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Effect of *Tiliacora triandra* leaf juice on qualities of Thai layered dessert

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ABSTRACT

The physical and nutritional values of Thai layered dessert added with *Tiliacora triandra* (Colebr.) Diels (or yanang) leaf juice were studied. The results indicated the most appropriate proportion of yanang leaf juice for making Thai layered dessert was 5% since this proportion received the highest levels of acceptance. The physical characteristics analysis revealed that the hardness and springiness values of Thai layered dessert with more yanang leaf juice added were significantly lower ($p \leq 0.05$). The L^* and b^* color values were also significantly lower when more yanang leaf juice was added. Conversely, the a^* value of the desserts increased when more yanang leaf juice was added. A comparison between the nutritional values found in Thai layered dessert with the yanang leaf juice and those found in such Thai layered dessert with pandan leaf juice added revealed that these two desserts contained different amounts of carbohydrate and calcium ($p \leq 0.05$). The Thai layered dessert with added yanang leaf juice contained 2.85 mg of calcium /100 g, which was higher than the amount of calcium found in the Thai layered dessert with added pandan leaf juice ($p \leq 0.05$).

Keywords: Thai layered dessert (Khanom Chan); yanang leaves; physical characteristics; nutritional values

1. INTRODUCTION

Thai layered dessert or Khanom Chan is one of the ancient Thai desserts. This dessert is subtly sweet and slightly oily. The texture is smooth yet sticky. The basic ingredients of Thai layered dessert include coconut milk, sugar, and 3-4 other types of flour. The different types of flour used in this dessert give different textures and properties. Tapioca flour makes it soft, sticky, viscous, and transparent. Arrowroot flour hardens it and makes it smooth and sticky, yet less transparent than with tapioca flour. Rice flour hardens it and makes it able to hold its shape easily. Finally, mung bean flour enables this dessert to hold its shape easily and not be too sticky. Two popular ways to eat Thai layered dessert are either eating bit by bit or layer by layer. There are no exact rules regarding how to eat Thai layered dessert but eating it layer by layer gives a sense of sticky, soft, and delicious enjoyment (Khuamornphatthana, 2010).

Nowadays, Thai layered dessert is very popular among consumers. It can be found in markets, souvenir shops, or tourist attractions. Thai layered dessert is colored by using artificial food color additives, such as those resulting in green, red, and purple colors. These color additives color the desserts but do not contribute to their nutritional content. Furthermore, frequent consumption of these artificial colors could harm consumers. Individuals who

regularly consume artificial color additives might put excessive artificial colors into their systems. Evidence suggests that a human's stomach and colon could be coated with these color additives, resulting in blockages, reductions in digestive enzymes, diarrhea, flatulence, exhaustion, muscle pains and aches, and weight loss. The continuous consumption of these color additives might have stimulated the growth of lymphoma (Phutiyanun, 2008). In fact, the study conducted by Soltan and Shehala (2012) revelated that the use synthetic color in various foods might lead to effect on the liver and kidney histopathological structure. In the past, there was no risk in eating Thai layered dessert because the colors added to Thai layered dessert were all natural. For example, green color was extracted from pandan leaves and blue color from butterfly pea petals. Besides, the green color extracted from yanang leaves is also used to add a green color to Thai layered dessert.

