The Effect of Cinnamon Extract (*Cinnamomum burmanii* L.) Addition Towards the Characteristics of Soy Milk Ice Cream

Melanie Cornelia*, Aurelia M. Tunardy, Wenny S. L. Sinaga

Food Technology Department, Faculty of Science and Technology, Universitas Pelita Harapan, Tangerang,1581
**Corresponding author. Email: melanie.cornelia@uph.edu*

ABSTRACT
Generally ice cream was made from cow's milk, resulting in high calorie and fat. Soy milk was used as an alternative for cow's milk which had several advantages, but soy milk contains beany flavor that some people did not like. Cinnamon (*Cinnamomum burmannii* L.) extract has a unique aroma and flavor and contains bioactive compounds that has health benefits. The IC50 value on cinnamon extract was 93.45 ppm (classified as a strong antioxidant because it is in the range of 50-100 ppm). The aim of the research was to utilize cinnamon extract as flavoring and source of antioxidants such as phenolic and flavonoid compounds in making non fat soy milk ice cream. This research was conducted using completely randomized two factor design with three replications, which is ratio of soy milk-skim milk (25:75, 50:50 and 75:25) and concentration of cinnamon extract added (0.1%, 0.3% and 0.5%), with control using ratio of soy milk-skim milk 100:0 and cinnamon extract concentration 0%. The result was that variation of milk ratio affected overrun value ice cream, but not for cinnamon extract concentration added. Both milk ratio and cinnamon extract concentration affected total phenolic, total flavonoid, viscosity and melting time of ice cream. Best ice cream formula (the ratio of soy milk-skim milk 75:25 and cinnamon extract 0.5%) was selected based on the best of total phenolic and flavonoid content and also has the highest overall hedonic acceptance. Addition of cinnamon extract was proven to increase the functional properties of soy milk that was seen in the total phenolic and antioxidant activity (IC50) that was increased in ice cream. Selected ice cream was classified as non fat ice cream and had good antioxidant content.

Keywords: *Cinnamon, Flavonoid, Non fat ice cream, Phenolic, Soy milk.*

1. INTRODUCTION

Functional food is a food that contains bioactive components that could provide health benefits. Bioactive components are found in plants, including the bark and seeds. One example of functional food is food with the addition of antioxidants [1, 2].

Ice cream is a food product that is commonly consumed. Ice cream was popular because it is refreshing with a sweet taste and soft texture. Globally, the ice cream industry has increased 3% annually [3]. However, ice cream generally contains high calories and fat. Ice cream with a low fat content or non fat types was still rare to find. The use of ingredients such as soybean and cinnamon could result in a lower fat content and contains phenolic and flavonoid compounds that play a role in health benefits.

Soybean is mostly processed into tempeh, tofu and milk. Production of soybean in Indonesia has increased 18.12% [4]. Consumption of soybean also increased annually as it's use as a substitute of dairy products is gaining popularity. Apart from being a protein source, soybean contains isoflavone which are a class of flavonoid that could prevent breast cancer, colon cancer and other [5]. Some of the advantages of soy milk over cow's milk includes lower calorie, lower fat content and cholesterol free [6].

Cinnamon was one of the most commonly used spices. Consumption of cinnamon in Indonesia has grown around 81.08% annually due to various cinnamon products that could be processed for health benefits [7]. Cinnamon has a distinctive aroma and taste that makes it commonly used as a flavoring. Besides that, cinnamon also contains bioactive compounds such as phenolic and flavonoid compounds. The main component in cinnamon extract is cinnamaldehyde and eugenol. Polyphenol content that plays a role in antioxidant activity was found to be higher in cinnamon compared to other spices, such as ginger, turmeric, nutmeg and cardamom [8]. Therefore, efforts that can be made to increase phenolic and flavonoid content in ice cream was by using soy milk and cinnamon extract in making functional ice cream

