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Extraction of tamarind seed jellose under different conditions and their rheological properties

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Abstract

Tamarind seed powder (TSP) was prepared from tamarind seed and further defatted with hexane. Non-defatted and defatted TSP samples were analyzed for pasting property using a Brabender viscoamylograph. Slightly lower of pasting temperature and significantly higher in PV, consistency index, and setback of defatted TSP was observed. Rheological property, especially flow behavior index, of high temperature extracted jellose (HT jellose) was described the samples as non-newtonian pseudoplastic type, and with higher consistency index than of room temperature extracted jellose (RT jellose). Precipitation with ethanol at pH 3, 4, and 5 of both extraction temperature group samples showed non-significant on consistency index in each group. However, HT jellose with precipitation at pH 4 resulted in highest viscous jellose.

Keywords: tamarind seed powder, jellose, xyloglucan, pasting property, rheological property

1. Introduction

Tamarind seed is a by-product from tamarind pulp industry. Currently, Thailand has exported tamarind seed in a form of seed powder. It is a raw material to produce tamarind seed gum which could be applicable to many industries such as textile, food, and medicine etc. Tamarind seed consists of polysaccharide, mainly xyloglucan, about 75% (Marathe et al., 2002). Xyloglucan has the ability to form gel and used widely as a thickening, stabilizing, or gelling agent in food industry, therefore, it is also known as jellose. Extraction procedure of jellose had been attempted by several scientists. Somsiri (1997) studied on extraction of tamarind polysaccharide in pilot scale production by extraction at 5°C, 25-30°C, and 85-90°C. It was found that higher extract temperature, more viscous fluid was obtained. Kai and Petkowicz (2010) studied on effect of extraction conditions to the properties of xyloglucan extracted from *H. courbaril* seed by precipitating with ethanol. The flow behavior index of extracted jellose exhibited a shear-thinning behavior at concentration higher than 1%. In addition, longer extract duration caused solution higher in viscosity. Sakaw et al. (2012) researched on processing of tamarind seed gum by

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precipitating using ethanol compared with using aluminium sulfate salt-ethanol. Therefore, this research was aim to study rheological property of jellose extracted from defatted tamarind seed powder (TSP) at room and heated temperature and precipitation at difference pH of 3, 4 and 5.

2. Materials and Methods

2.1 Preparation of defatted tamarind seed powder (TSP)

Tamarind seed obtained from a tamarind pulp factory was washed to remove attached pulp and float away the hollow seeds. The seed was then dried in hot air oven at 60°C for 6 h. Tamarind seed powder (TSP) was prepared by roasting the dried seed at about 120°C for 15 min, waiting to cool afterward, and crack out the shell with electrical stone mortar. The collected seed kernel was soaking in water of 1 kg kernel / 3 L of water for about 6 h, then washed and drained. Coarsely grinding the soaking kernel to smaller particle size with a waring blender and after that dried in hot air oven at 50-55°C for 6 h. The sample was finely ground using pin mill through a 0.25 mm sieve size. TSP was defatted with hexane of 1 g TSP / 3 mL hexane by shaking with separating funnel for 15 min, thereafter defatted TSP was separated and dried in hot air oven at 50-55°C for 2 h.

2.2 Extraction of jellose

Extraction procedure was adapted from the method of Somsiri (1997) and Marathe et al. (2002). The extraction step was shown in Fig. 1. Water was used as a solvent in the ratio of 1 g defatted TSP to 10 mL of water. The mixture was stirred for 45 min at room temperature (27.5±2.5°C). Upon removal of sediment, the solution was centrifuged at 6,000 rpm. The clear solution was fractionated into 3 fractions and pH adjustment at 3, 4, 5 of each and allowed to settle overnight. The solution was evaporated to half of its volume. Precipitating of fibrous jellose was done by adding 1.5 volume of 95% ethanol and stirred continuously. To obtain the precipitate muslin cloth was used to filter the fibrous jellose and dried afterward at 50-55°C. Dried jellose sample was finely ground with pin mill through a 0.25 mm sieve size. This jellose was so called room temperature extracted jellose (RT Jellose), since it was extracted at room temperature.

