Extraction of Pectin in Liquid and Powder Forms from Pomelo and its Applications in Food Industries

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Abstract

The aim of this research is to extract pectin in both liquid and powder forms from pomelo which is abundantly available in Myanmar. Traditionally, pectin is primarily used in the production of jams and fruit jellies. Nowadays, both liquid and powder forms of pectins are widely used in fruit applications (jams, jellies and desserts), bakery fillings and toppings, dairy applications (acidified milk and protein drinks, and yoghurt), confectionery, beverages, nutritional and health products, pharmaceutical and medical applications. Some manufacturers use their own liquid pectin. Apple pomace and citrus peel are the raw materials traditionally used for industrial extraction of pectin. Pomelo rinds that are used as raw materials in pectin extraction can be obtained cheaply and it can be used in many food applications. In the present work, pectin was produced with emphasis on wastes of albedos of pomelo. After the extracted liquid and powder pectin had been analyzed, they were used in food processing. The optimum concentration of pectin was found out by varying different amount of pectin in food making processes. The prepared pomelo liquid pectin was utilized in jelly making and powder form was used in milk fruit drinks (directly acidified) (strawberry, durian and orange). The prepared samples were also again analyzed. In extraction of pectin in powder form, it is found that the most suitable condition of extraction time and temperature was (30) min and 100ºC.In the extraction of both liquid and powder pectin, the most suitable concentration of citric acid solution was 0.1%. The most suitable conditions for pomelo jelly were (65) g of sugar, (100) ml of liquid pectin and (0.3) g of citric acid. Also, the most suitable conditions for milk fruit drinks (directly acidified) were (6) ml juice, (1.8) g pectin, (40) g sugar and (2) g citric acid and (25) g of milk powder respectively.

Key words: pomelo, pectin, pomace, albedo

Introduction

Pectin is the methylated esters of polygalacturonic acid. They are commercially extracted from citrus peel and apple pomace under mildly acidic conditions. Pectin is divided into two major groups on the basis of degree of esterification. (Sriamornsak , 1999).

Pectin was first isolated and described in 1825 by Henri Braconnot, though the action of pectin to make jams and marmalade was known long before. He de-esterified pectin to yield pectic acid and named the material according to its jellying properties. Vauquelin published the first information on water - soluble jellying substances in fruits. Kertesz authored a comprehensive book on pectic substances which review the literature through 1950.(http://www.Pectin.wikipedia.the free encyclopedia.html).

The main uses of pectin are in the manufacture of jams, jellies, marmalades and fruit preserves of all kinds of fruits containing naturally poor pectin content.

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Dry pectin is used in the preparation of synthetic powder, for home - made jellies and in a number of sweets. In the natural juice products, pectin can also be used for strengthening the permanent cloud stability, for raising the viscosity and for similar purposes. It can be used in ice cream production. Its ability to form gels is very important to act as an emulsifier. (Wollen, 1969).

Pectin makes good emulsions with edible oil or the production of mayonnaise and also with essential oils when used in the manufacture of various flavours. Good use of pectin is in medicine as cleansers for intestines, for treating wounds and in blood transfusions for raising the blood volume. Some use of pectin is also in the industry for steel hardening. The pectin, by itself or by its jelling properties, is employed in pharmaceutical industry, health promotion and treatment. Commercially extracted pectin either by themselves or in combination with other biopolymers, have found extensive use as gelling and thickening agents in foods (Wollen,1969).

Pectins are present in the primary cell walls and middle lamella of many plants, where they are frequently associated with other cells components such as cellulose, hemicelluloses and lignin. They can be found in different tissues, but are particularly abundant in fruit and young tissues. (Lopes & Rao, 1995). During the ripening of fruit ,the insoluble protopectin is progressively converted (probably enzymatically) to soluble pectin, which is a long chain polygalacturonic acid in which the d-galacturonic acid units are linked by alpha- (1:4) glycosidic linkages and in which the majority of the carboxyl groups were esterified with methyl alcohol. Small quantities of arabans and galactans are also present, and are believed to be covalently linked to the polygalacturonic acid chains, but their role, if any, in the behavior and properties of pectin is unknown. As ripening of fruit proceeds further, the pectin undergoes progressive conversion to substances lacking jelly power with sugar and acid, and further degradation of pectin might occur during the handling and processing of fruit and fruit pulp (Wollen, 1969).

