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Effects of Dried Sano (*Sesbania javanica* Miq.) Flowers Powder on the Quality of Thai Sponge Cake

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Abstract

The aim of this study was to investigate the physical, nutritional values and sensory evaluation of Thai sponge cake added with different levels of dried Sano flowers powder (DSFP) as a source of carotenoids. DSFP was prepared and analyzed for total carotenoids. DSFP contained lutein, zeaxanthin and β-carotene around 29,947.94, 620.03 and 1,555.98 µg in 100 g of dry sample, respectively. The sensory liking scores were determined to be suitable to produce Thai sponge cake. Results showed that, Thai sponge cake recipe consisted of 240 g of duck eggs, 180 g of chicken eggs, 180 g of cake flour, 360 g of granulated sugar. The effects of the addition with different levels of DSFP (20, 40 and 60 %w/w) of Thai sponge cake was studied. An increase of the DSFP decreased of lightness (L*), redness (a*) value, springiness, and chewiness while yellowness (b*) value, hardness, cohesiveness, and gumminess were increased. The sensory evaluation showed that all treatments obtained the overall liking score of 6.14-6.86. The study clearly showed that the levels of 20% w/w DSFP could be a desirable amount to produce the healthy Thai sponge cake with good enough appearance, odour, taste, texture, with an overall liking score of more than 6.00 that is considered as acceptable. The developed Thai sponge cake contained protein, fat, dietary fiber, ash, moisture, and carbohydrates 9.45, 5.23, 2.64, 1.16, 33.94 and 52.42 g in 100 g respectively, and 319.10 µg/100 g β-carotene 319.10 µg/100 g. The developed product supplemented with DSFP would be a guideline to increase the health and quality of cake products.

Keywords: Thai sponge cake, Dried Sano flowers powder, Carotenoids

1. Introduction

Thai sponge cake (Kanom-sa-lee) is a Thai dish that can be categorized in the same group as western desserts, Kha-nom-farang-kudi-chin, Thai eggs cake and Kha-nom-phing. Thai dessert is unique, traditional and considered as a Thai cultural heritage (Sanphom & Weenuttranon, 2018). Thai sponge cake is a type of air-leavened cake based on wheat flour, sugar, and eggs. Cake qualities are dependent on many factors, including the ingredients used for batter preparation, aeration of batters, and processing conditions (Chaiya & Pongsawatmanit, 2011). These cakes are prepared using a combination of a batter / foam and steamed in a variety of differently shaped pans. The structure of the cake is largely determined by the amount of air in the batter (Miller, 2016). Although wheat flour is the most suitable to deliver good structure for production of acceptable cake, they are often low in nutrient density (Jonglertjesdawong, 2000). The presence of compounds of interest such as carotenoids, and phenolic compounds makes these residues attractive resources for adding agro-industrial value because they are an important source of additives for the food, cosmetic and pharmaceutical industries (Ordóñez-Santos, Esparza-Estrada, & Vanegas-Mahecha, 2021). Moreover, consumers now demand products that are free of chemical agents with health benefits; therefore, the carotenoids found in Sano flowers can serve as an alternative, natural dye in bakery products, providing antioxidant activity and provitamin A (Martins, Pinho, & Ferreira, 2017).

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Sano (*Sesbania javanica* Miq.) or Sesbania flower is a flowering plant in the Fabaceae family (commonly known as the pea family). Sano is a tropical seasonal plant which naturally grows in wet areas, especially around the ditch or canal in the central region of Thailand (Kampangkaew, Thongpin, & Santawtee, 2014). The flower is yellow and is used in several Thai recipes (Kijparkorn, Plaimast & Wangsoonoen, 2010). In terms of nutritional value, Sano is a source of vitamins, dietary fiber, calcium, and carotenoids. Biological properties of Sano have been proposed as antioxidant activity and antibacterial activity (Chakkij, 2016), which are associated with a reduction of the risk of chronic diseases (Martins et al., 2017).

