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Analysis of ice creams from goat milk kefir and red dragon fruit

Aman Santoso[1], Lilik Eka Radiati[2], Evy Damayanthi[3], Armaini Armaini[4], Amiroh Nabilah Mujahidah[1], Eli Hendrik Sanjaya[1], Muntholib Muntholib[1], Muhammad Roy Asrori[1]
[1]Department of Chemistry, Faculty of Mathematics and Natural Sciences, Universitas Negeri Malang, Malang, Indonesia
[2]Department of Animal Product Technology, Faculty of Animal Science, Universitas Brawijaya, Malang, Indonesia
[3]Faculty of Human Ecology, IPB University, Bogor, Indonesia
[4]Department of Chemistry, Faculty of Mathematics and Natural Sciences, Universitas Andalas, Padang, Indonesia

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ABSTRACT

Ice cream from goat milk kefir is lower lactose than cow milk kefir. Combining goat milk kefir with red dragon fruit in ice cream formulations can improve the quality of the product. This study aims to determine the sensory characteristics, total solid, total flavonoid, and antioxidant activity of goat kefir-based ice cream flavored red dragon fruit as quality evaluation. The study used a completely randomized design with 4 treatments and 3 replications. The treatment was the ratio of goat kefir and dragon fruit, including 40:60, 50:50, 60:40, and 70:30 in the ice cream mixture. 30 panelists participated in the organoleptic test. Total solid testing referred to SNI 01-3713-1995. Determination of total flavonoid content was carried out by forming $AlCl_3$ complexes spectrophotometrically and assaying antioxidant activity used 2.2-diphenyl-1-picrylhydrazyl (DPPH) method. The results showed that there was no significant difference in the organoleptic test for taste, color, and texture. The results of the total solids test showed that the higher the addition of goat kefir to ice cream, the lower the total solids produced. While the addition of goat kefir increased the total flavonoids in ice cream. The antioxidant activity with the best formulation of 50:50 was categorized as moderate level, which is 136.59 ppm.

Corresponding Author:

Aman Santoso
Department of Chemistry, Faculty of Mathematics and Natural Sciences, Universitas Negeri Malang
Jl. Semarang No. 5, Malang, 65145, Indonesia
Email: aman.santoso.fmipa@um.ac.id

1. INTRODUCTION

Recent trending studies, functional food products combine nutritional value and health functions. Functional food products are active food ingredients that enrich the health benefits and the nutritional benefits [1]. Many functional food ingredients are made from natural ingredients with unique combinations [2]. One of the functional foods is ice cream. Ice cream is one of the favorite foods considering consumer perceptions because ice cream has high market potential, given its high prevalence of consumption and acceptability [3]. Ice cream is a food product with high sensory acceptance and has high opportunities if it is developed as a business [4]. The global consumption of ice cream was approximately 2 L per person per year [5]. Ice cream can be unhealthy and less interesting if it is made from high lactose content, sugar content, and fewer combinations for particular people [6].

Kefir is a probiotic drink produced through the fermentation process of milk using kefir grains [7]. Kefir has good benefits for the human body such as increasing immunity, controlling blood sugar levels, lowering blood cholesterol levels, improving the digestive process, and reducing the risk of cancer [2]. In general, kefir contains protein with complete essential amino acids, vitamins, and minerals [8]. Interestingly,

ice cream can be an alternative in developing kefir products to increase consumer acceptance. Kefir is a potential raw material for milk substituent, especially goat milk-based kefir [9].

Goat milk-based kefir has a higher content of proximate values and vitamin-mineral composition [10]. In addition to the most optimal kefir grains, namely 5%, the levels of carbohydrates and protein in goat milk kefir were higher than in cow's milk kefir [11]. The production of Etawa goat milk kefir was able to significantly reduce milk lactose levels from 3.29 to 2.45% [12]. The low lactose in goat milk kefir can be beneficial for the required nutrition of individuals who have lactose intolerance [13]. Based on these various advantages, goat milk kefir can be used as a substitute for milk in making ice cream.

Ice cream usually improves sensory characteristics and nutritional values using other ingredients, like flavored mint [14]. Based on previous studies, the addition of kefir as a raw material for making ice cream is less acceptable [4]. Subsequently, it is necessary to fortify fruits such as *Hylocereus polyrhizus* (F.A.C. Weber) Britton and Rose (red dragon fruit). Red dragon fruit was chosen as a fortifier because it contains betacyanin that is functions as a natural coloring agent. In addition, betacyanin in red dragon fruit also contains bioactive compounds such as vitamin C, vitamin B, vitamin E, flavonoids, carotenoids, anthocyanins, and polyphenols which have potential as antioxidants. The antioxidant activity of red dragon fruit is higher than white dragon fruit [15].

