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Edible films made from apple peel

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Abstract
Food packaging materials helps to save the food products from deteriorating external factors and avoiding losses of desirable compounds thus, extending food shelf-life. Currently, there is rising concern with renewable, recyclable and biodegradable packaging materials that are mostly preferred in the market. The edible film is a new trendy theory as it is food-grade prepared by bio- macromolecules are added in the fruits and vegetables to provide healthy nutrition value for human intake. The chronological development of films which are based on various types of fruits and vegetables purees, pomaces and extracts. Current packaging technology are generally analysis on the role that each film component which in results the materials whose production methods are examined from a technical perspective and essential properties are compile and contrast to their conventional, artificially set off.

Keywords: biodegradable material, biopolymer, edible film, food packaging

Introduction
India is the second largest producer of fruits in the world, after China. In the year of 2016-2017 about 93 million tones of fruit production was estimated which is 3 % higher than the earlier year. Among this 4128 metric tons and 2563 metric tons of fruits are produced. In recent years, the major contributing of ecological burden is the fruit misuse as since the waste from the fruit processing sector is very high. The biomass waste from the juice industry are used as fertilizer or animal feed or discarded in the landfills which leads to the environmental hazards and loss of value added products which includes pectin, phytochemicals and dietary fibers. Thus, involves in providing a variety of health benefits and nutritional value Edible food packaging is a type of packaging that is likely to be eaten or has the ability to biodegrade practically like the food. Food packaging systems have different occupations includes those related to containment, information and marketing. The primary function is to separate food from the surrounding environment, reducing exposure to spoilage factors and prolong the shelf-life of food products. In fruit processing industry about 700kg of by-product is generated from the 1 ton of fresh pomegranate fruit and that contains 23 % of seeds and 77 % of peel which are surplus as a waste materials. The study has been reported that peel of apple and its extract shown major polyphenols, flavonoids, anthocyanin concentrations, antioxidant activity and antimicrobial properties. Throughout the worldwide a large quantity of plastics are been used. Henceforth, recycling is limited for the reason that of technical and economic difficulties in fact less than 5% of the waste plastic globally gets recycled. However the detonation can turn out toxic compounds, such as furans and dioxins formed from burning of polyvinylchloride. Numerous studies have presented those Marco-compounds, such as polyphenols, flavonoids, anthocyanin concentrations and antioxidant activity in apples which differ among the edible parts of the fruit. As compared to whole fruit the peel has highest total phenolic and flavonoids concentrations components. The peels of apples have good amount of antioxidant compounds which enhances the dietary intake. The formation of film by using an edible material is known to be an edible film. There are a variety of forms of edible packaging material that are represented in the market which includes edible film wrap, pouches and edible coating in which the food materials are dipped or sprayed with the film forming liquids are usually used to increase the shelf life of food products. Biopolymer is the biodegradable material consists of polymers that are naturally degraded by microorganisms through the process of composting and break into carbon dioxide, methane, water and biomass. Biodegradable polymers are of two categories such as edible and non-edible biopolymer. Edible film is a thin sheet of packaging material which can be placed on the food components or in between the food products and are extremely produced from the food derivative ingredients. Edible film is a packaging material chiefly used to develop the mechanical properties, barrier properties, reduces microbial count and accordingly increases the shelf of the different food products. There are three major biopolymers with the aim to be typically used to form edible films are lipids, polysaccharides and protein. There are two methods involved in the formation of edible film processes and mechanisms. In dry processes technique thermoplastic extrusion are based to utilize thermoplastic properties of polymer when heated at higher temperature with low water content condition. As compare with wet process is based on film forming solution where the polymers are allowed to disperse in liquid phase and dried it. The most widely used technique to form edible film is wet process techniques.

Materials and Methods
The fruit and apple with its peel after the juice extraction was collected from the local market. The raw apple peels are

properly washed to remove unwanted particles. The washed peels are completely sun dried. After drying, the fruits peels are grinded into a fine powder by using an electric blender and sieve it by using mesh no.60. Thus, gain fine powder of the peels. Later the powdered peels are stored in an airtight container.

