ajfand SCHOLARLY, PEER REVIEWED
AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
Volume 23 No. 9
September 2023
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

Afr. J. Food Agric. Nutr. Dev. 2023; 23(9): 24680-24695 https://doi.org/10.18697/ajfand.124.23195

PHYSICOCHEMICAL CHARACTERISTICS OF HOMEMADE ICE CREAM WITH MUSTARD GREEN (*Brassica juncea)* POWDER OR PUREE

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ABSTRACT

Ice cream is a product of high sensory acceptance because of the countless flavor options and their combination. It has become one of the most popular desserts and its production is increasing year by year and highly accepted by children, adolescents, adults, as well as the elderly public. A number of studies have been carried out in developing new functional ice creams with ingredients such as fruits like avocado, dragon fruit, banana, passion, guava, lemon and soursop. The present study was, therefore, carried out to assess the possibility of producing homemade ice cream with enhanced nutritional value with mustard green leaves. This research explored the utilization of powdered and fresh mustard green leaves in the form of puree as nutritional enrichment for homemade ice cream. Homemade ice cream ingredients in this experiment consisted of 100 g solids and 150 ml water. The solids consisted of 74 g full cream milk powder, 15 g sugar, 10 g skimmed milk powder, 0.5 g emulsifier, and 0,5 g Carboxy Methyl Cellulose. Mustard green powder was added in accordance to treatments, namely 3%, 6%, 9% and 12% from the 100 g solids. Whereas mustard green puree were added as replacement of 100 ml water from the total of 150 ml water in the formula. Control treatment was made with no mustard green powder or puree. The chemical and physical characteristics were determined in three replicates using randomized completely blocked design. Data was submitted to Analysis of Variance (ANOVA) and further tested using Honestly Significant Difference (HSD). Based on the results of this study, the addition of mustard green powder and puree on homemade ice cream had significant increase in ash content, total chlorophyll, melting rate, viscosity, and yellowness, but a decrease in overrun, lightness, and redness. The higher the concentration of mustard green powder or puree, the higher the increase of ash content, total chlorophyll, melting rate, viscosity and yellowness. On the other hand, the higher the concentration of mustard green powder or puree the higher the decrease of overrun, lightness, and redness. Mustard green powder gave higher ash content and total chlorophyll than the puree, but mustard green puree gave brighter colour indicated by higher lightness, greenness, and yellowness.

Key words: ice cream, homemade, mustard green, powder, puree, enrichment

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INTRODUCTION

Ice cream is a liquid mixture of so many elements of different natures as sugar, fats, dairy, stabilizer, water, and others that turn into a paste after simultaneously shaking and cooling [1]. It is a product of high sensory acceptance because of the countless flavor options and their combinations [2]. Ice cream has become one of the most popular desserts and its production is increasing year by year [3] and highly accepted by children, adolescents, adults, as well as the elderly [4]. A number of studies have been carried out in developing new functional ice creams with ingredients such as fruits like avocado [5], dragon fruit [6], banana, passion, guava and lemon [2], and soursop [7]. However, there is little research on ice cream from vegetable raw materials.

Mustard green like other green leafy vegetables are valuable sources of nutrients. They contain numerous minerals like Calcium, Kalium, Ferrum, and Natrium which are vital for growth and metabolism and provide alkalizing effect to the acidity produced by other foods. These minerals are predominant elements in green leafy vegetables [8]. Leafy vegetables associated with antioxidant pigments like chlorophylls, carotenoids, and lycopene, also contain phytochemicals like polyphenols and several other metabolites which help to lower the risk of diseases such as cancer and cardiovascular diseases [9]. Mustard green leaves are rich in chlorophyll, β-carotene, ascorbic acid, potassium, calcium, and other minerals [10]. Due to their excellent nutritional properties, green leafy vegetables like mustard green are considered supplementing ingredients in food. Research of nutritional enrichment on several products with green leafy vegetables has been conducted on biscuits with cabbage powder [11], on rice crackers with moringa [12], on chapati premixes with spinach powder [13], on bread with fluted pumpkin leaves [14], on wheat bread with moringa leaf powder [15], on sponge cake with cabbage outer leaves [16], on cereal-based extruded snacks with mustard leaves powder [17]. Having in mind the above considerations, the present study was therefore carried out to assess the possibility of producing homemade ice cream with enhanced nutritional value with mustard green leaves. This research explored the utilization of powdered and fresh mustard green leaves in the form of puree as nutritional enrichment on homemade ice cream.

