

Edible Coatings of Carnauba Wax —A Novel Method For Preservation and Extending Longevity of Fruits and Vegetables- A Review.

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Abstract

Fruits and vegetables are highly perishable agricultural commodities with high nutritional values and some are seasonal. Edible films and coatings can extend the shelf life and improve the quality of fruits and vegetables by creating a modified atmosphere inside the fruit due to their barrier properties to gases and moisture. Coating materials can also act as carriers of food additives such as antioxidants and/or antimicrobial agents. Some reports says that along with carnauba wax combined with nisin can prevent many microorganisms, extends the shelf life of the products. Carnauba wax is also called as Brazil wax and palm wax, is a wax of the leaves of the palm *Copernicia prunifera*, a plant native to and grown only in the northeastern Brazilian states. The aim of this work is to review the existing knowledge of the way in which edible coatings like carnauba wax and nisin can improve the shelf life of salad vegetables during storage at room temp as well as at low temperature.

Key words : Edible Coatings, Carnauba Wax ,nisin, Extending shelf life, Fruits And Vegetables

Introduction

Edible films and coatings are generally designed using biological materials such as proteins, lipids and polysaccharides. Edible films and coatings can extend the shelf life and improve the quality of fruits and vegetables by creating a modified atmosphere inside the fruit due to their barrier properties to gases and moisture (Coma, *et al.*, 2001, Baldwin, 1994). It also acts as a barrier against microbial invasion (Puttalingamma *et al.*, 2006, 2010; Kester *et al.*, 1896). However, the ability of the edible film to enhance the shelf life of fruits and vegetables depends on their chemical composition, structure of the film forming polymer, the thickness of the coating, formation procedures, various emulsifiers and plasticizers present in it and conditions of storage (EI-Anany *et al.*, 2009).

The success of edible coating for extending the shelf life would also depend upon physiology of the fruit and the presence of coatings like waxes, cuticle etc on its surface.

Increased consumer demand for higher quality food in combination with the environmental need to reduce disposable packaging waste have led to increased interest in research into edible films and coatings (Hyun Jin Park, 2000., Del-Valle *et al.*, (2005).

Strawberry, have a very short post-harvest life, and spoilage can reach up to 40% during storage. Satin (1996) has reported that edible films and coatings, which can be divided into proteins, polysaccharides, lipids and composites, are defined as thin layers of edible material formed on a food surface as a coating. (Pa Technomic, 1996; Olivas *et al.*, 2008).

Coating materials can also act as carriers of food additives such as antioxidants and/or antimicrobial agents and can improve mechanical integrity or handling characteristics of the food. Stand-alone edible films with good mechanical properties could replace synthetic packaging films for specific applications (Pe ´rez Gago & Krochta, 1999; Raheleh Ghasemzadeh *et al.*, 2008). Dangaran *et al.*, 2009 had reported that sensory evaluation showed that the colour and texture of Thompson seedless variety (Raisins) coated with pectin were the best, while in the terms of flavour, samples covered with gum proved to be the best.

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Park et al, (1994) had reported edible corn-zein film coatings to extend storage life of tomatoes.

Table 1. Materials used as edible coatings

Sl.no	Coating material	Food Materials
1	Proteins	Soy, milk, corn, wheat, casein
2	Carbohydrates	cellulose, pectin, starch, gum
3	Lipids-Waxes and oils	carnauba waxes, vegetables oils
4	Resin- shellac	wood rosin Derivatives of acids and polysaccharides such as Chitosan

Different types of waxes

ANIMAL WAXES:

1. Bees wax.
2. Spermaceti wax
3. Shellac wax
4. Chinese insect wax

VEGETABLE WAX

1. Carnauba wax ,
2. Candelilla wax
3. Sugarcane wax
4. Palm wax
5. Esparto wax
6. Japan wax
7. Oricury wax

MINERAL AND SYNTHETIC WAX

Ozocerite/ Montan wax /Synthetic wax

Edible coatings, on the other hand, are mainly applied using spraying, drum coating, spray fluidization, pan coating or falling film techniques.

PROPERTIES OF WAX

- Kneadable at 20° C.
- Easily emulsifiable.
- Should not impart undesirable odour.
- Should be economical.
- Efficient drying performance.
- Non-sticky or tacky.
- Should never interfere with the quality of fresh fruit / vegetable.
- Melts above 40° C without decomposition.
- Has relatively low viscosity.
- Capable of being polished by slight pressure.
- Translucent to opaque form but not like glass.

