A Study on the Extraction of Tamarind Seed Polysaccharide and its Application in Food Industries

Seinn Lei Lei Phyu[*], Khin Thet Ni[**]

Abstract

Tamarind Kernel Powder (TKP) was prepared from tamarind seeds obtained from tamarinds of Kyaukpadaung and Pyay Townships by parching, pounding, winnowing and grinding. This research is mainly concerned with the production of Tamarind Seed Polysaccharide which can be used as a food additive for substitute of fruit pectin and it was used as a food additive in tamarind jelly and jams. Tamarind Seed Polysaccharide was extracted from tamarind seeds by acid boiling using water and citric acid. The characteristics of prepared Tamarind Kernel Powder (TKP) and Tamarind Seed Polysaccharide (TSP) were determined. The physical and chemical characteristics of prepared tamarind jellies were also compared with other jellies using fruit-pectin. The characteristics of tamarind products were determined and also compared with market products available in Myanmar. The most important characteristic property of tamarind seed polysaccharide was its ability to form jellies with sugar concentrates and citric acid over a wider pH range than fruit pectin. It was an excellent substitute for fruit pectin in jams, jellies and marmalades .The best tamarind seed polysaccharide gels were formed when its concentration was between 0.7 – 0.9 % .Good quality gels were formed by using 1.3% of pectin whereas better and stronger gels were formed with 0.7 % of tamarind seed polysaccharide. The best gel was obtained at pH (2.7 - 3).Commercial pectin required setting time of (5-10) minutes for gel-formation but the experiments with tamarind seed polysaccharide took only (1-5) minutes.

Key Words: TKP= Tamarind Kernel Powder, TSP = Tamarind Seed Polysaccharide

Introduction

Tamarind tree (*Tamarindus indica* L) is mainly found in South India and South East Asia. This tree flowers in spring (September to November). These seeds are flat and of irregular, rectangular shapes. The seeds have about 25% testa and 75% kernel.In this research work, Tamarind products were made by using tamarind from Kyaukpadaung and Pyay Townships. The sound tamarind seeds and tamarind fruits were used in the present work. Tamarind Kernel Power (TKP) was prepared from tamarind seeds by parching, pounding, winnowing and grinding. The second part of the research work was the preparation of Tamarind Seed Polysaccharide (TSP).Tamarind Seed Polysaccharide was used as a substitute for fruit pectin. It had been found that the gelling properties of tamarind seed polysaccharide were superior to that of fruit pectin. So, tamarind seed polysaccharide was used in the preparation of tamarind jelly and tamarind jams. The physico-chemical characteristics of tamarind products were also determined in this present work.

Objectives

- To extract the valuable product, Tamarind Seed Polysaccharide from tamarind seeds
- To use the Tamarind Seed Polysaccharide as a pectin substitute in food processing

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Materials and Methods

Raw Materials

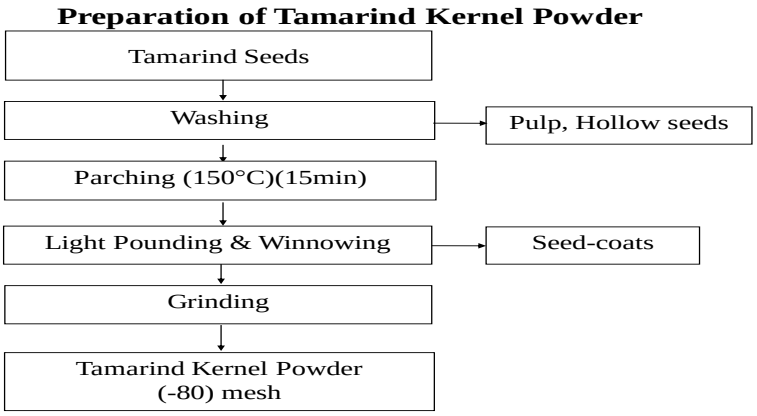
Tamarind

Botanical Name - *Tamarindus indica* L
English Name - Tamarind
Myanmar Name - Magyi
Family - Caesalpiniace

In this research, the tamarind products were made by using tamarind of Kyaukpadaung and Pyay Townships. The physical and chemical characteristics of the tamarind products obtained were determined. In this research, tamarind pulp from Kyaukpadaung Township was used in tamarind products preparation due to its superior quality.

