https://doi.org/10.46344/JBINO.2022.v11i02.23

EFFECT OF EDIBLE COATING IN EXTENDING SHELF LIFE OF FRUITS

Kiruba.S* Vishwa Rohini.M**

II MSc Food chemistry and food processing, Loyola College, Chennai**
Assistant professor, Food Chemistry and Food processing ,Loyola College ,Chennai**

ABSTRACT

Have you ever wonder an edible coating can extend the shelf life of fruits and prevent transpiration losses during storage. In recent past years, there are many innovative edible coatings from natural sources invented for packaging of fruits to increase their shelf life as well as qualitative parameters during storage. Fruits are soon degradable as they are perishable in nature and have low shelf life .Transpiration process starts after harvesting of fruits from plant, which lead to loss of quality and ultimately shortens the life of the fruit. In order to prevent from degrading of fruits, Edible coating act as a protection and barrier against mechanical damage using natural sources. An edible coating is any material formed from a combination of biopolymers and different additives dispersed in aqueous media. Dipping method is mostly used for applying edible coating for fruits ,dipped in coating solution for 5-30 seconds. There are many edible coating materials used like polysaccharide, protein, lipid, herbal and composite materials. It is important to know the nature of the material substance used and type of fruits for edible coating.This review paper presents different edible coating material and its impact on preserving fruits using simple preservation method. This work also show output of various natural coating materials providing beneficial effects on fruits.

Keywords- Edible coating; fruit; shelf life; Quality;Preservation

INTRODUCTION:

Edible coating enhance the postharvest quality of fresh fruits. Edible coating acts as an additional protective and preservative agent for fruits. Post-harvest losses of fruits are major concern in food industry .There is a consumer demand for fresh quality fruits with a longer shelf life. By demand, edible coating came into the worldwide market turnover for protecting fruits by minimizing respiration rate and maintaining quality parameters. For centuries, Edible coating are used to protect foods and prevent moisture losses..In 12th century, Wax as an edible coating was first used on citrus fruits in China(Hardenburg,1967) and prevent from water loss and add shine to fruits(Baldwin,1994).In Europe, Larding process stores fruit in wax or fats for later consumption(Contreras-Medellin and Labuza 1981).Edible coating defined as a thin layer of material that covers surface of food and eaten as a whole fruit(Guilbert et al.1995,Raghav PK et al.2016).Edible coating is done in many simple as well as technological methods in recent years. Dipping method is the most common and easiest widely used methods for fruits. It is simple and cost effective for laboratory purposes. The materials used for edible coating are polysaccharide, protein, lipids, herbal based and seaweed. Impact of Different edible coating material in fruits has been evident these days. Let see detailed information on how edible coatings preserve the fruits in different ways.

I) CHARACTERISTICS OF EDIBLE COATING:

According to Elsa. D.M, Roberto .C.M (2021),the important characteristics of edible coatings are

- act as mechanical barrier such as dents or cuts, (Guminaraes A et al.2018)
- contains bioactive components like antioxidants useful in preventing oxidation,(Sanchez.A.et al.2015,Salvia – Trujillo.et al.2017)
- Helps in protecting against UV light and other compounds(Debeaufort.F.et al.1998)
- Aids in antimicrobial properties , preventing from bacterial production and fungalcontamination (Krasniewska.K.et al.2020)
- Naturally made frombiodegradable materials(Guminaraes A et al.2018)
- Increasing shelf life of the product(Falguera.et al.2011)

II)EDIBLE COATING METHOD:

1. *DIPPING METHOD* :

Dipping method is widely used viscous coating method in fruits . Fruits are dipped in the coating solution between 5 to 30 secs.(Raghav et al., 2016). It involves three steps for dipping the product: (Andrade et al., 2012; Brinker, 2013; Costa et al., 2014; Tavassoli-Kafrani et al., 2016)

a) Immersion - Fruit is dipped into the coating solution at a constant speed in order to coat properly.

b) Deposition – Developing a thin layer of the precursor emulsion on the surface of the food.

c) Evaporation – The excess solvent are evaporated from the surface of the food by drying procedure.

The most effective way to increase microbial stability of fruits by dipping them in solutions with antimicrobials. Dipping method is the main laboratory coating application method due to its simplicity and low cost.

(Source: Suhag.R.Kumar ,et.al,(2020)

2. *SPRAYING METHOD:*

i)Air spray atomization:
In this method of spraying the high velocity stream of air is surrounding fluid flowing from a tube at a low speed. Fluid-air friction speeds up and disrupts the liquid fluid flow and induces atomization. In this technique, air is used for fine spraying of the droplet on food products. (Valdés et al., 2017)

ii) Air assisted airless atomization: Air-assisted airless spray guns first partially atomize the fluid with a special fluid nozzle tip similar to a standard airless tip. This method offers high production levels and a high-quality finish. (Peretto et al., 2017)

iii) Pressure atomization: In this technique the edible coating is applied to food products by using pressure.During the processing, the pressure maintains below 3.5 bars to avert the annihilation of the film-forming system (Andrade et al., 2012). The droplets of coating solution are formed due to high inertial forces and low viscous forces (Andrade et al., 2012)

3. *FLUIDIZED-BED PROCESSING METHOD:*
The fluidized-bed method of edible coating is widely used in food processing and research applications. The coating solution and suspension are sprayed onto the fluidized powder surface via a number of nozzles to form a shell-like structure in a fluidized coating process (Suhag.R.Kumar et.al,2020).The application comprises a wide range of high-quality food products, which include functional ingredients and additional products (leavens and enzymes), preservatives (acids and salts), fortifying substances (vitamins and minerals), aromatic compounds (natural and synthetic) flavours and spices (Chen et al., 2009). This methodology is also often used to coat seeds with pesticide slurry for protection against mechanical and biological damage (Debeaufort&Voilley, 2009).

III) EDIBLE COATING MATERIALS:

I. POLYSACCHARIDE
(a) Gum
- Gum Arabic
- Xanthum gum
- Guar gum

(b) Seaweed extract
- Carrageenan
- Alginates
- Agar

(c) starch
- dextrins
- amylose

(d) chitin/chitosan

(e) Cellulose
- Carboxymethyl cellulose
- Hydroxypropylmethyl cellulose
- Methyl cellulose

II. PROTEINS
- Gelatin
- Zein
- Wheat gluten
- Casein
- Whey protein
- Albumin + gelatin
- Soy protein

III. lipid films/coatings

(a) surfactants
- tweens
- lecithin

(b) waxes
- beeswax
- carnauba
- paraffin

IV. Resins
- Female lac bug
- Shellac
- Wood rosin

- Coumarone indene

V. Composite films :

- Blend of polysaccharide, protein, lipids or resins.
- Bilayer or conglomerate structure.