2. MATERIALS AND METHOD

2.1. Materials and Equipment

The main materials used was soybean from a farm at Solo (Central Java) and cinnamon (*Cinnamomum burmannii* L.) that was purchased at Balai Penelitian Tanaman Rempah dan Obat (Balitro). Other materials $NaHCO_3$, sugar, carboxymethyl cellulose "Koepoe Koepoe", mono-digliserida, skim milk powder "NZMP" and skim milk "Greenfields". Materials used for analysis includes DPPH 0. 1 mM, ethanol food grade 96%, ethanol pro analysis, gallic acid, Folin-Ciocalteu, Na_2CO_3 solvent, quercetin 50 ppm, $AlCl_3$, hexane pro analysis, H_2SO_4, K_2SO_4, selenium, H_2O_2 35%, NaOH 35%, boric acid 4%, HCl 0.2 N and HCl 20%.

The equipment that were used in making ice cream include ice cream maker, thermometer, blender, table and analytical scales, refrigerator, freezer, viscometer Brookfield, oven, spice grinder and 60 mesh sieve. For analysis were spectrophotometer UV-Vis, volumetric pipette, vortex, evaporating dish, ash crucible, muffle furnace, desiccator, Soxhlet, Kjeldahl distillation (Buchi Distillation Unit K 355), reflux, pH meter (Ohaus), chromameter (Minolta CR-410) and rotary evaporator (Buchi Rotavapor R-210).

2.2. Soy Milk and Cinnamon Extraction

Soybean was sorted and soaked in water (1:2 w/v) for 12 hours at room temperature. In the last hour, soybean was soaked in water (1:2 w/v) with $NaHCO_3$ 0.5%. And boiled in water (1:2 w/v) with $NaHCO_3$ 0.5% at 80℃ for 30 minutes, drained, dehulled and blended with water (1:3 w/v initial weight) then filtered with cloth. Resulting pulp was blended again (1:2 w/v initial weight) and filtered. Resulting filter was combined and pasteurized at 70℃ for 20 minutes, then was kept at 4℃.

Cinnamon was reduced in size and dried in an oven at 40℃ for 24 hours. Milling was done by using a spice grinder until a fine powder then sieved 60 mesh. Extraction was done by maceration and carried out using a shaker with food grade ethanol 96% as a solvent (1:10 w/v) for 24 hours at room temperature. Filtration was carried out and filtrate was concentrated using rotary evaporator with water of 50℃

2.3. Ice Cream Preparation

Ice cream was made and will find out the effect of different ratio of soy-skim milk and cinnamon extract addition towards phenolic and flavonoid content and physical characteristics of ice cream. The soy milk and skim milk ratio used was 25:75, 50:50 and 75:25, while cinnamon extract used was 0.1%, 0.3% and 0.5% (Table 1).

Table 1. Ice cream formulation

Composition	Total (%)
Fixed composition (A):	16.6
Sugar	12
Skim powder	4
CMC	0.4
MDG	0.2
Cinnamon extract (B)	0.1; 0.3; 0.5
Soy milk : skim milk (75:25, 50:50, 25:75)	100 – (A+B)

Ice cream making begins with weighing each ingredient based on formulation. Liquid ingredients were mixed and heated until 70℃. Dry ingredients were dry mixed then added slowly to liquid mix. The mixture was heated at 75℃ for 15 minutes. Cinnamon extract was added and the mixture was cooled at 4℃ for 4 hours (aging) and put into an ice cream maker for 20 minutes and stored at -20℃ for 24 hours (hardening).

2.4. Experimental Design and Data Analysis

Research was carried out using a completely randomized design with 2 factors and 3 repetitions. The factors were the ratio of soy milk and skim milk. A1: 25:75, A2: 50:50 and A3: 75:25 and concentration of cinnamon extract; B1: 0.1%, B2: 0.3% and B3: 0.5%. Control was soy-skim milk ratio of 100:0 and cinnamon extract concentration of 0%. Results were analyzed statistically using ANOVA Univariate SPSS version 23.

