Yadanabon University Research Journal, 2019, Vol-10, No.1

Extraction of Pectin Powders from Guava and Apple And their Applications in Jam Making Processes

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Abstract

This research presents the extraction of pectin in powder from guava and apple which are abundantly available in Myanmar.Pectin can be used as thickenerin soups, sauces and puddings, as stabilizer in ice cream, margarine, dairy products, salad dressings and mayonnaise and as gelling agent in jellies, jams, desserts, yogurts and candies. It can also be used in nutritional and health products, pharmaceutical and medical applications.Pectin was produced with emphasis on apple pomace and guava by boiling with 0.1% citric acid solution and then precipitated with ethanol.In the extraction of pectin, it was found that suitable conditions of extraction time and temperature were (30) minutes and (100) °C. The resulted paste was dried in Hot Air Oven at 70°C and then the dried pectin was powdered by grinding. It was found that suitable conditions of drying time for guava and apple were (150) minutes and (120) minutes respectively. After the extracted powdered pectin had been analyzed, prepared apple pectin powder was utilized in strawberry jam making and that of guava was used in orange marmalade making process. The prepared samples were also analyzed.The suitable amount of pectin used in jam making processes were (3.3) g of apple pectin powder for strawberry jam and (0.1) g of guava pectin powder for orange marmalade, respectively.

Key words: thickener, stabilizer, emulsifier, pectin, pomace

Introduction

Pectin (derived from Greek meaning - "congealed, and curdled") is a structural heteropolysaccharide contained in the primary cell walls of terrestrial plants. It was first isolated and described in 1825 by Heneri Bracannot. 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). Pectin is divided into two major groups on the basis of degree of esterification. The association of pectin chain led to the formation of the three – dimensional networks that is to gel formation. (Sriamornsak P., 1999).

Pectin is 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.The amount, structure and chemical composition of the pectin differ between plants, within a plant over time and in different parts of a single plant.

During the ripening of fruit, the insoluble protopectin is progressively converted 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 .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, A., 1969).

Pectin is also available as a solution or an extract, or as a blended powder, for home jam making. For conventional jams and marmalades that contain above 60% sugar and soluble fruit solids, high - ester pectin are used. Diet products can be made with low-ester amidated pectin. In jam making, the direct mixing of pectin encounters
difficulties in incorporation in a boiling. Typical levels of pectin used as a food additive is between 0.5-1. 0%.This is about the same amount of pectin in fresh fruit (Indian Journal of Natural Products and Resources,2011).Good use of pectin is in medicine as cleansers for

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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. (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 aim of this research is to analyze the pectin powders extracted from apple and guava and to analyze the sample jams in which the extracted pectin powders are used.

Materials and Methods

Preparation of Pectin Powder from Guava and Apple Pomace

Raw Materials

Good, and mature (but not overripe) guava (*Psidiumguajava*)and apple *(Malusdomestica)* were obtained from Thirimingalar market.Citric acid (commercial grade)and 95% ethanol were purchased from Academy Chemical Group, No.101, 28th Street, Middle Block, Pebedan Township.

Experimental Procedure

(100) g of guava was cut into thin slices of (2.5) mm thickness. These slices were boiled with (300) mlcitric acid (0.1%) solution at 100 ºC for 30 minutes. The whole was filtered and if soluble matter was present, this could be removed by centrifugation. The filtered liquid pectin was concentrated by water bath at 100 ºC until half of liquid pectin was obtained. The syrup obtained was poured into 95% ethanol and kept overnight. The gelatinous precipitate was washed twice with ethanol. It was then dehydrated in Hot Air Oven for 6 – 8 hrs at 70 ºC. Dried pectin was powdered by grinding and pectin powder was obtained.

The above experiment was carried out by varying extraction time (20, 25, 30, 35 minutes), different amount of 0.1% citric acid solution (200, 250, 300, 350 and 400 ml) respectively. Effect of extraction time on color of pectin paste is shown in Table (1). Preparation of apple pectin powder was carried out in the same way .Effect of citric acid volume on color and yield of pectin pastes are shown in Tables (2) and (3). Prepared guava and apple pectin powders are shown in Figures (1)and(2).Effect of drying time on moisture content of pectin powders from guava and apple are shown in Table (4) and Figure (6).

