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PHYSICOCHEMICAL QUALITY ANALYSIS OF ICE CREAM WITH THE ADDITION OF VARIOUS CONCENTRATION OF CHIA SEED (Salvia Hispanica L)

Karina Bianca Lewerissa*, Sarlina Palimbong, Jesslyn Graciela

Department of Food Technology, Faculty of Medicine and Health Sciences, Universitas Kristen Satya Wacana, Salatiga, Jawa Tengah, Indonesia
***Korespondensi**: karina.lewerissa@uksw.edu

ABSTRACT

***Background**: Ice cream is a popular semi-frozen dairy product because it has a soft texture and melts quickly in the mouth. However, ice cream has drawbacks because it has high fat and does not contain fiber so that it can trigger obesity. Therefore, it is necessary to add other food ingredients to increase the fiber content, such as chia seeds, which are rich in fiber.*

***Objectives**: This research aims to determine the characteristics and proportions of the use of chia seeds on the physical and chemical properties of ice cream.*

***Materials and Methods**: Three concentrations of 8, 10, and 12% chia seed were applied to determine the best concentration to produce the most preferred ice cream and the product's physicochemical characteristics and sensory quality. The analyzed parameters were protein content, fat content, crude fiber content, total solids, melting speed, overrun, and viscosity.*

***Results**:The water content of the ice cream with different chia seed concentrations is around 64%, fat 11%, and protein 4%. The crude fiber content of the product increased with increasing chia seed concentration. Addition of chia seeds with different concentrations made a real difference in the overrun and melting speed of the ice cream. The higher the chia seed concentration, the higher the overrun and total solids, and the longer the melting speed.*

***Conclusion**s: Ice cream with a chia seed concentration of 8% is the most preferred regarding color, taste, aroma, texture, and overall preference. However, statistical analysis shows that there are no significant differences in overall acceptance by panelist for all products. Therefore, ice cream with highest chia seed content can be endorsed as healthy food due to its fiber conten.t*

***Keywords**: Chia seed; dietary fiber; ice cream*

INTRODUCTION

Ice cream is a semi-frozen product made by freezing the mixture. Ice cream is composed of a mixture of main food ingredients such as dairy products, animal or vegetable fats, sweeteners such as sugar, stabilizers, flavour enhancers. Ice cream has a delicious taste, fragrant aroma, attractive color, and soft texture[1]. The principle of making ice cream is to form air cavities in the ice cream mixture to produce a larger volume. This makes ice cream lighter, not too dense, with a soft texture[2].

Ice cream has high nutritional value compared to other processed products because it is obtained from milk as the basic raw material which only slightly affected by the processes. On the other hand, the nutrient and bioactive compound in many processed foods has reduced due to processing techniques that involved exposure to light, air, heat, radiation, and changes in acidity.

However, ice cream also has a drawback, namely that it does not contain fiber and high fat content which can trigger obesity. Fiber is a nutrient that can help facilitate the human digestive system[3]. Therefore, it is necessary to add other food ingredients to complement the nutritional content of ice cream, one of which is chia seeds.

Chia seed is a natural ingredient that can be used as an alternative for developing functional food products that are good and beneficial for health. Studies show that chia seeds contain the active components of polyphenols, essential fatty acids, protein and antioxidants[4]. Chia seeds contain a high chemical composition, namely carbohydrates (26-41%), fat (30-33%), protein (15-25%), minerals (4-5%) and fiber (18-30%). Other study stated that in 100 g chia seeds contain 18.9 g protein, 31.2 g fat, 35.3 g dietary fiber[5]. According to BPOM regulation No. 13/2016 food rich in fiber has more

than 6 g fiber/100 g sample[6]. Therefore, chia seeds are categorized as high-fiber food. The fat content of chia seeds is very high, accounting for between 30-40% of the weight of the seeds. Nearly 60% of total fat is α-linoleic acid (omega 3)[7].

