



## Development of Banana Edible Film and Assessment of Physicochemical Properties

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### Authors' contributions

This work was carried out in collaboration between all authors. Author JKT designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Author SJ managed the analyses of the study and guided to prepare the manuscript. Both authors read and approved the final manuscript.

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### ABSTRACT

**Aim of Study:** In today's generation there is a need of biodegradable packaging material to overcome the diseases due to synthetic food packaging. Edible packaging is produced from renewable natural sources and can increase the shelf life of food product. In particular banana peel is abundantly present in nature, loaded with ample nutrients, renewable and low cost. Hence the research aimed to develop edible film from banana peel.

**Study Design:** Experimental design

Place and duration of study: Department of Food Science and Nutrition, College of Community and Applied Sciences, MPUAT, Udaipur, from January 2017 to August 2019.

**Methodology:** For film production acetic acid and glycerol was added in solution to provide the better gelatinization, transparency and flexibility of film. The developed film was assessed for its physicochemical properties such as thickness, density, transparency, tensile strength, elongation at break, water solubility, surface reflection spectra and appearance. Moreover sensory evaluation of films was also conducted to know the acceptability of film using nine point hedonic scale.

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**Results:** After the various trials edible film was successfully developed from banana peels and developed banana film was found to have desirable properties as a packaging material. Results of sensory evaluation showed that film was neither liked nor disliked by panel members.

**Conclusion:** A non harmful and environment friendly edible film can be developed from the banana peel which will be beneficial for industrial use as a food packaging material. Moreover further researches are needed to bring this film from laboratory to consumer market.

*Keywords: Edible film; banana peel film; physicochemical properties; sensory evaluation.*

## 1. INTRODUCTION

In order to protect the food from external environment and extend the shelf life of food product packaging is necessary. The major part of packaging comes from polymers and polymers are non-renewable and non biodegradable materials which are negatively affecting all living beings and surroundings. Therefore to achieve the sustainability and to increase the shelf life of the food products with maintaining the quality, scientific researches towards alternative packaging are required. Some alternative packaging materials obtained from renewable resources, such as poly(lactic acid), PLA, poly (hydroxyalkanoates) (PHAs), starch or proteins, have been proposed as alternatives to non-biodegradable polymers in food packaging applications. The term "edible film" has two main considerations. First part "edible" means, films may be consumed together with foods in contact so they need to cover all properties of safe-food ingredients according to Food and Drug Administration (FDA) having Generally Recognized as Safe (GRAS) status [1].

Edible packaging formats can be consumed with, or as part of the food product, but they may fulfill other functions; like acting as carriers for targeted food additives (antimicrobial agents, antioxidants, flavourings, etc.). Edible films may also be used to inhibit moisture, oxygen or carbon dioxide migration and to improve the mechanical integrity or handling characteristics of the food [2].

Edible films prepared from polysaccharide are strong and comparatively low cost as polysaccharides are abundantly present in nature. Banana is one of rich source of polysaccharide source and raw banana peels contains large amounts of starch, cellulose, hemicellulose and lignin. Banana peel is enclosed with fairly complete nutrients such as, fat, carbohydrates, protein, calcium, phosphorus, vitamin C and water. Composition of banana peel holds good amount of water 68.9 per cent and carbohydrates 18.5 per cent. Banana peels have potential to be used in making edible film [3].

These characteristics reveals its suitability as edible film development source hence edible film from banana was prepared and its physicochemical qualities were assessed.

To achieve the better functionality of edible films and coatings, some measurable quality parameters (physical, mechanical, chemical, organoleptic and antimicrobial properties) are necessary to assess. These properties of edible films and coatings are affected by various parameters such as the kind of film forming material composition, film forming mechanism like; type of solvent, pH of medium, heating temperature and the type and concentration of additives (plasticizers, antioxidants, antimicrobials, cross-linking agents) and method of drying [1,4].

