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The Addition of Broccoli (*Brassica oleracea* var italica) to Increase the Functional Properties of Ice Cream

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Abstract: Broccoli is sufficiently potential to be developed as an additive in the food manufactures. In addition to provide the color to foods, it also contains antioxidant compounds that can improve the functional properties of ice cream. The purpose of this study is to determine the addition of the best broccoli that can produce ice cream with the best quality, having the functional properties and organoleptic preferred. In this study, the addition of broccoli is at the rate of 5, 10, 15, 20, 25 and 30%. The results showed that the addition of broccoli on the quality of the ice cream had no effect on levels of fat, the amount of protein and sugar, but the effect was on the overrun, the total solids, the melting time, the antioxidant activity and the levels of fiber and vitamin C. The ice cream with the addition of 20% broccoli is the best product because it has 80% of color value, 75% of aroma, 75% of taste, 75% of texture, 30.16% of overrun, 56.99% of total solids, 10 min 51 sec of melting time, 9.79% of protein, 15.20% of sugar, 8.83% of fat, 37.25% of antioxidant activity, 17.11 mg/100 g of vitamin C, 1.13% of fiber content, 4.13 mg/L of chlorophyll and 1.05 mg/100 g of beta carotene.

Key words: Broccoli, ice cream, functional properties

INTRODUCTION

Ice cream is a cold meal that is rich with nutrients and has a delicious flavor. Ice cream is made from milk fat, nonfat-milk solids and added with sugar, flavors, colorants and stabilizers (Arbuckle, 1966). According to Mann and Anggarwal (2013) it is considered as a food of high nutritional and caloric density, but poor in dietary fibers and some of the natural antioxidants. This deficiency can be overcome with the addition of vegetables. Consuming vegetables provides vitamins donations especially vitamin A and C, fiber and phytochemical compounds that are essential for the body (Winarti, 2010). Vegetables do not only provide nutrients which are needed by the body, but it also contains non-nutritional components (phytochemicals) that are very useful for health (Lingga, 2010). Phytochemical compounds are chemical substances found in plants that can provide flavor, aroma or color in plants. The combination of phytochemical substances produce enzymes that have specific functions for health, such as an antidote to poison, stimulates the immune system, preventing pieces of blood clots, inhibit cholesterol synthesis in the liver, improve hormone metabolism, increase the dilution and binding of carcinogens in intestine, effect of anti-bacterial, anti-viral and antioxidants, regulate blood sugar and can lead to anti-cancer effects (Winarti, 2010). One of the vegetables that are rich in nutrients and phytochemicals compounds is broccoli.

Broccoli is one of the types of vegetables that can be used as an ingredient in making ice cream. It contains vitamin C which is quite high. The levels of vitamin C in broccoli is 93.2 mg/100 g. This vegetable also contains phytochemical compounds that can improve the functional properties of ice cream which are very useful for body. The functional properties are the properties in addition to the nutritional value that also affect the characteristics of a product. Phytochemical compounds which are contained in broccoli are glucolaparin, Sulforaphan, glucobrassicin, 13C (indole-3-carbinol), glucoerucin, glucoiberin-D-Glutaric acid, caffeic acid, quercetin, alpha-lipoic acid and lignin. In addition, broccoli also contains carotenoids such as beta carotene that can prevent cancer (Lingga, 2010). Broccoli also contains fiber. According to Astawan (2009), broccoli contains 4.67 g/100 g of fibers.

The lack of vegetable consumption is a diet problem that is frequently encountered in the community. The addition of broccoli in ice cream making process is expected to improve the functional properties of ice cream. The rich-fat content in ice cream is expected to maintain the availability of vitamins such as vitamin A, D, E and K and beta carotene. The processing of the ice cream which is not through high heating stage can also minimize the damage to nutrients and phytochemical compounds of broccoli. Thus broccoli ice cream can be used as an alternative of functional foods.

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Based on the description above, the research aimed to determine the best level of the addition rate of broccoli to produce the best quality ice cream which has functional properties and is preferred by the panelists.

MATERIALS AND METHODS

Materials: The materials that are used in this study were broccoli flowers, full cream milk, sugar, eggs, beef gelatin and water. The tools that are used in this study were scales, steamer pot, stove, blender, mixer, pan, spoon stirrer and a refrigerator (freezer).

