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Effect of Garlic Paste on the Physicochemical Attributes of Cheese

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Abstract

Cheese has recently gained a lot of popularity around the world. This experiment was carried out to make cheese from skim milk with the addition of garlic paste. This study focused on the impact of garlic paste on the physicochemical properties of cheese. Cheese samples S1, S2, S3, and S4 were prepared with 0%, 1%, 3%, and 5% garlic paste, respectively, where S1 was the control sample. Compared to sample S1, the higher proportion of garlic paste incorporation resulted in higher viscosity and water holding capacity; nevertheless, lower values for syneresis were obtained. Although no significant change was observed in the pH values, samples S4 (5% garlic) and S1 (0% garlic) exhibited the highest and lowest pH, respectively. The results in this investigation revealed that garlic inclusion had a substantial impact on the physicochemical parameters of the skim milk cheese.

Keywords

Skim Milk Cheese, Garlic Paste, Physicochemical Properties, Syneresis, Water Holding Capacity

1. Introduction

Cheese is a fermented milk-based food product made by draining milk after it has coagulated. It is also known as "a coagulated curd of milk solids in which milk fat is trapped by coagulated casein" [1]. Cheese is one of the most popular fermented dairy products and a good source of high-quality protein and milk fat. It is a concentrated energy source with high fat-soluble vitamins and minerals (calcium and phosphorus). Nevertheless, Cheeses that contain minimal fat and sodium are advised because consuming low-fat cheese and dairy products may help lose weight and have many health benefits. In recent years, consumers have expressed a growing interest in low-fat cheeses [2].

Cheese is prized for its long shelf life and varies in color, flavor, and texture from country to country [3] [4]. There are numerous types of cheese on the globe. Multiple variables contribute to this variation, including the type of milk used (cow, buffalo, goat, or sheep), the manufacturing procedure, and local tastes. It is made by coagulating milk protein (casein) through enzymatic action (rennet) or microbial fermentation in various flavors, textures, and shapes. The solid was split and shaped into its final shape. The physical characteristics of cheese, including flavor, are determined by a variety of factors, for example, milk composition and quality, milk heat treatment, acidification type (concentration and type of starter culture and coagulant agent), cheese composition (water, protein, and fat), the pH of the cheese, calcium and other mineral content, and ripening conditions (curd size, curd time, and cooking temperature, as well as temperature and relative humidity) [5].

The popularity of cheese is increasing due to its better biological and sensory values. Therefore, the inclusion of additives (herbs and spices) has considerably attained the attention of the producers and researchers. Several condiment plants have medical characteristics that could be a valuable natural alternative to chemical preservatives for food preservation [6], even at high concentrations. For example, thirty types of novel cottage cheeses were successfully developed with appropriate sensory properties, improved biological value, and prolonged shelf life by adding dried or fresh pepper, parsley, garlic, dill, and rosemary [7].

Garlic (Allium sativum) is utilized as a flavor component in cheese as well as for its health advantages. It is an antifungal, antibacterial, antiviral, and anti-inflammatory dietary component [8] [9]. It offers a lot of health benefits. Garlic's therapeutic abilities may aid in lowering blood pressure, lowering LED (Low-Density Lipoprotein) or bad cholesterol, managing high blood sugar levels, and preventing blood clots, all of which reduce the risk of strokes and heart disease. Garlic essential oil has antibacterial activity against *Staphylococcus aureus*, *E. coli*, *Bacillus subtilis* [10], as well as antifungal activity against *Penicillium funiculosum* [11]. Garlic in the raw inhibited *Helicobacter pylori*, while garlic nanovesicles were efficient against *Listeria monocytogenes* [12] [13].

For the functionality, texture, and flavor, garlic has been considered as an important additive in cheese. Therefore, in this study, different proportions of garlic paste were used (0%, 1%, 3%, 5%) to develop cheese with skim milk. Although several studies have been completed to analyze and know the effect of various compositions [14] [15], processing changes and post-manufacturing factors on cheese, the addition of a new ingredient and changes to the manufacturing process for cheese could have different effects [16] [17] that should be explored. To the best of our knowledge, investigation on the effect of garlic inclusion on the physicochemical properties of skim-milk cheese is scarce. So, the objective of this study was to investigate the influence of garlic paste on the physicochemical properties of skim milk cheese in terms of pH, viscosity, water holding capacity, and syneresis.

