

## บทความวิจัย

# ผลของปริมาณงาดำต่อคุณภาพของลวดช่องสิงคโปร์เสริมงาดำ ในนมสดขาดมันเนย

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## บทคัดย่อ

งานวิจัยนี้มีวัตถุประสงค์เพื่อศึกษาพัฒนาสูตรลวดช่องสิงคโปร์เสริมงาดำนมสดขาดมันเนย โดยทำการศึกษาอัตราส่วนที่เหมาะสมของงาดำในเส้นลวดช่องสิงคโปร์ จำนวน 3 สูตร คือ ร้อยละ 2, 4 และ 6 โดยน้ำหนักของส่วนผสมทั้งหมด จากนั้นนำมาศึกษาคุณภาพทางกายภาพ ได้แก่ ค่าเนื้อสัมผัส ค่าสี คุณภาพทางประสาทสัมผัส และคุณค่าทางโภชนาการ ได้แก่ ปริมาณแคลเซียม และคุณค่าทางโภชนาการ ผลการศึกษาพบว่า ค่าเนื้อสัมผัส Springiness, Adhesiveness และค่าสี  $L^* a^*$  มีค่าลดลงอย่างมีนัยสำคัญทางสถิติ ( $p \leq 0.05$ ) เมื่อเพิ่มปริมาณงาดำ จากการศึกษาคุณภาพทางประสาทสัมผัส พบว่า ลวดช่องสิงคโปร์เสริมงาดำร้อยละ 6 ได้รับการยอมรับทางประสาทสัมผัสมากที่สุด การศึกษาเปรียบเทียบปริมาณแคลเซียม พบว่า เส้นลวดช่องสิงคโปร์เสริมงาดำร้อยละ 6 มีปริมาณแคลเซียมสูงกว่าเส้นลวดช่องสิงคโปร์ ที่ไม่เสริมงาดำอย่างมีนัยสำคัญทางสถิติ ( $p \leq 0.05$ ) และคุณค่าทางโภชนาการ ได้แก่ ไขมัน คาร์โบไฮเดรตทั้งหมด พลังงานทั้งหมดต่อ 100 กรัม และพลังงานจากไขมันต่อ 100 กรัม ของลวดช่องสิงคโปร์เสริม งาดำในนมสดขาดมันเนยทดแทนน้ำกะทิ มีปริมาณน้อยกว่าลวดช่องสิงคโปร์ที่ไม่เสริมงาดำและไม่ทดแทนด้วยนมสดขาดมันเนยอย่างมีนัยสำคัญทางสถิติ ( $p \leq 0.05$ ) การศึกษาการยอมรับของผู้บริโภค พบว่า ผู้บริโภคยอมรับผลิตภัณฑ์โดยเฉลี่ยอยู่ในระดับการยอมรับมาก

**คำสำคัญ:** ลวดช่องสิงคโปร์ งาดำ นมสดขาดมันเนย คุณภาพทางกายภาพ คุณค่าทางโภชนาการ

# The Effects of the Amount of Black Sesame on Quality of Singapore Cendol with Black Sesame Seeds in Skimmed Milk

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## ABSTRACT

The objective of this study was to develop a recipe of Singapore Cendol with black sesame seeds in skimmed milk. The study analyzed three different recipes, namely 2%, 4% and 6% w/w of black sesame seeds in Singapore Cendol noodles and identified the most suitable recipe. There was physical property analysis covering texture analysis, color analysis, sensory evaluation and nutritional value analysis such as calcium analysis and other nutritional values. In addition, consumer acceptance of the product was also analyzed. The results showed that in terms of texture analysis, springiness and adhesiveness as well as color values of L\* and a\* reduced statistically ( $p \leq 0.05$ ). When there was more addition of black sesame seeds the 6% black sesame seed noodles were the highest acceptance in terms of sensory evaluation. Regarding calcium analysis, the 6% black sesame seed noodles provided higher level of calcium than the traditional Singapore Cendol noodles without black sesame seeds with a statistically significant difference ( $p \leq 0.05$ ). Concerning nutritional values, the Singapore Cendol with black sesame seeds in skimmed milk provided less fat, carbohydrates, total energy per 100 g and total energy from 100 g of fat when compared to the traditional Singapore Cendol without black sesame seeds and skimmed milk with a statistically significant difference ( $p \leq 0.05$ ). Regarding consumer acceptance, the consumers were satisfied with the product in all aspects in a high acceptance level.