## 2. METHODOLOGY

### 2.1 Locale of the Study

The study was conducted at Department of Food Science and Nutrition, College of community and applied sciences, Maharana Pratap University of Agriculture & Technology Udaipur (Rajasthan).

### 2.2 Selection and Processing of Base Material

Firstly, raw fresh bananas were procured from the local market. Banana peels were taken out using a stainless steel knife. Banana peels were washed with distill water to separate the dirt particles. Then peels were cut into small pieces. Peels pieces were dried in oven at 50°C for 48 hours. After that dried peels were ground using a mechanical grinder to obtain fine powder and strained with strainer. The banana peel powder was packed in an air tight polythene bag and stored in desiccators for the further study.

### 2.3 Edible Film Formation

Firstly 4 per cent (w/v) banana peel powder was dispersed in 100 ml of distilled water and then acetic acid (2% w/v) and plasticizer glycerol (4% w/w) was added in the solution. After that the

solution was heated at 70°C for 35 min on hot plate. The beaker was removed from the hot plate and solution was transferred in tube and stirred through vortex mixer for 25 minutes. Then the solution was strained through strainer and casted on equal level polythene sheet and dried for five days at room temperature. The dried and uniformed films were peeled off from polythene surface.

## 2.4 Assessment of Physicochemical Properties

### 2.4.1 Film thickness

Thickness of films was measured by using screw gauge to the nearest  $\pm 0.01$  mm.

### 2.4.2 Density

The density of film samples was calculated from the film weight and dimensions. The film strips 5-cm X 5-cm samples were weighed on a balance to the nearest 1 mg. Balance readings was divided by the area of the samples (25 cm<sup>2</sup>) to calculate surface density. For each type of film, five independent surface density values were obtained by using formula given:

$$\rho^s = m/(A \times \delta)$$

A- film area,  $\delta$ - thickness (cm), m- dry mass (g) and  $\rho^s$ -dry matter density [5].

### 2.4.3 Film transparency

Film transparency of samples was measured by using ultraviolet and visible range Spectrophotometer. Transparency of films was measured at 600 nm. and obtained data was calculated by method followed by Han and Floros, [6].

### 2.4.4 Tensile strength

Tensile strength of the films was measured by tensile strength testing machine, standard method [7]. The film samples were cut in the strips 8' x 4' cm. Values of breaking load of edible film sample were read directly on the digital screen. Total three observations of each film sample were recorded and mean breaking load was calculated.

### 2.4.5 Elongation at Break (EAB)

The elongation at break of the films was determined by using the same texture analyzer by the standard testing method AOAC, [7].

### 2.4.6 Water solubility

The water solubility test was conducted to simulate the dissolving property of the films in a liquid system by following the method by Shinjie [8], with slightly modifications. The reading of water solubility of each film was calculated from the following equation:

$$\text{Water solubility} = \frac{\text{Film initial weight} - \text{Undissolved matter weight}}{\text{Initial weight}} \times 100$$

### 2.4.7 Surface reflection spectra

The color of film samples was measured by using Hunter Lab Colorimeter. It uses three dimensional scale L, a\* and b\* to quantify color values.

### 2.4.8 Film appearance

The appearance of developed edible films was visually examined by the researcher.

## 2.5 Sensory Evaluation

Developed edible film was evaluated for their organoleptic characteristics: Appearance, color, transparency, surface smoothness, flavor, texture, taste or mouth feel and overall acceptability by a panel of 10 trained judges using 9-point Hedonic rating scale.

## 2.6 Statistical Analysis

All experiments were conducted in triplicate, and the results were presented as mean  $\pm$  standard deviation.