Making process of broccoli ice cream: The basic process in the manufacture of ice cream includes several stages, that are formulation, mixing ingredients, pasteurization, homogenization, ripening (aging), freezing and agitation, packaging, hardening and storage. The making process of the ice cream in this study is done as follows: smooth Broccoli (5, 10, 15, 20, 25 and 30%), full-cream milk, put it in warm water with a temperature of 40°C while stirring, then add the egg yolks, sugar and beef gelatin until it reaches the temperature of 80°C for 25 sec. The dough was raised, refrigerated for 2 min and then homogenized by using a mixer for 15 min. The dough was stored in the refrigerator at a temperature of 4°C for 4 h to the aging process, then either re-homogenized for 15 min. The dough was stored in the freezer for 4 hours at a temperature of -10°C and agitated by using a mixer for 15 min (repeated 3 times). It was packed in containers and then was stored back into the freezer at a temperature of -18°C.

Observation: The observations were conducted on the raw materials such as Vitamin C test, Crude Fiber Content, Beta Carotene and Chlorophyll. The observations which were carried out on ice cream were Overrun, total solids, melting time, protein content, fat content, Sugar, Antioxidant Activity, Vitamin C, Crude Fiber Levels and Organoleptic test. Beta Carotene and Chlorophyll Analysis on the best products.

Sensory analysis (Setyaningsih, Apriyantono, dan Sari, 2010): Organoleptic test was conducted by 20 panelists on color, flavor, aroma and texture with a hedonic scale of one to five criteria: dislike (1), less like (2), average (3), like (4), very like (5). The data that was obtained was processed by the formula:

$$\frac{\text{No. panelists who had selected the criteria of like and very like}}{\text{Total no. panelists}} \times 100\%$$

Determination of physical and chemical quality characteristics: Overrun was calculated in a percentage based on the difference in ice cream's volume and ICM (Ice Cream Mix) or a mixture of ice cream (Arbuckle, 1966). The Total Solids based on SNI 01-3713-1995 (BSN, 1995) was done by drying the sample in an oven at 105°C. Calculate the percentage of solids by weight division with the rest of the dry weight of the sample. Melting time (Wijanto, 1995) is done by letting the sample melts at room temperature and counted in seconds. Protein content with Semi Micro Kjeldahl method based on SNI 01-2891-1992 (BSN, 1992) is done by destruction, distillation and titration samples, total nitrogen Obtained is multiplied by a conversion factor to obtain the percentage of total protein sample. Levels of Fat Hydrolysis Method (Weibull) based on SNI 01-2891-1992 (BSN, 1992) is done by means of the samples that is extracted with hexane and then the extract of the fat which has obtained is dried at a temperature of 100-105 C, then calculate the percentage of fat by finding the excess between the weight of fat pumpkin after extraction and before extraction toward the weight of materials. Determination of Sucrose Sugar Luff Schoorl method based on SNI 01-2891-1992 (BSN, 1992) is done by determining the levels of the sugar before inversion and the sugar after inversion and then multiplied by 0.95. Determination of vitamin C content (Sudarmadji Haryono and Suhardi, 1997) can be done by adding 1 mL drops of starch indicator to the sample, then titrating with 0:01 N of iodine until the blue color arises, vitamin C can be calculated as 1 mL of 0:01 N iodine = 0.88 mg of ascorbic acid.

Determination of functional properties: Fiber content, antioxidant activity test, the levels of beta carotene and chlorophyll content. Crude fiber content (Sudarmadji *et al*., 1997) is done by adding H_2SO_4 to the sample and then it is filtered, the residue was added NaOH, then it is simmered with turning cooler, filter, dry filter paper and weigh, the crude fiber is calculated as residue weight.

Determination of Antioxidant Activity (DPPH) (Kubo, Masuoka, Xiao and Haraguchi, 2002): One milliliter of 100 mM acetate buffer (pH 5.5), 1.87 mL of methanol and 0.1 mL of 3 mM DPPH in methanol included in the test tube. DPPH solution was made fresh each will be used. Subsequently, 0.03 mL of the sample solution is added to the tube and incubated 25°C for 20 min. The resulting absorbance read at 517 nm. As a reference solution used in lieu of 0.03 mL distilled water sample solution. The more the DPPH solution neutralized indicated by increasingly fading color of the reaction mixture or even the magnitude of the absorbance of the blank solution. The antioxidant activity (%) = (1-Absobansi sample/absorbance of blank) x 100%.

Determination of β-carotene content by spectrophotometer method (AOAC, 1999): Two grams of sample is introduced into the erlenmeyer flask, then coupled with 5 g of KOH and 10% ethanol to 50 mL,

then refluxed at a temperature of 70-80°C for 30 min in a water bath after a cold, samples were filtered with a filter paper, the precipitate washed with hot 95% ethanol 20, then filtered again washed with 30 mL Erlenmeyer ether, the filtrate together. The filtrate was extracted with 50 mL of distilled water and added 10 mL of saturated solution of NaCl using a separating funnel. Ethanol and distilled water layer was removed and extracted again with 25 mL of ether. Ether solution containing beta carotene mixed with previously filtered ether solution, the mixture was washed with 50 mL of distilled water, 20 mL of ether and 10 mL of saturated NaCl. Furthermore, all layers of distilled water was transferred into a 25 mL flask peck through filtering the powder anhydrous Na_2SO_4 and then fulfilled the ether solution. The absorbance of samples was measured at a wavelength of 450 nm. Levels of β-carotene in the sample was calculated based on a standard curve of beta carotene.