Yanang, *Tiliacora triandra* (Colebr.) Diels (Menispermaceae), is a species of flowering plant native to Southeast Asia. It is also known as Joynang, Taowalkeaw, and Yadnang. This plant is widespread in every region of Thailand. It is a climbing plant with stem roots, brown bark, dark green oval-shaped leaves, and three linings (Chiramongkolgarn, 2004). Yanang is an indigenous vegetable with high nutritional values and medical properties. It has beta-carotene, which is an antioxidant that helps remove potentially damaging oxidizing agents in a living organism, and prevents cancer (Chumindrachak, 2010). In addition, 100 g of dried yanang leaves contains 11.47 mg of beta-carotene, 17.99 mg of xanthophylls, 31.26 mg of vitamin C, 0.0091 mg of vitamin E, 34.15 mg of tannin, 60.12 mg of phenolic compounds, 30,625 IU of vitamin A, 7.0 mg of iron, and 155 mg of calcium (Hongwiwat, 2007; Rakariyatham and Chanwitheesuk, 2002). Also, yanang leaf juice can be used as an ingredient in many kinds of local food. Chiramongkolgarn (2004) claimed that both yanang shoots and leaf juice could be boiled with bamboo shoots to reduce the levels of bitterness and poisonous substances in bamboo shoots. According to Meesup (2007), yanang could restrict the effect of uric acid in bamboo shoots as well as fortify foods with chlorophyll and beta-carotene. The use of natural substances in food seasoning and flavoring is considered as local wisdom. In addition, Samutsri and Timtuad (2016) used yanang juice extract as an addition to rice bran pudding cake with mixed yanang and pandan juice. Also, Onnompun et al. (2017) developed the recipe of Thai pandan and coconut pudding by adding yanang leaf juice.

Thus, this research was aimed at creating a new recipe for Thai layered dessert with added yanang leaf juice. The new recipe would result in a higher nutritional content as well as adopt natural food colors rather than artificial ones. This research was intended to preserve the authentic taste, soft and sticky texture, and identity of the original Thai layered dessert while offering an alternative to health and wellness lovers. In this research, the effect of adding yanang leaf juice on the attributes of sensations, physical characteristics, and nutritional value of Thai layered dessert was therefore examined.

2. MATERIALS AND METHODS

2.1 Materials

A bunch of yanang leaves were bought from a local market. All other ingredients consisted of tapioca flour (Dragon Fish Brand), arrowroot flour (Dragon Fish Brand), mung bean flour (Pine Brand), rice flour (Three-Headed Elephant Brand), coconut milk and sugar (Lin Brand). They were purchased from supermarkets located in the Pathum Thani area.

Table 1 The four recipes with four different specific proportions of yanang leaf juice and all other ingredients (Adapted from Potjanamanee, 2003)

Ingredients	**Recipe 1:3% of yanang leaf juice (g)**	**Recipe 2:5% of yanang leaf juice (g)**	**Recipe 3:7% of yanang leaf juice (g)**	**Recipe 4:9% of yanang leaf juice (g)**
Tapioca flour	215	215	215	215
Arrowroot flour	100	100	100	100
Mung bean flour	20	20	20	20
Rice flour	15	15	15	15
Thick coconut milk	400	400	400	400
Thin coconut milk	400	400	400	400
Sugar	400	400	400	400
Yanang leaf juice	46.5	77.5	108.5	139.5

2.2 Preparation of yanang leaf juice

The preparation started with soaking and cleaning fresh yanang leaves, and leaving them to dry. Then, the leaves were cut into small pieces of 1-inch in length. After that, 200 g of yanang leaf and 200 g of water were put into the blender before blending them well using the third speed setting for one minute. Then, the pulp was poured through muslin cloth (adapted from Duangjai et al., 2015). As a result, 250 g of yanang leaf juice was obtained.

2.3 Process of making Thai layered dessert

The process began with the mixing of flour with thick coconut milk for 30 min before adding thin coconut milk and sugar. Next, the mixture was heated until all ingredients had dissolved well and the texture had become smooth. After that, the mixture was divided into two equal portions; one of them was for the addition of yanang leaf juice. The mixture was then poured into the prepared tray to make the first layer of the Thai layered dessert. The first layer was steamed for twelve minutes until it kept its shape. Then, a different mixture was poured to make the second layer, alternating the dessert with a white layer. The process was repeated until 7 layers of the dessert were achieved. Then it was left to settle at room temperature before it was kept in plastic bags (polyethylene) at room temperature as the samples of the study.

2.4 Sensory evaluation

The attributes of sensations were examined by testing the four recipes of Thai layered dessert in terms of overall appearance, color, smell, taste, softness and stickiness, and overall satisfaction. Each recipe was examined by 30 general consumers, who rated their levels of satisfaction according to a 9-point hedonic scale (1 = the lowest level of satisfaction, and 9 = the highest level of satisfaction).

