

PHYSICOCHEMICAL CHARACTERISTICS OF RIPENED CHEESE WITH THE ADDITION OF KECOMBRANG (*ETLINGERA ELATIOR*) POWDER AS A MILK-CLOTTING AGENT

Rifda Naufalin^{1*}, Gunawan Wijonarko¹, Ananda Yasmin Nisa², Yuri Rossa Aprina¹, Nuke Faradhila¹

¹Faculty of Food Technology, Faculty of Agriculture, University of Jenderal Soedirman, Purwokerto 53121, Central Java Province, Indonesia

²Faculty of Animal Husbandry, University of Jenderal Soedirman, Purwokerto 53121, Central Java Province, Indonesia

*Email: rifda.naufalin@unsoed.ac.id

Abstract. Milk is a highly perishable livestock product due to its high water content, requiring appropriate processing to extend its shelf life and increase added value. Cheese is one of the most popular dairy products and offers strong potential for product innovation through the incorporation of natural and functional ingredients. Kecombrang flower (*Etlingera elatior*) contains bioactive compounds, including flavonoids and anthocyanins, which may contribute to sensory modification when applied in dairy products. This study aimed to evaluate the effects of kecombrang flower extract concentration (2.5%, 5%, and 7.5%) and ripening duration (0, 3, and 5 days) on the sensory characteristics (color, flavor, taste, texture, and overall acceptance) of cow's milk soft cheese. The experiment was conducted using a factorial completely randomized design, and sensory evaluation was performed using a hedonic test with semi-trained panelists. Data were analyzed using two-way analysis of variance (ANOVA) followed by Duncan's Multiple Range Test (DMRT) at a 5% significance level. The results demonstrated that variations in extract concentration and ripening duration significantly influenced the sensory attributes of cow's milk cheese. The highest panelist acceptance across most sensory attributes was observed in cheese supplemented with 5% kecombrang flower extract and ripened for 3 days. Unripened cheese generally received lower preference scores, particularly for texture, taste, and overall acceptance. Overall sensory scores ranged from 2 to 3, indicating that the cheese products were generally acceptable to panelists. Taste and flavor were identified as the most influential attributes affecting overall acceptance. In conclusion, the incorporation of 5% kecombrang flower extract with a 3-day ripening period produced the most favorable sensory profile among the evaluated treatments. However, further optimization of formulation and ripening conditions is necessary, particularly to enhance taste and flavor, in order to improve consumer acceptance and support the development of innovative dairy products.

Keywords: Cheese, kecombrang flower, pH, yield, sensory evaluation.

1. Introduction

Milk production from dairy cattle in Indonesia has shown a continuous increase in recent years. In Banyumas Regency, dairy milk production reached a substantial volume of 4,331,629 units in 2023, which was higher than production in 2021 (4,114,164 units) and 2022 (4,036,419.38 units) [1]. Despite this growth, most fresh milk is still marketed directly or processed into only simple products, even though milk is highly perishable. The high water content of milk makes it susceptible to rapid spoilage, classifying it as a perishable food. One effective strategy to extend shelf life while simultaneously increasing the added value of milk is through processing into cheese.

Cheese is a dairy-based food product that is widely favored by consumers. Data from the Indonesian Ministry of Agriculture indicate a significant increase in national cheese consumption, rising from approximately 130,000 tons in 2014 to 600,000 tons in 2017. Cheese consumption in 2017 reached 0.252 ounces per capita per year, representing a 240% increase compared to 2014 [2]. These figures reflect a growing consumer interest in cheese, which presents opportunities for product innovation aligned with the Sustainable Development Goals (SDGs), particularly SDG 9 (Industry, Innovation, and Infrastructure) and SDG 12 (Responsible Consumption and Production). Cheese products can be developed through innovation by incorporating natural ingredients that are safe, sustainable, and possess functional value, such as kecombrang (*Etlingera elatior*).