Pectin is usually prepared from apple pomace or citrus residues, by acid extraction, carbon decolorization, and vacuum concentration, to give a liquid which might be pasteurized in cans, or preserved with about (800) ppm sulphur dioxide for tanker delivery in bulk. Pectin is also available in powder form (obtained by alcohol precipitation from solution). The direct use of powder pectin in jam manufacture encounter dispersion difficulties in jam manufacture and the practice is mixing powdered pectin with the dry sugar before incorporation in a boiling. (Wollen, 1969).

Partially methoxylated pectinic acid (less than 7% methyl content) are now available commercially for the preparation of low-sugar, cold setting jellies, the gel being formed in the presence of divalent metallic ions (Wollen,1969). The aim of this research work is the extraction of pectin in liquid and powdered forms from pomelo which are abundantly available in Myanmar, the analysis of extracted pectins, the application of pectin in food and finally the analysis of prepared samples.

Materials and Methods

Preparation of Liquid Pectin from Pomelo Rinds

Raw Materials

Pomelo rinds (*Citrus maxima*), (source-Hmawbi Township, Yangon Region) were obtained from Thirimingalar market. Citric acid (commercial grade) and ammonium chloride (commercial grade) were purchased from local market.

Experimental Procedure

About (100) g of albedos or white portion of pomelo rinds were cut into thin slices of (2.5) mm thickness. These were boiled twice with (125) ml of ammonium chloride solution (strength 1g/ l) for 10 minutes followed by filtering and squeezing the pulp to remove water. The pulp was washed twice with (100) ml of distilled water. Then it was extracted by boiling with (300) ml of 0.1% citric acid solution for 30 minutes. The slurry obtained was centrifuged with basket type centrifuge and the liquid portion was collected from discharge pipe. This process was repeated three more times followed by concentrating until liquid pectin was obtained, shown in Figure (1).

The same procedures were carried out by varying the extraction time (20 min,25min and 35 min) and the results showing the effect of extraction time on the color of liquid pectin are recorded in Table(1). Extraction of pectin was carried out in the same manner with different amount of 0.1% citric acid solution (200, 250, 300, 350 and 400 ml) respectively.

Preparation of Pectin Powder

Extraction of Pectin Powder from Pomelo Rinds

Materials

Pomelo rinds (source-Hmawbi Township, Yangon Region) were obtained from Thirimingalar market, Yangon Region. Ammonium chloride (commercial grade), citric acid (commercial grade) and 95% ethanol (commercial grade) were purchased from local market.

Experimental Procedure

Preparation of liquid pectin from pomelo rind was the same as above. Then precipitated pectin was obtained by pouring 95% ethanol into liquid pectin with vigorous stirring. The precipitate was left overnight, filtered the whole day and dried in Hot Air Oven for 6-8 hr at 70 ºC.

The same procedures were carried out by varying the extraction time (20 min,25min and 35 min and the results showing the effect of extraction time on color of pectin paste are recorded in Table(1). Extraction of pectin was carried out in the same manner with different amount of 0.1% citric acid solution (200, 250, 300, 350 and 400 ml) respectively and yield percent of pectin are shown in Table (2) and effect of drying time on moisture content of pectin powder from pomelo rind is shown in Table (3) and its graph in Figure (7). Prepared pomelo pectin powder is shown in Figure (2).

Application of Liquid Pectin in Jelly Making

Materials

Sugar and citric acid (commercial grade) were purchased from local market. Liquid pectin from pomelo rind, extracted under most suitable condition was used.

Experimental Procedure

About (65) g of sugar was weighed in a (250) ml beaker and then (100) ml of pomelo liquid pectin was added. Then, the solution was boiled for 5 minutes at 105 °C and stirred until sugar was completely dissolved. After that, (0.3) g of citric acid was added into pectin-sugar solution until gelation occurred. The soluble solid content of jelly was measured by digital Refractometer. Prepared pomelo jelly is shown in Figure (3).

Application of Pectin Powder in Milk Fruit Drinks (Directly Acidified)

Materials

Fruit juice squash (strawberry), citric acid (commercial grade), sugar and milk powder (PEP) were purchased from local market.

Experimental Procedure

About (25) g of milk powder was dissolved in (225) g of water followed by adding (1.8) g of pectin into milk solution. Simultaneously, (150) g of fruit juice (strawberry) was mixed with (20) g of sugar under stirring slowly and poured into above mixture. About (1) g of citric acid solution (50%) was added to adjust the pH value and the mixture was then homogenized by homogenizer. Finally, the mixture was pasteurized, filled into containers and left in cool place. During the production of directly acidified drinks, pectin may also be added with the fruit juice or dispersed as syrup in the fruit juice concentrate.

