ALOE VERA: AN ALTERNATIVE TO CHEMICAL PRESERVATIVES FOR FRUITS AND VEGETABLES – A REVIEW.

Pravanchana Singh*[1], Anish Fatima*[2], Dr. Jyoti Tyagi*[3], Dr. Swati Tyagi*[4]

*[1,2]*Student, Department Of Microbiology, Faculty Of Life Sciences, Institute Of Applied Medicines And Research, Duhai, Ghaziabad, Uttar Pradesh India.*

[*3,4]Assistant Professor, Department Of Microbiology, Faculty Of Life Sciences, Institute Of Applied Medicines And Research, Duhai, Ghaziabad, Uttar Pradesh India.

ABSTRACT

All over the world, demand for food without any chemical preservatives is increasing day by day. Therefore, biologists are focusing to develop new natural preservatives to Reinforce the food quality and also by fulfilling the necessities. New technological advances hold a promise in extending the shelf life of the edibles, reducing the layers of packaging, meeting the food safety and quality requirements. Most of the Emerging researches shows that enzymes polysaccharides, essential oils, bacteriocins, proteins and lipids are the natural coatings that can be used in food preservation. Recently, interest has increased in *Aloe vera* gel-based edible coating material. *Aloe vera* gel coatings is biologically safe for different types of foods. It is easy to apply because of its film-forming properties, which is quite unique. It also possess antimicrobial actions, degradability and few immunological properties. Main component of *Aloe vera* is polysaccharide which acts as a natural barricade for the main emissaries of deterioration which are moisture and air. It also extends durability of the fruits and vegetables by reducing the rate of respiration and maintains quality aspects(color, flavor, rigidness etc.). It shows antifungal and antibacterial properties which provides a protective barrier against microbes which are responsible for contamination of edibles. The present review describes the Importance of natural coatings, why should they be used in place of chemical preservatives, preparation of the *Aloe vera* gel for coating, antimicrobial and antioxidant properties and various application of *Aloe vera* gel coatings to enhance the quality as well as post-harvest life of fruits and vegetables.

Keywords: *Aloe vera* gel, preservation, edible coating, fruits, postharvest life, shelf life, antibacterial properties.

INTRODUCTION

Since the issues of food-derived health has begun to increase, It is necessary to provide food of high quality, unescorted by chemicals. People are now switching towards natural methods of preservation and highly accepting chemical free products. Therefore, new natural preservatives and antimicrobials are being developed (Lin D *et al*. 2007). Fruits and vegetables are highly consumed all over the world. For its continuous supply, better storage and well applied natural preservation methods are being used. There are three main features which describes the quality of food: External (shape, color, appearance, etc.,), Internal (taste, texture, juice, etc.,), Hidden (food safety and nutritional value) (Cordenunsi *et al*. 2003*)*. Fungicides and other agrochemicals like bactericides are highly effective

against pathogenic as well as other microbes which deteriorates the quality of fruits and veggies. But their effective and continuous usage leads negative and harmful effects on human health (Coulibaly O *et al.* 2011).

Many storage techniques have been developed, among them the safest and easiest method is the use of edible coatings (Baldwin *et al*. 1995). In recent years, edible coatings have received a great recognition and acceptance due to their various advantages which mainly includes the edible packaging which is better than the synthetic one. Edible coatings are the thin edible layer of edible material which is applied to the surface of products as a replacement of chemical loads, so that the product can achieve a barrier to moisture, oxygen, solute movement for the food and microbial activity (mainly fungus) (Avena *et al*. 1997). The application of these coatings is done on the food surface directly by dipping, spraying, brushing (Mchugh *et al*. 2000). These coatings provide a better atmosphere to the merchandise and also reduce weight loss of food during transport and storage. Also acts as a barrier to the environment and protect the food from microbial attacks and oxidation.One of the prominent plants in the process of coating food is *Aloe vera*. Many researches have been conducted on the plant to determine the antioxidant and antimicrobial properties of *Aloe vera*. The gel of *Aloe vera* leaves are tasteless, odorless, colorlessand sticky in nature. This natural product is safe, eco-friendly and edible. This gel is used with a combination of mechanics (Serrano *et al*. 2006). Aloe gel layer helps to reduce the rate of respiration and transpiration of fresh produce and helps in the delay of post-harvest deterioration (Kahramanog lu *et al.* 2017). Aloe gel is potentially utilized in food industries, the ability of gel is maximally used in stable conditions. The results of a research proved that aloe gel can withstand the rate of respiration and some physiological changes due to maturation of fruits and vegetables (Valverde *et al.* 2006).