Determination of chlorophyll content (Gross, 1991): A number of extracts (1.5 mL) is mixed with 8.5 mL of 99.5% acetone and then left to stand for 1 night in the refrigerator. Subsequently the mixture is centrifuged at 3000 rpm for 10 min. The absorbance of the supernatant iss measured at 645 nm and 663 nm.

$$\text{Total chlorophyll (mg/L)} = 20.2\ A_{645\ nm} + 8.02\ A_{663\ nm}$$

Statistical analysis: The design used in this study is completely randomized design with six treatments and three replications. If the result shows a difference due to the treatment, then Followed by test Dunncan's New Multiple Range Test (DNMRT) at the 5% significance level.

RESULTS AND DISCUSSION

Physical and chemical properties of ice cream

Overrun: Overrun shows more or less air trapped in the ice cream mixture because of agitation process. The results of variance showed overrun ice cream with the addition of broccoli treatment significantly different at level α = 5% ($p<0.05$). The average overrun of ice cream can be seen in Table 1.

From Table 1, it can be seen that the value of the overrun in ice cream ranged between 22.83-41.00%. The highest value was 41.00% which had been found in the addition of 5% broccoli. The lowest value was 22.83% which had been found in the addition of 30% broccoli. The more broccoli is added, the less overrun value is gotten. This is due to the more addition of broccoli, the water in the ice cream is on the wane. The water will undergo expansion on freezing process. Thus, the less water that is contained in the ice cream, the overrun will decrease. The addition of broccoli can also increase the thickness (viscosity) of Ice Cream Mix (ICM), as the result it more limit the mobility of water molecules because the space between the particles in the ICM becomes increasingly narrow. The narrowness of the space between the particles causes the incoming air into the ICM during the agitation is getting a bit, so the overrun value is getting lower. The overrun which is too low can cause the frozen ice cream become a product that is too harsh, while the too high overrun can cause the ice cream become a product that is too soft and quickly melted.

According to Arbuckle (1966) the good overrun value in ice cream is 90-100% for the manufacture of ice cream on a large industrial scale because it is supported by an air injection on the dough during the freezing process (freezing). While this study was done on a household scale, so that the value of overrun is very low. This low overrun value is understandable, because at the manufacture of household scale, the air injection during the freezing process was not done. As described by Hubeis (1996) that the overrun value in ice cream is influenced by some factors; the making process and the composition of the ice cream such as the fat content, the amount of stabilizer and total solid of material used. Arbuckle (1966) states, although the overrun is not included in the assessment element of the ice cream's quality, it is noticed by large industrial-scale producers, as it relates to profitability.

Total solid: The results of variance showed a total solid of ice cream with the addition of broccoli treatment is significantly different at level α = 5% ($p<0.05$). The average of total solid in the ice cream can be seen in Table 1.

From Table 1, it can be seen that the value of the total solid in ice cream ranged between 54.32-58.24%. The highest value was found in the addition of 30% broccoli i.e., 58.24%. The lowest value was found in the addition of 5% broccoli i.e., 54.32%. Total solid which was produced in each treatment was significantly different. The higher the addition of broccoli is, the higher the total solid of ice cream has been produced due to the solid ingredients in broccoli. Total solid which has been obtained has fulfilled the minimum standard of SNI 01-3713-1995 i.e., 3.4% w/w (BSN, 1995). Total solid is very useful in improving the nutritional value, viscosity and repairing the texture of ice cream (Arbuckle, 1966).

Melting Time: Melting time is the time required to melt the ice cream perfectly at room temperature. The results of variance showed the melting time of ice cream at room temperature with the addition of broccoli treatment is significantly different at level α = 5% ($p<0.05$). The average of the melting time of the ice cream can be seen in Table 1.

