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Physicochemical Characterization of Kefir Combination from Goat Milk and Almond Milk

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ABSTRACT

Kefir is a fermented milk that contains probiotic bacteria. It is made by adding kefir grain starter as a source of lactic acid bacteria. The combination of goat milk and almond milk, along with the addition of pineapple core extract, is an effort to enhance the nutritional value of probiotic kefir milk. The aim of this study is to determine the quality characteristics of the combined kefir made from almond milk and goat milk with varying milk ratios (30:70, 40:60, and 50:50%) and the effect of pineapple core extract on the combined kefir. The combination is expected to produce kefir with unique characetristics due to the nutritional differences between animal-based and plant-based milk. Quality characteristics include pH testing measured using a pH meter, viscosity testing using a Brookfield viscometer, titratable acidity (total acid) using an alkalimetric titration method, and protein content tested using the Kjeldahl method. The results obtained show that the combined kefir made from goat milk and almond milk with the addition of pineapple core extract affects the pH, viscosity, titratable acidity, and protein content. The optimal variation was obtained at a 40:60% ratio, with a pH of 3.7650 ± 0.0849, viscosity of 0.7410 ± 0.0283, titratable acidity (%) of 1.2043 ± 0.0636, and protein content of 1.3509% ± 0.0304.

Keyword: Almond, Kefir, Milk, Probiotic, Pineapple.

ABSTRAK

Kefir adalah susu fermentasi yang mengandung bakteri probiotik. Pembuatannya ditambahkan dengan starter biji kefir sebagai sumber bakteri asam laktat. Pengkombinasian antara susu kambing dan susu almond dengan penambahan ekstrak bonggol nanas merupakan suatu upaya penambahan gizi pada susu probiotik kefir. Tujuan dari penelitian ini untuk mengetahui karakteristik mutu dari kefir kombinasi susu almond dan susu kambing dengan variasi penambahan susu (30:70, 40:60, and 50:50%) dan pengaruh penambahan ekstrak bonggol nanas pada susu kefir kombinasi. Kombinasi ini diperkirakan dapat menghasilkan kefir dengan karakteristik unik karena perbedaan kandungan nutrisi antara susu hewani dan nabatiKarateristik mutu meliputi uji derajat keasaman (pH) yang di ukur menggunakan pH meter, uji viskositas diukur menggunakan viskometer brookfielnd, keasaman tertitrasi (total asam) dengan metode titrasi alkalimetri, dan kadar protein diuji menggunakan metode kjeldahl. Hasil yang diperoleh menunjukkan bahwa kefir kombinasi susu kambing dan susu almond dengan penambahan ekstrak bonggol nanas mempengaruhi pH, viskositas, keasamaan tertitrasi dan kandungan protein. Diperoleh variasi 40:60% sebagai variasi optimum dengan pH 3.7650 ± 0.0849, viskositas 0.7410 ± 0.0283, keasaman tertitrasi (1.2043% ± 0.0636) dan kadar protein sebesar 1.3509% ± 0.0304.

Kata Kunci: Almond, Kefir, Nanas, Probiotik, Susu.

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1. Introduction

Kefir is a fermented dairy product well known for its unique probiotic content and various health benefits, including improved digestion, enhanced immune system function, and antimicrobial properties [1], [2]. Traditionally, kefir is made using cow's milk or goat's milk, fermented by a symbiotic culture of lactic acid bacteria and yeasts embedded in a polysaccharide matrix known as kefir grains [3]. While animal-based kefir is still widely consumed, the growing demand for plant-based milk alternatives—driven by dietary restrictions and lactose intolerance—has led to research into new formulations that combine both animal and plant-based milk [4].

Goat milk is becoming increasingly popular as a base for kefir due to its easy digestibility, higher medium-chain fatty acid content, and distinct nutritional profile compared to cow's milk [5]. On the other hand, almond milk is a plant-based alternative rich in vitamins, minerals, and unsaturated fats, but it has relatively low protein and carbohydrate content, making it less optimal for supporting microbial fermentation [6], [7]. Combining goat milk with almond milk may offer a balanced alternative that merges the functional properties of both ingredients, resulting in a kefir product that is nutritionally enhanced, more acceptable in terms of sensory qualities, and suitable for a wider range of consumers [8].