Therefore, the objectives of this study were to investigate the composition of carotenoids in Sano and study the physical, chemical and sensory characteristics of Thai Sponge Cake added with different levels of dried Sano flowers powder. As well as adding value to agricultural raw materials that would be applied to the household industry level.

2. Materials and Methods

2.1 Sano flower preparation

Fresh Sano flower was bought from the local market, dried in an oven at 50ºC for 24 hours, and ground with a hammer mill (Chakki, 2016). Ground sample was analyzed for total carotenoids content by HPLC method according to Speek, Temalilwa and Schrijver (1986).

2.2 Standard recipes of Thai sponge cake

Studied the standard recipes of Thai sponge cake obtained from Siriwong (2009), Wongpaisanrit (2010) and Suban (1989) as standard recipes. The samples were evaluated by untrained panelists (n = 50) for sensory acceptability using a 9-point hedonic scale (1 = disliked extremely, 5 = neither like nor dislike, 9 = like extremely). They were instructed to first visually evaluate acceptability of product appearance, color, and then consumed each sample before scoring for odor, taste, texture and then overall liking (Meilgaard, Civille, & Carr, 1999).

2.3 Study the effects of dried Sano flowers powder on the quality of Thai sponge cake

The optimization of Thai sponge cake recipe using a 9-point hedonic scale in the previous study was selected to improve the quality of Thai sponge cake by addition of dried Sano flowers powder. All ingredients (egg, cake flour and granulated sugar) were blended with three different levels of dried Sano flowers powder (DSFP) as follows: 20, 40 and 60 %w/w. Thai sponge cake without DSFP served as the control. Ingredients were mixed by hand with a plastic scraper until smooth. The cake batter was immediately deposited into cake pans and steamed. The cakes were allowed to cool for 1 h at room temperature, after which they were removed from the pans. The cooled cakes were packed in polypropylene bags at room temperature prior to the physical, and sensory evaluation.

Color:

The color of the samples was measured using a Hunter Lab apparatus (Hunter Lab, ColorFlex, USA), which measures three parameters: L*(lightness), a*(red-green), and b*(yellow-blue).

Texture properties:

The texture of the cake samples (3×3×3 cm) were based on the hardness, springiness, chewiness, cohesiveness, and gumminess as determined using a TA.XTplus Texture Analyzer (TA.XT PlusC, Stable Micro Systems, UK), using a cylindrical-shaped probe (12.45 mm in diameter). The testing conditions were: probe distance of 50 mm, test speed of 1 mm/sec, and post-test speed of 60 mm/sec.

Sensory evaluation:

The sensory evaluation using a 9-point hedonic scale was the same procedure as described in the previous experiment .

2.4 Nutritional value of developed Thai sponge cake

The developed Thai sponge cake (from section 2.3) was determined in terms of nutritional value: moisture content, protein, fat, ash, dietary fiber according to AOAC (2019) and β-carotene content according to Speek et al. (1986).

2.5 Statistical analysis

Experimental data were carried out using the completely randomized design (CRD) in physical properties and the randomized complete block design (RCBD) in sensory evaluation. The data were analyzed using analysis of variance facilitated by the IBM SPSS® version 23 software (IBM SPSS Inc., USA). Duncan's multiple range test was used to

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determine multiple comparisons of mean values with a statistically significant difference at $p \leq 0.05$.

3. Results

3.1 Carotenoids content of dried Sano flowers powder (DSFP)

Sano flowers is an important source of carotenoid pigments, which has biological properties as antioxidant activity and antibacterial activity (Chakkij, 2016). DSFP was prepared and analyzed for total carotenoids content. DSFP contained 29,947.94 µg lutein, 620.03 µg zeaxanthin and 1,555.98 µg β-carotene in 100 g of dry sample (Table 1). This is consistent with the research of Murkovic, Mülleder and Neunteufl (2002) that studied carotenoids in different pumpkin species; it was reported that pumpkin with orange had a lot of beta carotene, and the pumpkin that was yellow in color had high lutein with antioxidant properties, furthermore Palozza, Muzzalupo, Trombino Valdannini and Picci (2006) reported that β-carotene was an initial substance in the synthesis of vitamin A and had antioxidant properties.