2. Materials and Methods

2.1. Materials

Skim milk and garlic were purchased from the local market, and Starter Culture (YC-087, Cher. Hansen, inc., Milwaukee, WI), Rennet (Maxiren 180, 180 IMCU·mL^{-1}, DSM Food Specialties, Delft, Netherlands), Calcium Chloride, Sodium Chloride were supplied by a local supplier of Dinajpur. All the materials and chemicals used were analytical grade.

2.2. Milk Preparation and Pasteurization

The reconstituted milk was made with a 1:8 milk powder to water ratio (DMMPS-14). 50 g of milk powder was dissolved in 400 ml water to make reconstituted milk. A magnetic stirrer was used to stir the milk for 20 minutes to ensure appropriate dilution. The milk was then pasteurized (for 20 minutes at 72˚C). To bring the temperature of the processed milk back to normal, it was chilled with ice water.

2.3. Preparation of Garlic Paste

The garlic bulb's dry skins were removed under aseptic conditions. The garlic cloves were peeled, rinsed, and sliced with a sharp knife. After that, using an electric food grinder, the slices were crushed into a paste. The garlic paste was kept in a plastic jar at 4˚C.

2.4. Starter Culture

Yogurt starter culture (YC-087, Cher. Hansen, Inc., Milwaukee, WI), which contained mainly *L. bulgaricus* and *S. thermophiles*, was employed in the production of cheese. The starter culture was prepared from the mother culture. For making the culture, 12 g of skim milk was diluted into 100 ml distilled water. The mix was stirred for 20 minutes in a magnetic stirrer and pasteurized at 72˚C for 20 minutes. Afterward, 0.1 g of mother culture was added to the milk. Then the milk was incubated at 35˚C for 16 hours. The prepared culture was stored at 4˚C temperature.

2.5. Rennet Selection

Chymosin (Maxiren 180, 180 IMCU·mL^{-1}, DSM Food Specialties, Delft, Netherlands) was used for cheese manufacturing. It was added with milk sample by diluting one in ten with distilled water to aid water dispersion.

2.6. Cheese Preparation

Four cheese samples were prepared by the method described by Abou-Donia [18]. In each jar, 100 ml milk was used, and garlic paste (0%, 1%, 3% & 5%) was added. For proper mixing, the milk was stirred for 20 minutes using a magnetic stirrer. Afterward, pasteurization was achieved by heating at 72˚C for 20 minutes. After cooling at room temperature (28˚C ± 2˚C), 2 g of starter culture was introduced in each sample. For ripening, the mixture was left for 30 minutes with constant stirring. Then 0.25 g $CaCl_2$ was added and was equilibrated for 5 minutes before incorporating 2 ml of rennet solution. The milk was coagulated in less than one hour, and cheesecloth was used to separate the whey water from the curd. After straining the curd for 40 minutes, 2% NaCl was added. Next, the cheese was cut and kept at 4˚C in the refrigerator for further analysis. Table 1 showed the basic formulation for cheese preparation and the flow diagram for cheese preparation was presented in Figure 1.

2.7. Determination of pH

The pH of the cheese samples was determined using a standard approach developed by the Association of Official Analytical Chemists [19]. Before the whey was drained from the cheese, the pH was tested in the curd form using an electronic digital pH meter and the potentiometric approach, which involves measuring the potential difference between the sample and the electrolyte solution