The analysis done at preliminary research was moisture content, pH, color, protein, fat, total solid, total

phenolic [10] with modification, total flavonoid [11] with modification and antioxidant activity [12].

The main research analyses were total phenolic, total flavonoid, overrun [13], viscosity [14] with modification, melting time [15], scoring test [15] and hedonic test [16]. Selected ice cream was further analyzed for color, antioxidant activity and proximity [17].

3. RESULTS AND DISCUSSION

3.1. Physicochemical Characteristics of the Cinnamon Extract

Moisture content of cinnamon was 8.623% (SNI 01-3714-1995 was 12%). °Hue was 57.276° and classified as an orange color. The color was due to the carotenoid pigment that gives orange color [18]. Cinnamon extract contains bioactive components as an antioxidant activity. IC_{50} of cinnamon extract was 93.447 ppm and was classified as a strong antioxidant [19]. This was caused by cinnamaldehyde, eugenol and linalool components that builds 82.5% of the total bioactive component in cinnamon. Total phenolic of cinnamon extract was 53.649 mg GAE/mg and total flavonoid was 0,935 mg QE/mg. Some of the phenolic components of cinnamon extract include eugenol, kaempferol, gallic acid, vanillic acid and others. Flavonoid components include quercetin, catechin, epicatechin, procyanidin, hesperidin, rutin and others [20, 21].

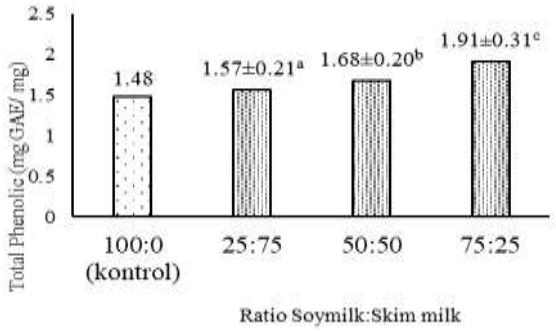
3.2. Physicochemical Characteristics of the Soy Milk

The °Hue value of soy milk was 93.865° and was classified as yellow. That is due to the content of isoflavone which acts as a yellow pigment [22]. The pH value of soy milk was 6.96 and (SNI 01-3830-1995 which was 6.5-7.0). Total soy milk was 11.865% and had fulfilled SNI 01-3830-1995 requirements of soy milk which was a minimum of 11.5%. Total solid was affected by usage of water when making milk. Protein content in soy milk was 3.388% (SNI 01-3830-1995 was minimum of 2%). Amino acid components that build soy milk's protein are alanine, arginine, proline, glutamic acid and others. The analysis result of fat content soy milk was 1.188% and had fulfilled SNI 01-3830-1995 requirements which was a minimum of 1%. The fat content in soy milk was high in unsaturated fatty acid and low in saturated fatty acid [23].

From the analysis, the IC_{50} of soy milk was 93776.667 ppm that was classified as a very weak antioxidant. Total phenolic of soy milk was 1.127 mg GAE/ml and total flavonoid was 0.304 mg QE/ml. Soy milk contains phenolic compounds such as phenolic acid. Isoflavone was the main component of phenolic in soybean products [24, 25]. Isoflavone belongs to the flavonoid group and contains 10 mg in each 100 ml of soy milk [26].

3.3. Phenolic and Flavonoid Content of Soy Milk Ice Cream with Addition of Cinnamon Extract

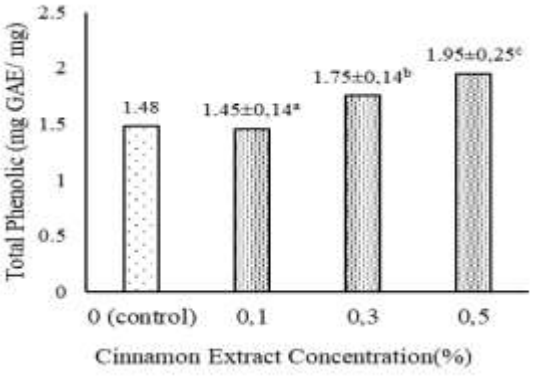
Based on statistical analysis, total phenolic of ice cream did not show an interaction ($p > 0.05$) between soy milk and skim milk ratio with cinnamon extract concentration added. Based on statistical results, soy milk and skim milk ratio gave a significant difference towards total phenolic of ice cream. Figure 1 showed that higher soymilk ratio results in higher total phenolic content. Total phenolic of ice cream control was 1.48 mg GAE/mg. The usage of higher soymilk ratio caused an increase in the total phenolic due to the phenolic content of soy milk such as gallic acid, ferulic acid, and syringic acid [24, 27].



