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Effect of avocado pulp puree on the quality of Thai-style custard cake

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ABSTRACT

The study aimed to evaluate the effects of replacing coconut milk with avocado pulp puree in a healthy Thai-style custard cake (Khanom Mor Kaeng) on their physicochemical, microbiological, and sensory properties. The results showed that Thai-style custard cake at different substitution levels of avocados: coconut milk (0, 25, 35, 45, and 55%) appeared darker and more green and yellow. Thai-style custard cake at a 35% substitution level of avocado pulp puree was selected with the highest scores in color, aroma, texture, taste, and overall acceptability at 7.23, 7.33, 7.36, 7.30, and 7.36, respectively. The calorie content, total carbohydrate, total fat, and saturated fatty acid were lower than those of the original product by 3.21, 0.82, 10.01, and 25.29%, respectively. However, the unsaturated fatty acid and crude fiber of the developed product were increased by 1.6-fold and 12.23%, respectively, when compared to the original product.

Keywords: Thai-style custard cake, avocado, coconut milk, avocado pulp puree, sweetener

INTRODUCTION

Obesity represents a global public health problem that affects almost every country in the world, including Thailand in this present time. Obesity is a non-communicable disease (NCD), and it is the leading cause of other serious diseases such as diabetes, stroke, heart disease, cardiovascular diseases, and metabolic syndrome. (Budreviciute et al., 2020; Jaoua et al., 2020) The World Health Organization (WHO) reported that the heart disease group and vascular disease group have been the number one cause of death globally since 2016 (Department of Disease Control, 2022). In 2022, the number of Thai obese patients was reported to be 9 percent of the total Thai population, or 6 million people, which was the second highest number after Malaysia, and the number has continued to increase. According to Puntiya (2020) stated that there were 17.9 million people died from obesity, accounting for 31% of the total death rate. The cause of obesity death rate could relate to regularly consuming high-fat and sugar in Thai food and desserts. Thai desserts are mainly comprised of coconut milk and sugar, which provide high energy. One of the famous Thai desserts that people usually have is Thai custard with mung beans or Khanom Mor Kaeng Thua.

Khanom Mor Kaeng Thua, or its original name, Khanom Mor Thong, was first made by Thao Thong Kip Ma (Maria Guyomar de Pinha) in the reign of King Narai, the Great. When she started promoting the dessert recipe to other people, one of them was a group of local people from Phetchaburi province who were her kitchen assistants. Therefore, the most famous and authentic recipe is in Phetchaburi. Nowadays, the recipe for making Khanom Mor Kaeng Thua has been adapted from palm sugar to jaggery palm sugar, increasing the sweetness and unique smell, which will help the dessert have a smooth texture, brown surface, soft texture, and sweet taste. The main ingredients in 100 grams of Khanom Mor Kaeng Thua is associated with a high content of sugars, flour, and coconut milk, which provide 223 calories of energy, 6.20 grams of protein, 26.60 grams of carbohydrates, 21.00 grams of sugar, and 10.10 grams of fat which is saturated fatty acid up to 4,517 milligrams (Jongjaithet et al., 2009). As a sequence of desserts provides high fat, many researchers have experimented with improving the recipe to be more nutritious and healthier by reducing the amount of sugar, replacing sweeteners of Maltitol, Sucralose, and fatty acids with other substances such as replacing coconut milk with Grains milk and avocado. Sukonthara (2016)

conducted a study on developing Khanom Mor Kaeng germinated Riceberry to reduce sugar. Chompoorat (2022) conducted a study on developing low calories in Khanom Mor Kaeng with no cholesterol from coconut milk oil and eggs. Sanon et al. (2009) studied reduced calories in Khanom Mor Kaeng and improved fatty acid proportion with sucralose and cream from grain milk.

Avocado is a fruit that provides an excellent essential source of many nutrients and minerals for the body, such as Potassium, Phosphorus, Calcium, Manganese, Vitamin A, Vitamin C, and Vitamin D (Kadam and Salunkhe, 1995). Avocado pulp has a high-fat content of up to 2735% (Phungbunhan et al., 2021), which is a monounsaturated fatty acid (MUFA) 10% (Okobi et al., 2013). This type of fatty acid helps reduce low-density lipoprotein (LDL) levels (Wang et al., 2015), increasing the blood's high-density lipoprotein (HDL) levels and decreasing the risk of having heart disease (Okobi et al., 2013). Tak province is another important avocado cultivation area in Thailand. Most of the plantation area is more than 1,369 rai or 219 hectares, and the total production is about 800–1,200 tons annually. These large amounts of harvesting could lead to market oversupply, low prices, and waste. For these reasons, the researchers aimed to develop the Khanom Mor Kaeng Thua recipe by replacing fatty acids in coconut milk with avocado pulp and utilizing maltitol and sucrose instead of sugar to enhance nutrition, reduce the energy to the body, and be the alternative for good healthy.