2.5 Analyses of physical characteristics

The physical characteristics of Thai layered dessert were analysed. Texture analysis was carried out with a texture analyser (TA-XT plus, Stable Micro Systems, UK) which used a 25-mm diameter P36R cylindrical probe to press on the sample in a double-cycle program. The speed of compression was 1 mm/s for 50 percent of the sample height. The second compression was 15 s after the first one. Results were reported as values of hardness and springiness. (Sinchaipanit et al., 2017). The color values (L^* a^* and

b^*) were determined with a chromameter model CR-300 (Minolta Co., Ltd., Osaka, Japan). The topmost of the Thai layered dessert which was green was measured for color values.

2.6 Analyses of nutritional values

The analyses of nutritional values involved analyses of the protein, moisture, fat, fiber, ash, carbohydrates (AOAC, 2000), calcium and iron (AOAC, 2005), and beta-carotene (Munzuroglu et al., 2003) found in the Thai layered dessert with added yanang leaf juice which received the highest level of acceptance. The obtained results were then compared with those of the Thai layered dessert with added pandan leaf juice which was produced using the same recipe and procedure.

2.7 Statistical analyses

Analysis of variance (ANOVA) was conducted to determine whether there were any statistically significant difference by using Duncan's New Multiple Range Test (DNMRT) with a confidence interval of 95% (Vanidbhuncha, 2007) and using SPSS for Windows.

3. RESULTS AND DISCUSSION

3.1 Sensory attributes

There were four recipes where yanang leaf juice was added to Thai layered dessert: 3, 5, 7, and 9. The evaluation of sensory attributes indicated that the Thai layered dessert with 5% added yanang leaf juice received the following levels of satisfaction and acceptance: overall appearance (7.60), color (7.37), smell (7.37), taste (7.40), and overall satisfaction (7.57). Softness and stickiness tended to receive the highest score among all attributes (7.40). It was found that the samples were significantly different in all attributes except for softness and stickiness, which were not significantly different ($p>0.05$). It was possible that the 5% addition of yanang leaf juice in each recipe was appropriate and balanced, so the testers accepted this recipe the most. It could be concluded that the more yanang leaf juice added in the recipe, the lower the level of acceptance; it was observed that Thai layered dessert with 7% and 9% added yanang leaf juice received lower scores regarding level of acceptance. The main cause might be related to the dark green color of Thai layered dessert resulting from the dark green color of yanang leaf juice. The darker color seen in such Thai layered dessert might reduce acceptance with regard to its sensory attribute of color. Also, the fresh yanang leaf juice provided unpleasant smell (Othong et al., 2015).

3.2 Physical characteristics

The textures of the four samples of Thai layered dessert with four different proportions of added yanang leaf juice were analyzed in terms of hardness and springiness. According to Table 3, it was found that the dessert with 3% addition of yanang leaf juice had the highest level of hardness and springiness. It was also found that the desserts exhibited significant differences in gradually decreased levels of hardness and springiness ($p\leq0.05$) when more yanang leaf juice was added. As seen from Table 3, the springiness of the one with 3% addition of yanang leaf juice contained the different level of springiness when compared to the ones with 5%, 7%, and 9% addition ($p\leq0.05$). It was in line with the study of Samutsri and Pasatang (2018) in that an increase of yanang leaf juice in chicken meatballs resulted in a decrease of hardness. ($p\leq0.05$). It could be explained by the fact that the different proportions of yanang leaf juice in each recipe directly modified the moisture of the Thai layered dessert. When boiled for the same length of time, each recipe contained different levels of moisture. The amount of yanang leaf juice added in recipe 1, 2, 3, and 4 were 46.5 g, 77.5 g, 108.5 g and 139.5 g, respectively. Therefore, the one with 9% yanang leaf juice exhibited the highest level of

moisture, the lowest level of hardness, and the lowest level of springiness. This could be a result of the substance so called hydrocolloids found in yanang leaves since the substance could increase stickiness. It could have increased the dessert's stickiness and reduced its hardness (Singthong et al., 2007).