This research aims to determine the characteristics and proportions of the use of chia seeds on the physical and chemical properties of ice cream. The analyzed parameters were protein content, fat content, crude fiber content, total solids, melting speed, overrun, and viscosity.

METHODS

The research was carried out in Food Processing Laboratory at Satya Wacana Christian University. The research was an experimental method. All obtained data were analyzed using analysis of variance (ANOVA) at α=5% to determine whether there is a real influence on each test parameter. The differences from ANOVA calculations were tested by Duncan's Multiple Range Test at α=5%. All statistical tests were assisted using IBM SPSS Statistics 20 software.

Reagents needed for analysis are sulfuric acid (H_2SO_4), boric acid, n-Hexane, kalium phosphate (K_2SO_4), taziro indicator, filter paper. All chemicals used are from Merck, Germany.

Making Sample Preparation:

Chia seed ice cream was made by using the formulation stated in Table 1. The flow chart for ice cream preparation was shown in Figure 1. Materials for making chia seed ice cream are Ultra High Temperature (UHT) whole milk of brand Ultra, chia seed of brand Granova, whipped cream of brand Anchor, sugar, egg yolk obtained from Salatiga traditional market.

Table 1. Formulation of the chia seed ice cream

No.	Ingredient	Quantity
1	UHT Milk	500 ml
2	Whipped cream	100 ml
3	Egg yolk	6
4	Sugar	120 g
5	Chia seeds	8,10,12% ($^{v}/_{v}$) from milk

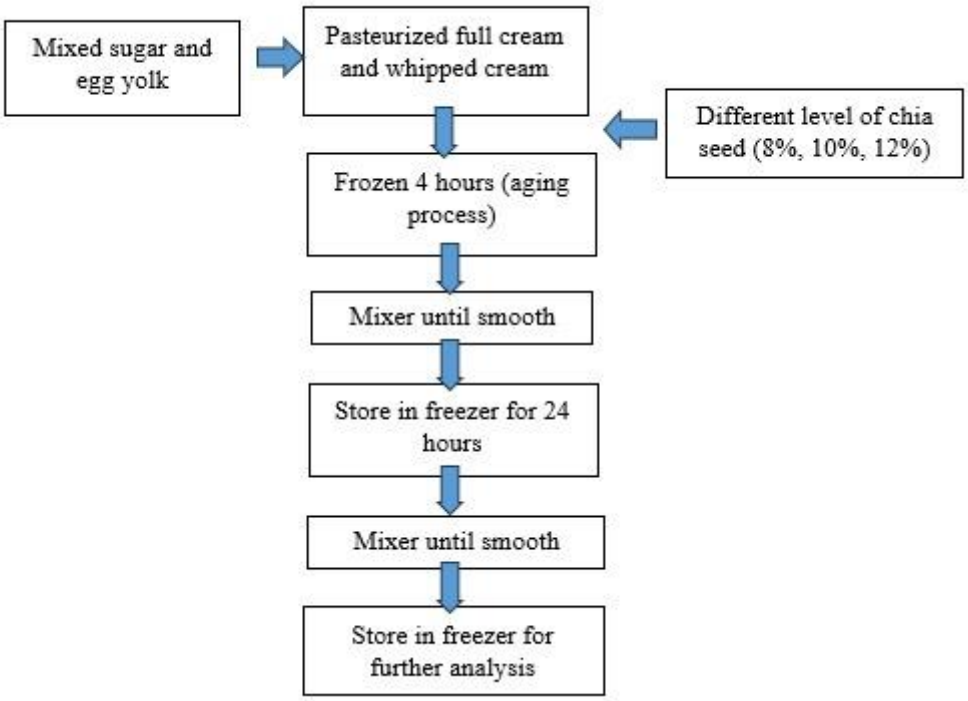

Figure 1. Flow Chart For Ice Cream Preparation

Chemical analysis:

Chemical analysis consists of determination of water, fat, protein, total solid, and fiber content. Water content, lipid (Soxhlet method), and protein (Kjeldahl method) were analyzed using AOAC methods[8]. Total nitrogen was converted to crude protein by using a factor of 6.25. Fiber content was analyzed by using enzymatic gravimetric[9]. Total

solid analysis was carried out by using gravimetric determination[2].