The previous study reported a goat milk kefir in probiotic ice cream [16] and goat milk kefir mixed with mono-acylglycerol in ice cream [17]. The goat milk kefir was reported to be mixed with Moringa leaf flour [18]. On the other hand, goat milk kefir-based ice cream flavored red dragon fruit [19]. The study just varied the kefir concentration of 0-30%. The previous studies did not evaluate the combined formulation of red dragon fruit [19]. In this study, the mixing combinations of goat milk kefir and red dragon fruit are 40:60, 50:50, 60:40, and 70:30). Therefore, this study aims to determine the sensory characteristics, total solid, total flavonoid, and antioxidant activity of goat kefir-based ice cream flavored red dragon fruit in their combination. The best formulation has been described. The addition of red dragon fruit can suppress the sour taste in kefir and the resulting color will be more attractive. The red dragon fruit is also expected to increase the potential for goat milk kefir as a healthy ice cream.

2. RESEARCH METHOD

2.1. Materials

The used ingredients included goat milk kefir, red dragon fruit, stevia sugar, cinnamon, and fiber crème. The materials used to carry out the tests included ethanol (70%, technical), 2.2-diphenyl-1-picrylhydrazyl (DPPH) (smartlab brand), $AlCl_3$ (10%, technical), sodium acetate (1 M, technical), ethanol p.a., and distilled water. The used equipment included Erlenmeyer, glass funnel, micropipette, ultrasonic cleaner (KSU-300), UV-VIS spectrophotometer (Jasco VP-730), porcelain cup, water bath, oven, desiccator, and analytical balance.

2.2. Production of ice cream

Ice cream making consisted of 4 treatments and 3 repetitions, namely the ratio of kefir and dragon fruit. The ingredients that have been mixed in Table 1 were pureed using a blender. Ice cream was made by stirring the product with a mixer over a bowl of ice cubes for 15 minutes. The ice cream was then frozen in the freezer.

Table 1. Composition of ice cream composition

Material	Treatment			
	I	II	III	IV
Kefir	40 g	50 g	60 g	70 g
Red dragon fruit	60 g	50 g	40 g	30 g
Fiber crème	20 g	20 g	20 g	20 g
Stevia sugar	3 drops	3 drops	3 drops	3 drops
Cinnamon	2 g	2 g	2 g	2 g

2.3. Organoleptic test

The organoleptic test is a hedonic test where panelists choose the best formulation based on their level of preference for taste, texture, and color [20]. The organoleptic test used 30 untrained panelists from the employees of Materia Medica Batu, Indonesia. This organoleptic test used 5 scales in the assessment, namely scale 1=really dislike, scale 2=dislike, scale 3=neutral, scale 4=like, and scale 5=really like.

2.4. Total solid test

Determination of total solids referred to SNI 01-3713-1995. Firstly, the porcelain cup was weighed. Then, 2 g of sample was added, followed by the addition of 5 mL of distilled water and evaporated in a water bath at 90 ℃ for 30 minutes. Then, it baked for 3 hours using a desiccator and cooled in a desiccator. The sample weight was weighed with an analytical balance. Total solids were calculated using (1).

$$\%Total\ solids = \frac{weight\ of\ remain\ dried\ sample}{weight\ of\ sample} \times 100\% \quad (1)$$

2.5. Total flavonoid test

Determination of total flavonoids using the $AlCl_3$ complex method with modifications of using ethanol solvent [21]. The total flavonoid test was carried out by dissolving the sample using 70% ethanol. The sample (1000 ppm) was pipetted as much as 0.5 mL and put into a brown bottle. It was then added 1.5 mL of ethanol p.a., 0.1 mL of 10% $AlCl_3$, 0.1 mL of 1 M sodium acetate, and 2.8 mL of distilled water. It was then shaken and left for 30 minutes. Then the absorbance of the UV-Vis spectrophotometer was measured at the wavelength (λ) of 425 nm.

2.6. Antioxidant activity test

Antioxidant activity was measured using the DPPH method with modifications of using ethanol solvent [22]. An antioxidant activity test was carried out by dissolving the sample using 70% ethanol. Concentration series of 100, 50, 25, 12.5, 6.25, and 1.5 ppm were prepared. 1 mL of each concentration was taken and put in a brown bottle. Then, it was added 1 mL of 4% DPPH solution. Next, it was incubated in a dark room for 30 minutes at room temperature. Then the absorbance of the UV-Vis spectrophotometer was measured at the wavelength (λ) of 522.5 nm. The value was then analyzed to determine the IC50 using SNI 8623:2018. The IC50 value categories are very active for <50 ppm, active for 50-100 ppm, moderate for 100-150 ppm, and weak for 151-200 ppm.