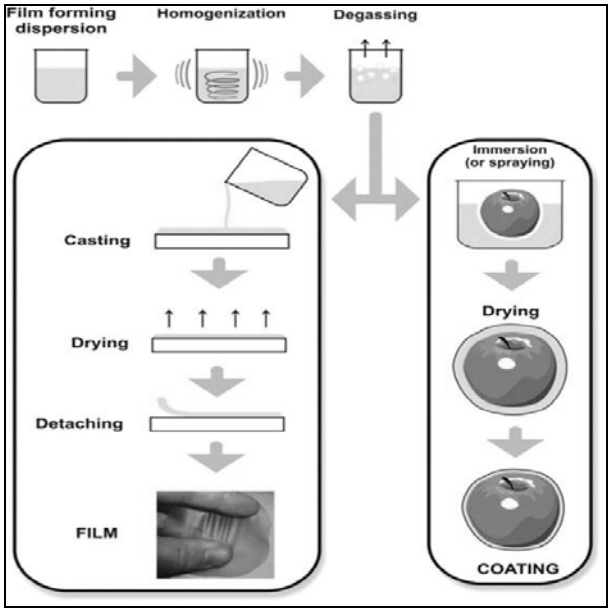

Fig 1: Pictorial view of production of films and coating of apple

Method A) The peeled apple powder is used for the preparation of edible film. The film forming solution is prepared by 3g of peel powder in 100 ml of distilled water under constant stirring using magnetic stirrer for 5 minutes. The solution was prepared by treating with ultrasonic sonicator run it for 30-40 mintues with frequency of 50 Hz. After treatment the solution was heated at 80°C for 30 minutes and glycerol was added as a plasticizer to increase the flexibility of the film. Once the solution is poured into the petri-plates and air-dried for 24 hours at room temperature. The dried films are peeled from petri-plates and immersed in the calcium chloride 2% solution for 5 minutes and the film allowed for drying again. As a cross-linking agent, calcium chloride used to increase the strength of films. The prepared edible films are kept in desiccators till it taken for further analysis.

Method B) Another method for preparation of apple peel based biopolymer edible film made by treating the suspension with high pressure homogenization and studied the effect of glycerol as a plasticizing agent by differing its concentration such as 23%, 33% and 44% w/w, dry basis of powder and observed that the inverse relation found in between glycerol concentration and moisture content of film as glycerol content increases the water content decreased at various levels of water activity and also showed that the increase in the glycerol content increases the barrier properties of the film. Thus, the apple based edible film can be used as an edible wrap or coating on food products.

Test for Edible Films

Mechanical properties

Various mechanical properties are studied for the basic requirement of edible films which helps to use as food packaging. The mechanical properties depend on fruit films composition. The fruit films are stronger than vegetable films due to their higher ratios of dietary fibers to total sugars.

1. Film thickness measurement

The thickness of the prepared film measured using a hand held micrometer 25 mm having a precision of 0.01 mm. The sample was kept in between the spindle and anvil of micrometer then by adjusting the ratchet reduces the gap till the film is clamped and there is no further adjustment can be done. The readings were taken randomly at 3 different position of each film and the average value of films thickness was calculated.

2. Film density

The density of the film was calculated according to the procedure of dividing the sample weight by the film volume. The volume of the film was calculated by multiplying the area of the film and film thickness.

Hydration properties

1. Moisture content

Moisture content of the film samples were determined by following the procedure reported by The initial weight of the prepared film samples were measured using analytical weighing balance with accuracy of 0.01g and samples were kept in an oven at 90˚C until the constant weight is reached and keep it in desiccators to cool it down and weighed it.

2. Film solubility in water

The solubility of the films was determined according to the procedure according to slight modification. The initial weight of the film samples were determined by dried them in oven at 100˚C for 24 hrs. Then, the dried samples were submerged in 30ml of distilled water for 24 hrs at a room temperature. The soaked films were filtered and re-dried at 100˚C for 24 hrs and weighed it to get the mass of insoluble matter.