Viscosity Measurement:

Apparent viscosity of chia seed ice cream was measured using a Brookfiled viscometer LVF with spindle number 3 (rpm 60). Readings were taken in 100 ml ice milk at 25C. Viscosity was expressed as centipoises (cP).

Overrun And Melting Rate Measurement[10]:

The overrun test is calculated by weighing the weight of the ice cream mixture that has been made and the weight of the ice cream that has gone through the mixing process with an ice cream maker. The overrun value in this study was calculated based on the following formula[2]:

$$\text{overrun} = \frac{(\text{weight of ice cream mixture} - \text{weight of ice cream})}{(\text{weight of ice cream})} \text{ x } 100\%$$

Sensory evaluation:

Ice cream samples were given to 30 untrained panelists for evaluation of organoleptic characteristics, i.e. color, taste, aroma, and overall acceptability. The samples were judged with rating score 1-5; 1 is dislike extremely, 2 is dislike slightly, 3 is neutral, 4 is like slightly, and 5 is like extremely of each parameter.

RESULTS

The chemical composition of chia seed ice cream is listed in Table 2. There are significant differences (α = 5%) of moisture content between samples. Ice cream with 8% chia seed differs from ice cream with 10 and 12% chia seeds. Table 2 shows that there is increment in water content as chia seeds level increases. There is no significant differences on fat and fiber content. Protein content differed in ice cream with 8 and 12 %. Total solid in 8% chia seed addition differed from two other samples.

The physical properties of ice cream with different level of chia seed were shown in Table 3. It can be seen that the overrun of the ice cream increases as the chia seed level increases. Viscosity is defined as the resistance force by internal friction that affects the flow ability of a fluid. Data shows the tendency of increasing viscosity as chia seed concentrations increases.

Table 2. Chemical Composition of Ice Cream with Different Level Of Chia Seeds

Parameter	Chia Seed		
	8%	**10%**	**12%**
Water (%)	63.889 ± 0.108^{a}	64.246 ± 0.142^{b}	64.420 ± 0.171^{b}
Fat (%)	11.12667 ± 0.263	10.54767 ± 0.163	11.49367 ± 1.293
Protein (%)	4.837 ± 0.119^{b}	$4.549 \pm 0.181^{a,b}$	4.112 ± 0.336^{a}
Fiber (%)	5.99367 ± 0.227	6.44633 ± 0.558	6.90267 ± 1.255
Total solid	41.1633 ± 1.605^{a}	45.98 ± 0.303^{b}	45.207 ± 1.882^{b}

Table 3. Physical Parameter of Ice Cream with Different Level Of Chia Seed

Parameter	Chia Seed		
	8%	**10%**	**12%**
Overrun (%)	27.677 ± 1.899^{a}	$34.527 \pm 1.062^{a,b}$	37.593 ± 1.045^{c}
Melting speed (s)	2083.5 ± 26.163^{a} s	2793.5 ± 6.364^{b} s	2911.5 ± 28.991^{c} s
Viscosity (Cp)	803.800 ± 27.259^{a}	911.800 ± 56.591^{b}	814.200 ± 26.761^{a}

Figure 2 showed the ice cream products with 3 different level of chia seed. Sensory analysis indicated that there were no significant differences in terms of all sensory attributed tested in this study (color, taste, aroma, texture, and overall acceptance). In case of the color, the ice cream has light brown color due to the chia seed color. It is important to maintain the color of the product since it has been reported that sometimes an undesirable of darkening was observed in in food application[11]. Sensory evaluation of chia seed ice cream was displayed in Table 4. There were no significant differences for each treatment in terms of color, taste, aroma, and overall acceptance.

