as antimicrobial activity. The addition of pomegranate peel extract in an edible matrix and applied to food products could also assist in the retardation of natural pigments, lipid oxidation, microbial contamination and influence shelf life by sustaining organoleptic properties of food products. However, more studies are needed to investigate practical implications related to the effects of pomegranate peel extract on the optical, physical and barrier properties of edible films and coatings.

Graphical abstract



Introduction

The current industrial food sector and scientific community are focused on the sustainable development of food packaging alternatives as replacements for synthetic-based packaging. This is mainly due to increased awareness of the benefits of active and edible packaging for fruits, vegetables and other food products. Edible packaging are food formulations that are typically very thin (generally less than 0.3 mm) and provide a protective layer of biopolymers used for enrobing food products to enhance their shelf life and organoleptic properties (Kumar and Neeraj, 2019, Petkoska et al., 2021, Senturk Parreidt et al., 2018). Recently, particular interest has been given to the development of antioxidant and antimicrobial enriched active packaging. In this context, "natural" active additives, such as plant extracts, essential oils, and probiotic bacteria, are especially important as nutritive and bioactive additives to ecologically friendly packaging materials that can maintain high quality and safe food for consumers for an extended period of time (Bharti et al., 2020, Daniloski et al., 2021, El-Sayed et al., 2021, Petkoska et al., 2021). A special category in active packaging options is edible packaging in the form of coatings and films. Edible packaging is regarded as a novel and essential trend that addresses minimization of food waste, reduces consumption of foods packed into synthetic packaging materials and prolongs the shelf life of food products through preservation of food from microbial contamination (Guillard et al., 2018, Kumar and Neeraj, 2019, Petkoska et al., 2021, Suhag et al., 2020). This type of packaging also provides adequate barrier properties against gases and water transpiration and enhances mechanical properties against physical damage.

Many researchers have investigated different types of edible coatings used on food products to extend their shelf life and improve storage stability (El-Sayed et al., 2021, Kumar et al., 2020, Venkatesh and Sutariya, 2019).

In general, edible packaging is biodegradable, non-toxic in nature, and can be used as either a coating or in the form of film depending on the nature of food products (El-Sayed et al., 2021, Petkoska et al., 2021). Different deposition methods of edible coating can be applied to food products and the most common application methods include dipping, spraying, fluidized bed processing and panning, whereas the film formation methods, such as casting and extrusion, can be used to form wrapping around food products (Raghav et al., 2012, Suhag et al., 2020). In addition, a variety of biopolymers from natural sources (polysaccharides, proteins, lipids, waxes) can be used alone and in composite form for developing edible coatings and films; starch, cellulose, chitosan, chitin, pullulan, alginate, gums, and plant- andanimal-based protein, among others (Kumar et al., 2019, Pal et al., 2021, Petkoska et al., 2021, Petkoska et al., 2021a, Petkoska et al., 2021b).

Edible packaging tends to retain or, in some cases, even improve nutritional composition, biological and sensory characteristics due to reducing moisture losses, improving surface shine and minimizing biochemical changes during storage (Cui et al., 2020, Kumar and Neeraj, 2019, Martău et al., 2019, Meighani et al., 2015, Reichert et al., 2020, Ruiz-Martínez et al., 2020).

The latest trend of using edible packaging containing fruits processing waste extracts high in bioactive compounds is becoming well recognized in industry and research alike. Their incorporation in edible packaging materials is proposed to enhance antioxidant and antimicrobial characteristics (Bayram et al., 2021, Kharchoufi et al., 2018, Kumar et al., 2020, Yadav et al., 2021), and modify the structure of films which improves their functionality for food applications (Munir et al., 2020, Rangaraj et al., 2021). In this context, relatively limited data is available on edible coatings and films enriched with pomegranate peel as a natural antioxidant agent. Therefore, the main objective of this review is to comprehensively evaluate the recent studies on enriched edible coatings and films using pomegranate peel extracts and their effects on food product quality. In addition, this review also provides information regarding the effects of pomegranate peel extract on the physical, mechanical, thermal and functional properties of edible packaging.

Physical and mechanical properties

The change of the physical and mechanical properties of edible packaging, such as tensile strength, Young's modulus and elongation at break, are dependent on the interactions between the polymers and additives. The decreasing strength of mechanical properties can be attributed to free volume and molecular mobility in these systems (He, Lan, Ahmed, Qin, & Liu, 2019). Previous findings have indicated that incorporating pomegranate peel extract increases the moisture and swelling index of edible

Edible packaging enriched with pomegranate peel extract – A case of active packaging

Edible coatings and films enriched with pomegranate peel extract can also enhance the shelf life of food products due to the control of the respiration rate, minimization of oxidative stress, decreased loss of color, flavor, and other sensory attributes of packed items (Bodbodak et al., 2021, Giannelli et al., 2021, Ko et al., 2021, Kumar et al., 2020). Wambura, Yang, and Mwakatage (2010) have applied a coating on roasted peanuts to investigate their oxidative stability and antioxidant property

Health benefits of pomegranate peel extract

Pomegranate fruits, peels, leaves, and seeds have been used for a long time as traditional herbal medicine in many countries. Due to many bioactive compounds found in pomegranate peels and pomegranate fruits in general, several health benefits are ascribed to the consumption of this fruit. Namely, consumption of pomegranate was reported to have cardio-protective, anti-inflammatory, anti-allergic, support immune function, cholesterol-lowering, and may protect against cancer and type 2 diabetes (

Conclusion

The beneficial effects of active edible packaging containing pomegranate peel extract as a carrier for naturally-derived food components on perishable foods has been proposed by several studies in this review. The pomegranate peel is considered as a valuable source for phenolic and flavonoid compounds, such as ellagic acid, gallic acid, punicalagin A, punicalagin B, quercetin, and several other bioactive compounds that contribute to its antioxidant, antimicrobial and antifungal properties. The

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. The authors declare no conflict of interest. N.N. has previously received funding from National Health and Medical Research Council, Australian Capital Territory government, Dementia Research Foundation, Arthritis ACT, Australian Association of Gerontology; university grants from University of Newcastle, Australian National

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