From Table 1, it can be seen that the melting time of ice cream ranged from 4:28 to 15:26 min. The highest value was found in the addition of 30% broccoli which was 15:26 min. The lowest value was found in the addition of

Table 1: Physical and chemical properties of ice cream of broccoli

	Parameters						
Treatment	overrun (%)	Total solid (%)	Melting time (minute)	Protein content (%)	Sugar (Sucrose) content (%)	Fat content (%)	Vitamin C content (mg/100 gr)
5% of broccoli	41.00±0.77^{f}	54.32±0.13^{a}	4.28±0.59^{a}	9.68±0.08^{a}	15.17±0.89^{a}	8.74±0.12^{a}	4.08±0.01^{a}
10% of broccoli	37.50±0.58^{e}	55.37±0.05^{b}	5.25±0.10^{b}	9.70±0.11^{a}	15.08±0.48^{a}	8.85±0.04^{a}	7.27±0.02^{b}
15% of broccoli	34.83±0.44^{d}	56.21±0.21^{c}	6.41±0.78^{c}	9.76±0.06^{a}	14.84±0.20^{a}	8.83±0.01^{a}	12.02±0.06^{c}
20% of broccoli	30.16±0.60^{c}	56.99±0.25^{d}	10.51±0.58^{d}	9.79±0.06^{a}	15.20±0.30^{a}	8.83±0.04^{a}	17.11±0.01^{d}
25% of broccoli	26.66±0.88^{b}	57.60±0.16^{e}	4.57±0.14^{e}	9.81±0.09^{a}	15.39±0.24^{a}	8.75±0.05^{a}	21.82±0.03^{e}
30% of broccoli	22.83±0.73^{a}	58.24±0.21^{f}	5.26±0.18^{f}	9.83±0.36^{a}	15.34±0.82^{a}	8.71±0.08^{a}	26.46±0.02^{f}
p	0	0	0	0.66	0.98	0.61	0

Table 2: Average of antioxidant activity and crude fiber content of broccoli ice cream

Treatment	Antioxydant activity (%)	Crude fiber content (%)	Beta carotene content (mg/100 g)	Chlorophyll content (mg/L)
5% of broccoli	29.73±0.36^{a}	0.26±0.01^{a}	-	-
10% of broccoli	31.61±0.28^{b}	0.52±0.02^{b}	-	-
15% of broccoli	34.55±0.28^{c}	0.83±0.06c	-	-
20% of broccoli	37.25±0.28^{d}	1.13±0.01d	1.05*	5.91*
25% of broccoli	39.78±0.43^{e}	1.46±0.03^{e}	-	-
30% of broccoli	42.15±0.28^{f}	1.72±0.02f	-	-
p	0.00	0.00	-	-

Number was followed by the same alphabet, is not significantly different at α = 5% by using DNMRT

*= To the best of broccoli ice cream products were evaluated from the physical and chemical properties, antioxidant activity, fiber content and sensory analysis

Table 3: Percentage of panelists' preference on color, aroma, taste and texture of broccoli ice cream

	Level of panelists' acceptance (Like + Very Like)			
Treatment	Color (%)	Aroma (%)	Taste (%)	Texture (%)
5% of broccoli	55	60	65	60
10% of broccoli	60	65	70	65
15% of broccoli	75	75	70	70
20% of broccoli	80	75	75	75
25% of broccoli	70	60	60	55
30% of broccoli	65	60	50	50

5% broccoli which was 4:28 min. The higher the addition of broccoli is, the longer the melting time of ice cream is required. This is because the total solid of the ice cream became higher, so the ice cream was more viscous. A good ice cream is the ice cream that is resistant to melting when it is served at the room temperature. The ice cream which melts faster is less favored because it will soon melt at the room temperature, but it is also needed to be noticed that the ice cream that slowly melts or the melting speed is too low is also not preferred by consumers because of the shape of ice cream that still remains (unchanged) at room temperature gives the impression of too many solids are used. According to Hubeis (1995), a good quality of ice cream is the ice cream that melts when having similar properties to the original dough. The good quality ice cream has about 10-15 min of melting time.

Protein content: The results of variance showed a protein content of ice cream with the addition of broccoli treatment was not significantly different at the level α = 5% (p>0.05). The average of protein content of ice cream can be seen in Table 1.

From Table 1, it can be seen that the levels of protein which had produced in the ice cream was not significantly different. The protein of broccoli ice cream is in accordance with SNI 01-3713-1995 standard that is 2.7% w/w of minimum protein content (BSN, 1995). The presence of protein in ice cream can increase the viscosity and the melting time of ice cream (Arbuckle, 1966).

Sugar (Sucrose) content: The results of variance showed the sugar (sucrose) of ice cream with the addition of broccoli treatment was not significantly different at the significance level α = 5% (p>0.05). The average of sugar content of ice cream can be seen in Table 1. From the Table 1, it can be seen that the sugar content (sucrose) of ice cream which was produced in each treatment was not significantly different, due to the amount of the sugar addition in the manufacture of ice cream was the same. The levels of sugar amount (sucrose) in broccoli ice cream are in accordance with the minimum standard of SNI 01-3713-1995 i.e., 8.0% (BSN, 1995). Sugar does not only serve as a sweetener, but also can increase the viscosity and the total solid of ice cream (Arbuckle, 1966).

