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RESEARCH ARTICLE

Herbal Edible Coatings of Fruits & Vegetables: A Newer Concept.

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Abstract

Post-harvest loss of fresh produces is a serious problem due to rapid deterioration during pre & post-harvest conditions. It is affecting the quality of fruits & vegetables. The application of edible coatings on fruits & vegetables is an effective method to improve their quality &thus, increase shelf-life. It can be safely eaten as a part of food. Presently there has been increased interest in using herbal extract such as lemongrass, oregano, Aloe vera, tulsi, mint, neem, cinnamon & clove as an edible coating material for fruits & vegetables driven by its beneficial properties. Herbs based edible coatings have been shown to prevent water loss, control ripening process & respiration rate, delay oxidative browning & reduce microbial growth in fruits & vegetables such as grapes, papaya, orange, cucumber, tomato, apple & mango. These herbal edible coatings increased the shelf-life of fresh produce & it also increased storage time of 15-35 days at low temperature whereas all uncoated fruits & vegetables decayed within 8-10 days. Thus herbal extracts are being increasingly studied as additive in edible coating on fruits & vegetables which would be an interesting & innovative for commercial application & an alternative to the use of post-harvest chemical treatment leading to the increment of shelf-life of fruits & vegetables.

Introduction:-

The fresh produce is harvested seasonally in high quantity throughout the whole world and these are mostly stored at suitable temperature until sell to the market and consumed by the consumers. The fresh fruits and vegetables consumption increase day by day due to their health benefits (Huxley et al., 2004). Some organizations like USDA, WHO, FAO are recommended to increase consumption quantity of fruits and vegetables which is helpful to reduce the risk of many diseases (Gatto, 2011).

About 35-40% fruits and vegetables are lost during post-harvest conditions (Kumar & Bhatnagar, 2014). Fresh fruits and vegetables are livingbeingswhich have high moisture content (75-95%) and which continue respiration thereby producing heat and water at the expense of reserve food (Mishra and Gamage, 2007). After harvesting, fresh fruits and vegetables cannot replenish water or carbohydrates. The fresh produce use stored sugar or starch in respiration process and will stop when such reserve become finished. As a result, ageing begins and culminating fruits and vegetables to death and decay (FAO, 1993).

Post-harvest loss of fruits and vegetables is a serious problem due to rapid deterioration during harvesting, transportation, handling and storage condition in tropical regions (Gatto, 2011; Terry and Joyce, 2004). So maintaining the quality of fresh fruits and vegetables is a big challenge. Packaging is mostly used for preservation of fruits and vegetables. It is widely used in combination with other preservative techniques (Hoover, 1997). However, disposal and recycling of packaging material leads to environmental problems (Vina et al., 2007).

Recently edible coatings are one of the most useful innovations for extending the shelf life of fresh fruits and vegetables. Edible coatings act as barrier to gases (O_2 and CO_2) and moisture; produce similar effects to storage as in controlled atmosphere (Park, 1999).

Edible coatings:-

Edible coatings are thin layers that improve product quality which covers the surface of the food and it can be safely eaten as a part of the whole food. So, the composition of edible coatings has to be food grade or Generally Recognized as Safe ((Baldwin, 1994; Ahvennainen, 1996; Kester & Fennema, 1986).

Edible coatings are new technique which is used to increase shelf life of whole or fresh-cut fruits & vegetables. Edible coatings have been developed for quality maintenance of fresh fruits and vegetables by preventing changes in color, aroma, appearance, taste & texture (Tharanathan, 2003). Edible coatings are usually made from materials such as polysaccharides, proteins and lipids; the polysaccharides used in edible coatings are starches and modified starches, chitosan, alginates, gums, cellulose derivatives and Pectins (Krochta& Johnson, 1997).