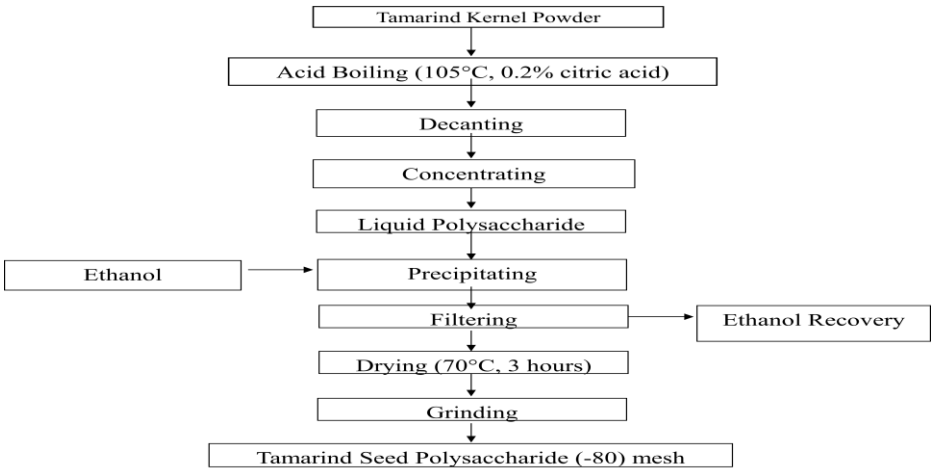
The chemicals used in the preparation of tamarind products were,

1. Pectin
2. Carboxy methyl cellulose
3. Potassium metabisulfite
4. Citric acid
5. Sugar
6. Ethanol



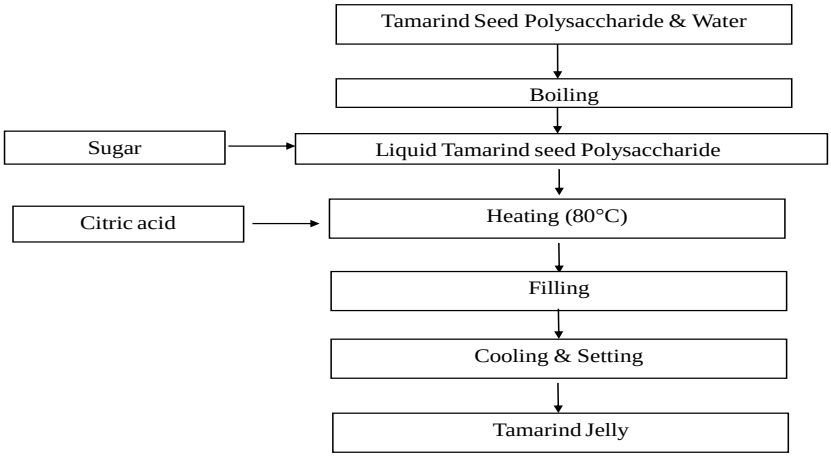
Process Flow Diagram for Preparation of Tamarind Kernel Powder

Preparation of Tamarind Seed Polysaccharide



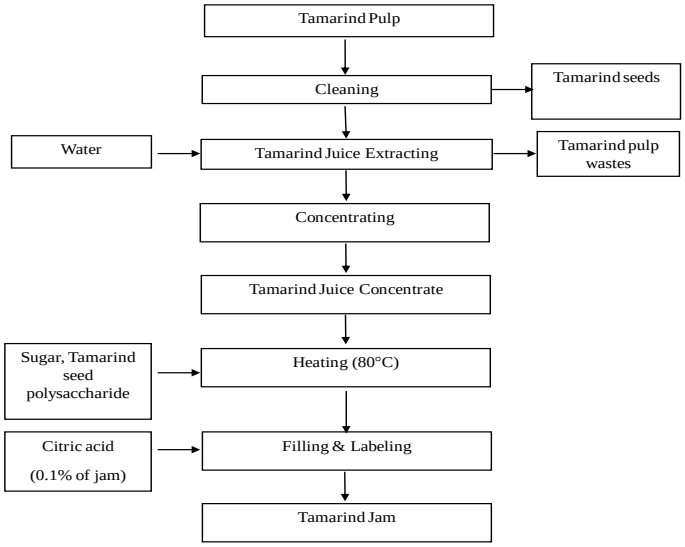
Process Flow Diagram for Preparation of Tamarind Seed Polysaccharide

