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Quality of fermented goat milk with carrot juice during cold storage

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Abstract. The purpose of this research was to determine the effect of storage duration in refrigerator temperature on moisture content, pH, and antioxidant activity of fermented goat milk (*Lactobacillus fermentum* PE2) with the addition of carrot juice. The experiment used a completely randomized design with 5 treatments of goat milk fermentation at the refrigerator temperature of 0, 5, 10, 15, and 20 days with 4 replications. The results showed that the storage duration at a refrigerator temperature had a significant effect ($P < 0.05$) on the antioxidant activity but no noticeable effect ($P > 0.05$) on the moisture content and pH. Goat milk fermentation with *Lactobacillus fermentum* PE2 can maintain quality until 20 days at a refrigerator temperature with the moisture content 81.32%, pH 4.48, and antioxidant activity 23.50%.

1. Introduction

The global attention in utilizing the advantageous properties of microbes support human health provided by fermented food as functional foods and probiotics. Previous studies have shown that even simple fermentation of cereal grains with indigenous lactic acid bacteria microflora generates significant increases in the levels of some B-Vitamins. Many adults are intolerant to lactose, the principal sugar of milk, but fermentations such as those which produce yoghurt, reduce or eliminate this problem [1].

Goat milk is a food material from livestock that has high nutritional value, is complete and balanced. Goat milk has many features including it can increase the absorption of Fe [2], is useful for healing asthma and tuberculosis, contains protein, vitamin A, vitamin B (riboflavin), enzymes, and high minerals [3], has great potential as probiotic carriers [4], and does not cause diarrhoea [5]. With the features of goat's milk, it makes this milk a medium for the growth of pathogens. Several ways to extend the shelf life of goat milk can be done by processing goat milk into goat milk soap [6], by fermentation process [7] and paying attention to its storage. 9

Fermented goat milk is a dairy product that has been added starter from lactic acid bacteria. Fermented goat milk products that have been studied is yoghurt. Goat milk yoghurt is one of the processed, fermented milk products by adding *Lactobacillus acidophilus*, resulting in a yoghurt product that is resistant to gastric pH and has antimicrobial activity [7]. *Lactobacillus fermentum* PE2 has the potential to make fermented milk [8]. This bacterium was isolated from dadih in 50 Kota District [9].

Probiotic bacteria that have developed many benefits include being able to lower cholesterol, tumors and balance the health of the intestinal microflora [10, 11]. As living microorganisms, given sufficient amounts of probiotics will provide health benefits to the host. Probiotic bacteria, especially such as *Lactobacillus* and *Bifidobacterium*, are found to be beneficial in preventing the growth of pathogenic bacteria, reducing inflammation, and inhibiting glycation of protein in hyperglycemia [36]. Several

previous studies mentioned that milk fermented using probiotics has good biochemical activity and antioxidant activity [12, 13]. *Lactobacillus* species from lactic acid bacteria, are known to have good probiotic potential to improve human health [14]. Some milk fractions such as lactoferrin, casein, and whey have anti-oxidant properties [15].

Increasing the nutritional content of fermented milk products can be done by adding rosella and carrot juice as local food into fermented milk so that it can produce functional food [6] and [16]. According to [17], carrot juice contains beta carotene, which functions to maintain immunity, healthy skin, lungs, intestinal organs, and helps the growth of new cells. The addition of 5% carrot juice in the production of *Lactobacillus fermentum* PE2 fermented milk showed good results in terms of its antioxidant activity value of 10.53 mg, pH value of 4.73, total acid value of 1.36% and total lactic acid bacteria colonies of 20×10^8 CFU / ml [8].

The results of research [18], on fermented milk in the form of yoghurt, the storage time for fermented milk is up to 13 days at refrigerator temperature, indicating that the quality of fermented milk is still fit for consumption and meets the quality requirements of the Indonesian National Standard. Added by [19] that fermented products with the addition of durian fruit juice with *Lactobacillus* culture supplementation during storage at low temperature up to 2 weeks of storage, can maintain the quality of the resulting product and can be sensory accepted. The results of the study [20] on testing the length of shelf life of fermented goat milk at refrigerator temperature, showed that fermented milk storage until 15 days of storage, can still maintain the quality of fermented milk, with the number of lactic acid bacteria of 4.8×10^8 CFU / ml. The purpose of this study was to determine the effect of storage time for fermented goat milk with the addition of carrot juice at refrigerator temperature on moisture content, pH and antioxidant activity.

