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Review: Effects of edible coating on fresh-cut fruits

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Abstract
Fresh-cut fruits have a shorter shelf life due to its perishable nature. Edible coating being biodegradable and environmental friendly, provides protective covering to fresh-cut fruits. This review covered the effects of edible coating on fresh cut fruits, i.e., apple, apricot, banana, kiwi, mango, papaya, pineapple, strawberries, watermelon and melon. It was observed that edible coating positively affected weight loss, titratable acidity, ph, firmness, shelf life, color, respiration rate and microbial load in fresh cut fruits. Shelf life of all fresh-cut fruits was significantly enhanced by edible coating. Being pre-processed products, it also reduced the time required for cutting fruits. Sensory scores were also acceptable for edible-coated fruits. Literature available on the extension of shelf life of fresh-cut fruits are not sufficient especially of kiwi, strawberry, banana and mango.

Keywords: Edible coating, fresh-cut, strawberries, *Aloe vera*, storage

1. Introduction

Fresh cut fruits were found to decay more quickly than whole fruits, resulting in greater outer browning and textural disintegration. Such changes could be reduced by using an edible coating. Edible coating extends the storage of products because it gives a semi-permeable barrier to gases and moisture loss as well as increased mechanical qualities, delaying natural ageing,and maintaining the structure of coated products (Tabassum *et al*., 2020) [63]. Due to rising demand for healthier alternative foods as well as advancements in processing technology, the manufacturing and distribution of fresh-cut items has increased in popularity around the world. Routine procedures of fresh-cut preparation, such as peeling, cutting, chopping, etc., expose the tissue to loss of moisture, microbial activity, and biochemical reactions, that result in textural degradation, colour change, and loss of quality in the fruit (Velderrain-Rodrguez *et al*., 2015) [65]. Fruits with edible coatings have a longer shelf life and better quality. They play a useful role in controlling moisture transfer, decay ratio, as well as weight loss, oxidation processes, and even increasing the nutritional and sensory characteristics of fruits (Dhall, 2013) [23]. The physiology of fresh-cut fruits changes, increasing carbon substrate usage, reactive oxygen species formation, and perishability variables. Furthermore, removing the outer natural protective barrier increases moisture and solute outflow from the fruit surfaces. These conditions create ideal circumstances for microbial growth (Silva *et al*., 2018; de Souza *et al*., 2015; Ma *et al*., 2017) [58, 22, 40]. Anthracnose, is among the most frequent post - harvest infections in tropical fruit, is caused by *Colletotrichum* species, resulting in financial losses (Berger *et al*., 2018; Zahid *et al*., 2012) [16, 68]. *Colletotrichum gloeosporioides* is the main source of anthracnose in guava and other commodities such as papaya, cashew, banana, and mango. It is largely controlled by synthetic fungicides. The growth of synthetic fungicide resistance, as well as increased consumer demand for pesticide-free food, emphasises the need for new phytopathogen control strategies (Zhou *et al*., 2016) [71].

Fresh-cut fruit production and consumption have increased dramatically. One of the biggest challenges in the preservation of newly cut fruits is colour change, which is caused by polyphenol oxidases' oxidation process of phenolic components. Several treatments, such as coating and chilling, are employed to enhance the storage and quality of fruits (Noshad *et al*., 2019) [47]. In recent years, there has been a developing focus on generating various techniques to improve fresh-cut product storage ability and microbiological safety (Kuorwel *et al*., 2015; Tavassoli-Kafrani *et al*., 2016) [64]. Fruits that have been freshly sliced are popular among people since they are healthy, affordable, and ready-to-eat. Minimally processed fruits have a shorter life span than whole fruits because of the increased vulnerability to microbe activity, faster oxygen rate, and ethylene gas in fresh fruits (Alikhani-Koupaei, 2015) [5].

