EFFECT OF JELLOSE AND SWEET TAMARIND PULP OF THAILAND ON SOME PHYSICAL PROPERTIES AND SENSORY CHARACTERISTICS OF TAMARIND GELATO ICE CREAM

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Abstract

The objectives of this research was to study the effect of jellose and sweet tamarind pulp on some physical and sensory properties of tamarind gelato ice cream (TGI). Tamarind gelato ice cream was produced by using jellose (xyloglucan) and sweet tamarind pulp from Thailand. Jellose was used as stabilizer at level of 1% and 2% (w/w,db) while sweet tamarind pulp as flavor at level 15%, 25% and 35% (w/w,wb). TGI was measured mix viscosity before aging, melting rate, overrun, hardness and color. Sensory test of TGI was also done. Mix viscosity of the mixture before aging was significantly increased with increasing concentration of jellose and the amount of sweet tamarind pulp with r=0.48 and 0.58(p <0.05), respectively, while high significantly increased with the interaction of jellose concentration and the amount of sweet tamarind pulp (r = 0.84, p <0.01). Melting rate of TGI was high significantly decreased with increasing jellose concentration and the amount of the sweet tamarind pulp at p<0.01with r = –0.74 and –0.66, respectively. But overrun and hardness of TGI was high significantly decreased with increasing sweet tamarind pulp (p <0.01) with r = –0.86 and –0.99, respectively. TGI have rust color with L*64.09 ± 3.03, a*6.82 ± 0.57, b*20.59 ± 0.12 and hue angle (b*/a*) 71.69 ± 1.48°. Sensory evaluation, TGI made from jellose 1–2% (w/w, db) and sweet tamarind pulp 25% (w/w, wb) was the highest acceptance score and >70% of untrained panelists accepted in all attributes.

Keywords : Gelato, Ice cream, Jellose, Xyloglucan , Sweet tamarind

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Introduction

Thailand is one of the Southeast Asia country that has many kind of fruits all the year round. Tamarind (*Tamarindusi ndica* L.) is one of the GI (Geographical Indication) plant of the country, especially at the northern part. Phetchaboon province (Sweet tamarind city) is the famous area that sweet tamarind has been grown. There is tamarind seed as a waste (more than 200 ton/year) from food manufactures that produce seedless sweet tamarind products every year. In 2015, our research worked on extraction and purification tamarind seed gum or xyloglucan from tamarind kernel powder (TKP), namely jellose (60–65% of seed) for food utilization (Narkrugsa et al. 2015). Jellose is hemicelluloses and consists of galactoxyloglucan configuration which has beta–(1–4) linked D–glucan backbone that is partially substituted at the O–6 position of its glucopyranosyl residue with alpha–D–xylopyranose. Some of xylose residues are linked with beta–D–galactosylpyranose at O–2 position. Jellose is a polymer with a molecular weight 115,000 to 2,500,000 Dalton (Nishinari et al. 2009), non toxic (Iida et al. 1978) and generally recognized as safe (GRAS), namely glyloid by DSP GOKYO FOOD & Chemical Japan (DSP GOKYO FOOD&Chemical, 2017). In Japan, jellose was permitted to use in the food industry as a thickening agent, stabilizer and gelling agent (Gliksman, 1986; Marathe *et al*. 2002). Reducing the budgets for the imported gum used in food industry, such as pectin, guar gum and locust bean gum etc., the applications of jellose for food industry in Thailand is very important and necessary to be done.

With the average temperature between 30–40°C of Thailand and having fruit varieties all the year round in the country, and together with the ice cream market in the country expanding 15% of marketing value (about 410 million US dollar) in the year 2014 (Marketeer, 2015), the resistant- melting ice cream especially made from fresh fruits was very interesting. Ice cream is one of dairy base frozen product with generally contains fat, sugar, non–fat milk solid, flavors and stabilizers. The quality of ice cream is evaluated not only its taste, texture and structure but also the resistant to melting. Stabilizers, such as guar gum, locust bean gum etc., are usually imported and used in ice cream production to give the effect on the viscosity of the mix, texture and maintaining the structure from melting of ice cream (Crichett and Flack 1977; Akesowan, 2008; Tharp and Young, 2013). Gelato, a kind of ice cream developed in Italy, namely Italian Gelato, it is a low fat ice cream flavored with fresh fruits that has overrun below 10%, smooth and viscous than general ice cream (Marshall et al. 2003). So, the research to apply jellose as stabilizer in gelato ice cream in Thailand is interested to be done. The objective of this experiment is to study the effects of jellose as stabilizer and sweet tamarind pulp as flavor on some physical and sensory properties of Tamarind gelato ice cream (TGI).

