CHAPTER 3 MATERIALS AND METHODS

The details of the raw material, apparatus and experimental procedure were included in this chapter. The procedures of dielectric and flow properties measurement were also described.

3.1 Raw Material

Ripe papaya (*Carica papaya* L., cv. Kheak Dham) from the local market

3.2 Apparatus

1. Open-ended coaxial probe connected to network analyzer: Agilent technologies N5230C 300 kHz-13.5GHz PNA-L network analyzer model, USA
2. Open-ended coaxial probe connected to network analyzer: Agilent technologies N5230A 300 kHz-13.5GHz PNA-L network analyzer model, USA
3. Rotational concentric cylinder viscometer, Haake VT500 model, Germany
4. Rotary evaporator, the lab-scale Rotavapor R210 model, Buchi, Switzerland
5. Rotary evaporator, Resona Model Labo Rata S-300, Germany
6. UV-VIS scanning spectrophotometer, Shimudzu UV210 model, Kyoto, Japan
7. Refrigerated centrifuge, CR21 model, Hitachi, Ibaraki, Japan
8. Hand refractometer, Atago N1 (Brix 0-32%) model, Tokyo, Japan
9. Digital thermometer, Yogogawa model 2455, Japan
10. Dual chopping and grinding capabilities separate bowl assembles, WCG75E model, USA
11. Water bath, Memmert W600, Schwabach, Germany
12. Digital water bath, LWB 111D model, Daihan Labtech, Korea

13. Hot plate
14. Vortex
15. Laboratory test sieve 50 mesh
16. Beakers
17. Volumetric flasks
18. Pipettes
19. Evaporating flask
20. Stirring rods
21. Distilled water bottle
22. Cylinder
23. Test tube
24. Knife
25. Stainless spoon
26. Stainless tray
27. Separating funnel
28. Filter papers, Whatman No.1 and 42

3.3 Experimental Procedures

3.3.1 Preparation of Papaya Puree Sample

Ripe papaya (*Carica papaya* L., cv. Keak Dam) from the local market was washed with tab water to get rid of pesticides and contaminated substances. Then, papaya was peeled, halved, deseeded and cut into small pieces. Papaya puree was prepared from papaya flesh using a pilot plant crushing machine. Initial concentration of papaya puree was about 10 °Brix and it was concentrated in a rotary evaporator (Resona model Labo

Rata S – 300, Germany). The papaya puree samples were finally packed into polyethylene bottles and stored in the refrigerator at 4 °C for further experimental measurement.

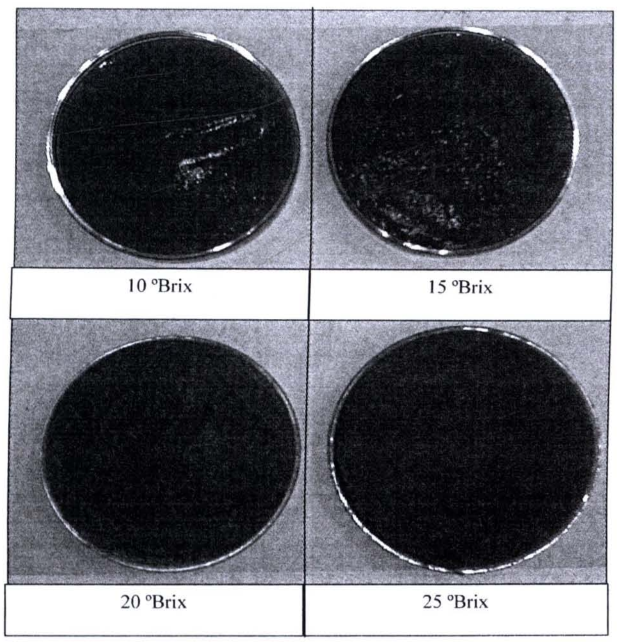

Figure 3.1 Papaya puree sample at various soluble solids contents

- **Determination of Physicochemical Characteristics**

During evaporation process, the papaya puree was measured soluble solids contents by hand refractometer, Atago N1 (Brix 0-32%) Model, Japan and expressed in °Brix. Proximate compositions including fat, moisture content, protein, fiber and ash of the single strength papaya puree samples were first analyzed according to the Association of Official Analytical Chemists method (AOAC, 1995). The pH of papaya puree was measured using pH meter (Schott Gerate, model CG841, Germany) and acidity was measured by titration method and was calculated as percent citric acid (AOAC, 1995). The details of proximate, pH and acidity analyses were shown in Appendix A.