**Keywords:** Singapore Cendol, black sesame seeds, skimmed milk, physical properties, nutritional values

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## Introduction

In the past, there were contacts between Thailand and various foreign countries such as China, India, Melayu, Persia and other countries from Europe. The contacts covered trade contacts and cultural exchanges in particular food cultures. Later, cooking ingredients and utensils were adapted to suit contexts [1]. Thai desserts have influenced Thai eating cultures. In fact, western desserts have had an effect on Thai desserts, resulting in the loss of some Thai desserts. However, a number of Thai desserts are still available and have offered taste sensations in Thai cultures [2]. Traditional ingredients of Thai desserts are mostly based on flour, sugar and coconut. Flour is a main component of dough. Sugar adds sweetness to a dessert and coconut is oily and sweet. Cooking methods derive from folk wisdom. For example, Singapore Cendol is made from tapioca starch. Flour together with hot water is combined and kneaded. Then dough is cut into strips and boiled. This dessert is topped with fresh coconut, syrup with jasmine flowers and crushed ice to add freshness into our body. Singapore Cendol is popular in summer, which is suitable for Thai's climate [3].

Singapore Cendol contains carbohydrate and fat. When served with coconut and syrup, it provides high energy [4]. Black sesame seeds have high nutritional value with some nutrients, covering 20% of protein and amino acids: methionine and high tryptophan. Normally, both amino acids are less found in plants. Moreover, there are vitamins and minerals such as B6 vitamin, iron, iodine, zinc, sulphur, copper, calcium, phosphorus, potassium and fibers. More importantly, the amount of calcium in black sesame seeds is three times higher than of milk with the same amount [5]. Combining skimmed milk with coconut milk can reduce an amount of fat in a dessert since skimmed milk contains less fat than coconut milk. In fact, 100 g of coconut milk contains 34.7 g of fat [6]. On the other hand, 100 g of skimmed milk contains 0.1 g of fat [7].

The data above shows that black sesame seeds contain nutrients that are beneficial for human bodies since black sesame seeds are full of calcium and skimmed milk has less fat than coconut milk. As a result, adding black sesame seeds into Singapore Cendol and combining skimmed milk with coconut cream syrup can increase nutritional value, resulting in high calcium and low fat Singapore Lod Chong, yet tasty. The dessert can create customer acceptance and is suitable for consumers who love their health. Also, it can provide a guideline to maximize the utility of black sesame seeds and add creativity to Thai desserts.

## Materials and Methods

### 1. Ingredients of Singapore Cendol

The ingredients were as follows: Tapioca flour (Dragon Fish Brand), black sesame seeds (Raithip Brand) water, fresh coconut milk from a market, skimmed milk (Meiji Brand), salt (Prungthip), Sugar (Lin Brand) as seen in the recipes in Table 1.

**Table 1** Recipes of Singapore Cendol with black sesame seeds and skimmed milk

Ingredients	Amount (g)		
	2% black sesame seeds	4% black sesame seeds	6% black sesame seeds
<u>Ingredients of Singapore Cendol noodles</u>			
Tapioca starch	200	200	200
Water	250	250	250
Black sesame seeds	9	18	27
<u>Ingredients of skimmed milk cream syrup</u>			
Coconut milk		460	
Skimmed milk		460	
Salt		4	
<u>Ingredients of syrup</u>			
Sugar		340	
Water		450	

**Note:** In this study, the three levels of black sesame seeds were studied and they were 2%, 4% and 6% w/w black sesame seeds of the total Singapore Cendol noodles.