8% 10% 12%

Figure 2. Ice Cream with Different Level of Chia Seeds Concentration

Table 4. Sensory Evaluation of Ice Cream with Different Level Of Chia Seeds

Sensory Parameter	Chia Seed concentration		
	8%	**10%**	**12%**
Colour	4.03 ± 0.669^a	3.87 ± 0.73^a	3.9 ± 0.845^a
Taste	4.13 ± 0.86^a	4.07 ± 0.691^a	4.03 ± 0.928^a
Aroma	3.63 ± 0.85^a	3.43 ± 0.858^a	3.63 ± 0.85^a
Texture	4.03 ± 0.928^a	3.5 ± 0.861^a	3.87 ± 0.9^a
Overall acceptance	4.00 ± 0.743^a	3.73 ± 0.691^a	3.87 ± 0.776^a

DISCUSSIONS

The mucus from chia seeds has ability as moisture retainer[12]. It is known that water absorption of chia seeds can reach up to 95.6 g H_2O/g[13]. The mucus consists of D-xylose, D-glucose, 4-O-methyl glucuronic acids, those of which make polymeric chains that have anionic characters. Therefore, it has high hygroscopicity, due to the hydrophilic groups and free chains in its molecular structure[13]. Water content of chia seed ice cream in this study is well aligned with other study[14]. The water content of product of ice cream with different level of chia seed gels (0.1-0.4%) are in the range of 63-64%[14]. The similar water content of different chia seed levels (0.1-0.4 % versus 8-10 %) can be due to different form of chia seed gel. In their study, the addition of chia seed was done when the chia seeds already form a pure gel. The water has been separated through centrifugation, while in this study chia seed was added without centrifugation. In addition, the formulation of ice cream preparation also different.

Interestingly, the fat and protein content of chia seeds in this study were also similar with other study[12]. On that study, the fat and protein content were in the range of 10.3 – 10.9%, and 4.04 – 4.09%, respectively, meanwhile our studies were in the rage of 10.5 – 11.5% (fat) and 4.1 – 4.8% (protein). There is no significant different in fat content for each sample in this study.

There is a specification for ice cream mix formulations that specify the fat content, solids-non-fat, sweeteners, stabilizers, emulsifiers, and water content that are desired[15]. Fat content in ice cream mix is in the range of 10-16%. Based on fat content of chia seed ice cream, it can be categorized as ice cream dessert, but it cannot be categorized as low-fat food since it has more than 30% calories that come from fat[16]. Nevertheless, chia seed contains 30-40% fat, whereas nearly 60% of total fat is omega 3[7].

The chia seeds addition also made the ice cream moderately high in fiber. Chia seed addition makes those ice cream contains more than 6% fiber in 12% chia seed addition, while 8% chia seed addition contains 6%, and 10% chia seed addition contains 6,4% fiber, respectively. According to BPOM regulation No. 13/2016 food rich in fiber contain more than 6 g fiber/100 g sample[6].

Protein content in different dosage of chia seeds differs among sample. The one with 8% chia seeds level has the highest protein content, and the one with 12% chia seeds has the lowest. It has tendency to decrease with the increasing chia seeds level. The higher the chia seeds content causes the ice cream mixture become more diluted since the addition of chia seeds were based on the milk volume. Higher content of chia seeds causes less protein that comes from milk and egg. Therefore, it is reasonable to see the protein reduction with higher chia seeds content. Nevertheless, all treatment shows the protein content is in the range of 4-5%.

The crude fiber content increases as chia seeds level increase. It is understandable as chia

seeds are one of ingredient that is rich in dietary fiber[17]. Total solid content is the highest in sample with 10% chia seed levels, although there are no significant differences with the one with 12% chia seed levels. According to Indonesian National Standard, total solid requirement for ice cream is minimal 31%, and all chia seed ice cream fulfils the requirement[18].

It can be seen that the overrun of the ice cream increases as the chia seed level increases. This finding was correlated well with other studies that indicated the role of chia seed gel in affecting overrun of the ice cream[14]. Chia seed gel increases the whipping rate, resulted in increases of overrun. In addition, chia seed has an excellent water holding capacity.