2. Methods

2.1. Fermented Milk Starter and Carrot Juice

The starter bacteria used for fermented goat's milk was *Lactobacillus fermentum* PE2 (a collection of Animal Product Technology Laboratory, Andalas University). Carrot juice is made by cutting carrots into 2-3 mm sizes and mashing them with a juicer to extract the juice. Furthermore, the carrot juice is filtered using a filter cloth and pasteurized for 8 minutes at 64 °C (a modification from [21]).

2.2. Manufacture of Fermented Goat Milk

Lactobacillus fermentum PE2 starter for the manufacture of fermented goat milk is prepared. Goat milk added with 4% skim, 6% sugar, and 0.5% CMC are pasteurized at 72°C for 15 seconds and immediately cooled at 43°C. Furthermore, the starter and carrot juice were added as much as 5% (v / v) to the pasteurized milk, then incubated at 37°C for 7 hours. After that, fermented goat milk is stored according to the 0 days, 5 days, 10, 15, and 20 days treatment at the refrigerator temperature of 4°C, then the water content, pH, and antioxidant activity are measured.

2.3. Analysis of Moisture Content, pH, and Antioxidant Activity

Moisture content was analyzed by the drying oven method. 2 g sample of fermented goat milk powder were prepared and put into a cup, which had measured its empty weight with an analytical balance, then each sample and cup was put into the oven and dried at 105°C. After it, the sample was removed from the oven. Next, it was put in a desiccator for 15 minutes and weighed with an analytical balance. The moisture content was determined by calculating the weight subtraction between the samples before and after drying, and then was divided by the sample's weight, and finally multiplying it with 100% [22].

pH meter using to get a pH value. Before using, the pH meter must be calibrated with a standard (pH 4 and 7) and then the electrodes of the pH meter are immersed in fermented goat milk, and readings are carried out until a constant number is obtained.

The antioxidant activity is based on [23]; the antioxidant activity testing was carried out using the DPPH method. The test solution is obtained by mixing the sample into 1 ml of methanol which is then centrifuged until a precipitate is formed. After that, 1 ml of the test solution was put into a tube protected

from light, then 1 ml of DPPH ⁵ was added. Next, the solution was incubated at 37 ° C for 30 minutes in a dark room. This decrease in absorbance was measured with a spectrophotometer at a wavelength of 517nm. All parameters were measured after 0 days, 5 days, 10 days, 15, and 20 days of storage, with 4 replications.

2.4. Statistical Analysis

The software SPSS 22 by using an analysis of variance (ANOVA).