2. Edible coating

Traditional edible coatings have been used to protect fresh produce against physiological problems and microbiological invasion. The Chinese created a wax coating for use on lemons and oranges in the twelfth century to preserve them against microbial degradation (Kumar & Neeraj, 2019) [35]. The edible coating did not contain any harmful or allergic substances. It was easily digestible and delayed the ageing process of fruits. It also has good moisture barrier properties. It did not affect the nutritional and functional characteristics of fruits, and they contain antimicrobial and antibacterial properties (Sharma *et al*., 2019) [56]. There were several coating methods for coating fruits, but they depended on the nature of the fruits and the surface characteristics of the products that they coated. The applying method of coating depends on the adhesion method that contains diffusion between the outer surface of products and the coating solution (Senturk perreidt *et al*., 2018) [54, 55]. Fruits have waxy protective coating on their surfaces by nature. During postharvest processing, this natural coating declines or thins. As a result, edible coatings are placed on the fruit surface using thin layers of edible substances in fruits in addition to natural protective wax (Misir *et al*., 2014) [44]. Traditional refrigerated storage, MAP, and CA have all been utilised to prevent food loss and improve the storage of fruits and vegetables (Ramaswamy, 2014) [51]. Active packaging, which consists of artificial package including varying active parameters like oxygen scavengers, CO2 absorbents etc., has been used to minimise post-harvest losses. Furthermore, edible coating has gained popularity in recent years due to the longer storage life of fruits (Siddiqui *et al*., 2018) [57]. Furthermore, when edible coatings are placed on the surface of fresh fruit, they provide an internal environment that decreases respiration and prevents quality alteration and ripening stage (Singh and Singh, 2018) [59]. When we used edible coating in fruits it increases the fruits appearance and storage of products. Natural gums were used in the formulation of edible coatings to improve their properties. Benefits include longer storage life, delayed maturation, lower oxygen consumption, and bio-compatibility (Salehi, 2020) [53]. Edible coating should contain a hydrophilic and hydrophobic feature for providing good barrier properties (Cofelice *et al*., 2019) [21]. The use of emulsion-based edible coatings to enhance and prolong the shelf life of freshly cut fruits.Vegetable oil, vegetable waxes, animal oil, different EOs, emulsifiers, and water can be used to make emulsion-based edible coatings (Galus *et al*., 2015) [26]. Alginate coating has been effectively utilised to coat newly cut fruits, allowing for the creation of a suitable micro-modified environment that surrounds the fruits. Plant essential oils stand out as a good substitute to synthetic preservatives in the fight against health issues (Bitencourt *et al*., 2014) [17]. Organic acids, polypeptides, fatty acid esters and EOs from plants. Antimicrobial compounds like nitrites and sulfites could be employed in edible coatings. Though the usage of essential oils including lemongrass, oregano, thyme, and rosemary is restricted due to high costs and strong odour (Zillo *et al*., 2018) [72], combining such oils in coatings minimises the EO concentration and odour in fruits (Perdones *et al*., 2012) [48]. It act as primary packaging, interacting with the cut-fruit and surrounding it, protecting it from gas and moisture loss, improving mechanical qualities, lowering microbial load, sensory attributes, and extending shelf life (Galus and Kadzi, 2015) [26]. It offers a lot of potential as carrier for many active substances, such as antibacterial agents. Antimicrobial chemicals, such as EO_s derived from various sources, have lately been added to coatings and films used on freshly fruits (Moreira *et al*., 2015; Guerreiro *et al*., 2015) [45, 28]. It based on polysaccharides, particularly chitosan & cellulose derivatives have now attracted much interest. Cellulose is among the most abundant polysaccharides found in the environment. Extracting and modifying cellulose is easy, resulting in a range of cellulose derivatives with various characteristics. CMC is extensively used in fruits due to its low toxicity and solubility in water, and excellent capacity to form a film (Gol *et al*., 2013) [27]. Aloevera gel was the best edible coating because of its film-forming capabilities, antibacterial effects, biodegradability, and biochemical features. It is primarily composed of polysaccharides and serves as a natural barrier to oxygen and moisture, which are the primary causes of fruit decay. Aloevera coating lowering the rate of respiration and retaining quality features. A. vera gel extend the shelf life of fruits. It contains antifungal and antibacterial properties, making it a good barrier against microbiological pathogens of fruits (Misir *et al*., 2014) [44].