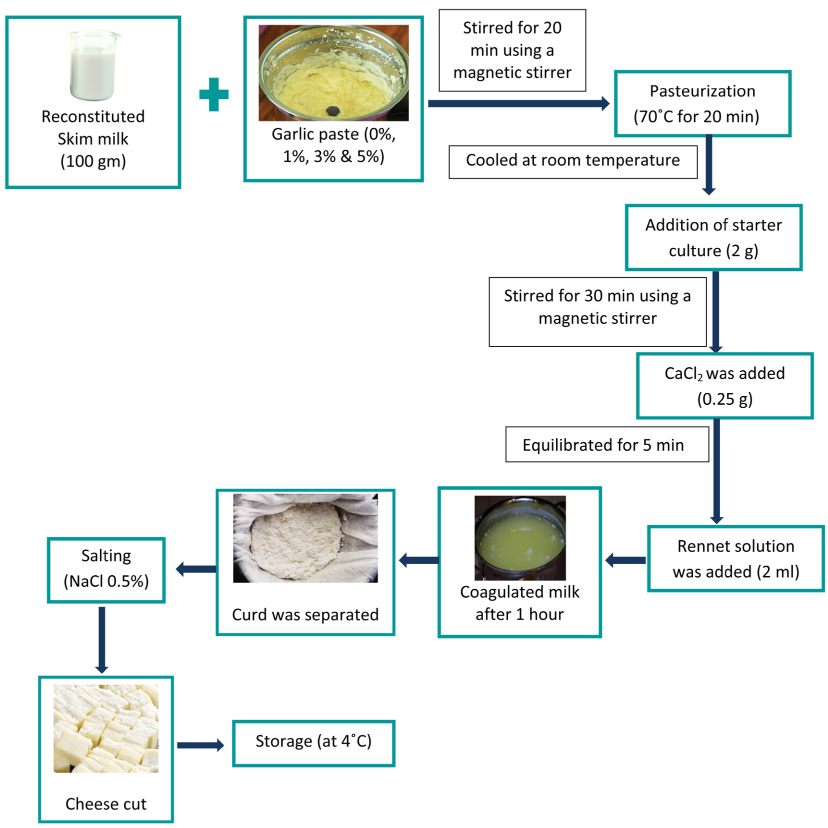

Figure 1. Flow diagram of cheese preparation.

Table 1. Basic formulation of cheese samples.

Ingredients	Samples			
	S1	S2	S3	S4
Milk (ml)	100	100	100	100
Garlic paste (%)	0	1	3	5
Starter culture (g)	2	2	2	2
$CaCl_2$	0.25	0.25	0.25	0.25
NaCl (g)	0.5	0.5	0.5	0.5
Rennet (g)	2	2	2	2

present inside the electrode of the pH meter (Model HI2211 HANNA instrument, Portugal). The electrode was directly dipped into the curd form of the cheese samples. New pH 4.0 and 7.0 standard buffers were used to calibrate the pH meter on a regular basis.

2.8. Viscosity Analysis

Viscosity was measured using a rotational viscometer (model VR 3000, Myr). The curd was broken by stirring with a glass rod. No. 3 spindle was used, with about one-third of the spindle immersed. Each measurement was done three times at room temperature (28˚C ± 2˚C) at 100 rpm for 1 minute. The data was recorded in Pa·s.

2.9. Determination of Water Holding Capacity

The Water Holding Capacity (WHC) of yogurt is defined as its ability to hold all or part of its water. The centrifugation method is used to determine the Water Holding Capacity (WHC) of a gel as a result of a strong internal force or the gel's resistance to compaction. WHC of the samples was determined using a slightly modified centrifugation method [11]. The curd was taken in a falcon tube in principle. Three tubes were obtained from each batch of material. An equal amount of sample was obtained from each tube. The curd tube was centrifuged at 600 rpm for 10 minutes. The amount of eliminated water was determined by carefully weighing the supernatant. The resulting supernatant was weighed to determine the amount of excluded water. The water holding capacity was calculated by the equation:

$$\text{WHC}(\%) = (Y - W)/Y \times 100$$

where: Y = weight of the sample, W = weight of water

2.10. Syneresis Analysis

Syneresis, or whey ejection of acid milk gel, is required for dehydration during cheese production and can be accomplished by concentrating the gel after incubation (*i.e.*, whey removal) by cutting, heating, or whey separation. The syneresis of the cheese samples was done by whey separation. The cheese samples were synthesized in their cured state. A thin coating of 100 g curd was placed across the surface of the Whatman No. 1 filter paper. For ten minutes, the curd was filtered under a vacuum. The liquid that flowed through the filter paper was gathered and analyzed. The percentage of syneresis was calculated as the weight of the liquid divided by the weight of the initial sample multiplied by 100 [20]. The formula can be written as:

$$\text{Syneresis}\ (\%) = W/Y \times 100$$

where: W = Weight of whey water, Y = Weight of sample

2.11. Statistical Analysis

All the observations were performed thrice. Comparisons of means were performed by one-way Analysis of Variance (ANOVA) followed by Tukey's test ($p < 0.05$). Statistical analyses were run using the Minitab 16 (State College, Pa).

3. Result and Discussion

3.1. Physiochemical Properties of the Prepared Cheese Samples

3.1.1. pH Value

Based on **Figure 2**, there were no significant differences in the pH value ($p < 0.05$) of the cheese samples. However, the pH values of all garlic pastes treated samples (S2, S3, and S4) were higher than the control sample S1, and the values increased with the higher concentration of garlic paste. The highest and lowest pH was exhibited by samples S4 and S1 (5.87 and 5.80), respectively. In contrast, a reduction in the pH (from 6.50 to 6.10) was observed by other researchers who added garlic extract to West African soft cheese [21]. In another work, the reduction in pH value was also observed with the increasing proportion of garlic in the herby (Otlu) cheese [22]. These dissimilarities in results could be due to processing differences in cheese. Both authors incorporated garlic after the coagulation of milk, whereas, in this work, garlic was added with the milk at the beginning.