3. RESULTS AND DISCUSSION

3.1. Sensory analysis of the ice cream

Based on the research, the organoleptic test results for ice cream are listed in Table 2. Based on the analysis of color, taste, and texture, it shows that there is no significant difference between the treatments. The color of goat milk kefir-based ice cream flavored red dragon fruit did not show a significant difference. The lower the addition of goat milk kefir, the darker the purple color will be. So, betacyanin content (as in flavonoid content) relates to the addition of goat milk kefir. In the color study of the treatment (70:30), dragon fruit had the highest score. This is caused by the increasing betacyanin pigment produced by dragon fruit. Betacyanin is a red pigment that has the potential as a natural coloring agent [23]. Compared to goat milk kefir, the color of moringa leaves was higher (score: 3.37) [18].

Table 2. Sensory characteristics of goat kefir-based ice cream flavored red dragon fruit

Parameter	Treatment of kefir: red dragon fruit				Score criteria (1–5 scale)
	70:30	60:40	50:50	40:60	
Color	4.04±0.71	3.96±0.71	3.7±0.67	3.67±0.62	not interest-very interest
Taste	3.26±1.06	3.37±0.74	3.3±0.95	3.19±1.11	not tasty-very tasty
Texture	3.52±0.75	3.63±0.57	3.7±0.78	3.85±0.72	Dislike-very like

The addition of goat milk kefir did not show a significant difference to ice cream. The taste with the highest score was obtained in the treatment (50:50). This is caused by the higher addition of goat milk kefir causing the ice cream to taste sourer. Based on the study, ice cream with goat milk kefir has a sour taste and aroma and has the aroma of alcohol and carbonates produced during the fermentation process by kefir grains [24]. In addition, the treatment (50:50) produced the right combination of flavors where the addition of red dragon fruit did not cover the distinctive taste of goat milk kefir. On the other hand, the use of stevia sugar in the ice cream gives good nutrition because of its low caloric value [25], so the ice cream is worthy as a healthy ice cream. Compared to goat milk kefir, the flavor of moringa leaves was higher (score: 3.14) [18].

Goat milk kefir-based ice cream flavored red dragon fruit did not show a significant difference in the resulting texture. The texture of ice cream is influenced by the composition of the ingredients used (ice cream mix), how the ice cream is processed and how it is stored [6]. The lower the addition of goat milk kefir, the higher the level of preference for texture because the amount of water produced decreases. Where the highest score on texture was obtained in the treatment (40:60). This is in accordance with research that

the reduced amount of water will increase the total solids thereby reducing the potential for the formation of larger ice crystals [26]. In this way, the softer ice cream, the less the addition of goat milk kefir. An ice cream with good texture is an ice cream that is smooth/soft, not hard, and looks shiny [27]. In the case of storage, the texture of the ice cream tends to change because of the significant change in grainy texture, serum separation, protein precipitation, and heterogeneous display in the kefir [24]. Compared to goat milk kefir, the texture of moringa leaves was higher (score: 3.22) [18].

The hedonic test assessment of ice cream that was carried out included color, texture, and taste. Selection of the best treatment was carried out by statistical analysis using the exponential comparison Method. The results of the best treatment for the sensory characteristics of the ice cream, namely the addition of goat milk kefir and dragon fruit with a ratio of 50:50. The treatment gives the three parameters (color, taste, and texture) in the balance value. The color produced in this study is purplish red which is dominated by the betacyanin content of dragon fruit. The sweet, slightly sour taste of ice cream is characteristic of kefir and red dragon fruit. The soft texture of ice cream is a characteristic of an ice cream that is known and liked by society. In this study, the combined formulation has had a significant effect on hedonic tests. This result was the same as the effect of kefir concentration in the previous study [19].

3.2. Total solids of the ice cream

Total solids are all the solid components contained in foodstuffs, the solids content also includes protein, fat, and carbohydrates [28]. Total solids play a role in the formation of taste, lowering the freezing point and increasing the viscosity of the ice cream mixture [29]. The higher the addition of goat milk kefir, the lower the total solids produced due to the high-water content it has. Whereas goat milk kefir has a water content of 88.06% [30]. The total solids of the ice cream in this study can be seen in Figure 1.