The physicochemical characterization of this kefir combination is essential to evaluate its fermentation behavior, nutritional composition, and storage stability. Parameters such as pH, titratable acidity, protein content, and viscosity provide important insights into the fermentation dynamics and quality characteristics of the final product. This study aims to investigate the physicochemical properties of kefir produced from various ratios of goat milk and almond milk, and to evaluate its potential as a functional fermented beverage aligned with modern nutritional trends and dietary patterns.

2. Materials and Method

Materials

The ingredients used are goat milk, almond milk, and pineapple core.

Kefir Preparation

Kefir was produced using a modified procedure. Various ratios of goat milk and almond milk (30:70, 40:60, and 50:50%) were prepared and pasteurized at 70°C for 15 seconds, then allowed to cool to room temperature (approximately 27°C). Pineapple core extract was incorporated into the mixture at concentrations of 5%, 10%, 15%, and 20%. Afterward, kefir grains were added to initiate fermentation. The mixture was then homogenized, poured into sterile containers, and left to ferment at room temperature (±27°C) for 24 hours, during which it developed into kefir. Following fermentation, the kefir grains were removed by filtration, and the resulting kefir was subjected to analysis. Parameters measured included pH, titratable acidity, protein content, and viscosity.

pH Test

The acidity level (pH) of the sample was measured using a pH meter calibrated at pH 7. The pH measurement was conducted in an Erlenmeyer flask containing 10 mL of the sample. The reading was taken after waiting for the pH meter scale to stabilize, and the result was then recorded [9].

Titratable Acidity

Titratable acidity, calculated as lactic acid, was analyzed using the titration method. According to the Indonesian National Standard (SNI, 2009), the standard range is 0.2%–0.9%. A total of 10 mL of the sample was pipetted into an Erlenmeyer flask and mixed with 20 mL of distilled water. Then, 3 drops of phenolphthalein indicator were added, and the solution was titrated with 0.1 N NaOH until a light purple (pinkish violet) color appeared (National Standardization Agency, 2009). The total acid content was determined using the titration method, and calculated using the following formula (Eq.1):

$$Total\ Lactic\ Acid = \frac{V \times N \times 90}{W(mg)} \times 100\% \qquad \text{Eq.1}$$

Protein Content

Protein content was determined using the Kjeldahl method, which consists of three stages: the digestion process, the distillation process, and the titration stage. The kefir quality standard according to SNI is a minimum of 1%. One gram of the sample was pipetted into a Kjeldahl flask, followed by the addition of 10 mL of concentrated H_2SO_4 and 0.3 g of selenium mix. The sample was then digested at a temperature of 400°C until a clear solution was formed. Methyl red indicator and 10% H_3BO_3 (boric acid) were added, with 10 mL of the latter. The sample was distilled using a protein distillation apparatus by adding 20 mL of distilled water and 20 mL of 30% NaOH until a green solution was obtained in the Erlenmeyer flask. If no green solution was formed, additional 30% NaOH was added. The solution was then titrated with 0.05 N H_2SO_4 until a color change from green to purple occurred [10].

Viscocity Test

Viscosity testing was carried out using a Brookfield viscometer. A 100 mL sample was placed in a 100 cc container. The spindle was then lowered until it reached the bottom level of the sample. The device was turned on by pressing the power button. The spindle speed was set to 60 rpm, and the dial reading was recorded once the red needle stabilized. The viscosity value (μ) in centipoise (cP) was obtained by multiplying the dial reading by the correction factor corresponding to the selected spindle speed.

3. Results and Discussion

Probiotic milk product, kefir, with varying concentration ratios (30:70, 40:60, and 50:50) combined with pineapple core extract and a control kefir, was subsequently characterized to determine its quality. The quality characterization included parameters such as acidity (pH), viscosity, total acid, and protein content, with the results presented in Table 1.

Table 1. Physicochemical characteristics of formulated kefirs.