3.3.2 Dielectric Properties Measurement

Prior to dielectric properties measurement, 90 ml of each papaya puree sample with soluble solids contents 10, 15, 20 and 25 °Brix was poured and packed well into 100 ml beaker. The height of a measured sample is 5 cm. After pouring papaya puree into beaker, removing the air space that might occur by pressing papaya puree sample, made sure that the air space was removed as much as possible. After packing papaya puree sample into beaker well, put beaker in a water bath at various temperatures to receive the papaya puree sample at each desired temperature, i.e., 30, 40, 50, 60, 70 and 80 °C. The coaxial probe was calibrated with distilled water at measured temperatures are 40, 50, 60, 70 and 80 °C and frequency range from 355 to 8010 MHz. The results of dielectric constant and dielectric loss factor of distilled water at various frequencies and temperatures were plotted as shown in an appendix A (Figure1).

Open-ended coaxial probe system, this system is commercially available from Agilent Technologies, consists of N5230C 300 kHz- 13.5 GHz PNA-L network analyzer with commercial software as shown in Figure 3.2. The measurement was performed with the network analyzer and coaxial probe in the frequency range from 355 MHz to 8.01 GHz. The microwave signal launched by a vector network analyzer was reflected by the papaya puree sample. The analyzer received the reflected waves (S_{11}), and the dielectric properties were then automatic calculated by commercial software.

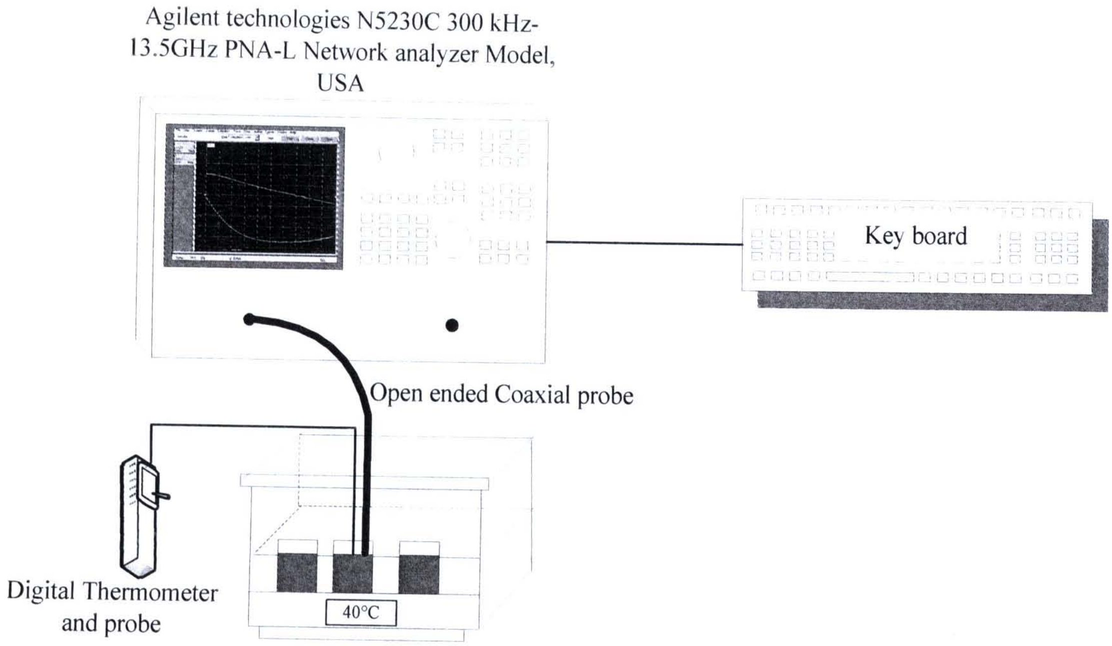

Figure 3.2 Open-ended coaxial probe connected to network analyzer, Agilent technologies N5230C 300 kHz-13.5GHz PNA-L Model, USA

3.3.3 Flow Properties Measurement

The rheological behavior of papaya puree with different soluble solids contents (10, 15, 20 and 25 °Brix) was determined using a rotational, concentric cylinder viscometer (Haake, Model VT500, Germany) with SV1 Type measuring system. For each measurement, 9 ml of each papaya puree sample was used. The rheological analysis was carried out varying the shear rate from 0 to 300 s^{-1} (ascending curve) for 1 min, steady shear rate at 300 s^{-1} for 1 min and from 300 to 0 s^{-1} (descending curve) for 1 min.

The temperatures of the samples were varied at 5, 20, 35, 50, 65 and 80 °C by a thermostat bath for controlling the temperature of the samples (Figure3.3).

