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Effect of Ripening on the Extracted Pectin from Banana Peels, Its Concentration and Characterization

Shalini Chanda, Dr Soumitra Banerjee *

Dept. of Food Technology Techno Main Salt Lake (TMSL),

Kolkata – 700091, West Bengal, India

Abstract

Banana is a climacteric fruit and produces ethylene gas during its storage. More the production of ethylene faster will be ripening rate. The effect of ethylene induced ripening also has an effect of pectin degradation in the banana peels. At higher ripening rate pectin degradation is also faster and results lesser extractability of pectin from the peels both for unripe and ripe banana system. Pectin characterization obtained from unripe banana was also made and it showed banana stored under modified atmospheric condition of storage where the ethylene was absorbed by potassium permanganate, showed better character of pectin. With greater ethylene production rate ripening process is faster resulted more pectin degradation, resulting in softening of texture.

***Key words*:** Pectin, Methoxyl content, Degree of esterification, wax coated banana, Modified atm storage,

1. Introduction

Banana (*Musaspp.*) is herbaceous flowering plant that is extensively grown in humid tropical and subtropical regions [1]. Peels of bananas has gained recognition in recent times for being a rich source of natural substances like cellulose, pectin, and antioxidants. The complex hetero polysaccharide pectin connects the middle lamellae and cell wall of plant cells. The primary backbone of pectin is made up of 1,4-α linked D-galacturonic acid units [2]. In a variety of food products, it could be utilized as a stabilizing agent, thickening, texturizer, emulsifier, and gelling agent [3].The process of extracting pectin from banana peels involves the regular use of acid solvents with a pH range of 1.0–3.0,such as hydrochloric, or citric acid, etc. [4]. The insoluble pectin that is firmly attached to the plant materials' cell matrix is primarily extracted by the acids [5].

Variations in pectin properties, such as the degree of esterification and degree of methylation, among others, may result from different pectin extraction circumstances (pH, temperature, kind of acid, time, etc.). According to Stephen et al. (2006), degree of esterification is the existence of acetic ester and acetic carboxy connected to one of galacturonic acid's secondary alcohols [6]. According to Liew et al. (2018), degree of methylation denotes the presence of a methoxyl ester in pectin, which is measured as the proportion of methylated galacturonic acid to galacturonic acid [7]. As a result, pectin can be further classified as low methoxyl pectin with degree of esterification or degree of methylation $<$50% and high methoxyl pectin with degree of esterification or degree of methylation ≥50%, which indicates that more than 50% of the pectin's carboxylic groups are methylated. There are two other types of high

methoxyl pectin: "rapid set" and "slow set." All high methoxyl pectin gels are in strongly acidic environments with high solids content; however, the quickset variety takes longer to set and has a higher temperature than the slow set variety. However, Yang et. al., (2018) notes that the low methoxyl pectin needs calcium ions (Ca2+) for the gel to set. Thus, different degree of etherification and degree of methylation values of pectin could significantly affect the resulting texture in food products [9].
The objective is to study the characteristic changes in pectin extracted from different banana samples mainly for ripe and unripe samples, under different storage conditions.

2. Literature Review

There are not many literature studies in relation to the effect of ripening on pectin concentration using banana peel. But a research article named "Effect of Acid Type and Concentration on Properties of Pectin Extracted from Unripe Cavendish Banana Peel and Its Application in Raspberry Jam," evaluated the properties of pectin from unripe cavendish banana peel using different acidic extractions. Hydrochloric, citric, and malic acid solutions at various pH values (1.5, 2.0, and 2.5) were used in this study. The properties of a raspberry jam added with the obtained pectin were also investigated. The extraction yield, galacturonic acid content, degrees of esterification and degree of methylation of the samples were quantified and compared. The highest pectin yield was obtained using extraction with citric at pH 2.0. The citric extraction also gave the highest percentages of degrees of esterification (50.27 %) and degree of methylation (59.57%) at pH 1.5.Extraction with HCl gave higher galacturonic acid content to the extracted pectin. Additionally, the use of HCl at pH 1.5 also provided the highest gel hardness (30.26 g) [9].
Another research article by Lina Du and their fellow mates studied the proteome changes in banana fruit peel tissue in accordance with the ethylene and high-temperature treatments, where ethylene treatment, treated and untreated fruit were stored at 20 or 30°C for 24 hours. Fruit peel tissues were then sampled after one and one day of storage, and peel color and chlorophyll fluorescence were evaluated. Quantitative proteomic analysis was conducted on the fruit peels after 1 day of storage. In total, 413 common proteins were identified and quantified from two biological replicates. Among these proteins, 91 changed significantly in response to ethylene and high-temperature treatments [10].