IV) IMPACT OF EDIBLE COATING MATERIAL ON FRUITS:

1)POLYSACCHARIDE BASED EDIBLE COATING:

Polysaccharide based edible coating are most common used coating material for fruits.They can be obtained from natural sources such as plants,crustaceans and microorganisms(Kocira. A.et.al.,.2021).Microbial polysaccharide,Gums, Seaweed extract, Starch, chitosan and cellulose derivatives are the most polysaccharides used in the making of edible coating. These coatings have ability to prevent gases exchange, ability to reduce the water loss, and controls ripening and senescence.

a) GUM

Gum based edible coating are used due to their ability either to form the gel or make the viscous solution or stabilize the emulsion systems (Salehi and Kashaninejad, 2015; Williams and Phillips, 2000). Water-soluble gums also known as "hydrocolloid" are used for various applications as thickening and gelling agent,film and coating packaging and dietary fiber (Barak and Mudgil, 2014; Dick et al., 2015)

- **Arabic gum:** El-Anany et al. (2009) reported using Arabic gum as a coating for apple fruit delays ripening compared to control sample. Maqbool et al. (2011) suggest that using 10% Arabic gum and 0.4% cinnamon oil as a biofungicide for controlling postharvest anthracnose of papaya. Khaliq et al. (2015) shown the result of 10% Arabic gum with 3% calcium chloride improve the mango quality during storage.
- **Xanthan gum :** L.P.T. Quoc,et.al. (2014) showed the effect of xanthan gum in acerola fruit by reducing respiration process, increasing storage time and keeping the color.Adetunji.C.O.et al(2014). Reported that xanthan gum delayed softening of the fruit, ascorbic acid and TSS losses and maintained the quality of papaw fruit.

b) SEAWEED BASED EDIBLE COATING:

Seaweed Edible coating such as alginate, carrageenan and agar are products obtained from marine algae.

- **ALGINATE**: These are polysaccharides obtained from marine brown algae(Phaeophyceae). Alginate is soluble in water; it also has good filming and good adhesion properties. Alginate has white, yellow, fibrous powder form. Alginate polymers form gels, i.e., ionic cross-linksform in the presence of several divalent cations such as $Ca2^{+}$, $Mg2^{+}$, $Sr2^{+}$ and $Ba2^{+}$, by cross-linking the carboxylate groups of the guluronate groups on the polymer backbone.(Aarushi Sachdeva,et.al.2021).According to GhaidaaAlharaty.et al.(2020),Sodium alginate-calcium chloride edible coating extended the shelf life of strawberry cut fruits stored at 4 ◦C for up to 15 days. Based on sodium alginate and its blends with ascorbic acid coating method have proven to be a useful strategy for the preservation of the visual appearance of minimally processed pineapple under refrigerated storage(Alex L.et al(2019).
- **CARRAGEENAN**: Carrageenan is a natural hydrophilic polymer and has a high potential for film-forming. Carrageenan is produced from various genera and species of family Rhodophyceae. According to Fenny .M.D .et al.,(2020);At 20℃ storage, 1.5% Carrageenan coating treated for

banana extended the shelf life for six days than control.

- **AGAR AGAR**: Agar-agar, a polymer made up of a subunit of galactose sugar extracted from red-purple marine algae, mainly Gelidiumamansii.It is used as food additive and considered as GRAS(Generally Recognized as Safe) by FDA. The output is agar suspensions at different concentrations, especially at 2 g · l−1, applied by dipping banana fruit for 10 min could be a promising protective coating agent for management of postharvest rot disease(10 days). El Sayed Hussein Ziedan,.et.al.,(2018).

c) **STARCH BASED EDIBLE COATING**:

Starch is a complex form of carbohydrate which is made up of long chain of sugar or glucose molecules. Starch is the storage polysaccharide found in legumes, cereals, and tubers vegetables, like potato, cassava, corn, rice, banana etc. It is a good barrier to oxygen transmission but poor to water vapour.(K. Susmitha Reddy and Jatinder Singh.2020).Strawberries coated with cassava starch without antimicrobial agent showed good conditions for acceptance upto 12 days of storage(Loreno .C.G, et al.2012).

d) CHITOSAN BASED EDIBLE COATING:

- Chitosan ,an edible polymer,made by treating the chitin shells of shrimp and other crustaceans with an alkaline substance, like sodium hydroxide. It is a natural product which is non-toxic and eco-friendly. Chitosan has an antibacterial and antifungal property which helps in food protection. These films are flexible, tough, high durable and very difficult to tear.(K. Susmitha Reddy and Jatinder Singh.2020). Edible coating prepared with 2% chitosan of 80% DD and without the addition of TEA emulsifier was proved to be the most effective coating for banana in terms of weight loss reduction, vitamin C retention, and desirable sensory analysis.(Natalia Suseno,et.al(2013). is Chitosan nanoparticles and chitosan can provided a good effects on postharvest quality of banana include shelf-life, starch content, weight loss, pulp to peel ratio,Total soluble solids and sensory quality.

(Cita.L,et.al(2018).

e) CELLULOSE BASED EDIBLE COATING:

Cellulose is the polysaccharide produced from plant source such as methylcellulose, hydroxypropyl cellulose (HPC), carboxymethyl cellulose (CMC), and hydroxypropyl methylcellulose (HPMC) have good film-forming properties. These are usually transparent, tasteless, odorless, flexible, and of moderate strength, water-soluble, resistant to fats and oil, and resistant to oxygen and moisture transmission. (K. Susmitha Reddy and Jatinder Singh.2020).CMC help to maintain the original firmness and crispiness of apples,berries,peaches.(D.F.Mason.1960,Atul.T.et.al.2016).

2) PROTEIN BASED EDIBLE COATING:

Proteins edible coating material are used to avoid the moisture loss and to improve the shelf life of the product. Protein used in EC is usually in forms of isolate protein powder that can come from plant source (Soy protein isolate) or dairy/poultry industry (Whey protein isolate, Albumin).Soy protein isolate contains more than 90% protein and is obtainex by aqueous or mild alkali extraction by isoelectric precipitation.(Elizabeth.A.Baldwin.et al.2011) The output is 5% SPI exude the best result to control the weight loss of the banana.(Wan Mahfuzah Wan Ibrahim.et al.2020).The use of zein 5% and gelatin 10%

could be a good alternative in maintaining the quality attributes and extending the shelf life of mango fruit during storage.(Neeta B. GOL,et.al.2013). Compared to commercial shellac coatings, zein coatings are favorable for gloss and other quality characteristics on apples (Bai and others 2002, 2003a, 2003b).Caseinate and Whey protein isolate coatings were reported to efficiently delay browning of apple and potato slices by acting as oxygen barriers (Le Tien and others 2001).Whey protein represents approximately 20% of total milk proteins(Brunner 1977) with diverse functional properties.Casein edible coatings have been applied to whole and fresh cut fruits.Shelf life of Kinnow fruits was extended by 20 days when fruits coated with casein formulations and stored in high density polyethylene bags(Alam and Paul,2001)