### Cooking methods

The cooking methods of the Singapore Cendol noodles with black sesame were as follows:

1. The black sesame seeds were rinsed and put in a colander until they were drained. The drained black sesame seeds were baked in an oven at 175 °C for 10 minutes.
2. The black sesame seeds were put into the water and boiled, and the tapioca starch was added into the boiling water before stirring and kneading it. When it became dough, it was rolled into thin sheets and cut into strips.

3. The cooking method of the skimmed milk topping syrup was to combine all the ingredients together in a boiling pot and boil them at 60 degree Celsius for 30 minutes.

4. The cooking methods of the syrup were to combine the sugar with the water and simmer it over medium heat for 10 minutes.

## **2. Physical Properties**

The texture profile analysis of the three recipes of the Singapore Cendol (2%, 4% 6%) was conducted using Texture Analyzer model TA-XT plus (Stable micro system, Surrey, UK) in the following areas: Hardness, Springiness, Cohesiveness and Adhesiveness. 10 g of samples filled in the cup 25 mm cylindrical probe were used at 50 mm/min

## **3. Color analyzer**

Color values of the Singapore Cendol noodles with three levels of black sesame seeds, namely the 2%, the 4% and the 6%, were measured with color values ( $L^*a^* b^*$ ) were tested by using Minolta colorimeter model CR-300 (Minolta co., Ltd, Osaka, Japan).

## **4. Sensory evaluation**

Sensory evaluation of the Singapore Cendol with three levels of black sesame seeds, namely the 2%, the 4% and the 6%, was conducted using 9 - Points Hedonic Scale questionnaire in the following aspects: appearance, color, smell, overall flavor, hardness as well as overall satisfaction in order to choose the most preferred recipe.

## **5. Study of food chemical compositions**

5.1 The amount of calcium was analyzed by ICP-OES Technique [8].

5.2 The food nutritional analysis was performed to measure protein, moisture, fat, ash, Total Carbohydrate, Total Calories kcal/100 g, Calories from fat kcal/100 g [9].

## **6. Study of customer acceptance of Singapore Cendol**

The selected recipe of the Singapore Cendol with black sesame seeds and skimmed milk was tasted by 100 participants who were randomly selected. The participants received a three-section questionnaire. The first section focused on demographic data such as gender, age, occupations, educational levels and monthly income whereas the second section was related to product preference with the sensory evaluation covering appearance, color, smell, overall flavor, hardness and overall satisfaction using 9 - Points Hedonic Scale. The third section was related to the consumers' purchase intent. Then the data was analyzed for percentage and mean scores.

## **7. Data analysis**

The results from the experiment were analyzed using analysis of variance and the mean scores of each experiment were compared using Duncan' New Multiple Rang Test (DNMRT) with confidence interval of 95%.

## Results

### 1. Texture analyzer

Table 2 reveals that the texture value of the Singapore Cendol with black sesame seeds classified into three different categories: 2%, 4% and 6% black sesame seeds. Hardness and cohesiveness of the three categories were not significantly different ( $p > 0.05$ ). Springiness of the Singapore Cendol with 4% black sesame seeds was significantly different from that of the 2% and the 6% with the value of 19.40, 17.18 and 16.85, respectively. Adhesiveness of the Singapore Cendol with 2% black sesame seeds was significantly different ( $p \leq 0.05$ ) from that of the 4% and the 6% with the value of 0.67, 0.29 and 0.21, respectively.

