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Advances in edible films for enhancing food quality and sustainability

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Abstract
The use of readily available fresh vegetables has increased recently as prepared salads become more and more popular as a result of changes in consumer preferences. Fruits and vegetables now benefit greatly from edible films that extend their post-harvest shelf life. Notably, chitosan-based films have become more popular recently because of their benefits for the environment, such as non-toxicity, biodegradability, and biocompatibility. Chitosan Film, a bio-polymer-based layer made from modified chitin, is primarily derived from shellfish. The main goal in developing these films was to provide food products with a reasonable albeit temporary protective layer during lengthy transportation. Meanwhile, the use of edible films offers a sophisticated response to the problems with waste management related to traditional packaging materials. This paper critically examines the research surrounding pectin, which has gained attention as a key raw material for producing edible films. Its appeal is a result of its abundant natural resources, low cost, and ability to be renewed. The use of pectin film has been successful in extending the shelf life and improving the quality of food products. Importantly, it mitigates the environmental risks posed by non- biodegradable plastics by acting as a sustainable replacement for synthetic polymer-based packaging. These biopolymers can significantly increase the shelf life, quality, total soluble salt (TSS) content, and flavor preservation of different fruits. By using this strategy, we could reduce both agricultural and marine waste, which would be beneficial for environmental preservation.

Keywords: Edible film, chitosan-based films, modified chitin, pectin, synthetic polymer-based packaging, total soluble salt

Introduction

Edible Film generally defined as continuous matrices that can be prepared from edible materials such as proteins, Poly- saccharides and lipids etc. They can be using film wraps or pouches for food formed as film coatings on food or between food components. (Chang *et al*. 2019) [8] has studied the preparation of chitosan films by neutralization for improving their preservation effects on chilled meat. In the study it has found that the chitosan film neutralized with 10% NaOH solution for 90 seconds exhibited the best barrier performance. (Shivangi *et al*. 2021) [5] studied t0he development and application of pectin-based edible films enriched with bioactive compounds, deoxy-nojirimycin, and chlorogenic acid, extracted from crude mulberry leaf extract. The precursor solution of the films was a chitosan solution containing 1% (w/w) of polymer in a solvent mixture containing 0.5% (v/v) of acetic acid in water. Glycerol was used as a plasticizing agent for chitosan chains in the proportion of 30% (w/w) relative to the chitosan mass (Zhang *et al*. 2018) [7].

The physical and chemical characteristics of the film are crucial for the effectiveness of the packaging system. Antimicrobial drug addition could alter the polymeric structure of the film, which would impact its mechanical capabilities and barrier effectiveness. Therefore, while creating active packaging, potential interactions between biopolymers and antimicrobial agents should be taken into account.

Edible Film: Edible films are generally defined as continuous matrices that can be prepared from edible materials such as proteins, Poly- saccharides and lipids etc. They can be using film wraps or pouches for food formed as film coatings on food or between food components.

In this paper we are talking about the characteristics of edible film using Chitosan and Pectin solution.

Chitosan Film: Chitosan is a bio-polymer made out of modified Chitin that is usually derived from Shell fish. The general development of the film was to provide adequate, albeit impermanent, lamination of food products for protecting during long transportation.

Characteristics of Chitosan: Chitosan is non-toxic and also an active coating material for perishable and anti - microbial activity. 1% of Chitosan Solution contains 64 µg/ml Ni-sin & 250 µg/ml E- Poly-lysin. Chitosan films, which have a single type of polymer, retained volatile compounds less effectively and therefore allowed more molecules into the vapor phase with resultant increase in antimicrobial activities (Avila-Sosa *et al*. 2012) [2].

Preparation of Chitosan Film

At first 2 gm amount of powdered Chitosan taken at the beaker than 1% of Acetic Acid mixed with 100ml of distilled water. After that the solution is taken to the heating stirrer for 3.5 hrs. at the temperature of 60° centigrade. After that 20ml solution is casted in petri-dish and taken to the drying oven for film at the temperature of 40° centigrade for 2 to 3 days. Then film will be prepared.

The thickness of the chitosan film is – 0.118 mm. A digital micrometer (Mitutoyo Corp. MDC- 1 SB digital micrometer, Japan) with accuracy of 0.001 mm used at least on 5 random positions of the film sample to determine the thickness after evaluation (Ahmadi, R. *et al*., 2012) [1]

The Color of the Chitosan film is measured by the following data

Sl. No.	Name of the product	Value of L*	Value of a*	Value of b*	Value of Chroma	Value of Hue	Value of Hue angle
1.	Chitosan Film	93.15±0.01	-1.675±0.025	40.555±32.545	60.47	77.645	102.355

Where L* value stands for Brightness and Darkness (0-50 dark, 51-100 light). a* value stands for Red and Green colour (0-50 red, 51-100 green).

b* value stands for blue and yellow colour (0-50 blue, 51-100 yellow).