3)LIPID BASED EDIBLE COATING

Lipid based edible coating is used widely in ancient times such as waxes for citrus fruit and contains glyceride compounds. The important characteristics of lip based edible coating aids in water-vapor barrier and imparting hydrophobicity.Paraffin and waxes with some chemical substances like fungicide or growth regulators are stored long time in fruits.(Furkan.K et al.(2017). An emulsion coating with CMC as the hydrophilic phase and paraffin wax, beeswax, or soybean oil as the hydrophobic phase also extended shelf life and reduced weight loss of apples, peaches, and pears (Togrul and Arslan 2004, 2005).Shahid and Abbasi (2011) evaluated the influence of bee wax coating to maintain physical and biochemical parameters of sweet orange.The main properties of Shellac and other resin-based coatings having lower permeability towards O2, CO2, and ethylene gas. Shellac coatings also dry fast and produce a shiny surface on coated produce (Baldwin 1994). Resin coatings are least permeable to gases meaning that fruit can easily undergo anaerobic respiration and flavor changes that are usually undesirable(Daniel Lin and Yanyun Zhao.2007) The beneficial properties of lipid-based coating act as a water–vapor and gas-barrier in comparison with polysaccharides and protein-based coatings (Greener and Fennema 1992).

4) *HERBAL BASED EDIBLE COATING:*

Herbal based extracts like aloevera gel, neem, tulsi, lemon grass, turmeric and rosemary contains antimicrobial , antioxidant and therapeutic properties and also act as a nutraceutical. (Pramod.k.R.et al.2016 and K. Susmitha Reddy and Jatinder Singh(2020))Chauhan et al.(2014) reported the effect of antifungal and anti bacterial on grape fruit by aloe vera gel coating and neem extract has antimicrobial property , extend the shelf life of apple for 45 days. According to Roller et al.(2002),Cinnamic acid and Carvacrol reduced the microbial spoilage of kiwifruit and fresh-cut melon.Herbal coating are excellent coating because of its non-toxic and eco-friendly nature.

5) *COMPOSITE BASED EDIBLE COATING:*

Composite based edible coating is the combination of polysaccharide,protein as well as lipids. Lipid coating are less permeable characteristics to water vapor, so it can combine to other coating for extending shelf life. Kittur et al.(2001), effect

of combining Chitosan, modified starch and cellulose and glycerol and tween-80 extend the shelf life of banana. Combination ofAlginate,chitosan, apple fibre and orange fiber.Glycerol, inulin and oligofructose shows improvement of sensory quality and increase in shelf life of blueberries(Alvarez, M.V.et al.(2018)

V)FOOD ADDITIVES

- **PLASTICIZER:**
  A plasticizer is a substance which is significantly non-volatile, non-separating and has a high boiling point(Banker GS.1996)Glycerol, sucrose, polyethylene glycol, and acetylated monoglyceride, are used as a plasticizer material for coating of fruits. (K. Susmitha Reddy and Jatinder Singh.2020)

- **ANTIOXIDANT**
  Addition of antioxidants also helps in increasing the shelf-life, increasing food stability, maintaining food quality and maintaining the nutritional value (Embuscado ME, Huber KC.2009,García.MP.etal.2016,Shahidi.F.2000).Natural antioxidants such as tocopherols, tocotrienols, ascorbic acid, carotenoids, citric acid are also used
  .
- **ANTIIMICROBIAL AGENT:**
  Antimicrobial substances control the contamination by increasing the lag-phase or by inhibiting the growth rate of the micro-organisms which are targeted (Quintavalla S, Vicini L.2002)Eg.Potassiumsorbate.

- **SURFACTANT**
  Surfactants are added with edible coatings and films as it promotes the adhesion of coating material, increases the wettability of the product and also reduces moisture loss.(SenturkParreidtT.et al.2018). Some common surfactants are: Sorbitan esters (commonly known as spans) and their ethoxylates (commonly known as tweens).(AarushiSachdeva.et al.2018)

CONCLUSION

This review work provides an recent studies about application of edible coating in fruits. Edible coating is an effective agent for extending shelf life and reduce respiration loss in fruits. Dipping method is one of the most commonly used method for coating fruit in laboratory scale. Fluidized bed processing method is used in food industry for coating of foods.Different edible coating materials were used such as polysaccharide, protein, lipid, resin, herbal and composite based coating for fruits.Combination of different edible coating material gives the best result for extending shelf life and minimize losses in fruits.Other than that, food additives also plays a role inplasticizer,antioxidant, antimicrobial and surface active agent. This paper gives summary on different edible coating on fruits with their impacts. Overall, Edible coating plays a vital role in protecting fruits from environmental barriers.

APPLICATION OF EDIBLE COATING IN FRUIT

Type of coating	Fruit	Composition	Benefits	Reference
POLYSACCHARIDE GUM BASED EDIBLE COATING	Fresh-cut Apple	Gellan gum	Improvement in apple quality parameters by pulsed light in combined with gellan based coatings	Moreira et al.(2015)
		Arabic gum with soybean gum, jojoba wax, glycerol	Shows significant delay in change of weight loss, ripening, firmness, TSS during storage	El- Anany et al.(2009)
	Apricot	Basil seed gum with essential oils	Provide high improvement in quality, odor and overall acceptability of apricot	Hashemi et al.(2017)
	Banana	Arabic gum with Lemongrass and cinnamon oils.	10% Arabic gum with 0.4% cinnamon oil as a biofungicide for controlling postharvest anthracnose.	Maqboolet.al(2011)
	Guava	Arabic gum with sodium caseinate and tulsi extract Also with essential oils.	Increase shelf-life and quality of guavas	Murmu and Mishra(2017)(2018)
	Mandarin	Locust bean gum with biocontrol yeasts	Improve against fungi causal agents of postharvest decay.	Parafati et al.(2016)

	Mango	Arabic gum	Influence on the mango ripening, quality and aroma biosynthesis.	Dang et al.(2008)
		Arabic gum with calcium chloride	Reduces weight loss,TSS,color changes, respiration rate, ethylene production and maintain high firmness,ascorbic acid.	Khaliq et al;.(2015)
	Melon	Xanthan gum with β-carotene nonocapsules	Improves the characteristics and increase shelf time to 21 days at 4ºC.	Zambrano-Zaragoza et al.(2017)
	Orange	Guar gum with pea starch and oleic acid	Increasing shelf life of oranges	Saberi et al.(2018)
	Papaya	Arabic gum with lemongrass and cinnamon oils	10% Arabic gum with 0.4% cinnamon oil as a biofungicide for controlling postharvest anthracnose	Maqbool et al.(2011)
	Pears	Xanthan gum with cinnamic acid	Xanthan gum(2.5g/L) and cinnamic acid(1g/L) slow down surface browning and increase the shelf life of pear slices.	Sharma and Rao (2015)
POLYSACCHARIDE **SEAWEED EXTRACT BASED EDIBLE COATING**	Apples	Alginate	Increasing shelf-life and quality of gala apples	Olivas et al.(2007)
	Mango	Alginate	Act as a anti-browning agent on bioactive compounds and antioxidant activity.	Robles-Sanchez et al.(2013)
	Melon	Alginate with cinnamon oil	Significant differences in taste,odor and firmness of fresh cut melon	Raybaudi-Massila et al.(2008)

