Use of Natural Antioxidants in Edible Films and Coatings

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Abstract

As a result of the increasing population, food safety and quality have also been among the issues that consumers have taken into consideration in recent years, in addition to the access of people in the population to food production. For this reason, the packaging used in the past has been replaced by environmentally friendly biodegradable edible films and coatings, which improve the organoleptic properties of foods. In recent years, emphasis has been placed on the use of antimicrobial and antioxidant packaging materials, as they generally provide good protection against oxidative and physical stress. It has been determined as a result of studies that edible films and coatings with different application methods have approximately similar qualities. In this article, after providing information about edible films and coatings, it is aimed to provide information about application methods and antioxidant application in edible films and coatings.

Keywords: Edible Films, Natural Antioxidants, Food Quality, Coating

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INTRODUCTION

Food resources are decreasing due to the increasing world population. For this reason, food production has become important in meeting the food needs of the population as well as food safety (Ruchir et al., 2018). Foods can deteriorate for various reasons at various stages from production to delivery to the consumer. Different packaging is used to prevent deterioration and quality loss in products and to maintain their integrity (Uçan and Mercimek, 2013). Packaging is a practice that prevents and protects the food items placed inside from contact with the external environment and ensures that the food does not lose its property throughout the period from storage to delivery to the consumer. While food packaging used to only protect food from external physical and environmental factors, today it is used for a wide variety of purposes (Han 2000; Quintavalla and Vicini, 2002). The fact that the materials from which packaging is produced cause environmental pollution and create undesirable interactions in foods has led people to use edible packaging as an alternative to synthetic packaging. Edible films and coatings protect foods from physical, chemical and biological deterioration while also having a positive effect on the quality of the products (Uçan and Mercimek, 2013).This article aims to discuss what edible films and coatings are, application methods, and edible films and antioxidant packaging.

EDIBLE FILM

The use of edible films, which have become increasingly popular in recent years, dates back to ancient times. Edible films were first applied to prevent moisture loss that may occur during storage and transportation of products. Today, edible films produced using different biopolymers prevent food from spoiling by building a wall between food and packaging and have a positive effect on shelf life and are biodegradable (Pavlath and Orths, 2009).

The main function of edible films is to create a moisture and gas barrier between food and its packaging. While they make a positive contribution to the environment due to their biodegradable properties, they do not leave any undesirable effects on the physical appearance of the food and at the same time they are edible and non-toxic, which are some of the advantages of edible films. They contain ions that help stop additional browning reactions, while preventing lipid oxidation, loss of taste and unwanted color formation. They also serve to store valuable components for foods (antioxidants, antimicrobial substances, aroma compounds, pigments and vitamins) in the packaging. Due to the antimicrobial effect of edible films, there is a significant decrease in the development of microorganisms in foods. Today, studies on the properties of edible films continue to improve (Oğuzhan and Yangılar, 2016; Tural et al., 2017). Its disadvantages are in addition to being uneconomical, the number of materials to be applied is small, consumers have little knowledge because it is a new application, and it is usually used with different packaging material because it is consumed with food (Baldwin, 1994). Compared to other packaging films, they have many important features such as being environmentally friendly due to their easy dissolvability in nature, improving the organoleptic qualities (flavor, taste and smell) of foods, preserving foods by preventing them from losing moisture, acting as a good barrier against oxygen and preventing food from spoiling, and containing antimicrobial substances that are edible by the consumer (Işık et al., 2013). Edible films and coatings usually have various application methods and areas of use. While edible film coatings are applied directly to the surface of foods to obtain a specific appearance, edible films are the application of previously produced rolls or sheets to the surface of foods (Bourtoom, 2008; Guimaraes et al., 2018). It has been found that edible films and coatings have approximately similar properties despite different application techniques (Tavassoli-Kafrani et al., 2016).

APPLICATION METHODS of EDIBLE FILMS and COATINGS

Edible film/coating preparation technology; factors such as the selection of additives that are resistant to difficulties and have the ability to adapt to the application and the application method play an effective role on the coating thickness. Damage to the product should be prevented during the coating application. It varies according to the distinctive qualities of the foodstuff to be applied and the application materials. Dipping, spraying, pouring, painting and foaming, extrusion methods are used in the application of edible films and coatings.