Table 1. Carotenoids composition of dried Sano flowers 100 g of dry sample.

Carotenoids composition	DSFP, µg/100 g
Lutein	29,947.94
Zeaxanthin	620.03
β-carotene	1,555.98

3.2 Standard recipes of Thai sponge cake

Thai sponge cake recipes showed that the three standard recipes had an effect on the appearance, odor, taste, texture and overall liking score with statistical significance ($p \leq 0.05$) but without affecting the color's preference score with statistical significance ($p > 0.05$) (Table 2).

Considering the appearance, the recipe 1 and 2 had the preference scores in the like moderately while the recipe that 3 had the like slightly due to the appearance that the recipe 3 was contained less sugar than recipes 1 and 2; it might make the Thai sponge cake look less flaky and the texture of the Thai sponge cake was dry (Figure 1). This is consistent with Chaemmek and Naiwikul (2011) reported that the amount of sugar affects the quality of the cake. The less sugar in the recipe would be the cause of cake volume reduction. The texture of the cake also would be dried and hard. The odor, taste, texture, and overall liking score shown that recipes 1 and 3 had more liking scores than recipe 2. Due to the process of making the Thai sponge cake recipe 2, there was not sifting, the flour may cause the dough to rise unevenly and the texture was tight.

Therefore, the standard recipes of the Thai sponge cake were the standard recipe 1 as the appropriate recipe for bringing to produce Thai sponge cake supplemented with DSFP. Thai sponge cake recipe consisted of 240 g of duck eggs, 180 g of chicken eggs, 180 g of cake flour, 360 g of granulated sugar.

Table 2. Sensory liking of the three standard recipes of Thai sponge cake.

Sensory characteristics	Recipes		
	1	2	3
Appearance	7.61±0.94^{a}	7.43±0.88^{a}	6.88±0.90^{b}
Color^{ns}	7.50±1.17	7.46±1.03	7.30±1.03
Odor	7.96±0.84^{a}	7.53±0.76^{b}	7.68±0.92^{ab}
Taste	7.65±1.14^{a}	7.15±1.02^{b}	7.36±1.02^{ab}
Texture	7.41±1.18^{a}	6.43±0.74^{c}	7.03±0.88^{b}
Overall liking	7.73±1.02^{a}	6.91±0.82^{c}	7.36±0.93^{b}

Mean ± SD with different lowercase superscripts in each low are significantly ($p \leq 0.05$) different; ns = not significantly ($p > 0.05$) different

Recipe 1 Recipe 2 Recipe 3

Figure 1. Characteristic of the three standard recipes of Thai sponge cake.

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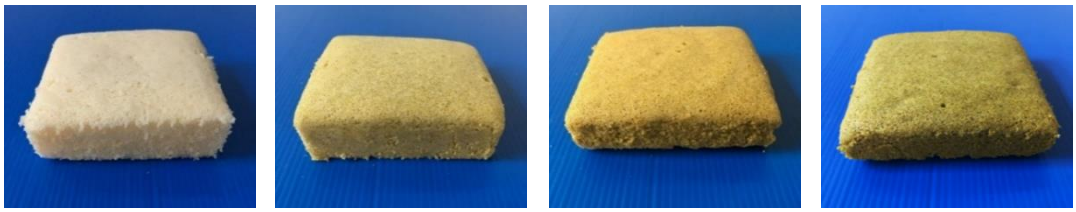
3.3 Effects of dried Sano flowers powder on the quality of Thai sponge cake