Table 1: Constituents of *Aloe vera* gel (Sikandar *et al*. 2016)

Constituent of Aloe vera	**Examples**
Carbohydrates	Cellulose, Hemicellulose, storage polysaccharides, galactose
Anthraquinones	Aloin, aloe-emodin, aloetic acid, anthranol, barbaloin
Enzymes	Catalase, amylase, oxidase, cellulose, lipase, carboxypeptidase,
Saccharides	Mannose, Glucose, Aldo-Pentose, L-Rhamnose
Mineral	Calcium, chlorine, chromium, potassium, phosphorus, zinc etc.,
Vitamins	A, C, E, B1, B2, B6, B9, Folic acid, choline
Lipids	Cholesterol, lupeol, beta sitosterol, triglycerides, triterpenoid
Amino acids	Alanine, arginine, aspartic acid, glycine, histidine etc.,

NEED OF EDIBLE COATINGS:

Edible coatings have a number of advantages over synthetic coatings. Some of the advantages are as follows:

- Edible films are a great barrier against gases and moisture that creates modified atmosphere within the fruit or vegetable, which in turn extends the shelf life. It also retains the quality of fruits and vegetables.
- These naturals coatings also create a barrier against the microbial attacks and hence prevents microbial invasion.

- It does not compromise with the nutrition. Several active ingredients such as anti-browning agents, colorants, flavors, nutrients, spices can be incorporated into the polymer matrix and consumed with the fruit and vegetable, thus enhancing safety or even nutritional and sensory attributes (Mahajan *et al.* 2017).

ALOE VERA PLANT:

Aloe vera plant is a luscious plant species belongs to the genus aloe. The *Aloe vera* plant has been known for centennials for its medicinal, beauty and skincare properties. According to its name 'Aloe' means 'shiny bitter substance', while 'vera' means 'true'. The scientific name of *Aloe vera* is *Aloe barbadensis miller*. It belongs to Asphodelaceae (Liliaceae) family. *Aloe vera* is also named as plant of immortality due to its brilliant properties. The transparent gel from Aloe leaves is of pharmacological importance. This plant had been traditionally used in skin treatment also it has many other therapeutic properties like anticancer, antioxidant, antihyperlipidemic and antidiabetic. *Aloe vera* has more than 75 different compounds including vitamin (A, C, E and B12), minerals (i.e., calcium, zinc), enzymes (amylase, catalase, peroxidase), sugar (monosaccharides such as mannose-6-phosphate and polysaccharides like glucomannas), hormones (auxins and gibberellins), anthraquinones (aloin, emodin), fatty acids and others (salicylic acid, lignin, saponins) (Surjushe *et al*. 2008), (Malik *et al.* 2008), (Maan *et al*. 2018). *Aloe vera* leaf are extreme source of many useful compounds. And it is a great dietary source of many amino acids.The *Aloe vera* plant can be grown easily by removing 2-3 leaves per plant. It also grows flowers of Red, yellow colored with strips grows in 4 years on a long stalk from the center.

Fig 1: *Aloe vera* plant having green and fleshy leaves.

ANTIOXIDANT PROPERTIES OF *Aloe vera*

Antioxidants are the compounds that inhibits oxidation. Oxidation is a chemical reaction that can produce free radicals, there by leading to chain reaction that may damage the cells of organism. Antioxidants such as thiols or ascorbic acid terminates these chain reactions (Cook., 2008).

Application of antioxidants has become a necessity for food products to prevent food degradation via., oxidation. Chemical oxidants are highly effective (e.g., BHA, BHT, TBHQ), but they are not good for health. This has increased the demand of natural ingredients in processed food. Keeping the demand in focus natural compounds with antioxidant capacities are in popular use (Marzanna *et al*. 2019).