Fat content: The results of variance showed that the fat content in the ice cream with the addition of broccoli treatment was not significantly different at level α = 5% (p>0.05). The average of fat content in the ice cream can be seen in Table 1.

From the Table 1, it can be seen that the fat content of ice cream, which was produced, tended to be the same in each treatment, because the amount of fat source in the manufacture of ice cream was the same. This value has been in accordance with SNI 01-3713-1995, i.e., a minimum fat content of 5.0% w/w (BSN, 1995).The addition of broccoli does not affect the fat content of ice cream because it has little fat broccoli.

The fat in ice cream is very important because the presence of fat in the ice cream forms a soft texture, improves the taste of the ice cream, helps in giving shape to the ice cream and assists in the provision of good melting properties of the ice cream (Arbuckle, 1966).

Vitamin c content: The results of the variance analysis to the total vitamin C in broccoli ice cream showed that the addition of broccoli was significantly different at level α = 5% ($p<0.05$) on the total of the vitamin C in the broccoli ice cream which had produced. The average value of the total vitamin C in the broccoli ice cream can be seen in Table 1.

Based on Table 1, it can be seen that the amount of vitamin C in broccoli ice cream ranged from 4.08-26.46 mg/100 g of material. The highest value was found in the addition of 30% broccoli i.e., 26.46 mg/100 g of material. The lowest result of vitamin C test was found in the addition of 5% i.e., 4:08 mg/100 g of material. The more the broccoli is added, the more the vitamin C increases. According to Astawan (2009), the content of vitamin C in fresh broccoli is 123.4 mg/100 g.

Functional properties of ice cream

Antioxidant activity test: Natural antioxidants most often have been associated with plant secondary metabolites, such as well-known vitamins C and E (ascorbic acid and tocopherols) and numerous plant phytochemicals (phenolic acids, flavonoids, terpenoids and other chemical classes) (Venskutonis, 2014). Phytochemical compounds that are contained in broccoli are chlorophyll and beta-carotene.

The ability of antioxidants to inhibit the oxidation process can be known through antioxidant activity test. By definition, the antioxidant activity is the capability of a compound (composition) to inhibit oxidative degradation (Roginsky and Lissi, 2005). The principle of this test is the donation of hydrogen atoms of the substance to be tested on DPPH radical non-radical compounds diphenyl picryl hydrazine which will be indicated by a color change (Molyneux, 2004).

The results of variance showed the antioxidant activity of ice cream with the addition of broccoli treatment was significantly different at level α = 5%. The antioxidant activity of ice cream can be seen in Table 2.

Based on Table 2, it can be seen that the antioxidant activity of broccoli ice cream ranged between 29.73-42.15%. The lowest result of antioxidant activity test was found in the addition of 5% broccoli i.e., 29.73%.The highest value was found in the addition of 30% broccoli i.e., 42.15%. The more the addition of broccoli is, the antioxidant activity is more increasing. This is due to the influence of the content of phytochemical compounds which are found in broccoli such as vitamin C, chlorophyll and beta-carotene which is an antioxidant compound. According to Astawan (2009), phytochemical compounds can synergies with vitamin C and serves as an antioxidant. Broccoli contains 70.5 ug/g of chlorophyll and 0:28 mg/100 g of β-carotene (Muchtadi, 2012).

Crude fiber content analysis: The results of variance showed the fiber content in the ice cream with the addition of broccoli treatment was significantly different at level α = 5%. The average of fiber content of ice cream can be seen in Table 2.

Based on Table 2, it can be seen that the fiber content in the broccoli ice cream ranged from 0.26-1.72%.The highest value was found in the addition of 30% broccoli i.e., 1.72%. The lowest fiber test result was contained in the addition of 5% broccoli i.e., 0.26%. The more the addition of broccoli is, the fiber content is more increasing, because broccoli contains fiber. According to Astawan (2009), broccoli contains 4.67 g/100 g of fibers. There are numerous scientific investigations that report the antioxidant activity of dietary fiber (Hassan *et al*., 2011; Navarro-Gonzalez *et al*., 2011; Borchani *et al*., 2011 cited in Martos *et al*., 2014).

Sensory analysis: Organoleptic test is one factor in determining a food product. Organoleptic tests that were conducted by 20 panelists can determine the levels of the panelists' preference to the ice cream with the addition of broccoli through observation of color, aroma, flavor and texture.

