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Research Article

Nutrition data and antioxidant capacity of soy milk ice cream and black sesame flavoured soy milk ice cream

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Abstract: The aim of this study was to determine some nutrition data and the antioxidant capacity of soy milk ice cream and black sesame flavoured soy milk ice cream (5 and 7 % [w/v] ground toasted sesame seed added). Nutrition data of products were analyzed by proximate analysis, atomic absorption spectrophotometer and ascorbic acid method. The antioxidant capacity of products was assessed by ABTS and DPPH free radical decolourisation assay. It was found that 100 grams of soy milk ice cream consisted of 69.99% moisture, 10.31% fat, 2.21% protein, 15.84% carbohydrate, 1.18% fibre and 0.47% ash (including 11.20 mg calcium, 8.26 mg phosphorus, 0.29 mg iron and 0.18 mg zinc). Antioxidant capacity of the samples was equal to 69.8 mg ascorbic acid equivalent/100 g for ABTS assay, and 7.2 mg ascorbic acid equivalent/100 g for DPPH assay. Significantly higher contents of protein, fat, ash (including calcium, phosphorus, iron and zinc), and significantly higher antioxidant capacity (2 – 4.5 times) were found ($p \leq 0.05$) for black sesame flavoured soy milk ice cream.

Keywords: food, confectionary, additives, ABTS, DPPH, Thailand

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Introduction

Ice cream is a smooth and soft frozen mixture of a combination of components of milk, cream, sweeteners, stabilizers, emulsifiers, flavouring and possibly other ingredients such as egg products and coloring [1]. It is a popular frozen dessert for all people throughout the world. In Thailand, ice cream is generally referred to as "*I-tim*". In the past Thais did not have much access to dairy products, and a dessert similar to ice cream, called "*I-tim kati sot*", was produced from coconut milk obtained by squeezing

coconut flesh that had been soaked in water. Even today, with dairy products readily available in Thailand, the ice cream made by vendors and hawkers is often made solely

from coconut milk or from a combination of dairy and coconut milk. The enduring Thai fondness for ice cream made from coconut is probably not just a question of taste preference. The Thais, like most people in Asia, have difficulty digesting lactose, the sugar that occurs naturally in milk. Since lactose is not present in coconut milk, large quantities of coconut-based ice cream can be consumed without the irritating side effects produced by dairy ice cream [2].

However, the saturated fat found in coconut may not be beneficial for human health. Consumption of coconut meal can result in significantly reduced blood flow due to the reduced ability of the arteries to expand and it also reduces the anti-inflammatory effects of high density lipoproteins [3]. Soymilk, a beverage made from soybean, could be used as an alternative choice for making ice cream because it is normally is used as a substitute for dairy milk and soybean is also a source of bioactive molecules. It contains good amounts of protein, polysaccharides and indigestible fibre, unsaturated fat and lecithin, vitamins and minerals, as well as bioactive organic molecules including polyphenols, such as phenolic acids, isoflavones, tannins and saponins. However, all soy-based food, including soymilk, must be sufficiently heated to inactivate protease inhibitors, lectins and other undesirable factors prior to consumption [4].

Sesame (*Sesamum indicum* L., Pedaliaceae) is one of the world's oldest spices. It has a nutty sweet aroma with a rich, milk-like buttery taste. After roasting or toasting, it acquires a delicate almond-like flavour. Black sesame has a stronger, earthier and nuttier taste than the white seed [5]. Sesame also has antioxidant and health promoting activities. It contains three times more calcium than a comparable measure of milk and several nutraceutical and pharmaceutical uses have been discovered from sesame [6]. Soy milk ice cream and black sesame flavoured soy milk ice cream were developed by Wongcharoenkit and Chuchom [7]. This study was conducted to explore the potential of these products as functional food.

Materials and Methods

Samples

Soy milk ice cream was produced from 71.7% soy milk, 15.9% refined cane sugar, 12.0% soybean oil, 0.2% salt and 0.2% sodium carboxyl methyl cellulose. Ground toasted black sesame seed was added to the mixture (5 and 7% w/v) to produce black sesame flavoured soy milk ice cream. The mixture was pasteurized, homogenized and held overnight in a refrigerator before freezing, together with vigorous agitation until it formed a semi-solid consistency. The ice cream was then packaged and placed into a freezer for hardening and storing [7].