Panning, dipping, and spraying are all processes that can be used to apply edible coatings (Andrade *et al*., 2012) [9]. The dipping method was the most useful technique for coating a product. In this process the the products is immersed in coating solution (Senturk parreidt *et al*., 2018) [54, 55]. Dipping is advantageous for fresh produce with uneven surfaces or that needs an entire covering. Dipping ensures that the product is uniform throughout (Andrade *et al.*, 2012) [9]. Another common technique in edible coating for coating products is spraying. In this method, the coating solution is not viscous because viscous solutions are difficult to spray. Spray coating is a method of applying a continuous thick or thin coating layer on the outer surface of the products, and in this method, drying time and temperature are also important (Zhang *et al.*, 2018) [69, 70].

3. Effects of edible coating on fresh-cut fruits

3.1 Apple

Two probiotics were shown to be able to withstand GID simulations while maintaining a high level of viability. *Bifidobacterium lactis* and *Lactobacillus rhamnosus* mixed with apples could reach the human small intestine in adequate amounts to demonstrate their beneficial health effects. This is a benefit since the alginate-coated apples retain their microbiological and nutritional properties. Fresh-cut apple coated with an inulin and fructose-rich alginate-based solution is a good probiotic carrier and might be used in the development of new non-dairy functional food products. Apple slices with prebiotic-alginate are a hopeful approach for creating novel carriers for probiotic bacteria (Alvarez *et al*., 2020). Some reserachers emphasized to see if ferulic acid (a recognised antioxidant with cross-linking properties) could be incorporated into the SPI composition. It would extend the quality, shelf life, preventing their firmness and loss of weight in fresh-cut apples. When compared to an aqueous solution, the soy protein isolate/ferulic acid-based formulation produced a suitable outcome for managing the colour of apple slices, with the results indicating a reduction in the oxidative degradation of ferulic inside the SPI network (Alves *et al*., 2017) [8]. Chiabrando *et al*. studied fresh-cut Golden Delicious apples coated with biodegradable alginate coatings with and without EO_s in order to explore healthier choices for preserving fresh fruit quality and safety during refrigerated conditions after harvest. Cinnamon oil-infused alginate coatings inhibited respiration rates better than rosemaryinfused alginate coatings. Essential oils and antioxidants were found to be better than alginate alone the weight loss was reduced and the original colour and brightness were preserved. PPO and peroxidase activity are also reduced by EO, particularly in the first several days after processing. For fresh-cut fruit applications, EOs can be employed to make edible films (Chiabrando *et al*., 2015) [20]. Coated apple slices with whey protein concentrate (WPC) and apple pomance extract (APE) reduced weight loss. After 12 days of storage, the coated apple slices with WPC/1.5 percent APE had the maximum lightness compared to other coated and untreated apple slices. In addition, as compared to uncoated apple slices, the coated apple slices with WPC/1.0 and 1.5 percent APE had the lowest browning index. The antibacterial efficacy of WPC and APE as coating agents was demonstrated, although it had minimal effect on the sensory evaluation of apple slices (Hammad *et al*., 2021) [29]. Combining thyme oil with an alginate edible coating may considerably reduce loss of weight, microbial population and browning in fresh sliced apple fruits (Hu *et al*., 2018) [32]. Increased soluble soybean polysaccharides (SSPS) concentration was connected to better titratable acidity. The lowest tissue stiffness and maximum level of vitamin C were found on days 12 and 13 when treated with 3 percent SSPS and 0.5% Tragacanth gum. There was no noticeable effect of the treatments on weight loss or antioxidant activity. Acc. to above results this edible coating was best for fresh sliced apple fruits. Kumar *et al*., 2018 [36] studied that fresh sliced apples were coated with CMC and A. vera, as well as anti-browning chemicals, to keep their quality throughout storage. The microbial load on wedges coated with CMC and A. vera was substantially lower. The activity of the enzymes PPO and peroxidase was also decreased in the coated fruits. During storage, the untreated apple wedges lost firmness faster than the coated fruits. CMC and A. vera coatings, in combination with anti-browning chemicals, increased the quality of preserved apple (Jafari *et al*., 2018) [33]. Moreira *et al*. studied the addition of apple fiber, combined with ascorbic acid was found to preserved antioxidant activity for at least one week of storage. Furthermore, regardless of the addition of dietary fibre, gellan gum coatings had a significant impact on lowering psychrophilic and mesophilic counts on fresh sliced apples during storage. Higher sensory scores were obtained when fresh sliced apples were coated with polysaccharide-based edible coatings that included dietary fibre. As a result, adding dietary fibre extracts to fresh-cut apples to improve their nutritional content while maintaining their excellent qualities (Moreira *et al*., 2015) [45]. Fruit samples treated with D. sophia had the highest TA value and the lowest ºBx and browning index. On day 10 of storage, fruits treated with P. psyllium had the maximum vitamin C content, hardness, and bacterial growth inhibitory effects and it reduced bacterial counts by 0.7 log CFU/g. Finally, P. psyllium L. mucilage can be suggested as a unique coating for enhancing the freshness and quality of apple slices (Noshad *et al*., 2019) [47]. Fresh aloevera gel coating preserved the fresh-cut surface colour and slowed the browning of fresh sliced apple fruits, and changes in antioxidant activity were not connected to the browning of freshly cut wax apple (Supapvanich *et al*., 2016) [62].