Preparation of Tamarind Jelly



Process Flow Diagram for Preparation of Tamarind Jelly

Preparation of Tamarind Jam



Process Flow Diagram for Preparation of Tamarind Jam

Figure (1) Tamarind Tree (*Tamarindus indica* L) (Kyaukpadaung Township)

Figure (2) Tamarind Fruit (*Tamarindus indica* L)(Kyaukpadaung Township)

Figure (3) Tamarind Seed (Kyaukpadaung Township)

Figure (4) Tamarind Kernel Powder (Kyaukpadaung Township)

Figure (5) Liquid Tamarind Seed Polysaccharide

Figure (6) Tamarind Seed Polysaccharide Precipitate

Figure (7) Tamarind Seed Polysaccharide

Figure (8) Tamarind Jelly

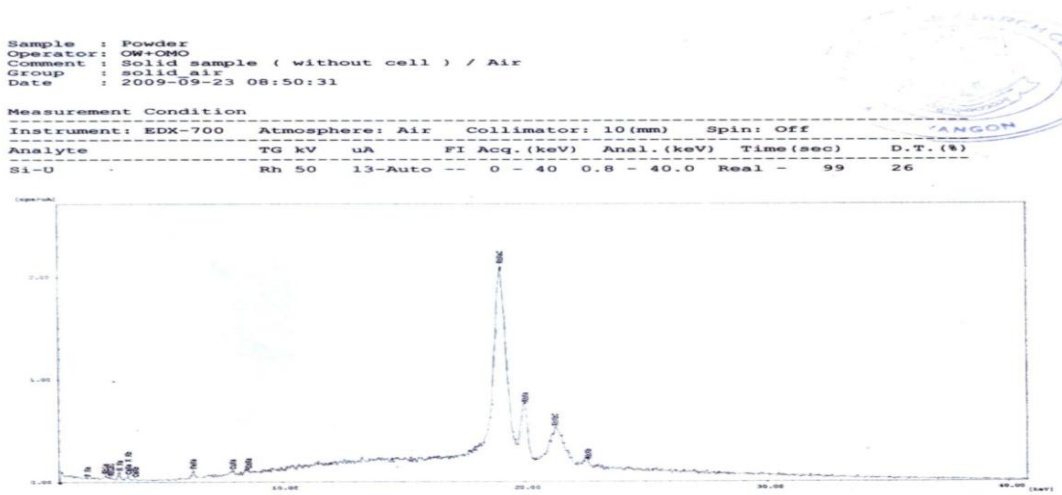
Figure (9) Tamarind Jam

Results

Table (1) Characteristics of Tamarind Kernel Powder and Tamarind Seed Polysaccharide

pH of tamarind kernel powder = 6.8
pH of tamarind seed polysaccharide = 6.8
Sources of Tamarind = Kyaukpadaung and Pyay Townships

Sr. No.	Characteristics	Tamarind Kernel Powder (TKP)(%, w/w)		Tamarind Seed Polysaccharide(TSP) (%, w/w)	
		Kyaukpadaung	Pyay	Kyaukpadaung	Pyay
1.	Acidity (%, w/v)	0.306	0.4	0.473	0.473
2.	Sugar Content	0.3	0.28	0.5	0.48
3.	Moisture	9.08	9.07	10.503	10.5
4.	Ash	1.471	1.38	1.853	1.84
5.	Protein (%, w/v)	7.2	6.9	4.9	4.87
6.	Crude Fiber	1.6	1.48	0	0
7.	Fat	2.6	2.6	0.526	0.526
8.	Yield	70	70	39.18	39.09



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Sample   : Powder
Operator: OW+OMO
Comment  : Solid sample ( without cell ) / Air
Group    : solid_air
Date     : 2009-09-23 08:50:31