Figure 1. Plain soy milk ice cream, 5 and 7% (w/v) ground toasted black sesame seed added samples.

Chemical analysis

Moisture, protein, fat, crude fibre and ash contents of samples were determined in accordance with AOAC methods [8] and carbohydrate content was calculated by subtraction of the sum of moisture, protein, fat, crude fibre and ash contents. Samples containing ash were used for the analysis of some mineral content. Calcium, iron and zinc contents were analyzed by atomic absorption spectrophotometer [9], and phosphorus content was analyzed by ascorbic acid method according to APHA [10]. Antioxidant capacities of samples were determined by improved ABTS radical cation decolourisation assay [11] and DPPH free radical scavenging activity [12]. Ascorbic acid (0-500 μg) was used as a standard for calculating the antioxidant capacity of samples.

Statistical analysis

Chemical analyses were repeated three times. Completely randomized design (CRD) was used for analysis of variance and mean comparisons were performed by Duncan's new multiple range test (DMRT). Correlation of ABTS and DPPH assays was also undertaken.

Results and Discussion

Proximate analysis data and some mineral contents of the three samples are shown in Table 1. Ground toasted black sesame seed added samples contained significantly higher protein, fat and ash content ($p \leq 0.05$) because of the high fat contents (52.24% dry weight [DW] and 54.26% fresh weight [FW]), protein (25.77% DW and 21.00 % FW) and ash (4.68% DW and 4.41% FW) of sesame seed [13, 14]. Mineral content, including calcium, iron, zinc and phosphorus of ground toasted black sesame seed added samples was also significantly higher ($p \leq 0.05$) because sesame seed contains high amounts of calcium (10.3% DW and 359 mg/100 g FW), iron (11.39 mg/100 g DW and 64.2 mg/100 g FW), zinc (8.87 mg/100 g DW, 2.48 mg/100 g FW and 63-71 ppm) and phosphorus (516 mg/100 g DW and 1.06-1.17%) [9, 13, 15].

The chemical composition in Table 1 shows that all samples in this study could still not be claimed as functional food by their nutrient content. In October 1999, the US-FDA approved a health claim that can be used on labels of soy-based food to promote their cardiovascular health benefits. This approval was based on one serving size containing 6.25 grams of soy protein, less than 3 grams of fat, less than 1 gram of saturated fat, less than 20 mg of cholesterol and less than 480 mg of sodium [16]. However, the soy milk ice cream used in this study contains insufficient soy protein (2.21% FW or 2.21 g/100 g) and the fat content is too high (10.31% FW or 10.31 g/100g). For nutrient content claims, products containing 20% or more of the Daily Value (DV) of protein, vitamins, minerals and dietary fibre, could be claimed as; "*High*", "*Rich In*", or "*Excellent Source Of*" and products containing more than 10% DV could be claimed as; "*Good Source Of*", "*Contains*", "*Provides*", "*More*", "*Fortified*", "*Enriched*", "*Added*", "*Extra*", or "*Plus*". Since the DV is based on a caloric intake of 2,000 calories, the minimums for adults and children four or more years of age for calcium, iron, zinc, and phosphorus are 1,000, 18, 15, and 1,000 mg [17]. All samples in this study could not meet the definition for these claims.

Table 1. Proximate analysis data and some mineral contents of soy milk ice cream and black sesame flavoured soy milk ice cream.

Nutrient	**Ice cream**		
	Soy milk	**5% Sesame seed added**	**7% Sesame seed added**
Moisture (%)	69.99 ^{a} ± 0.21	67.00 ^{b} ± 0.34	65.80 ^{c} ± 0.13
Fat (%)	10.31 ^{c} ± 0.67	11.54 ^{b} ± 0.39	12.28 ^{a} ± 0.40
Protein (%)	2.21 ^{c} ± 0.08	3.06 ^{b} ± 0.17	3.51^{a} ± 0.82
Crude fibre^{ns} (%)	1.18 ± 0.09	1.25 ± 0.08	1.31 ± 0.03
Ash (%)	0.47 ^{c} ± 0.01	0.58 ^{b} ± 0.01	0.64 ^{a} ± 0.02
Calcium (mg /100 g)	11.20 ^{c} ± 0.10	38.51 ^{b} ± 0.16	58.39 ^{a} ± 0.24
Iron (mg /100 g)	0.29 ^{c} ± 0.02	0.51 ^{b} ± 0.04	0.64 ^{a} ± 0.03
Zinc (mg /100 g)	0.18 ^{c} ± 0.01	0.29 ^{b} ± 0.01	0.33 ^{a} ± 0.02
Phosphorus (mg /100 g)	8.26 ^{c} ± 0.11	10.21 ^{b} ± 0.30	11.44 ^{a} ± 0.21
Carbohydrate^{ns} (%)	15.84 ± 0.56	16.57 ± 0.71	16.55 ± 0.58