Note: the different notation indicate a significant different 0.05.

Figure 1. Effect of ratio variation of soy-skim milk towards total phenolic content of ice cream

Based on statistical results, variation of cinnamon extract concentration added gave a significant difference towards total phenolic content of ice cream. Figure 2 showed that the higher use of cinnamon extract, the total phenolic of ice cream increased. Phenolic content of cinnamon such as catechin, kaempferol, cinnamic acid, and vanillic acid. [20, 28].



Note: the different notation indicate a significant different 0.05.

Figure 2. Effect of cinnamon extract concentration variation added towards total phenolic of ice cream

Total flavonoid in ice cream control was 0.036 mg QE/mg which was pretty high compared to other ice cream treatments. This happened because ice cream control used fully soy milk, the isoflavone content in soy milk contributes to total flavonoid, hence resulting in a high flavonoid content. Figure 3 showed that the higher use of cinnamon extract concentration and soy milk ratio could increase the total flavonoid of ice cream. Flavonoid compounds in cinnamon were quercetin, isorhamnetin, procyanidin, and hibifolin which plays a role in anti-inflammation and anti-diabetes [20].

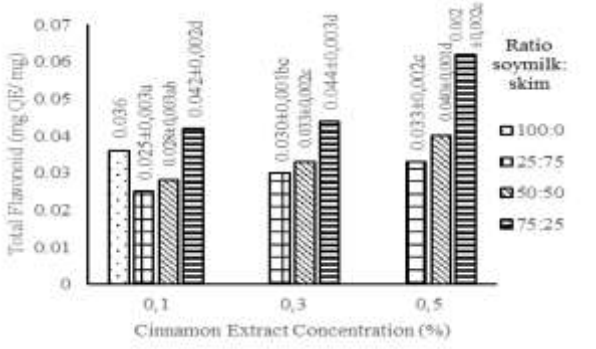


Figure 3. Effect of cinnamon extract concentration variation added towards total flavonoid of ice cream

3.4. Profile and Acceptance of Soy Milk Ice Cream with Addition of Cinnamon Extract

3.4.1. Overrun

Based on statistical results, an overrun test of ice cream did not show an interaction ($p > 0,05$) between ratio of soy-skim milk and cinnamon extract concentration. Variation of milk ratio gives a significant difference (Figure 4). The higher use of soy milk ratio will result in a lower overrun value. This overrun value was related to total solid, the higher use of soy milk ratio will increase the total solid. According to [29], the higher total solid content will result in a low overrun value. This due to a high total solid will increased viscosity and caused limited mobility of water molecules, then caused the limited space between particles. Therefore, it is more difficult for air to enter, resulting in a low overrun [30].

Lowest overrun value was given by ice cream control, which was 41.18%. Based on statistical analysis, variation of cinnamon extract concentration did not give a significant difference. This could happen because the amount of addition was too small, which was under 1% and did not affect the total solid content. This finding was also supported by [15] that said the minimum of cinnamon extract addition that gave a significant difference was 1%.

