Extraction of Pectin from Banana Peel

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Abstract

The aim of this research is to prepare the value added product from waste banana peel. Pectin was extracted from banana peel(Saba banana, *Musa 'saba'*,pheegyan) by using citric and phosphoric acids. The physico-chemical characteristics of banana peel such as moisture, ash, protein, crude fat, crude fiber, carbohydrate , pectin, sugar contents and pH were determined. The effect of extraction temperature, extraction time, volume and concentration of citric acid and phosphoric acid on the yield of methoxyl content were studied. The physico-chemical properties of the resulting pectin such as moisture content, ash content , sugar content , pH , swelling index, solubility , gel formation , formation of precipitate were studied and compared with that of the pectin (BDH , England).The functional group of extracted pectin was analyzed by FT-IR (Fourier Transformed Infrared Spectroscopy). Identification of extracted pectin compound was carried out by XRD(X-Ray Diffraction Spectrometer).

Keyword: banana peels, pectin,methoxyl content

Introduction

Bananas are one of the most important fruit crops. Banana peels constitute about 30% of the fruit, and represent an environmental problem because of their large nitrogen and phosphorus contents as well as their high water content, making them highly susceptible to microbial degradation. The use of banana peels as a source of high value compounds such as pectin, cellulose nanofibers, and phenolic compounds is interesting not only from an economic point of view, but also from an environmental perspective. Pectin is a structural hetero-polysaccharide contained in the primary cell walls of terrestrial plants.Pectin is a class of complex polysaccharides found in the cell walls of higher plants(Prashansa, P., et al., 2017). The plant cell wall is composed of polysaccharides and proteins. The wall polysaccharides are often classified into cellulose, hemicelluloses and pectin (Dong, 2010). Pectin as extracted normally has more than 50% of the acid units esterified, and is classified as high methyl ester (HM) pectin. The percentage of ester groups is called degree of esterification. Modification of the extraction process, or continued acid treatment, will yield a low methyl ester LM pectin with less than 50% methyl ester groups. Some pectins are treated during manufacture with ammonia to produce amidatedpectins. Pectin is one of the most versatile stabilizers available. Its gelling, thickening and stabilizing is an essential additive in the production of many food products. It was evaluated the differences in concentration, temperature and time on pectin extraction from banana peels using organic acids. Strong mineral acids are cheaper and more effective than organic acids. Organic acids are more interesting than strong acids from an environmental point of view (Oliveira, T.S. *et al*, 2015) .The objective of this study was to evaluate the influence of concentration, temperature, an time on pectin extraction from banana peels with citric and phosphoric acids.

Materials and Method

Banana peel – It was collected from Hledan Market.

Citric acid and phosphoric acid (Analar grade, BDH), 95% Ethanol were purchased from Super Shell Chemical Trading, No.(117), 27 street, Middle Block, Yangon.

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Fig. (3) Banana peel (pheegyan)

The physico-chemical characteristics of banana peels such as moisture, ash, protein, crude fat, crude fiber, carbohydrate, pectin, sugar contents and pH were determined.

Extraction of Pectin from Banana Peels

Banana peels were blanched in water for 15 minutes at 90˚ C. After that the blanched banana peels were scrubbed with spoon. Banana paste was formed by using motor and pestle. About (50)g of banana paste was thoroughly mixed with 50ml of 0.4% citric acid solution at 90˚ C for 15 minutes by treatment with ultra-turrax. The mixture was filtered through the filter paper. The filtrate was poured into 95% ethanol. After that, the precipitate was filtered through the filter paper. The resulted precipitate was dried in a hot air oven at 60˚ C for about (3-4) hours. And then, dried pectin was formed by using motor and pestle to obtain fine powder. Then, it was put into clean airtight plastic bag and stored at cool dry place.

Results and Discussion

Table (1) Physico-chemical Properties of Banana Peel

Sr. No.	Properties	Banana peels	Literature***
1	*Moisture % (w/w)	81.22	86.01
2	*Ash % (w/w)	1.69	1.75
3	**Protein % (w/w)	0.56	1.27
4	* Sugar (Brix)	5	-
5	**Crude Fat %(w/w)	0.69	1.82
6	**Crude fiber % (w/w)	1.96	2.28
7	**Carbohydrate (%)	13.88	9.15
8	* pH	5.1	5
9	*Pectin % (w/w)	1	0.7-1.2

*The experiments were carried out at the laboratory of Department of Industrial Chemistry, University of Yangon.

** The experiments were conducted at food Industries Development Supporting Laboratory (FIDSL). UMFCCI To Lanmadaw Township, Yangon Region.