MATERIALS AND METHODS

Materials

Full cream milk, skimmed milk, sugar, Ryoto SP as an emulsifier, and Carboxy Methyl Cellulose (CMC) as a stabilizer were purchased from chemical and grocery

stores in Sidoarjo. Mustard greens used in this experiment were obtained from the local farmer's vegetable store in Sidoarjo, East Java, Indonesia. The mustard greens were then removed from the roots and petioles as well as the withered leaves. The leaves were then processed into powder and paste and added to the homemade ice cream in order to enrich it.

Preparation of mustard green powder

Mustard green powder preparation was done by selecting the leaves, then washing the leaves thoroughly. Clean leaves were then steam blanched at a temperature of 70°C for two minutes, they were then dried in a cabinet dryer at 45°C for six hours. Dried leaves were then crushed by a flour maker and sieved by an 80 mesh sieve.

Preparation of mustard green puree

After selecting leaves as in the above step, the mustard green leaves were weighed and washed, then steam blanched for 5 minutes at a temperature of 77°C. The blanched leaves were then blended with water according to the treatments, they were 15%, 20%, 25%, and 30% weight per volume. Mustard green puree was made into 100 ml, those 15%, 20%, 25%, and 30% puree were made with 15 g, 20 g, 25 g, and 30 g blanched leaves in 85 ml, 80 ml, 75 ml, and 70 ml water, respectively.

Preparation of homemade ice cream experiment with mustard greens

Homemade ice cream ingredients in this experiment consisted of 100 g solids and 150 ml water. The solids consisted of 74 g full cream milk powder, 15 g sugar, 10 g skimmed milk powder, 0.5 g emulsifier, and 0,5 g Carboxy Methyl Celloluse. Mustard green powder was added in accordance with treatments, namely 3%, 6%, 9%, and 12% from the 100 g solids, whereas mustard green puree was added as replacement of 100 ml water from the total of 150 ml water in the formula. The control treatment was made with no mustard green powder or puree. The homemade ice cream was made according to the modified method by Simanungkalit *et al.* [18]. Solid ingredients were mixed until homogeneous. A homogeneous mixture of ice cream ingredients was then shaken by a mixer to form an ice cream dough. While shaking, 150 ml water or 100 ml puree and 50 ml water at a temperature of about 70°C were added. The dough was then packed in a closed container, and stored in the freezer at -18°C for 5 hours. The frozen dough was then shaken again for 7 minutes. The shaken dough was then put back into the freezer for 10 hours. The homemade ice cream was then ready to analyze.

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Determination of physicochemical characteristics

Minerals or ash content was determined following procedures of ash content by incineration at 550°C in a muffle furnace [19].

Total chlorophyll was determined by using Dimethyl Sulfoxide (DMSO) method [20].

Viscosity: The viscosity of the ice cream was determined using an NDJ-5S digital rotary viscometer at room temperature. The reading was made at 6 rpm with spindle number 4 and the result expressed in mPa*s.

Overrun: This was determined by measuring the ice cream mix volume before and after cooling. The difference then was compared to the volume of the original ice cream mix [21].

Melting rate: This property was determined according to the method described by Rahim et al [22].

Colour Profile : The colour profile of the ice cream was analyzed with Cs 10 colour reader (Colorimetri) and expressed by L* (lightness), a* (redness), and b* (yellowness).