This group includes plants having positive effects on human body like vegetables, fruits, tea, spice and herbs. The high content of antioxidant vitamins such as A, C, E, carotenoids and phenolic compounds in these raw materials enables them to become a source of effective and safe natural antioxidant additives that reduce lipid oxidation. (Shahidi *et al.* 2010), (Duthi G *et al*. 2013).

DIFFERENT TYPES OF ANTIOXIDANTS

1. Free radical scavenger- Block of the radicals by donating a Hydrogen Atom. E.g., BHA, BHT, TBHQ, Propyl gallate, Tocopherols

2. Oxygen scavengers and reducing agents- Reacts with oxygen. E.g., Ascorbic acid, Erythorbic acid, Sulphites, Bisulphite, Ascorbate.

3. Chelating agent- EDTA, Citric acid, Amino acid. (Embuscado 2015), (Thorat 2013).

POTENTIALLY ACTIVE CHEMICAL COMPOUNDS:

FROM THE GEL:

1. Polysaccharides: Acemannan, Glucomannan.

2.Other: Carboxypeptidase, Magnesium, Zinc, Calcium, Glucose, Cholesterol, Salicylic Acid, Prostaglandin precursors (gamma linolenic acid [GLA]), Vitamins A, C, E, Lignin, Saponins, Plant Sterols and Amino acids (Atherton 1998).

FROM THE LATEX LEAF LINING:

3. Anthraquinone glycosides: Aloin, Aloe-emodin, Barbaloin.

ANTIMICROBIAL ACTIVITIES OF *Aloe vera*

Studies have shown that *Aloe vera* has antimicrobial properties. Antimicrobials are those which are able to kill or inhibit the growth of microorganisms (Habeeb *et al*. 2007). *Aloe vera* plant contains 6 antiseptic agents due to which it shows some powerful properties against some microbes. The agents are as follows: Urea, Lupeol, nitrogen, salicylic acid, cinnamomic acid, sulfur and phenols. These agents act as a growth inhibitors for fungi, bacteria and viruses. Acemannan acts alone and synergistically with Azidothymidine (AZT) acyclovir to block reproductive cycle of dangerous viruses like Herpes virus and the AIDS virus (Kahlon *et al*. 1991). Antifungal Aloe extract treatment of guinea pig feet that had been infected with *Trichophyton mentagrophytes* resulted in a 70% growth inhibition compared with untreated animals (Kawai *et al.* 1998). Some studies has also been reported which suggests that aloe gel may possess some effective benefits in Cancer Chemoprevention (Surjushe A *et al*. 2008), (Kim HS *et al*. 1997), (Kim HS *et al.* 1999).

Anthraquinones presented antimicrobial activities against *Staphylococcus aureus* and *Escherichia coli* through the inhibition of the solute transport in membrane (Hammam *et al*. 2008), (Lone *et al*. 2009). It was reported that Emodine shows potential against several Gram-positive bacteria (Cock., 2008). The gel of *Aloe vera* plant shows a great spectrum against many food-borne pathogens such *as Bacillus cereus, Escherichia coli, Salmonella typhimurium, Klebsiella pneumoniae*, etc., (Shelton *et al*. 1991). It also acts against some pathogenic Fungi like *Fusarium oxysporum, Aspergillus niger.*

Aloe vera AS FRUIT AND VEGETABLE COATING:

Aloe vera gel is being used for fruit and vegetable coatings. This acts as a preservative which helps to prevent deterioration of the edibles. It's a great replacement for chemical preservatives and packaging. This also helps in reducing the use of Carbides, harmful plant growth hormones and toxic chemicals.