Edible coatings provide a barrier against external elements and therefore enhance shelf life of fresh produce (Guilbert et al., 1996) by reducing water loss and gas exchange. The first kind of edible coatings were water–wax micro emulsions, used since the 1930s to increase brightness and color in fruits, as well as fungicide carriers (Saltveit, 2003). Water loss is another problem that can be controlled with edible wax coatings. Edible waxes can also offer protection against cold damage under storage (Debeaufort et al., 1998).

Herbal extract used in edible coatings:-

Recently, Edible coatings are prepared by the mixing extracts of herbs such as Thyme (*Thymus vulgaris*), cinnamon (*Cinnamon cassia*), Oregano (*Origanum vulgare),* Lemon grass (*Cymbopogon citratus*), neem (*Azadirictica indica*) and *Aloe vera* (Chauhan et al., 2014; Padmaja & Bosco, 2014; Zinoviadou et al., 2009). The herbal extracts containing antimicrobial, antioxidant and therapeutic properties; it also acts as a nutraceutical. Lower oxygen permeability had been observed in films that contained lemon grass, cinnamon oil, and oregano than in those that contain its antibacterial compounds Citral, cinnamaldehyde and Carvacrol, respectively (Rojas-Grau et al., 2006 and Rojas-Grau et al., 2007a). The common herbs used in edible coatings are as follows-

- ***Aloe vera*:** At present*Aloe vera* extract is used in edible coatings on large scale for increasing the shelf-life of fruits and vegetables (Martinez- Romero et al., 2006). *Aloe vera* has medicinal properties and it is a semi-tropical plant. The *Aloe vera* had two type of gel one is 'yellow latex (exudate)' and other is 'clear gel (mucilage)', which is found in parenchymatus cells (Ni et al., 2004).

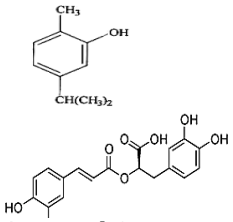
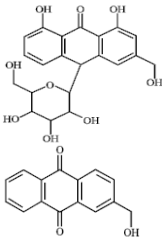
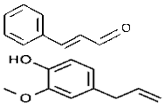
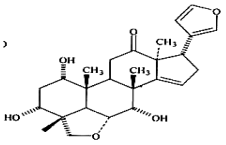
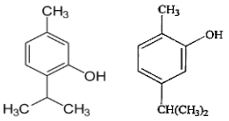
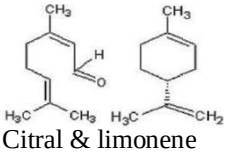
Aloe vera containsmany beneficial complex components including glycoproteins, polysaccharides, salicylic acids, phenolic compounds, lignins, amino-acids, vitamins, saponins and enzymes which provide *Aloe vera* its many beneficial properties. The main component of *Aloe vera* extract is "Aloin and Aloe-emodin". *Aloe vera* extract is used as anti-fungal, anti-bacterial, anti-inflammatory (Serrano et al., 2006). *Aloe vera* gel based edible coatings are good moisture and gas barrier.

Chauhan et al., (2014)analyzed theeffects of biodegradable Aloe vera gel coating on Grapes fruits and determined antifungal and antibacterial properties of *Aloe vera*gel against pathogenic microbes. *Aloe vera* gel improves the texture of fruits and vegetables by suppressing respiration, reducing microbial growth and retaining volatile flavor components; it also increases the shelf-life of grapes fruits for 40 days.

Aloe vera gelalso prevent softening, oxidative browning and reduced the risk of microbial contamination in fruits and vegetables such as apple, banana, cherries, grapes and papaya (Ahmad et al., 2009; Valverde et al., 2005; Martinez- Romero et al., 2006; Marpudi et al., 2011).

- **Neem (*Azadirictica indica*):**Neem is a medicinal and also a non-toxic plant which possesses excellent antimicrobial properties.Baswa et al., (2001) and Mahfuzul Hoque et al., (2007)determined the antibacterial properties of neem extract and neem oil against pathogenic micro-organism such as Salmonella, Staphylococcus, E. coli, Vibrio and other microbes.Neem has active components mainly Azadirachtin and Nimbidin and Nimoid. These components act as an antimicrobial agent in neem extract.