Materials and methods

Jellose (purifiedtamarind seed powder or xyloglucan) and sweet tamarind pulpfrom Srichompoo variety growth in Phetchaboon province were supported by Pinphet Co.Ltd, Thailand.

Proximate analysis

Proximate analysis of jellose, sweet tamarind pulp and accepted TGI were done by AOAC (1995) Methods. The data were shown in **Table 1**.

Table 1 Proximate analysis of jellose, sweet tamarind pulp and accepted tamarind gelato ice cream (TGI).

Composition	Jellose (%,db.)	Sweet tamarind pulp (%,wb)	Accepted TGI (%,db)
Moisture content	–	22.38 ± 0.48	–
Fat	1.90 ± 0.01	0.31 ± 0.07	10.65 ± 0.52
Protein	2.02 ± 0.04	0.36 ± 0.03	7.62 ± 0.32
Crude fiber	1.23 ± 0.01	3.79 ± 0.44	19.42 ± 0.41
Ash	3.01 ± 0.01	3.38 ± 0.01	2.89 ± 0.12
Carbohydrate (total by different)	91.84	69.78	59.42

* The data in this table are mean and standard deviation from three experimental data.

Tamarind Gelato Ice cream preparation

Six batches of TGI were prepared each treatment represented one batch (**Table 2**). The mixture preparation, non-fat pasteurized milk (200 g), whipping cream (100 g), skimmed milk (10 g) and salt (0.25 g) were mixed and heated up to 70°C for pasteurization 10 min in water bath and then were cool to room temperature. Solubilize sweet tamarind pulp (15%, 25% and 35% w/w of mixture, wet basis) with 150 g mixture and heated up to70°C for 10 min again and cooled to room temperature. Jellose (1%

and 2% w/w of mixture, dry basis) was solubilized in 100 mL hot water (80–85°C) and cooled to room temperature. Homogenized all portions together with sugar syrup (70 g) in Waring blender withhigh speed for 2 min, cooled and aging the mixture at 4°C overnight. The aged mixeswas made to ice cream with ice cream maker (Nemox, Creaserie, Gelato 5K, Italy) for 20–25min. The ice cream sample was poured in to PE cup and store at –18°C throughout some physical property measurements and sensory evaluation.

Table 2 Jellose concentration and the amount of sweet tamarind pulp added per 100 g of base formulation of tamarind gelato ice cream (TGI).

Treatment	Jellose (% w/w,dry basis)	Sweet tamarind pulp (% w/w,wet basis)
1	1	15
2	1	25
3	1	35
4	2	15
5	2	25
6	2	35

Mix viscosity

Mix viscosity of mixture before aging was measured by using modified method of Muse and Hartel (2004). Brookfield viscometer model DV-III with small sample (15 mL) was used to measure viscosity of mixture at temperature 8 ± 1°C, torque > 80% and reported as mPa.s (milli–pascal seconds).

Melting rate

To measure melting rate of ice cream, the modified method of Muse and Hartel (2004) was used. Ice cream 40 grams of cubic cut sample was placed on the screen which mounted on measuring cylinder at the control temperature 25°C. Every 5 min, for up to 60 min, the dripped volume was recorded and calculated in melting rate (mL/min).

Overrun

Overrun of ice cream was measured and calculated in percent by using modified method of Muse and Hartel (2004). One overrun measurement of ice cream was taken by comparing the weight of ice cream mix and ice cream in a fix volume container and calculated as follows Equation (1),

$$\text{Overrun} = (\text{weight of mix} - \text{weight of ice cream}) \times \frac{100}{\text{weight}} \text{of ice cream} \quad (1)$$

Hardness

To measure hardness of ice cream, modified method of Alfaifi and Stathopoulos(2010) was used. The Texture Analyzer, model TA-Xi 2 was used in the measurement with 2 mm diameter stainless steel cylinder probe (P/2). Compression mode, pre–test speed 1.0 mm/s, test speed 2.4 mm/s, post–test 7.0 mm/s, target mode distance 10 mm, trigger type: auto–20 g and data acquisition rate: 200 pps was used. The temperature of ice cream control at–10°C in dry ice chamber during measurement.