***Chongkhong.S, Doromae.A, Alkali-pretreatment and acid-hydrolysis of banana peels,2012.

Table (2) Effect of Extraction Time on the Yield of Pectin by UsingCitric Acid

Weight of Sample = 50 ,Volume of 0.4% Citric Acid = 50 ml
Extraction Temperature = 90 ˚ C, Volume of 95% Ethanol = 100ml

Sr. No.	Extraction Time (min)	Methoxyl Content (%w/v)	Yield of Pectin(wt %)	Colour
1	5	5.77	0.92	Pale brown
2	10	6.78	0.94	Pale brown
3	15*	9.43	1.00	Pale brown
4	20	8.49	0.88	Pale brown
5	25	8.37	0.87	Pale brown

The most suitable condition

The experiments were conducted at the Laboratory of Industrial Chemistry Department, University of Yangon.

Table (3) Effect of Extraction Temperature on the Yield of Pectin by UsingCitric Acid

Weight of Sample = 50 ,Volume of 0.4%Citric Acid = 50 ml
Extraction Time = 15 min, Volume of 95% Ethanol = 100 m

Sr. No.	Extraction Temperature (˚ C)	Methoxyl Content (%w/v)	Yield of Pectin (wt%)	Colour
1	60	5.02	1.32	Pale brown
2	70	5.64	1.60	Pale brown
3	80	6.07	1.70	Pale brown
4	90*	9.43	1.82	Pale brown
5	100	7.27	1.80	brown

*The most suitable condition

The experiments were conducted at the Laboratory of Industrial Chemistry Department, University of Yangon.

Table (4) Effect of Concentration of Citric Acid on the Yield of Pectin

Weight of Sample = 50g, Extraction Time = 15 min, Extraction Temperature = 90 ˚ C
Volume of Citirc acid = 50 ml, Volume of 95% Ethanol = 100ml

Sr. No.	Concentration of Citric acid (%w/v)	Methoxyl Content (%w/v)	Yield of Pect (wt %)	Colour
1	0.1	8.31	1.00	Pale brown
2	0.2	7.50	1.12	Pale brown
3	0.3	7.56	1.14	Pale brown
4	0.4*	9.43	1.20	Pale brown
5	0.5	8.12	1.18	Pale brown

*The most suitable condition

The experiments were conducted at the Laboratory of Industrial Chemistry Department, University of Yangon.

Table (5) Effect of the Volume of 0.4% Citric Acid on the Yield of Pectin

Weight of Sample = 50g
Extraction Time = 15 min , Extraction Temperature = 90 ˚ C
Volume of 95% Ethanol = 100ml

Sr. No.	Volume of 0.4% Citric acid (ml)	Methoxyl Content (%w/v)	Yield of Pectin (wt%)	Colour
1	25	7.75	1.90	Pale brown
2	50*	9.43	1.94	Pale brown
3	75	9.11	1.90	Pale brown
4	100	8.90	1.86	Pale brown
5	125	8.37	1.80	Pale brown

*The most suitable condition

The experiments were conducted at the Laboratory of Industrial Chemistry Department, University of Yangon.

Table (6) Effect of Extraction Time on the Yield of Pectin by Using Phosphoric Acid

Weight of Sample = 50g, Volume of 0.1%Phosphoric Acid = 50ml
Extraction Temperature = 90 ˚ C ,Volume of 95% Ethanol = 100ml

Sr. No.	Extraction Time (min)	Methoxyl Content (%w/v)	Yield of Pectin (wt %)	Colour
1	5	6.94	1.32	Pale brown
2	10	7.44	1.43	Pale brown
3	15*	9.67	1.65	Pale brown
4	20	8.06	1.45	Pale brown
5	25	7.81	1.22	Pale brown

*The most suitable condition

The experiments were conducted at the Laboratory of Industrial Chemistry Department, University of Yangon.

Table (7) Effect of Extraction Temperature on the Yield of Pectin by UsingPhosphoric Acid

Weight of Sampl = 50g,Volume of 0.1%Phosphoric Acid = 50ml
Extraction Time = 15 min, Volume of 95% Ethanol = 100ml

Sr. No.	Extraction Temperature(˚ C)	Methoxyl Content (%w/v)	Yield of Pectin (wt %)	Colour
1	60	6.82	1.45	Pale brown
2	70	7.44	1.48	Pale brown
3	80	7.94	1.54	Pale brown
4	90*	9.67	1.65	Pale brown
5	100	7.68	1.46	brown

*The most suitable condition

The experiments were conducted at the Laboratory of Industrial Chemistry Department, University of Yangon.