Kecombrang is a spice plant belonging to the Zingiberaceae family and thrives in tropical regions. Traditionally, it has been utilized as a culinary ingredient and herbal medicine. Several parts of the kecombrang plant can be used as food additives, including the leaves, stems, rhizomes, and flowers. Kecombrang flowers contain compounds that play an important role in coloration, particularly anthocyanins (a class of flavonoids), with an average content of 2.189 mg/100 mL [3]. The anthocyanin content of kecombrang flowers can be utilized as a natural colorant in food products. In addition, kecombrang flower extract contains protease enzymes capable of hydrolyzing proteins [4]. Previous studies have shown that the addition of kecombrang flower extract influences the physicochemical and sensory characteristics of yogurt [5]. The percentages of kecombrang flower extract added to kefir ranged from 2.5%, 5%, to 7.5%, with 7.5% identified as the most effective concentration; however, sensory panelists preferred the lower concentration of 2.5% [6].

The ripening duration also plays a crucial role in determining cheese quality, as it contributes to the development of flavor, aroma, texture, and chemical stability. Changes in cheese quality during ripening are influenced by biochemical factors, such as pH and water activity, as well as microbiological changes occurring throughout the ripening process [7]. Research focusing on variations in ripening duration remains limited; therefore, this study was conducted by combining different treatments. These treatments involved the addition of kecombrang flower extract at concentrations of 2.5%, 5%, and 7.5% to unripened cheese and cheese ripened for 3 and 5 days. This study is expected to elucidate the effects of these treatments on the sensory characteristics of cow's milk cheese.

2. Methods

This study was conducted using an experimental approach with a factorial Completely Randomized Design (CRD). Two factors were evaluated: (1) kecombrang (*Etlingera elatior*) flower extract concentration at three levels (2.5%, 5%, and 7.5%), and (2) cheese ripening time at three levels (0, 3, and 5 days). The combination of these factors resulted in nine treatment combinations. The effect of each treatment on the sensory characteristics of cow's milk cheese was evaluated.

Sensory characteristics of cow's milk cheese supplemented with kecombrang flower extract were evaluated using a hedonic test. Sensory analysis was conducted in accordance

with Indonesian National Standard SNI 01-2346-2006 (BSN, 2006). A total of 25 semi-trained panelists, consisting of university students, participated in the evaluation. Panelists assessed nine cheese samples and recorded their preferences on a structured score sheet based on four sensory attributes: color, aroma, taste, and texture. A five-point hedonic scale was applied, where a score of 1 indicated dislike very much, 2 dislike, 3 neither like nor dislike, 4 like, and 5 like very much.

The results of sensory evaluation were tabulated and presented in bar charts using Microsoft Excel 2019. Data were statistically analyzed using two-way analysis of variance (ANOVA) to determine the effects of kecombrang flower extract concentration, ripening time, and their interaction. When significant or highly significant differences were observed, mean comparisons were performed using Duncan's Multiple Range Test (DMRT) at a significance level of $\alpha = 0.05$.

The materials used in this study included fresh cow's milk, kecombrang flowers (*Etlingera elatior*), microbial rennet, and salt. The equipment employed comprised beakers, thermometer, knife, stainless steel pan, filter, measuring cylinder, stove, cabinet dryer, chopper, juice extractor, and hammer mill.

The preparation of kecombrang flower extract was carried out based on the method described by Naufalin et al. (2020) with modifications in the water-to-powder ratio, as well as extraction temperature and time [8]. Fresh kecombrang flowers were sorted and chopped using a chopper. The chopped flowers were then dried in a cabinet dryer at 50–60°C for 4 hours. The dried kecombrang flower material was ground using a hammer mill and sieved through a 60-mesh sieve to obtain kecombrang flower powder. The powder was subsequently extracted using a juice extractor with a powder-to-water ratio of 1:28 (g/mL). The extraction process was conducted at 70°C for 3 hours.