Table 2- Foodstuffs that are waxed

1	Fruits	Apple, Avocados, Bell pepper, Lemon, Grapes, Banana ,Melons, Oranges, Lime, Passion fruit, Peaches, Pineapples.
2	Vegetables	Cucumber ,Tomato ,Sweet potato, Melon

Copernicia prunifera or the carnauba palm or carnaubeira palm is a **species of palm tree** native to northeastern **Brazil**. Carnauba wax comes from the carnauba palm, a Brazilian tree formally named *Copernicia prunifera*. In hot, dry weather, the plant secretes wax to protect the leaves from damage.

Advantages of using carnauba wax Sometimes called the “Queen of Wax,” carnauba wax has a much harder melting point (78 °C) than other waxes, and is also extremely hard and usually comes in the form of hard yellow-brown flakes. Brazil wax and palm wax, is a wax of the leaves of the palm *Copernicia prunifera*, a plant native to and grown only in the northeastern Brazilian states. Combined with things such as tints and dyes, carnauba wax can be used to create an enduring colored polish. Natrajan, *et al*, (2000), Gill, *et al*. (2000), had reported that it can control *Salmonella typhimurium* on fresh broiler skin. (www.wisegeek.com/what-is-carnauba-wax.htm)

Carnauba wax uses Carnauba wax is used for a wide array of products mostly falling into the categories of: Cosmetics, food products and polishes. Some of the products are: Candies/sweets, chewing gums, chocolates, confectionary sugar, fruit coating, polishing wax (for car, leather, floor, furniture), food packing, can coating, plastic film, matches, medicine/capsules, graphite pencils, paints, cosmetics, bullets coating, bar codes, dry batteries, computer chips, printing ink, carbon paper, toner, dehydrated vegetables, modeling flowers and fruits, dental wax, textile coatings, lubricants, skin care, hair care, shave creams.

Some reports says that along with carnauba wax combined with nisin can prevent many microorganisms, extends the shelf life of the products.(Hyun Jin Park,(2000), Hoffman,*et al.*, (2001). Vegetable waxes /Carnauba wax production is about 100 g for one tree in a year. It contains mainly fatty esters (80-85%), free alcohols (10-15%), acids (3-6%) and hydrocarbons (1-3%). As a peculiarity, carnauba wax contains esterified fatty dialcohols (diols, about 20%), hydroxylated fatty acids (about 6%) and cinnamic acid (about 10%). This last phenolic acid compound (antioxidant in free form) may be hydroxylated or methoxylated. This wax is the hardest and highest melting of the natural waxes (melting point : 78-85°C) and is used mainly mixed to bee wax to make various polishes for shoes, floor and furniture but also in cosmetics (lipsticks, creams) and in food industry (glazes for candies, gums, fruit coatings). It is used also in the paper industry for paper coating (the largest application in the USA).Puttalingamma,*et al*, 2009.

Composition of Carnauba wax

Carnauba consists mostly of aliphatic esters (40 wt%), diesters of 4-hydroxycinnamic acid (21.0 wt%), ω-hydroxycarboxylic acids (13.0 wt%), and fatty acid alcohols (12 wt%). Parish, *et al* ., (2002). Steinle, *et al* 1936).The compounds are predominantly derived from

acids and alcohols in the C26-C30 range. Distinctive for carnauba wax is the high content of diesters as well as methoxycinnamic acid.

Cinnamic acid (about 10%), an antioxidant may be hydroxylated or methoxylated. Carnauba wax is sold in several grades, labeled T1, T2, and T4, depending on the purity level. Purification is accomplished by filtration, centrifugation, and bleaching.

Altoids are a popular brand of breath mints that have existed since the turn of the 19th century. Altoids are produced in Britain by Callard & Bowser-Suchard at Bridgend, Wales, although Wrigley announced in mid 2005 they planned to move Altoids production to an existing plant in Chattanooga, Tennessee in order to manufacture its products closer to where they are sold. The move is expected to be complete by mid-2006. The history of Altoids actually dates back to the reign of King George III.

Table 3. Technical characteristics

No	Characteristic features of Carnauba wax
1	INCI ⁴ name is <i>Copernicia Cerifera (carnauba) wax</i>
2	E Number is E903
3	Melting point: 82–86 °C (180–187 °F), among the highest of natural waxes, higher than beeswax, 62-64C.
4	Relative density is about 0.97
5	It is among the hardest of natural waxes
6	It is practically insoluble in water, soluble on heating in ethyl acetate and in xylene, practically insoluble in ethyl alcohol. (Wikipedia).