Dipping Method

It is the application of coating the food after direct contact with the film solution, filtering it and providing suitable temperature and environmental conditions. This application is more suitable for food products that require the use of various coating materials or that require coating on irregular areas (Suhag et al., 2020).

It is a method based on direct contact of the food with the prepared solution for 5-30 seconds (Pavlath and Orts, 2009). In this method, the food absorbs the solution, and a film layer of the desired thickness is formed (Dhanapal et al., 2012). While its advantages include creating a smooth and even appearance on uneven surfaces and the coating material being suitable for cleaning and drying, its disadvantage is that it is difficult to coat large volumes of food (Salcı, 2021). It is the simplest application used mostly for covering fruits and vegetables (Dhanapal et al., 2012; Tural et al., 2017).

Spray Method

It is a method applied on surfaces where thin, smooth and equal coating is desired (Suhag et al., 2020). This method is usually used in dual applications such as calcium-alginate (Üstünol, 2009) and is used extensively to create a second film layer on coated foods (Polat, 2007). In the food industry, this is a traditional method used when the solution forming the coating is not too fluid (Suhag et al., 2020).

Pouring Method

It is a method of coating the food after the film solution, which is prepared by taking into account factors such as shape, thickness and size of the food to be applied, is placed on the area in an appropriate manner, spread, dried and then cooled (Suhag et al., 2020).

The pouring method can be used together with spraying and dipping methods, or it can be used alone (Polat, 2007; Gökalp, 1995; Caner, 2004; Sarıoğlu, 2005).

Painting and Foaming Method

It is applied by applying the fluid coating solution to the outside of the product, painting it and coating it after drying. This method is used when partial coating is to be done on the product or when an even and thin layer is desired (Polat, 2007).

It is a frequently used method because it is an application that provides thinner, smoother and more equal film formation compared to other methods, applied to the products by giving compressed air to the foam machine or application tank (Polat, 2007; Krochta, 1994).

Extrusion Method

It is frequently used in the formation of edible films based on starch. In the application based on the thermoplastic properties of polymers, plasticizers are added to the polymer materials in the range of 10-60% (polyethylene, glycol, sorbitol, etc.). Its advantage is that it is used more compared to the pouring method since there is no need for drying or solvent addition (Dhanapal et al., 2012).

USE of ANTIOXIDANTS in EDIBLE FILMS and COATINGS

The purpose of using packaging technology in all stages of the food supply chain, from food production to reaching the consumer, is to provide healthy and quality products to consumers (Cutter, 2006). Nowadays, the application of edible films and coatings in active packaging is a new method in food preservation. In addition to being cheap and easy to produce, environmentally compatible edible packaging materials have the potential to significantly reduce the use of synthetic materials by replacing them (Campos et al., 2011).
The development of environmental awareness, consumer awareness and demands in this direction have led the packaging industry to work on natural and recyclable packaging materials. Among biodegradable packaging materials, the use of edible films and coatings formed using biopolymers in the application of antimicrobial and antioxidant packaging has attracted much attention in the food sector in recent years, as they provide good protection against oxidative and physical stress (Cutter, 2006).

The main reasons for food spoilage are the increase in microorganisms and lipid oxidation in lipids. These lead to staling and undesirable taste in foods (Shahidi and Rubin, 1987; Guillen and Goicoechea, 2008). To prevent lipid oxidation, antioxidants are added directly to foods or methods are used to enrich edible packaging materials with antioxidants. It is necessary to determine that the limits of antioxidants added directly to food are not exceeded and that they do not pose a risk to consumers' health (Lopez-de-Dicastillo et al., 2010).

Recently, the increasing interest in natural plants and active ingredients derived from these sources has led to the addition of more natural antioxidant substances in antioxidant packaging techniques. In this regard, the application of antioxidant spices, extracts of various plants and natural color pigments has a critical role (Oussalah et al., 2004).