The cheese-making process consisted of pasteurization, acidification, coagulation, whey syneresis, curd pressing, salting, and ripening. Initially, fresh cow's milk was pasteurized using the low-temperature long-time (LTLT) method at 63°C for 30 minutes. After pasteurization, kecombrang flower extract was added to the milk at concentrations of 2.5%, 5%, and 7.5% (v/v) and allowed to stand for 15 minutes to ensure uniform distribution. Coagulation was subsequently induced by the addition of microbial rennet at 0.5% (v/v). The coagulated milk then underwent a scalding process, followed by whey syneresis, in which the whey was separated from the curd. The curd was pressed to remove excess whey and subsequently salted with 1% (w/w) non-iodized salt based on the weight of the curd. Finally, the cow's milk cheese was subjected to ripening periods of 0, 3, and 5 days, according to the experimental design.



Figure 1. Cow's Milk Cheese Samples with Different Levels of Kecombrang (*Etlingera elatior*) Flower Extract Addition

3. Results and Discussion

3.1. Result

3.1.1. Colour

Color is the first sensory attribute perceived by panelists and plays a crucial role in shaping the initial perception of cheese quality. Based on the hedonic test results, panelists' preference for the color of soft cheese varied across treatments, with mean scores ranging from 2.61 to 3.69. The P2K2 sample exhibited the highest color preference score (3.69), indicating that this treatment combination produced the most visually appealing appearance to the panelists.

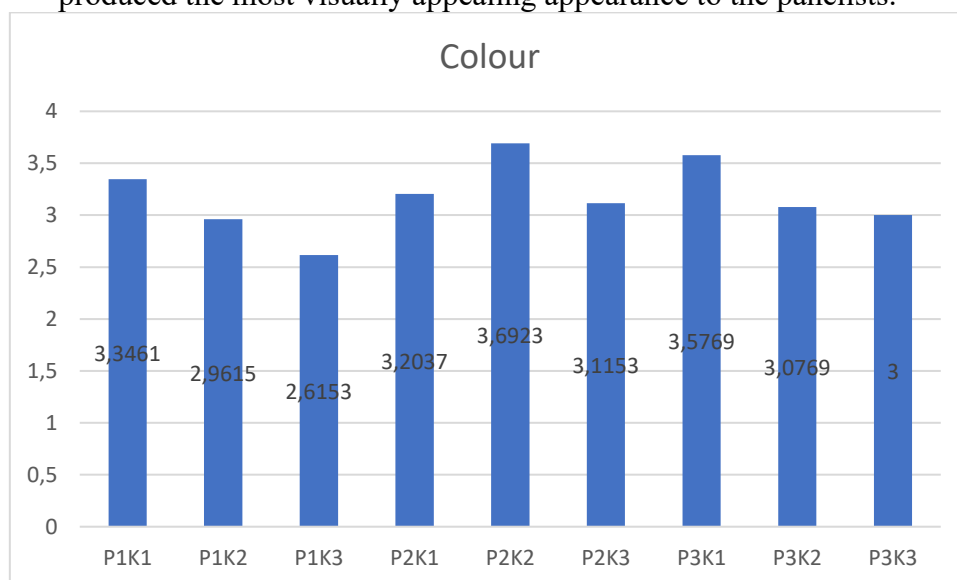


Figure 2. Color Attribute Scores from Sensory Evaluation

3.1.2. Texture

Texture quality is a critical indicator in determining the physical quality of soft cheese. The hedonic evaluation revealed a wide range of texture preference scores, varying from 1.69 to 3.53, indicating that both kecombrang flower extract concentration and ripening time substantially influenced the textural properties of the cheese. The P2K2 treatment again achieved the highest texture score (3.53), suggesting that this combination produced a texture that was soft yet cohesive and spreadable, which aligns with the desirable characteristics of soft cheese.