As the same procedure, other milk fruit drinks (durian and orange) were carried out and prepared samples are shown in Figures (4), (5) and (6).

Chemical and Physical Analysis of Prepared Liquid, Pectin Powder and Prepared Products

The characteristics of prepared liquid pectin such as pH, acidity and soluble solid content (°Brix) were analysed and pectin powder by pH, acidity, moisture content, jelly grade, setting time and physical characteristics such as solubility, gel formation and precipitate formation were conducted for the assessment of pectin powder quality. The results can be seen in Tables (4), (5), (6), (7) and (8).

The prepared jelly by pomelo liquid pectin was analysed by pH, acidity moisture content, soluble solid content (°Brix) and organoleptic properties. The results of jelly are tabulated in Table (9). Prepared milk fruit drinks (directly acidified) using pectin powder were analysed by pH, moisture content , organoleptic properties, protein content, lactic acid content, fat content, total solid and solid not - fat content. The results of physical and chemical characteristics of milk fruit drinks are shown in Tables (10) and (11).

Results and Discussion

Some mineral acids can be used effectively in the extraction of pectin from pomelo rind. Although, different types of acids can be used in the extraction of pectin, previous research conducted by Min Aung , 1994 – indicated that citric acid was the best among them and the most widely used in food industries. So, in this present research, pectin was extracted only by citric acid.

The yield percent of pectin was also dependent upon the degree of maturity of the fruits. Fully developed and green fruits (under ripe fruits) gave the higher yield than fully ripe fruits. Optimum extraction time was found out by varying the extraction time such as 20 min, 25 min, 30 min and 35 min respectively. According to Table (1), the most suitable extraction time was found to be 30 min for both types of pectins. Extraction of pectin was also carried out at different volume of 0.1% citric acid solution (i.e., 200, 250, 300, 350 and 400 ml respectively) to find out the optimum volume of 0.1% citric acid .It can be seen in Table (2) that the highest yield of pomelo pectin was 4.3% (350 ml of 0.1% citric acid) but the texture of powder using 300 ml of 0.1% citric acid solution was better than others. So, the most suitable concentration of citric acid was 300 ml of 0.1% citric acid. The jelly made from pomelo was clear light color, and transparent but much tougher than normal.

From pectin paste to produce pectin powder using drying techniques, the effect of drying time on moisture content of each pectin in Table (3)and Figure (7) show that the most suitable condition of drying time for pomelo was (150) minutes Beyond these, the texture of pectin became bad.

Figure (1) Pomelo Liquid Pectin

Figure(2) Pomelo Pectin Powder

The jelly grade for all types of jellies were determined by making jelly with varying amount of sugars at fixed amount of minimum concentration of pectin . All types of jellies for selected jelly grade had capacity to retain its moulded shape when placed on plate for serving, which confirmed that all of them possessed good jelly grade. Jelly grade of prepared pectin shown in Table (5) was compared local market pectin shown in Table (6). Results in Table (7) show the comparison of physical properties of pomelo pectin powder and pectin from market. Table (8) also indicates that setting time for pomelo jelly was 18 minutes which is slower than jelly made from market pectin (16 minutes).According to Table (9), the optimum concentration of sugar and pectin in jelly making are 65 g and 100 ml of liquid pectin. According to Tables (10) and (11), it was found that the physical and chemical properties of milk fruit drinks were nearly in agreement with literature values. The shelf-life of each was 2 weeks without preservative.

Figure (3) Prepared Pomelo Jelly

Figure (4) Milk Fruit Drink (Strawberry

Figure (5) Milk Fruit Drink (Durian)

Figure (6) Milk Fruit Drink (Orange)

Table (1) Effect of Extraction Time on the Color of Liquid Pectin and Pectin Paste

Weight of Pomelo rind (white portion) = 100 g

Concentration of Citric Acid = 0.1% (w/v)

Volume of Citric Acid = 300 ml

No.	Extraction Time(min)	Extraction Temperature (°C)	Observation	
			Liquid Pectin	Pectin Paste
1	20 min	100°C	White color	White color paste
2	25 min	100°C	White color	White color paste
3	30 min*	100°C	Pale yellow color	Pale yellow color paste
4	35 min	100°C	Yellow color	Yellow color paste

*The most suitable condition

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

Table (2) Effect of Citric Acid Volume on Color and Yield Percent of Pectin Powder