**Table 2** Texture of Singapore Cendol with black sesame seeds

Texture	2% black sesame seeds (n=3)	4% black sesame seeds (n=3)	6% black sesame Seeds (n=3)
Hardness <sup>ns</sup> (kgf)	0.66 ± 0.06	0.56 ± 0.12	0.63 ± 0.15
Springiness (mm)	17.18 <sup>b</sup> ± 0.35	19.40 <sup>a</sup> ± 2.71	16.85 <sup>b</sup> ± 0.71
Cohesiveness <sup>ns</sup>	0.69 ± 0.59	0.64 ± 0.39	0.63 ± 0.02
Adhesiveness (kgf)	0.67 <sup>a</sup> ± 0.23	0.29 <sup>b</sup> ± 0.18	0.21 <sup>b</sup> ± 0.12

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

<sup>ns</sup> letters mean that there was no statistically significant difference ( $p > 0.05$ ).

### 2. Color analyzer

In terms of color value analysis, the color value ( $L^*$   $a^*$   $b^*$ ) of the Singapore Cendol with black sesame was analyzed from three different levels: 2%, 4% and 6% black sesame seeds. Table 3 shows that lightness value ( $L^*$ ) of the 6% black sesame seeds was significantly different ( $p \leq 0.05$ ) from that of the 2% and the 4% with the value of 27.44, 32.04 and 33.52, respectively. It was clearly seen that the larger amount of black sesame seeds caused the lower light of the Singapore Cendol. Due to one of their physical properties, black shells of sesame seeds, adding the black sesame seeds blackened the Singapore Cendol noodles. Red value ( $a^*$ ) of the 2% and 4% black sesame seeds were compared and there was a significant difference ( $p \leq 0.05$ ) between them, with the value of 1.88 and 0.82, respectively. Lastly, there was no significant difference ( $p > 0.05$ ) of yellow color ( $b^*$ ).

**Table 3** Color value of Singapore Cendol with added black sesame seeds

Color value	2% black sesame seeds (n=3)	4% black sesame seeds (n=3)	6% black sesame seeds (n=3)
L*	32.04 <sup>a</sup> ± 4.43	33.52 <sup>a</sup> ± 1.25	27.44 <sup>b</sup> ± 1.82
a*	1.88 <sup>a</sup> ± 0.71	0.82 <sup>b</sup> ± 0.67	1.18 <sup>ab</sup> ± 0.51
b* <sup>ns</sup>	2.34 ± 0.72	2.84 ± 0.71	2.52 ± 0.40

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

<sup>ns</sup> letters mean that there was no statistically significant difference ( $p > 0.05$ ).

### 3. Sensory evaluation

The results of sensory evaluation of the Singapore Cendol with three levels: 2%, 4% and 6% black sesame seeds as in Table 4 reveal that appearance, smell and overall flavor were not significantly different ( $p \leq 0.05$ ).

In terms of color, the 6% black sesame seeds in the Singapore Cendol were different ( $p \leq 0.05$ ) from the 4% in that the average of the 6% was 7.60 and that of the 4% was 7.07. When more black sesame seeds were added, the score in the color increased.

In terms of hardness, the 2% black sesame seeds in the Singapore Cendol were different ( $p \leq 0.05$ ) from the 4% with an average of 7.80 and 7.33, respectively. With fewer black sesame seeds, the score of hardness increased.

In terms of overall preference, the 6% black sesame seeds in the Singapore Cendol were different ( $p \leq 0.05$ ) from the 2% black sesame seeds with an average of 8.10 and 7.73, respectively. The sensory evaluation shows that the 6% black sesame seeds in the Singapore Cendol received the highest scores in the aspect of color and overall preference. As a result, the 6% was chosen for further development.

