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The effect of adding mango juice in the production of kefir on PH, syneresis, and water holding capacity (WHC)

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Abstract
This study evaluates the effects of substituting goat milk with mango extract in kefir production on pH, syneresis, and water-holding capacity (WHC). Three experimental treatments were conducted using different ratios of mango extract to goat milk: P1 (3:7), P2 (4:6), and P3 (5:5). The parameters assessed included pH levels, syneresis percentage, and WHC. The findings revealed that increasing the proportion of mango extract altered the pH and the structural stability of the kefir. The highest WHC was observed in treatment P2, while treatment P3 exhibited the highest syneresis. These results indicate that the optimal balance for incorporating mango extract without significantly compromising the physical attributes of kefir was found in the 4:6 ratio (P2). This research provides insights into how fruit extract substitution can influence the quality and properties of dairy-based kefir, suggesting potential applications for enhancing its nutritional and sensory profile.

Keywords: Kefir, mango, syneresis, WHC

Introduction

Dairy-based kefir is renowned for its probiotic benefits and is commonly produced using cow's or goat's milk. This fermented beverage is valued for promoting gut health due to its rich content of beneficial bacteria and yeast. The nutritional properties of kefir contribute to overall wellness, making it a popular choice among health-conscious consumers.

In recent years, there has been growing interest in enhancing the functional and sensory qualities of kefir by adding natural ingredients such as fruit extracts. Mango (Mangifera indica) is particularly appealing due to its vibrant flavor and abundance of vitamins, antioxidants, and bioactive compounds. These nutrients have potential health benefits that could synergize with the properties of kefir, enhancing its appeal and nutritional profile.

Substituting part of the milk content in kefir with mango extract introduces new opportunities for product innovation. However, this substitution may also influence the physical and chemical characteristics of the final product, such as pH levels, syneresis (the tendency to expel liquid), and water-holding capacity (WHC). These properties are critical for determining the texture, stability, and consumer acceptability of the kefir.

This study aims to explore the impact of substituting goat milk with varying amounts of mango extract in kefir production. Specifically, it examines the effects on pH, syneresis, and WHC, providing insights into how such modifications can optimize the quality and nutritional value of dairy-based kefir.

Materials and Methods

Mango Juice Preparation: Mango fruits were diced into small pieces (±5 cm²), and 50 g of mango was blended with 50 ml of water. The resulting juice was strained through cloth and pasteurized at 60°C.

Kefir Preparation: Mix the mango extract with goat milk according to the desired treatment ratio of goat milk and mango extract: P1 (3:7), P2 (4:6), P3 (5:5). Add kefir grains or a starter culture to the mixture (generally, 1-2 tablespoons of kefir grains per 1 liter of liquid). Stir gently to distribute the culture evenly. Cover the container with a cloth or a loose-fitting lid to allow airflow while preventing contamination. Leave the mixture at room temperature (20-25°C) for 24-48 hours to ferment. The fermentation time can be adjusted based on the desired flavor and consistency. After fermentation, strain the kefir to remove the grains (if using kefir grains) and store the final product in the refrigerator.

pH Measurement: The pH was measured using a calibrated digital pH meter, following a modified protocol by Arkan *et al*. (2021) [1].

Syneresis and WHC Measurement: Samples were centrifuged at 3000 rpm for 10 minutes, and whey separation was quantified. Calculations followed the Setyawardani *et al*. (2020) [3] method:

$$WHC\ (\%) = \frac{Initial\ sample\ mass - Final\ sample\ mass}{Initial\ Sample\ mass} \times 100\%$$

The type of research used is experimental research, which aims to test the effect or cause-and-effect relationship between manipulated variables and observed outcomes. In this research, a Completely Randomized Design (CRD) is employed, which is a common experimental design in research.

Discussion

Table 1

Treatment	pH	Syneresis (%)	WHC (%)
P1	4.05a	19%a	81%a
P2	4.06a	21%a	79%a
P3	3.86b	27%b	73%b

The pH range for these kefir samples is between 3.86 and 4.06, indicating that all samples are acidic, which is typical for kefir. A pH in this range suggests that the fermentation process has progressed sufficiently to produce the characteristic lactic acid and other organic acids responsible for kefir's acidity.

The analysis of variance results showed that the addition of mango juice at different levels had a significant effect ($P<0.05$) on the pH value of kefir. Duncan's post-hoc test indicated that the pH value of kefir produced at mango juice concentrations in P1 and P2 was significantly higher than other treatments. As the concentration of mango juice used increased, the resulting pH decreased. The decrease in kefir pH with higher mango juice concentrations was due to the growth of lactic acid bacteria during the fermentation process.

Pranayanti and Sutrisno (2015) [2] stated that the increase in acid levels is due to the activity of lactic acid bacteria (LAB) breaking down simple sugars in the medium to the maximum extent through the glycolysis process, resulting in fermentation metabolites in the form of increased lactic acid. The decrease in pH is also caused by the increased growth of lactic acid bacteria due to the availability of the necessary nutrients and an optimal temperature for their growth.

Based on the data presented in Table 1, it is evident that kefir with the addition mango jouice has an average
water holding capacity ranging from 73% to 81%. The water holding capacity values in kefir with mango juice tend to decrease. The analysis of variance (ANOVA) results indicates that the addition of mango juice in kefir production has a significant effect ($P<0.05$) on the water holding capacity values of kefir. Subsequently, a Duncan's multiple range test was conducted to determine the differences among treatments involving the addition of mango juice in the kefir-making process. The decrease in water holding capacity values of the resulting kefir is due to the addition of mango juice, which can reduce the water holding capacity of the kefir.

Syneresis is the percentage of water released due to a decrease in the ability of protein networks during treatment using the drainage method. Research results showed that kefir produced with the addition of mango juice resulted in different levels of syneresis. The lowest syneresis was found in P1, while the highest syneresis was found in P3. High syneresis occurs due to weak protein networks, resulting in a weak water-binding capacity. This is consistent with the statement by Setyawardani *et al*. (2020) [3] that low syneresis reflects good fermentation product quality, while high syneresis indicates weak water retention, leading to more nutrients separating from the solid due to low gel strength. According to Rohman and Maharani (2020), the low protein-water interaction results in precipitation, causing the protein network to release water. This leads to protein gel shrinkage, which accelerates curd formation and whey separation. The study revealed that increasing the proportion of mango extract led to variations in the pH and WHC of the kefir. The highest WHC was observed in treatment P2 (81%), while P3 showed the highest syneresis at 27%. These findings suggest that mango extract influences the structural properties of kefir.

Conclusion

Substituting goat milk with mango extract affects the physical properties of kefir. Optimal results in terms of pH and WHC were seen at a 4:6 ratio of mango extract to goat milk (P2).

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