3. Result and Discussion

3.1 Moisture Content

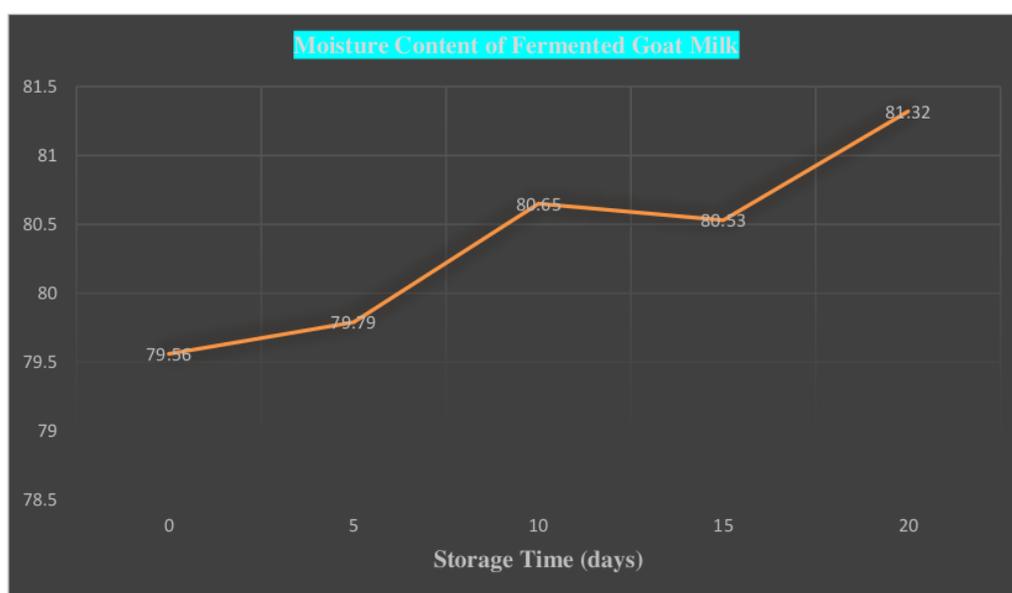


Figure 1. Moisture content of fermented goat milk over the storage durations

The moisture content (Figure 1) in a food material has an important role because it can affect the metabolic activity of the food itself. The results of statistical analysis showed that the longer fermented milk products were stored at the refrigerator temperature showed an insignificant difference ($P > 0.05$) on the resulting moisture content. This is due to the use of hermetic packaging in the form of bottles in this study, where the nature of this packaging can minimize the occurrence of evaporation during the storage process in the refrigerator.

Therefore, during storage, there is no change in the resulting moisture content. This is following the opinion of [24], which states that water content is influenced by storage conditions using hermetic packaging, which can create a barrier to incoming water vapour so that this property can minimize changes in water content contained therein.

The moisture content of fermented goat's milk during storage resulted in this study in the range of 79.56% to 81.32%. The results of this study indicate that the moisture content of fermented milk during storage is not much different from the results of the research of [25], that the moisture content of yoghurt with the addition of *S. polycystum* extract ranged from 75.39-85.76%.

