LenteraBio
Berkala Ilmiah Biologi

LenteraBio, 2026; Volume 15, Issue 2: 191-196

p-ISSN: 2252-3979 e-ISSN: 2685-7871
https://journal.unesa.ac.id/index.php/lenterabio/index

Effect of Mung Bean Microgreen (*Vigna radiata*) Filtrate and Fermentation Time on Yogurt Quality

Fatimah Nabila Putri*, Mahanani Tri Asri
Program of Biology, Faculty of Mathematics and Natural Sciences, Universitas Negeri Surabaya
Kampus Unesa 1, Jl. Ketintang Surabaya 60231 Indonesia
* e-mail: fatimahnabila.21015@mhs.unesa.ac.id

Article History:
Received:
22-July-2025
Revised:
4-May-2026
Available online:
31-May-2026
Published regularly:
31-May-2026

Abstract
This study aims to evaluate supplementation of mung bean microgreen (*Vigna radiata*) filtrate concentration and fermentation duration on the protein and fat content, as well as the organoleptic and hedonic properties of yogurt. This test used an experimental method with a completely randomized design (CRD) with two replications. Yogurt was added filtrate at various level and fermented at the duration of 12 h or 24 h. Data was analyzed both descriptively and quantitatively. The results showed that fermentation duration and the addition of mung bean microgreen filtrate at different concentrations affected the protein and fat levels, as well as the organoleptic and hedonic properties of yogurt. The protein ranged from 1.65-3.25%, fat ranged from 0.24-0.74%, texture ranged from score 1.13-2.86, odor ranged from score 1.2-2.66, taste score ranged from 1.13-2.8, consistency ranged from score 2-2.4, color ranged from score 1.2-2.73, and hedonic ranged from score 1.13-2.06. The best result was obtained from yogurt with 25% filtrate at 24 h fermentation.

Keywords: microgreens; protein content; *Vigna radiata*; yogurt quality; nutrition.

How to Cite: Putri FN and Asri MT, 2026. Effect of mung bean microgreen filtrate and fermentation time on yogurt quality. LenteraBio; 15(2): 191-196.

DOI: https://doi.org/10.26740/lenterabio.v15n2.p191-196

INTRODUCTION

The necessity for healthy food for the community continues to increase as advances in science and technology significantly impact human health; therefore, continuous innovation is driving the food industry. Functional foods are also known as healthy food products (Rizal *et al*., 2016), for example yogurt (Suter, 2013), which was made from milk fermented using lactic acid bacterias (LAB) such as *Lactobacillus bulgaricus* and *Streptococcus thermophilus*. Yogurt contains probiotics beneficial to gut health resulted from fermentation process. Fermentation caused by microbe growth changes the chemical composition of its substrate. Fermentation is affected by many factors, for example its duration. Fermentation can also affect bacterial activity, and prolonged fermentation possibly results in intensified activity of LAB (Kartikasari & Nisa, 2014).

Yogurt is also enjoyed widely by Indonesians, including children. The benefits of consuming yogurt include regulating digestive function, preventing diarrhea, lowering blood cholesterol levels, and helping people with lactose intolerance (Purwantiningsih *et al*., 2022). It also contains protein at 4-6% and fat at 0.1-1% (Damunupola *et al*., 2014). Various ingredients can be added to enhance nutrition of yogurt, for example mung bean microgreen.

Microgreens are a type of plant cultivation harvested at seedling stage (Ramadhayanti *et al*., 2021). Microgreens have been studied to contain higher nutritional value than mature vegetables (Singh *et al*., 2019). Many Indonesians consume mung beans as a source of plant-based protein. The level of protein and fat in mung bean microgreens was found at 4.55% and 0.36%, respectively (Kowitcharoen *et al*., 2021), higher than those in mung bean sprouts and seeds. Previous study on yogurt added with mung beans found that it m*et al*l criteria of Indonesian quality standards for yogurt, except for protein content (Kumalasari and Fajriyanti, 2024). As microgreens contains higher protein and fat, it can be a promising innovation to enhance the nutritional content of yogurt.

The use of mung bean microgreen filtrate in different fermentation periods to enhance yogurt quality as specified by SNI 2981:2009 had not been studied. Thus, this study is aimed to evaluate the effects of mung bean (*V. radiata*) microgreen filtrate addition and fermentation duration on the protein and fat levels, organoleptic properties, and hedonic characteristics of yogurt.