## 3. RESULTS AND DISCUSSION

Banana peel contains good amount of nutrients i.e. fat, carbohydrate, protein, vitamin C, calcium, phosphor and water. The major contain of banana peel is carbohydrate- starch. Starch is basically a polysaccharide of hydrocolloid which is the main constituent in making edible film. The process of film formation is gel formation due to temperature treatment, resulting in the development of matrix. Therefore edible film from banana peel powder was obtained successfully. Results obtained from physicochemical properties and sensory evaluation is presented below:

### 3.1 Physicochemical Properties

#### 3.1.1 Film thickness

Thickness of the edible films affects other characteristics of the films, such as density,

tensile strength, elongation, and water solubility [9,10]. The thickness of banana film was observed  $0.90\pm 0.10$  as presented in Table 1. Zuo [11], reported that the film thickness improved significantly ( $P < .05$ ) with the increase in starch and zein addition, the film made up of corn, wheat and zein was 0.14 mm thick. On the basis of review of literature it was found that thickness of edible films depends on both composition of film and film processing parameters such as concentration of basic ingredients, plasticizer, antibacterial, heating temperature and amount of solution spreading.

**Table 1. Physicochemical properties of developed banana edible film**

S. no.	Attributes	Banana peel edible film
1	Thickness(mm)	0.90±0.10
2	Density (g/m <sup>3</sup> )	0.42±0.02
3	Transparency (nm)	1.13±0.04
4	Tensile strength (kg/cm <sup>2</sup> )	1.83±0.06
5	Elongation at break (%)	93.73±3.86
6	Water solubility (%)	70.11±1.92

### 3.1.2 Density

Basically density is a measure of the quantity of matter or mass (weight) that can fit in a given space (volume). Density of edible film is important because it reflects how much space is there and what maximum safe load it can carry, so whether filling it with a specific material will be safe or not, it also affects whether the film will float or sink in water. The density of banana edible film was noted  $0.42\pm 0.02$  g/m<sup>3</sup>. Reduction in density might be ascribed to the enhanced thickness (and volume), higher the thickness, density will be lower (Table 1).

### 3.1.3 Film transparency

Transparency of edible film is a desirable property because it is clearly relevant to its acceptability by the consumer. As transparency enhance the visibility of food products, packed within the edible film and consumer needs to clearly see the product covered by the film. The transparency of banana edible film (Table 1) was observed  $1.13\pm 0.04$  nm. Khairunnisa, [12] reported that the higher the thickness value of the developed edible film there will be augment the diffusion of light so that the edible film object will appear more opaque and the brightness will be lower.

### 3.1.4 Tensile strength

Tensile strength of edible film is the most vital mechanical property, which reflects that how much maximum stress that the film sustains before it eventually breaks. Tensile strength demonstrates the film strength in defend against the mechanical damage. The tensile strength of developed film was found  $1.83\pm 0.06$  (kg/cm<sup>2</sup>) as depicted in Table 1.

### 3.1.5 Elongation at break

Elongation at break is the highest extension value that an edible film can reach before it is finally broken down. Elongation at break of banana edible film was demonstrated  $93.73\pm 3.86$  per cent (Table 1). Murrieta-Martínez, [13] also observed 90 per cent elongation at break of edible film. The difference between the per cent elongation value of reported studies clearly indicates that elasticity of edible films varied due to the base ingredient used, method of preparation, as well as amount of plasticizer incorporated for the film formation.

### 3.1.6 Water solubility

Edible film solubility in water is associated with its structural characteristics, some type of potential food applications may involve the edible films to be soluble in water and on the other hand some may not necessitate the water solubility of film, to increase the water resistance and integrity of product. The Table 1 indicates that water solubility per cent of banana edible film was exhibited  $70.11\pm 1.92$ . Reis et al. [14] has stated in their study that water solubility of edible films of yam starch and glycerol was found to be affected by the contact between starch and glycerol. Higher solubility of films was found for enhanced levels of glycerol and lower level of yam starch. Lower solubility was observed for lower amount of glycerol and higher amount of starch contents. The researcher has concluded that concentration of glycerol was a major affecting factor in water solubility per cent of the edible films.

### 3.1.7 Surface reflection spectra

A Surface reflection spectra is a major characteristic for general appearance and consumer acceptability of developed edible films. L\* value (lightness0 = black, 100 = white) of developed film was found  $16.38\pm 0.05$ . The a\* value of banana film was noted  $3.94\pm 0.01$  and b\* value was observed  $6.64\pm 0.02$ . The result of surface reflection spectra revealed higher

L\* value which indicates that banana film was dark in color (Fig. 1).

