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Extraction and Characterization of Pectin from Fruit Waste

P.S. Panchami* and S. Gunasekaran

Department of Agricultural Microbiology, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India
**Corresponding author*

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A B S T R A C T

Fruit wastes such as citrus peel, mango peel, apple pomace and banana peel were collected from fruit juice manufacturing industries and were subjected to pectin extraction. The results revealed that citrus peel is containing higher pectin content of about 24.5%. Characterization of different fruit waste were also done

Introduction

India is the third major producer of fruits and vegetables and ranks next to Brazil and China respectively, in the world. In recent years, the effect of fruit waste is one of major concern contributing to global environmental burden. For instance, the fraction of discarded materials in the majority of fruit processing industries is typically very high (Laufenberg *et al.,* 2003; Parfitt *et al.,* 2010) depending on the location and method of harvest (e.g. mango 30–50%, banana 20%, pomegranate 40–50% and citrus 30–50%).The food processing industry generates approximately 45 per cent of total industrial organic pollution (Akerberg and Zacchi, 2000). These organic wastes are rich in biodegradable materials, making them suitable substrate for biotechnological production of biochemicals. (Anuradha *et al.,* 1999). Bioconversion of carbohydrate waste is receiving increased attention in view of the fact that these wastes can act as substrate for the production of useful biomaterials and chemical intermediates (Baker *et al.,* 1998).

Pectins are complex polysaccharides consisting mainly of galacturonic acid units being linked by α-(1→4) linkages. Pectin is a polysaccharide widely used in food and pharmaceutical industries is as thickening and gelling agents (May, 1990).

Extraction is the most important process in the pectin production. Pectic substances are usually extracted by chemical or enzymatic methods, with a process of physical and chemical multiple stages, in which involves hydrolysis, extraction and solubilization of macromolecules (Pagan *et al.,* 2001). Extraction with hot water is the simplest and oldest method for recovery of pectic substances from plant tissues (Hermann,

1919). The extraction of pectin involves the hydrolysis of insoluble protopectin into soluble pectins and then leaching them out of fruit tissues.

The extraction of pectin from fruit peels using weak organic acid such as citric acid has been intensively conducted in recent studies (Minjares-Fuentes *et al.,* 2014; Kulkarni *et al.,* 2010; Pinheiro *et al.,* 2008). This work aims to extract and characterize pectin from different fruit wastes.

Materials and Methods

Sample collection

Fruit wastes such as citrus peel, mango peel, apple pomace and banana peel were collected (approximately 5kgs) from different locations in and around the fruit juice manufacturing industries in Coimbatore. Collected fruit wastes were dried in open to eliminate the available moisture and mixed thoroughly. The homogenized samples were powdered, kept separately and used for periodical analyses

Extraction of pectin from fruit wastes

From the fruit wastes of orange, mango, apple and banana, pectin was extracted as per the following procedure. About fifty gram of fruit waste was ground and 300 ml of 0.1 N HCL was added. The contents were boiled for 30 min. and filtered under suction. To the residue, boiling water was added and filtrate was collected. The process was repeated with 0.05 N HCL and 0.3 N HCL and filtrates collected.

All the filtrates were pooled and the volume was made up to 500 ml. From this 200 ml was transferred into a beaker and 250 ml of water was added. The acid present in the filtrate was neutralized by adding 1N NaOH using phenolphthalein indicator and allowed to stand for 24 h. Fifty ml of 1N acetic acid was added and after 5 min. 25 ml of 1 N calcium chloride was added with stirring and allowed to stand for an hour. The contents were then boiled for 2 min. and filtered through a pre weighed Whatman No. 1 filter paper. Finally the precipitate was washed with boiling water until the filtrate was free from chloride.