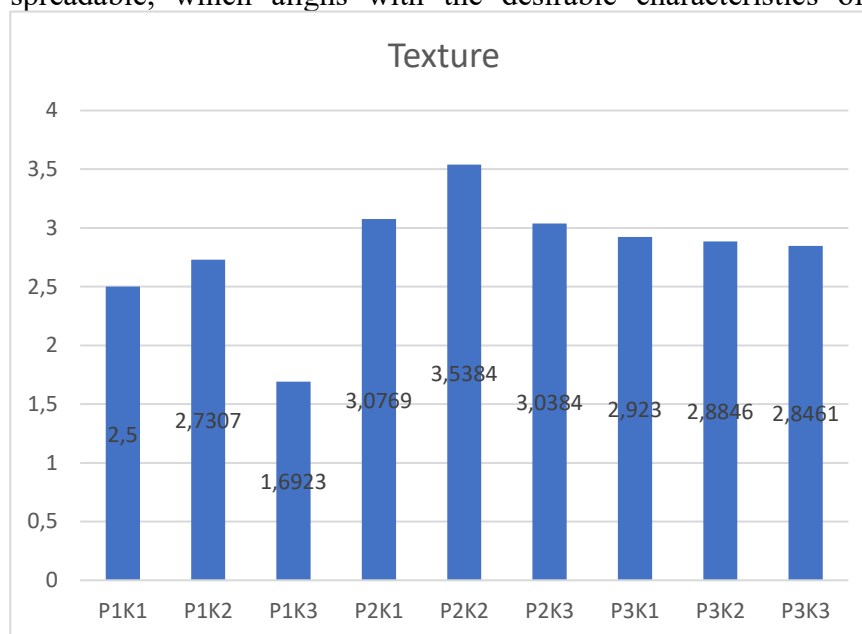


Figure 3. Sensory Evaluation Results for Texture Attribute

3.1.3. Taste

The taste attribute exhibited high sensitivity among panelists, with hedonic scores ranging from 1.42 to 3.11, indicating considerable variation in flavor acceptance across treatments. Although the P2K2 treatment remained the most preferred sample with a mean score of 3.11, the overall taste scores for all samples were generally lower compared to other sensory attributes.

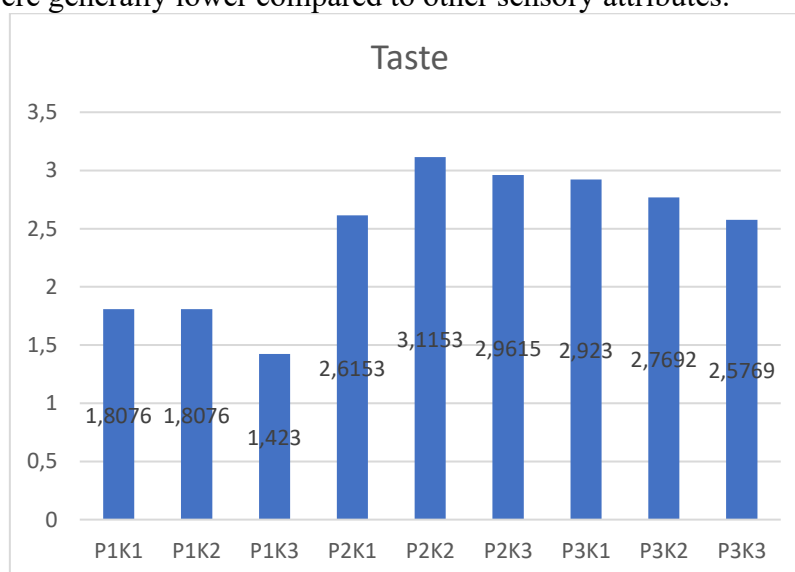


Figure 3. Sensory Evaluation Results for Taste Attribute

3.1.4. Flavor

Flavor is a crucial sensory parameter that reflects the fermentation profile of cheese products, encompassing both aroma perception and overall flavor impression. The results of the sensory evaluation indicated that flavor preference scores ranged from 2.88 to 3.65, demonstrating moderate variation among treatments. The P2K2 sample again exhibited the highest flavor score (3.65), followed by P3K3 and P2K1, both of which achieved scores of 3.50.