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Table 4. Methods of Waxing: Four principle methods of waxing of fruits and vegetables

Sl no	Methods	Principle
1	Liquid Paraffin wax method	In this method fruits and vegetables are dipped in hot paraffin. Some times resins are added. The main disadvantage of this method is much of coating material is used.
2	Slab wax method	In this case the wax is pressed against rapidly revolving brushes. But the efficiency is very less
3	Spray method	Spraying of melted wax on the fruit,

		which is subsequently brushed Mechanically until a film of desired thickness is obtained. The wax is dissolved in a suitable solvent. This depends on, <ul style="list-style-type: none"> • The pressure employed • Volume of wax used • Wax temperature • Distance of fruit from the spray • • Number of spray nozzles
4	Dipping or cold wax method	Fruits and vegetables are washed and then Fruits and vegetables are washed And then without being dried are dipped into a wax emulsion of proper concentration. They are dried before packing. Purified wax is odour less, tasteless and nontoxic and it can be heat- sealed.

The properties of wax depend primarily on molecular structure rather than molecular size and chemical constitution.

Scale of the production of carnauba wax In 2006, 22.409 tons of carnauba wax were being produced in Brazil. 3130 tons were solid wax, while 19.279 tons was carnauba powder. Between 1990 and 2006, 285.344 tons of carnauba wax was being produced in Brazil. Of this, 66.100 tons were solid wax, while 219.244 tons were in powdered form. Of the 285.344 tons being produced 1990-2006, ca. 40% was produced in the state Ceara, ca. 50% was produced in Piaui, and 6% in Rio Grande do Norte. Between 1990 and 2006, the value of the production of the 285.344 tons of carnauba wax was 1.199.364.000 reais corresponding to ca. 3.598.092.000 DKK and 479.745.600 EUR. (Sources:– Banco do Nordeste, Puttalingamma, vignana loka 2010)

Main Brazilian exporters Between 20 and 25 industrials/exporters exist in Brazil, who buy crude carnauba wax from producers in the countryside and refine the wax before it is being exported around the world. The companies buy either directly from the farmers or from brokers/middle men. Export data from January-June 2010 shows the top 4 exporters to be Foncepti, Carnauba do Brasil, Pontes and Brasil Ceras. Medium scale exporters include Rodolfo, Cerpol and Cerapeles.

Destinations of the export According to the Ministry of Development, Industry and Commerce (MDIC) the main

destinations According to the Brazilian Ministry of Development, Industry and Foreign Trade, the major destinations for exported carnauba wax are:

- USA (around 25%)
- Germany (10-15%)
- Japan (15-25%)
- Holland (around 5%)
- Italy (around 5%)

According to these MDIC data there is no direct export from Brazil to Denmark and have not been during 2001-2010. According to the regional development Bank, Banco do

Companies uses carnauba wax This research have focused on sweets being sold in Denmark. Sweets brands being sold in Denmark include: Haribo, Toms, Malaco, M&M, Menthos, Gajol, Läkerol, Stimorol, Bassett's, Budget, Carletti. Companies selling these brands are: Haribo, Toms, LEAF, Cadbury/Kraft Foods, Continental Candy Industries, Carletti.

Sources: – Field study in Danish supermarkets and kiosks 11.

List of interviews used as sources in this document
Edgar Gadelha, President of Sindicarnauba (organisation of carnauba wax exporters in Ceara) and Director of Natural Wax

Ana Carolina Fontelene, Director of Foncepi

Lara Pontes, Director of Pontes

Marina Azevedo, Head of Exports in Carnauba do Brasil

Johannes Maehlmann, exporter of carnauba wax

Oscar d'Alva, former employee of the ngo Instituto Sertão and author of "O extrativismo da carnauba no Ceara" (2007)

Countryside workers and landowners from three different places of carnauba production

Udo Thaysen, Sales Manager in Kahl & Co., Europe's biggest carnauba wax importer

Mei Ling Yuan, Production Manager in Ter Hell, major carnauba wax importer

Conclusion

Coating improves product appearance, colour, crispness, flavour, nutritive value, juiciness, texture, etc. From fruits/vegetable to meat products can be coated including chocolates, various nuts, wafers, French fries, chicken, fish, corn chips, apple, and lemon. Continuous Mechanization is not available for various coating operations. Till now, many of the coating operations are done by batch processing. Safety of food product should be maintained in the coating operations. For example reuse of batter in battering operation will induce the chance of contamination over the food product. Many of the coating materials are high in cost and some of the coating operations are also higher cost. This leads to

increase the cost of operation of coating. So, we have to reduce the cost of coatings. Coatings can extend shelf-life and make product available thought-out the season by

- Delay the ripening processes,
- Delay the color changes,
- Reduce the weight loss,
- Maintain the texture,
- Reduce the decay, and
- Simple technology

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