	Papaya	Sodium alginate,cellulose acetate	More effective in preserving papaya stored for 12 days	Denise.A.S.et al.(2014
	Pineapple	Alginate and lemongrass essential oil	Increasing shelf life and quality of fresh-cut pineapple	Azarakhsh et al.(2014)
	Plum	Alginate	The weight and acidity losses, softening and color changes slow downs	Valero et al.(2013)
	Raspberry	Alginate , pectin and essential oils	Protects them from pathogen spoilage	Adriana.C.G et al.(2015)
	Strawberry	Sodium alginate and calcium chloride	Extend the shelf life of strawberry cut fruits stored at 4C for 15 days.	Ghaidaa.A et al.(2020)
	Sapota	Sodium alginate, pectin and glycerol	Significant reduction in changes in the physic-chemical parameters such as weight loss, TSS, acidity , colour and pH.	Joslin.Met.al(2016)
	Banana	Agar	Reduce weight loss, firmness loss and fruit infections by pathogenic fungi, and in turn, the extension of the shelf-life of banana fruit.	El Sayed Hussein Ziedanet.al.(2018)
		Carrageenan	At 20℃,1.5% carrrageenan can extend the shelf life and maintain fruit quality	Fenny.M.D.et al.(2020)

POLYSACCHARIDE **CHITOSAN BASED EDIBLE COATING**	Apricot	Chitosan	Increasing quality of apricot during storage.	Ghasemnezhadet.al(2010)
	Banana	Chitosan and cinnamon oil	Increase quality of banana fruit during storage	Win et al.(2007)
	Figs	Chitosan with cinnamon essential oil, acetic acid	Antioxidant capacity, color change delays	Contreras .S.S. et al(2020)
	Guava	Chitosan with cassava starch and LippiagracilisSchaue	Increase shelf life upto 10 days at 25ºC	Aquino et al.(2015)
	Mango	Chitosan	Improve quality and shelf life of sliced mango fruit	Chien et al.(2007)
	Orange	Chitosan ,Bergamot thyme and tea tree essential oil	Increasing postharvest quality of orange Fungal decay and increasing shelf life of oranges	Chafer et al.(2012)
	Papaya	Chitosan	Control papaya shows Early increase in respiration and ethylene producing as compared to 1.5% chitosan coated sample	Ali et al.(2011)
	Strawberries	Chitosan and beeswax	Decrease in senescence and weight loss, retention of the color and the texture and titrableacidity,pH, soluble solids, enhancement antimicrobial properties of chitosan	Velickova et al.(2013)

POLYSACCHARIDE **CELLULOSE BASED EDIBLE COATING**	Orange	Hydroxypropyl methyl Cellulose(HPMC)	Extended shelf life of orange	Adetunji et al.(2012)
	Plum	HPMC, shellac, stearic acid and glycerol	Effect were only noticeable at long term storage	Perez-Gago et al(2003)
	Papaya	CMC (Carboxymethyl cellulose) with essential oil	Extend shelf life and maintain postharvest characteristics	Zilloet al.(2018)
PROTEIN BASED EDIBLE COATING	Apples	Whey protein + Gellan gum	Reduce weight loss,better TSS, acidity content	Javanmard(2011)
	Persian lime	Soy protein-based coatings including some antimicrobial compounds	Regulates infestation of blue mould, lessens water loss and thus maintains colour.	GonzálezEstrada et al., (2017)
	Bananas	Soy protein isolate	Control weight loss	WanMahfuzah Wan Ibrahim.et al.(2020).
LIPID BASED EDIBLE COATING	Citrus Fruits	Waxes	Prevent water loss and add shine .	Hardenburg,(1967)
RESIN BASED EDIBLE COATING	Orange	Shellac, gelatin and Persian gum	TSS,weight loss, firmness,titrableacidity,pH, ascorbic acid,total antioxidant capacity and respiratory rate were influenced by the coatings	Khorraam et al.(2017)

HERBAL BASED EDIBLE COATING	Fresh cut melon	Alginate based Cinnamom, palmarosa and lemongrass oils	Improve shelf life from microbiological (9 days)and physiochemical(14days)	Raybaudi-Massila et al.(2008)
	Apple	Aloe vera gel	Increase shelf life and act as a bio-preservarive	Ergun &Satiei(2012)
	Table grapes	Aloevera gel with ascorbic acid and citric acid	Reduce weight loss, browning, cracking and decrease fungal and bacterial count.	Chauhan et al.(2014)
	Peach(Prunus persica)	Cinnamon leaf essential oil , pectin (3%) +glycerol	Antimicrobial, antioxidant activity, Odour acceptability up to 10 days(5ºC	Ayala-Zavala et al.(2013)
COMPOSITE BASED EDIBLE COATING	Papaya	Carrageenan and carboxymethyl cellulose	Decaying percentage, sugar content, phenols and ascorbic acid delayed.	Vyas et al.(2013)
	Banana	Chitosan, modified starch and cellulose+ glycerol and tween-80	Improved shelf life and quality of banana	Kittur et al.(2001)
	Orange	Chitosan and locust bean gum with pomegranate peel extract	Reduce disease incidence by 49% and 28%	Kharchoufi et al.(2018)
	Blueberries	Alginate, chitosan,apple and orange fiber	Extension of shelf life of fruit and improvement in sensory quality	Alvarez, M.V.et al.(2018)

	Fresh-cut Jackfruit bulbs	Xanthan, alginate and gellan gum and glycerol and 1-methylcyclopropene	Improvement in the shelf life of fruit and growth of microbes inhibited	Vargas-Torres, A.et al(2017)

REFERENCE

[1] Aarushi S, Varsha G, Ravi K Rahi, Deepesh N and Devki(2021), Seaweed Polysaccharides Based Edible Coatings And Films: An Alternative Approach. International Journal of Recent Scientific Research Vol. 12, Issue, 03 (A), pp. 41198-41206. DOI: http://dx.doi.org/10.24327/ijrsr.2021.1203.5844

[2] Adentunji,C.O , Fawole.O .B ,Arowra,K .A., Nwaubani,S .I,Ajayi,E.S.,Oloke,J.K, Majolagbe.O.N., Ogundele.B.A, Aina .J.A,Adentunji.J.B(2012),Quality and Safety of Citrus Sinensis Coated with Hydroxypropylmethylcellulose Edible coatings containing Moringa olifera Extract Stored At Ambient Temperature.Global Journal Of Science Frontier Research Bio-Tech & Genetics.Volume 12 Issue 5 Version 1.0.ISSN :2249-4626.

[3] Adetunji.C.O,Ogundare.M.O,Ogunkunle .A.T.J,Kolawole.O.M,Adetunji.J.B., (2014),Effects of edible coatings from xanthum gum produced from Xanthomonas campestris pammel on the shelf life of carica papaya linn fruits.Asian.J.Agri Biol,2(1):8-13.