Table (8) Effect of Concentration of PhosphoricAcid on the Yield of Pectin

Weight of Sample = 50g, Extraction Time = 15 min, Volume of Phosphoric Acid = 50ml, Extraction Temperature = 90 ˚ C, Volume of 95% Ethanol = 100ml

Sr. No.	Concentration Phosphoric acid(%v/v)	Methoxyl Content (%w/v)	Yield of Pectin (wt%)	Colour
1	0.01	7.07	1.50	Pale brown
2	0.05	8.18	1.66	Pale brown
3	0.10*	9.67	1.77	Pale brown
4	0.15	7.93	1.53	Pale brown
5	0.20	7.68	1.37	Pale brown

*The most suitable condition

The experiments were conducted at the Laboratory of Industrial Chemistry Department, University of Yangon.

Table (9) Effect of the Volume of 0.1%Phosphoric Acid on the Yield of Pectin

Weight of Sample = 50g,Extraction Time = 15 min

Extraction Temperature = 90 ˚ C ,Volume of 95% Ethanol = 100ml

Sr. No.	Volume of 0.1(%v/v) Phosphoric acid (ml)	Methoxyl Content (%w/v)	Yield of Pectin (wt%)	Colour
1	25	8.80	1.21	Pale brown
2	50*	9.67	1.40	Pale brown
3	75	8.18	1.34	Pale brown
4	100	7.94	1.28	Pale brown
5	125	7.81	1.24	Pale brown

*The most suitable condition

The experiments were conducted at the Laboratory of Industrial Chemistry Department, University of Yangon.

Table (10) Comparism of the Physico-chemical Properties of Pectin extracted with Commerical Pectin

Sr. No.	Properties		Pectin extracted with Citric acid	Pectin extracted with Phosphoric acid	Commercial Pectin
1	*Moisture (% w/w)		12	9	13.5
2	*Ash (% w/w)		5	4	3.0
3	*Sugar content (Brix)		6	5	7
4	* pH		4	3.8	2.8
5	*Swelling index (v/v)		25	28	25
6	*Equivalent weight		1000	900	400
8	*Gel-formation		Formation of slightly opaque gel	Formation of slightly opaque gel	Formation of translucent gel
9	*Precipitate formation		Colorless gelatinous precipitate	Colorless gelatinous precipitate	Translucent gelatinous precipitate
10	*Solubility	Hot water	+	+	+
		Ethanol	_	_	

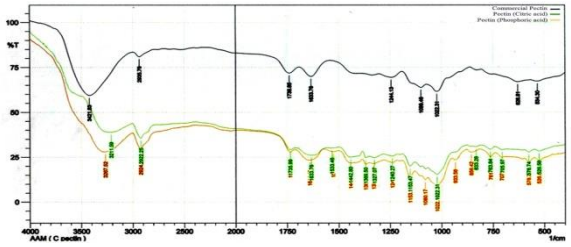
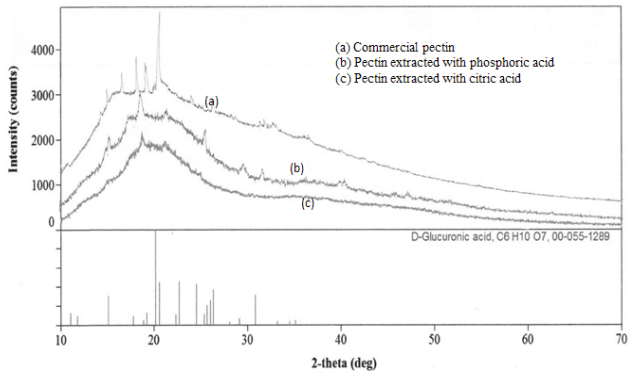


Fig. (4) Comparison of the Functional Group of Commercial Pectin and Pectin Extracted using citric and phosphoric acids by FT-IR Spectrum

Table(11) Interpretation of FT-IR Spectrum of Pectin Extracted using citric and phosphoric acids and Commercial Pectin

Sr. No.	Observed Frequency (cm^{-1})			Literature Frequency (cm^{-1})	Possible Assignments
	Extracted Pectin (citric acid)	Extracted Pectin (phosphoric acid)	Commercial Pectin		
1	3211.59	3267.52	3421.83	2500-3700	-OH stretching vibration of alcoholic and acid group
2	2922.25	2924.18	2935.76	2872-2962	Aliphatic(C-H) stretching vibration group
3	1735.99	1735.99	1739.85	1735-1750	C=O stretching vibration of ester group
4	1633.76	1641.48	1633.76	1550-1650	COO-Asymmetric stretching vibration group
5	1240.27	1240.27	1244.13	1000-1300	C-O stretching vibration of ester group
6	-	-	1099.46	1085-1150	C-O-C stretching vibration of ether group
7	1022.31	1022.31	1022.31	1000-1300	C- O stretching vibration of ester group
8	-	-	628.81	650-769	O-H out of plan bending vibration of alcoholic group



Fi Using citric and phosphoricacids by XRD(X-Ray Diffraction ient of Physics, University of Yangon.