Statistical analysis

The complete experiment consisted of nine treatments namely, four concentrations of addition of mustard green powder, four concentrations of mustard green puree and a control (ice cream without mustard green powder or puree). The physicochemical characteristics were determined in three replicates using randomized completely blocked design. Data was submitted to Analysis of Variance (ANOVA) and further tested using Honestly Significant Difference (HSD).

RESULTS AND DISCUSSION

Ash Content

The research showed that the concentration of mustard green powder and puree significantly affects the ash content of homemade ice cream (Table 1.). Ash is the inorganic residue remaining after burning or complete oxidation of organic carbonaceous matter which describes the total mineral content in the material [23]. Mustard leaves which grow in Bangladesh have 16.27 % ash content [24], pickled and dried mustard contain 21.80 -27.81 % [10], while mustard green powder used in this experiment contained 12.38% ash. The specific nutrients and their content

in mustard vary with the variety, location, growing area, and processing method [25].

Table 1 shows that the higher the concentration of mustard green powder and mustard green puree, the higher the ash content.

Enrichment with mustard green powder gave higher ash content than mustard green puree even in a higher concentration of the puree. The content of ash per unit weight of the mustard green powder was much higher than the puree because fresh mustard green which has 92.1% moisture content has been dried until a moisture content about 7.8% [24].

Total Chlorophyll

The total chlorophyll of homemade ice creams enriched with mustard green leaves powder and puree is presented in Table 2. Chlorophyll is a very common pigment that gives the green colour to vegetables and some fruits [26] and is one of the major anti oxidative components [9]. Table 2 shows that the higher the concentration of mustard green powder, the higher the total chlorophyll, as well as the higher the concentration of mustard green puree, the higher the total chlorophyll.

Total chlorophyll in fresh mustard green is 161.89 mg/g [10], while in mustard green powder which has gone through the process of steam blanching at 77 ^{o}C for 2 minutes and drying at 45^{o}C for 6 hours is 98.44 mg/g. Drying and grinding greatly influence the quality attributes of biological materials. It implies physical, textural, sensorial, functional, and nutritional changes [27]. Preparation of mustard green puree also goes through a steam blanching process at a temperature of 77^{o}C for 5 minutes. Blanching also results in some degree of chlorophyll degradation with the subsequent formation of pheophytin [28].

Total chlorophyll in homemade ice cream enriched with mustard green powder is higher than in ice cream with mustard green puree because higher chlorophyll content in dried compact form of mustard green leaves, although more degradation occurred during powder processing.

Viscosity

Table 2 shows that concentration of mustard green powder and mustard green puree affects the viscosity of homemade ice cream. The higher the concentration of mustard green powder and mustard green puree, the higher the viscosity of ice

cream. Viscosity of ice cream is one of the vital physical properties that helps in maintaining all the components in homogeneous state [29].

Mustard green which is included in the green leafy vegetable group is known to contain a crude fiber content of 1.2 g/100 g [30] and other studies have shown that food fiber content is 3.3 g/100 g [10]. Fiber in ice cream dough increases the solids then the dough becomes thick, raising the viscosity. A thicker dough indicates that there are a lot of solids contained [31]. When the viscosity increases, a resistance occurs against melting and smoothness of the body, leading to a decrease in the rate of whipping. Additionally, an increase in apparent viscosity leads to an increase in resistance to melting of the final product and enhanced smoothness [32].

Overrun

Ice cream is a product with generally aerated and characterized as frozen foam namely overrun. The overrun of an ice cream is important as it influences the quality and profits, but also of the legal standards that must be met [33]. The value of overrun in the general literature review is 80 – 100% [34], between 50 and 100% and reaching 150% in some cases [2], but for homemade ice cream is between 35-50% [35]. Homemade ice cream in this experiment have an average overrun ranging from 32.31% to 42.60%. A possible reason for getting a lower overrun for the homemade ice cream due to poor freezing process in because of limited equipment.