Texture Analysis of Chitosan Film

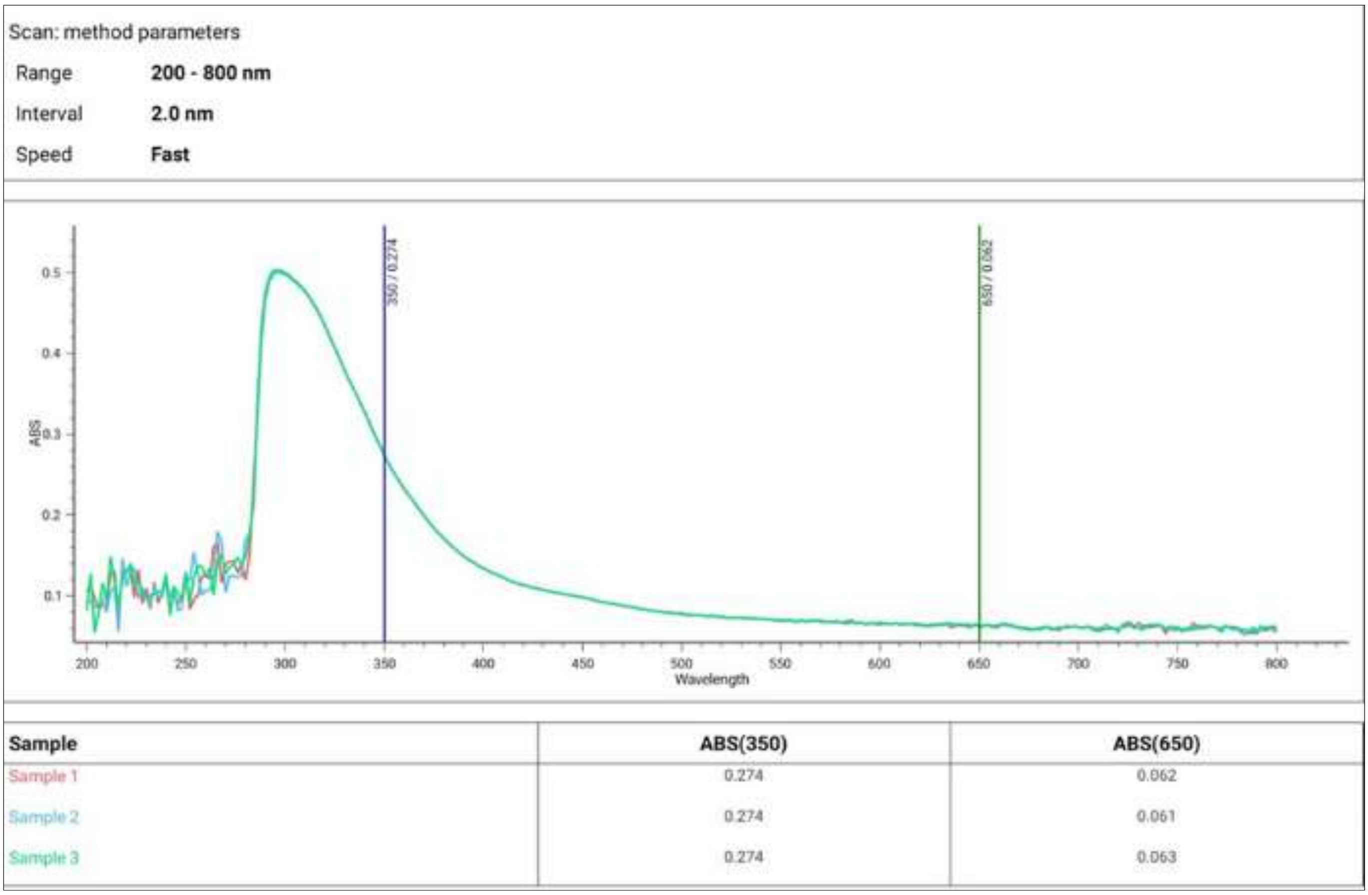
The most crucial physical characteristics for determining the flexibility and strength of any film are tensile strength (TS) and elongation (E) (Klangmuang *et al*. 2016) [4]. The tensile strength and elongation of chitosan/CNC composite films were tested mechanically to determine the impact of CNC fraction integrated in various percentages (5, 10, 20 and 30% (w/w)). As a control, CS film devoid of CNC was employed. The texture or more appropriately we can say the tensile stress of the Chitosan film is measured by the formula Force/Area.