The sensory analysis were performed by using a hedonic test with hedonic scale of 1 to 5; 1 = dislike (DL), 2 = less like (LL), 3 = regular (R), 4 = like (L), 5 = very like (VL). The panelists' assessment results were next tabulated based on the distribution of panel assessment. The figures in the table are the percentage of panelists' choice on any parameters which had been tested. The determination of the most preferred products was made by doing summation of the value of the percentage of panelists who expressed like to very like and the highest value was expressed as a number of the best product testing results. A percentage of panelists' preference on color, aroma, taste and texture of the ice cream with the addition of broccoli can be seen in Table 3.

Color: Based on Table 3, it can be seen that almost all of the colors of ice cream with the addition of broccoli can be accepted by the panelists. Of the six treatments,

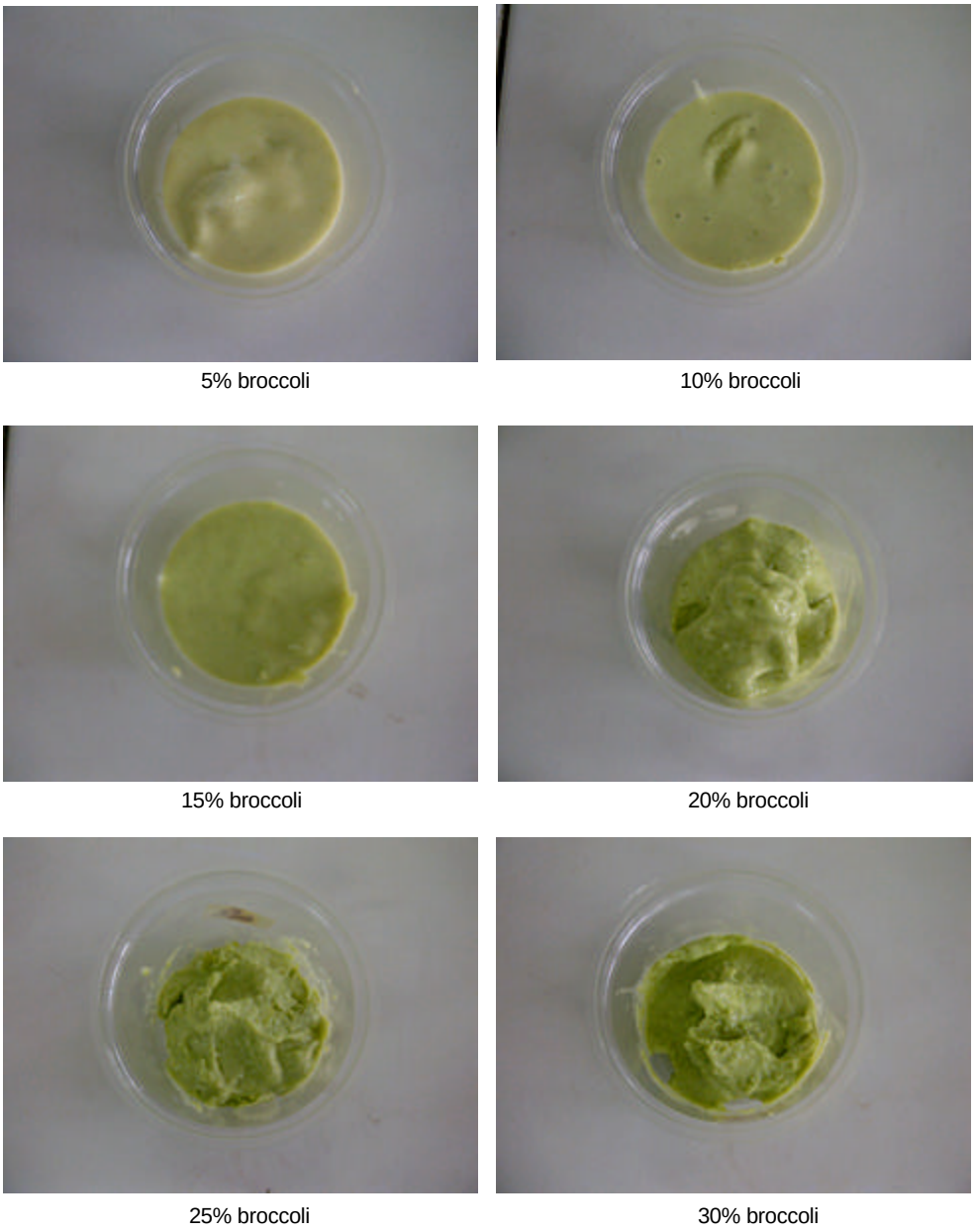

Fig. 1: Ice creams with the different additions of broccoli

there were two treatments that the acceptance rate of the color relatively showed higher numbers where panelists expressed like to very like on the addition of 15% and 20% of broccoli. In the addition of 15% broccoli, the panelists who expressed like and very like were 75% and in the addition of 20% broccoli, there were 80% of panelists who expressed like to very like.

