Syneresis, and acidity value of fermented goat milk added with beet (Beta vulgaris L.) juice using Lactobacillus rhamnosus

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Abstract. The purpose of this study was to determine the effect of adding beet juice in fermented goat’s milk using Lactobacillus rhamnosus bacteria on the acidity, syneresis value. This study applied a Complete Randomized Design (RAL) consisting of five treatments Control (P0), 2% of beet juice (P1), 4% of beet juice (P2), 6% of beet juice (P3), and 8% of beet juice (P4) with four repetitions. The data obtained were analysed using ANOVA (Analysis of Variance). If a significant difference is found, then Duncan's multiple range (DMRT) test is conducted. The results showed that the addition of beet juice with a different percentage in fermented goat milk had significant effect (P<0.05) on syneresis but had a very significantly effect (P<0.01) on the pH value. The addition of 2% of Beet juice resulted in the lowest syneresis value of 9.88%. The low value of syneresis in this study was caused by the addition of beet juice which has high acidity, carbohydrate and protein content. The higher the lactic acid, the lower the pH and the denser the texture formed because the protein's ability to bind water increases so that the syneresis formed is lower.

1. Introduction
Fermented milk is known as one of the dairy products produced through a fermentation process by lactic acid bacteria (LAB). In this case, LAB will hydrolyse milk sugar (lactose) into lactic acid. The milk fermentation process can prevent the growth of unwanted pathogenic microbes in a product so that its nutritional value can be improved. Lactobacillus genus is a LAB used in the milk fermentation process and is part of the normal flora of the human digestive tract. One of them is Lactobacillus rhamnosus, bacteria which was discovered by Sherwood Gorbach and Barry Goldin in 1983 [1] According to the previous research conducted by [2], Lactobacillus rhamnosus bacteria have the ability to ferment lactose and produce good fermented milk products. During processing, fermented milk experiences clumps due to the addition of BAL starter which further produces a distinctive odor, taste, and acidity with a thick liquid to semi-solid texture form. The formation of such fermented milk texture is caused by the protein clumping due to the increase of acidity during the fermentation process. Therefore, the water holding capacity decreases and causing syneresis to occur in fermented milk products. Syneresis is a complex process that includes shrinkage or contraction of protein gels. Syneresis occurs due to a decrease in protein-water interactions, thereby accelerating the formation of curd and the occurrence of whey separation simultaneously [3]
To avoid syneresis, natural ingredients can be added. One of the natural ingredients that can be added during the process milk fermentation is beet (*Beta vulgaris* L.). Beet is a tuber containing betaxanthin and sucrose which can be utilized as natural source of soluble solids to improve the texture of fermented milk. Furthermore, the addition of beet juice can affect the lactic acid production and the physicochemical properties of fermented milk. High stability in fermented products will reduce the formation of whey with a high total solid so the texture of fermented products will be better [4]. This study aims to determine the effect of beet juice on the pH value and syneresis of fermented goat's milk added with beet (*Beta vulgaris* L.) juice.

2. Materials and methods

2.1. Materials

The material used in this study was goat's milk obtained from UD. Abi Makmur Sentosa Banda Aceh, Indonesia. *Lactobacillus rhamnosus* obtained from PAU Universitas Gajah Mada Yogyakarta, Indonesia. Beets (*Beta Vulgaris* L.) were obtained from the Peunayong market, Banda Aceh, Indonesia.

2.2. Methods

2.2.1. Starter preparation. A total of 200 mL of pasteurized goat's milk was poured into a sample bottle, then inoculated with 5% *Lactobacillus rhamnosus* and was incubated at 37°C for 24 h.

2.2.2. Beet juice preparation. As much as 250 gr of beets were washed with running water and peeled, then cut into several parts and then mashed it using a juicer and filtered to obtain beet juice. Next, the beet juice was pasteurized at 75°C for 15 sec (Agricultural Research and Development, 2017).

2.2.3. Sample preparation. Goat's milk was pasteurized at 85°C for 15 sec, and was cooled to 40°C. The pasteurized milk (100 mL) was poured into 20 sample bottles. Each bottle was inoculated with 5% starter *L. rhamnosus*, beet juice was added based on each treatment 2, 4, 6 and 8% level, on each sample bottles and mixed evenly. The sample were incubated at 37°C for 24 h.