### 3.1.8 Film appearance

The appearance of developed film varied from two sides dull to smooth surface, the films facing to the casting sheets were shiny but the other side was found dull. Film was opaque and brown in colour.

### 3.2 Sensory Evaluation

The sensory attributes of developed banana film were neither liked nor disliked on nine point

hedonic scale (Fig. 2). The colour attribute of film scored  $5.80 \pm 0.23$ . The banana film scored 5.70 and 5.57 from transparency and flavour point of view respectively. Similar kind of observations in result of other attributes was noted. The overall acceptability of developed film was found  $5.77 \pm 0.32$ . The data clearly indicates that banana film was not liked by panel members for its organoleptic properties this might be due to the fact that film was dark in colour which affected the overall appearance of film and film was evaluated solely without any food product which might be a reason of low scores as film was not having any dominant taste or flavor.

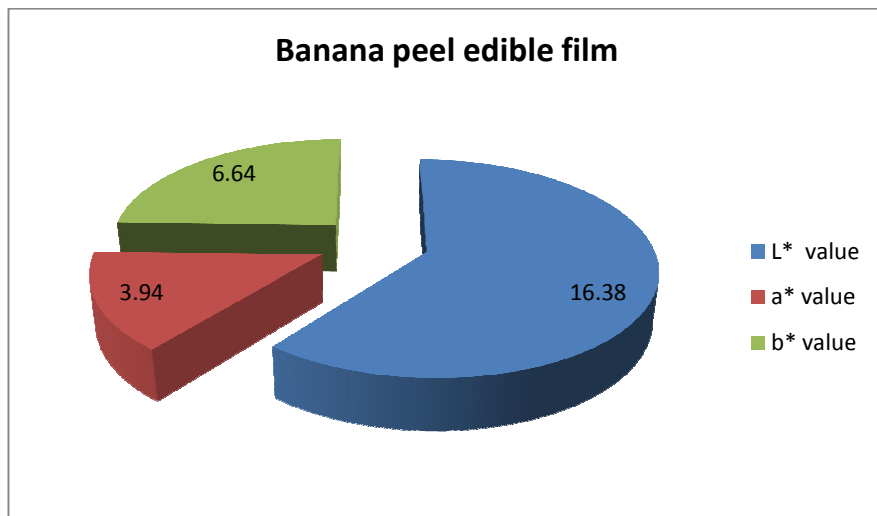


Fig. 1. Surface reflection spectra of banana edible film

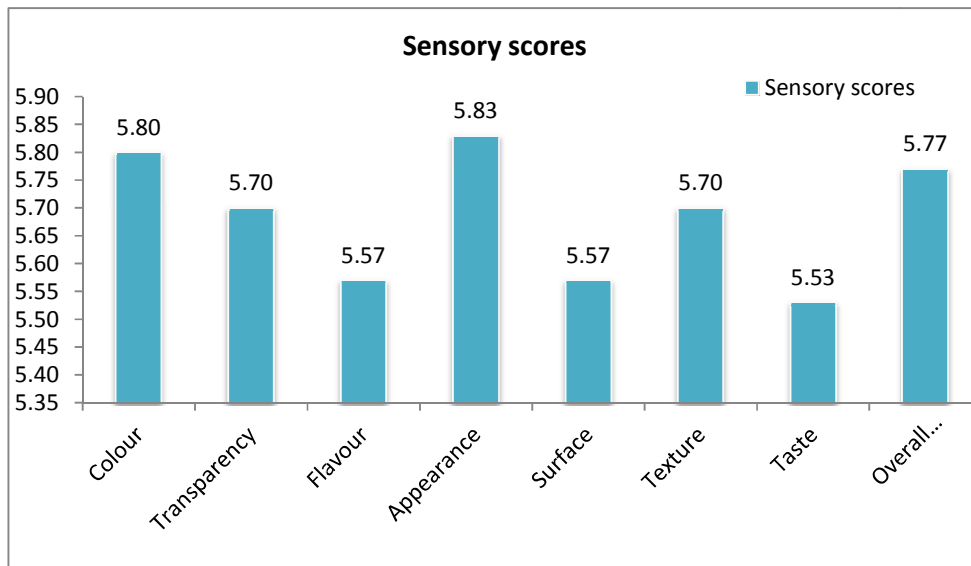


Fig. 2. Sensory scores of banana edible film

#### 4. CONCLUSION

Banana peel can be potentially used to prepare the edible film. The only drawback is its colour which can be solved by starch extraction and discoloration by using blanching method. The result of physicochemical properties and organoleptic qualities showed that banana edible film holds good characteristics as a packaging material and these characteristics can be improved by further researches on banana edible film. Film production from banana peel would be applicable on various food materials.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

#### REFERENCES

1. Erkmen O, Barazi A. General characteristics of edible films. *Journal of Food Biotechnology Research*. 2018;2:1-3.
2. O'Sullivan A, Shaw NB, Murphy SC, Van de Vis JW, Van Pelt-Heerschap H, Kerry JP. Extraction of collagen from fish skins and its use in the manufacture of biopolymer films. *Journal of Aquatic Food Product Technology*. 2006;15(1):21–32.
3. Astuti P, Erprihana A. Antimicrobial edible film from banana peels as food packaging. *American Journal of Oil and Chemical Technologies*. 2014;2(2):66-70.