Nevertheless, based on Table 2, it is found that the higher the concentration of mustard green powder, the lower the overrun value, as well as the higher the concentration of mustard puree given, the lower the overrun. This result is in line with Sapiga *et al.* [36] research in manufacturing ice cream with vegetable puree from beet and broccoli, higher mass fraction of vegetable puree resulting in lowered overrun. The increasing viscosity of ice cream due to the addition of mustard green powder and puree in this study had an effect on lowering the overrun. Higher viscosity will reduce the intake of air during aeration in the freezing process thus resulting in lowering overrun [22].

Melting Rate

Table 2. shows that the higher the concentration of mustard green powder or mustard green puree, the higher the melting rate. The melting rate of homemade ice cream in this experiment ranged from 36.86 to 44.47 minutes which is higher than the standard melting rate which is considered good for ice cream, 15 – 20 minutes for 10 g ice cream [35].

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The higher melting rates in this experiment were due to higher viscosity and also due to lower overrun especially with the addition of mustard green powder and mustard green puree. This relation is stated by El Hadad *et al.* [37]. This result is in line with the research of Rahim *et al.* [22] in pumpkin ice cream and Haryanti and Zueni [35] in mangosteen leather ice cream.

Melting rate is attributed to water holding capacity which refers to the properties involving interaction between the protein, product and water as a result of which some of the water remains with the product [29]. The more total solids in the addition of mustard green powder and mustard green puree causes more water to be bound. The mustard green powder has higher total solid than mustard green puree, which causes the ice cream added by mustard green powder to have higher viscosity, lower overrun and so higher melting rate.

A higher melting rate indicates that the ice cream would be more resistant to temperature fluctuations during storage and without losing structure [2], on the other hand, ice cream manufacturers prefer high overrun for efficiency [22].

Color Profile

Color is one of the important sensory characteristic and plays a vital role in the acceptability of food items in the food industry. This study showed that concentrations of mustard green powder and mustard green puree have significant effects on color profile (L*, a*,b*) (Table 3). Table 3 shows that the higher the concentration of mustard green powder and mustard green puree, the lower the lightness (L value) of homemade ice cream. Mustard green contains chlorophyll, a pigment with green colour. Addition of those green color pigments might have lowered the lightness of the ice cream. Addition of mustard green puree results in higher lightness than the powder.

On the other hand, the higher the concentration of mustard green powder and mustard green puree, the lower the redness (a*) or the higher the greenness, and the higher the yellowness (b*) of the homemade ice cream.

Addition of mustard green puree gave higher lightness, lower redness or higher greenness, and higher yellowness. This result is in line with Khan *et al.* [13] research of the addition of spinach powder on chapati premixes.

Ice cream with mustard green powder has higher total chlorophyll than the puree, but has lower greenness in color profile, maybe due to mustard green powder that

has gone through a long heating process starting from blanching to a long drying process and grinding process that degrades chlorophyll into phaeophytin with olive green colour or even into phaeophorbide with brownish green colour [38, 39].

CONCLUSION, AND RECOMMENDATIONS FOR DEVELOPMENT

Based on the result of this study, the addition of mustard green powder and puree on homemade ice cream significantly increased ash content, total chlorophyll, melting rate, viscosity, and yellowness, but decreased overrun, lightness, and redness. The higher the concentration of mustard green powder or puree the higher the increase or decrease of the homemade ice cream's characteristics. The mustard green powder gave higher ash content and total chlorophyll than the puree, but mustard green puree gave brighter colour indicated by higher lightness, greenness, and yellowness.

ACKNOWLEDGEMENTS

The authors would like to acknowledge the Ministry of Education and Culture of Indonesia for funding this study; Directorate of Research and Community Service of UMSIDA for facilitating the research implementation and our teamwork in Teknologi Pangan laboratory for helping the work.