Measurement Condition
Instrument: EDX-700   Atmosphere: Air   Collimator: 10(mm)   Spin: Off
Analyte   TG kV   uA      FI Acq.(keV)  Anal.(keV)  Time(sec)   D.T.(%)
Si-U      Rh 50   13-Auto --  0 - 40    0.8 - 40.0  Real -  99  26
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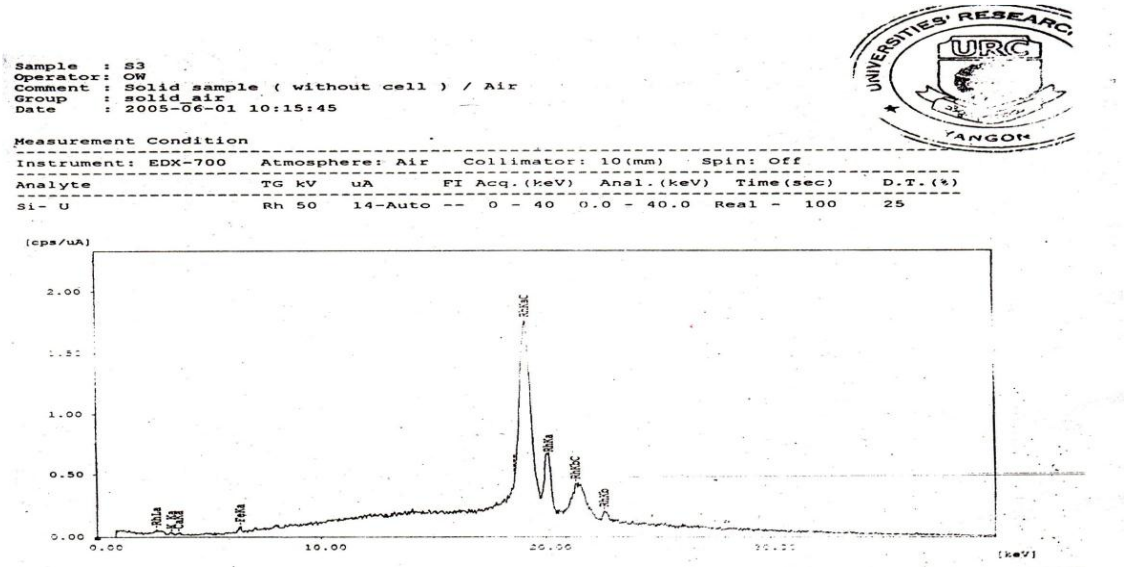
Quantitative Result

Analyte	Result	Std.Dev.	Proc.-Calc.	Line	Int.(cps/uA)
P	39.759 %	4.824	Quan-FP	P Ka	0.071
K	30.814 %	1.485	Quan-FP	K Ka	0.451
Ca	16.498 %	0.988	Quan-FP	CaKa	0.292
Fe	5.841 %	0.243	Quan-FP	FeKa	0.606
Cu	3.720 %	0.152	Quan-FP	CuKa	0.629
Zn	3.368 %	0.133	Quan-FP	ZnKa	0.669

Figure (10) Quantitative Result of Mineral Contents of Tamarind Kernel Powder (Kyaukpadaung) by Energy Dispersive X-ray Fluorescence Spectrometry (EDXRF)



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Sample   : S3
Operator: OW
Comment  : Solid sample ( without cell ) / Air
Group    : solid_air
Date     : 2005-06-01 10:15:45

Measurement Condition
Instrument: EDX-700   Atmosphere: Air   Collimator: 10(mm)   Spin: Off
Analyte   TG kV   uA      FI Acq.(keV)  Anal.(keV)  Time(sec)   D.T.(%)
Si- U     Rh 50   14-Auto --  0 - 40    0.0 - 40.0  Real -  100 25
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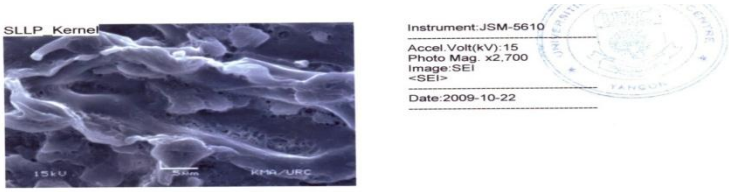
Quantitative Result

Analyte	Result	Std.Dev.	Proc.-Calc.	Line	Int.(cps/uA)
K	0.038 %	0.003	Quan-FP	K Ka	0.170
Ca	0.016 %	0.001	Quan-FP	CaKa	0.151
Fe	0.005 %	0.000	Quan-FP	FeKa	0.467
C	99.940 %	--------	Balance	--------	--------