3. Optimization of edible film

Take 5g of peel powder in a 250ml conical flask and add 150 ml of distilled water by continuous stirring to dissolve it completely. Citric acid was added to maintain pH 2 respectively. Then the mixture was heated at 85°C for 60 minutes in a hot water bath. After heating, the hot acid extract was filtered through muslin cloth. The filtrates were cooled to normal room temperature and add equal volume (1:1) of 99.1% of pure ethanol and kept at 4°C for 1 hour. Finally, the coagulated pectin (ethanol insoluble substance) obtained was recovered by filtration and centrifugation then it was washed with 75% followed by 55% ethanol respectively. The washed pectin was dried at 35°C in hot air oven to remove the moisture content and obtain the pectin in dried powder form. The film properties such as film thickness, film density, moisture content and solubility of film in water are studied to obtain best film and based on the properties best film taken for further analysis study.

4. Estimation of pectin content

The powder of apple peel is analyzed for the pectin content. Extraction of pectin from fruits peel powder was carried out by following the procedure. Where, yield is the extraction yield in percentage, p is the amount of extracted yield of pectin in grams.

Results and Discussions

The study was conducted on the final sample of edible film the properties packaging material and quality parameters were analyzed. The results obtained are given below in Table.1. It was observed that the thickness of film increases with increase in the glycerol concentration. Thus, due to the hydrophilic nature of glycerol which adsorbed more moisture with increase in concentration leads to swelling of film and resulted in increased film thickness. The thickness value obtained was higher due to the addition of different raw materials in film formulation and the variation in the film forming procedure. The density of the film shows a decrease upon increasing the addition of glycerol. However, there was no significant ($p > 0.05$) difference was found between the glycerol concentration used for film preparation. The apple peel powder was analyzed for the pectin content to check its suitability as raw material to form film. The extracted pectin from apple peel is shown in Table 1. The pectin content in the peeled apple powder is due to the different varieties of apples used and also different extraction conditions. Thus, both the raw materials contains pectin which is an significant component required for the better formation of biopolymer based edible film. The moisture content of the films was significantly ($p \leq 0.05$) increased from 12.85% -18.04% as increase in the addition of apple powder and the results are mentioned in Table.1. The moisture content depends on the concentration of apple peel powder. The film solubility ranges from 42.03 % to 49.05%. The film showed lesser film solubility as compared to the other composite films. From the result it was observed that as the concentration of peel powder increase the solubility of films increased significantly ($p \leq 0.05$). Thus, the higher concentration of apple peel based films shown lesser solubility it might be due to the presence of essential oils in which limits the hydroxyl group to interact and causes lesser solubility. The addition of calcium chloride as a multivalent cation into the pectin based film increase the bonding between the polymers and causes less solubility. The hydration properties such as moisture content and film solubility are important properties which are to be considered in order to select the film for specific food applications and determine the biodegradability of films. If the film has low solubility nature it can be suitable for high moisture content foods and high solubility films can be used for low to intermediate foods and also it can used as edible pouches or ready to eat foods as it melts easily during boiling of food products.

Table 1: Properties of edible film from apple peel

Properties	Content
Film thickness (mm)	0.094-0.097
Film density (g/cm^3)	1.2-1.4
Pectin content (%)	2-2.5
Moisture content (%)	12.85-18.04
Film solubility (%)	42.03-49.05

Application of edible film as a wrap on food products

Apple puree based edible film and edible coating was prepared and studied its effect on fresh cut apple pieces. The edible film and coating was arranged with the blend of 70% of apple puree, 1.5% of ascorbic acid, 27% of vegetable oil and 1.5% of citric acid (w/w on dry solid basis) respectively. The prepared film and coating solution are wrapped and coated over the apple pieces and considered its quality and shelf life for 20 days storage period at refrigerated condition. The results showed that the moisture loss was reduced during 12 days of storage period as compared to dipped one and the wrapped apple show100% inhibition of browning up to 10 days as compared to coating which show 80% inhibition up to 3 days. The wrapped apple samples maintained aroma, flavor and taste till the end of storage period. Therefore it was concluded the wraps is better than the coating and can be used in food applications. The outcome is that sample wrapped had less reduction in weight and hardness as compared to the unwrapped one. As a end result, the biopolymer film can widely utilize for commercial application.