The highest flavor preference observed in the P2K2 treatment suggests that this combination was able to produce a balanced and characteristic cheese flavor without generating pungent or undesirable sensory notes. Flavor development in cheese is largely influenced by volatile and non-volatile compounds produced through microbial metabolism during ripening, including organic acids, ketones, alcohols, and sulfur-containing compounds. In addition, the incorporation of kecombrang flower extract contributed a distinctive herbal flavor, which at appropriate concentrations enhanced the overall sensory appeal of the product.

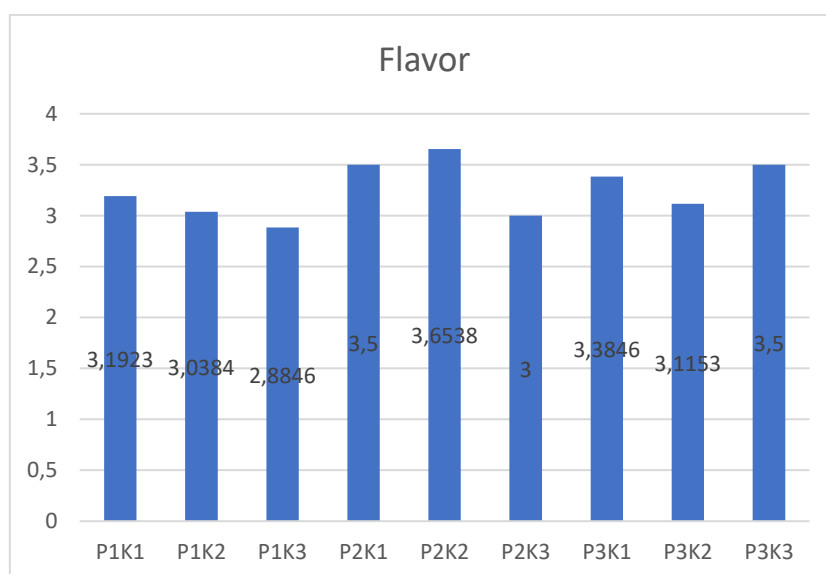


Figure 4. Sensory Evaluation Results for Flavor Attribute

3.1.5. Overall

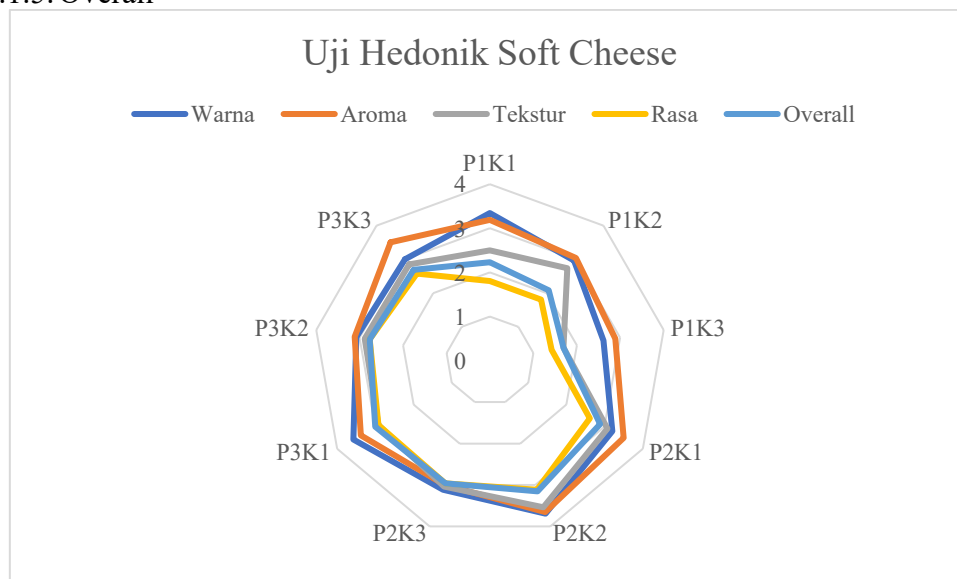


Figure 5. Sensory Evaluation Results for Overall Attribute

Overall sensory evaluation indicated that most panelists preferred soft cheese subjected to a 3-day ripening period with the addition of 5% kecombrang flower extract (P2K2) and cheese ripened for 5 days with 2.5% kecombrang flower extract (P3K1). The P2K2 treatment demonstrated favorable scores for color, flavor, and texture, while the taste and overall acceptance were rated as moderately liked by the panelists. This suggests that the P2K2 formulation achieved a generally appealing sensory profile, although further improvement in taste is necessary to enhance consumer acceptance.