Figure (11) Quantitative Result of Mineral Contents of Tamarind Seed Polysaccharide (Kyaukpadaung) by Energy Dispersive X-ray Fluorescence Spectrometry (EDXRF)



Figure(12) Surface Morphology of Tamarind Kernel Powder (Kyaukpadaung) by using Scanning Electron Microscope (SEM)

Figure (13) Surface Morphology of Tamarind Seed Polysaccharide (Kyaukpadaung) by using Scanning Electron Microscope (SEM)

Table (3) Gel Formation Test of Tamarind Kernel Powder and Tamarind Seed Polysaccharide Using Different Solvents

Sr. No.	Sample	Gel Formation Using Different Solvents	
		Water	2 M NaOH Solution
1.	Tamarind Kernel Powder	Formation of a yellowish white solution	Formation of a yellowish white curd
2.	Tamarind Seed Polysaccharide	Formation of a white translucent solution	Formation of white translucent semi-gel

Table (4) Solubility Test of Tamarind Kernel Powder and Tamarind Seed Polysaccharide Using Different Solvents

Sr. No.	Sample	Solubility Test with Different Solvents	
		Water	Ethanol
1.	Tamarind Kernel Powder	Formation of a yellowish white solution	Insoluble
2.	Tamarind Seed Polysaccharide	Formation of a white translucent solution	Insoluble

Table (5) Precipitation Test of Tamarind Kernel Powder and Tamarind Seed Polysaccharide Using Different Solvents

Sr. No.	Sample	Precipitation Test with Different Solvents	
		Ethanol	0.1M HCl solution
1.	Tamarind Kernel Powder	A yellowish white gelatinous precipitate	A yellowish white gelatinous precipitate
2.	Tamarind Seed Polysaccharide	A white semi-gelatinous precipitate	The color changed from yellowish white to white

Table (6) Effect of Extraction Time on Yield Percent of Tamarind Seed Polysaccharide (Kyaukpadaung)

Tamarind Kernel Powder = 25 g Water = 250 ml
Citric Acid = 50 mg Extraction Temperature = 100ºC
Source of Tamarind = Kyaukpadaung Township

Sample No.	Extraction Time(min)	Tamarind Seed Polysaccharide(g)	Tamarind Seed Polysaccharide (Yield %)
1	20	2	8
*2	30	5	20
3	40	2.5	10
4	50	2	8

*= the most suitable condition

Table (7) Effect of Citric Acid Content on Yield Percent of Tamarind Seed Polysaccharide (Kyaukpadaung)

Tamarind Kernel Powder = 25 g Extraction Time = 30 min
Extraction Temperature = 100ºC Water = 250 ml
Source of Tamarind = Kyaukpadaung Township

Sample No.	Citric Acid(mg)	Tamarind Seed Polysaccharide(g)	Tamarind Seed Polysaccharide (Yield %)
1	25	4.5	18
*2	50	5	20
3	75	3.25	13
4	100	2.5	10

* = the most suitable condition

Table (8) Effect of Extraction Time on Yield Percent of Tamarind Seed Polysaccharide (Pyay)

Tamarind Kernel Powder = 25 g Water = 250 ml
Citric Acid = 50 mg Extraction Temperature = 100ºC
Source of Tamarind = Pyay Township

Sample No.	Extraction Time(min)	Tamarind Seed Polysaccharide(g)	Tamarind Seed Polysaccharide (Yield %)
1	20	1.75	7
*2	30	3.5	14
3	40	2.25	9
4	50	2	8

*= the most suitable condition.