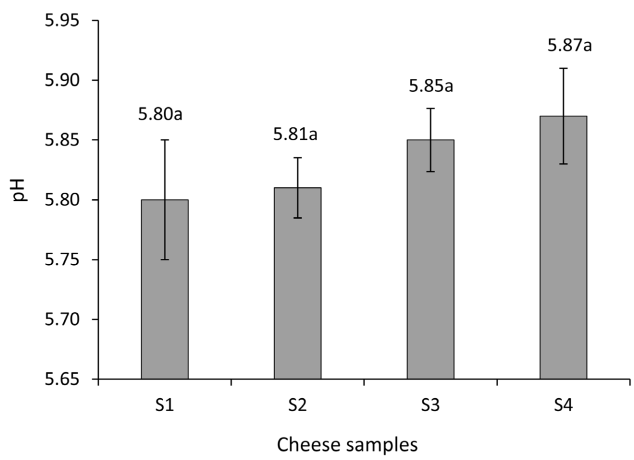

Figure 2. pH of prepared cheese samples. Different lowercase letters indicate significant differences by the Tukey's test ($p < 0.05$). S1, S2, S3, and S4 are the cheese samples with 0%, 1%, 3%, and 5% garlic paste respectively.

Therefore, this could be related to the garlic's ability to slow or stop the growth of lactic acid bacteria, hence affecting their action [9]. Acidifying activities of Lactic Acid Bacteria (LAB) present in cheese are most likely to blame for the pH variations [23]. Besides, during cheese ripening, an increase in pH value may occur because of yeast's metabolic activity that utilizes lactic acid as a source of carbon or as a result of large amounts of alkaline chemicals generated during proteolytic processes [24].

3.1.2. Viscosity

The viscosity of the cheese samples significantly varied from one another ($p < 0.05$). An expansion in viscosity of the cheese samples can be seen in **Figure 3**. The viscosity of garlic added cheese was more than the control sample where the viscosity increased (from 6.82 to 14.83 Pa·s) with the higher amount of garlic paste incorporation. This result could be attributed due to the addition of garlic paste. Garlic paste could have improved the consistency of the cheese, which in turn resulted in a higher viscosity. It is also evident that the percent of dry matter present in the product could affect the viscosity [25]. According to previous research, the viscosity of the product can be affected by almost every processing stage in the production of dairy products [26], and an increase in viscosity could indicate structural healing or rebodying [27].

3.1.3. Water Holding Capacity (WHC)

The WHC of the produced cheese samples was significantly affected by the addition of garlic paste. **Figure 4** demonstrated that the WHC of cheeses treated with 1%, 3%, and 5% garlic paste showed a substantial increase compared to the sample without garlic paste. Garlic inclusion might have affected the protein complex and the binding of micelle [28]. Besides, pH change during the processing could change the texture and WHC of cheese [29].

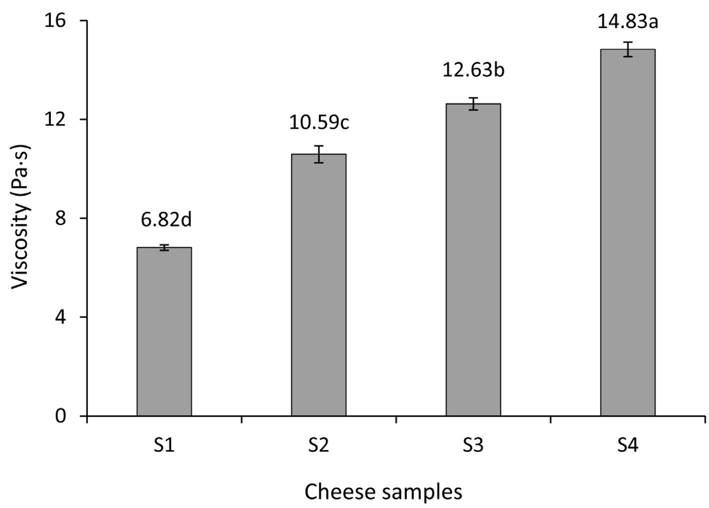

Figure 3. Viscosity of prepared cheese samples. Different lowercase letters indicate significant differences by the Tukey's test ($p < 0.05$). S1, S2, S3, and S4 are the cheese samples with 0%, 1%, 3%, and 5% garlic paste respectively.