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MATERIALS AND METHODS

This experimental study was conducted in the Microbiology Laboratory Building C-10, Department of Biology, and IDB Biology Laboratory, Faculty of Mathematics and Natural Sciences, Surabaya State University, from January to February 2025. This study used a completely randomized design with combination of two factors; first was concentration of mung bean microgreen filtrate (0%, 15%, 20%, and 25%) while the second was fermentation duration (12 h and 24 h). The treatment groups consisted of L1 (12 h fermentation period, 0% filtrate); L2 (12 h, 15%); L3 (12 h, 20%); L4 (12 h, 25%); B1 (24 h, 0% filtrate); B2 (24 h, 15%); B3 (24 h, 20%); B4 (24 h, 25%).

The preparation of mung bean microgreen filtrate followed Serlahwaty and Syarmalina (2015). Filtrate was prepared by weighing 100 g of fresh, rootless mung bean microgreens, washed with running water, which then blended in 400 ml of distilled water (1:4 w/v). The mixture was then filtered using a strainer and the resulting filtrate was collected. Filtrate was added at established concentration to skim milk before the mixture was heated.

Yogurt was prepared by dissolving 50 g skim milk to 500 ml of distilled water, then the milk was stirred until dissolved. Microgreen filtrate was added to the skim milk at concentrations of 0%, 15%, 20%, and 25%. The mixture was heated at 90°C for 1 h (Hasanah & Rosma, 2021) before it was cooled to 45°C. Sugar (4%) and yogurt starter (5% w/v) were added to mixture (Hidayati & Sulandari, 2014), and stirred again evenly. The yogurt was incubated at 27-35°C for 12 h and 24 h (Winarsi, 2019).

Protein levels were determined using the Lowry method as describe by Puteri *et al*. (2020), while fat levels were determined using the Weibull method (SNI 2891:1992). The percentage of protein levels is calculated using the following formula (Sarita *et al*., 2021):

$$\text{Protein levels (\%)} = \frac{C \,.\, FP \,.\, V}{\text{BS}} \times 100\%$$

Note:
C = concentration (µg/ml)
FP = dilution factor
V = volume of water added (ml)
BS = sample weight (g)

Hedonic test measurements used the Friedman test, conducted by 15 semi-trained panelists consisting of undergraduate students majoring in Culinary Arts at Surabaya State University, aged 19–21 years, both male and female, with sufficient sensitivity and no milk allergies. The parameters measured in the organoleptic test were aligned with the criteria specified in SNI 2981:2009, including texture, smell, taste, consistency, and color. Favorability was evaluated as 1-3 scale, in which 1 means less favored and 3 was most favored.

Resulting data of protein and fat level analysis was compared to the SNI 2981:2009 standard for yogurt quality. The results of the yogurt organoleptic test were evaluated against the test in SNI No. 2981:2009, using the following parameters: appearance or texture, odor, taste, consistency, and color. Hedonic test observations were analyzed descriptively.

RESULTS

This study examined the supplementation of mung bean microgreen filtrate and fermentation duration on yogurt product (Figure 1). Protein and fat content of produced yogurts is presented in Figure 2.

a)  b)  c) 

Figure 1. (a) Mung bean microgreens. (b) Yogurt fermented for 12 h, and (c) yogurt samples fermented for 24 h.