Parameter(s)	Kefir formulations			
	A	B	C	D
pH	4.6450 ± 0.0311	3.7650 ± 0.0849	3.6240 ± 0.0778	3.3620 ± 0.0566
Viscosity (cP)	0.7210 ± 0.0354	0.7410 ± 0.0283	0.5700 ± 0.0636	3.1600 ± 0.0510
Titratable acid (%)	0.5363 ± 0.0721	1.2043 ± 0.0636	1.6089 ± 0.0566	3.2042 ± 0.0849
Protein content (%)	1.0941 ± 0.0665	1.3509 ± 0.0304	0.9678 ± 0.0919	2.4428 ± 0.0778

Note: Kefir formulations with pineapple core extract with almond milk-to-goat milk ratios of 30:70 (Sample A), 40:60 (Sample B), 50:50 (Sample C), and a commercial kefir product (Sample D)

pH Value

The pH value was tested using a pH meter, and the results determined the acidity level of the product. Based on the data from Table 1, an increase in the pH value of the kefir milk product was observed. The higher the concentration of goat milk added, the greater the acidity of the probiotic kefir milk. According to Rahayu et al. (2020) [11], the pH value of kefir typically ranges from 4.6 to 4.8. The optimum result for the combination kefir was obtained at a 1:4 ratio, with a pH of 4.645. Other variations showed pH values that were too acidic. This decrease in acidity may be attributed to the fermentation process that forms lactic acid, as well as the activity of lactic acid bacteria and yeasts present in the kefir grains.

Titratable Acidity

Total acidity is calculated as total lactic acid, and this test is performed to determine the level of acidity due to microbial activity, which produces acid by converting carbohydrates or lactose into lactic acid in the combined kefir. The research results, as shown in Table 1, indicate that the lower the ratio of almond milk added, the higher the total acidity. According to SNI 2009, the threshold for total acidity in kefir products is around 0.2% to 0.9%.

The total acidity results obtained show that the combination ratio of goat milk and almond milk at 1:4 meets the standard threshold. According to Setiawati & Yunianta (2018) [12], the increase in total acidity is due to the decrease in pH. This creates an environment conducive to the growth of lactic acid bacteria, leading to the process of lactic acid metabolite production. The greater the amount of lactic acid metabolites produced, the more it indicates the growth of lactic acid bacteria.

Protein Content

The fermentation process in kefir hydrolyzes proteins through the activity of proteolytic enzymes, which break down proteins into protein fractions. In addition, protein is hydrolyzed into amino acids and peptides by lactic acid bacteria in the kefir grains, which are proteolytic in nature. Lactic acid bacteria utilize free amino acids and peptides as a source of nutrition for their growth. The kefir grains used in the production of kefir also affect the protein content of the kefir because yeasts degrade casein into simpler protein components, such as peptides and free amino acids [11].

In Table 1, it is shown that all variations of the combined kefir meet the SNI standard, which is a minimum of 1%. The highest protein content was found in the 2:3 combination, with a value of 1.3509%. The results indicate that the protein content of the combined kefir is lower than that of the control kefir. The lower protein content in the combined kefir may be due to protein denaturation during the heating process of the milk and pineapple core extract. Additionally, it is known that goat milk has a higher protein content compared to almond milk. The control kefir is made from goat milk, which results in a higher protein content compared to the combined kefir.

Viscocity Test

Viscosity testing was performed using a Brookfield viscometer, and the results determined the thickness of the kefir milk product. The addition of pineapple core to the combined kefir stimulates the growth of lactic acid bacteria. According to Rahayu et al. (2020) [11], the increased number of lactic acid bacteria produces exopolysaccharide texturizing agents, which are generated by kefir grains. When these exopolysaccharides interact with milk proteins, they enhance the viscosity of the combined kefir. Additionally, the production of exopolysaccharides is also influenced by factors such as temperature, pH, and yeast concentration.

In Table 1, a significant difference in the results can be observed, showing that the thickness of the product is lower compared to the control kefir. The addition of pineapple core extract affects the viscosity of the kefir, which occurs due to the low sugar content, and because no sugar was added during its preparation, unlike in the control kefir. According to Tarihoran et al. (2022) [9], low sugar content leads to increased water activity and decreases the viscosity of the combined kefir.

4. Conclusions

The addition of 5% pineapple core extract in the production of combined kefir made from goat milk and almond milk results in a better quality product compared to commercial products. The best combination of almond milk and goat milk kefir was obtained at a 40:60 ratio. This is based on all the quality standards that have been tested quantitatively. The resulting kefir has the potential as a functional alternative to commercial kefir.

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