No.	Weight of Pomelo Rind (g)	Extraction Time (min)	Extraction Temperature (^oC)	Volume of 0.1% citric acid solution (ml)	Pectin yield percent w/w (%)	Observation
1	100	30	100	200	-	Overcooked
2	100	30	100	250	2.8	Pale yellow color
3	100	30	100	300*	3.9	Pale yellow color
4	100	30	100	350	3.9	Pale brown color
5	100	30	100	400	4.3	Brown color

*The most suitable condition

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

Table (3) Effect of Drying Time on Moisture Content of Pectin Powder from Pomelo Rind

Weight of Pectin Paste = 3 g

Sr. No.	Drying Time (min)	Moisture Content w/w (%)
1	0	1.01
2	30	0.84
3	60	0.73
4	90	0.56
5	120	0.42
6	150*	0.32
7	180	0.29

*The most suitable condition

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

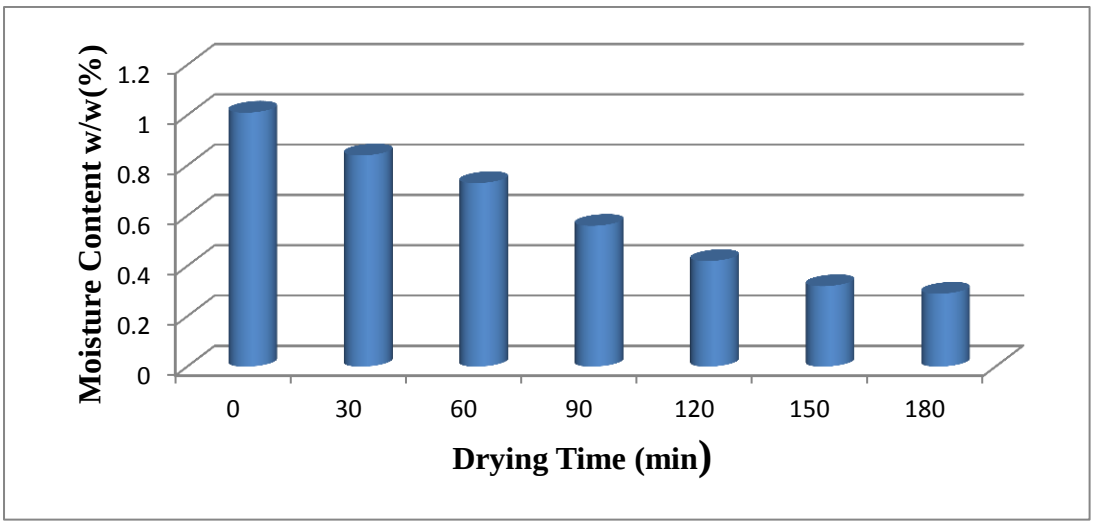

Figure (7) Effect of Drying Time on Moisture Content of Prepared Pectin Powder from Pomelo.

Table (4) Characteristics of Liquid Pectin and Pectin Powder

Parameters	Characteristics	
	Liquid Pectin	Pectin Powder
pH	3.6	3.2
Acidity,w/w (%)	1.4	1.3
Soluble Solid Content, (°Brix)	6.8	-
Ash Content, w/w (%)	-	0.68
Moisture content, w/w (%)	-	0.43
Jelly Grade	-	120
Setting Time, (min)	-	18

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

Table (5) Effect of Sugar Content on Characteristics of Jelly from Pomelo Pectin Powder (Prepared under Most Suitable Condition)

No.	Pectin		Citric Acid	Sugar	Jelly Grade	Gelation Time	Soluble Solids Content (ºBrix)	Remarks
	Volume (ml)	Weight (g)	Volume (ml)	(g)		(min)		
1	5	0.05	20	5	100	15	65	Stiff, sour
2	5	0.05	20	5.5	110	15	65	Stiff, slightly sour
3	5	0.05	20	6	120*	15	65	Acceptable, sweet
4	5	0.05	20	6.5	130	15	65	Slightly sticky, sweet
5	5	0.05	20	7	140	15	65	Sticky, sweet

*The most suitable condition

The experiments were conducted at laboratory of Industrial Chemistry Department, University of Yangon

Table (6) Effect of Sugar Content on Characteristics of Jelly from Pomelo Pectin Powder (from Market)

No.	Pectin		Citric Acid	Sugar	Jelly Grade	Gelation Time (min)	Soluble Solid Content (ºBrix)	Remarks
	Volume (ml)	Weight (g)	Volume (ml)	(g)				
1	5	0.05	20	5	100	15	65	Stiff, sour
2	5	0.05	20	5.5	110	15	65	Stiff, slightly sour
3	5	0.05	20	6	120*	15	65	Acceptable, sweet
4	5	0.05	20	6.5	130	15	65	Slightly sticky, sweet
5	5	0.05	20	7	140	15	65	Sticky, sweet
6	5	0.05	20	7.5	150	15	65	Sticky, sweet