[4] Adriana C.G,Custoida M.L.G,Maria L.F,Maria.G.C.M,Maria D.C.A.(2015),Raspberry fresh fruit quality as affected by pectin-and alginate-based edible coatings enriched with essential oils.Science Horticulture.ISSN:0304-4238.DOI:10.1016/J.SCIENTA,2015.08.004.

[5] Alam M.D.S and Paul S.(2001),Efficacy of casein coating on storage behaviour of kinnow.Journal Food Science Technology.38(3)235-238.

[6] Alex López-C and Andrea Aldana-U.(2019). ,Edible coatings based on sodium alginate and ascorbic acid for application on fresh-cut pineapple (Ananas comosus (L.) Merr). Agronomía Colombiana 37(3), 317-322, Doi: 10.15446/agron.colomb.v37n3.76173

[7] Ali, M. T. M. Muhammad, K. Sijam, and Y. Siddiqui, (2011). Effect of chitosan coatings on the physicochemical characteristics of Eksotika II papaya (Carica papaya L.) fruit during cold storage. Food Chem. 124(2):620–626. doi: 10.1016/j.foodchem.2010.06.085

[8] Alvarez, M.V.;Ponce, A.G. Moreira, M.R.(2018),Influence of polysaccharide-based edible coatings as carriers of prebiotic fibers on quality attributes of ready-to-eat fresh blueberries. J. Sci. Food Agric. 98: 2587–2597.

[9] Andrade, R.D., Skurtys, O. & Osorio, F.A. (2012).,Atomizing Spray Systems for Application of Edible Coatings. Comprehensive Reviews in Food Science and Food Safety, 11 (3), 323–337

[10] Aquino, A.B., A.F. Blank, and L.C.L. de Aquino Santana. (2015), Impact of edible chitosan– cassava starch coatings enriched with Lippia gracilis Schauer genotype mixtures on the shelf life of guavas (Psidium guajava L.) during storage.

[11] Ayala-Zavala, J.F.,Silva-Espinoza, B. A.,&Cruz-Valenzuela, M. R. et al, (2013),Pectin–cinnamon leaf oil coatings add antioxidant & antibacterial properties to fresh-cut peach. Flavor Fragr J, 28: 39–45

[12] Azarakhsh, N., A. Osman, H.M. Ghazali, C.P. Tan, and N.M. Adzahan. (2014), Lemongrass essential oil incorporated into alginate-based edible coating for shelf-life extension and quality retention of fresh-cut pineapple. Postharvest Biol.Technol. 88:1–7. doi: 10.1016/ j.postharvbio.2013.09.004

[13] Bai J,Baldwin EA,Hagenmaier RH.(2002),Alternatives to shellac coatings

provide comparable gloss, internal gas modification, and quality for 'Deliciou' apple fruit.HortScience 37:559-63.

[14] Bai.J,Alleyne V,Hagenmaier RD,MattheisJP,Baldwin EA,(2003a).Formulation of zein coatings for apples(Malus domestica Borkh).Postharvest Biol Technol 28:259-68.

[15] Bai.J,Hagenmaier RD,Baldwin EA.(2003b).Coatind selection for 'Delicious' and other apples.Postharvest Biol Technol.28:381-90.

[16] Baldwin EA,(1994),Edible coating for fresh fruits and vegetables:Past,present and future.In : Krochta JM,Baldwin EA,Nisperos-Carreido MO(Eds),Edible coating and films to improve food quality, Publishing Company,Inc.,Lancaster,Pennsylvania,USA, pp 25-64.

[17] Banker GS.(1966). Film coating theory and practice. Journal of pharmaceutical sciences. 55(1): 81-9.

[18] Barak, S., and D. Mudgil. (2014),Locust bean gum: Processing, properties and food applications—A review. Int. J. Biol. Macromol. 66:74–80. doi: 10.1016/j.ijbiomac.2014.02.017

[19] Brinker, C.J. (2013), Deposition Techniques: Dip Coating. Schneller, T., Waser, R., Kosec, M., Payne, D. (Eds.), 3, 233-262.

[20] Brunner.J.R.(1977),Milk proteins,in Food proteins.pp.175-208(Eds Whitaker,J.R. and Tannenbaum,.R.).Westport,Conn.:Avi Publshing Co.Inc.

[21] Carmen.C,Lia.G,Silvia.F.(2010).Develop ment of Edible fims and coatings with Antimicrobial activity.Food and Bioprocess Technology.4(6):849-875.DOI:10.1007/s11947-010-0434-1.

[22] Cháfer, M., L. Sánchez-González, C. González-Martínez, and A. Chiralt. (2012), Fungal decay and shelf life of oranges coated with chitosan and bergamot, thyme, and tea tree essential oils. J. Food Sci. 77(8):182–187. doi: 10.1111/j.1750-3841.2012.02827.x.

[23] Chauhan, S., K.C. Gupta & Agrawal, M. (2014), Efficacy of natural extract on the storage quality of Apple. Int J Curr Microbiol App Sci, 3(3): x-xx (1-6).

[24] Chen, Y., Yang, J., Mujumdar, A. & Dave, R. (2009). Fluidized bed film coating of cohesive Geldart group C powders. Powder Technology, 189 (3), 466–480.

[25] Chien, P.J., F. Sheu, and F.H. Yang.(2007), Effects of edible chitosan coating on quality and shelf life of sliced mango fruit. J. Food Eng. 78(1):225–229. doi: 10.1016/j. jfoodeng.2005.09.022.

[26] Cita.L.,Fenny.M.D.,Veinardi.S,M.Reza,(2018),Effect of chitosan and chitosan nanoparticles on postharvest quality of banana fruits.J Plant Biotechnol 45:36-44. https://doi.org/10.5010/JPB.2018.45.1.036.

[27] Contreras Saavedra, S.,Ventura-Aguilar, R.I., Bautista-Baños, S.; Barrera-Necha,, L.L.(2020) Biodegradable chitosan coating for improving quality and controlling Alternaria alternata growth in figs. World J. Adv. Res. Rev., 7, 115–125.

[28] Contreras-Medellin R,Labuza T P.(1981).Prediction of moisture protection requirements for foods.Cereal Food World.26(7):335-340.

[29] Costa, C., Conte, A. & Del Nobile, M.A. (2014). Effective preservation techniques to prolong the shelf life of ready-to-eat oysters. Journal of the Science of Food and Agriculture, 94, 2661–2667.

[30] D.E.Mason,Fruit preservation process(1969).US.,patent 3,472,662.

[31] Dang, K.T., Z. Singh, and E.E. Swinny. (2008),Edible coatings influence fruit ripening, quality, and aroma biosynthesis in

mango fruit. J. Agric. Food Chem. 56(4):1361–1370. doi: 10.1021/jf072208a.

[32] Daniel.Land Y.Zhao.(2007).,Innovations in the Development and Application of Edible Coatings for Fresh and Minimally Processed Fruits and Vegetables Comprehensive in Food Science and Food Safety. Vol 6.