3.2. pH Value

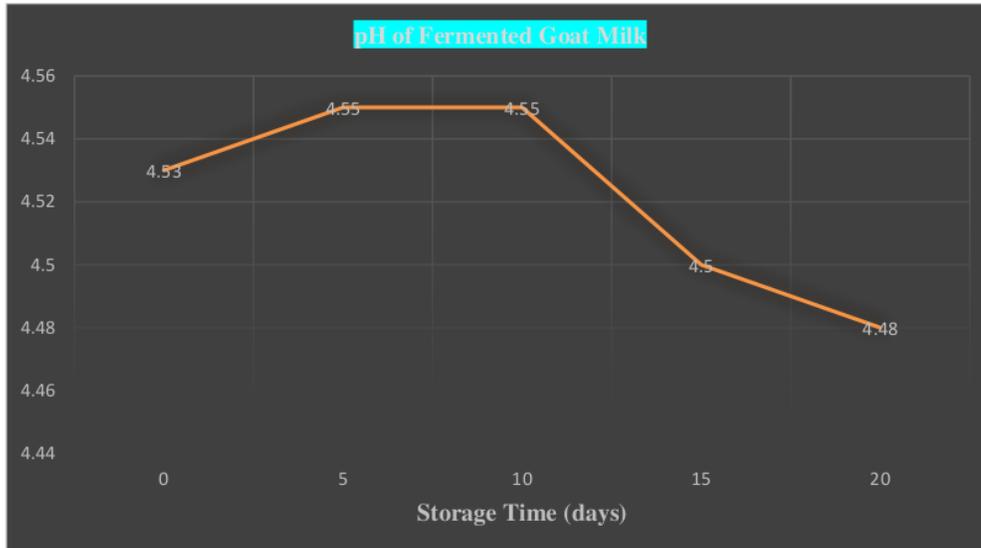


Figure 2. pH of fermented goat milk over the storage durations

The longer the storage of fermented goat milk at refrigerator temperature shows a slight decrease in the pH value (Figure 2). This is due to the activity of lactic acid bacteria *Lactobacillus fermentum* PE2 which is a starter for fermented milk that will convert milk carbohydrates (lactose) into lactic acid and along with the longer storage time, the more lactic acid formed will also cause the pH value to decrease slightly. This is in accordance with the opinion of [26] and [27] which state that lactic acid bacteria will produce a large amount of lactic acid from the fermentation of lactose into glucose and galactose, and then this glucose is broken down into lactic acid so that it will lower the pH value and can cause a sour taste. The results of this study are also in line with the research of [28] which states that the longer the storage of fermented milk in cold conditions will show a tendency to decrease the pH value of fermented goat milk produced. Furthermore, [29] reported that the decrease in pH during storage was due to the metabolic activity of culture. The storage time for fermented milk at 4°C significantly lowers the pH value, but the decrease does not result in the pH value [30]. According to [31] that the longer it is stored, the more lactic acid is formed.

The storage of fermented goat milk during the study caused the pH to tend to decrease slightly. Based on the Indonesian National Standard, the standard requirements for the quality standard of Indonesian yoghurt fermented milk pH value between 4-4.5. In research on the manufacture of fermented goat milk, it shows that the pH value is following the SNI during storage.

3.3. Antioxidant activity

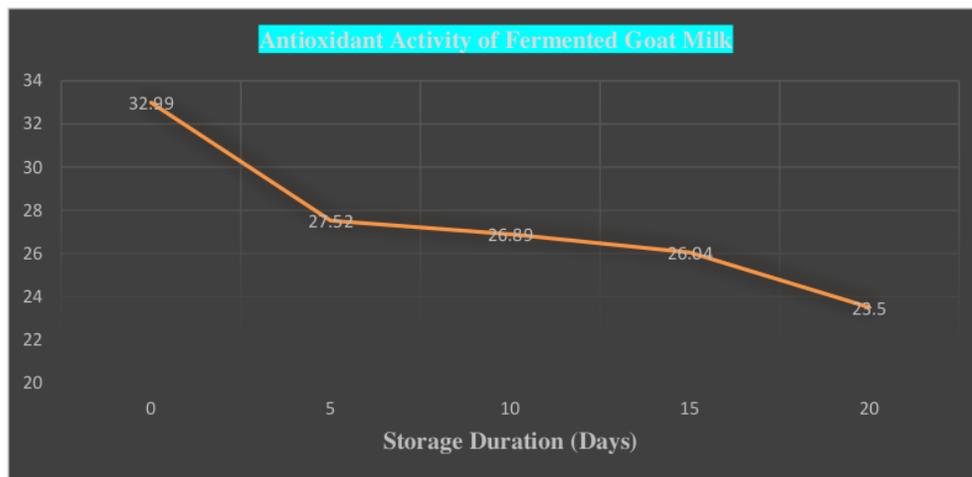


Figure 3. Antioxidant activity of fermented goat milk over the storage durations

Antioxidants (Figure 3) have the ability as an inhibitor of the oxidation reaction by reactive free radicals. The longer storage time at the refrigerator temperature showed a decrease in the antioxidant activity of the fermented goat milk produced. This decrease is thought to be caused by the damage to the structure of the bioactive compounds in the form of carotenoids which act as antioxidants in fermented milk with the addition of carrot juice so that the longer storage of fermented milk will reduce the level of antioxidant activity produced. This is in accordance with the opinion of [32] which states that one of the bioactive compounds found in carrots is carotenoids which can improve health and immunity. [33] reported that the longer the product is stored, the antioxidant activity will decrease due to the loss of bioactive compounds from the products produced.

When compared with previous studies, the value of antioxidant activity obtained was higher than the research of [34] regarding the antioxidant activity of sesame milk yoghurt with the addition of beetroot extract (the value of antioxidant activity was 15.22). According to [35] that antioxidants have the ability as inhibitors of oxidation reactions by reactive free radicals.

4. Conclusion

Storage of fermented goat milk (*Lactobacillus fermentum PE2*) with the addition of carrot juice at the refrigerator temperature for up to 20 days is still able to meet the quality requirements of fermented milk in terms of moisture content, pH, and antioxidant activity.

Acknowledgment

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