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Use of Natural Antioxidants in Edible Films and Coatings

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Abstract

Today, the intensive use of chemical fertilizers causes various environmental problems. Inoculation of microbial preparations as an alternative to chemical fertilizers to plants can be an effective method for sustainable production efforts. Silicon application shows potential to increase nutrient uptake by roots and nutrient availability in the rhizosphere through complex mechanisms, can increase P availability in the soil. In this study, the effects of silicon application and inoculation of phosphorus solubilizing bacteria and mycorrhiza on sunflower plant growth and phosphorus utilization efficiency were investigated. Sunflower Seed, *Glomus etunicatum*, mycorrhiza complex and with P bacteria were inoculated. Si application was also made at doses of 0-30-60 kg/da. The experiment was terminated when 50% of the flowers bloomed. According to the results, average plant height, flower wet and dry weights showed significant differences with Si treatments, Si with mycorrhiza and P bacteria treatments. 30 Si kg/ha dose had more positive effects on plant growth. The triple interaction had a positive effect on improving the P utilization efficiency of sunflower.

Keywords: *Sunflower, Mycorrhiza, Silicon, Phosphorus, Phosphorus bacteria, P utilization efficiency*

Ayçiçeğinde (*Helianthus annuus*) Fosfor Kullanım Verimliliğini ve Gövde Direncini Artırmada Silisyum, Mikoriza ve Fosfor Bakterilerinin Etkisi

Özet

The creation of edible films and coatings containing natural antioxidants has drawn more attention due to the rising demand for safe, sustainable, and minimally processed foods. These biodegradable films are made of lipids, proteins, and polysaccharides, act as barriers to improve food quality and increase shelf life. Natural antioxidants made from plant extracts, essential oils, herbs, and spices, are becoming more popular than synthetic antioxidants because of their safety, biocompatibility, and consumer acceptability. High concentration of polyphenols, flavones, glycosides, tannins, and flavonoids, are derived from number of herbal extracts, which acts as good antioxidants. These antioxidants aid in lowering lipid oxidation, postponing microbiological deterioration, maintaining sensory qualities, and preserving food items' nutritional value when added to edible films and coatings. All things considered, adding natural antioxidants to edible films and coatings is a sustainable and practical way to enhance food preservation and lessen dependency on synthetic packaging materials.

Anahtar Kelimeler: *Food preservation, Edible films, Coating, Lipid oxidation, Antioxidant*

Introduction

The short shelf life of food goods, which results from oxidation processes like oxidative rancidity, enzymatic browning, and degradation, is the biggest obstacle facing the food sector (Soliva-Fortuny & Martín-Belloso, 2003). One of the primary reasons of food deterioration is lipid oxidation. When lipids in food oxidize, rancidity-related off-flavors appear, making the product unfit for human ingestion. Toxic aldehyde production and nutritional quality loss due to polyunsaturated fatty acid (PUFA) breakdown are additional adverse impacts (Guillen & Goicoechea, 2008). A number of techniques have been used to lessen lipid oxidation, including the direct addition of antioxidants to food or the development of an appropriate packing technology, such as vacuum or modified-atmosphere packaging in conjunction with high-barrier packaging materials (Lopez de Dicastillo et al., 2010).

Food packaging now plays a more active role in promoting and safeguarding food products. Different creative ways of intelligent packaging are used to prolong the shelf life, preserve, enhance, or monitor food quality and safety. An edible film or coating is any type of substance that is used for food packaging to extend its shelf life and may be eaten with the food. Thin layers of material that are safe to eat and serve as a barrier against various agents (such as moisture, oxygen, and water vapor) make up edible films or coatings. They aid in enhancing the fresh and processed foods' quality and prolonging their shelf life. These films and coatings' functional qualities can be improved by adding active substances, such as antioxidants, which may make them useful for food preservation (Sánchez-González et al., 2011).

Edible films and coatings

An edible film is a prepared, thin layer of edible material that may be applied to or in between food components, whereas an edible coating is a thin layer of edible material created as a coating on a food product (McHugh, 2000). In addition to being similar to active packaging technology, edible film and coating technology may help prevent oxidative food deterioration. Reducing the rate of oxygen transport and the potential to include antioxidant chemicals in the edible film or coating matrix are the primary mechanisms of action. This vehicle has the benefit of tight interaction between food and coating in the latter scenario. The use of edible coatings or edible films in food applications is dependent on a number of factors, including cost, availability, functional characteristics, mechanical properties and optical properties (Ganiari et al., 2017).