[33] Debeaufort, F.; Quezada-Gallo, J.-A.; Voilley, A.(1998) ,Edible films and coatings: Tomorrow's packagings: A review. Crit. Rev. Food Sci. Nutr., 38, 299–313.

[34] Debeaufort, V.M., G. Blond, M. Capelle. & A, Voilley. (2002).,Factors affecting the moisture permeability of lipid-basededible films: a review. Critical Reviews in Food Science and Nutrition, 42 (1), 67–89.

[35] Denise Andrade da S, Juliana Krieger Oliveira , Clovis M.S , Carla Crislan S.B , Alessandra A.C and João Antônio B.S. (2014)The use of sodium alginate-based coating and cellulose acetate in papaya post-harvest preservation. Doi: 10.4025/actascitechnol.v36i3.17645.

[36] Dhall,Rajinder .K.(2016).Application of coatings in fruits and vegetables. In book:Atul.T,Anthony .G,Mark D.Soucek.(2016).Biobased and Environmentally Benign Coatings.1st Edition..Wiley.Scrivener publishing(pp.87-120)

[37] Díaz-Montes, E.; Castro-Muñoz, R.(2021) Edible Films and Coatings as Food-Quality Preservers: An Overview. Foods , 10, 249. https://dx.doi.org/10.3390/ foods10020249

[38] El.Sayed,H.Ziedan.,H.M.E.Zahaby,H.F.Maswada,E.H.A.E.R.Zoeir.(2018),Agar-agar a promising edible coating agent for management of postharvest diseases and improving banana fruit quality.Journal of Plant Protection Research.VOL.58,NO.3:234-240.DOI: 10.24425/122938.

[39] El-Anany, A.M., G.F.A. Hassan, and F.M. Rehab Ali.(2009), Effects of edible coatings on the shelf-life and quality of Anna apple (Malus domestica Borkh) during cold storage. J. Food Sci. Technol. 7:5–11.

[40] Elizabeth.A.Baldwin,Robert.H,Jinhe.B,(2011),Edible coatings and films to improve food quality,2nd edition,CRC Press, Technology & Engineering.

[41] Elsa. D.M, Roberto .C.M ,(2021),Edible films and coatings as food quality Preservers: An Overview.Foods,10,249 .https://dx.doi.org./10.3390/foods10020249

[42] Embuscado ME, Huber KC.(2009), Edible films and coatings for food applications. New York, NY, USA:: Springer

[43] Ergun, M. & Satici, F.,(2012),Use of Aloe vera gel as bio-preservative for „Granny Smith" and „red Chief" appels. J of Animal& Plant Sci, 22: 363-368

[44] Fakhreddin.S.,(2020),Edible coating of fruits and vegetables using Natural gums:A review.International Journal of Fruit Science.VOL.20.NO.S2,S570-S589. https://doi.org/10.1080/15538362.2020.1746730.

[45] Falguera, V.; Quintero, J.P.; Jiménez, A.; Muñoz, J.A.; Ibarz, A.(2011), Edible films and coatings: Structures, active functions and trends in their use. Trends Food Sci. Technol. , 22, 292–303. [CrossRef]

[46] Fenny.M.D.,Ayesha.N.N.Aprilyandi,Veinardi.S,Nisrina.S,(2020).Carrageenan Edible coating application prolongs Cavendish Banana shelf life. International Journal of Food Science.vol.11 pages. https://doi.org/10.1155/2020/8861610

[47] Furkan.A,H.I.Kahve,Mustafa.A.(2017).Lipid based edible films.The Journal of Scientific and Engineering Research 4(9):86-92.

[48] García MP, Gómez-Guillén MC, López-Caballero ME, Barbosa-Cánovas GV,

editors. (2016),Edible films and coatings: fundamentals and applications. Crc Press.

[49] Ghaidaa Alharaty and Hosahalli S. Ramaswamy ,(2020). The Effect of Sodium Alginate-Calcium Chloride Coating on the Quality Parameters and Shelf Life of Strawberry Cut Fruits. J. Compos. Sci. 2020, 4, 123; doi:10.3390/jcs4030123

[50] Ghasemnezhad, M., M.A. Shiri, and M. Sanavi. (2010), Effect of chitosan coatings on some quality indices of apricot (Prunus armeniaca L.) during cold storage. Caspian J. Environ. Sci. 9:25–33

[51] González-Estrada, R. R., P. Chalier, J. A. Ragazzo-Sánchez, D. Konuk and M. Calderón-Santoyo. (2017), Antimicrobial soy protein based coatings: Application to Persian lime (Citrus latifolia Tanaka) for protection and preservation. J. Postharvest Bio and Tech. 132: 138–144.

[52] Greener IK, Fennema O. (1992), Lipid-based edible films and coatings. Lipid Technol 4:34–8.

[53] Guilbert S, Gontard N, Cuq B. (1995),Technology and applications of edible protective films. Packaging Technology and Science.; 8(6): 339-46.

[54] Guimarães, A.; Abrunhosa, L.; Pastrana, L.M.; Cerqueira, M.A.(2018) ,Edible films and coatings as carriers of living microorganisms: A new strategy towards biopreservation and healthier foods. Compr. Rev. Food Sci. Food Saf. , 17, 594–614.

[55] Hardenburg RE. ,(1967),Wax related coatings for horticultural products.A bibilography,Agricultural Research Service Bulletin 51-55,United States Department of Agriculture,Washington,DC.

[56] Hashemi, S.M.B., and A. Mousavi Khaneghah. (2017), Characterization of novel basil-seed gum active edible films and coatings containing oregano essential oil. Prog. Org. Coat. 110:35–41. doi: 10.1016/j.porgcoat.2017.04.041.https://doi.org/10.20546/jcmas.2020.911.359.

[57] Javanmard.M,S.(2011).,Shelf Life Of Apples Coted With Whey Protein Concentrate-Gellan Gum Edible Coatings.Journal of Food Biosciences and Technology.,55-62.

[58] Jian Ju, Yunfei Xie, Yahui Guo, Yuliang Cheng, He Qian & Weirong Yao (2018), Application of edible coating with essential oil in food preservation, Critical Reviews in Food Science and Nutrition, DOI: 10.1080/10408398.2018.1456402.

[59] Joslin Menezes and K.A. Athmaselvi,(2016), Polysaccharide based edible coating on sapota fruit, Int. Agrophys., 2016, 30, 551-557 doi: 10.1515/intag-2016-0019.

[60] Khaliq, G., M.T. Muda Mohamed, A. Ali, P. Ding, and H.M. Ghazali. (2015),Effect of gum arabic coating combined with calcium chloride on physico-chemical and qualitative properties of mango (Mangifera indica L.) fruit during low temperature storage. Sci. Hortic. 190:187–194. doi: 10.1016/j.scienta.2015.04.020.