Table 2 Scores on satisfaction with the four recipes of Thai layered dessert (n = 30)

Sensory evaluation	Thai layered dessert with added yanang leaf juice			
	Recipe 1:3% of yanang leaf juice	**Recipe 2:5% of yanang leaf juice**	**Recipe 3:7% of yanang leaf juice**	**Recipe 4:9% of yanang leaf juice**
Overall appearance	7.33^{ab}±0.88	7.60^{a}±1.40	6.67^{bc}±1.24	6.23^{c}±1.65
Color	7.33^{a}±1.06	7.37^{a}±1.27	6.63^{b}±1.32	6.47^{b}±1.50
Smell	7.07^{ab}±1.28	7.37^{a}±1.45	6.83^{ab}±1.53	6.53^{b}±1.45
Taste	7.37^{ab}±1.12	7.40^{a}±1.38	6.70^{b}±1.36	6.77^{ab}±1.07
Softness and stickiness	7.23^{ns}±1.16	7.40^{ns}±1.35	7.17^{ns}±1.31	7.00^{ns}±1.36
Overall satisfaction	7.37^{ab}±0.99	7.57^{a}±0.93	6.93^{b}±1.17	7.00^{ab}±1.11

Note: Different superscripts in the same column indicate statistical differences among mean values at the 95% confidence level ($p \leq 0.05$); ^{ns} means that there was no statistically significant difference ($p > 0.05$)

Table 3 Analyses of the textures of Thai layered dessert with 3%, 5%, 7%, and 9% added yanang leaf juice (n=3)

Thai layered dessert with added yanang leaf juice	Results	
	Hardness (kgf)	**Springiness (mm)**
3%	0.36^{a}±0.03	12.75^{a}±0.76
5%	0.31^{b}±0.02	11.50^{b}±0.21
7%	0.27^{bc}±0.00	11.30^{b}±0.15
9%	0.25^{c}±0.03	11.02^{b}±0.32

Note: Different superscripts in the same column indicate statistical differences among mean values at the 95% confidence level ($p \leq 0.05$)

3% 5% 7% 9%

Figure 1 Thai layered dessert with 3%, 5%, 7%, and 9% added yanang leaf juice

The analyses of the color value of the Thai layered dessert with added yanang leaf juice showed that the different amounts of yanang leaf juice added to the dessert significantly influenced the lightness value (L^*) ($p \leq 0.05$) (Table 4). With regard to the quantitative color value, lower values of L^* and b^* were exhibited when more yanang leaf juice was added. From the L^* and b^* values, it can be seen that the dessert with 3% added yanang leaf juice had the highest L^* value (24.40). Also, the L^* values of the ones with 5%, 7%, and 9% added yanang leaf juice were second, third, and last in the rankings of the L^* value, respectively. It could be interpreted that the L^* value was statistically correlated to the increasing amount of yanang leaf juice ($p \leq 0.05$). According to Rattana et al. (2010), the fresh yanang leaf juice was dark green due to the tannin. The yanang leaf contained tannin, which was oxidized by oxygen and reacted with the blender's metallic blade when extracted. This reaction turned the green color into dark green or brown (Boonchai, 2007; Chitravimol, 2010; Vorasuntharosod, 2001). Therefore, it reduced the L^* value. In addition, this finding was in line with Tanasombun and Pichaiyongvongdee (2015) which found that Job's tears juice with 10%, 20%, 30%, 40%, and 50% concentrations of yanang leaf juice had lower L^* values as the proportion of yanang leaf juice was increased. In other words, the amount of yanang leaf juice added to the Job's tears juice and the L^* value were inversely related.