- All values are means of three determinations ± standard deviation.
- Means in raw followed by different letters are significantly different ($p \leq 0.05$).
- "ns" after crude fibre and carbohydrate shows insignificantly different contents ($p > 0.05$) of 3 samples.

Results of ABTS and DPPH assays are shown in Figure 2. The reaction of both free radical inhibition occurred rapidly within the first minute, and it still increased slowly if the reaction time was prolonged, whilst the reaction of ascorbic acid, a standard reagent, occurred completely within 1 minute, therefore the reaction time for antioxidant capacity analysis in this study was chosen at 1 minute, following the applied standard. Additionally, it was found that ABTS results were higher than those of the DPPH assay. These results could be explained by the work of Wang *et al.* [18], which showed that some compounds which have ABTS scavenging activity may not show DPPH scavenging activity and the work of Arts *et al.* [19] which showed that products of ABTS and antioxidant reaction may have a high antioxidant capacity and can react with ABTS free radicals again. However, while the correlation of ABTS and DPPH results in this study were found (r=0.881), it was not a linear correlation (Figure 3).

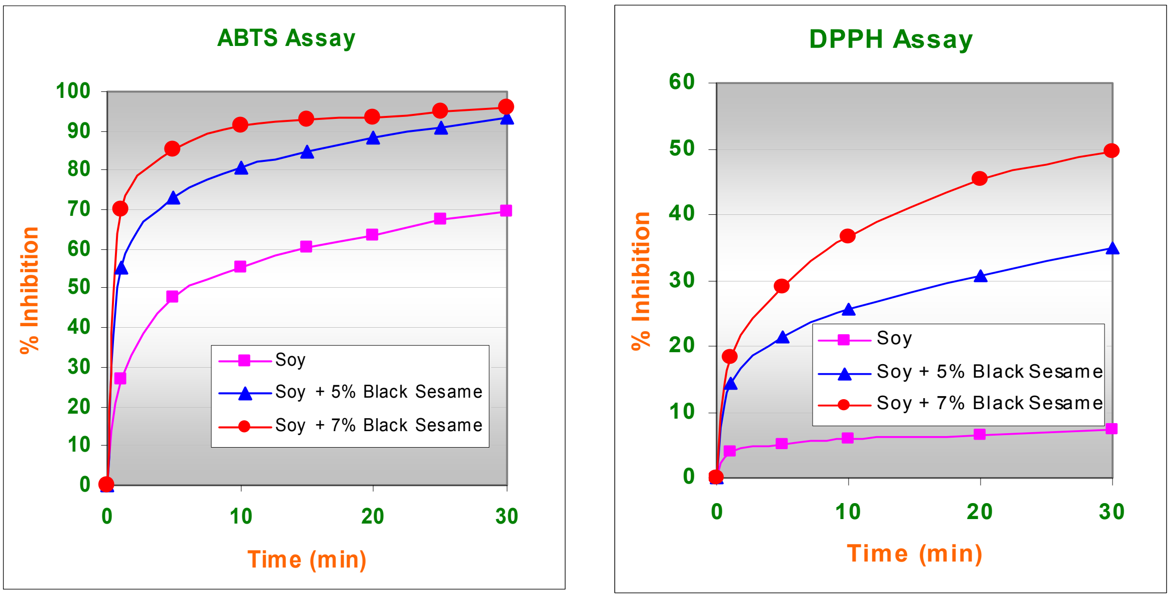

Figure 2. ABTS and DPPH free radical inhibition reaction of soy milk ice cream and black sesame flavoured soy milk ice cream.