Conclusion

Consumers come across for the healthy balanced diet for consumption on a daily basis. Apple is rich source of antioxidants and high content of polyphenols that helps in protection from diseases. Relating to mechanical and barrier properties are useful in order to enhance chemical modifications and incorporation of food. However, any modification to the material is considered in order to protect the edibility test essential for the development of edible films based on fruits and vegetables with suitable physical properties. The edible film is made from fruits and vegetables peel which is new concept for consumers and as nutritional values that impart flavor to it and appeal as well as attractive sensory properties. Edible film from fruits peel waste were successfully made by glycerol as a plasticizing agent and studied its various properties such as film thickness, density, moisture content and film solubility. The edible film from apple fruit was further improved by optimizing the film forming components by the addition of emulsifiers and flavor compounds. The application of film is used as an edible wrap/coating which depends on the food product and studied its quality parameters and suitable for the commercially in food industries.

References

1. Borah PP, Das P, Badwaik LS. Ultrasound treated potato peel and sweet lime pomace-based biopolymer film development. Ultrasonic's sono chemistry, 2017:36:11-19.
2. Chandra RUSTGI, Rustgi R. Biodegradable polymers, Progress in polymer science,1998:23(7):1273-1335.
3. Farahnaky A, Saberi B, Majzoobi M. Effect of glycerol on physical and mechanical properties of wheat starch edible films, Journal of Texture Studies, 2013:44(3):176-186.
4. Indrarti L. Incorporation of citrus essential oils into bacterial cellulose-based edible films and assessment of their physical properties, In *IOP* Conference Series: Earth and Environmental Science,2017:60(1),012018, Bristol, England: IOP Publishing
5. Jayasekara R, Harding I, Bowater I, Lonergan G. Biodegradability of a selected range of polymers and polymer blends and standard methods for assessment of biodegradation, J Polym Environ, 2005:13(3):231.
6. Jouki M, Yazdi FT, Mortazavi SA, Koocheki A. Physical, barrier and antioxidant properties of a novel plasticized edible film from quince seed mucilage. International Journal of Biological Macromolecules, 2013:62:500-507.
7. Kang HJ, Jo C, Lee NY, Kwon JH, Byun MW. A

combination of gamma irradiation and $CaCl_2$ immersion for a pectin-biodegradable film, Carbohydrate polymers,2005:60(4):547-551.
8. McHugh TH, Senesi E. Apple wraps: A novel method to improve the quality and extend the shelf life of fresh-cut apples. Journal of Food Science, 2000:65(3):480-485.
9. Pavlath AE, Voisin A, Robertson GH. Pectin-based biodegradable water insoluble films, *Macromolecular Symposium*, 1999:140(1):107-113.
10. Peressini D, Bravin B, Lapasin R, Rizzotti C, Sensidoni A. Starch– methylcellulose based edible films: rheological properties of film-forming dispersions. Journal of Food Engineering, 2003:59(1):25-32.
11. Pitak N, Rakshit SK. Physical and antimicrobial properties of banana flour/chitosan biodegradable and self-sealing films used for preserving fresh-cut vegetables, LWT-Food Science and Technology, 2011:44(10):2310-2315.
12. Regalado C, Pérez-Perez C, Lara-Cortes E, Garcia-Almendarez B. Whey protein based edible food packaging films and coatings. In R.G. Guevara-Gozalez, I. Torres- Pacheco (Eds.), Advances in Agricultural and Food Biotechnology, Kerala, India: Research Signpost,2006:237-262.
13. Sablani SS, Dasse F, Bastarrachea L, Dhawan S, Hendrix KM, Min SC. Apple Peel Based Edible Film Development Using a High-Pressure Homogenization. Journal of food science,2009:74(7):372-381.
14. Sothornvit R, Krochta JM. Plasticizer effect on mechanical properties of β-lactoglobulin films, Journal of Food Engineering, 2001:50(3):149-155.
15. Tee YB, Wong J, Tan MC, Talib RA. Development of Edible Film from Flaxseed Mucilage Bio Resources, 2016:11(4):10286-10295.
16. Wolfe K, Wu X, Liu RH. Antioxidant activity of apple peels, Journal of Agricultural and Food Chemistry, 2003:51:609-614.