In addition, the analyses of the value of greenness and redness (a^*) revealed that the amount of yanang leaf juice added to Thai layered dessert statistically affected the value of a^* ($p \leq 0.05$) (Table 4). Above all, the dessert with 9% added yanang leaf juice had the highest a^* value (0.42). Higher values of a^* were observed when more yanang leaf juice was added. The desserts changed from green to red. Noticeably, it was possible that yanang leaves contained tannins, lignans and flavonoids which were considered colorants, such as anthocyanins (colorants for claret colors) and theaflavins and thearubigins (colorants for brick colors) (Boonsong et al., 2009).

Furthermore, the analyses of the yellowness value (b^*) revealed that the amount of yanang leaf juice added to the Thai layered dessert statistically affected the value of b^* ($p \leq 0.05$) (Table 4). It was found that the dessert with 3% added yanang leaf juice got the highest value of b^* (6.30). Also, the more yanang leaf juice added to the dessert, the lower the b^* value tended to be as shown in Figure 1. This could be a result of the dark green color of yanang leaf juice. This finding was consistent with Tanasombun and Pichaiyongvongdee (2015), which found that the amount of yanang leaf juice added to the Job's Tear juice inversely influenced the b^* value of the juice.

Table 4 Analyses of the color value of Thai layered dessert with 3%, 5%, 7%, and 9% added yanang leaf juice (n=5)

Proportion of yanang leaf juice added to Thai layered dessert	Results		
	L^*	a^*	b^*
3%	$24.40^{a} \pm 0.56$	$0.32^{c} \pm 0.08$	$6.30^{a} \pm 0.52$
5%	$24.34^{a} \pm 0.41$	$0.27^{c} \pm 0.14$	$6.26^{a} \pm 0.53$
7%	$23.32^{b} \pm 0.31$	$0.16^{b} \pm 0.05$	$5.52^{b} \pm 0.37$
9%	$21.90^{c} \pm 0.29$	$0.42^{a} \pm 0.10$	$4.52^{c} \pm 0.43$

Note: Different superscripts in the same column indicate statistical differences among mean values at the 95% confidence level ($p \leq 0.05$)

3.3 Nutritional values

According to Table 5, the analyses of nutritional values covered the analyses of protein, moisture, fat, fiber, ash, and carbohydrate, and included the analyses of the amounts of calcium, iron, and beta-carotene found in the most acceptable recipe (Recipe 2: 5% addition of yanang leaf juice). The nutritional values found in Recipe 2 was then compared to the mentioned nutritional values found in Thai layered dessert with added pandan leaf juice. The two samples were produced using the same ingredients and same procedure. Both yanang and pandan leaf juice were similarly prepared in the same concentration: one part yanang leaf juice to one part water and one part pandan leaf juice to one part water.

According to Table 6, no significant difference was observed in the protein, moisture, fat, fiber, ash, iron, and beta-carotene levels of the two samples ($p>0.05$). However, some significant differences were observed between the carbohydrate and calcium levels of the two samples ($p\leq0.05$). It was found that every aspect of the nutritional values of the Thai layered dessert with the addition of yanang leaf juice was higher than that of the one with addition of pandan leaf juice, except carbohydrate. It should be noted that the one with the addition of yanang leaf juice had especially higher level of calcium, iron, beta-carotene than the one with the addition of pandan leaf juice. It was found that Thai layered dessert with added yanang leaf juice contained more calcium than the one with added pandan leaf juice. It might be a result of the nutritional content, in that yanang leaf contains a higher level of calcium than pandan leaf. A 100-g yanang leaf sample contains 155 mg of calcium, while 100 g of pandan leaf contains 124 mg of calcium. Once pandan leaf has been diluted, it contains only 73 mg of calcium.