Application of Pectin Powders inJam and Marmalade Making Process

Materials

Strawberry and pineapple for jam making and orange for marmalade making were purchased from Thirimingalar Market. Citric acid was purchased from Academy Chemical Group, No.101, 28th Street, Middle Block, Pebedan Township. Sugar was purchased from a local market. Extracted Apple pectin powder was used in jam making and that of guava pectin powder was used in marmalade making.

Preparation of Jam

(100) g of fresh and ripe strawberries were washed with water and placed in the stainless steel pot. (3.3) g of apple pectin powder was mixed with (100) g of sugar in a (250) ml beaker and stirred thoroughly. (50) ml of warm water was added to pectin-sugar mixture and then it was heated and stirred until all the pectin was dissolved. The syrup was poured into a stainless steel pot that contained (100) g of the prepared fruits. Then (0.1) g of citric acid was added and cooking was carried out by heating and stirring until a reasonably thick jam

was obtained and poured into the container and cooled at the room temperature. The soluble solid content was measured with Refractometer.

The same procedure was carried out for pineapple jam makingand prepared jams were shown in Figures (3) and (4).

Effect of sugar content in strawberry and pineapple jam making is shown in Tables (7) and (8). Effect of pectin concentration in strawberry and pineapple jams is recorded in Tables (8) and (10) respectively.

Preparation of Marmalade

The sound ripened orange was washed, cut and the juice was extracted with a juice extractor. The juice was filtered with a suitable filter cloth to remove the pulp. (10) g of peels were cut into pieces and boiled with water to remove bitterness until all the peels were tendered. The juice was discharged and peels were washed with water.(100) ml of extracted fruit juice was heated, (0.1) g of guava pectin powder and (100) g of sugar was added into it. Then the solution was stirred until all the pectin and sugar were dissolved completely. Then the tendered peel was also added into the mixture .While being stirred it was heated to 105 ºC, and citric acid solution (5) ml (10 g/ l) was added into mixture. Heating and stirring was carried out until a thick marmalade was obtained and poured into the glasses. The soluble solid content was measured with Refractometer.

Prepared orange marmalade is shown in Figure (5) .Effect of sugar content in marmalade making is shown in Table (11). Effect of pectin concentration in marmalade is shown in Table (12).

Chemical and Physical Analysis of Prepared Pectin Powders and Prepared Products

The characteristics of prepared pectin powder by pH, acidity, soluble solid,ash,moisture, jelly grade, setting timeand 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 (5) and (6).

Organoleptic properties of preparedstrawberry and pineapple jamand orange marmaladewere examined and suitable conditions of each jam are shown in Table (13).Analysis of prepared jams and marmalade by pH, acidity, soluble solid content (°Brix) moisture, ash, protein, crude fiber are shown in Table (14).

Results and Discussion

Some mineral acids can be used effectively in the extraction of pectin from guava and apple. Although different types of acids can be used in the extraction of pectin, a research conducted by Min Aung (1994) indicated that citric acid is the best and it can be more safely used in food industries. So, in this research, pectin was extracted only with citric acid.

The yield of pectin was also dependent upon the degree of maturity of the fruits. Optimum extraction time was found out by varying the extraction time such as 20 mins, 25 mins, 30 mins and 35 mins respectively. According to Table (1), suitable extraction time was 30 mins for both pectin types. Extraction of pectin was carried out at different ratios of 0.1% citric acid solution (i.e., 200, 250, 300,350 and 400 ml respectively) to find out the optimum concentration of citric acid. It can be seen in Table (2) that the highest yield of guava pectin was 4.4% (400 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, suitable concentration of citric acid was (300) ml of 0.1% citric acid. (yield -4.1%) .Similarlyfrom Table (3), suitable condition for apple pectin was (300) ml of 0.1% citric acid (yield - 2.3%). In the production of pectin powders from the pectin precipitate using drying techniques, the effect of drying time on moisture content of

each pectin (see Table 4) shows that suitable condition of drying time was (150) minutes for guava and (120) minutes for apple. Beyond these, the texture of pectin became bad.