3.2 Apricot

When OEO was added to films, it reduced their WVP, whereas increasing their moisture content. The coatings reduced the TPC, yeast, and mould populations. Basil seed gum plus 6% *Origanum vulgare* essential oil treatments were shown to be the most effective in lowering the microbial populations of fresh apricots. The total soluble phenolic and antioxidants activity of OEO supplemented samples was significantly higher than the control at the end of cold storage. The newly developed OEO BSG film and coating was used to keep fresh cut apricot fruits (Hashemi *et al.*, 2017) [30]. Zhang *et al*. analysed the two different coating formulas on apricots soybean protein isolate and SPI combined with chitosan.SPI-chitosan coating, significantly reduced apricot weight loss. Meanwhile, this treatment helped the tissue's textural qualities while also preventing firmness loss. The results showed that coating apricots with SPI-chitosan was a good way to keep their quality (Zhang *et al*., 2018) [69, 70].

3.3 Banana

Polyphenoloxidase and lipoxygenase activity, fruit softening, and weight loss were all decreased when the liposomal oil was mixed with mucilage, while maintaining firmness and soluble solids content. Free RO mixed in water of a similar quantity had less effect on the physico-chemical properties than the control, with lower variations in chroma, L* value, and pH. According to the evidence given, mucilage (Mu) plus liposomal oil and rosemary oil (LipoRo) have the ability to improve the quality of bananas (Alikhani-Koupaei, 2015) [5].

3.4 Kiwi

Allegra *et al.* investigated the impact of a mucilage edible coating produced from Opuntia ficus-indica on the storage and quality of kiwi slices. Fresh kiwifruit surfaces were combined with Opuntia ficus-indica mucilage alone or in combination with TWEEN 20. The results demonstrated that mucilage had a good influence on the fruits' firmness, ascorbic acid, pectin content and visual quality throughout storage at 5º C. While Opuntia ficus-indica mucilage and Tween 20 increased microbial expansion. The treatment without Tween 20 was also shown to be more successful in quality measure (Allegra *et al.*, 2016) [6]. Quality of fresh cut kiwi was enhanced after being coated with aloevera. Coated sliced kiwi fruits lower respiration rate and spoilage. The texture of untreated kiwi fruits was deteriorating more quickly as compared to coated kiwi. The 5 percent coating produced great performance in the instrumental texture profile and preference panel tests, showing that it could be a healthy substitute coating for fresh-cut kiwi (Benitez *et al*., 2013) [15]. Benitez *et al*. analysed chitosan with acetic or citric acid and alginate based coating function as a gas barrier and it produce a significant amount of CO2 gas. The aloe-vera coating kept the fruit solid and protected it from ascorbic acid losses and ripening. Microbial multiplication was inhibited by A. vera and chitosan-AC. Fruit coated with an alginate coating, showed greater microbe growth than untreated fruits. In comparison to some other coatings, the panelist appreciated the fresh cut kiwifruit coated with A. vera or chitosan-C. A. vera was really the most excellent coating for both extending the postharvest storage life and maintaining the product's sensory qualities throughout storage (Benitez *et al*., 2015) [14]. Fresh-cut kiwifruit with an alginate-based edible coating had less electrolyte leakage and MDA levels while retaining their green colour, total chlorophyll concentrations, vitamin c and antioxidant properties. Furthermore, at the end of the study, 0.05 percent PL treatment decreased total aerobic counts and mould counts. Our findings suggest that using an edible coating combined with PL to maintain the quality of cut kiwifruit (Li *et al*., 2017) [39].