In addition, the nutrition of the cakes obtained from the two Thai layered dessert recipes was compared to the Thai nutrition table (Bureau of Nutrition, 2001). It was found that the amount of calcium in Thai layered dessert with added yanang leaf juice was 12.05 mg, which was significantly higher than in the Thai layered dessert, which contains only 2 mg of calcium. Thai layered dessert with added yanang leaf juice also contained a higher level of iron (0.50 mg) compared to Thai layered dessert with added pandan leaf juice (0.44 mg) because yanang leaves have more iron than pandan leaves. This finding was also in line with the Thai nutrition table (Bureau of Nutrition, 2001) which reported that 100 g of yanang leaves contains 7 mg of iron, while 100 g of pandan leaves contains only 0.1 mg of iron. When squeezed, pandan leaf juice contains no iron. Therefore, Thai layered dessert with added yanang leaf juice had more iron than Thai layered dessert with added pandan leaf juice did.

With regard to the amount of beta carotene, it was found that the Thai layered dessert with yanang leaf juice contained a higher amount of beta carotene than the one with pandan leaf juice (10.30 µgRE and 9.67 µgRE, respectively) but there was no statistically significant difference found ($p>0.05$). Yanang leaf naturally has high levels of beta-carotene, which is an antioxidant that inhibits oxidation in the human body and reduces the degeneration of body cells caused by oxidants. This degeneration leads to problems of aging and chronic diseases such as coronary artery disease and cancer (Jenviteesuk, 2001; Sribusaracome, 2011; Theanboon, 2010). This finding was consistent with Onnompun et al. (2017), which found that the nutritional content of rice flour custard with added pandan leaf juice and yanang leaf juice was different due to the higher amounts of beta-carotene and antioxidants found in yanang leaf juice.

4. CONCLUSION

In conclusion, the appropriate recipe of Thai layered dessert with added yanang leaf juice was 215 g of tapioca flour, 100 g of arrowroot flour, 20 g of

mung bean flour, 15 g of rice flour, 400 g of thick coconut milk, 400 g of thin coconut milk, 400 g of sugar and 77.5 g of yanang leaf juice. The proportion of added yanang leaf juice could be up to 5% of the overall weight of the ingredients. With regard to the sensory attributes, it was found that Thai layered dessert with added yanang leaf juice received the high level of acceptance in terms of overall appearance, color, smell, taste, softness and stickiness, and overall satisfaction. With regard to the nutritional value of Thai layered dessert with added yanang leaf juice, it contained 3.19% protein, 40.96% moisture, 4.25% fat, 3.34% fiber, 0.42% ash, 47.84% carbohydrate, 12.05 mg of calcium, 0.50 mg of iron, and 10.30 µgRE of beta-carotene.

Table 5 Recipes of Thai layered dessert with added yanang leaf juice and pandan leaf juice

Ingredients	**(Thai layered dessert with added yanang leaf juice)**	**(Thai layered dessert with added pandan leaf juice)**
	(g)	**(g)**
Tapioca flour	215	215
Arrowroot flour	100	100
Mung bean flour	20	20
Rice flour	15	15
Thick coconut milk	400	400
Thin coconut milk	400	400
Sugar	400	400
Yanang leaf juice	77.5	-
Pandan leaf juice	-	77.5

Table 6 Nutritional content of Thai layered dessert with added yanang leaf juice and pandan leaf juice

Nutritional values	**Thai layered dessert with added yanang leaf juice**	**Thai layered dessert with added pandan leaf juice**
Protein (%) ^{ns}	3.19±0.04	3.15±0.05
Moisture (%) ^{ns}	40.96±1.07	39.94±0.92
Fat (%) ^{ns}	4.25±0.20	3.98±0.33
Fiber (%) ^{ns}	3.34±0.34	3.21±0.21
Ash (%) ^{ns}	0.42±0.06	0.38±0.08
Carbohydrate (%)*	47.84±0.73	49.34±0.55
Calcium (mg/100 g)*	12.05±0.15	9.20±0.20
Iron (mg/100 g) ^{ns}	0.50±0.05	0.44±0.04
Beta-carotene (µgRE/100 g) ^{ns}	10.30±0.30	9.67±0.67

Note: Different superscripts in the same column indicate statistical differences among mean values at the 95% confidence level ($p \leq 0.05$); ^{ns} means that there was no statistically significant difference ($p > 0.05$)

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