The type of material used as a structural matrix (composition, molecular weight), the conditions under which films are produced (solvent type, pH, component concentration, and temperature), and the kind and concentration of additives (plasticizers, cross-linking agents, antimicrobials, antioxidants, or emulsifiers) all affect these characteristics (Rojas-Graü et al., 2009). In this technique, plasticizers, colors, scents, and antibacterial or antioxidant agents can be added. To create freestanding films, the film solution is subsequently cast and dried at the appropriate temperature and relative humidity (Bourtoom, 2008). Antioxidants are added to the films using a variety of technical techniques. The majority of them include either co-extrusion of the antioxidant with the film-forming plastic material (Granda-Restrepo et al., 2009) or direct mixing of an antioxidant agent with the plastic ingredients (LaCoste et al., 2005). Edible films or coatings are very likely to contain active chemicals including colorants, tastes, nutrients, spices, antioxidants, and anti-browning agents that can improve the food's organoleptic qualities and nutritional value or prolong its shelf life. The fact that these films and coatings may be eaten with the food, reducing the need for extra external packaging, is another significant aspect (Ganiari et al., 2017).

Natural antioxidants

Any substance that has the ability to postpone, slow down, or stop the development of rancidity in food or other oxidation-related flavor deterioration is considered a food antioxidant. The natural antioxidants, includes tocopherol, plant extracts, essential oils, or their components (Tovar et al., 2005). The potential utilization of food industry waste as a source of antioxidant agents is also pertinent (Barbosa-Pereira et al., 2013).

High quantities of phenolic compounds with potent H-donating activity are frequently found in spices and herbs, which are utilized in food for their flavor and in medical combinations for their physiological benefits. To stop oxidation, these substances can be collected and added to food systems. The Lamiaceae family of herbs, which includes rosemary, oregano, thyme, marjoram, savory, sage, and others, has been extensively studied. Tea, a member of the Theaceae family, is another herb that has been extensively studied as a natural antioxidant. Herbs and spices include antioxidant components that can be extracted and concentrated as oleoresins, extracts, or essential oils. Extracts from plant by-products, such as barley husks, pomegranate peel, olive leaves, etc., have shown good antioxidant properties in addition to herbs and spices (Marcos et al., 2014; Qin et al., 2015; Yuan et al., 2015).

Antioxidant activity of enriched edible packaging films

Devoid of employing the enhanced films to cover food, several studies have concentrated on their antioxidant qualities. It is evident that the greatest research has been done on chitosan films. Chitosan's inherent antibacterial and antioxidant qualities, together with its superior film-forming capacity, have made it a desirable material for food packaging (Abdollahi et al., 2012). The film's capacity to liberate the confined active polyphenols is linked to its antioxidant action. According to Peng et al. (2013), increasing the concentration of tea extracts in chitosan film led to a quicker release of the antioxidant compounds and, as a result, higher radical scavenging activity. Lopez de Dicastillo et al. (2015) also noted this with various film materials and additives. Martucci et al. (2015) measured the DPPH radical scavenging activity in gelatin films after adding oregano and lavender EOs (2000–6000 ppm). The findings indicated that the film was more effective against the DPPH radical when 6000 ppm of oregano EO was added, however the film's ability to scavenge radicals was minimal when lavender EO was added. These findings may be explained by the various activities of each plant's EO components or by interactions between the EO components and the gelatin matrix.

Applications of enriched edible films as antioxidant

The best antioxidants for fish and meat products are extracts of oregano and rosemary. More precisely, the oxidation of smoked sardines has been successfully delayed by adding aqueous extracts of both herbs to edible films composed of gelatin or gelatin-chitosan (Gomez-Estaca et al., 2007). Similar to this, smoked eel fillets were shielded by the ethanol extract of rosemary added to the CMC (carboxymethylcellulose) coating, which also slowed the build-up of primary and secondary oxidation products (Choulitoudi et al., 2017). Polyphenols, which have a strong antioxidant potential and may be employed in films, could derived from borage seeds and leaves (Fabra et al., 2011). Films containing extract from borage leaves exhibited superior antioxidant qualities compared to those containing α-tocopherol (Gomez-Estaca et al., 2009). High concentration of polyphenols, flavones, glycosides, tannins, and flavonoids, a number of herbal extracts, derived from green tea (Wu et al., 2013), ginkgo leaves, ginger, and grape seeds (Li et al., 2014).

Biopolymers with antioxidant qualities can be created by adding these extracts to biodegradable films. For instance, it has been discovered that adding extracts from grape seeds, ginkgo leaves, or green tea reduced oxidation. Gingko leaf extracts were shown to have the greatest DPPH radical scavenging activity when added to films (Li et al., 2014). Due to its high antioxidant content, which includes phenolic acid and flavonoids, quince seed mucilage also provided films with high antioxidant activity by evaluating DPPH radical scavenging activity (Jouki et al., 2013). To prevent the oxidation of meat's lipids and pigments, antioxidants like vitamin C and E can be added to edible films and coatings (Kenawi et al., 2011).

Conclusion

It is concluded from this review that edible films used for packaging and preservation of perishable food for longer time storage and transport purpose. As food especially meat could be damaged due to oxidation of lipids in it, so this process could be delayed by adding antioxidants in packaging materials. These antioxidants could retard or slow the process of food oxidation and preserve the food for longest time.

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