S.no	Fruits and Vegetable	Coating used/ treatment with edible coating	References
1.	Table Grapes	Solution of *Aloe vera* diluted with distilled water	(Asghari *et al*. 2013)
2.	Papaya	Treatment with *Aloe vera* gel along with ascorbic and citric acid	(Marpudi *et al*., 2011)
3.	Tomato	*Aloe vera* gel	(Athmaselvi *et al.* 2013)
4.	Grapes	*Aloe vera* gel	(Chauhan *et al*. 2014)
5.	Mango	Chitosan, *Aloe vera*	(Chauhan *et al*. 2014)
6.	Oranges	*Aloe vera*, Ascorbic acid and citric acid	(Arowora *et al*. 2013)
7.	Fig Fruit	*Aloe vera* coating	(Marpudi *et al*. 2013)
8.	Strawberries	*Aloe vera* gel or chitosan	(Nasreen *et al*. 2017)
9.	Guava	*Aloe vera* gel coating	(Akbar Anjum *et al*. 2020)
10.	Banana	*Aloe vera* gel enriched with garlic essential oils	(Ghulam *et al*. 2019)
11.	Egg plant	*Aloe vera* gel coating	(Sikandar *et al*. 2016)
12.	Button Mushroom	*Aloe vera* gel coating	(Mohebbat *et al*. 2011)

Table 2: Edible coatings of *Aloe vera* gel.

PREPARATION OF *Aloe vera* GEL MATRIX

Fresh leaves are required for the preparation of the gel matrix. Fresh leaves are harvested, the gel lies beneath the leaves. The leaves are cut carefully in vertical direction and the gel matrix was separated. The gel id grounded in a blender. Then the mixture was filtered, so that the fibers can be removed from it. The gel was pasteurized at 70° C for 45 minutes (Maughan *et al.* 1984). After pasteurization, the former preparation was cooled down immediately. For coating purpose, the gel was thickened using 1% gelling agent. Now the fruits or vegetables are finally coated by dipping, brushing or spraying (Jawadul *et al*. 2014).

EFFECT OF GEL COATING ON PROPERTIES OF FRUITS AND VEGETABLES

1.Weight loss

Weight loss happens due to the loss of water by the process called transpiration and loss of carbon reserve due to respiration (Voglar *et al*. 1999). The rate of loss of water depends on the water pressure gradient between the fruits tissue and the environment. Hence the Aloe gel coating acts as a barrier between the environment and wall of fruits, thereby prevents the transfer of water and protect the fruit from mechanical injury. This was done on Papaya (Brishti *et al*. 2013), Grapes (Tripathi *et al.* 2004), pine apple (Lin *et al*. 2007), Sweet cherry (Martinez *et al*. 2006), Granny

Smith and Red Chief apples (Ergun *et al*. 2012). It was also recorded that *Aloe vera* also retard the production of ethylene, which helps in delay ripening of fruits (Ibrahim *et al.* 2019).

2. **Color**

Appearance decides the first key impression and is a compulsory feature in the choice of fruits and veggies. Hence, color is the most important attribute for fruits. According to a research, Apples were treated with *Aloe vera* gel which resulted in the delay of color loss on the fruit skin of apples which were stored at 2°C for 6 months (Ergun *et al.* 2012). The better surrounding created by *Aloe vera* gel coating prevents the rate of ethylene production rate, therefore, ripening of fruits get delays, chlorophyll degradation, and carotenoids synthesis thus ultimately delaying color change of fruits (Carrillo Lopez *et al.* 2000).

3. **Total soluble solid, Titrable acidity and Ascorbic acid**

Fruits and vegetable are the basic food taken by all of us. They help in maintaining human health. Fruits are a rich source of various vitamins minerals and carbohydrate. A research reported that *Aloe vera* coating to lower the TSS (Total Soluble Solid) and a greater TA content (titrable acidity) retention in berries which were coated, this indicated that the uncoated (control) fruits presented more maturation and development than the coated berries during the storage time (Tripathi *et al*. 2004)

In case of oranges, coated one and uncoated, there were no such differences in TSS and TA content of fruits during storage time. Ascorbic acid value for coated fruit was higher than the uncoated one (Arowora *et al.* 2013). Some studies also found that the content of ascorbic acid was higher than the control (uncoated) fruit (Jawadul Misir *et al.* 2014).

4. Decay Percentage

Decay Percentage simply calculates the time taken by a fruit or a vegetable to retard and loose its firmness and freshness with time and action of microbes. Decay percentage means to observe the effectivity of coated material on fruit to retard fruit disease. *Aloe vera* successfully reduces microbial action in table grapes, effect was higher for yeast and molds than for mesophilic aerobes (Tripathi *et al*. 2004).