The color of the Thai sponge cake with DSFP in different levels of 20, 40 and 60 %w/w had significant effected on the lightness (L *), redness (a *) and yellowness (b *) (p□0.05) as shown in Table 3 and Figure 2. An increase of the DSFP decreased of L*, and a* value, flexibility, and cohesiveness while b* value to be increased due to the DSFP 's carotenoids, especially β-carotene. Carotenoids are among the most widely distributed pigments and naturally exhibit red, orange and yellow colors (Ngamwonglumlert & Devahastin, 2019), which affects the color of the product. This is consistent with the research of Khumkhom (2018), the color value of the Sano butter cookies has been found to decrease L*, a*, while the b* values increased when the level of DSFP increased. This made butter cookies yellow to dark brown in color. Manantaphong, Songpranam, and Dang (2011) reported that the addition of lotus (Nelumbo nucifera) in bread increased the yellow color of the bread. The texture properties of the cake products are perceptible attributes to consumers and may be correlated with the expansion and cell structure of the product. The increases in the hardness, cohesiveness, and gumminess were likely caused by decreased expansion at a higher DSFP while springiness, and chewiness to be decreased (Table 3). Sano flower has high fiber content in which the porous fibers consist of cellulose and hemicellulose can be inserted between the starch granules, that have good combination properties, resulting in decreased swelling and increased hardness of cake (Mudgil, Barak, & Khatkar, 2017).

Table 3. Physical properties of dried Sano flowers powder in Thai sponge cake.

Physical properties	DSFP (%w/w)			
	Control	20	40	60
Lightness (L*)	56.33±0.21^{a}	44.09±0.36^{b}	38.84±0.08^{c}	37.19±0.09^{d}
Redness (a*)	4.42±0.10^{a}	2.40±0.25^{d}	3.23±0.15^{c}	3.43±0.09^{b}
Yellowness (b*)	15.66±0.26^{c}	21.26±0.15^{b}	22.90±0.23^{a}	22.87±0.16^{a}
Hardness	830.65±77.54^{c}	1045.26±127.20^{cb}	1221.60±251.89^{b}	1706.39±408.59^{a}
Springiness	0.90±0.01^{a}	0.83±0.11^{ab}	0.78±0.10^{b}	0.74±0.14^{b}
Chewiness	0.84±0.01^{a}	0.81±0.02^{b}	0.78±0.04^{bc}	0.76±0.04^{c}
Cohesiveness	700.22±62.85^{c}	841.69±82.99^{ab}	943.85±157.95b	1275.98±253.47^{a}
Gumminess	633.50±62.66^{b}	705.08±142.54^{b}	753.79±213.71ab	967.69±351.42^{a}

Mean ± SD with different lowercase superscripts in each low are significantly (p □ 0.05) different



Control 20% 40% 60%

Figure 2. Characteristic of dried Sano flowers powder (control, 20%, 40%, 60% w/w) in Thai sponge cake.

The DSFP content was the most important parameter affecting the sensory properties of Thai sponge cake. The results of the current study showed that DSFP content (20-60% w/w) had significant effects on the appearance, color, odor, taste, texture, and overall liking of the Thai sponge cake (Table 4). The SSP content was the most important parameter affecting the sensory properties of the extrudate. Table 4 shows that increasing the DSFP from 20% to 40% resulted in increased liking scores for odor, taste, and overall liking. Thai sponge cake obtained from the highest DSFP had the minimum color scores. Because DSFP contains carotenoids, which have a yellow pigment. In addition, it also affects the texture quality; the DSFP had an effect on the puffiness of the Thai sponge cake. This is consistent with the research of Panichakornkul (2016) that supplementing DSFP in sandwich bread products; when considering physical quality, it was found that supplementing DSFP made the product with more dietary fiber affecting the structure of the bread, resulting the bread with more hardness, and firmness. It also showed that sandwich bread had a higher yellow color than the control sample. However, the liking score of odor, taste, texture, and overall liking

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had more than 6.0 score, especially for 20% w/w DSFP. Therefore, the levels of 20% w/w DSFP could be a desirable way to produce the healthy Thai sponge cake with appearance, odor, taste, texture, and an overall liking score of more than 6.00 which considered to be acceptable.