In this research, the extracted apple pectin powder was used in strawberry jam and pineapple jam and guava pectin was used in marmalade making at different ratio of sugar and pectin.For jams, suitable amounts of ingredients were (100) ml of sugar, (100) ml of fruit pulp, (3.3) g of pectin powder and (0.1) g of citric acid. In marmalade making, (100) ml of sugar, (100) ml of fruit juice, (0.1) g of pectin powder and (5) g of citric acid were suitable amounts (see Tables 7-13).

Figure 1 Guava Pectin Powder

Figure 2 Apple Pectin Powder

Figure 3 Prepared Strawberry Jam

Figure 4 Prepared Pineapple Jam

Figure 5 Prepared Orange Marmalade

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

Weight of Guava/ Apple = 100 g
Concentration of Citric = 0.1% (w/v)
Volume of Citric Acid = 300 ml

No.	Extraction Time (min)	Extraction Temperature (°C)	Observation	
			Guava Pectin Paste	Apple Pectin Paste
1	20 min	100°C	Yellow color	Pale brown color
2	25 min	100°C	Pale brown color	Pale brown color
3	30 min*	100°C	Pale brown color	Brown color
4	35 min	100°C	Brown color	Pale red color

*Suitable condition

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

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

No.	Guava (g)	Extraction Time (min)	Extraction Temperature (ºC)	Volume of 0.1% citric acid solution (ml)	Pectin yield percentw/w (%)	Observation
1	100	30	100	200	-	Overcooked
2	100	30	100	250	3.9	Pale brown color
3	100	30	100	300*	4.1	Pale brown color
4	100	30	100	350	4.2	Brown color
5	100	30	100	400	4.4	Brown color

*Suitable condition

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

Table (3) Effect of Citric Acid Volume on Color and Yield Percent of ApplePectin Paste

No.	Apple (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	1	Brown color
2	100	30	100	250	1.2	Brown color
3	100	30	100	300*	2.3	Brown color
4	100	30	100	350	2.3	Deep brown color
5	100	30	100	400	4.2	Deep brown color

*Suitable condition

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

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Table (4) Effect of Drying Time on Moisture Content of Pectin Powder from Guava and Apple

Weight of Pectin Paste = 3 g

Sr.No.	Drying Time (min)	Moisture Contentw/w (%)	
		Guava	Apple
1	0	0.92	1.12
2	30	0.83	0.94
3	60	0.59	0.56
4	90	0.48	0.42
5	120**	0.45	0.27
6	150*	0.4	0.17
7	180	0.26	0.16

* Suitable condition for Guava

** Suitable condition for Apple

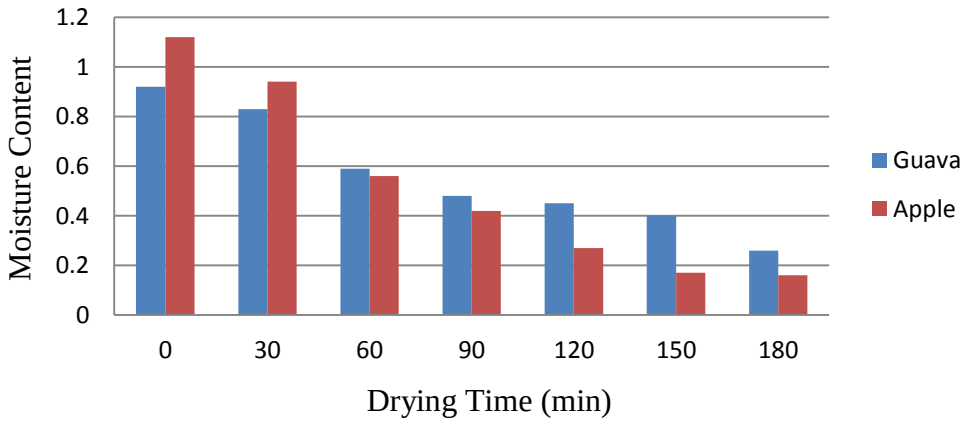

Figure (6) Effect of Drying Time on Moisture Content of Prepared Pectin Powder from Guava and Apple