5.Firmness

Firmness means the texture of fruits and veggies which determines the quality attribute and freshness. The rate of firmness gradually reduces with time due to lack of storage facility. Fruits gets soften due to the degradation of middle lamella of the cell wall (Jawadul Misir *et al*. 2014). These changes in the structure and composition of cell wall happens due to the action of some enzymes. Aloe vera coating delays softening of fruits and maintains its texture.

6.Appearance of coated Fruits

The overall appearance of coated fruit is little shiny and bright. Coated papaya fruits are well described in reference (Brishti *et al*. 2013). The fruits look shiny and attractive and they do not produce any bad odor or off flavor. In cherry fruit it was seen that uncoated fruit showed several symptoms of browning and decaying which was not observed in *Aloe vera* coated fruits (Martinez *et al*. 2006).

Aloe vera AS A Promising Natural Preservative:

In this Era of using chemical preservatives, the use of natural preserving agents should be encouraged more. Studies have shown that *Aloe vera* plant is chosen because of its tremendous properties which can readily help in preserving the edibles for longer time without the use harsh chemicals. This plant and its products are edible and fully safe, so the gel of aloe vera can be used for preserving the fruits and vegetables for longer duration. The gel of the plant is odorless, colorless, and does not affects the taste of fruit or vegetable on which it is applied (Jawadul Misir *et al.* 2014). It does not possess any risk to human health. This helps in reducing the use of harmful chemicals in food which accumulates in the body and causes various life-threatening diseases. It also reduces the use of Carbides in fruits to keep them fresh. A combination of two or more basic ingredient with some bioactive properties have been

reported to be a very promising postharvest strategy (Zhang *et al*. 2018). *Aloe vera* plant hold many medicinal properties which also makes this a wonder plant.

CONCLUSION

Fruits and vegetables are grown and stored for distribution in various places to provide edibles to everyone. During storage they can lose their natural appearance and quality, so apart from cold storage they are treated with many chemicals(preservatives) to maintain their quality and increase their shelf life. Increasing shelf life of edibles is mandatory for their long storage but if the chemical method is replaced by natural one, this can help in reducing the health hazards happening due to chemical preservatives. Alternative methods should be accepted and managed for public health to avoid the chemicals. Post-harvest losses are a major concern now a days, specially for the countries which are based on agriculture for their economy. So, a natural plant-based preservative could replace the chemicals. Studies have shown that *Aloe vera* can be a substantial preservative and can be easily applied as fruit coating.

For a better and more extended life, the aloe vera coating can be used with Bagging method for more effective results. This also plays an important role in reserving the nutrients. Thus, without compromising the quality of edibles, their shelf life and storage time could be increased by some easy natural preservative methods. *Aloe vera* coating would definitely carry a wide perspective in the field of preservation of post-harvest fruits and vegetables in future.

REFERENCES

[1] Arowora et al.2013, Effect of *Aloe vera* coatings on Quality Characterstics of Oranges Stored Under Cold Storage Greener Journal of Agricultural Sciences; Vol. 1, pp 039-047.

[2] Asghari M et al. 2013. Effect of salicylic acid and edible coating-based *Aloe vera* gel treatment on storage life and postharvest quality of grape (Vitis vinifera L. cv. Gizel Uzum) Intl J Agri Crop Sci. Volume 5 (23), pp 2890-2898.

[3] Atherton P**.** 1998**.** *Aloe vera*: magic or medicine? Nurs Stand; 12:49, pp 52, 54.

[4] Avena et al. 1997. M.E., "Water vapor resistance of red delicious apples and celery sticks coated with edible caseinate-acetylated monoglyceride films", Journal of Food Science 62 (2), pp 351-354.

[5] Baldwin et al. 1995**.** "Edible coatings for lightly processed fruits and vegetables", Hort Science, pp 30-35.

[6] Brishti et al. 2013. "Effect of Bio-preservatives on storage life of Papaya fruit (Carica Papaya L.)", International Journal of Food Studies 2 (1), pp 126-136.