Table (i): Important constituents and properties of herbs

S. No.	Herb's name	Active component	Structure	Properties	References
1.	Oregano ((*Origanum vulgare)*) Extract & oil.	Carvacrol& Rosmarinic acid	 Carvocrol & Rosmarinic acid	Antimicrobial and antioxidant.	De-Falco et al., 2013
2.	*Aloe vera*	Aloin & aloe-emodin	 Aloin & Aloe-emodin	Antimicrobial, antioxidant and inhibitory properties against micro-organism.	Eugene Sebastian et al., 2011
3.	Cinnamon (*Cinnamon cassia*) - Extract	Cinnamaldehyde, Eugenol	 Cinnamaldehyde & Eugenol	Antioxidant and Inhibitory properties against microbes.	Vangalapati et al., 2012
4.	Neem (*Azadirictica indica*) - Extract & oil.	Nimbidin & Azadirichtin	 Nimbidin	Antimicrobial	BOSTID, 1993.
5.	Thyme (*Thymus vulgaris)*- Extract& oil.	Carvacrol	 Thymol &Carvacrol	Antibacterial, antifungal & antioxidant	Kokate et al., 2009
6.	Citrus fruits (Essential oil)	Citric acid & citral	 Citral & limonene	Antifungal and antibacterial	Shah et al., 2011

Neem oil and extract are also used as an antimicrobial agent in edible coatings. Neem extract is used in many biodegradable edible coating for applying on fruits and vegetables to enhance their shelf-life (Rao, 1990). Chauhan et al., (2014) reported in his study that the neem extract had excellent antimicrobial property and it extend the storage life of Apple for 45 days.

- **Tulsi (*Ocimum sanctum*):** Tulsi is the most sacred herbal plant of India and is also called "Queen of Herbs". Ocimum belongs to the Lamiaceae family and important for their therapeutic potentials (Kumar et al., 2011). Tulsi have many constituents such asalkaloids,tannins, saponins, glycosides and aromatic compounds. It is also used in the treatment of many diseases. The main constituents of tulsi extract and oil are linalool, Eugenol, carvacrol, camphor, methyl cinnamate and β-caryophyllene. Therefore, it was used in enhancement of shelf-life of fruits and vegetables (Reuveniet al., 1984 and Kayastha, 2014).

The therapeutic uses of Tulsi extract or oilis as old as 4000-5000 BC; are safe and effective as their ease of availability(Kumar et al., 2011; Mongaet al., 2011). The extract and oil of Tulsi had many beneficial properties such as antibacterial, antifungal; antiviral, antioxidative, insecticidaland it also act as antioxidative agents(Chogoet al., 1981; Reuveniet al., 1984 and Kayastha, 2014).

- **Cinnamon (*Cinnamon cassia*):** Cinnamon is a spice and it has good antimicrobial, antioxidative and inhibitory properties against pathogenic microbes. It is natural food additive used as flavoring agent and preservative which prevent the growth of bacteria and fungi (Roller & Seedhar, 2002). Cinnamon mainly contains are cinnamaldehyde, Eugenol, camphor and caryophyllene oxide.Cinnamon as an antimicrobial agent has been evaluated in fresh-cut apple slices (Muthuswamy et al. 2008).

The cinnamon bark has ethanol extract (1.5-2% w/v) and cinnamic aldehyde, which reduced the gram-negative& gram-positive bacteria in fresh cut apples and increased the storage life for 12 days at 6°C (Muthuswamy et al. 2008).

Cinnamic acid and Carvacrol reduced the microbial spoilage of kiwifruit and fresh-cut melon. The treatment with carvacrol or cinnamon acid also reduced viable counts on kiwifruit by 4 and 1.5 log CFU/g for 5 days of storage at 4°C & 8°C, respectively (Roller & Seedhar, 2002).