4. Falguera V, Quintero JP, Jimenez A, Munoz JA, Ibarz A. Edible films and coatings: Structures, active functions and trends in their use. *Trends in Food Science and Technology*. 2011;22:292-303.
5. Ramos OL, Silva SB, Soares JC, Fernandes J. Features and performance of edible films, obtained from whey protein isolate formulated with antimicrobial compounds. *Food Research International*. 2012;45(1):351-361.
6. Han JH, Floros JD. Casting antimicrobial packaging films and measuring their physical properties and antimicrobial activity. *Journal of Plastic Film and Sheeting*. 1997;13(4):287-298.
7. ASTM. Standard test method for tensile properties of thin plastic sheeting. E 882-02, Annual Book of ASTM Standard. Philadelphia, PA. 2002;1–9.
8. Shinjie MS. Development of edible packaging for selected food processing applications. Ph.D. Thesis Submitted to The Ohio State University; 2012.
9. McHugh TH, Aujard JF, Krochta JM. Plasticized whey protein edible films: Water vapour permeability properties. *Journal of Food Science*. 1994;59(2):416-419.
10. Galus S, Lenart A. Development and characterization of composite edible films based on sodium alginate and pectin. *Journal of Food Engineering*. 2013;115: 459-465.
11. Zuo G, Xiaoyng S, Fusheng C, Zhixiang S. Physical and structural characterization of edible bilayer films made with zein and corn-wheat starch. *Journal of the Saudi Society of Agricultural Sciences*; 2017. [Retrieved from: 2017.09.005 on 28 May 2019] Available: <https://doi.org/10.1016/j.jssas>
12. Khairunnisa S, Zahidah J, Rostini I. The effect of glycerol concentration as a plasticizer on edible films made from alginate towards its physical characteristic. *International Journal of World Scientific News*. 2018;112:130-141.
13. Murrieta-Martínez CL, Soto-Valdez H, Pacheco-Aguilar R, Torres-Arreola W, Rodríguez-Felix F, Márquez-Ríos E. Effect of different polyalcohols as plasticizers on the functional properties of squid protein film (*Dosidicus Gigas*). *Coatings*. 2019; 9(77):1-12.
14. Reis RC, Devilla IA, H. Oliveira GH, Corrêa P, Ascheri DPR, Athina BM, Souza ABM, Servulo ACO. Mechanical properties, permeability and solubility of films composed of yam starch and glycerol. *Interciencia*. 2014;39(6):410-415.

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