3. Materials and Methods

3.1. Extraction of pectin from banana peel
3.1.1. Sample Preparation

The banana peel was weighed and cut into small pieces to fasten the drying process using a tray dryer at 55 degree centigrade for 24hrs.

3.1.2. Pectin Extraction

The dried pieces were grounded to form finer particles using a mortar pestle. It was treated with 0.5N Citric acid to bring down its pH to 2-2.5 at temperature 90℃ under stirring condition for 4 hrs to extract the pectin from the peel. After that, to the solution twice the volume of ethanol was added. Finally, it was filtered through a Whatman filter paper to get the pectin precipitate and dried at 40℃ for 24hrs.

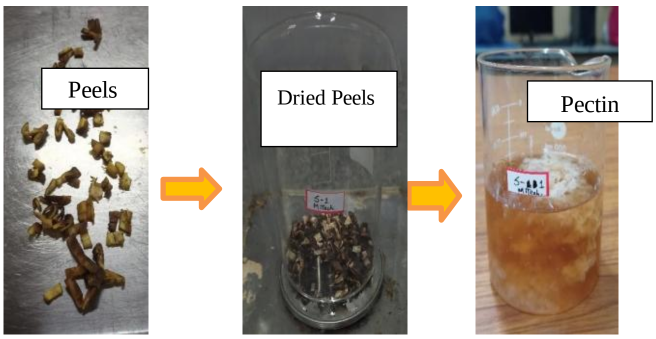

Fig. 1: Banana peels, Fig. 2: Dried Banana Peels, Fig. 3: Pectin
Extraction

3.2. Characterization of pectin

3.2.1. Equivalent weight

Equivalent weight was used for calculating the anhydrouronic acid content and the degree of esterification. It was determined by titration with NaOH (Titration A) to pH 7.5 using phenol red or Hinton's indicator. Equivalent weight (EW) was calculated using the equation:
EW= {(weight of sample (g)x 1000)/(mL of alkali x N of alkali)}… [11]

3.2.2. Methoxyl content
The methoxyl content or degree of esterification is an important factor in controlling the setting time of pectin, the sensitivity to poly valent cations, and their usefulness in the preparation of low solid gels, films, and fibers. It is determined by the saponification of the pectin and titration of the liberated carboxyl group. To the neutral solution titrated for equivalent weight containing 0.5g of pectic substance, 25 mL of 0.25N NaOH was added, shaken thoroughly, and was allowed to stand for 30 minutes at room temperature in a flask with stopper. A 25 mL portion of 0.25N HCl (or an amount equivalent to the base added) was added and was titrated with 0.1N NaOH to the same end point as the previous one (Titration B).The methoxyl content was calculated using the equation:

Methoxyl content (%) = (mL alkali x N alkali x3.1)/Weight of sample(g)...[11]

3.2.3. Total Anhydro Uronic Acid (TAUA)

Pectin, which is a partly esterified poly-galacturonide, contains 10% or more of organic material composed of arabinose, galactose, and other sugars. Estimation of anhydro uronic acid content is essential to determine the purity, degree of esterification, and in evaluating the physical properties of pectin. Making use of the equivalent weight, methoxyl content and the alkalinity of the ash data, anhydro uronic acid was calculated from the expression given below.

AUA (%) = {(176 x0.1zx 100)/ (W x 1000)} + {(176 x 0.1y x 100)/ (W x1000)}

Where molecular unit of AUA (1unit) =176 gm, z = mL of NaOH from equivalent weight determination, y=mL of NaOH from methoxyl content determination, W=weight of sample taken. [12]

3.2.4. Degree of Esterification

The degree of esterification (DE) of pectin was determined according to the formula below (Shaha et al.,2013):
DE(%)={176xMethyoxylContent(%)x100}/{31xAUA(%)}[11,13]

3.2.5. The Pectin Yield calculating formula:

%Pectin Yield=(Extracted Pectin in gm/Weight of sample in gm)x100%…[11]

4. Result and Discussion

Fig. 4: Unripe banana samples were used for pectin characterization.