Table (9) Effect of Citric Acid Content on Yield Percent of Tamarind Seed Polysaccharide (Pyay)

Tamarind Kernel Powder = 25 g Extraction Time = 30 min
Extraction Temperature = 100ºC Water = 250 ml
Source of Tamarind = Pyay Township

Sample No.	CitricAcid(mg)	Tamarind Seed Polysaccharide(g)	Tamarind Seed Polysaccharide(Yield %)
1	25	1.5	6
*2	50	2.9	11.6
3	75	2.25	9
4	100	0.8	3.2

* = the most suitable condition

Table (10) Comparison of Characteristics of Tamarind Jelly Using Different Amounts of Tamarind Seed Polysaccharide (or) Pectin

Sugar = 15g, Setting Temperature = 29ºC
Citric acid = 0.1g, Source of Tamarind = Kyaukpadaung Township
Jelly Grade = Amount of Sugar/Amount of TSP (or) Pectin used

Sr. No.	Tamarind Seed Polysaccharide / Pectin (g)	Characteristics					
		Setting Time (min)		Souble Solid (ºBrix)		Jelly Grade	
		TSP Jelly	Pectin Jelly	TSP Jelly	Pectin Jelly	TSP Jelly	Pectin Jelly
1	* 0.2	1	5	65	60	75	75
2	**0.4	5	10	68	68	37.5	37.5
3	0.6	10	10	55	72	25	25
4	0.8	10	3	55	75	18.7	18.7
5	1.0	10	3	52	77	15	15

* = the most suitable condition for TSP Jelly, **= the most suitable condition for Pectin Jelly
0.2 g of TSP = the most suitable condition for TSP Jelly
0.4 g of pectin = the most suitable condition for pectin jelly

Table (11) Comparison of Characteristics of Tamarind Seed Polysaccharide Jelly and Pectin Jelly Using Different Amounts of Sugar

Citric acid =0.1g,, Setting Temperature = 29ºC, Source of Tamarind = Kyaukpadaung Township
Gelling Agent= 0.2 g of TSP (or) 0.4 g of pectin
Jelly Grade= Amount of Sugar/Amount of TSP (or) Pectin,

Sr. No.	Sugar (g)	Characteristics					
		Setting Time (min)		Souble Solid (ºBrix)		Jelly Grade	
		TSP Jelly	Pectin Jelly	TSP Jelly	Pectin Jelly	TSP Jelly	Pectin Jelly
1	5	3	1	50	40	25	25
2	10	3	2	40	50	50	50
3	*15	1	5	65	68	75	75
4	20	1	no setting	70	73	100	100
5	25	5	no setting	72	75	125	125

* = the most suitable condition

Table(12) Comparison of the Characteristics of Tamarind Seed Polysaccharide and Pectin Jellies

Sr. No.	Characteristics	Tamarind Jelly	Pectin Jelly	*J- Cup Jelly
1	Setting time (minute)	1-5	5-10	60-120
2	Soluble solid (˚Brix)	65	58	21
3	Jelly grade	75	75	-
4	pH	2.9	2.4	3.5
5	Acidity (%, w/v)	1.3	1.5	0.9
6	Sugar (as sucrose) (%,w/w)	8.33	8.33	9.2
7	Protein (%,w/v)	0.22	0.22	0.22
8	Crude fiber (%,w/w)	0	0	0
9	Vitamin C (%,w/w)	0.038	0.038	0.03

*= Jelly from market

Table (13) Effect of Tamarind Content on the Characteristics of Tamarind Jam

Sugar = 60.5 g, Tamarind seed polysaccharide = 0.5 g, Citric acid = 0.1 g ,Water = 11 ml

Sample No.	Tamarind		Soluble Solid (°Brix)	Acidity(%,w/v)	pH
	g	(%,w/w)			
1	36.5	30	77	0.045	3.7
*2	48.7	40	75	0.048	2.8
3	60.8	50	68	0.048	2.6
4	73	60	67	0.048	2.6
5	85.1	70	67	0.049	2.5

*= the most suitable condition

Table (14) Effect of Tamarind Seed Polysaccharide Content on the Characteristics of Tamarind Jam

Sugar = 60.5 g , Tamarind = 50 g, Citric acid = 0.1 g , Water = 11 ml

Sample No.	Tamarind seed polysaccharide		Soluble Solid (°Brix)	Acidity (%,w/v)	pH
	(g)	(%,w/w)			
*1	0.5	0.42	68	0.048	3.1
2	0.6	0.5	70	0.048	3.1
3	1.1	1.0	72	0.048	3.1
4	1.67	1.5	76	0.048	3.1
5	2.2	2.0	77	0.048	3.1