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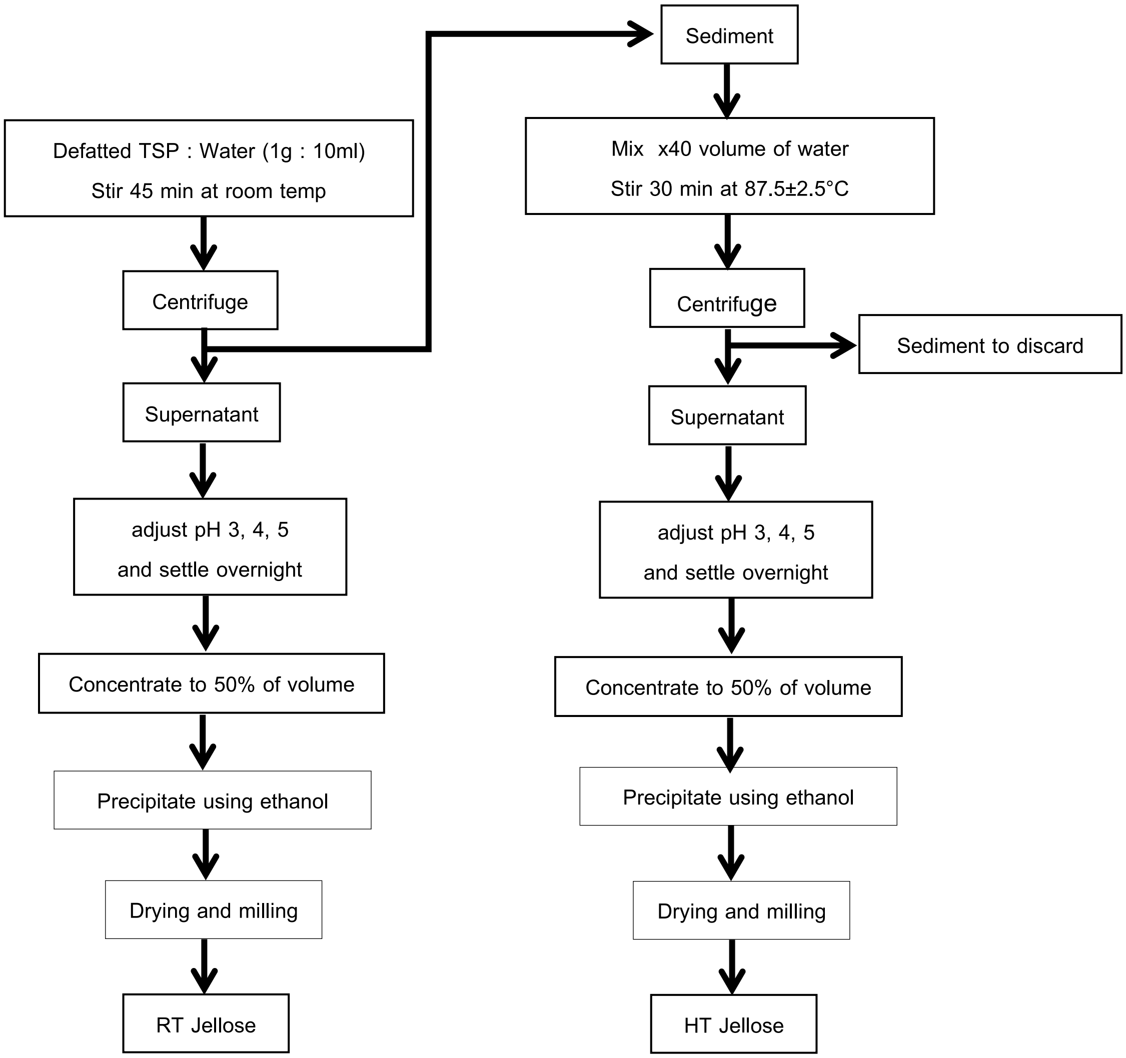

Figure 1. Jellose extraction steps from defatted tamarind seed powder.