Table (5) Characteristics of Prepared Pectin Powders

Parameters	Guava	Apple
pH	3.9	3.7
Acidity,w/w (%)	1.5	1.4
Soluble Solid Content,(°Brix)	65	65
Ash Content, w/w (%)	4.15	1.68
Moisture content,w/w (%)	0.4	0.27
Jelly Grade	130	120
Setting Time, (min)	15	17

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

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Table (6) 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	Extracted Guava Pectin	Formation of a colloidal and opalescent solution	Formation of pale yellow translucent gel	Pale yellow gelatinous precipitate
3	Extracted Apple pectin	Formation of a colloidal solution	Formation of pale yellow translucent gel	Pale yellow gelatinous precipitate

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

Table (7) Effect of Sugar Content in the Preparation of Strawberry Jam

Sample	Sugar (g)	Fruit Pulp (g)	Apple Pectin (g)	Citric Acid (g)	Water (ml)	Remarks
1	80	100	3.3	0.1	50	Soft,slightly sour
2	100*	100	3.3	0.1	50	Acceptable,sweet
3	120	100	3.3	0.1	50	Sticky,sweet

*Suitable condition

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

Table (8)Effect of Pectin Concentration in the Preparation of Strawberry Jam

Sample	Sugar (g)	Fruit Pulp (g)	Apple Pectin (g)	Citric Acid (g)	Water (ml)	Remarks
1	100	100	3	0.1	50	Soft, slightly sour
2	100	100	3.3*	0.1	50	Acceptable, sweet
3	100	100	3.6	0.1	50	Sticky, too sweet

*Suitable condition

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

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Table (9)Effect of Sugar Content in the Preparation of Pineapple Jam

Sample	Sugar (g)	Fruit Pulp (g)	ApplePectin (g)	Citric Acid (g)	Water (ml)	Remarks
1	80	100	3.3	0.1	50	Slightly stiff, sour
2	100*	100	3.3	0.1	50	Stiff,sweet
3	120	100	3.3	0.1	50	Stiff,too sweet

*Suitable condition

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

Table (10)Effect of Pectin Concentration in the Preparation of Pineapple Jam

Sample	Sugar (g)	Fruit Pulp (g)	Apple Pectin (g)	Citric Acid (g)	Water (ml)	Remarks
1	100	100	3	0.1	50	Stiff,slightly sour
2	100	100	3.3*	0.1	50	Stiff, sweet
3	100	100	3.6	0.1	50	Stiff, too sweet

*Suitable condition

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

Table (11) Effect of Sugar Content in the Preparation of Orange Marmalade

Sample	Sugar (g)	Fruit Juice (ml)	GuavaPectin (g)	Citric Acid Solution (ml)(10g/l)	Orange Peel (g)	Remarks
1	80	100	0.1	5	10	Slightly stiff,sour
2	100*	100	0.1	5	10	Stiff, sour
3	120	100	0.1	5	10	Stiff,sweet

*Suitable condition

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

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Table (12)Effect of Pectin Concentration in the Preparation of Orange Marmalade

Sample	Sugar (g)	Fruit Juice (ml)	GuavaPectin (g)	Citric Acid Solution (ml) (10g/l)	Orange Peel (g)	Remarks
1	100	100	0.1*	5	10	Slightly stiff , sour
2	100	100	0.2	5	10	Stiff, slightly sour
3	100	100	0.3	5	10	Stiff, sweet

*Suitable condition

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

Table (13) Organoleptic Evaluation of Strawberry Jam, Pineapple Jam and Orange Marmalade

Sample	Color	Taste	Aroma
Strawberry Jam*	Red	Sweet	Pleasant
Pineapple Jam*	yellow	Sweet	Pleasant
OrangeMarmalade*	yellow	Slightly sour	Pleasant