**Table 4** Color value of Singapore Cendol with added black sesame seeds

Sensory evaluation	2% black sesame seeds (n=30)	4% black sesame seeds (n=30)	6% black sesame seeds (n=30)
Appearance <sup>ns</sup>	7.20 ± 1.06	7.40 ± 1.03	7.53 ± 1.35
Color	7.23 <sup>ab</sup> ± 1.13	7.07 <sup>b</sup> ± 1.08	7.60 <sup>a</sup> ± 1.03
Smell <sup>ns</sup>	7.00 ± 1.11	6.80 ± 1.37	7.23 ± 1.40
Flavor <sup>ns</sup>	7.40 ± 0.93	7.17 ± 1.46	7.37 ± 1.09
Hardness	7.80 <sup>a</sup> ± 0.80	7.33 <sup>b</sup> ± 1.12	7.63 <sup>ab</sup> ± 0.85
Overall satisfaction	7.73 <sup>b</sup> ± 0.78	7.83 <sup>ab</sup> ± 0.83	8.10 <sup>a</sup> ± 0.92

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

<sup>ns</sup> letters mean that there was no statistically significant difference ( $p > 0.05$ ).

#### 4. Food chemical compositions

##### 4.1 Calcium content analysis

The analysis was conducted with two samples, namely the Singapore Cendol with added black sesame seeds and the Singapore Cendol made from tapioca starch without black sesame seeds with the same amount. The calcium content of both samples was compared. Table 5 shows that the calcium amount of the Singapore Cendol with added black sesame seeds was significantly different ( $p \leq 0.05$ ) from those without black sesame. The Cendol with black sesame seeds contained more calcium than those without black sesame with the value of 51.12 mg/100 g and 14.43 mg/100 g, respectively.

**Table 5** Comparison of calcium content

Food product	Calcium, mg/100 g*
Singapore Cendol without sesame seeds	14.43
Singapore Cendol with added black sesame seeds	51.12

**Note :** \* letters found with any number in the vertical row mean that there was statistically significant difference ( $p \leq 0.05$ )



#### 4.2 Nutritional analysis

The nutritional analysis was conducted with two samples of the Singapore Cendol: (1) the Singapore Cendol with 6% black sesame seeds and 50% of skimmed milk together with 50% of coconut milk (2) traditional Singapore Cendol made from 100% tapioca starch and 100% coconut milk. Each was blended before the analysis. Table 6 indicates that the nutritional values of the Singapore Cendol with black sesame seeds and skimmed milk covering moisture, fat, carbohydrates, total energy per 100 g and total energy from 100 g of fat were different ( $p \leq 0.05$ ) with the following values: 73.43%: 67.90%, 7.54%: 12.96%, 16.54%: 17.29%, 140.90 kcal: 190.28 kcal and 67.86 kcal: 116.64 kcal, respectively.

**Table 6** Nutritional values

Nutritional values	Singapore Cendol with added black sesame seeds and skimmed milk	Traditional Singapore Cendol
Protein <sup>ns</sup>	1.72%	1.12%
Moisture*	73.43%	67.90%
Fat*	7.54%	12.96%
Ash <sup>ns</sup>	0.77%	0.73%
Total Carbohydrate*	16.54%	17.29%
Total Calories, kcal/100 g*	140.90	190.28
Calories from fat, kcal/100 g*	67.86	116.64