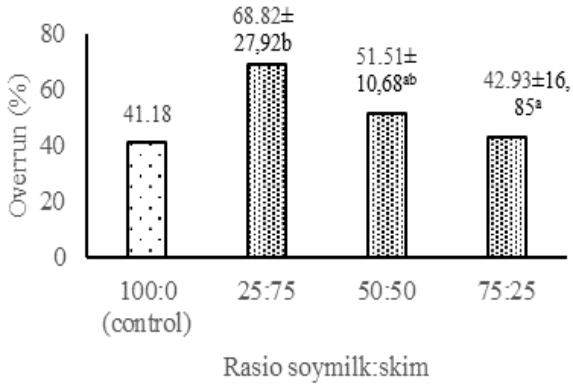


Figure 4. Effect of ratio of milk dan cinnamon extract concentration added towards overrun of ice cream

3.4.2. Viscosity

Based statistical analysis on viscosity test, results show that there is interaction ($p < 0,05$) between soy-skim milk ratio and cinnamon extract concentration. The higher use of cinnamon extract and soy milk ratio will increase ice cream's viscosity (Figure 5). The higher use of soy milk ratio will increase total solid content because soy milk contains a higher total solid than skim milk [31].

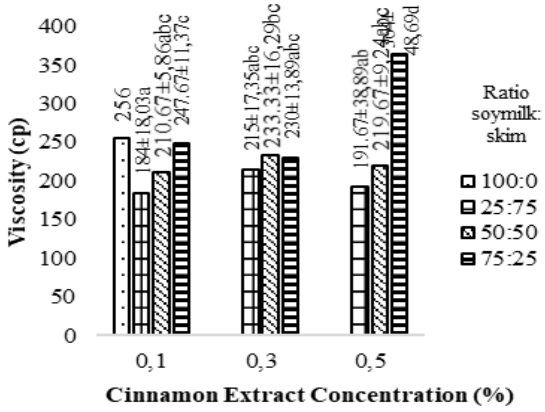


Figure 5. Effect of ratio of milk and cinnamon extract concentration added towards viscosity of ice cream

Viscosity value of ice cream control was 256 cp and was considered high if compared to other ice cream treatments. According to [9], viscosity of similar ice cream was 399.27 cp. This is due to the use of fully soy milk in ice cream control, resulting in an increase in total solid content and causing a high viscosity. Cinnamon extract which is viscous also increases viscosity and polysaccharide compounds that contain in

cinnamon also has an ability to form a gel, hence resulting in an increase in viscosity [32-33].

3.4.3. Melting Time

Based on statistical analysis, the melting time test of ice cream shows an interaction ($p < 0.05$) between ratio of soy-skim milk and cinnamon extract concentration. Melting time was related to overrun and viscosity value. Ice cream with a high overrun value will result in a faster melt ice cream. This is due to a rise in air phase and it will form a lot of air space which will release simultaneously with ice crystal during melting [34]. A high viscosity value will result in a longer melting time of ice cream. This happens because high viscosity shows that the water molecule was tightly bound and will make the ice cream much denser, hence a longer melting time [30].

Melting time of ice cream control was 93 minutes and 47 seconds, which was classified high compared to other ice cream treatments. This finding corresponds to the low overrun value and high viscosity value. The higher use of cinnamon extract concentration and soy milk ratio will result in a higher or longer melting time (Figure 6). This happens because both contribute to adding up total solid content and resulting in a high viscosity and longer melting time. Highest melting time was the treatment with the use of soy-skim milk ratio of 75:25 and cinnamon extract concentration of 0.5%. This result corresponds to the low overrun value (Figure 5) and the high viscosity value (Figure 6).

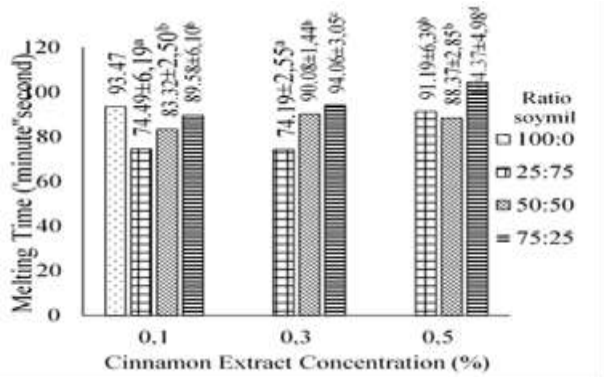


Figure 6. Effect of ratio of milk and cinnamon extract concentration added towards melting time of ice cream