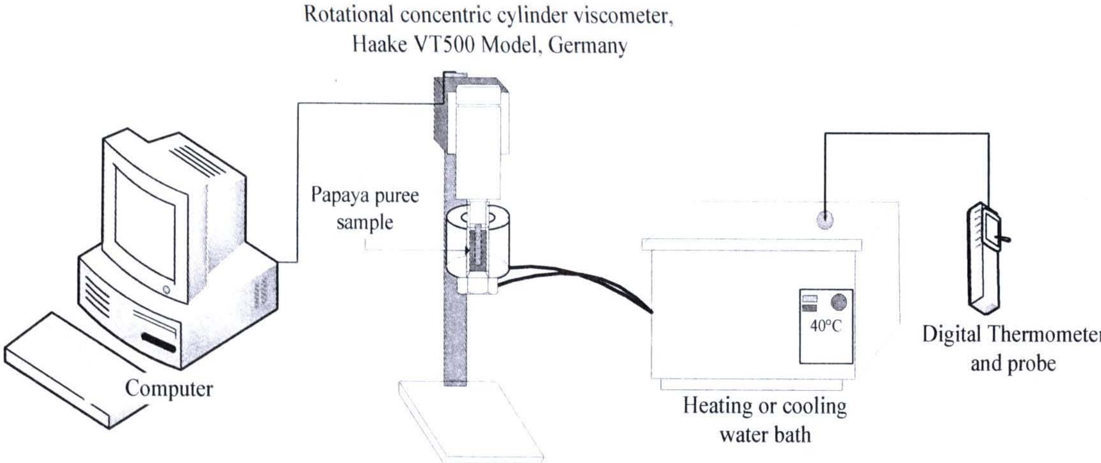

Figure3.3 Rotational concentric cylinder viscometer, Haake VT500 model, Germany connected to computer and heating or cooling water bath

3.3.4 Experimental Design

The effects of different soluble solids contents, temperature and frequency of papaya puree were determined in this study. The assumptions of this experiment were the following.

1. Soluble solids contents of papaya puree affects dielectric and flow properties.
2. Temperature of papaya puree affects dielectric and flow properties.
3. Frequency affects dielectric properties.

For dielectric properties, factors studied were soluble solids content, temperature and frequency. There were 4 (i.e., 10, 15, 20 and 25 °Brix), 5 (i.e., 40, 50, 60, 70 and 80 °C) and 2 (i.e., 915 and 2450 MHz) levels of soluble solids content, temperature and frequency, respectively. A 3 factors, i.e., soluble solids content, temperature and frequency, 4×5×2 full factorial design was used in scheduling of experiment with three replications in each case, as shown in Table 3.1.

For rheological properties, factors studied were soluble solids content and temperature. There were 4 (i.e., 10, 15, 20 and 25 °Brix) and 6 (i.e., 40, 50, 60, 70 and 80 °C) levels of soluble solids content and temperature, respectively. A 2 factors, i.e., soluble solids content and temperature, 4×6 full factorial design is used in scheduling of experiment with three replications in each case, as shown in Table 3.2.

Table 3.1 A 3 factors, 4×5×2 full factorial design for dielectric properties

Soluble solids content	Temperature (°C)	Dielectric constant (ε′)		Dielectric loss factor (ε″)	
		915 MHz	2450 MHz	915 MHz	2450 MHz
10 °Brix	40				
	50				
	60				
	70				
	80				
15 °Brix	40				
	50				
	60				
	70				
	80				
20 °Brix	40				
	50				
	60				
	70				
	80				
25 °Brix	40				
	50				
	60				
	70				
	80				

Table 3.2 A 2 factors, 4×6 full factorial design for rheological properties τ_y

Soluble solids content	Temperature (°C)	Yield stress, τ_y (Pa)	Consistency index *K*, (Pa.s)	Flow behavior index, *n* (-)
10 °Brix	5			
	20			
	35			
	50			
	65			
	80			
15 °Brix	5			
	20			
	35			
	50			
	65			
	80			
20 °Brix	5			
	20			
	35			
	50			
	65			
	80			
25 °Brix	5			
	20			
	35			
	50			
	65			
	80			

3.3.5 Statistical Analysis

All results were analyzed using statistical program MINITAB. The data was analyzed and presented as mean values with standard deviations. The level of significance was determined at a confident level of 95%. The dependent variables of this study are dielectric at various soluble solids contents, temperatures and frequencies and rheological properties at various soluble solids contents and temperatures. Least significant differences were calculated by Tukey's test.