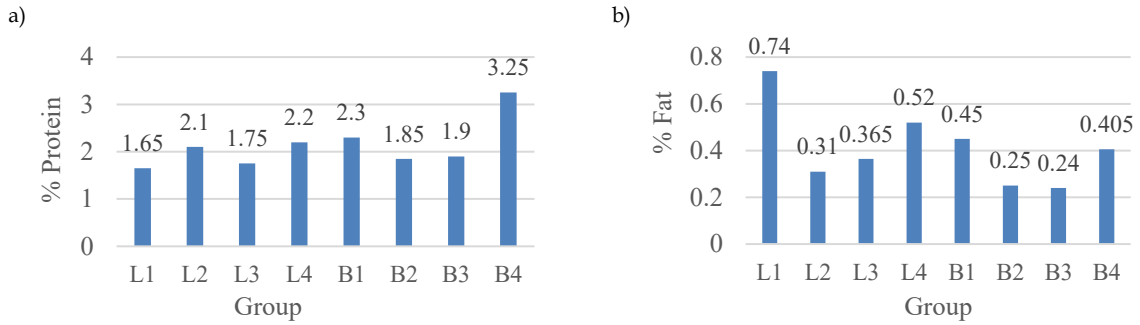

Figure 2. Protein (a) and fat level (b) of yogurt**.** L1= 12 h fermentation period, 0% filtrate; L2 = 12 h, 15%; L3=12 h, 20%; L4=12 h, 25%; B1=24 h fermentation, 0% filtrate; B2=24 h, 15%; B3=24 h, 20%; B4=24 h, 25%.

B4 yogurt added 25% filtrate at 24-hour fermentation resulted in the highest average protein content (3.25%), while lowest protein content was found in 12-h L1 control yogurt (1.65%) (Figure 2). Based on SNI 2981:2009, standard criteria for protein content in yogurt is 2.7%. On the other hand, L1 12-h control yogurt had the highest fat content at 0.74%, while the lowest was in B3 (0.24%).

Results of organoleptic test is presented in Figure 3. Score of each organoleptic aspect ranged from 1 to 3. Texture ranged from 1.13 to 2.86, with B1 showed the highest level indicating a thick yogurt, while the lowest was 1.13 from L2, indicating non-viscous texture. In odor, score ranged from 1.2 to 2.66, in which B1 also had the highest score (2.66) having a typical yogurt odor, while atypical odor was present in L4 (1.2).