3.5 Mango
Afifah *et al*. studied a composite edible coating with two plasticizers in fresh sliced mangoes. Edible coatings were proven to help retain the quality of sliced mangos by minimising weight reduction, delaying the increase in TSS, preserving pH, total acidity, and microbe's growth. It also showed that there was no sensory variation between both the coated and untreated sliced mangoes (Afifah *et al*., 2019) [1]. Edible coating could extend the storage ability of fresh cut mangoes stored at 6°C for 6 days. It reduces weight loss, delays a rise in TSS, and inhibits the growth of microbes in fresh sliced mangoes. Both the coated and uncoated fresh sliced mangoes showed no differences in sensory perception (Li *et al*., 2020) [38]. Marin *et al*. investigated to see if edible coatings can help fresh-cut mangoes last longer after being treated at a ripening phase. For 'Tommy Atkins' and 'Kent,' the combination of anti-browning chemicals, whether used alone or with coatings, has to be very helpful in preventing darkening for up to10 and 11days at 5°C, respectively. There have been no changes in texture or flavour in coated fruits. Citric acid has a highest antibrowning impact on fresh sliced fruits, but calcium ascorbate alone did not consistently suppress browning. Fresh-cut mangoes can readily apply citric acid to prevent browning (Marin *et al*., 2021) [43]. Mangoes coated with alginate or antioxidant showed that alginate and an anti-browning compound improved the colour of cut fruits and boosted the antioxidant capacity. According to the findings, fresh-cut mangoes may be stored for 12 days at 4ºC without losing nutritional or physicochemical quality (Robles-Sanchez *et al*., 2013) [52]. Chitosan-alginate nanomultilayer coating extended the storage life of mangoes by up to 8 days. Mass loss, pH, malondialdehyde concentration, browning rate, soluble solids and microbe proliferation were all reduced in the coated mangoes during the storage period. The nanomultilayer coating had no effect on vitamin C retention in fresh-cut mangoes during storage (Souza *et al*., 2015) [61].