Chia seed fortifications resulted in reduce of melting rate[19]. The reduction rate was parallel with chia seeds concentrations. Ice creams containing chia seed gel should melt more slowly than the one without chia seed gel[14]. This is due to the slow rate of heat transfer through the ice cream. Our study shows the same pattern, the higher the chia seeds level the slower the melting rate of the ice cream. The good melting rate for ice cream is 900-1200 seconds, and all the ice cream with different addition of chia seed level has reached the requirements[20].

Chia seed has ability of making gel, which is caused by its mucus property that swells and forms a gel when contact with water[12]. Freezing also has a positive effect on the properties of chia seed gel. Many authors had observed this phenomenon[19]. However, our data showed that there was no significant different in viscosity for ice cream with 8 and 12% addition of chia seed. Surprisingly, the highest viscosity occurs in ice cream with 10% chia seed, instead of 12% addition and the statistical data showed significant differences from 2 other samples (8 and 12% level of chia seed). Viscosity is affected by the hydration degree of chia seed. It is assumed that the hydration degree reached its maximum at 10% level, and decrease at 12%. Other researchers showed that there was slight fluctuation in effective viscosity for system with different level of hydration[12]. It decreases at 1:10, does not change at 1:15, decreases at 1:20, and increases at 1:25 hydration level. So, the fluctuation of viscosity in Table 3 can be caused by the hydration levels of chia seed.

Many studies have reported that the addition of chia seed improve the texture of ice cream. Addition of chia seed form homogenized structure, good distribution of air cells[21]. However, it seems that there is maximum concentration for chia seed addition in ice cream preparation. Furthermore, in our study the addition of chia seed also includes the seed, not only the mucilage. From Table 4, it can be seen that the highest rank for texture occurred for sample with 8% addition. The score for 12% chia seed addition only got score of less than 4 (neither like nor dislike). Higher concentration of chia seed causes panelist to taste the seeds, and affects the overall acceptance and sensory attributes in this study. Some panelists found it is uncomfortable to sense the sandiness of the product due to the existence of chia seeds in the product.

CONCLUSIONS

From this study, it can be concluded that it is possible to increase the total fiber content of ice cream using chia seeds. Addition of chia seeds improve the overrun, viscosity, and slow down the melting rate of the ice cream. For sensory analysis, there was no significant different in each sample. Physical analysis showed that the viscosity, overrun, and melting rate has tendency to increase due to chia seeds' addition. The best addition of chia seeds in the ice cream was 8% according to the result of sensory analysis. However, statistical analysis shows that there are no significant differences in overall acceptance by panelist. Therefore, ice cream with highest chia seed content can be endorsed as healthy food due to its fiber content.

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REFERENCES

1. Lanusu AD, Surtijono LCM, Kasiroh, Sondakh EHB. Sifat Organoleptik Es Krim dengan Penambahan Ubi Jalar Ungu (Ipomea batatas L). . Zootech. 2017;37(2):474–82.
2. Pangesti WD, Valentinus PB, Antonius H. Karakteristik Es Krim Ubi Jalar Ungu (Ipomoea batatas L.) dengan Penambahan Pati Garut (Maranta arundinacea) sebagai Bahan Penstabil. Jurnal Teknologi Pangan. 2019;3(2):1–6.
3. Nuryati N, Cicilia, Legowo AM, Nurwantoro N. Karakteristik Fisik dan Sensoris Es Krim Kacang Merah (Phaseolus vulgaris L.) Dengan Penambahan Tepung Umbi Gembili (Dioscorea esculenta L.) Sebagai Penstabil. Jurnal Agroteknologi. 2020;14(2):199–207.
4. Arumsari, Imas, Mira S. Evaluasi Zat Gizi Tepung Chia (Salvia hispanica L.) dan Tepung Wijen (Sesamum indicum L) Sebagai Alternatif Tepung Tinggi Serat dan Protein. Argipa. 2020;5(1):27–33.