*Suitable conditions

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

Table (14)Characteristics of Prepared Jams and Marmalade

Characteristics	Strawberry Jam	Pineapple Jam	Orange Marmalade	Literature Value*
pH	4.1	3.4	3.6	3.3 - 3.6
Acidity w/w(%)	0.603	0.38	0.6	0.34
Soluble Solid Content(º Brix)	68	68.2	68.9	65 - 68
Moisture Content w/w(%)	14.1	7.2	18.5	-
Ash Content w/w(%)	0.19	0.15	0.07	-
Protein Content w/w(%)	2.6	2.4	2.2	-
Crude Fiber Content w/w(%)	1.2	1.837	0.3165	-

* (Herbstreith& Fox 2001)

pH, Acidity , Soluble Solid Content , Moisture Content and Ash Content were conducted at theLaboratory of Industrial Chemistry Department, University of Yangon.

Protein Content was analyzed at SGS (Society of General Service) Co. Ltd, Wartan Street, Bahosi Housing, Yangon , and Crude Fiber Content at No.11031,Small Scale Industries Department, Thudama Main Road, North Okkalapa, Yangon.

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Cost Estimation for Preparation of Guava Pectin Powder

No.	Particulars	Quantity	Rate	Cost (Kyat)
1	Raw Materials			
	Guava	14000 No.	50 Ks/No.	700000.00
	Citric Acid	80lb	500 Ks/lb	42500.00
	Ethanol	3260 liters	1000/liter	3260000.00
	Pure Water	200 gallon	300 Ks/gallon	60000.00
2	Labour Cost			
	Operator	1	20000 Ks/man	20000.00
	Unskilled Labour	1	30000 Ks/man	30000.00
3	Packaging Cost	10 bags	50 Ks/100 lb bag	500.00
4	Electricity	800 units	50 Ks/unit	40000.00
Total				4153000.00
Unit Price				4153.00

Average cost for 1000 lb of guava pectin powder

Ks 4153000.00/1000 lb

Ks 4153.00/ lbKs 4200/ lb

Cost Estimation for Preparation of Apple Pectin Powder

No.	Particulars	Quantity	Rate	Cost (Kyat)
1	Raw Materials			
	Apple	14000 No.	60 Ks/No.	840000.00
	Citric Acid	85 lb	500 Ks/lb	42500.00
	Ethanol	3260 liters	1000/liter	3260000.00
	Pure Water	200 gallon	300 Ks/gallon	60000.00
2	Labour Cost			
	Operator	1	20000 Ks/man	20000.00
	Unskilled Labour	1	30000 Ks/man	30000.00
3	Packaging Cost	10 bags	50 Ks/100lb bag	500.00
4	Electricity	800 units	50 Ks/unit	40000.00
Total				42930000.00
Unit Price				4293.00

Average cost for 1000 g of apple pectin powder

Ks 42930000/1000 lb

Ks 4293.00/ lb

Ks 4300/ lb

Conclusion

In this research, guava and apple are selected for extraction of pectin powder with organic acid. The content and composition of pectin vary depending on the species, variety, and maturity of the plant, plant part, tissue, and growing condition. Although other mineral acids can be used for extraction of pectin, using organic is better than any other mineral acids for food safety. The highest yield of pectin was guava .So guava is a good source of pectin in addition to apple pomace. After being extracted, pectin was dried in Hot Air Oven at 70 ºC for 6 – 8 hours. Pectin used in jams , jellies and marmalade serves as stabilizer and in beverages as clouding agent and it also imparts smoothness.

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 last for 2 – 3 months under refrigeration whereas, pectin powder, if properly packaged, could last for years).Powder form could be used the whole year round as demand necessary by the market resulting in great profits.

Acknowledgements

I am grateful to Dr. Maung Maung Naing, Rector, Dr. Si Si Khin and Dr. Tint Moe Thuzar , Pro-Rectors, and Dr. Khin Hnin Aye, Professor and Head of Department of Industrial Chemistry, Yadanabon University, for their permission to submit this research.

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