For estimating the total pectin content, the filter paper with calcium pectate was transferred to pre weighed dish and dried at 100^0 C overnight, cooled and dry weight determined (Manickam and Sadasivam, 1996).

$$\% \text{ Calcium pectate} = \frac{\text{Weight of calcium pectate} \times 100 \times 500}{\text{ml of filtrate taken} \times \text{Weight of sample taken for estimation}}$$

Calorimetric determination of pectin

About 100 mg of pectin was dissolved in 100 ml of 0.05 N NaOH and allowed to stand for 30 min. to deesterify the pectin. From this 2 ml of the solution was taken and made upto 100 ml with water. Two ml of deesterified pectin solution was pippetted and 1 ml of carbazole reagent was added. A white precipitate was formed.

To this 12 ml of conc. H_2SO_4 was added with constant stirring. The tubes were then closed with rubber stopper and allowed to stand for 10 min. to develop the colour. To set the blank, 1 ml of purified alcohol was added instead of carbazole reagent. The absorbance was read at 525 nm exactly 15 min. after the addition of acid.

For standards

About 120.5 mg of galacturonic acid monohydrate was taken in 1 litre volumetric

flask. To this 10 ml of 0.05 M NaOH was added and diluted to volume with water. After mixing it was allowed to stand overnight. From this 10,20,40,60 and 80 ml was taken and diluted to 100 ml with water. From this 2 ml was taken for analysis and standard graph drawn.

$$\% \text{ anhydrogalacturonic acid} = \frac{\mu g \text{ of anhydrogalacturonic acid in the aliquot} \times \text{dilution} \times 100}{\text{ml taken for estimation} \times \text{wt. of pectin sample} \times 1{,}000{,}000}$$

Results and Discussion

Characterization of fruit wastes

The fruit wastes were fractionated to assess the biochemical components and the results are presented in table 1. The results showed that there was appreciable amount of reducing sugars, total sugars, nitrogen, phosphorous, potassium and organic carbon is present in citrus peel, mango peel, banana peel and apple peel respectively

Calorimetric determination and extraction of pectin

The pectin content of the four fruit wastes was estimated by calorimetric method. The results showed that citrus peel had the maximum pectin content (25.5 per cent) followed by apple pomace (12.5 per cent), mango peel (8.8 per cent) and banana peel (2.8 per cent). The results clearly indicated that citrus peel could be a better source for pectin extraction (Table 2).

The fruit wastes such as citrus peel, mango peel, banana peel and apple pomace were subjected to pectin extraction. The results showed that from citrus peel 24.5 per cent of pectin could be extracted whereas apple pomace, mango peel and banana peel 10.8 per cent, 7.5 per cent and 2.5 per cent respectively could be extracted. From 25.5 per cent of pectin (citrus peel), 24.5 per cent can be extracted. Among the fruit wastes tested, the citrus peel was chosen as the best possible source for the production of pectinase enzyme based on its high pectin content (Fig. 1).

Table.1 Characterization of fruit waste

S. No.	Types of fruit wastes	Reducing sugar (%)	Total sugars (%)	Total Nitrogen (%)	Total Phosphorous (%)	Total potassium (%)	Organic carbon (%)
1	Citrus peel	8.50	17.30	4.50	0.18	0.16	28.20
2	Mango peel	12.50	28.50	2.10	0.27	0.35	23.50
3	Banana peel	10.90	18.30	3.30	0.25	0.30	20.50
4	Apple peel	9.50	13.50	2.40	0.70	0.12	18.5