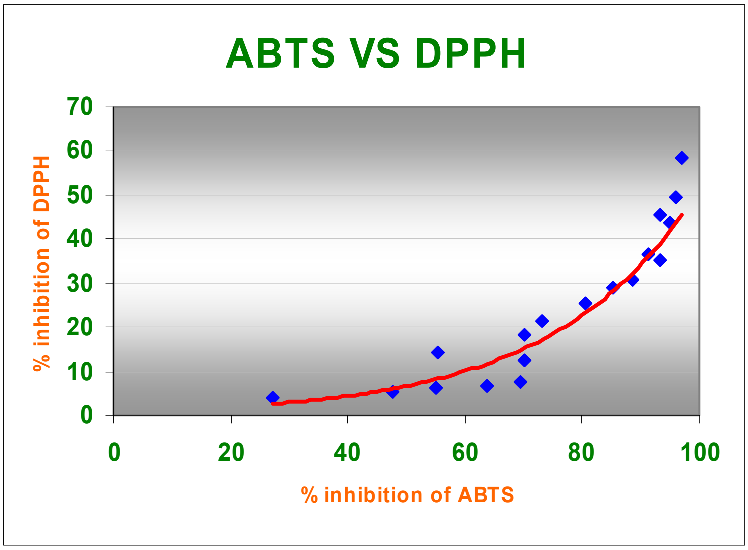

Figure 3. Correlation of ABTS and DPPH results (r=0.881).

Antioxidant capacities of all samples were calculated as mg ascorbic acid equivalent/100 g sample and are shown in Table 2. Ascorbic acid was used as a standard because it is one of the antioxidant vitamins including vitamin C (ascorbic acid), vitamin E (tocopherol) and beta carotene which could be used for antioxidant nutrient content claims because there is scientific evidence that after it is consumed and absorbed from the gastrointestinal tract, the substance participates in physiological, biochemical or cellular processes that inactivate free radicals or prevent free radical-initiated chemical reactions. The level of each nutrient that is the subject of the claim must be sufficient to qualify for nutrient content claims and the names of the nutrients that are the subject of the claim are included as part of the claim, e.g., "*high in antioxidant vitamin C*", the product must contain 20% or more of the DV for vitamin C, US-FDA [20]. Other ingredients still can not be used for antioxidant claims. However, the comparison between antioxidant capacity of products and antioxidant vitamins may be used to express the antioxidant potential of products. In this study the lowest antioxidant capacity value of the samples was 7.2 mg ascorbic acid equivalent/100 g and was higher than 10% DV of vitamin C or ascorbic acid, the DV being based on a caloric intake of 2,000 calories = 60 mg [17].

Table 2. Antioxidant capacity of soy milk ice cream and black sesame flavoured soy milk ice cream.

Method	Antioxidant capacity (mg ascorbic acid equivalent/100 g) of ice cream		
	Soy milk	5% Sesame seed added	7% Sesame seed added
ABTS assay	$69.8^{c} \pm 5.8$	$143.5^{b} \pm 9.0$	$180.9^{a} \pm 7.8$
DPPH assay	$7.2^{c} \pm 0.5$	$25.6^{b} \pm 0.7$	$32.7^{a} \pm 0.8$

- All values are means of three determinations ± standard deviation.
- Means in raw followed by different letters are significantly different ($p \leq 0.05$).

The results in Table 2 showed that the antioxidant potential of soy milk ice cream was due to some components of soybean, e.g. vitamin E and polyphenols [4]. Sesame seed-added ice cream provided higher antioxidant capacity (about 2 – 4.5 times that of plain soy milk ice cream) because sesame seed contains several antioxidant compounds such as vitamin E, sesamol, sesamol dimmer, syringic acid, ferulic acid and lignin compounds, including sesaminol and sesamolinol. Specially, sesaminol, with much higher antioxidant activity than γ-tocopherol (a form of vitamin E), occurs in sesame seed in amounts 4 times that of γ-tocopherol [21].

Conclusion

Soy milk ice cream and black sesame flavoured soy milk ice cream in this study could not meet the definition of health claims for soy protein, nutrient content and antioxidant nutrient content claims. However, the high antioxidant capacities of both products might be used to claim health benefits because these were found to be equivalent to about 10% DV of vitamin C for soy milk ice cream and about 2 times or more for black sesame flavoured soy milk ice cream.

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