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

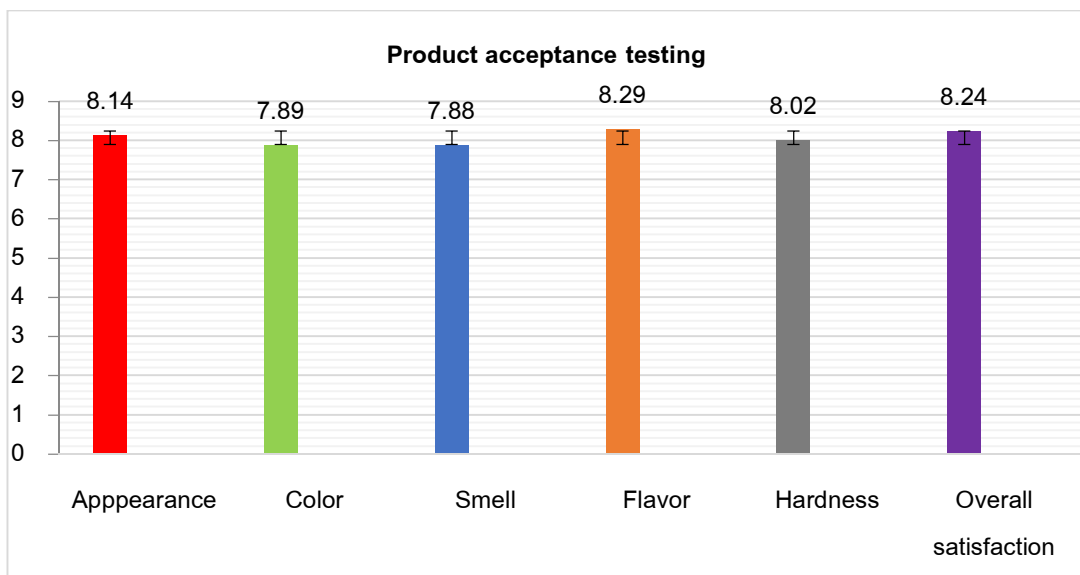
<sup>ns</sup> letters mean that there was no statistically significant difference ( $p > 0.05$ ).

#### 5. Customer acceptance analysis

To obtain the results regarding customer acceptance towards Singapore Cendol with black sesame seeds, the Singapore Cendol was tasted by 100 participants who were randomly selected and the questionnaire was distributed after the tasting. As mentioned, the questionnaire covered three sections: demographic data, the satisfaction in terms of food quality and sensory evaluation and purchase intent. The result reveals that most of the respondents were female, accounting for 70%. The rest of them were male respondents, accounting for 30%. More than half

were from 15-24 years old. Roughly 64% of them were university students and 76% reported that they possessed bachelor's degree. Approximately 37% earned from 5,001 to 10,000 baht a month.

Figure 1 reveals that scores of product acceptance of the consumers towards the Singapore Cendol with black sesame seeds and skimmed milk. The overall score from all aspects was 8.88, referring to high acceptance. In details, “smell”, “color” and “hardness” were highly accepted with the mean scores of 7.88, 7.89 and 8.02, respectively. “Appearance”, “overall satisfaction”, and “flavor” had the highest acceptance with the mean scores of 8.14, 8.24 and 8.29, respectively. The reason was that adding the baked black sesame seeds provided the good smell and better tastes [10].



**Figure 1** Singapore Cendol acceptance

In terms of purchase intent, 99% of the respondents reported that they would purchase the product if it were launched in the market. Once they receive the product details, 100% of them would purchase it. Nearly half of the respondents provided a purchase reason in that black sesame seeds were healthy and combining skimmed milk with coconut milk would lessen the amount of fat. About one third of the respondents viewed it as a new healthy alternative while one fifth of them viewed it as a new product in the markets. This is in line with the results of the study aiming for developing tofu egg custard sauce with black sesame in that 100% participants accepted the tofu egg custard sauce with the black sesame replacement and that 94% of them reported purchase intent due to its health benefits in the form of health promoting products [11]. This is consistent with current consumers' consumption behaviors in that consumers pay more attention to food and health issues, and there is an increase in health promoting foods. This results in development supplementary foods such as vitamin added foods [12-13].

## Conclusion and Discussion

The addition of different levels of black sesame seeds revealed that the most suitable recipe was the 6% black sesame seeds into the Singapore Cendol noodles due to its most acceptance. This might be because the noodles 6% with black sesame seeds were beautifully black. The texture analysis showed that the 6% black sesame seed noodles were darker than the 2% and the 4%. When the 6% black sesame seed noodles were boiled, the noodles were less sticky than the 2% and the 4%. This was consistent with the score of hardness of the 2% black sesame seeds in texture analysis, the highest score of 0.66.