At First Area is measured, then the force is determined from the highest peak point of the shown graph.

Force = 2.8333 N, Area = 15.206 M^2.

So, the Tensile Stress = F/A = 2.8333 N / 15.206 M^2 = 0.186 N/M^2

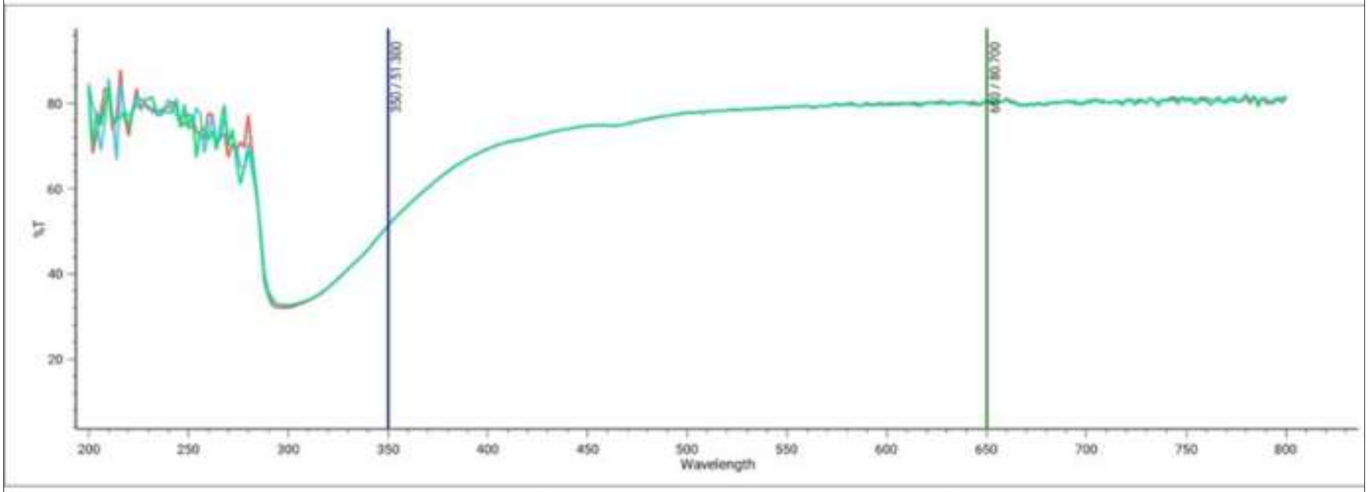
UV characteristics of the Chitosan film



Graph of UV light absorbance of Chitosan Film

Scan: method parameters

Range	**200 - 800 nm**
Interval	**2.0 nm**
Speed	**Fast**



Sample	%T(350)	%T(650)
Sample 1	51.300	80.700
Sample 2	51.300	80.600
Sample 3	51.300	80.700

Graph of UV light tolerance of Chitosan Film

Chitosan Film

Pectin Film: Pectin Film is used to increase the food quality and extend the shelf life of food products which is considered as an alternative to packaging materials from synthetic polymers, thus preventing environmental pollution from non- biodegradable plastic materials. Pectin-based coatings and edible films are bio-degradable and exhibit enhanced antioxidant and antimicrobial properties.

Characteristics of Pectin: Pectin is Soluble in pure water, but it is insoluble in aqueous solution in which it would gel at the same temperature if dissolved at a higher temperature.

Preparation of Pectin Film: At first 2gm powdered Pectin is taken. After that 0.6 gm glycerol added with 100 ml distilled water after preparing the solution it takes to the heating stirrer for oil bathing and heated at 60° Centigrade temperature for 1 hour. Then it is Casted at the amount of 25 mm petri dish and takes to the drying oven at temperature of 45° centigrade for 2 to 3 days. Then film will be prepared.
The thickness of the pectin film is 0.104 mm. A digital micrometer (Mitutoyo Corp. MDC-1 SB digital micrometer, Japan) with accuracy of 0.001 mm used at least on 5 random positions of the film sample to determine the thickness after evaluation (Ahmadi, *et al*. 2012) [1]

