PHYSICO-CHEMICAL CHARECTRISTICS AND APPLICATIONS OF EDIBLE FILMS FOR FRUIT PRESERVATION

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Abstract:

The increasing demand of fresh fruits for food industry to develop new and better methods for maintaining food quality and extending shelf life. Recently, edible coatings have been widely studied for preservation of fruits and vegetables. The interest in the development of edible and biodegradable films has increased because it is every day more evident that non-degradable materials are doing much damage to the environment. Edible films and coatings can include antioxidant agents in their formulation and at the same time, they represent a barrier to oxygen, which results in a better preservation of quality. The water activity of the product, as well as the ambient relative humidity, determines the antioxidant effect of films and coatings. This paper reviews the latest studies dealing with the effectiveness and application of antioxidant films and coatings.

Key Words: **1.Edible films, 2.Antioxidant, 3.Fruits, 4.Coatings, 5. Shelf life**

1. INTRODUCTION

The application of edible films and coatings to food products represents a new approach to solve the problem. Edible films and coatings can include antioxidant and antimicrobial agents in their formulation, which results in a better preservation of quality (Bonilla et al 2012). There is increasing public interest in development of edible natural biodegradable coatings for maintaining postharvest quality of fruit.

The increasing demand for fresh fruits and vegetables forces the food industry to develop new and better methods for maintaining food quality and extending shelf life. Edible coatings are thin layers of edible material (protein, polysaccharide and lipid) which form directly on the surface of fresh-cut fruit (González et al., 2010), and transfer of moisture, oxygen, carbon dioxide, lipid, aroma and flavor compounds in food systems, can increase food product shelf-life and improve food quality and also decrease amounts of conventional synthetic packaging materials needed to preserve and protect foods, as well as improve package recyclability by decreasing the need for coating, laminating or co-extrusion. Edible films and coatings generally formed from renewable natural biopolymers, such as polysaccharides, proteins, lipids or the combination of these components, have been widely used as lipid, water vapor, gas and flavor barrier for fresh fruits and vegetables, confectioneries, frozen foods and meat products (Butler et al, 1996, Hoagland & Parris, 1996, Kaya. S.& A. Kaya, 2000, Ou et al, 2005), and also using biological materials such as proteins, lipids and polysaccharides, depending on their composition, the functionality of these materials may vary, as each component offers different properties to the composite matrix, for example films made up of polysaccharides or proteins usually have suitable mechanical and gas barrier properties but may be highly sensitive to moisture and show poor water vapor barrier properties. (Tony Diab 2001) furthermore, to our knowledge, very little is known about the thermo mechanical properties of films as affected by composition (Moisture plasticizers, emulsifiers etc), and temperature (Krochta et al.,1994).

Edible films and coating have been known to protect perishable food products from deterioration and some types of quality loss, however, over the last decade there has been a rapidly growing interest in the development and use of bio based packaging materials to prolong the shelf- life and improve the quality of fresh, frozen and formulated food products because of the following factors (Koelsch, 1991), films can also decrease amounts of conventional synthetic packaging materials needed to preserve and protect foods . (McHugh and Krochta 1994, Mchugh et al, 1996).

The increasing demand for fresh fruits and vegetables forces the food industry to develop new and better methods for maintaining food quality and extending shelf life, the application of edible films and coatings to food products represents a new approach to solve this problem. Edible films and coatings can include antioxidant and antimicrobial agents in their formulation, which results in a better preservation of quality (Bonilla et al, 2012).Fruit coated with edible coatings showed significant delays in the change of weight loss, decay percentage, titratable acidity, pH, total soluble solids and ascorbic acid content as compared to uncoated control fruit. The optimal composition of edible coatings in view of their application to extend the shelf life of several tropical fruits was studied (Miguel, et al, 2009).Loss of quality in this fruit is connected with its sensitivity to fungal infection and susceptibility to water loss, bruising, mechanical injuries and texture softening due to the lack of protective rind (Atress et al, 2010).

The main functional advantages attributed to use of edible coatings are slower respiration rate, extended storage periods, firmness retention and controlled microbial growth (Fan et al., 2009; Garcia et al, 2010; Vu, et al, 2011).The development of environmental friendly materials is a continuing area of challenge for food packaging and coating technology. (Matsumura et al, 1999).

2. MATERIALS AND METHOD

2.1 Antioxidant Effect of Edible Films

The antioxidant efficiency for edible films was tested using different approaches. In previous studies, the films were disintegrated and different tests (such as radical scavenging assays) were performed to the resulting formulation. In these cases, the disintegration procedure depended on the material and its solubility properties. For instance, chitosan films can be dissolved in distilled water (Siripatrawan and Harte, 2010), whereas a more elaborated procedure (freezing, grinding and extraction with methanol) was necessary for alginate films (Norajit et al., 2010). Table 2 summarized some of these reported studies were include the following antioxidant tests: 2,2-diphenyl-1-picryhydrazyl radical (DPPH), N-diethyl-p-phenylenediamine (DPD) radical scavenging assay, ferric-reducing antioxidant power (FRAP), 2,20-azinobis (3- ethylbenzothiazoline-6-sulphonate) (ABTS) assay and total phenolic content. Testing the activity of an antioxidant by more than one assay is desirable, because different methods approach this measurement in different ways (Erkan et al., 2008). Very often, radical trapping methods have been applied. These methods – DPPH, DPD, ABTS, FRAP, amongst others (Frankel and Meyer, 2000), measure the ability of an antioxidant agent to intercept free radicals. Additionally.