[7] Carrillo-Lopez et al. 2000. "Ripening and quality changes in mango fruit as acted by coating with an edible film", American Journal of Food Science and Technology Journal of Food Quality, 23 (5)., pp 479-486.

[8] Cook, 2008. Antimicrobial activity of *Aloe barbadensis miller* leaf gel components., The internet Journal of Microbiology, volume 4, number 2.

[9] Cordenunsi et al. 2003. F.M. Physicochemical changes related to quality of five strawberry fruit cultivars during cool-storage. Food Chem. 83, pp 167–173.

[10] Coulibaly O et al. 2011**.** Consumers' Perceptions and Willingness to Pay for Organically Grown Vegetables. Int. J. Veg. Sci., 17, pp 349–362.

[11] Duthie G et al**.** 2013**.** Antioxidant effectiveness of vegetable powders on the lipid and protein oxidative stability of cooked Turkey meat patties: implications for health. Nutrients 5, pp 1241–1252. https://doi.org/10.3390/nu5041241

[12] Embuscado ME. 2015. Spices and herbs: natural sources of antioxidants – A mini review, J Funct Foods, pp 18:811–819. https://doi. org/10.1016/j.jff.2015.03.005

[13] Ergun et al. 2012. "Use of *Aloe Vera* gel as Bio-preservative for Granny Smith and Red Chief Apples", The Journal of Animal and Plant Sciences, 22 (2)., pp 363-368.

[14] Ghulam et al**.** 2019**.** "*Aloe vera* gel enriched with garlic essential oil effectively controls anthracnose disease and maintains postharvest quality of banana fruit during storage" Environment and Biotechnology, volume 60, pp 659–669.

[15] Habeeb et al. 2007. "Screening methods used to determine the anti-microbial properties of *Aloe* vera inner gel methods," Methods, 42 (4) pp 315-320.

[16] Hamman et al. 2018**.** "Composition and application of *Aloe vera* leaf gel", Molecules, pp 1599-1616.

[17] Ibrahim et al. 2019. Review Chemical Constituents, Antimicrobial Activity, and Food Preservative Characteristics of *Aloe vera* Gel.

[18] Jawadul misir et al. 2014. *"Aloe vera* gel as a Novel Edible Coating for Fresh Fruits: A Review", American Journal of Food Science and Technology, Vol. 2, No. 3, pp 93-97.

[19] K.A. Athmaselvi et al. 2013. Development of *Aloe vera* based edible coating for tomato, Int. Agrophy., 27, pp 369-375.

[20] Kahlon et al. 1991. Inhibition of AIDS virus replication by acemannan in vitro. Mol Bio ther. 3:pp 127-35.

[21] Kahramanog˘lu, 2017. "Introductory chapter: Postharvest physiology and technology of horticultural crops In Postharvest Handling", Ed.; InTech Open: London, UK, P-1–5.

[22] Kawai *et al*. 1998. In vivo effects of Aloe arborescens Miller var. natalensis Berger on experimental tinea pedis in guinea pig feet. Phytotherapy Research. 12: pp 178-182.

[23] Kim HS et al. 1997. Inhibition of benzo (a) pyrene-DNA adduct formation by *Aloe barbadensis Miller*. Carcinogenesis. 18: pp 771-776.

[24] Kim HS et al. 1999. In vitro chemopreventive effect of plant polysaccharides (*Aloe barbadensis Miller*, Lentinus edodes, Gandoderm lucidum, and Coriolus vesicolor). Carcinogenesis. 20: pp 1637-1640.

[25] L. Zhang. 2018. LWT - Food Sci. Technol. 96, pp 604.

[26] Lin D et al. 2007, "Innovations in the development and application of edible coatings for fresh and minimally processed fruits and vegetables", Comprehensive Reviews in Food Science and Food Safety-CRFSFS,6(3). pp60-75.

[27] Lone et al. 2009**.** "Anti-inflammatory and antimicrobial activity of anthraquinone isolated from *Aloe vera* (Liliaceae)", Asian Journal of Chemistry, 21 (3), pp 1807-1811.

[28] Maan et al. 2018. The therapeutic properties and applications of *Aloe vera*: A review. J. Herb. Med. 12, pp 1–10.