The color of the pectin film is measured by the following data

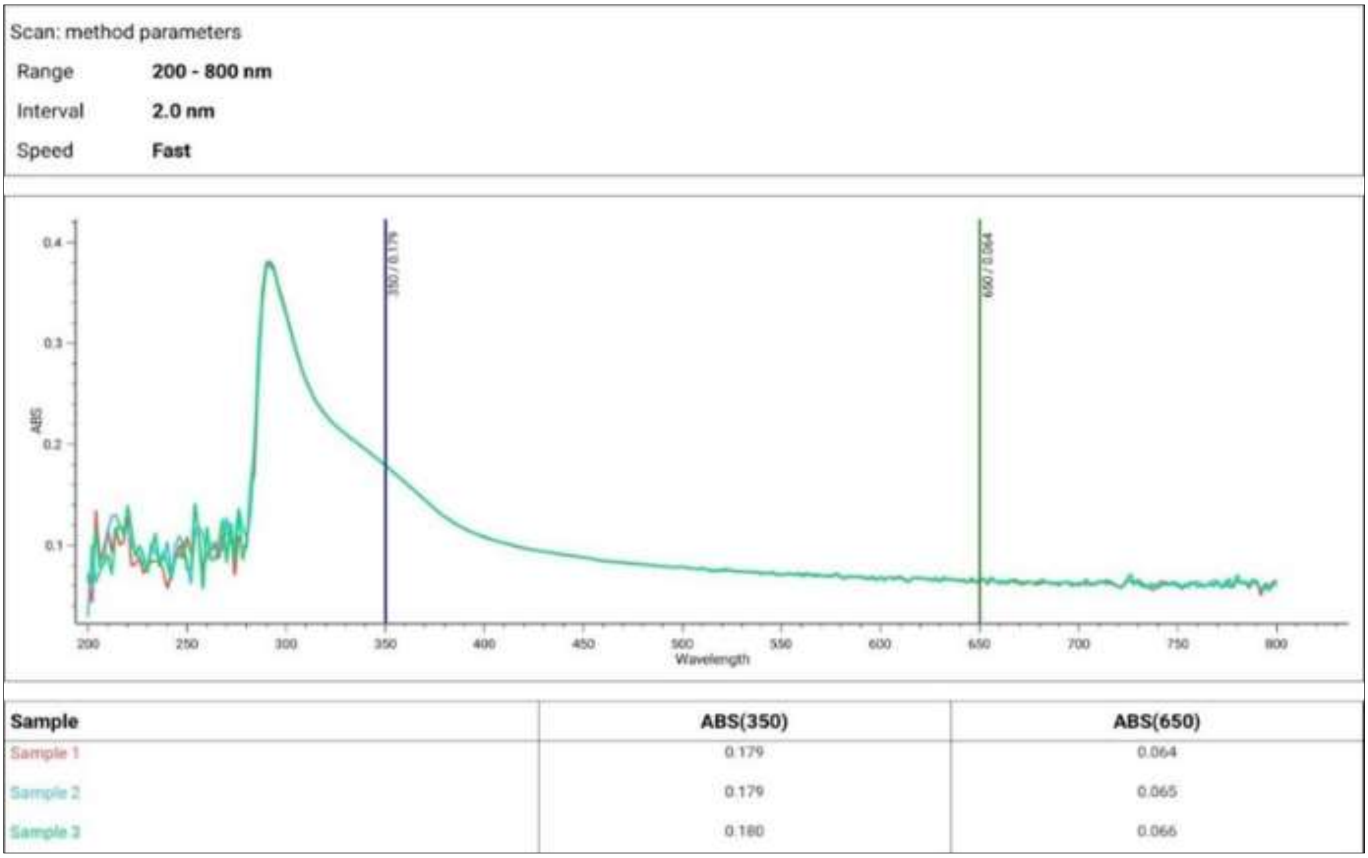
Sl. No.	Name of the product	Value of L*	Value of a*	Value of b*	Value of Chroma	Value of Hue
1.	Pectin Film	90.87±1.22	-0.83±0.06	5.07±0.43	26.77	80.53

Where,
L* value stands for Brightness and Darkness (0-50 dark, 51-100 light). a* value stands for Red and Green colour (0-50 red, 51-100 green).
b* value stands for blue and yellow colour (0-50 blue, 51-100 yellow).