MATERIALS AND METHODS

Materials

Thai avocados (PP08 varieties), and other food-grade ingredients (eggs, granulated sugar, palm sugar, coconut milk, and salt) were purchased from the local market (Tak, Thailand). The avocado fruits were transported to the laboratories in Rajamangala University of Technology Lanna Tak and allowed to ripen for 5 days in a room at ambient temperatures before use. The avocados were washed and separated pulp from seed and peel. The avocado pulp was mashed into a paste and kept in polyethylene bags at –20°C until use.

Thai-style custard cake preparation

Thai-style custard cake was prepared following the formulations as shown in Table 1 with the addition of five different concentrations of PP08 avocado pulp puree (0, 25, 35, 45, or 55%). The ingredients were mixed in the smoothie blender (OTTO, BE-127A, Thailand); first, eggs, granulated sugar, palm sugar, and salt were mixed at low speed for 2 minutes; steamed peeled-split mung bean, avocado pulp puree, and coconut milk were added to the mixture. It was then mixed until it was uniform in consistency. The batter was then placed in baking tins and baked in the baking oven (Electrolux, EOT70DB, Thailand) set at 200°C for 40 minutes. The Thai-style custard cakes were then cooled, wrapped in plastic bags, and stored at room temperature for further analysis.

Table 1. The Thai-style custard cake formulation with five different proportions of coconut milk and avocado pulp puree

Ingredients	Formulations (%)				
	F1 (0%)	F2 (25%)	F3 (35%)	F4 (45%)	F5 (55%)
Egg	18	18	18	18	18
Granulated sugar	12	12	12	12	12
Palm sugar	7	7	7	7	7
Salt	1	1	1	1	1
Steamed peeled-split mung bean	26	26	26	26	26
Coconut milk	36	27	23.40	19.80	16.20
Avocado pulp puree	0	9	12.60	16.20	19.80

Color

A chromaticity instrument (Hunter, Miniscan EZ 4500L Spectrophotometer, USA) was employed to measure the surface and inner color of the samples. A white and black standard board was used for calibration. The color values were expressed as L* (whiteness/darkness), a* (redness/greenness), and b* (yellowness/blueness). Three samples were analyzed for each substitution level, and each sample was analyzed at three different locations.

Texture analysis

A TA-XT pules Texture Analyzer (Texture Analyzer, TA-XT pules, Stable Micro Systems Ltd., England) was used to measure the hardness, adhesiveness, springiness, cohesiveness, and chewiness of the samples. The samples were cut into

a cube (5.0 cm*5.0 cm*1.5 cm). A 5 mm cylindrical probe was used to cut the samples. The crosshead speed was set at 1 mm s-1, and the probe traveled 75% of the depth into the sample in the first stage (Murdia, 2010).

Calorific and nutritional value

The determination of calorific and nutritional value was performed by indirect calorimetry: Using the food composition table developed by the nutritive values of Thai foods and FoodData Central (Bureau of Nutrition, 2018; United Department of Agriculture, 2020), the sample was calculated for energy (kcal), protein (g), lipid (g), carbohydrate by difference (g), dietary fiber (g), and saturated and unsaturated fatty acids in mg.

Sensory evaluation

The sensory characteristics of Thai-style custard cake were evaluated by 100 untrained panelists aged between 25 and 70. The samples were prepared the day before testing. The samples were cut into 2.0 cm*2.0 cm*1.5 cm cubes. In total, five custard cake samples were presented simultaneously on a serving plate. Each sample was coded with a 3-digit random number. The nine-point hedonic scale used to evaluate color, aroma, taste, and overall acceptability had a verbal interpretation where 9 denoted extremely, 5 denoted neither like nor dislike, and 1 denoted dislike extremely. For the texture parameter, 9 denotes extremely smooth, 5 denotes neither smooth nor rough, and 1 denotes extremely rough.

Statistical analysis

All experiments were conducted in triplicate. Differences between means were determined by one-way analysis of variance (ANOVA) and Duncan's post-hoc test (using SPSS statistical software version 26, IBM Corp., New York, USA) with a significance level of $P < 0.05$.