*= the most suitable condition

Table (15) Effect of Sugar Content on the Characteristics of Tamarind Jam

Tamarind seed polysaccharide = 0.5 g, Citric acid = 0.1 g, Water = 11 ml

Sample No.	Sugar		Soluble Solid (°Brix)	Acidity (%,w/v)	pH
	(g)	(%,w/w)			
1	36.5	30	62	0.025	3.5
2	48.6	40	68	0.029	3.5
*3	60.8	50	72	0.032	3.4
4	73	60	76	0.032	2.9
5	85.1	70	77	0.032	2.9

*= the most suitable condition

Table (16) Comparison of Characteristics of Tamarind Jams Using Different Thickening Agents

Sugar= 60.5g, Tamarind = 50 g, Citric acid= 0.1 g, Water= 11ml

Sr. No.	Characteristics	Tamarind Jam using Different Thickening Agents			*Literature Value
		TSP(0.5 g)	Pectin(1.0 g)	SCMC(1.0 g)	
1	Moisture (%,w/w)	16.1	16.29	15.9	29.6
2	pH	3.1	3.2	3.1	3.2-3.4
3	Acidity (%,w/v)	0.048	0.039	0.042	-
4	Soluble solid (°Brix)	68	65	63	68
5	Sugar (as sucrose) (%,w/w)	40.85	19.11	6.73	-
6	Protein (%,w/v)	0.55	0.35	0.47	-
7	Crude Fiber (%,w/w)	0.31	0.32	0.57	-
8	Vitamin C (%,w/w)	0.043	0.043	0.043	0.01

TSP = Tamarind seed polysaccharide , SCMC = Sodium carboxy methyl cellulose

*Dauthy, M.E.(1995)

Discussion

Table (1) shows that the contents of sugar, moisture, ash and protein of tamarind seed polysaccharide (Kyaukpadaung) were higher than that of tamarind seed polysaccharide (Pyay).The crude fiber content of tamarind seed polysaccharide was zero due to its standing overnight and decantation in the preparation. The gel formation, solubility and precipitation tests of both TKP and TSP were determined by using different solvents and shown in Tables (3-5). In the present research work, the yield percents of tamarind seed polysaccharide were determined by using different extraction time of (20-50) minutes. It was found that 30 minutes was the most suitable extraction time for maximum yield per cent and the data are shown in Tables (6 and 8). The yield percents of tamarind seed polysaccharide were determined by using different amount of citric acid (20-100 mg).It was found that 50 mg of citric acid content was the most suitable amount for the 25 g of tamarind kernel powder. The data are shown in Tables (7 and 9). Table (10) shows that tamarind seed polysaccharide jelly required only half of the amount of commercial pectin. Table (11) shows that 15 g of sugar was the most

suitable for 0.2 g of TSP. Tables (12) shows the comparison of the characteristics of tamarind Seed polysaccharide and pectin Jellies. Tables (13-15) show the effects of contents of tamarind, TSP and sugar in jam making. Table (16) shows the comparison of characteristics of jam using TSP, Pectin and Sugar and it can be seen that tamarind seed polysaccharide can be used as the pectin substitute.

Conclusion

The tamarind seed polysaccharide was not starch. It formed mucilaginous gels with sugar concentrates and citric acid as pectin. The most important characteristic property of tamarind seed polysaccharide was its ability to form jellies with sugar concentrates and citric acid over a wide pH range than fruit pectin. It was an excellent substitute for fruit pectin in jams and jellies. The gels prepared from tamarind seed polysaccharide can be compared very favorably with those obtained from the fruit pectin. In fact, the best tamarind seed polysaccharide gels were formed when its concentration was between 0.7 – 0.9 % of the weight of the final gel, whereas the required concentration of fruit pectin was nearly double. Furthermore, tamarind seed polysaccharide could form gels over a wide pH range but the fruit pectin set only in acid media. Good quality gels were formed by using 1.3% of pectin and better gels were formed with 0.7 % of tamarind seed polysaccharide. For both TSP and Pectin the best gel was obtained at pH (2.7 - 3). Commercial pectin required setting time of (5-10) minutes for gel-formation but the experiments of tamarind seed polysaccharide took only (1-5) minutes. There is no additional preservative in tamarind jam because the sugar serves as preservative for long storage (one year). The shelf-life of resulting tamarind jam samples was about one year. So, the prepared product (TSP) would be used as pectin substitute and would also supplement the domestic market as it has good quality and low cost.

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