Color Measurement

For color value of ice cream, Chroma meter Konica Minolta model CR–400 was used to measure L^*, a^*, b^* while Hue angel ($\tan^{-1} b^*/a^*$) was also calculated.

Sensory Evaluation

All treatments of TGI were panel tested by using 90 untrained panelists with 9 poin–Hedonic scale (1 = dislike and 9 = very much like) for flavor test and Just About Right (JAR) method for adjust the attributes of ice cream that accept < 70% of the panelists.

Statistical analysis

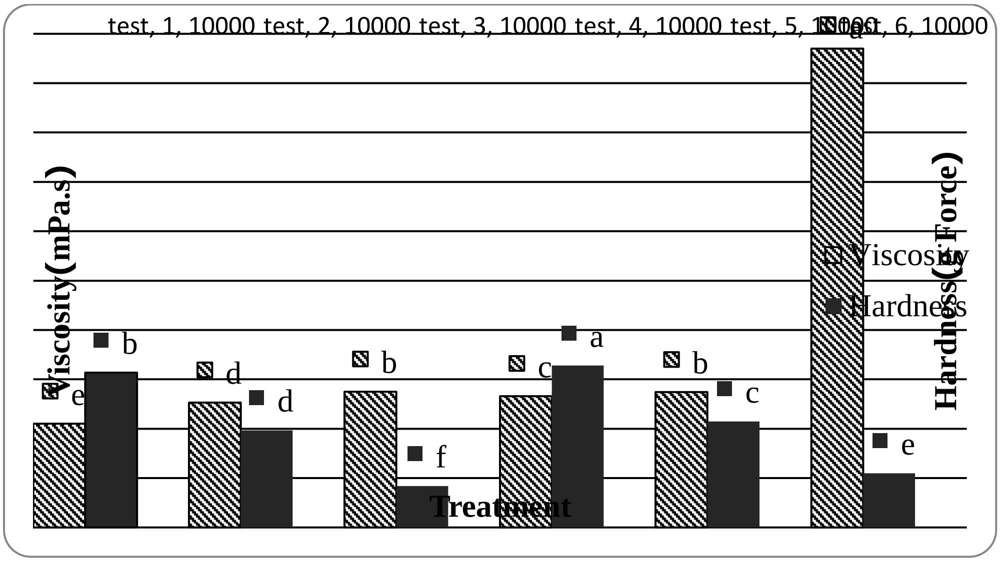
Analysis of variance (ANOVA) was used to compare means of all observations and using Duncan‘s multiple rank test (DMRT) to identify significant differences at $p< 0.05$ with SPSS-program version 23 (licensed for King Mongut’s Institute of Technology Ladkrabang, Bangkok Thailand).

Results and Discussion

Mix viscosity

From the **Fig. 1**, means of the mix viscosity from all treatments were shown. The results revealed that the TGI using jellose concentration at 2% (w/w,db) mixed together with 35% (w/w,wb) tamarind pulp had the highest viscosity (9700 ± 5.03 mPa.s) while TGI using jellose concentration at 1% (w/w,db) together with tamarind pulp 15% (w/w,wb) had the lowest viscosity (2100 ± 7.21 mPa.s). The increasing of jellose concentration as stabilizer and the amount of sweet tamarind pulp as flavor, will increase mix viscosity of TGI before aging; the mixture will be increased total solid and sugar from the sweet tamarind pulp addition. Regarding with correlation coefficient in **Table 4**, it showed that increasing jellose concentration and sweet tamarind pulp will significantly increased mix viscosity with r = 0.48^{*} and 0.58^{*}, respectively at $p< 0.05$, while the interaction between them showed high significantly increased mix viscosity with r = 0.84^{**} at $p< 0.01$. In general, as the viscosity increases, the resistance to melting and smoothness of texture increases (Marshall *et al*. 2003).

Figure 1 Mean values of viscosity and hardness of TGI.



* Different alphabet on top of the bar were significantly different at $p< 0.05$

Melting rate

With the melting rate of TGI in the experiments, the results showed that TGI using more jellose and tamarind pulp will give the significantly lower of their melting rate. TGI using 2% jellose (w/w,db) mixed together with 35% (w/w,wb) tamarind pulp had the lowest melting rate (0.03 mL/min) (**Table 3**). The correlation coefficients revealed that increasing jellose concentration, tamarind pulp and their interaction will high significant decreased the melting rate of TGI with r -0.74^{**}, -0.66^{**} and -0.97^{**} at $p<$ 0.01, respectively (**Table 4**). Corresponding with the mix viscosity, high mix viscosity of the mixture before aging will give low of melting rate or high resistance to melting TGI. Because of the ability of jellose and sugar inside the pulp to hold water in ice crystal form in the mixture, all TGI were able to resistant to melting out of the system like in the experiment of Muse and Hartel (2003) and Akesowan (2008).