3.6 Papaya
Multilayered antimicrobial edible coating was found to improve the microbiological quality of sliced papaya. It increased the storage and quality of fresh papaya for 15 days at 4º Celsius, but untreated fruits only lasted 7 days and this coating reduced total carotenoids content and vitamin C content. When it comes to storing fresh-cut papaya at room temperature, the Ziploc tray with the Ziploc lid is the superior option. Fruits lose their quality quickly if they are not packed (cheesecloth control). These findings suggest that multilayered antimicrobial edible coatings could be used on fresh fruits (Brasil *et al.*, 2012) [19]. Use of $CaCl_2$ has maintained the maximum weight loss, firmness, soluble solid content, titratable acidity and respiration rate values. K carrageenan and sodium alginate, on the other hand, have supplied an oxygen barrier, reducing respiratory rate and enhancing firmness retention. Lastly, the edible coating made from A. vera gel and other chemicals had no impact on the natural flavour of papaya (Farina *et al*., 2020) [24]. Newly harvested papaya fruits were sliced into equal-sized slices and coated with 2%, 3%, and 4% CMC, respectively. The fruits were kept at 4°C for 14 days. When compared to other coated and uncoated fruits, the 4 percent CMC coated material reduced quality loss during storage. In uncoated samples, total soluble solid content reduced. In coated sample, a minimum size reduction was found (Kohli *et al.,* 2018) [34]. Alginate-based coatings were shown to be ineffective against microbial activity. The microbiological quality of Fresh cut papaya was successfully maintained by coatings containing essentials oil. Although increasing the concentration of essentials oils improved their antibacterial effect, but original aroma of the fruit was overshadowed by the oil. To avoid any detrimental effects on taste, essentials oils should be used at lower concentrations. Coating fresh cut papaya with 1% Thyme-Essential Oil and Oregano-Essential Oil for 12 days at 4°C successfully slows the process of physico-chemical property degradation, resulting in improved microbiological safety (Tabassum *et al*., 2020) [63]. Psyllium gum was used in various concentrations i.e., 0.5, 1, and 1.5 percent, to coat a fresh sliced papaya. When kept in refrigerated conditions, coating fresh-cut papaya with a mixture of psyllium gum and sunflower oil could increase the storage ability of the fruit by up to two weeks. Combining 1% psyllium gum with sunflower oil had better effects (Yousuf *et al*., 2015) [67].

3.7 Pineapple
Weight and respiration rate were considerably reduced after 10 days of storage (10 °C, 65 percent relative humidity), and firmness was maintained in both optimised coated samples compared to the control after 10 days of cold storage. As a result, either alginate or gellan-based formulations have the ability to increase the storage and preserve the freshness of sliced pineapple (Azarakhsh *et al.,* 2012) [12, 13]. There was no significant difference in total plate counts among the coated and untreated samples when using gellan-based coatings without limonene. As a result, gellan-based edible coating formulations containing 0.3 percent (w/v) limonene significantly lower TPC while retaining the sensory qualities of pineapple (Azarakhsh *et al.,* 2012) [12, 13]. Alginate-based coating containing 0.3 percent (w/v) lemongrass lowered the respiration rate, total plate count, yeast, weight and mould count while maintaining the firmness, colour, sensory attributes, and morphological characteristics of sliced pineapple at low Temperature. As a result, this coating has the ability to increase the shelf life of cut fruits and preserve its freshness also (Azarakhsh *et al.,* 2014) [10, 11]. The antibacterial characteristics of the gellan edible coating were not found to be significant. When compared to the untreated samples, the gellan edible coating considerably lowers the respiration rate, reduces weight loss, and preserves the stiffness, colour, and sensory attributes of freshly sliced pineapple in low-temperature conditions. After 16 days of storage at 5 ºC, there was no significant difference in the pH, titratable acidity, and TSS of coated and untreated samples. Cut pineapple can be kept fresh for a long time in the refrigerator with the help of the gellan edible coating solution (Azarakhsh *et al.,* 2014) [10, 11]. Fresh-cut 'Josapine' pineapple from all treatments was found good only for 6 days when stored at 10°C. It has not been proven that using gelatin (0.5, 1.0, and 1.5 percent) as an edible coating on fresh-cut pineapple improves quality. According to the overall microbiological examination; there was no improvement in quality. There was a minor reduction in TBCs and TYMs in 0.5 percent gelatin and a drop in total coliforms in 1.0 percent gelatin (Bizura Hasida *et al.,* 2012) [18]. Chitosan-modified edible coating containing starch and glycerol can extend the shelf-life of pineapples to 14 days. Furthermore, in an organoleptic examination, this characteristic received the highest overall acceptability score (Maharsih *et al*., 2021) [41]. Mantilla *et al.* checked the effectiveness of a multilayered edible coating (beta-cyclodextrin and trans-cinnamaldehyde) combined with a microencapsulated antibacterial complex in