The texture analysis regarding the adhesiveness of the Singapore Cendol with 2% black sesame seeds was significantly different ( $p \leq 0.05$ ) from that of the 4% and the 6% with the value of 0.67, 0.29 and 0.21, respectively. This may be because the larger amount of added black sesame seeds into the Singapore Cendol reduced the value of adhesiveness. It could be explained black sesame seeds contain cellulose. Cellulose is insoluble in water so it could hold and absorb water until the noodles were inflatable. When the noodles were mixed with the ingredients which contained water, the viscosity and toughness of the Singapore Cendol noodles also reduced [14-15].

The calcium analysis of the 6% was compared with that of the noodles without black sesame seeds (100% Tapioca starch) in the amount of 100 g and the result showed that there was more calcium in the noodles with black sesame seeds than those without sesame seeds 36.69 mg/100 g. This is because black sesame seeds provide higher amount of calcium than tapioca starch. In fact, 100 g of black sesame offers 1,469 mg of calcium while 100 g of tapioca starch has only 84 mg of calcium [6]. As a result, adding black sesame seeds into the Cendol led to a high increase in the amount of calcium in the Singapore Cendol. In fact, there is a higher amount of calcium in black sesame seeds than in one box of plain milk. When compared with plain milk, there was 226 mg of calcium in a box of plain milk (250 ml) [16]. The study investigating the quality of black sesame crispy rice cakes with herbs revealed that an amount of calcium in 100 g of black sesame crispy rice cakes with herbs ranges from 61.74-66.74 mg [17]. In addition, the study aimed to examine the tofu egg custard sauce with black sesame seeds. The study provided a comparison of nutritional values between tofu egg custard sauce with black sesame seeds and pandan custard. The study indicated that the tofu egg custard sauce with black sesame seeds contained 1,672.5 mg of calcium while the pandan custard had 848.3 mg of calcium, which means the tofu egg custard sauce with black sesame seeds contains more calcium [11]. Moreover, using black sesame seeds as food ingredients can increase an amount of calcium in a body, and calcium is useful for strengthening bones and teeth. It is suitable for consumers who need calcium because enough calcium consumption can reduce osteoporosis. In fact, human bone mass decreases with increasing age. Therefore, people

need to receive enough calcium regularly from childhood to adolescence to prevent shortage of calcium which leads to osteoporosis in the elderly [18].

In terms of nutritional comparison, the 6% black sesame seed noodles in the 50% skimmed milk replacement was compared to the traditional Singapore Cendol (100% coconut milk). The results of the nutritional values show that the Singapore Cendol with black sesame seeds and 50% skimmed milk replacement provided less fat, carbohydrates, the total energy per 100 g and the energy from fat per 100 g when compared to the tradition Singapore Cendol (100% coconut milk) without black sesame seeds and skimmed milk. It can be seen that the Singapore Cendol with black sesame seeds and skimmed milk contains lower fat than the traditional one because skimmed milk contains lower fat than coconut milk. 100 g of skimmed milk offers 0.1 g of fat [7], while 100 g of coconut contains 34.7 g of fat [6]. Moreover, using skimmed milk can reduce the amount of fat since the fat in the milk was extracted, resulting in no more than 0.01 fat of the total weight [7]. Besides, coconut milk is rich in fat and calories. Coconut oil has medium chain triglyceride (MCTs) and a large amount of saturated fat, [19] which can increase the cholesterol level and promote high blood pressure, arteriosclerosis, heart disease and obesity [20]. According to previous studies, 30% skimmed milk replacement provides more protein as compared with 100% coconut milk [21]. It could be said that replacing coconut milk with skimmed milk is more useful for consumers who want to shed their weight and who are health lovers who want to have low energy density food.

Regarding consumer acceptance, the chosen recipe of the Singapore Cendol was tasted by the consumers, and the consumers revealed the high acceptance for all aspects. The majority of the consumers reported purchase intent due to black sesame seeds' usefulness and less fat in skimmed milk. It could be said that using black sesame seeds and skimmed milk is an alternative to produce healthy food products to satisfy health concerning consumers' needs.

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