In contrast, the P3K1 treatment showed that panelists favored the color attribute, whereas flavor, texture, taste, and overall acceptance were evaluated as moderately liked. These results indicate that extended ripening combined with a lower concentration of kecombrang flower extract can produce acceptable sensory characteristics, although not all attributes reached a high preference level.

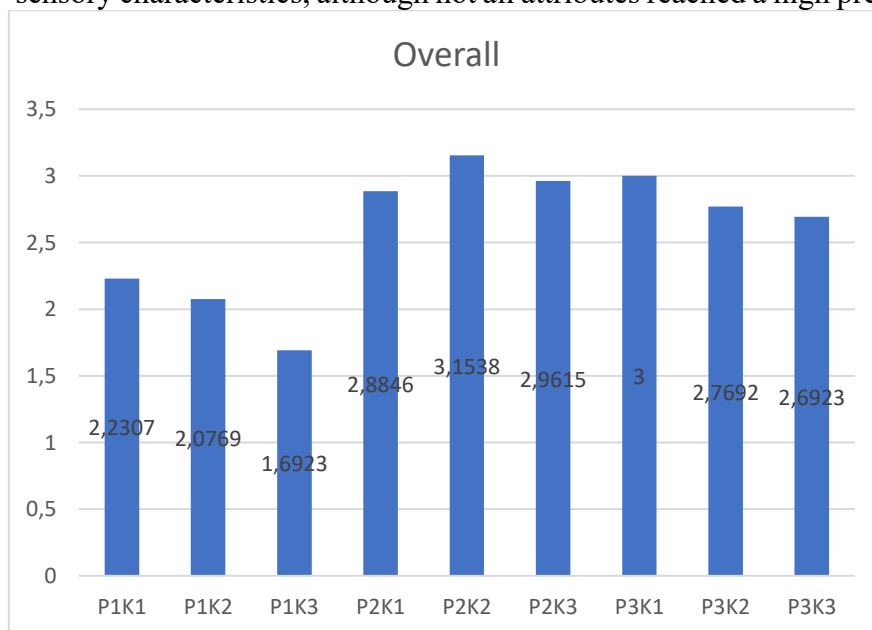


Figure 6. Sensory Evaluation Results for Overall Attribute

3.2. Discussion

3.2.1. Colour

The color of soft cheese is generally influenced by factors such as fat content and the type of coagulant used, which affect light reflection and curd structure. The higher acceptability of the P2K2 treatment suggests that an optimal balance between kecombrang flower extract concentration and ripening time contributed to a more desirable color intensity and uniformity. In contrast, the lowest score observed in the P1K3 sample indicates that increasing extract concentration or extending the ripening duration under the P1 treatment tended to reduce the brightness or visual attractiveness expected by consumers.