[61] Kharchoufi, S., L. Parafati, F. Licciardello, Muratore, G., Hamdi, M., Cirvilleri, G., & Restuccia, C. (2018),Edible coatings incorporating pomegranate peel extract and biocontrol yeast to reduce Penicillium digitatum postharvest decay of oranges. Food Microbiol. 74:107–112. doi: 10.1016/j.fm.2018.03.011.

[62] Khorram, F., A. Ramezanian, and S.M.H. Hosseini. (2017), Shellac, gelatin and Persian gum as alternative coating for orange fruit. Sci. Hortic. 225:22–28. doi: 10.1016/j. scienta.2017.06.045.

[63] Kittur, F.S., N. Saroja, and R.N. Habibunnisa Tharanathan. (2001), Polysaccharide-based composite coating

formulations for shelf-life extension of fresh banana and mango. Eur. Food Res. Technol. 213(4–5):306–311. doi: 10.1007/s002170100363.

[64] Kocira.A;Panasiewicz.K;Staniak,M,Szpunar-Krok,E,Hortynska,P.(2021).Polysaccharides as Edible films and Coatings:Characteristics and Influence on Fruit and vegetable Quality –A Review.Agronomy,11,813 https://doi.org/10.3390/agronomy11050813.

[65] Kra´sniewska, K.; Galus, S.; Gniewosz, M. (2020),Biopolymers-based materials containing silver nanoparticles as active packaging for food applications—A review. Int. J. Mol. Sci. , 21, 698 [CrossRef][PubMed]

[66] L.P.T.Quoc,D.P.Hoa,H.T.B.Ngoc,T.T.Y.Phi.(2015),.Effect of xanthan gum solution on the preservation of acerola(Malpighia glabra L.Cercetari Agronomics in Moldova.Vol XLVII,No.3(163)

[67] Le,Tien & Vachon,Mateescu,Mircea A& Lacroix,Monique.(2001),Milk protein coatings prevent oxidative browning of apples and Potatoes.Journal of Food Science.66.512-516.10.1111/j.1365-2621.2001.tb04594.x.

[68] Lorena.C.G,Leila .M.P,Claire.I.G.de Luca.S,Miriam .D.H.(2011),Effect of antimicrobial starch edible coating on shelf life of Fresh Strawberries.Packaging Technology and Science/Volume 25,Issue 7/ p413-425.https://doi.org/10.1002/pts.987

[69] M.S.Alam,S.Paul ,(2001),Efficacy of casein coating on storage behaviour of kinnow.Journal of Food cience and Technology-Mysore-38(3):235-238.

[70] Maqbool, M., A. Ali, P.G. Alderson, M.T.M. Mohamed, Y. Siddiqui, and N. Zahid.(2011),Postharvest application of gum arabic and essential oils for controlling anthracnose and quality of banana and papaya during cold storage. Postharvest Biol. Technol. 62(1):71–76. doi: 10.1016/j.postharvbio.2011.04.002

[71] Maria P. M.Garcia,M.Carmen G.G,M.Elvira Lopez-Caballero,Gustavo V,Barbosa-Canovas,(2016),Edible films and Coatings:Fundamental and Applications.CRC Press.Technology and Engineering.

[72] Milda E.Embuscado,Kerry.C.Huber,(2009.)Edible Films And Coatings For Food Applications.Springer Science & Business Media.Technology and Engineering.pg.1-25.

[73] Moreira, M.R., B. Tomadoni, O. Martín-Belloso, and R. Soliva-Fortuny. (2015), Preservation of fresh-cut apple quality attributes by pulsed light in combination with gellan gum-based prebiotic edible coatings. LWT-Food Sci. Technol. 64(2):1130–1137. doi: 10.1016/j.lwt.2015.07.002.

[74] Murmu, S.B., and H.N. Mishra.(2018).,The effect of edible coating based on Arabic gum, sodium caseinate and essential oil of cinnamon and lemon grass on guava. Food Chem. 245:820–828. doi: 10.1016/j.foodchem.2017.11.104.

[75] Natalia.S,Emma.S,OLanny.S,Karsono.S.P, (2014),Improving shelf life of Cavendish Banana using Chitosan edible coating.Elsevier B.V.doi: 10.1016/j.proche.2014.05.014.

[76] Neeta B. GOL, T.V. Ramana RAO.(2013), Influence of zein and gelatin coatings on the postharvest quality and shelf life extension of mango (Mangifera indica L.). Fruits, 2014, vol. 69, p. 101–115. DOI: 10.1051/fruits/2014002

[77] Olivas, G.I., D.S. Mattinson, and G.V. Barbosa-Cánovas. (2007), Alginate coatings for preservation of minimally

processed 'Gala' apples. Postharvest Biol. Technol. 45(1):89–96. doi: 10.1016/j.postharvbio.2006.11.018.

[78] Parafati, L., A. Vitale, C. Restuccia, and G. Cirvilleri. (2016), The effect of locust bean gum (LBG)-based edible coatings carrying biocontrol yeasts against Penicillium digitatum and Penicillium italicum causal agents of postharvest decay of mandarin fruit. Food Microbiol. 58:87–94. doi: 10.1016/j.fm.2016.03.014.

[79] Peretto, G., Du, W.X., Avena-Bustillos, R.J., De, J., Berrios, , Sambo, P. & McHugh, T.H. (2017).,Electrostatic and conventional spraying of alginate-based edible coating with natural antimicrobials for preserving fresh strawberry quality. Food and Bioprocess Technology, 10, 165–174.

[80] Perez-Gago .M.B, C.Rojas,M.D.Del Rio.(2006),Effect of HydroxypropylMethylcellulose-Lipid Edible Composite Coaatings on Plum(cv. Autumn giant) Quality During Storage.Journal of Food Science 68(3):879-883.DOI:10.1111/j.1365-2621..2003.tb08260.x

[81] Pramod K.Raghav,Nidhi.A,Mitu.Saini.(2016),Herbal Edible Coatings of Fruits & Vegetables:A Newer Concept.International Journal of Advanced Research 4(6):1452-1458.DOI: 10.2147/IJARO1/660.

[82] Quintavalla S, Vicini L.(2002),Antimicrobial food packaging in meat industry. Meat science.62(3): 373-80

[83] Raghav, P.K, Agarwal, N. & Saini, M. (2016), Edible coating of fruits and vegetables: a review. International Journal of Scientific Research and Modern Education, 1 (1), 2455–5630

[84] Raybaudi-Massilia, R.M., J. Mosqueda-Melgar, and O. Martin-Belloso. (2008), Edible alginate-based coating as carrier of antimicrobials to improve shelf-life and safety of fresh-cut melon. Int. J. Food Microbiol. 121(3):313–327. doi: 10.1016/j.ijfoodmicro.2007.11.010.

[85] Robles-Sánchez, R.M., M.A. Rojas-Graü, I. Odriozola-Serrano, G. González-Aguilar, and O. Martin-Belloso. (2013), Influence of alginate-based edible coating as carrier of antibrowning agents on bioactive compounds and antioxidant activity in fresh-cut Kent mangoes. LWT-Food Sci. Technol. 50(1):240–246. doi: 10.1016/j.lwt.2012.05.021.