5. Marineli R da S, Moraes ÉA, Lenquiste SA, Godoy AT, Eberlin MN, Maróstica Jr MR. Chemical characterization and antioxidant potential of Chilean chia seeds and oil (Salvia hispanica L.). LWT - Food Science and Technology. 2014 Dec;59(2):1304–10.
6. Badan Pengawas Obat dan Makanan. Peraturan BPOM No. 13/2016 Tentang Pengawasan Klaim pada Label dan Iklan Pangan Olahan. Jakarta; 2016.
7. Rasbawati, Irmayani. Pemanfaatan Biji Chia (Salvia hispanica L.) untuk Meningkatkan Kualitas Susu Diversifikasi. Jurnal Peternakan Indonesia (Indonesian Journal of Animal Science). 2021;23(2):159–67.
8. AOAC. Official Methods of Analysis of the Association of the Official Analytical Chemist. Washington DC, USA; 2005.
9. McClearly BV, Draga A. Measurement of Total Dietary Fiber Using AOAC Method 2009.01 (AACC International Approved Method 32-45.01): Evaluation and Updates. Cereal Chemistry . 2013;90(4):396–414.
10. Choi MJ, Shin KS. Studies of Physical and Sensory Properties of Premium Vanilla Ice Cream Distributed in Korean Market. Korean Journal Food Science Animal. 2014;34(6).
11. Silva ELLG, Da Silva CAS, Santana RDC. Rheology of dispersions and emulsions composed of chia mucilage and the application of chia in food. J Sci Food Agric . 2022 Oct;102(13):5585-5592.
12. Strashynskyi I, Grechko V, Fursik O, Pasichnyi V, Marynin A. Determining The Properties Of Chia Seed Meal Gel. Eastern-European Journal of Enterprise Technologies. 2021;6(11(114)):90–8.
13. Ramos IF da S, Fernandes VL, Lucena M de A, Geronço MS, Da Costa MP, Rizzo M dos S, et al. Chia seed mucilage (Salvia hispanica L.): An emerging biopolymer for industrial application. Brazilian Journal of Development. 2023 Jan 11;9(1):2237–58.
14. Krishi Vidyapeeth M, Gadhe IK, Dipak Sharma I, Hingade IS, Sharma D. Studies on extraction and utilization of chia seed gel in ice cream as a stabilizer. ~ 1367 ~ Journal of Pharmacognosy and Phytochemistry. 2017;6(5).
15. Goff HD. Lipid. In: Fox PF, McSweeney PLH, editors. Advanced Dairy Chemistry. 3rd edition. New York: Springer; 2006.
16. Bhandari P, Sapra A. Low Fat Diet. Treasure Island (FL): StatPearls Publishing; 2023.
17. Hrnčič MK, Ivanovski M, Cör D, Knez Ž. Chia Seeds (Salvia Hispanica L.): An overview-phytochemical profile, isolation methods, and application. Vol. 25, Molecules. MDPI AG; 2020.
18. Badan Standarisasi Nasional. Syarat Mutu Es Krim SNI-01-3713. Jakarta; 2018.
19. Zaky WM, Abbas M, Abd WI, Nasr EA, El-Desoki WI. Chia Seeds as Natural Stabilizer and Healthy Ingredient in Ice Milk Preparation. World Journal of Dairy & Food Sciences. 2019;14(1):52–8.
20. Haryanti N, Zueni A. Identifikasi Mutu Fisik, Kimia Dan Organoleptik Es Krim Daging Kulit Manggis (Garcinia Mangostana L.) Dengan Variasi Susu Krim. AGRITEPA: Jurnal Ilmu dan Teknologi Pertanian. 2015 Nov 12;2(1).
21. Coorey R, Tjoe A, Jayasena V. Gelling Properties of Chia Seed and Flour. J Food Sci. 2014;79(5).