[29] Mahajan et al. 2018. "Review Article- Natural Coatings for Shelf-Life Enhancement and Quality Maintenance of Fresh Fruits and Vegetables" - A Review Bal., Journal of Postharvest Technology, 06(1): pp 12-26.

[30] Malik et al. 2003. *Aloe vera*-A Review of its Clinical Effectiveness, Int. Res. J. Phar., 4, pp 75–79.

[31] Marpudi et al. 2011**.** Enhancement of storage life and quality maintenance of papaya fruits using *Aloe vera* based antimicrobial coating, Indian Journal of Biotechnology vol 10, pp 83-89.

[32] Marpudi et al. 2013. "Aloe vera gel coating for post-harvest quality maintenance of fresh fig fruits", Research journal of Pharmaceutical, Biological and Chemical Sciences, Vol.4 No.1, pp 878-887.

[33] Martinez-Romero et al. 2006**.** "Postharvest sweet cherry quality and safety maintenance by *Aloe vera* treatment: A new edible coating", Postharvest Biology and Technology, 39 (1).,pp 93-100.

[34] Marzanna et al. 2019. *Aloe vera* (L.) Webb.: Natural Sources of Antioxidants – A Review Plant Foods for Human Nutrition volume 74, pp 255–265.

[35] Maughan. 1984. R. G., "Method to increase color fastness of stabilized *Aloe vera*.", US Patent, pp 465,629.

[36] Mchugh et al. 2000. "Apple wraps: A novel method to improve the quality and extend the shelf life of fresh-cut apples", Journal of Food Science, 65 (3), pp 480-485.

[37] Mohebbat et al. 2012 Suitability of *Aloe Vera* and Gum Tragacanth as Edible Coatings for Extending the Shelf Life of Button Mushroom, Food and Bioprocess Technology. volume 5, pp 3193–3202.

[38] Muhammad Akbar et al. 2020. "Effect of gum arabic and *Aloe vera* gel based edible coatings in combination with plant extracts on postharvest quality and storability of 'Gola' guava fruits", Scientia Horticultura Volume 271, pp 109506.

[39] Nasrin et al. 2017**.** Postharvest quality response of strawberries with *Aloe vera* coating during refrigerated storage., The Journal of Horticulture Science and Biotechnology, Volume 92, Issue-6, 414, pp 598-605.

[40] S. Chauhan et al. 2014. Development of *A. vera* gel to control postharvest decay and longer shelf life of Grapes, Int. J. Curr. Microbio. App. Sc. 3(3), pp 632-642.

[41] Serrano M et al. 2006. "Use of *Aloe vera* gel coating preserves the functional properties of table Grapes", Journal of Agricultural and Food Chemistry, 54 (11), pp 3882-3886.

[42] Shahidi F et al. 2010**.** Novel antioxidants in food quality preservation and health promotion. Eur J Lipid Sci Technol 112, pp 930–940. https://doi.org/10.1002/ejlt.201000044

[43] Shelton. 1991. "*Aloe vera*: Its chemical and therapeutic properties", International Journal of Dermatology 30 (10), pp 679- 683.

[44]Sikandar et al. 2016**.** *"Aloe vera* Coating Efficiency on Shelf Life of Eggplants at Differential Storage Temperatures", Journal of Northeast Agricultural University (English Edition)Volume 23, Issue 4, pp 15-25.

[45] Surjushe *et al*. 2008. *Aloe vera*: A short review, Indian J.Dermatol, 53,pp 63–166.

[46] Thorat I. 2013**. "**Antioxidants, their properties, uses in food products and their legal implications". Int J Food Stud, pp 2:81–104.

[47] Tripathi et al. 2004. "Exploitation of natural products as an alternative strategy to control postharvest fungal rotting of fruit and vegetables", Postharvest Biology and Technology 32 (3), pp 235-245.

[48] Valverde et al. 2006. Novel Edible Coating Based on *Aloe Vera* Gel to Maintain Table Grape Quality and Safety. Journal of Agricultural and Food Chemistry. 53, pp 7807-7813.

[49] Vogler et al. 1999. "*Aloe vera*: a systematic review of its clinical effectiveness", British Journal of General Practice 49 (447), pp 82-90.