Texture Analysis of Pectin Film

The texture or more appropriately we can say the tensile stress of the Pectin film is measured by the formula Force/Area.
At First Area is measured, then the force is determined from the highest peak point of the shown graph
Force = 4.6529 N, Area = 21.425 M^2.
So, the Tensile Stress = F/A = 4.6529 N / 21.425 M^2 = 0.217 N/M^2

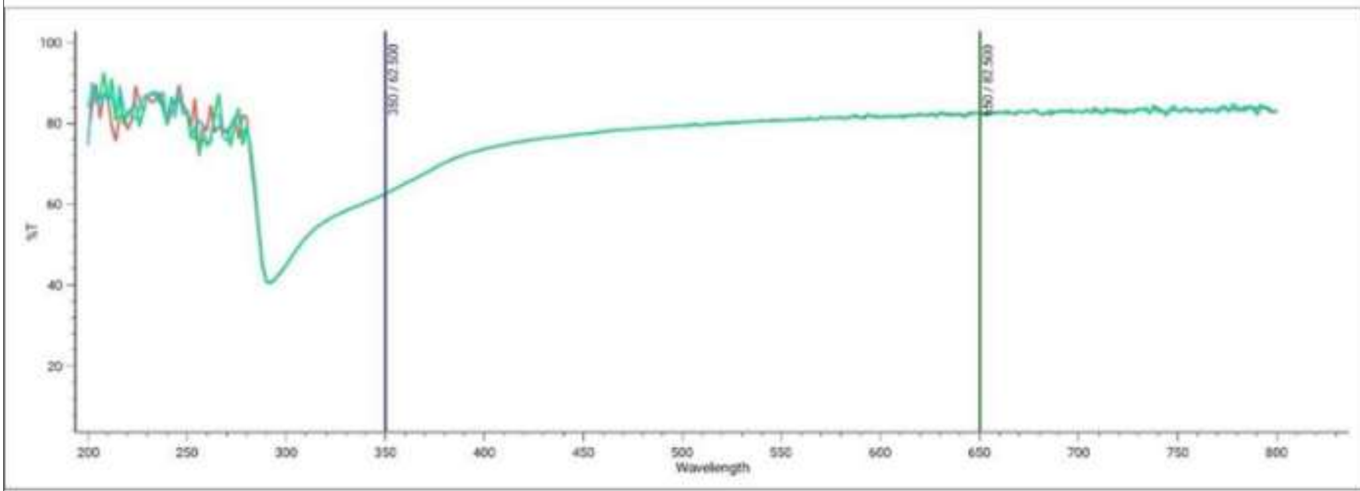
UV characteristics of the Pectin film



Graph of UV absorbance of Pectin Film

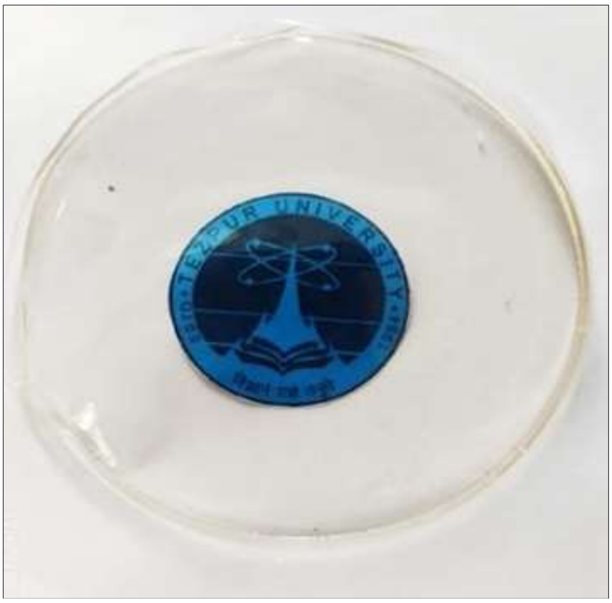
Scan: method parameters

Range	**200 - 800 nm**
Interval	**2.0 nm**
Speed	**Fast**



Sample	%T(350)	%T(650)
Sample 1	62.500	82.500
Sample 2	62.600	82.400
Sample 3	62.600	82.700

Graph of UV tolerance of Pectin



Pectin Film

Conclusion

After studying this paper we are come to know that Chitosan a polysaccharide- based bio-polymer is a nontoxic has anti-microbial activity can be used in various field of food industry, it is a good at UV absorbing and has excellent barrier properties against water vapour and oxygen and in the other hand Pectin also polysaccharide-based bio-polymer made up of extract of citrus fruits skin like lemon peels and skins, orange peels and skin etc. has great advantages to extend shelf-life of food by retarding lipid oxidation, inhibiting microbial growth, controlling water movement. As per the research we found pectin is best in some ways than chitosan film. The raw materials for producing Pectin are easily available in the nature than Chitosan and the use of Pectin film is more in various types of food industry such as dairy, processing etc. than Chitosan film. As per the availability of raw materials, making procedure, uses in industry we can say Pectin is more appropriate for use as packaging material than Chitosan.

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