RESULTS AND DISCUSSION

Effect of substitution level on color

Figure 1 and Table 2 show the physical appearance and the results of color tests, respectively. For the five custard cakes, L* and a* values decrease significantly with increased avocado pulp puree (APP) content. By contrast, the b* value of the surface and inner of custard cakes increased significantly. There was a significant difference in corresponding color values among the custard cakes containing different APP substitution levels. This indicates that samples with more APP are darker, greener, and more yellow. The decrease in the L* value is attributed to the browning reaction. Cut avocados turn brown due to an enzyme present in the avocado called polyphenol oxidase (PPO) that oxidizes polyphenols, causing a brown color to develop. PPO catalyzes the oxidation of phenols to quinones that subsequently polymerize into brown pigments (Zhou et al., 2016). However, these phenomena can be avoided using anti-browning agents such as citric acid, ascorbic acid, and oxalic acid (Suttirak and Manurakchinakorn, 2010). The changes in a* and b* values were caused by plant pigments in avocado pulp, including chlorophylls and carotenoids, especially lutein (Ashton et al., 2006). A similar result has been reported for muffins incorporated with avocado pulp puree (Narul Ain et al., 2016).

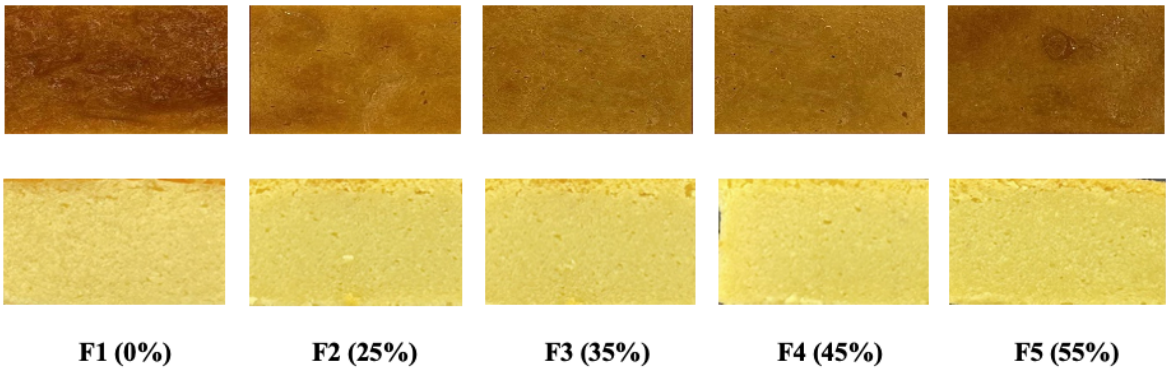

Figure 1. Effect of avocado pulp puree substitution on the physical appearance of Thai-style custard cake.

Table 2. Effect of avocado pulp puree substitution on color value of Thai-style custard cake

Color value	Sample				
	F1	F2	F3	F4	F5
Surface of Thai-style custard cake					
L*	50.08 ± 0.58^{a}	48:89 ± 0.58^{a}	43.68 ± 0.58^{b}	42.45 ± 0.58^{b}	37.18 ± 0.58^{c}
a*	21.77 ± 0.57^{a}	16.38 ± 0.57^{b}	15.84 ± 0.57^{b}	13.51 ± 0.57^{c}	12.07 ± 0.57^{c}
b*	31.36 ± 0.12^{d}	33.82 ± 0.12^{c}	35.26 ± 0.12^{b}	35.44 ± 0.12^{b}	40.60 ± 0.12^{a}
Inner of Thai-style custard cake					
L*	63.51 ± 0.84^{a}	56.21 ± 0.84^{b}	53.59 ± 0.84^{c}	52.53 ± 0.84^{c}	52.92 ± 0.84^{c}
a*	7.71 ± 0.34^{a}	6.83 ± 0.34^{b}	5.68 ± 0.34^{c}	5.64 ± 0.34^{c}	5.24 ± 0.34^{d}
b*	26.18 ± 0.05^{c}	28.67 ± 0.05^{b}	28.54 ± 0.05^{b}	31.72 ± 0.05^{a}	31.75 ± 0.05^{a}

Mean ± standard deviation (n=3). Values with different superscript letters in a row differ significantly ($P < 0.05$). F1 = control, F2 = 25% APP, F3 = 35% APP, F4 = 45% APP, F5 = 55% APP. APP = avocado pulp puree.