It was reminded that the sediment separated from the upcoming process did not go to discard. It was brought to re-extract of jellose with 40 volume of water and stirred at 87.5±2.5°C for 30 min in water bath. Jellose extraction was performed just the same as at room temperature (as in Fig. 1). The extracted sample from this step was called high temperature jellose (HTJellose).

2.3 Determination of pasting property of non-defatted and defatted TSP

Pasting property of non-defatted and defatted TSP was evaluated with Brabender viscoamylograph which followed from the method of Adebowale and Lawal (2002). Prepared a mixture of TSP solution at 4% concentration by weight and programmed the temperature to increase 1.5°C/min, when the temperature raised to 95°C held constantly for 15 min and cooled down at the same rate. Maintained the temperature at 50°C for 15 min. Determined pasting parameters e.g. pasting temperature, peak viscosity, breakdown, consistency, and setback of the test samples.

2.4 Determination of rheological property of extracted jellose

Extracted Jellose solution at 2% concentration was prepared and measuring its rheological characteristic using a small sample of Brookfield viscometer model DVIII at 30±1°C. Shear rate and the corresponding shear stress were recorded. Flow behavior index (η) and consistency index (*k*) were calculated according to the Power Law Model.

2.5 Statistical analysis

The experiment was conducted in completely randomized design (CRD) with triplicates. Statistical software with analysis of variance and Duncan's new multiple range test for analyzing mean differences were calculated at 95% confidence level.

3. Results and Discussion

3.1 Pasting property of non-defatted and defatted TSP

The pasting property of non-defatted and defatted TSP were compared. Changing on viscosity (in Brabender Unit) of TSP solution during heating and cooling cycle offered several parameters reflecting the pasting properties e.g. peak viscosity, breakdown, consistency, and setback of the samples (Table 1).

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Table 1. Pasting property of defatted and non-defatted TSP.

Treatment	Pasting temperature^{ns} (°C)	Viscosity (BU)			
		Peak* viscosity	Breakdown^{ns}	Consistency*	Setback*
non-defatted TSP	53.00±1.55	724.00±46.66	151.50±19.09	742.00±15.55	663.50±7.77
defatted TSP	51.10±0.56	959.50±3.53	184.50±21.92	891.50±9.19	786.50±16.26

Note: 1. * significantly difference ($p<0.05$).
2. ^{ns} non-significantly difference ($p>0.05$).

Pasting temperatures of TSP samples were ranged in 51-53°C without significant difference. However, Rongthong (2009) found lower gelling temperature of tamarind kernel powder prepared from microwave drying seed. The difference from our experiment might cause from the destruction of internal cell structure due to the heating method. All viscosity parameters (peak viscosity, breakdown, consistency and setback) of defatted TSP were significantly higher than of non-defatted which confirm the interference of non-carbohydrate component to its starch properties.

3.2 Rheological property of extracted jellose

Relationship between shear stress (N/m^2) and shear rate (1/sec) of jellose solutions extracted at pH 3, 4, 5 of RT and HT jellose is presented in Fig. 2. Steeper slope responded of higher viscosity solution, therefore HT jellose exhibited more viscous than of RT jellose. However, precipitating pH did not show influence on rheological parameters of each group of jellose samples. Power law model was accordingly fitted to describe the flow behavior (η) and consistency index (k) of the liquid. Value of η is determined by the nature of the fluid. Newtonian fluid describe η equal to 1, where non-newtonian describe the η not equal to 1, if less than 1 describe pseudoplastic type, and in case of higher than 1 it is dilatant fluid. Flow behavior index of RT Jellose samples at all precipitation pH were close to 1 (0.99), therefore they exhibited Newtonian fluid, while of HT jellose group were lesser that 1 (0.91), exhibited non-Newtonian fluid. It corresponded to the result of Pongsawatmanit et al. (2006) reported that 2% jellose measured at

30°C with η = 0.79 and *k* = 2.58 Pa.s shown pseudoplastic fluid. In addition, Sittikijyothin (2010) stated that low concentration of jellose showed newtonian flow behavior, but when the concentration increased showed non-newtonian type pseudoplastic fluid or shear thinning. It was noticeable there was not affect to pH in a group of the extract temperature. It was because jellose had tolerated to a wide range of pH values (Sims et al., 1998; Rao and Srivastava, 1973).