improving the shelf life of sliced pineapple. The flavour of the fruits was impacted by the encapsulated trans-cinnamaldehyde, but the coating increased its storage to 15 days at 4ºC by preventing microbial development. The best coating composition for preserving the quality features of pineapple is 1 gm/100 gm alginate, 2 gm/100 gm antibacterial ingredient (trans-cinnamaldehyde) and 2 gm/100 gm pectin. The freshly sliced fruits coated with 0.5 and 1gm/100gm sodium alginate, which effectively preserved the pineapple quality while increasing its storage life at 4º C temperature. During storage, the inclusion of an alginate edible coating had no effect on the pH or ºBrix of fresh-cut pineapple (Mantilla *et al.*, 2013) [42]. Citral nanoemulsion was used as a coating to maintain microbiological quality and extend the shelf life of sliced pineapples refrigerated for 12 days at 4°C and 90% RH. Droplet sizes in the nanometric range were discovered in three different citral nanoemulsion concentrations of 0.1, 0.5, and 1 percent used in alginate edible coatings. After a 12-day storage period, nanoemulsion 2 and nanoemulsion 3 coated pineapples had better colour retention, reduced respiration rates, and less microbiological growth. As a result, edible coatings contain 0.5% citral nanoemulsion could be researched further on a large level to increase the shelf life of sliced fruits (Prakashn *et al.,* 2020) [50].

3.8 Strawberry
When fresh sliced strawberries were stored at 4ºC for 15 days, the sodium alginate-calcium chloride coating enhanced their shelf life. Because the edible coating lowered the transpiration and respiration rates of the strawberries, it acted as a protective barrier, preventing mold formation and preserving their taste and texture. Aside from that, the edible coating of sodium alginate and calcium chloride slowed the increase in total soluble solid concentration and ph of the sliced strawberry. when sliced fruits are coated with edible sodium alginate, both customers and producers save money by reducing food losses (Alharaty & Ramaswamy, 2020) [3]. Layer- by- layer edible coating was helpful in preventing the loss of strawberry firmness and fragrance volatiles while having no influence on total soluble solid and total acidity content. The above results showed that this coating preserve strawberry quality by reducing metabolite levels after 8 days of storage (Yan *et al*., 2019) [66].

3.9 Watermelon and Melon
After fourteen days of storage, osmotic dehydration and pectin coating were suitable storage methods for fresh cut melon, enabling the lowering of fruit oxygen consumption and also the keeping of sensory attributes and quality metrics of melon (Ferrari *et al*., 2013) [25]. Multilayered anti-microbial edible coating extended the shelf life for15 days. when compared to the untreated sample, the coated melon was retained its colour and carotenoids while losing weight and firmness. The Ziploc cover was the most effective packaging technique for extending shelf life. The layer-by-layer method is used in this work to demonstrate the use of natural antimicrobial agents (Moreira *et al*., 2014) [46]. Ph and degree Brix of sliced watermelon were not affected by the alginate-based multilayered antimicrobial coating during storage, and only a minor variation in colour was found between the coated and control. Watermelons that have been coated lost considerably a less weight and maintained their texture. This is a significant finding because texture is the most essential sensory characteristics of cut fruits. Panelists were fine with the coated fruits because it didn't change the colour and flavour. Microbiological experiments confirmed the coating's utility as its ability as a transporter of natural antibacterial substances to inhibit microbial count. The efficacy against, yeasts, coliforms, psychrotrophic bacteria, and moulds was particularly good. The use of a multilayered edible coating will prolong the freshness and increase its shelf life also (Sipahi *et al*., 2013) [60].

4. Conclusion and future recommendations
In conclusion, we can state that edible coating on fresh-cut fruits was the best technique for preserving fruits compared to other traditional techniques used on fruits. In the edible coating, we combine other nutritionally rich compounds like antioxidants, vitamin C, dietary fibre and other compounds that are essential in our body. By applying this method, nutrient loss in fresh cut fruits was minimized, reduce time and fruits remained in fresh conditions for longer periods of time, while microbial load was also reduced in edible coated fruits. Edible coating improved weight loss, titratable acidity, ph, prevented firmness, shelf life, color, respiration rate and microbial load in all fresh cut fruits. Edible coated fruits had a good sensory score also. Literature available on the extension of shelf life of fresh-cut fruits are not sufficient especially of kiwi, strawberry, banana and mango.

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