3.4.4. Overall Acceptance

Based on statistical analysis on overall acceptance of hedonic test, results did not show an interaction ($p > 0.05$) between variation of soy-skim milk ratio and cinnamon extract concentration. Soy-skim milk ratio did not give a significant difference, the same goes for cinnamon extract concentration variation. Highest value which was 5.53 (range 1-6) was produced by the treatment using soy-skim milk ratio of 25:75 and cinnamon extract concentration of 0.5%. Therefore, it could be said that the panellists like the addition of cinnamon extract in ice cream.

3.5. Physicochemical Characteristics of the Selected Ice Cream

Selected ice cream formula was the use of soy: skim milk ratio of 75:25 and cinnamon extract added was concentration of 0.5%. Selected ice cream were further analyzed for color, antioxidant activity (IC_{50}), total solid, ash, protein, fat, and carbohydrate.

The °Hue of selected ice cream was 80.77° and classified as yellow. This color group was the same as soymilk's color but with a lower value. The antioxidant activity for selected ice cream was IC_{50} 55866 ppm and was classified as a very weak antioxidant activity [19]. Addition of cinnamon extract 0.5% had not produced a good antioxidant activity. But, IC_{50} of ice cream was still lower than IC_{50} of soy milk 93776 ppm. This concludes that the addition of cinnamon extract could increase the antioxidant activity of soy milk in ice cream making.

In the proximate content analysis, the fat content of the selected ice cream was very low, which was 0.890 %. If classified based on fat content, this ice cream was classified into non fat ice cream because a low fat type require a minimum of 2% fat content [35]. This analysis was also supported by [36] that said non fat ice cream contains fat under 1.5%. Total solid of selected ice cream was 33.267 % and had fulfilled the quality requirement of ice cream according to [37]. A high total solid content will increase viscosity and result in a smooth texture of ice cream [35]. Ash content of selected ice cream was 0.713%. This analysis data correspond to [38] which founding ash data was ranged between 0.6 - 1.7%. Protein of selected ice cream was 4.130% and had fulfilled the requirement of ice cream according to [37]. Protein content plays a role in the structure of ice cream by stabilizing the air bubble [39] (Patel et al., 2006). Fat content of the selected ice cream was 0.890%. This value has not fulfilled quality requirements of ice cream according to [37], which was minimum 5%. The result obtained was much lower because of the use of skim milk that contains a lower fat content compared to soy milk. Carbohydrate in selected ice cream was 27.534% come from the use of milk and sugar. A high carbohydrate content could make the ice cream texture become smoother [40].

4. CONCLUSION

Preliminary research in making soy milk was needed to enhance the antioxidant activity in soy milk, such as various ratios of water and soybeans treatment during blending or different temperature treatment during the heating process. Cinnamon extraction resulting in a small yield and its use in a small amount had given a

very strong taste. Total phenolic, flavonoid and physical characteristic of ice cream was affected by variation of ratio soy-skim milk and cinnamon extract addition. The higher usage of soymilk ratio and cinnamon extract addition will increase total phenolic and flavonoid content, lower overrun, higher viscosity and higher melting time. Best ice cream formulation was selected based on phenolic and flavonoid content and the overall acceptance of ice cream was the ratio of soy-skim milk of 75:25 and cinnamon extract concentration of 0.5%. Addition of cinnamon extract was proven to increase the functional properties of soy milk that was seen from the total phenolic and antioxidant activity (IC_{50}) that was increased in ice cream. Selected ice cream was classified as non fat ice cream and had an antioxidant activity (IC_{50}) of 55866ppm, total solid of 33.27%, ash of 0.71%, protein of 4.13%, fat of 0.89% and carbohydrate of 27.53%. The soy ice cream with the addition of cinnamon could be developed further in order to be used as a functional food.

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