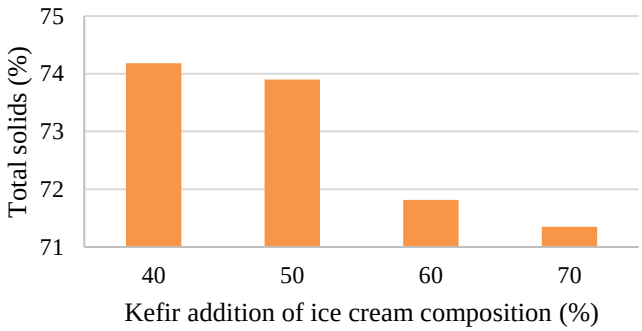

Figure 1. Total solids of ice cream based on the addition of goat milk kefir composition

The results of the total solids test (Figure 1) showed that there were significant differences ($p < 0.05$) between the treatments. The highest total solids obtained in the treatment (40:60) was 74.18%. While the lowest total solids were obtained in the treatment (70:30) was 71.35%. The yield of total solids in this study is in accordance with SNI 01-3713-1995, which is a minimum of 34%. A previous study showed that ice cream of cow milk kefir with the addition of purple sweet potato obtained 40.60%, and the previous study was lower than this study.

3.3. Total flavonoid of the ice cream

Flavonoids are a group of natural antioxidants that are easily digested by humans and play an important role as anti-inflammatory, anti-allergic, and anti-cancer [31]. Flavonoids have a framework consisting of an aromatic ring A, an aromatic ring B, and a ring in the middle which is heterocyclic and has oxygen, where the oxidized form of the ring is the basis for dividing flavonoids into their sub-groups [32]. Flavonoids act as antioxidants which can directly capture free radicals to produce radicals that are more stable and less reactive [33]. Based on their oxidative properties, flavonoids have certain biological effects [34].

Determination of levels of flavonoids refers to the previous method [35]. The principle of this method is the formation of a complex between aluminum chloride with the keto group on the C-4 atom and the hydroxy group on the C-3 or C-5 atom. In this study, the determination of the levels of flavonoids using quercetin solution as a standard. The results showed that quercetin had the highest absorbance reading among

the 15 standardized flavonoids [35]. Therefore, this study uses a quercetin solution as a standard at a concentration of 0-125 ppm to build a calibration curve.

Absorbance measurements were carried out at a wavelength (λ) of 435 nm. Based on a standard quercetin solution, a linear regression value of y=0.0027x+0.0006 was obtained with an R^2 value of 0.9997. The value of R^2 which is close to 1 indicated that the resulting calibration curve is linear and there is a relationship between the concentration of the quercetin solution and the absorbance value. Based on the calculation results in Figure 2, the total flavonoids increased with the addition of goat milk kefir. Additionally, the flavonoid content in this study is affected by the composition of the ice cream. In the previous study, the flavonoid content in this study is lower than the flavonoid content of grape, pomegranate, and sesame seed powder on cow milk-based ice cream [36]. This may be caused by the formulation and different production methods.

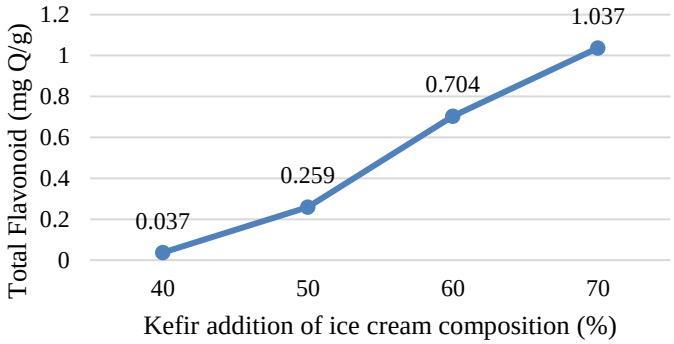

Figure 2. Total flavonoids based on addition to goat milk kefir composition

3.4. Antioxidant activity of the ice cream

In this study, the method used was the DPPH method. The basis of the DPPH method is the ability of a compound to capture DPPH radicals giving a violet color [37]. The sample to be tested is reacted with DPPH solution. After being reacted, the DPPH solution which was originally purple changed to yellow due to the addition of the sample. This color change occurs due to the presence of compounds in the sample that donate hydrogen atoms to the DPPH radical so that it is reduced to a more stable form, namely DPPH-H [38].