The colors of the ice cream that were produced were in white-green to dark green. The higher the addition of broccoli, the color of the ice cream is more green. The color of the ice cream that was the most favored by the panelists was light green which was gotten from the addition of 20% broccoli. The color is influenced by the increase of the addition of broccoli, where the higher the concentration, the color of the ice cream was getting darker so it was less favored by the panelists.

Aroma: Table 3 showed the aroma of the addition of broccoli can be accepted by the panelists. There were two treatment levels of panelists' acceptance on the aroma which showed higher figures. The treatment levels were the addition of 15 and 20% broccoli. The

percentage of panelists who expressed like to very like on the addition of 15% broccoli was 75% and the panelists who expressed like to very like on the addition of 20% broccoli was 75%. The aroma of ice cream which had been produced was influenced by the distinctive aroma of milk. The aroma that was the most preferred by the panelists was the addition of 15 and 20% broccoli. Table 4 also showed that the addition of 5 and 10% broccoli were less favored by the panelists because they were very flavorful milk, as well as the addition of 25 and 30% broccoli which were also less favored because the aroma of broccoli were prominent.

Taste: From Table 3, it can be seen that there were three treatments whose taste can be accepted by the panelists. The treatments were the addition of 10, 15 and 20% broccoli. The highest valuation was the addition of 20% broccoli, that was 75% of panelists stated like to very like on the taste of ice cream. The lower the addition of broccoli into the ice cream, the flavor of milk was more dominant, so it was less favored by the panelists. However, the higher the addition of broccoli into the ice cream, it was also less favored by the panelists because the milk flavor was almost lid by the prominent taste of broccoli.

Texture: From Table 3, it can be seen that there were three treatments whose texture can be accepted by the panelists. The treatments were the addition of 10, 15 and 20% broccoli which were preferred on the scale of like to very like. The texture of the ice cream which was the most favored by the panelists was the addition of 20% broccoli, where there were 75% of panelists expressed like and very like.

The texture of the resulting ice cream was smooth enough. The higher the addition of broccoli into the ice cream, the texture was rougher so the panelists' rate waned. This is because the amount of solids that are too high so overrun tends to more decline and makes the texture rougher and more solid. However, the lower level of the addition of broccoli, the texture of the ice cream is more mushy and it quickly melts at room temperature, so it is less favored by the panelists.

Based on the results of organoleptic test with five assessment parameters that was used i.e., 1 = dislike (DL), 2 = less like (LL), 3 = regular (R), 4 = like (L), 5 = very like (VL) of the color, aroma, taste and texture of the ice cream produced, it was taken one of the treatments that was preferred by the panelists. The most favored treatment by the panelists was the addition of 20% broccoli. Based on the organoleptic test, the physical test and the chemical test, the addition of 20% broccoli produced the ice cream with the best characteristics and functional properties. Then the levels of beta carotene and chlorophyll content of the best products were tested. Ice cream with the addition of different broccoli can be seen in Fig. 1.

Beta carotene content: In this study, beta-carotene trials was conducted only on the best product that is the course of treatment with the addition of 20% broccoli. From the observations, it was obtained the values of beta carotene as much as 1.05 mg/100 g. In the test of raw materials, it was obtained 2.67 mg/100 g of beta carotene value. The value of beta carotene in the ice cream was lower than in the raw materials because there was a pasteurized treatment in the process of making the ice cream. According to Fellows (2003), pasteurization can reduce partial carotene content in food.

The carotenoids in green plants are masked by chlorophyll. When the latter is degraded, the presence of carotenoids is readily revealed (Belitz *et al*., 2009). Beta carotene in the body acts as antioxidants that plays role as electron donators and singlet oxygen radical Scavengers (Venskutonis, 2014).

Chlorophyll content: In this study, the chlorophyll test was only conducted on the best ice cream product that was on the addition of 20% broccoli. From the observations, it was obtained the values of 4.13 mg/L of chlorophyll. The low of chlorophyll content in the ice cream was caused by the use of pasteurization stage and also stirring. It is based on Fennema (1996) that conversion of chlorophyll to pheophytin after holding for 60 min at 60 or 100°C was 32 until 97%. It is because they have weak linkages (non covalent bonds) exist between these molecules. The bonds are easily broken. Furthermore Tonucci and Von Elbe (1992) adds that the chlorophylls are known to be Easily degraded by conditions such as dilute acids, heat, light and oxygen.