Discussion

The physico-chemical properties of banana peels are shown in Table (1).The results in Table (1) indicate that 81.22 % (w/w) moisture, 1.69 % (w/w) ash , 0.56 % (w/w) protein, 5 (Brix) sugar , 0.69 % (w/w) crude fat, 1.96 % (w/w) crude fiber , 13.88% carbohydrate, 5.1 pH and 1 % pectin present in banana peels. Pectin from banana peels was extracted with both citric acid and phosphoric acid solution. During the extraction, the effect of extraction time, concentration of citric acid and phosphoric acid, volume of citric acid and phosphoric acid solution and extraction temperature on methoxyl content were studied. According to the results of Table (2) and Table (6) , it were found that 15 min of extraction time was suitable for extraction of pectin from banana peels because of the highest methoxyl content. The results in Table (3) and Table (7) were observed that among five different extraction temperatures, (90˚ C) was chosen as the most suitable condition because of the highest percentage of

methoxyl content. The results in Table (4) and Table (8) show that 0.4% (w/v) concentration of citric acid and 0.1(%v/v) concentration of phosphoric acid were selected as the most suitable condition because of the highest methoxyl content. The results in Table (5) and Table (9) show that (50)ml volume of 0.4% (w/v) citric acid and 0.1(%v/v) phosphoric acid were suitable for extraction of pectin from banana peels because of the highest methoxyl content. The physico-chemical characteristics of the prepared pectin (citric acid and phosphoric acid) are shown in Table (10).Ash content and pH of the extracted pectin (citric acid and phosphoric acid) were slightly higher than that of commercial pectin but moisture and sugar content of pectin (citric acid and phosphoric acid) were lower than that of commercial pectin. The inorganic impurities in pectin were indicated by the ash content. Lower ash content indicates good quality of pectin. Figure (4) and Table(11) describe the FT-IR spectra of extracted pectin (citric acid and phosphoric acid) obtained from banana peels and the reference commercial pectin. The strong band at 3211, 3267 cm^{-1} and 3421 cm^{-1} were occurred from reference commercial pectin as well as extracted pectin (citric acid and phosphoric acid), Figure (4) confirmed OH-stretching frequency of alcohol group. The bands at 2922, 2924cm^{-1} and 2935 cm^{-1} represented for C-H stretching vibrations. The bands at 1735,1735 cm^{-1} and 1739 cm^{-1} represented for C=O stretching vibration of ester group. The region of 1633,1641 cm^{-1} and 1633 cm^{-1} represented for COO-Asymmetric stretching vibration group. The region of 1022, 1022 cm^{-1} and 1022 cm^{-1}representedfor C- O stretching vibration of ester group. The various characteristics of absorption bands of above spectra obviously show that the pectin (citric acid and phosphoric acid) obtained from this research was closely matched with the reference commercial pectin. The XRD pattern of the commercial pectin and the extracted pectin (citric acid and phosphoric acid) were showed in Fig.(5).The XRD pattern of commercial pectin and the extracted pectin (citric acid and phosphoric acid) showed as D-glucuronic acid.

Conclusion

In this research, pectin was extracted from banana peels by using both citric and phosphoric acids.50ml of 0.4% (%w/v) citric acid and 50ml of 0.1 (%v/v) phosphoric acid are the most suitable acid concentrations and volume for the preparation of pectin from banana peel. The extraction temperature of 90˚ C and extraction time of 15 min are the suitable temperature and time for both acids because of the highest yield of methoxyl content. At the temperature, more than 90˚ C, the yield of pectin decreases because pectin molecules were found to be break down. Longer extraction temperature gave the brown color of the pectin. The lower acid concentrations were not sufficient to hydrolyze the insoluble pectin constituents. It was found that the pectin content extracted using both acids is not apparently different. The XRD pattern of extracted pectin using both citric acid and phosphoric acid showed D-glucuronic acid. It was noted that the lower ash content of pectin using both acids indicated good quality of pectin.

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