*The most suitable condition

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

Table (7) Comparison of Physical Properties of Extracted Pectin Powder and Pectin from Market

No.	Sample	Solubility	Gel-formation	Precipitate formation
1	Pectin from market	Formation of a colloidal and opalescent solution	Formation of translucent gel	Translucent gelatinous precipitate
2	Pomelo Pectin	Formation of a colloidal opalescent solution	Formation of a colourless translucent gel	Colourless gelatinous precipitate

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

Table (8) Comparison of Setting Time of Prepared Jellies with Extracted Pectin Powder and Pectin from Market

No.	Sample	Pectin (g)	Distilled water (ml)	Sugar (g)	Citric Acid		Setting Time (min)	Strength of jelly formed
					Volume (ml)	Weight (g)		
1	Pectin from market	0.3	50	7.2	20	0.2	16	Stiff jelly
2	Pomelo	0.3	50	7.2	20	0.2	18	More stiff jelly

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

Table (9) Characteristics of Prepared Pomelo Jelly

Volume of pomelo liquid pectin = 100 ml
Weight of citric acid = 0.3 g
Weight of sugar = 65 g

	pH	Acidity	Soluble Solid (°Brix)	Color	Taste	Aroma
Jelly	3.4	1.4	62.3	Pale yellow	Sweet	Pleasant smell

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

Table (10) Physical Characteristics of Milk Fruit Drinks (Directly Acidified)

Physical Properties	Strawberry Flavour	Durian Flavour	Orange Flavour	Literature Value *
Moisture Content (w/w) (%)	78	88	79	88.80
pH	4.2	4.6	4.3	4.1-4.3
Texture	smooth	smooth	smooth	-
Taste	Slightly sour	Slightly sour	Slightly sour	-

*Eckles, C.H., Combs, W.B & Macy, H., 1982

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

Table (11) Chemical Characteristics of Milk Fruit Drinks (Directly Acidified)

Chemical Properties	Strawberry Flavour	Durian Flavour	Orange Flavour	Literature Value*
Total Solid w/w (%)	11.4	11.5	11	11.20
Fat w/w (%)	3.5	3.2	4	≥ 3.0
Solid not-fat w/w (%)	7.9	8.3	7	≥ 8.2
Protein w/w (%)	3.7	3.9	3.6	-
Lactic Acid w/w (%)	1.7	1.5	1.9	11-1.8

*Eckles, C.H., Combs, W.B &Macy, H., 1982.

The data were conducted at SGS (Society of General Service) Co. Ltd , Wartan Street, Bahosi Housing, Yangon.

Cost Estimation for Preparation of Pomelo Pectin Powder

Sr. No.	Particulars	Quantity	Rate	Cost (Kyat)
1	Raw Materials			
	Pomelo rinds	13800g	50 Ks/1g	690000.00
	Citric Acid	85 lb	500 Ks/lb	42500.00
	Ethanol	3260 liters	1000/liter	3260000.00
	Ammonium Chloride	175lb	300Ks/lb	52500.00
	Pure Water	300 gallon	300 Ks/gallon	90000.00
2	Labour Cost			
	Operator	1	20000 Ks/man	20000.00
	Unskilled Labour	1	30000 Ks/man	30000.00
3	Packaging Cost	10 lb	50 Ks/lb	50000.00
4	Electricity	800 units	50 Ks/unit	40000.00
Total Cost				4275000.00
Unit Price				4275.00

Average manufacturing cost for 1000 lb of pomelo pectin powder

= Ks 4275000.00/1000 lb

= Ks 4275.00/ lb

= Ks 4300 / lb

Conclusion

There are many fruits that are rich in pectin and are abundantly available in Myanmar. The content and composition varies depending on the species, variety, maturity of the plant, plant part, tissue, and growing condition .In this research work emphasis was based on the extraction of pectin with organic acid. After being extracted, pectin was dried in Hot Air Oven at 70 ºC for 6 – 8 hours.

Pectin concentrates could be made either as syrup (liquid pectin extract) or powder form with respect to market demand. However, if one considers the seasonal aspects of most fruits, the powdered form is undoubtly far better as it has comparatively very long shelf- life (liquid pectin extract is 2 – 3 months under refrigeration whereas, pectin powder - if properly packaged could last years). This powder form could be used the whole year round as demand necessary by the market resulting in great profits.

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