Table.2 Pectin extraction from fruit wastes

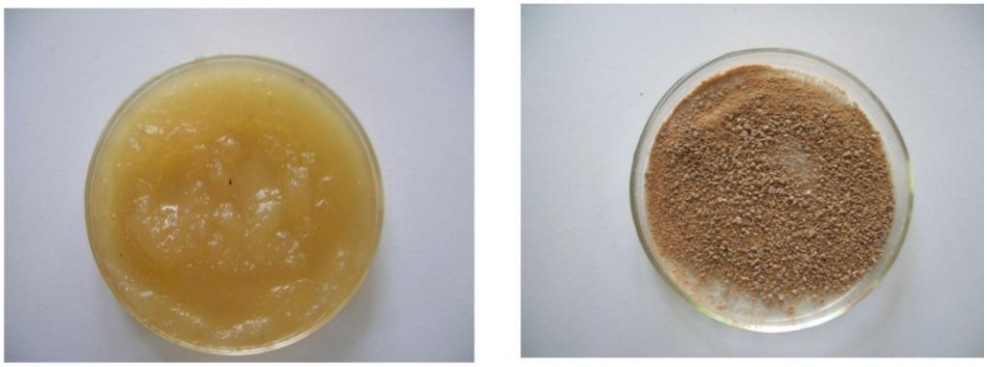
Source	Calcium pectate (%)	Pectin (%)
Citrus peel	24.5	25.5
Mango peel	7.5	8.8
Banana peel	2.5	2.8
Apple pomace	10.8	12.5

The following particulars were done to characterize different fruit wastes

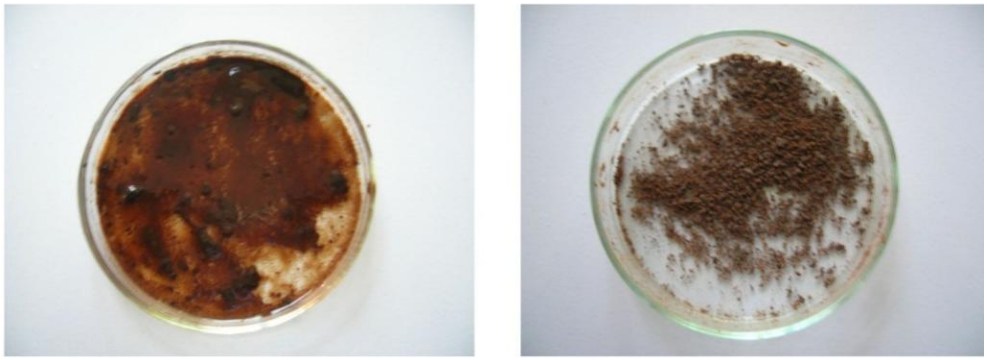
Particulars	Method	Reference
Reducing sugars	Dinitro salicylic acid	Miller (1972)
Total nitrogen	Micro Kjeldahl (Diacid extract)	Humphries (1956)
Total phosphorous	Vanadomolybdate yellow colour in HNO_3 medium (Triple acid extract)	Jackson (1973)
Total potassium	Flame photometry (Triple acid extract)	Jackson (1973)
Organic carbon	Chromic acid wet digestion method	Walkley and Black (1934)

Fig.1 Pectin extracted from fruit waste

a) Citrus pectin (Before drying) b) Citrus pectin (After drying)



c) Mango pectin (Before drying) b) Mango pectin (Before drying)



Pectin is a high value functional food ingredient widely used as gelling agent and stabilizer. It is also an abundant ubiquitous and multifunctional component of cell wall of all land plants (William *et al.,* 2005).Pectin is present mainly in fruits of citrus peel, apple, mangoes, banana but commercially it is manufactured from citrus peel and apple pomace which are the waste products of citrus and apple processing industries (Smock and Neubert, 1950).

In our study also although all the fruit wastes (citrus, mango, banana and apple pomace) had pectin, citrus peel alone had the maximum pectin content of 25.5 per cent and

also when subjected to pectin extraction with HCl, about 24.5 per cent could be extracted which, account for more than 98 percent recovery. A wide range of reagents could be used for the extraction of pectin. But hydrochloric acid is the most widely used reagent for extraction of pectin from various sources and cost wise also HCl is cheaper than other organic acids (Sudhakar and Maini, 1995).

In conclusion, fruit wastes such as citrus peel, mango peel, apple pomace and banana peel were subjected to pectin extraction and the results revealed that citrus peel is containing higher pectin content of about 24.5%. Since the citrus peel was found to contain appreciable quantity of pectin, further studies can be conducted to isolate pectinolytic enzyme producing microbes from citrus waste.

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