Table 3 Some physical properties of tamarind gelato ice cream (TGI).

Treatment	Jellose (%,db)	Sweet tamarind pulp (%,wb)	Physical properties	
			Melting rate (mL/min)	Overrun (%)
1	1	15	0.12 ± 0.00^{a}	6.72 ± 0.08^{a}
2	1	25	0.09 ± 0.00^{b}	5.55 ± 0.20^{bc}
3	1	35	0.07 ± 0.01^{cd}	4.01 ± 0.39^{d}
4	2	15	0.08 ± 0.01^{bc}	6.80 ± 0.61^{a}
5	2	25	0.05 ± 0.00^{e}	6.14 ± 0.50^{ab}
6	2	35	0.03 ± 0.00^{f}	5.16 ± 0.61^{c}

[*] The data in this table are mean and standard deviation from three experimental data.

[†] Means with the different superscripts in the same column were significantly different at $p<$ 0.05.

Overrun

All treatments of TGI in this experiment, they had the overrun values below 10% while most ice creams had overrun around 50–60% (Muse and Harel, 2003). The results revealed that only tamarind pulp will hight significantly affected the overrun of TGI samples with r = -0.86^{**} at $p<$ 0.01 (**Table 4**). It may be due to the sugar in the pulp (30–40%, w/w) of sweet tamarind variety (Singh *et al*., 2007). The sugar inside the pulp could bound with water and retarded the forming with air during mixing. From Table 3, the lowest overrun TGI (4.01 ± 0.39%) was made by using 35% (w/w,wb) of tamarind pulp and 1% (w/w,db) of jellose; it also showed the lowest melting rate. This contradicts the research by Sakurai *et al*. (1996), Sofjan (2002) and Sofjan and Hartel (2004), who showed that ice creams with lower overruns had faster melting rates.

Hardness

Hardness of TGI will expressed as gram force when probe of texture analyzer pressed on the surface of ice cream. The results, in **Fig.1**, showed that TGI made by using 35% (w/w, wb) of tamarind pulp and 2% (w/w,db) of jellose had the highest value of hardness (3277.54 ± 18.08 g. force). The amount of tamarind pulp and the interaction between jellose concentration and tamarind pulp will highly affected to decrease the hardness of TGI with $r = -0.99^{**}$ and -0.60^{**} at $p < 0.01$, respectively (**Table 4**) while the increasing jellose concentration from 1 to 2% non significantly affecting on TGI hardness. It may be due to the high amount of moisture content (**Table 1**) and sugar in the tamarind pulp (Singh et al., 2007). The more added tamarind pulp in the mixture will caused the soft texture of TGI because of the increasing water and sugar in the mixture could deform ice cream especially the fat net work (Tharp *et al*. 1998; Ronald *et al*., 1999a, 1999b; Prindivilleet *al*.1999 and Alfaifi and Stathopoulos, 2010).

Table 4 Correlation coefficient between jellose concentration, the amount of tamarind pulp and their interaction on some physical of tamarind gelato ice cream (TGI).

Factors	Physical properties			
	Mix viscosity	Melting rate	Overrun	Hardness
Jelellose conc., X_1	0.48^{*}	-0.74^{**}	0.27^{ns}	-0.11^{ns}
the amount of tamarind pulp, X_2	0.58^{*}	-0.66^{**}	-0.86^{**}	-0.99^{**}
$X_1 \times X_2$	0.84^{**}	-0.97^{**}	-0.35^{ns}	-0.60^{**}

† The data in this table are mean and standard deviation from three experimental data.

‡ * at the correlation value means significant correlation at $p< 0.05$. ** at the correlation value means high significant correlation at $p< 0.01$. ns at the correlation value means non significant correlation.

Color measurement value

TGI had rust color which had L^*, a^*, b^* and hue angle between 60.53 ± 2.86–68.48 ± 2.93, 5.03 ± 0.65–8.04 ± 0.56, 17.71 ± 1.03–20.97 ± 1.65 and 68.16 ± 3.16°–77.25 ± 2.65°, respectively (**Table5**). The amount of tamarind pulp high significantly affected to L*, a*, b* and hue angle with r = –0.76**, 0.94**, 0.69** and –0.82** at p< 0.01, respectively (**Table 6**).