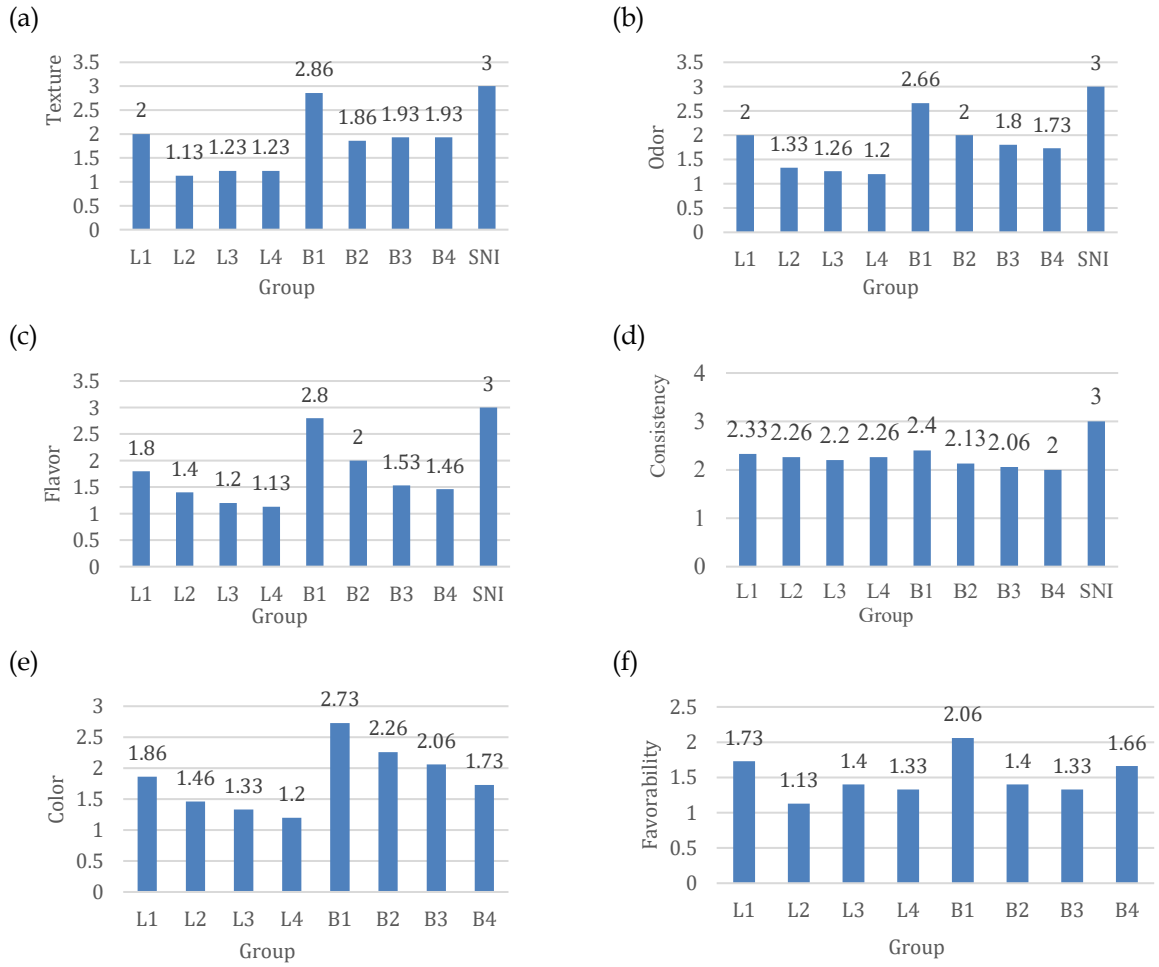

Figure 3. Yogurt organoleptic test results on (a) texture, (b) smell, (c) taste, (d) consistency, (e) color, (f) overall favorability. L1= 12 h fermentation period, 0% filtrate; L2 = 12 h, 15%; L3=12 h, 20%; L4=12 h, 25%; B1=24 h fermentation, 0% filtrate; B2=24 h, 15%; B3=24 h, 20%; B4=24 h, 25%

Flavor aspect resulted in the range of 1.13 to 2.8. B1 also resulted in the most optimal flavor (2.8), indicating a sour, typical yogurt flavor. The lowest score was L4 (1.13), which exhibited different taste from normal yogurt. For consistency, score ranged 2 to 2.4, with relatively homogeneous criteria (2), which indicated that the eight groups produced similar consistency which however, did not meet criteria standard. Score of color ranged 1.2 to 2.73, in which B1 also had the most optimal color (2.73), while the lowest was L4 (1.2), which showed no yellow color. Overall favorability across groups ranged 1.13 to 2.06. The highest favorability was B1 (2.06), while the lowest was L2 (1.13). Most of panelists favoured the sour taste typical of yogurt, but did not like the taste caused by additional filtrate.

DISCUSSION

The study results showed that the highest protein levels were found in B4 (24 h fermentation, 25% filtrate) at 3.25%. Yogurt supplemented 25% mung bean microgreen filtrate and fermented for 24 hours had met the standard according to SNI 2981:2009, in which protein content of yogurt should be at least 2.7%. This result was attributed to the higher protein content of mung bean microgreens at around 4.55% (Kowitcharoen *et al*., 2021). Long-term fermentation of yogurt also affects enzymes involved in proteolytic activities. Ingredients also affects protein level of yogurt; the higher the protein content of the ingredients, the higher the protein in the resulting yogurt (Purwantiningsih *et al*., 2022).

Fat plays an important role in the body, serving as an energy source and facilitating intestinal absorption of fat-soluble vitamins (Adriani & Wirjatmadi, 2014). In this study, L1 (12 h fermentation, 0% filtrate) could be categorized as low-fat yogurt, while all other groups were lean yogurts based on SNI 2981:2009. Longer fermentation process reduces fat content in yogurt due to rapid microbial growth, leading to lack of nutrient for growth. As population of microbes such as *L. bulgaricus* and *S. Thermophilus* increase, the nutrients required for their development also increase (Agustina *et al*., 2015). Previous study has produced high-fat mung bean yogurt met the quality standards (Kumalasari and Fajriyanti, 2024). Adding mung bean microgreens changed yogurt fat content, as mung bean microgreens was studied to have fat content of 0.36% (Kowitcharoen *et al*. 2021).

Texture is a determinant of yogurt quality. Only B1 yogurt fermented for 24 h met the thick national quality standard. Long period of fermentation results in more acidic and thicker yogurt (Adiputra *et al*., 2022). The thick texture of yogurt is due to its lower pH, as it can affect the solubility of casein, leading to hydrophobic interactions between casein micelles that contribute to the structure and consistency of yogurt, resulting in a thicker texture (Setianto *et al*., 2014). Filtrate addition resulted in lower viscosity, due to filtrate might increase the water content in yogurt.