3.1.4. Syneresis

Syneresis is a defect that affects the shelf-life and sensory quality of dairy products [30]. With lower syneresis, the homogeneity and quality of dairy products would improve. **Figure 5** represented that the syneresis of cheese samples was significantly ($p < 0.05$) decreased when different concentrations of garlic paste were added. Compared to the control sample, the syneresis of cheese samples reduced with the higher loading of garlic paste. The control sample S1 had the highest syneresis value of 48.33%, while S4 had the lowest syneresis value of 36.11%. It has been reported that a reduction in WHC leads to more whey release and increases the syneresis [31]. This work observed an increase in WHC with the addition of garlic paste, which could lead to a reduction in syneresis. However, many factors can influence the syneresis in milk products, such as

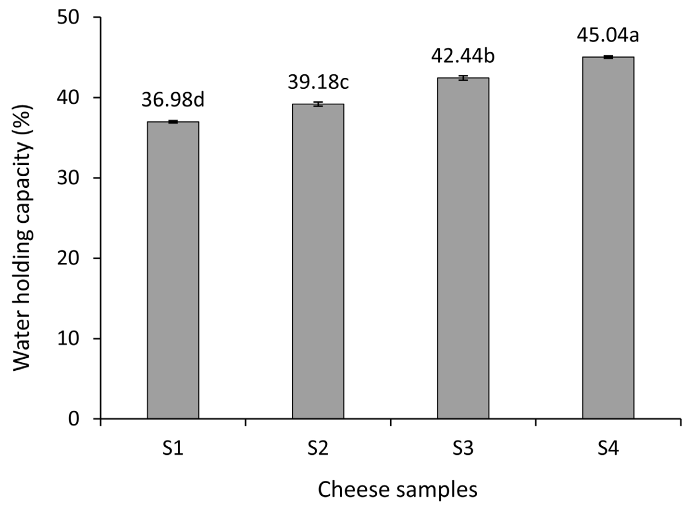

Figure 4. Water holding capacity of prepared cheese samples. Different lowercase letters indicate significant differences by the Tukey's test ($p < 0.05$). S1, S2, S3, and S4 are the cheese samples with 0%, 1%, 3%, and 5% garlic paste respectively.

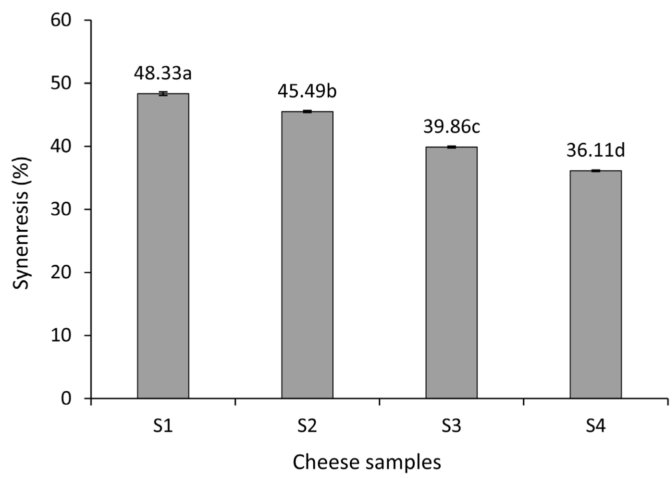

Figure 5. Syneresis of prepared cheese samples. Different lowercase letters indicate significant differences by the Tukey's test ($p < 0.05$). S1, S2, S3, and S4 are the cheese samples with 0%, 1%, 3%, and 5% garlic paste respectively.

processing conditions, acidity, and low fat. It has been reported that rearrangement of the casein micelles network was the leading cause of syneresis in dairy products (yogurt) [32] [33]. Horne [34] described that acidification of milk could also influence syneresis.

4. Conclusion

In this paper, skim milk-based cheese was prepared by incorporating different loadings of garlic paste (0%, 1%, 3%, and 5%). The influence of garlic paste on the physicochemical qualities of the cheeses was investigated. The addition of garlic pastes significantly increased the viscosity and water holding capacity of the cheese, which resulted in decreasing in the syneresis. Meanwhile, the pH of the cheese samples was not statistically different. The findings show that the incorporation of garlic has improved the physicochemical properties of the cheese, and the garlic dose used in this study has a lot of potential in terms of cheese production technology. However, further research is suggested to analyze the consumers' perceptions of the cheese samples.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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