3. Results and Discussion

3.1.Oxygen barrier properties of edible films and coatings

Films are made from proteins and carbohydrates are excellent barriers to oxygen, because of their tightly packed, ordered hydrogenbonded network structure (Yang and Paulson, 2000). The antioxidant effect of stand-alone edible films are strongly linked to their oxygen permeability (OP), which can be measured directly by oxygen permeation tests, which are mostly based on the standard described by ASTM (1988). The measurement of oxygen gas transmission through films involves the flowing an oxygen gas stream on one side of the film and a nitrogen stream on the other side that carries the transmitted oxygen gas to the analyzer. A coulometric sensor, an infrared sensor, a gas chromatograph or a dedicated oxygen analyser may be used for monitoring (Ayranci and Tunc, 2003). The oxygen permeability of edible materials depends on many factors, such as temperature and relative humidity. Maté and Krochta (1998) measured the OP of whey protein films and b-lactoglobulin plasticized with glycerol and observed that high temperature promoted gas transference across the film in an exponential way.

3.2 Composition and Application of antioxidant film and coatings on fruits and vegetables

Oxygen can also reduce the quality of plant products. Table 1 & 2 shows some examples of antioxidant film and coating applications and compositions on some fruits and vegetables. In these formulations, the films and coatings prevent the enzymatic browning, which is caused by the enzyme polyphenol oxidase that in presence of oxygen converts phenolic compounds into dark coloured pigments. Pérez-Gago et al. (2006) studied the development of the browning index of coated and non-coated apple slices to test the antioxidant effect of whey protein–beeswax–ascorbic acid coatings. Rather than direct antioxidant addition, the best results in terms of colour preservation were obtained by incorporating the antioxidants into the coatings. Lin et al. (2011) edible coatings, which resulted in a significant reduction in the activity of polyphenol oxidase during storage as compared with non coated samples The addition of ascorbic acid as antioxidant in alginate or gellan-based coatings led to a better preservation of the natural ascorbic acid content in fresh-cut papaya, maintaining its nutritional quality throughout cold storage (Tapia et al., 2008), The quantification of vitamin C is a generally accepted method to evaluate the oxidation of fruits and vegetables. For instance, the applications of coatings containing antioxidant agents (ascorbic acid and citric acid) led to reduced vitamin C loss in mushroom, cauliflower, apricots and green peppers (Ayranci and Tunc, 2003, 2004).

Table.1: Measurement of the antioxidant capacity of disintegrated edible films.

Film composition	Antioxidant additive	Method of measurement	References
Squid skin gelatin	Hydrolysates from squid gelatin	FRAP, ABTS	Giménez et al. (2009)
Milk protein (calcium caseinate and whey protein isolate)	Oregano and/or pimento essential oils	DPD and total phenolic content	Oussalah et al. (2004)
Pumpkin oil cake	----	ABTS	Popovic et al. (2011)
Tuna-skin and bovine-hide gelatin	Oregano and rosemary extracts	FRAP, ABTS	Gómez-Estaca et al. (2009a)
Chitosan	Green tea extract	DPPH radical scavenging and total phenolic content	Norajit et al. (2010)
Alginate	Ginseng extract	DPPH radical scavenging and reducing power activity	Norajit et al. (2010)
Sole skin gelatin/	Borage extract	FRAP, ABTS, iron	Gómez-

commercial fish gelatin		chelation activity	Estaca et al. (2009b)

DPD: N,N-diethyl-p-phenylenediamine; DPPH: 2,2-diphenyl-1-picryhydrazyl radical; ABTS: 2,20-azinobis(3-ethylbenzothiazoline- 6-sulphonate). FRAP: ferric-reducing antioxidant power;

Table .2: Application of antioxidant edible films to fruits and vegetable products.

Film or coating	Antioxidant compound	Application	Analyses	References
Methylcellulose-polyethylene glycol (3 g:1 ml) stearic acid	Ascorbic acid, citric acid	Mushroom and cauliflower	Water loss, colour, vitamin C, polyphenoloxidase activity, total phenol	Ayranci and Tunc (2003)
Alginate and gellan with glycerol	Ascorbic acid	Papaya	Water loss, respiration rate, ethylene production, firmness, ascorbic acid content	Tapia et al. (2008)
Methylcellulose-polyethylene glycol (3 g:1 ml) stearic acid	Ascorbic acid, citric acid	Apricots and green peppers	Water loss, vitamin C	Ayranci and Tunc (2004)
Whey protein concentrate and beeswax	Ascorbic acid, cysteine and 4-hexylresorcinol (4-hexyl)	Apple	Weight loss, colour, sensory evaluation	Pérez Gago et al. (2006)
Chitosan coatings	Oleoresins: rosemary, onion cranberry, garlic and carvacrol	Butternut squash	Peroxidase and polyphenoloxidase activities	Ponce et al. (2008)

4. CONCLUSION

It can be concluded from the present study that the physico-chemical characteristics and Applications of Edible Films for fruit preservation that the edible coating affects positively on the physicochemical parameters. The coated sample shows significant difference in almost all parameters as compared to control sample. As far as storage period is concerned as the storage period increase the quality parameters, which results in a better preservation of quality. The water activity of the product, as well as the ambient relative humidity, determines the antioxidant effect of films and coatings, and the effectiveness and application of antioxidant films and coatings. Thus it is observed that composite edible coating can satisfactorily enhance the shelf life of fruits and vegetables stored at ambient conditions.

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