Control yogurt fermented for 24 hours (B1) also had the most optimal aroma, at 2.66. Yogurt can develop odor due to LAB fermentation (Pamela *et al*., 2022). Increasing fermentation time decreased the pH, thereby affecting the aroma. Mung bean microgreens had grassy odor which affected yogurt aroma. The aroma was caused by lipoxygenase activity, naturally presents in nuts. Lipoxygenase catalysed the breakdown of unsaturated fatty acids, forming volatile compounds that produce a strong odour (Andarwulan *et al*., 2011).

The flavor of yogurt is developed during fermentation. From results, the highest taste score was also B1 at 2.8, with a distinctive sour taste. Requirement of SNI 2981:2009 for yogurt taste is distinctive and sour, therefore, B1 fulfilled the requirement. The longer the fermentation process, the more acidic the yogurt and the thicker the texture (Adiputra *et al*., 2022). The fermentation process produces a sour taste in yogurt due to LAB such as *L. bulgaricus* and *S. thermophilus*. The bacteria that produces the distinctive yogurt flavor are mainly *S. thermophilus* (Cahyadi, 2018). LAB ferment carbohydrates to form lactic acid, which increases acidity and decreases pH. Previous study has produced the flavor of mung bean yogurt meets the quality standards of SNI 2981:2009 (Sari *et al*., 2021). Results showed that the taste of mung bean microgreen yogurt is slightly sour than control, due to grassy taste of mung bean microgreens, which affected yogurt taste.

Consistency is one of the criteria for yogurt compliance to SNI 2981:2009. High-quality yogurt has a compact viscosity, no separation between solids and liquids, and no gas (Purbasari *et al*., 2014). The panelists mentioned that the yogurt consistency in all treatments was relatively homogeneous, likely due to coarse microgreen particles. During the filtrate preparation, the microgreens were blended less thoroughly to retain coarse mung bean particles. Fine particle sizes make the material more homogeneous, resulting in a thicker film (Hasibuan, 2015). The difference in fermentation time and the addition of mung bean microgreen filtrate at different concentrations did not affect yogurt consistency; therefore, it did not comply with the criteria of SNI 2981:2009.

Generally, yogurt has a color similar to that of its raw material. Good yogurt is generally yellowish-white. Based on the research, the most optimal color was obtained also from B1, at score 2.73 and a yellow color, fulfilling the criteria standard for yogurt color of yellowish-white. Based on the panelists' assessment, the greater the concentration of mung bean microgreen filtrate added to yogurt, the more the yogurt color shifted toward green. This color change is due to the presence of green chlorophyll compounds in mung bean microgreens, which can affect yogurt color. The green color produced by mung bean microgreen filtrate can make yogurt look healthier, more attractive, and less yellowish-white.

Each panelist had a different level of favorability, as the yogurt's taste influenced their preferences and acceptance. The results showed that yogurt fermentation time and the addition of mung bean microgreen filtrate at different concentrations affected the panelists' preferences. A decrease in a product's palatability, consistency, or appearance can negatively affect sensory assessment (Asri *et al*., 2023). The yogurt with the highest favorability was also B1. From these results, the panelists preferred the sour or yogurt distinctive taste. The fermentation duration also affects yogurt flavor. The longer the fermentation process, the more acidic the yogurt and the thicker the texture (Adiputra *et al*., 2022).

Adding mung bean microgreens also affected yogurt favorability. In yogurt, the addition of mung bean microgreen filtrate at various concentration with 12-hour fermentation, as well as 15% and 20% filtrate at 24-hour fermentation, was not favored by most panelists because yogurt has a distinctive taste of green vegetables, which caused a grassy taste typical of vegetables. Many individuals across Indonesian society, from children to adults, dislike green vegetables, which can affect their preferences.

CONCLUSION

The microgreen filtrate from mung beans and fermentation duration affected the protein and fat levels, as well as the organoleptic and hedonic properties of yogurt. The protein and fat levels of yogurt with 25% mung bean microgreen filtrate after a 24-hour fermentation period met the quality standards of SNI 2981:2009, with results of 3.25% and 0.405%, respectively. The organoleptic and hedonic tests that met the quality standards of SNI 2981:2009 were the control yogurt with a 24-hour fermentation period. The panelists somewhat disliked the mung bean microgreen filtrate yogurt, but they liked it for its distinctive green vegetable flavor.

ACKNOWLEDGEMENTS

The authors thank the staff of the Department of Biology at the Surabaya State University for their assistance in writing this article.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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