The results of the analysis of the antioxidant activity of the made ice cream were carried out using the DPPH method. A compound is said to be a very active antioxidant if the IC50 value is <50 ppm, active if the IC50 value is between 50-100 ppm, moderate if the IC50 value is 100-150 ppm and weak if the IC50 value is between 151-200 ppm [39]. In this study, the IC50 value of the made ice cream was 136.59 ppm. The IC50 value may be affected by the composition of the ice cream, especially the fruit contributing to the antioxidant activity. The content of betacyanin which has N-heterocyclic in red dragon fruit has antioxidant activity and is able to ward off free radicals [40]. More composition of the fruit may increase the antioxidant activity. IC50 value in this study is better than the previous study in which cow milk kefir-based ice cream with the addition of mint aroma showed IC50 in the range of 736.22–594.75 ppm as a weak category [14].

4. CONCLUSION

In this study, the formulation of goat milk kefir-based ice cream flavored red dragon fruit did not show a significant difference. The result of the best treatment for the sensory characteristics is the addition of goat milk kefir and dragon fruit with a ratio of 50:50. The total solids test showed that the higher the addition of goat milk kefir to ice cream, the lower the total solids produced. The results of the total flavonoid test showed that the addition of goat milk kefir increased the total flavonoids in ice cream. Antioxidant activity in ice cream with the treatment of 50:50 was categorized as moderate (136.59 ppm). As a result, additional and in-depth research may be required to confirm its nutritional content regarding healthy benefits. The formulation of the ice cream can be introduced into an economic start-up, and the future research of this study will implement proximate analysis, nutritional degradation test, preservative test, and get licensing business. As an economic implication, this study can promote the new variant of ice cream both in the market and in e-commerce.

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AUTHOR CONTRIBUTIONS STATEMENT

This journal uses the Contributor Roles Taxonomy (CRediT) to recognize individual author contributions, reduce authorship disputes, and facilitate collaboration.

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Aman Santoso	✓	✓		✓		✓	✓	✓	✓	✓			✓	✓
Lilik Eka Radiati	✓			✓	✓					✓		✓		
Evy Damayanti	✓				✓					✓		✓		
Armaini Armaini	✓			✓				✓	✓					
Amiroh Nabilah Mujahidah		✓	✓			✓	✓		✓		✓		✓	
Eli Hendrik Sanjaya				✓	✓				✓					
Muntholib Muntholib					✓					✓				
Muhammad Roy Asrori	✓		✓							✓	✓			

C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

DATA AVAILABILITY

The data that support the findings of this study are available from the corresponding author, [AS], upon reasonable request.

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BIOGRAPHIES OF AUTHORS

Aman Santoso is a full professor at Chemistry, Universitas Negeri Malang. He received a Ph.D. degree in Agricultural Science from Brawijaya University. His research interests are biodiesel, pyrolysis, cracking, antioxidants, agricultural products, and methanol. He can be contacted at email: aman.santoso.fmipa@um.ac.id.

Lilik Eka Radiati is a full professor at the Department of Animal Product Technology, Faculty of Animal Science, Universitas Brawijaya. Her research interests are yogurt, fermented milk, kefir, and probiotics. She can be contacted at email: lilik.eka@ub.ac.id.

Evy Damayanthi is a full professor at the Faculty of Human Ecology, IPB University, Jl. Raya Dramaga, Bogor, 16680, Indonesia. Her research interests are antioxidants, plant extract, and moringa oleifera. She can be contacted at email: edamayanthi@apps.ipb.ac.id.

Armaini Armaini is a full professor at the Department of Chemistry, Faculty of Mathematics and Natural Sciences, Universitas Andalas, Limau Manis, Pauh, Padang, 25175, Indonesia. Her research interests are microorganisms, carotenoids, nanoparticles, and antioxidant activity. She can be contacted at email: armaini@sci.unand.ac.id.

Amiroh Nabilah Mujahidah is student at Chemistry, Universitas Negeri Malang. She received student in chemistry from Universitas Negeri Malang. Her research interest is antioxidants. She can be contacted at email: amiroh.nabilah.1903326@students.um.ac.id.

Eli Hendrik Sanjaya is lecture at Chemistry, Universitas Negeri Malang. He received a Ph.D. degree in Environmental Engineering from Tohoku University. His research interests are nitrogen removal, wastewater treatment, biodegradation, and biodiesel. He can be contacted at email: eli.hendrik.fmipa@um.ac.id.

Muntholib Muntholib is a full professor at Chemistry, Universitas Negeri Malang. He received a doctorate in chemical education from Universitas Negeri Malang (UM). His research interests are science education, metacognition, and sequential extraction. He can be contacted at email: muntholib.fmipa@um.ac.id.

Muhammad Roy Asrori is an analyst at Universitas Negeri Malang. He received a master's degree in Chemistry from Universitas Negeri Malang (UM) in 1998. His research interests are biodiesel, transesterification, and methanol. He can be contacted at email: muhammad.royasrori@um.ac.id.