Table 5 Color values of tamarind gelato ice cream (TGI) made by using jellose as stabilizer and sweet tamarind pulp for flavor.

Treatment	Jellose (% w/w,db)	Sweet tamarind pulp (% w/w,wb)	Color values			
			L^*	a*	b*	Hue angle
1	1	15	60.53 ± 2.86^{b}	4.54 ± 0.27^{c}	17.71 ± 1.03^{b}	77.25 ± 2.65^{a}
2	1	25	64.09 ± 3.03^{ab}	6.82 ± 0.56^{b}	20.21 ± 1.75^{a}	71.69 ± 1.03^{bc}
3	1	35	68.13 ± 3.36^{a}	8.04 ± 0.56^{a}	20.59 ± 0.12^{a}	68.16 ± 3.16^{c}
4	2	15	61.89 ± 2.97^{b}	5.03 ± 0.65^{c}	18.22 ± 0.41^{ab}	74.57 ± 1.94^{ab}
5	2	25	64.87 ± 2.56^{ab}	6.77 ± 0.10^{b}	20.53 ± 0.84^{a}	71.71 ± 0.95^{a}
6	2	35	68.48 ± 2.93^{a}	7.71 ± 0.20^{a}	20.97 ± 1.65^{a}	69.71 ± 2.01^{c}

[*] The data in this table are mean and standard deviation from three experimental data.

[†]Means with the different superscripts in the same column were significantly different at p< 0.05.

Table 6 Correlation coefficient between jellose concentration, the amount of tamarind pulp and their interaction on color value of tamarind gelato ice cream (TGI).

Factors	Color value			
	L^*	a^*	b^*	Hue angle
Jelellose conc., X_1	0.11^{ns}	0.01^{ns}	0.13^{ns}	–0.05^{ns}
the amount of tamarind pulp, X_2	–0.76**	0.94**	0.69**	–0.82**
$X_1 \times X_2$	–0.43^{ns}	0.62**	0.56*	–0.58*

[†] The data in this table are mean and standard deviation from three experimental data.

[‡] * at the correlation value means significant correlation at p< 0.05. ** at the correlation value means high significant correlation at p < 0.01. ns at the correlation value means non significant correlation.

Sensory Evaluation

From the sensory evaluation of TGI with 9–point Hedonic scale method in **Table 7**, the results showed that TGI from treatment 2 and 5 were accepted in the highest score in all attributes from the panelists. TGI added more sweet tamarind pulp (35%w/w,wb) cause lower the total acceptance score than TGI adding 25% (w/w,wb) because of there high sweet flavor. After that the two treatments were sensory tested again with JAR method; the panelists was accepted in all attributes of TGI from both treatments more than 70% of panelists.

Table 7 Sensory evaluation of tamarind gelato ice cream (TGI) by 9-point Hedonic scale method.

Treatment	Jellose (%,db)	Sweet tamarind pulp (%,wb)	TGI characterics				
			Flavor	Color	Odor	Texture	Total Acceptance
1	1	15	5.90 ± 1.45^{b}	5.67 ± 1.47^{b}	5.43 ± 1.50^{b}	6.10 ± 1.32^{a}	5.80 ± 1.37^{b}
2	1	25	6.57 ± 1.18^{b}	6.77 ± 1.17^{a}	6.43 ± 0.20^{a}	6.53 ± 1.01^{a}	6.60 ± 1.19^{a}
3	1	35	5.93 ± 1.41^{b}	6.57 ± 1.25^{a}	6.40 ± 1.28^{a}	6.23 ± 1.65^{a}	5.87 ± 1.07^{b}
4	2	15	5.97 ± 1.07^{b}	5.63 ± 1.22^{b}	5.53 ± 0.97^{b}	6.17 ± 1.21^{a}	5.90 ± 1.07^{b}
5	2	25	6.90 ± 1.22^{a}	6.80 ± 1.06^{a}	6.30 ± 1.24^{a}	6.73 ± 1.20^{a}	6.87 ± 1.17^{a}
6	2	35	5.93 ± 1.23^{b}	6.53 ± 1.22^{a}	5.77 ± 1.38^{ab}	6.30 ± 1.39^{a}	5.83 ± 1.15^{b}

[*] The data in this table are mean and standard deviation from three experimental data.
[†]Means with the different superscripts in the same column were significantly different at $p < 0.05$.

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