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Table 1: Ash Content and Total Chlorophyll of homemade ice cream enriched with Mustard green powder and puree

Powder (%)	Puree (%)	Ash content (%)	Total Chlorophyll (mg/g)
0	0	0.67 ± 0.13 ^{a}	0.00 ± 0.00 ^{a}
3	0	0.93 ± 0.04 ^{bcd}	0.64 ± 0.11 ^{c}
6	0	1.09 ± 0.09 ^{d}	1.58 ± 0.11^{d}
9	0	1.27 ± 0.07^{e}	2.34 ± 0.20^{e}
12	0	1.33 ± 0.07^{e}	3.27 ± 0.28 ^{f}
0	15	0.77 ± 0.07^{ab}	0.19 ± 0.08^{ab}
0	20	0.84 ± 0.07^{ab}	0.60 ± 0.02^{bc}
0	25	0,90 ± 0.03 ^{bc}	0.78 ± 0.05^{c}
0	30	1.07 ± 0.13 ^{cd}	1.28 ± 0.22^{d}
HSD 5%		0.17	0.44

Notes: Figures followed by the same letter shows insignificant differences based on 5% HSD

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Table 2: Viscosity, Overrun and Melting Rate of Homemade Ice Cream enriched with mustard green powder and puree

Powder (%)	Puree (%)	Viscosity (mPa*s)	Overrun (%)	Melting rate (minute)
0	0	723.67 ± 54.37^{a}	42.60 ± 0.85^{e}	36.86 ± 2.41 ^{a}
3	0	767.67 ± 30.53^{ab}	38.73 ± 0.83^{de}	40.77 ± 2.52^{ab}
6	0	805.67 ± 21.08^{bc}	36.93 ± 1.98^{bcd}	41.47 ± 3.06^{ab}
9	0	859.67 ± 40.72^{de}	34.48 ± 1.98^{abc}	43.00 ± 1.81^{b}
12	0	924.33 ± 22.81^{f}	32.31 ± 1.04^{a}	44.47 ± 2.35^{b}
0	15	772.00 ± 42.44^{abc}	38.64 ± 1.73^{de}	39.71 ± 1.65^{ab}
0	20	821.00 ± 20.95^{cd}	38.08 ± 0.72^{cd}	40.97 ± 1.22^{ab}
0	25	857.00 ± 25.51^{de}	37.72 ± 1.01^{cd}	41.94 ± 1.29^{b}
0	30	881.33 ± 26.50^{ef}	33.66 ± 1.50^{ab}	43.85 ± 2.12^{b}
HSD 5%		49.16	4.00	4.43

Notes: Figures followed by the same letter shows insignificant differences based on 5% HSD

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Table 3: Color Profile Due to Addition of Mustard Flour and Mustard Puree

Flour (%)	Puree (%)	Color Analysis		
		Lightness (L)	Redness (a*)	Yellowness (b*)
0	0	83.78 ± 5.99^{e}	0.89 ± 1,36^{a}	11.37 ± 4.23^{a}
3	0	70.93 ± 2.33^{de}	-9.59 ± 0,26^{ab}	26.51 ± 0.35^{ab}
6	0	62.42 ± 0.92^{bcd}	-11.18 ± 0,09^{ab}	28.75 ± 0.65^{bc}
9	0	55.70 ± 3.76^{abc}	-11.46 ± 0,15^{b}	28.36 ± 0.73^{de}
12	0	52.22 ± 1.88^{a}	-11.56 ± 0,30^{b}	28.77 ± 1.20^{f}
0	15	74.06 ± 1.26^{de}	-15.97 ± 0,71^{ab}	32.16 ± 1.65^{abc}
0	20	70.10 ± 1.02^{cd}	-17.75 ± 0,91^{ab}	34.42 ± 1.26^{cd}
0	25	65.84 ± 1.87^{cd}	-16.90 ± 3,93^{b}	33.41 ± 1.37^{de}
0	30	62.53 ± 3.01^{ab}	-18.88 ± 1,48^{b}	36.80 ± 1.06^{ef}
HSD 5%		4.00	4.43	49.16

Notes: Figures followed by the same letter shows insignificant differences based on 5% HSD

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