Fig.5&6: Pectin extraction from 3 different unripe banana samples.

Here, sample-1 being untreated, sample-2 being controlled and sample-3 is the wax coated or modified banana sample. Itwas observed during this pectin extraction that the binding properties of the controlled sample were far better as compared to other two. It was just an observation, and further analytical results will clear this aspect much more.

4.1. Physico- chemical Properties characterization of pectin.

4.1.1. Equivalent Weight Calculation:

4.1.1.1. Untreated Unripe Banana Sample:

Equivalent Weight = {(weight of sample (g) x 1000)/ (mL of alkali x N of alkali)} Or, EW=(0.008 x 1000)/ (0.08 x 0.1)=1000

4.1.1.2. Controlled Unripe Banana Sample

EW=(0.056 x 1000)/ (0.17 x 0.1)=3294.11

4.1.1.3. Modified or Wax Coated Unripe Banana Sample

EW=(0.003 x 1000)/ (0.04 x 0.1)=750

4.1.2. Methoxyl Content Calculation

4.1.2.1. Untreated Unripe Banana Sample:

Methoxyl content (MeC) (%)=(mL alkali x N alkali x3.1)/Weight of sample (g)
Or, MeC= (0.28x 0.1 x 3.1)/ 0.0986 = 0.8803%

4.1.2.2. Controlled Unripe Banana Sample:

MeC=(0.26x 0.1 x 3.1)/ 0.0724 = 1.1132%

4.1.2.3. Modified or wax-coated Unripe Banana Sample:

MeC=(0.26x 0.1 x 3.1)/ 0.081 = 0.995%

4.1.3. TAUA (Total Anhydro Uronic Acid):

4.1.3.1. Untreated Unripe Banana Sample:

AUA(%) = {(176 x 0.1z x 100)/ (W x 1000)} + {(176 x 0.1y x 100) / (W x 1000)} Or,AUA(%) = {(176 x 0.1 x 0.08 x 100)/ (0.008 x 1000)} + {(176 x 0.1 x 0.28 x100/(0.0986 x 1000)=22.5979 %.

4.1.3.2. Controlled Unripe Banana Sample

AUA(%)={(176x0.1x0.17x100)/(0.056x1000)}+{(176x0.1x0.26x100)/(0.0724 x 1000) =11.6632 %.

4.1.3.3. Modified or Wax Coated Unripe Banana Sample

AUA(%)={(176x0.1x0.04x100)/(0.003x1000)}+{(176x0.1x0.26x100)/(0.081 x 1000)}=29.116 %.

4.1.4. Degrees of Freedom:

4.1.4.1. Untreated Unripe Banana Sample:

Degree of Esterification (DE) (%) = {176 x Methyoxyl Content(%)x100}/{31xAUA(%)}

4.1.4.2. Controlled Unripe Banana Sample

DE= (176 x 1.1132 x 100) / (31 x 11.6632) =54.1884%.

4.1.4.3. Modified or Wax Coated Unripe Banana Sample

DE= (176x0.995 x 100) / (31 x 29.116) =19.4018 %.

4.1.5. Pectin Yield for Ripe Banana Samples was estimated

4.1.5.1. Untreated Unripe Banana Sample:

% Pectin Yield = (Extracted Pectin in gm/Weight of sample in gm) x100% Or, % PY = (4.897/ 17.3) x 100 % = 28.3 %.

4.1.5.2. Controlled Unripe Banana Sample

%PY=(4.821/ 17) x100 %=28.35 %.

4.1.5.3. Modified or Wax Coated Unripe Banana Sample

%PY=(5.138/ 18.5) x100 %=27.77 %.

5. Conclusion

Finally, it can be concluded that the effect of ethylene and ripening on the pectin characterization is significant. Higher the release of ethylene, higher will be the degradation of pectin in the banana peels. The overall analysis of the controlled atmospheric condition sample with potassium permanganate as ethylene absorber has shown very promising results as compared to untreated and wax coated samples. With ethylene regulation or removal by controlling the storage conditions, the shelf life of bananas can be increased. It can further solve the problem of long-distance transportation of bananas as they are very much perishable in nature. The storage inventory for bananas will also find this proposed prototype idea very much helpful for upgrading their old systems. Hence, this IOT based sensor storage system can be of much use to the fruits and vegetable industries especially the banana supplying inventories.

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