With increasing of pH, slightly higher values of consistency index or more viscous of fluid of a RT jellose group was observed. In contradictory of HT jellose, at pH 4, the highest viscosity was observed. This might because of at pH 4 was closing to the isoelectric pH of protein to precipitate out of the extracted solution resulted in more purity of jellose.

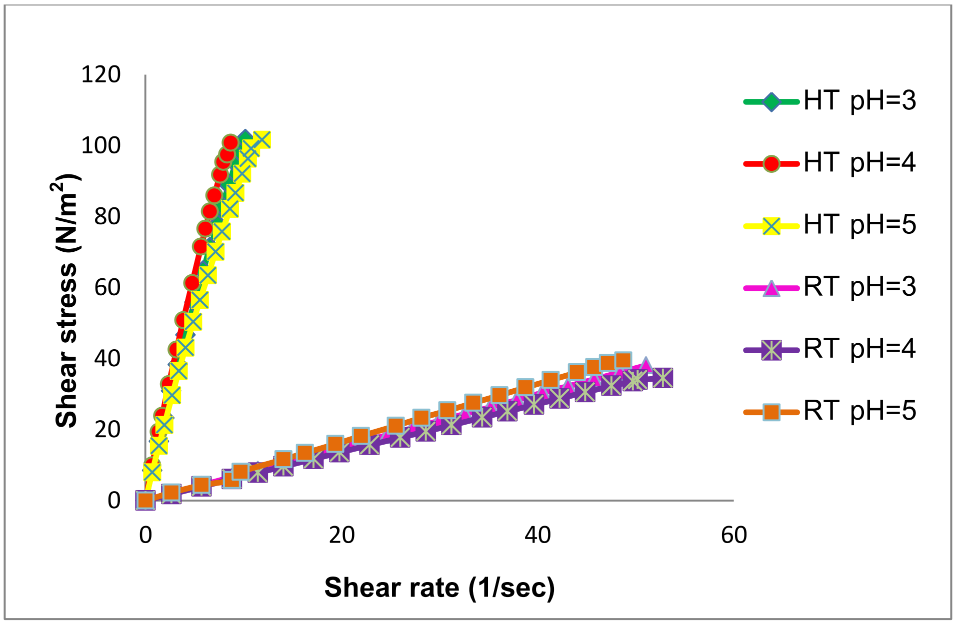

Figure 2. Relationship between shear rate and shear stress of RT and HT jellose extracted at pH 3, 4 and 5.

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Table 2. Flow behaviour index (η) and consistency index (*k*) of RT and HT jellose extracted at pH 3, 4 and 5.

Temperature	pH	η	*k* (Pa.s)
RT	3	0.99 ± 0.00^{a}	0.84 ± 0.04^{a}
	4	0.99 ± 0.01^{a}	0.68 ± 0.04^{a}
	5	0.99 ± 0.04^{a}	0.77 ± 0.05^{a}
HT	3	0.91 ± 0.00^{b}	12.54 ± 0.36^{b}
	4	0.91 ± 0.00^{b}	14.57 ± 1.41^{c}
	5	0.91 ± 0.00^{b}	11.65 ± 1.37^{b}

Note: Mean value ± standard in the same column with different superscripts indicate significantly different ($p<0.05$).

4. Conclusion

Pasting property of non-defatted and defatted TSP are slightly different with lower of pasting temperature and higher for all viscosity parameters of defatted sample. HT jellose group exhibited non-newtonian type pseudoplastic fluid, when of RT jellose group exhibited Newtonian fluid. Higher viscous fluid was obtained in HT jellose group. Jellose extracted at high temperature (87.5±2.5°C) and ethanol precipitation at pH 4 had got the highest consistency index. In conclusion, extraction temperature had highly impact to the rheological property of extracted jellose when precipitation pH had less influence.

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