Conclusion: The addition of broccoli on the quality of the ice cream had no effect on levels of fat, the amount of protein and sugar, but the effect was on the overrun, the total solids, the melting time, the antioxidant activity and the levels of fiber and vitamin C. The ice cream with the addition of 20% broccoli is the best product because it has 80% of color value, 75% of aroma, 75% of taste, 75% of texture, 30.16% of overrun, 56.99% of total solids, 10 min 51 seconds of melting time, 9.79% of protein, 15.20% of sugar, 8.83% of fat, 37.25% of antioxidant activity, 17.11 mg/100g of vitamin C, 1.13% of fiber content, 4.13 mg/L of chlorophyll and 1.05 mg/100 g of beta carotene.

REFERENCES

AOAC, 1999. Official Methods of Analysis. Associaton of Official Analytical Chemists, Washington DC.

Arbuckle, W.S., 1966. Ice Cream. The AVI Publishing Company, Inc Westerport. Connecticut.

Astawan, M., 2009. A-Z Ensiklopedia Gizi Pangan Untuk Keluarga. Dian Rakyat. Jakarta.

Belitz, H.D., W. Grosch and P. Schieberle, 2009. Food Chemistry. Springer, Germany.

Badan Standarisasi Nasional (BSN), 1992. *Cara Uji Makanan dan Minuman* (SNI 01-2891-1992). Badan Standarisasi Nasional. Jakarta.

Badan Standarisasi Nasional BSN, 1995. Es Krim (SNI 01-3713-1995). Badan Standarisasi Nasional (BSN). Jakarta.

Fennema, O.R., 1996. Food Chemistry, Third Edition. Marcell Dekker, Inc.New Yrok.

Fellows, P.J., 2003. Food Processing Technology. CRC Press, America.

Gross, J., 1991. Pigments in vegetables: chlorophylls and carotenoids. Van Nostrand Reinhold. New York.

Hubeis, M., N. Andarwulan and M. Yunita. 1996. *Kajian Teknologi dan Finansial Produksi Es Krim* (*Melorin*) *Skala Kecil*. Buletin Teknologi dan Industri Pangan. ITB. Vol VII (1).

Kubo, I., N. Masuoka, P. Xiao and H. Haraguchi, 2002. Antioxidant Activity of Dodecyl Gallate. J. Agri. Food Chem., 50: 3533-3539.

Lingga, Lanny, 2010. Plus Minus 54 Jenis Sayuran Cerdas Memilih Sayuran. Agro. Media. Jakarta.

Martos, M.V., J.A.P. Alvarez and J.F. Lopez, 2014. Functional Antioxidant Food. In: Bartosz , G (Eds.), Food Oxidants and Antioxidants; Chemical, Biological and Functional Properties. CRC Press, New York, pp: 489-528.

Mann, S. and K.S.M.P. Aggarwal, 2013. Development of Phytochemical Rich Ice Cream Incorporating Kinnow Peel. Global J. Sci. Frontier Res. Agri. Vet., Volume XIII Issue IV Version I. USA.

Muchtadi, D. 2012. Pangan Fungsional dan Senyawa Bioaktif. Alfabeta, Bandung.

Martos, M.V., J.A.P. Alvarez and J.F. Lopez, 2014. In Bartosz (Eds.), Food Oxidants and Antioxidants; Chemical, Biological and Functional Properties. CRC Press, New York, pp: 489-528.

Molyneux, P., 2004. The Use of The Stable Free Radical Diphenylpicrylhydrazyl (DPPH) for Estimating Antioxidant Activity. J. Sci. and Technol., 26: 211-219.

Roginsky, V. and E.A. Lissi, 2005. Review of Methods to Determine Chain-Breaking Antioxidant Activity in Food. Elsevier, Amsterdam, p: 235-254.

Setyaningsih, D., A. Apriyantono and M.P. Sari, 2010. Analisis Sensori untuk Industri Pangan dan Agro. IPB Press. Bogor.

Sudarmadji, Haryono and Suhardi, 1997. Prosedur Analisa untuk Bahan Makanan dan Pertanian. Liberty, Yogyakarta.

Tonucci, L.H. and Von J.H. Elbe, 1992. Kinetics of The Formation of Zinc Complexes of Clorophyll Derivatives. J. Agri. Food Chem., 40: 2341-2344.

Venskutonis, P.R., 2014. In Bartosz (Eds.), Food Oxidants and Antioxidants; Chemical, Biological and Functional Properties. CRC Press, New York, pp: 235-302.

Wijanto, A., 1995. Pengaruh Penggunaan Lemak Sawit dan Kacang Hijau terhadap Mutu Es Krim. Skripsi Fakultas Teknologi Pertanian IPB, Bogor.

Winarti, Sri, 2010. *Makanan Fungsional*. Graha Ilmu. Yogyakarta.