Table(ii): Role of Herbs in extending shelf-life of fruits and vegetables-

S. No.	Herbal component	Edible coating material	Fruits and Vegetables	Quality improvement of food	References
1.	Cinnamon, palmarosa and lemongrass oils	Alginate based	Fresh cut Melon	Improve shelf life of fresh-cut melon from micro-biological (up to 9.6 days) and physicochemical (>14 days)	Raybaudi-Massilia et al. (2008)
2.	Green tea extract	Tapioca starch/ decolorized hsian-tsao leaf gum	Fruit-based salads, romaine heart sand pork slices	Pronounced antimicrobial activity on Gram positive bacteria	Chiu and Lai (2010)
3.	Lemongrass, oregano oil and vanillin	Apple puree, alginate	Fresh cut Apple	All coatings significantly inhibited growth of psychrophilic aerobes, yeasts and moulds	Rojas-Graü et al. (2007)
4.	Aloe vera gel	Glycerol, Tween 80	Tomato,	Delay the ripening process & shelf life extend 39 days.	Athmaselvi et al., (2013)
			Apple	Increase shelf-life and act as a bio-preservative.	Ergun & Satici, (2012)
		Pectin	Jujube fruit	Extending shelf-life 45 days under refrigerated temperature and 21 days ambient temperature.	Padmaja & Bosco, (2014)
		Ascorbic acid, citric acid	Table Grapes	Reduce weight loss, browning, cracking and decrease fungal & bacterial count.	Chauhan et al., (2014)

5.	Lemongrass & peppermint oil	Gelatin	Zaghloul date palm	Reduce weight loss and decay	El-Moneim et al., (2015)
6.	Cinnamon leaf essential oil	Pectin (3%) + glycerol	Peach (*Prunus persica*)	Antimicrobial, antioxidant activity. Odour acceptability up to 10 days (5 °C)	Ayala-Zavala et al., (2013)
7.	Turmeric	Casein, polyvinyl and propylene glycol alcohol	Carrot	Inhibition of coliforms growth extending shelf -life for 7 days	Jagannath et al., 2006

- **Other important extracts:** The other herbs like mint, peppermint oil, lemongrass, turmeric, green tea extract, marigold, thyme, clove oil, basil extract and garlic extract were also used in edible coatings applying on fruits and vegetables (Baranauskien et al., 2007; Chauhan et al., 2014; Chiu & Lai, 2010;Del Toro-Sánchez et al., 2010). These herbal coatings were enhancing their shelf-life, storage time for 20-35 days at low temperature and they are excellent barrier of gases & moisture (Kumar and Bhatnagar, 2014).

Lemongrass oil had been used with alginate, Gelatin, apple puree& chitosan applied on fresh cut melon, fresh cut apple, date palm, papaya and mango. It improves the quality of fruits and extends their shelf-life for three weeks (Chiu & Lai, 2010; El-Moneim et al., 2015).

Conclusion:-

Today,edible coatings are alternative source to increase shelf life of fresh produce as compare to other preservation techniquesdue to their eco-friendly nature. Generally, edible coatings are made up of proteins, lipids& polysaccharides; not only they act as good barriers to moisture & oxygen during processing, handling& storage but also increase its safety due to their natural bioactive component.

Recently, herbal extracts such as neem, Aloe vera, oregano, cinnamon, clove, mint & peppermint are used in edible coatingsof fresh produce as they possess several beneficial properties. They have been shown to prevent water loss, control respiration rate & ripening process, reduce microbial growth & delay oxidative browning in fruits & vegetables.Thus the various scientific reports showed that using herbs based antimicrobial coating in fruits and vegetables such as papaya, oranges, grapes, cucumber, tomato, cherry's, apples, oranges etc. provide promising results.The herbal edible coated fruits & vegetables act as a nutraceutical & also act as a medicine. Therefore,herbal edible coatings are a promising concept because of their non-toxic & eco-friendly nature. That's why herbal edible coatingsincrease the market value of fruits & vegetables.

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