Effect of substitution level on textural properties

The texture analysis results including hardness, adhesiveness, springiness, cohesiveness, and chewiness of the Thai-style custard cakes (TSC) are shown in Table 3. The hardness and chewiness ranged from 123.44–131.17 g and 56.43–65.62 g, respectively, and the use of APP made the TSC significantly harder and chewier. Usually, fat substitution, either partially or fully, produces harder-baked products (Nurul et al., 2016). Many studies have reported this on the incorporation of fat replacers such as sesame oil, peanut butter, and extra virgin olive oil as margarine substitutes in baked goods (Matsakidou et al., 2010; Sadaf et al., 2013; Sowmya et al., 2009). The chewiness of the TSC increased with the addition of APP and reached a maximum of 55% fat level. The avocado contains about 6.7 g/100 g of fiber (U.S. Food and Drug Administration, 2018), and this factor could also contribute to a slightly chewier texture in the fat-replaced samples. On the other hand, increasing APP substitution level significantly decreases the adhesiveness, springiness, and cohesiveness, ranging from –59.38 to –46.47 (g/s), 0.90–0.96 mm, and 0.47–0.51, respectively. A similar result was reported by Marina et al. (2016). The results showed that the butter cakes became harder while springiness and cohesiveness decreased with increasing APP substitution levels. Rodríguez-García et al. (2014) also observed a decrease in springiness when the cake was replaced with inulin as a fat replacer.

Table 3. Textures of Thai-style custard cake containing different substitution levels of avocado pulp puree

Textural properties	Sample				
	F1	F2	F3	F4	F5
Hardness (g)	123.44 ± 3.42^{c}	125.18 ± 12.46^{bc}	126.89 ± 5.82^{b}	126.89 ± 9.40^{b}	131.17 ± 11.00^{a}
Adhesiveness (g/s)	–46.47 ± 5.69^{a}	–53.19 ± 6.82^{b}	–55.54 ± 6.49^{bc}	–57.04 ± 8.31^{bc}	–59.38 ± 7.00^{c}
Springiness (mm)	0.96 ± 0.06^{a}	0.97 ± 0.02^{a}	0.97 ± 0.03^{a}	0.92 ± 0.09^{b}	0.90 ± 0.06^{b}
Cohesiveness	0.51 ± 0.01^{a}	0.51 ± 0.01^{a}	0.47 ± 0.02^{c}	0.49 ± 0.00^{b}	0.47 ± 0.08^{c}
Chewiness (g)	56.43 ± 19.77^{c}	56.56 ± 7.81^{c}	57.90 ± 4.25^{c}	63.44 ± 6.43^{b}	65.62 ± 6.36^{a}

Mean ± standard deviation (n=3). Values with different superscript letters in a row differ significantly ($P < 0.05$). F1 = control, F2 = 25% APP, F3 = 35% APP, F4 = 45% APP, F5 = 55% APP. APP = avocado pulp puree.

Sensory Analysis of TSC

The data on the sensory scores of the finished products are listed in Table 4. For all the organoleptic properties of the TSC tested by the panelists, no significant differences ($P > 0.05$) were observed in the color and aroma. The mean for the texture for almost all formulations was not significantly different except for the F5 formulation. Regarding taste, the F1 and F2 had the highest score at 7.50 but no significant difference from the F3 and F4 formulations with a verbal interpretation of moderately. The overall acceptance of TSC was greatly influenced by the texture and taste. Thus, applying APP up to 35% substitution resulted in acceptable TSC. In comparison, more than 35% substitution lowered the preference of TSC among panelists, which indicates that higher avocado substitution negatively affected the sensory properties.

The taste and overall acceptability gradually decreased with an increase in avocado pulp puree (APP), which is attributed to the distinctive aftertaste

due to the long-chain C17-aliphatic triols 1,2,4-trihydroxyhepta-deca-16-yne and 1,2,4-trihydroxyheptadeca-16-ene were successfully identified in the skin, seed, and pulp of avocado, exhibiting an unpleasant bitter off-flavor. Moreover, 1-acetoxy-2,4-dihydroxyheptadeca-16-ene, C17-C21oxylipins with 1,2,4-trihydroxy-, 1-acetoxy-2,4-dihydroxy-, and 1-acetoxy-2-hydroxy-4-oxo motifs, 1-O-stearoyl-glycerol and 1-O-linoleoyl-glycerol were reported as bitter-tasting compounds in thermally processed avocado (*Persea americana* Mill.). Unfortunately, Thermal treatment or air-drying of avocado and products made thereof has long been known to induce the development of an unpleasant off-taste centering around a slightly pungent mouthfeel and a pronounced lingering bitter after-taste (Brown, 1972; Degenhardt and Hofmann, 2010). Considering overall acceptability there were no significant differences among the products. So, the highest substitution level is 35 g by APP from 100 g coconut milk in Thai-style custard cake.