2.3. Experimental design

Completely randomized design (CRD) used in the study which was consisted of 5 (five) treatments, namely P0 = 0% Beet juice (control), P1 = 2% Beet juice, P2 = 4% Beet juice, P3 = 6%, P4 = 8 % Beetroot juice, each treatment was repeated 4 times.

2.4. Data analysis

The data obtained were analysed by analysis of variance (ANOVA) and if the results showed an effect on the treatment, then continued with the Duncan Multiple Range Test (DMRT) [5].

2.5. Parameters measured

2.5.1. Syneresis test. This test was carried out using the method of [6]. A total of 10 ml of the sample was put into a syneresis tube and then left in the refrigerator (5°C) for 1 hour. Then the sample was centrifuged for 10 minutes at 3000 rpm. The supernatant (whey liquid) was weighed and calculated using the formula:

\[
\text{Syneresis} = \frac{\text{Weight of Supernatant}}{\text{Weight of Sample}} \times 100\%
\]  

2.5.2. Acidity test. The pH of the sample was measured using a pre-calibrated pH meter. The pH of the sample is measured by dipping the electrode of the pH meter into the sample being measured. used a pH meter, then the pH of the sample will appear on the monitor screen.
3. Results and discussion

3.1. Syneresis test
Syneresis is the release of whey liquid from the fermented milk gel, a high syneresis value indicates the instability of the gel bond and shows the lower quality of fermented milk [7]. Based on analysis of variance, it showed that the syneresis value is affected by the addition of beet juice as shown in Figure 1.

Duncan's further test results showed that the syneresis value in the P0 treatment was significantly different from the other treatments (P1, P2, P3 and P4). The high value of syneresis in the P0 treatment was thought to be due to the lack of total solids contained in fermented milk. This is as expressed by [8] which states that the formation of syneresis in fermented milk is caused by the low amount of solids contained in fermented goat's milk. Figure 1 also shows that the addition of beet juice with different percentages indicates a decrease in the syneresis value at the end of fermentation. It was seen that there was no difference between each treatment, namely 2, 4, 6 and 8% addition of beet juice but significantly different from the control which has a higher syneresis value (23.20%).

The addition of beet juice as much as 2% resulted in the lowest syneresis value of 9.88% this is most likely due to the role of total solids contained in beet juice so that the syneresis that occurs is lower. This is supported by 10% of the total soluble solids contained in beets, namely glucose, fructose and sucrose.

The acidity and protein content of raw materials are several factors that affect syneresis in fermented milk [9]. The high total dissolved solids and protein in beet helped reduce syneresis. This is in line with the results of [10] research which states that an increase in the protein content in milk can increase gel strength and reduce syneresis levels. A better gel structure can increase the ability to hold water by preventing loosening of the pores between casein molecules, thereby reducing free water molecules that come out so that the syneresis formed will be lower [11].

3.2. Acidity (pH)
The addition of beet juice with different percentages was highly significant (P <0.01) effect on the pH value of fermented goat milk. The average pH value can be seen in Figure 2. The higher pH in the control (P0) indicates that the amount of lactic acid formed is still low. This is caused by the growth of L. rhamnosus which has not been optimal, because the nutrients for its growth only come from milk. Meanwhile, with the addition of beet juice, the pH tends to be lower. This is due to the use of more carbohydrates by LAB [12] the source of carbohydrate is not only from milk but also from beet juice,
so that lactic acid production increases and lowers the pH of fermented milk. It can be seen that the addition of beet juice with different levels tends to decrease the pH through the hydrolysis of lactose into lactic acid [13][14] and the optimal decrease occurs in the addition of 4% beet juice.

In this study, it can be seen that fermented goat milk which was not added with beet juice (0%) had an average pH of 4.13, while the fermented goat milk which was added with different beet juice percentages had an average pH ranged from 4.07 to 4.05. Based on the results it can be seen that the pH of fermented goat milk is in the range of the Indonesian National Standard, namely 4 - 4.5.

However, statistically there is no difference between level of beet juice treatments. An increase in the total amount of acid can trigger a decrease in pH which causes the water holding capacity to decrease, resulted in fermented milk to be susceptible to syneresis [15].

![Figure 2](image-url)  
**Figure 2.** The average pH of goat milk.

### 4. Conclusions
The addition of beet juice as much as two percent produces a lowest syneresis value and appropriate pH of fermented goat milk.

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