Table 4. Sensory evaluation of dried Sano flowers powder in Thai sponge cake.

Sensory characteristics	DSFP (%w/w)			
	Control	20	40	60
Appearance	7.12±0.93^{a}	6.32±0.79^{b}	6.40±0.85^{b}	6.78±1.03^{a}
Color	7.26±1.10^{a}	5.88±0.84^{c}	6.40±0.88^{b}	7.20±1.06^{a}
Odor	5.86±0.80^{c}	6.74±1.08^{a}	6.40±0.92^{ab}	6.12±1.00^{b}
Taste	5.76±0.68^{c}	6.66±1.23^{a}	6.24±0.84^{b}	6.10±0.83^{bc}
Texture	6.28±0.99^{b}	6.98±1.02^{a}	6.18±0.94^{b}	5.28±0.51^{c}
Overall liking	6.50±0.81^{b}	6.86±0.90^{a}	6.44±0.73^{b}	6.14±0.35^{c}

Mean ± SD with different lowercase superscripts in each low are significantly (p □ 0.05) different

3.4 Nutritional value of developed Thai sponge cake

The developed Thai sponge cake contained protein, fat, dietary fiber, ash, moisture and carbohydrates in 9.45, 5.23, 2.64, 1.16, 33.94 and 52.42 g/100 g respectively, and 319.10 µg/100 g β-carotene. The developed product supplemented with DSFP is a guideline to increase healthy nutrition especially dietary fiber, and β-carotene. The addition of DSFP in Thai sponge cake resulted in increased protein, fiber, and β-carotene, because the DSFP contains high dietary fiber and β-carotene. This is consistent with the research of Kijparkorn, Plaimast and Wangsoonoen (2010) reported that DSFP contained a lot of dietary fiber, and β-carotene, followed by lutein and β-cryptoxanthin. Khumkhom (2018) reported that the butter cookies with the DSFP had a high dietary fiber, and β-carotene when increasing DSFP. Therefore, it is possible to increase nutritional values by adding DSFP in healthy cake products.

Table 5. Nutritional values of developed Thai sponge cake.

Nutritional values	Developed Thai sponge cake 100 g
Moisture content (g)	33.94
Carbohydrates (g)	52.42
Protein (g)	9.45
Fat (g)	5.23
Dietary fiber (g)	2.64
Ash	1.16
β-carotene (µg)	319.10

4. Conclusion

In conclusion, the present study showed that the Sano flowers can be a material with agro-industrial potential with an important source of total carotenoids. Carotenoid has biological properties as antioxidant activity and antibacterial activity. Dried Sano flowers powder (DSFP) prepared and analyzed for total carotenoids. DSFP contained lutein, zeaxanthin and β-carotene. The effects of the addition with different levels of DSFP (20, 40 and 60 %w/w) of Thai sponge cake had been studied. An increase of the DSFP decreased the lightness (L*), redness (a*) value, springiness, and chewiness as well as yellowness (b*) value, hardness, cohesiveness, and gumminess. The sensory evaluation showed that all treatments obtained the overall liking score of 6.14-6.86. The study clearly showed that the levels of 20% w/w DSFP could be desirable to apply for producing the healthy Thai sponge cake. The developed Thai sponge cake contained protein, fat, dietary fiber, ash, moisture, and carbohydrates, indicating the DSFP is a guideline to increase healthy nutrition especially dietary fiber, and β-carotene. Therefore, the dried Sano flowers powder could enhance the quality of finished product and consumer satisfaction.

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Conflict of Interest

The authors would like to declare that there is no conflict of interest in this paper.

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