This decrease in color preference may be associated with pigment degradation or browning reactions occurring during ripening, which can alter the natural color of the cheese matrix. Additionally, higher concentrations of kecombrang flower extract, which contains anthocyanin pigments, may intensify color beyond the preferred level, resulting in reduced consumer acceptance. These findings suggest that both extract concentration and ripening duration significantly influence the color perception of soft cheese, highlighting the importance of optimizing formulation and processing conditions to achieve desirable visual quality.

3.2.2. Texture

The favorable texture observed in the P2K2 sample is presumed to result from a balanced interaction between protein coagulation, whey syneresis, and enzymatic activity during ripening. Proper coagulation and controlled whey release contribute to the formation of a uniform protein network, while moderate enzymatic activity supports texture development without excessive structural breakdown.

In contrast, the lowest texture score was recorded for the P1K3 treatment, indicating that prolonged ripening combined with a specific extract concentration may have caused the cheese matrix to become overly fragile or non-homogeneous. This phenomenon is likely associated with excessive protein degradation due to intensified enzymatic activity during extended ripening, leading to a weakened curd structure. As a result, the textural properties of the cheese were less preferred by the panelists. These findings highlight the importance of optimizing extract concentration and ripening duration to achieve acceptable textural quality in soft cheese products..

3.2.3. Taste

The relatively low taste scores observed in the P1 treatment group (average score < 2.0) suggest the presence of undesirable flavor perceptions, such as excessive sourness or the emergence of a bitter aftertaste. These sensory defects are likely associated with intensified proteolytic activity, which can lead to the accumulation of bitter peptides and free amino acids during cheese ripening. Excessive acid development may also contribute to an imbalanced flavor profile that is less acceptable to consumers.

In contrast, the treatments corresponding to P2 and P3 parameters demonstrated improved taste acceptance, indicating that better control of extract concentration and ripening duration contributed to a more balanced and harmonious flavor profile. This balance likely results from moderated biochemical reactions during ripening, allowing flavor compounds to develop without leaning toward bitterness or excessive acidity. These findings emphasize

the importance of optimizing formulation and processing conditions to enhance taste acceptability in soft cheese supplemented with kecombrang flower extract.

3.2.4. Flavor

In treatments with extended ripening durations, flavor intensity tended to increase and, in some cases, exceeded the panelists' acceptance threshold, leading to reduced preference. This effect may be attributed to the excessive accumulation of flavor-active compounds during prolonged fermentation, which can result in overly strong or imbalanced flavor characteristics. These findings indicate that careful control of both ripening time and extract concentration is essential to achieve an optimal and acceptable flavor profile in soft cheese supplemented with kecombrang flower extract.

3.2.5. Overall

A considerable proportion of panelists expressed lower preference for unripened cheese (0-day ripening) across all levels of kecombrang flower extract addition, particularly with respect to texture, taste, and overall acceptance. This finding highlights the importance of the ripening process in developing desirable sensory properties in soft cheese.

Overall acceptance scores for all soft cheese samples ranged between 2 and 3, indicating that soft cheese supplemented with kecombrang flower extract and subjected to various ripening durations was generally acceptable to the panelists. Among the evaluated attributes, taste and flavor exerted the greatest influence on overall acceptance, emphasizing the need for further optimization of flavor development to improve consumer preference and market potential.

4. Conclusion

Variations in kecombrang (*Etlingera elatior*) flower extract concentration and ripening duration significantly influenced the sensory characteristics of cow's milk cheese. Based on the hedonic test results, the combination of 3 days of ripening with the addition of 5% kecombrang flower extract resulted in the highest panelist acceptance across most sensory attributes. In contrast, unripened cheese generally exhibited lower preference scores compared to ripened samples.

Overall, soft cheese supplemented with kecombrang flower extract was acceptable to panelists, indicating its potential as an innovative dairy product. However, further optimization of formulation and ripening conditions is required, particularly to enhance taste and flavor attributes, in order to achieve higher consumer acceptance and improve the product's marketability. experiences.

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