Antioxidants can be produced and used naturally and synthetically, but from the past to the present, artificial antioxidants such as polyphenol, organophosphate and thioester compounds have been primarily used to prolong the freshness of products in the industry. However, with the evidence that some artificial antioxidants have undesirable side effects in living beings, the application of natural antioxidant spices and natural aromatic plants in food production has become increasingly important. The phenolic compounds found in these plants cause antioxidant effects due to their properties such as eliminating free radicals, forming compounds with metal ions and preventing the formation of singlet oxygen. In parallel with this, some studies have determined that the antioxidant capacities of some of these plants and spices are higher compared to artificial antioxidants. Plants and spices, which tend to have more bioactivity due to their organoleptic properties such as taste and aroma, as well as their antimicrobial and antioxidant properties, are natural antioxidant substances that can be applied as alternatives in the food industry (Dopico-Garcia et al., 2011).

Antioxidants that can be used in the food industry can be divided into four classes as; antioxidants that form complexes with free radicals, which inhibit the initial free fatty acid radical formation by donating hydrogen from phenolic hydroxide groups due to the phenolic configuration in their phenolic or molecular structures; reducing antioxidants (oxygen binders) that eliminate the oxidative effect of oxygen by binding hydrogen atoms with oxygen and delay spoilage, and also help antioxidants and prevent color changes; chelates

(kelates, sequestrants) that play an active role under the name of synergists in stabilizing foods, although they are not antioxidants; and finally, secondary antioxidants that help antioxidants by decomposing hydrogen peroxide during lipid oxidation (Fiorentino et al., 2008).

Synthetic antioxidants most commonly used in the food industry are butylated hydroxyanisole, butylated hydroxytoluene and propylgallate (Abreu et al., 2010) however, natural antioxidants, which have been preferred in recent years, are generally produced in plants and spices (Fiorentino et al., 2008). In recent years, the demand for natural products with antioxidant effects such as tea, rosemary, thyme, cloves, blueberries, mustard and red wine has increased (Alen-Ruiz et al., 2009; Beddows et al., 2000; Bhale et al., 2007; Houhoula et al., 2004; McCarthy et al., 2001; Murphy et al., 2009; Ramos et al., 2014). Antioxidants have been produced from a variety of plants including marjoram, mustard, thyme, ginger, grape seed extract, aloe vera, sage, angelica, peony, reed, rosemary and cumin extracts (Fiorentino et al., 2008).

In recent years, there have been various studies on the use of edible films and coatings alone or in combination with antioxidant substances. A study on the physicochemical, mechanical, antioxidant and antimicrobial properties of carboxymethyl cellulose-based films with different ratios of essential oils obtained from different plants (*Santolina chamaecyparissus, Schinus molle, and Eucalyptus globulus*) (Eke, 2020). Some of the research on antioxidants produced using plants has focused on rosemary extract (Botsoglu et al., 2007; Pszczola, 2001). Another study shows that propolis extract can be used as a natural antioxidant source to provide oxidative stability in fish oil (Uçak, 2018). In a study conducted in 2020, semi-refined carrageenan-based edible films containing different concentrations of *Persicaria minor* (small water pepper) extract and 0.4% (BHA) were produced and the phenolic substance and antioxidant activity of the extract were determined, and the aim was to extend the shelf life of meatballs with the produced film. As a result, it was concluded that the application of the film containing the extract prevented lipid oxidation; at the same time, active films containing 2% extract had better mechanical properties compared to other films (Yahaya et al., 2020). There is a study on the antioxidant and antimicrobial effects of pomegranate peel extract in cold-stored trout burgers (Uçak, 2020). One of the studies examined the total antioxidant activity of 3 different concentrations of nettle (*Urtica diocia*) extract, which contains natural antioxidants, on rainbow trout (*Oncorhynchus mykiss*) fillets during storage and as a result, it was determined that nettle extracts extended the shelf life of fillets stored under aerobic conditions and prevented lipid oxidation (Hisar et al., 2008).

CONCLUSION

Today, against the increasing population and environmental pollution, it is important to protect food from production to delivery to the consumer, and to be respectful of the environment while doing this. For this purpose, antioxidant application in edible film and coating products extends the shelf life and has a positive effect on their quality. In addition, the fact that their source is made of natural polymers, they can be consumed by consumers and are degradable in nature is in harmony with the environment and leads to the reduction of environmental pollution.

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