[86] Rohant .K.D. and Ashutosh.U.(2018),Edible films and Coatings: a brief overview.Thr Pharma Innovation Journal;7(7):331-333.

[87] Roller S,Seeddar P.(2002),Caravcrol and cinnamic acid inhibit microbial growth in fresh cut melon and kiwifruit at 4 degrrees and 8 degrees C.Lett Appl Microbial;35(5):390-4.doi:10.1046/j.1472-765x.2002.01209.x.PMID:12390487

[88] Saberi, B., J.B. Golding, J.R. Marques, Pristijono, P., Chockchaisawasdee, S., Scarlett, C. J., & Stathopoulos, C. E. (2018), Application of biocomposite edible coatings based on pea starch and guar gum on quality, storability and shelf life of 'Valencia' oranges. Postharvest Biol. Technol. 137:9–20. doi: 10.1016/j.postharvbio.2017.11.003

[89] Salehi, F., M. Kashaninejad, and A. Jafarianlari. (2017), Drying kinetics and characteristics of combined infrared-vacuum drying of button mushroom slices. Heat Mass Transfer 53 (5):1751–1759. doi: 10.1007/s00231-016-1931-1.

[90] Salvia-Trujillo, L.; Soliva-Fortuny, R.; Rojas-Graü, M.A.; McClements, D.J.; Martín-Belloso, O. (2017) ,Edible nanoemulsions as carriers of active ingredients: A review. Annu. Rev. Food Sci. Technol. , 8, 439–466.

[91] Sánchez Aldana, D.; Contreras-Esquivel, J.C.; Nevárez-Moorillón, G.V.; Aguilar, C.N.(2015) ,Caracterización de películas comestibles a base de extractos pécticos y aceite esencial de limón Mexicano. CYTA J. Food , 13, 17–25.

[92] SenturkParreidt T, Schmid M, Müller K. (2018),Effect of dipping and vacuum impregnation coating techniques with alginate based coating on physical quality parameters of cantaloupe melon. Journal of food science.83(4): 929-36.

[93] Shahidi F. (2000),Antioxidants in food and food antioxidants. Food/nahrung.44(3): 158-163.

[94] Sharma, S., and T.V.R. Rao.(2015),Xanthan gum based edible coating enriched with cinnamic acid prevents browning and extends the shelf-life of fresh-cut pears. LWT - Food Sci. Technol. 62(1, Part 2):791–800. doi: 10.1016/j.lwt.2014.11.050.

[95] Suhag, R., Kumar, N., Trajkovska Petkoska, A., Upadhyay, A., (2020),Film formation and deposition methods of edible coating on food products: A review, Food Research International , doi: https://doi.org/10.1016/j.foodres.2020.109582

[96] Susmitha Reddy.K and Jatinder.S,(2020),Edible coatings in fruits-A review.International Journal of Current Microbiology and Applied Sciences.ISSN:2319-7706.V0l.9,No.11.

[97] Tavassoli-Kafrani, E., Shekarchizadeh, H. &Masoudpour-Behabadi, M. (2016),Development of edible films and coatings from alginates and carrageenans. Carbohydrate Polymers, 137, 360– 374.

[98] Togrul H, Arslan N. (2005),Carboxymethyl cellulose from sugar beet pulp cellulose as a ˘ hydrophilic polymer in coating of apples. J Food Sci Technol 42:139–44.

[99] Valdés, A., Ramos, M., Beltrán, A., Jiménez, A. & Garrigós, C.M. (2017), State of the art of antimicrobial edible coatings for food packaging applications. Coatings, 7 (56), 1-23.

[100] Valero, D., H.M. Díaz-Mula, P.J. Zapata, Guillén, F., Martínez-Romero, D., Castillo, S., & Serrano, M. (2013),Effects of alginate edible coating on preserving fruit quality in four plum cultivars during postharvest storage. Postharvest Biol. Technol. 77:1–6. doi: 10.1016/j. postharvbio.2012.10.011.

[101] Vargas-Torres, A.; Becerra-Loza, A.S.; Sayago-Ayerdi, S.G.; Palma-Rodríguez, H.M.; de Lourdes García-Magaña, M.; Montalvo-González, E. (2017),Combined effect of the application of 1-MCP and different edible coatings on the fruit quality of jackfruit bulbs (Artocarpus heterophyllus Lam) during cold storage. Sci. Hortic., 214, 221–227.

[102] Velickova, E., E. Winkelhausen, S. Kuzmanova, V.D. Alves, and M. Moldao-Martins. (2013), Impact of chitosan-beeswax edible coatings on the quality of fresh strawberries (Fragaria ananassa cv Camarosa) under commercial storage conditions. LWT-Food Sci. Technol. 52 (2):80–92. doi: 10.1016/j.porgcoat.2017.04.041.

[103] Vyas.P.B,Neeta.B.Goi,T.V.Ramana Rao.(2013),Postharvest Quality Maintenanace Of Papaya Fruit Using Polysaccharide-Based Edible Coatings.Internationational Journal Of Fruit Science.Volume 14-Issue 1.https://doi.org/10.1080/15538362.2013.801753.

[104] W.Mahhfuzah.W.I.,N.Dalila.N.D.,Hanif.M. A.,Siti.A.H,N.Hanis.A.Yusoff.,W.MohdReza.I. W.Husin.(2020),Study on efficacyof edible protein based fruit coating to delay the ripening of banana(MUSA

SPP.).International Journal of Agriculture,Forestry and Plantation.Vol.10.ISSN 2462-1757

[105] Williams, P.A., and G.O. Phillips. (2000), Introduction to food hydrocolloids. In: G.O. Phillips and P.A. Williams (eds.). Handbook of hydrocolloids (pp. 1-19). CRC Press, New York, NY

[106] Win, N.K.K., P. Jitareerat, S. Kanlayanarat, and S. Sangchote. (2007), Effects of cinnamon extract, chitosan coating, hot water treatment and their combinations on crown rot disease and quality of banana fruit. Postharvest Biol. Biotechnol. 45(3):333–340. doi: 10.1016/j. postharvbio.2007.01.020

[107] Zambrano-Zaragoza, M.L., D. Quintanar-Guerrero, A. Del Real, E. Piñon-Segundo, and J. F. Zambrano-Zaragoza. (2017), The release kinetics of β-carotene nanocapsules/xanthan gum coating and quality changes in fresh-cut melon (cantaloupe). Carbohydr. Polym. 157:1874–1882. doi: 10.1016/j.carbpol.2016.11.075.

[108] Zillo.R.R,Porrelli.P,Moreira da.S,Jacqueline de.O,Gloria.E.M,Marta H.F.S.(2018),Carboxymethylcellulose coating associated with essential oil can increase papaya shelf life.Scientia Horticulturae.Volume 239,Pg 70-77.https:// doi.org/10.1016/j.scienta.2018.05.025