Table 4. Influence of avocado pulp puree substitution on sensory qualities of Thai-style custard cake

Textural properties	Sample				
	F1	F2	F3	F4	F5
Color	7.40 ± 1.40	7.40 ± 1.32	7.23 ± 1.35	7.13 ± 1.45	6.96 ± 1.56
Aroma	7.35 ± 1.47	7.16 ± 1.36	7.33 ± 1.34	7.03 ± 1.37	7.13 ± 1.38
Texture	7.26 ± 1.22^{ab}	7.23 ± 1.86^{ab}	7.36 ± 1.21^{ab}	7.30 ± 1.44^{ab}	6.93 ± 1.61^{b}
Taste	7.50 ± 1.26^{ab}	7.50 ± 1.47^{ab}	7.30 ± 1.23^{ab}	7.23 ± 1.65^{ab}	6.80 ± 1.84^{b}
Overall acceptability	7.42 ± 0.97^{ab}	7.30 ± 1.26^{b}	7.40 ± 1.51^{ab}	7.03 ± 1.42^{b}	6.93 ± 1.65^{b}

Mean ± standard deviation (n=3). Values with different superscript letters in a row differ significantly ($P < 0.05$). F1 = control, F2 = 25% APP, F3 = 35% APP, F4 = 45% APP, F5 = 55% APP. APP = avocado pulp puree.

Calorific and nutritional value of TSC: Energy and nutrients

The calorific and nutritional value of Thai-style custard cakes was evaluated by calculating the energy and nutrients per serving for one piece of 104-g Thai-style custard cakes, as summarized in Table 5. The selected formulation (F3) was lower in calorie content, protein carbohydrate, fat, and saturated fatty acid but higher in dietary fiber and unsaturated fatty acid than the control. Protein and fat content were slightly decreased because the protein content in avocado pulp puree was less than in coconut milk. In contrast, the dietary fiber of custard cake was increased from 5.52 to 6.25 g (12.23%) by partially replacing coconut milk with 35% avocado pulp. Avocados are a good source of fiber, low in total carbohydrates, and rich in monounsaturated fats. According to the USDA, one avocado contains around 13.5 grams of fiber, nearly half of the 2020 - 2025 Dietary Guidelines for Americans' recommendation of 28 to 34 g per day (U.S. Department of Agriculture & U.S. Department of Health and Human Services, 2020). Dietary fiber is shown to have numerous benefits, such as improved intestinal function, cholesterol reduction, and increased microbial biomass. The fat content of muffins decreased from 46.06 to 45.68 (0.82%), with the addition of APP in the formula. The saturated fatty acid (SFA) and unsaturated fatty acid (USFA) improved as predicted. The unsaturated fatty acid was increased in Thai-style custard cake incorporating avocado pulp puree (F3) compared to the control. In general, SFA was decreased while USFA was increased with avocado incorporation. The total SFA decreased by 25.29% from the control to the F3 sample. The USFA content, on the other hand, increased by 1.62-fold from the control to the F3 sample. Previous studies also showed a similar trend, in which avocado pulp puree progressively improves the SFA and USFA content in food products (Moolwong et al., 2023; Nurul Ain et al., 2016).

Table 5. Calorific and nutritional value of Thai-style custard cake per piece of 104-g Thai-style custard cake

Calorific and nutritional value	Sample		Nutrient changes
	Control	F3 (35% APP)	
Energy (kcal)	327.58	317.08	–3.21%
Protein (g)	10.99	10.94	–0.41%
Carbohydrate (g)	13.94	12.54	–10.01%
Fat (g)	45.68	46.06	–0.82%
Dietary fiber (g)	5.52	6.20	+12.23%
Saturated fatty acid (mg)	7.63	5.70	–25.29%
Unsaturated fatty acid (mg)	2.59	4.20	+1.62-fold

APP = avocado pulp puree.

CONCLUSIONS

The Thai-style custard cakes incorporating avocado pulp puree were accepted up to 35% avocado incorporation, with 0.82% fat reduction and 3.21% lower calorie content compared to the control sample. Sensorial studies revealed that the acceptability of avocado-incorporated Thai-style custard cakes depends on their texture and taste properties. Therefore, further study must be done to eliminate the aftertaste and unfavorable flavor of avocado pulp puree in another product at full-fat substitution in order to produce a full-fat replacement in the product.

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