



Analysis of Total Plate Count in Gouda Cheese Using Different Drying Methods and Durations

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Abstract. Drying is a widely used method to extend the shelf life of Gouda cheese, which is prone to microbial growth due to its high moisture and protein content. This study aimed to evaluate the microbial content of Gouda cheese dried using different drying methods and drying time. The 2x2 factorial design was used: drying method (oven and dry roasting) and drying time (60 and 120 minutes). The observed variable was the Total Plate Count (TPC). As a result, only the different drying methods showed a significant influence ($p < 0.01$) on the TPC of dried Gouda cheese. The dry roasting method had lower TPC (1.94 ± 0.44 Log CFU/g) than the oven method (2.57 ± 0.33 Log CFU/g). Meanwhile, the lowest value of TPC (1.58 ± 0.19 Log CFU/g) was reached by the dried Gouda cheese with a dry roasting method in 60 minutes drying time. In conclusion, dry roasting could be recommended for producing dried Gouda cheese.

Keywords: Gouda Cheese, Drying, Total Plate Count, Dry Roasting.

1 Introduction

Cheese is a globally popular food, with approximately 30% of its production utilized as an ingredient in diverse culinary applications due to its high nutritional value and role as a significant source of animal protein [1]. Drying is an effective method to extend the shelf life of cheese, addressing challenges associated with limited cold chain systems during storage and distribution. Among various cheese products, dry cheese offers distinct advantages, including prolonged shelf life, ease of storage and transportation, and enhanced flavor concentration. Producing dry cheese involves reducing moisture content while preserving the original cheese's taste, texture, and nutritional properties. Owing to its practicality and versatility, dry cheese is widely employed in the food industry, particularly in snacks, condiments, sauces, dressings, and ready-to-eat foods [2].

Cheese's high water and protein content makes it susceptible to microbial spoilage, necessitating processing techniques to extend its shelf life. Drying inhibits the growth of spoilage microorganisms by reducing water activity, thereby preserving the cheese's quality during storage [3]. However, selecting an appropriate drying method is crucial to producing dry cheese that meets chemical and microbiological quality standards and maintains consumer acceptability. Common drying techniques include oven drying,

spray drying, and roasting, each with unique functional properties [4-6]. Microbiological testing is pivotal in evaluating the product's durability and assessing microbial growth during storage. Recognizing the importance of optimizing drying techniques, this study aimed to evaluate the microbial content of dried Gouda cheese subjected to different drying methods and durations, with the ultimate goal of identifying optimal conditions for producing high-quality dry cheese.

2 Materials and Methods

2.1 Materials and Place of Study

This study was conducted in the Laboratory of Animal Product Technology, Faculty of Animal Science, Universitas Brawijaya. The primary material used was aged Gouda cheese (8–12 months of ripening), produced by the Regional Technical Implementation Unit (UPTD) for Breeding and Processing Animal Products under the Animal Husbandry and Health Service of Malang Regency.

2.2 Experimental Design

This research used a factorial, completely randomized design (CRD). The first factor was the drying method (oven drying and roasting), and the second was the drying time (60 minutes and 120 minutes). Each treatment combination was replicated five times to ensure statistical validity.

2.3 Microorganism Analysis

The number of microorganisms (TPC) was determined using the spread plate method. The procedure was as follows: preparing nutrient agar media sterilized in a Petri dish. The sample was weighed as much as 10 grams and dissolved in 100 ml of sterile distilled water. This dilution was calculated as a dilution of 100. A 1.5 mL microtube was prepared and filled with 900 μL of sterile distilled water. From the 100 dilution, 100 μL was taken and put into a microtube until it diluted up to 10^9 . For each microtube dilution, 100 μL of the bacterial suspension was inoculated and spread evenly over the surfaces of the prepared nutrient agar medium, following the spread plate method. Once finished, the media was placed in an incubator at 37°C for 24 hours. After 24 hours, bacterial populations were observed and counted; bacterial counts were taken with a number in the 30-300 colonies range.

2.4 Data Analysis

The data obtained were analyzed using analysis of variance (ANOVA) to determine the effect of treatment. If significant differences were found, Duncan's multiple range test was performed to identify differences between treatment groups.

3 Results and Discussion

The analysis revealed that the total microbial content of dried cheese was significantly influenced by the drying method ($P < 0.01$) but not by drying time ($P > 0.05$). An interaction effect between the drying method and drying time was also observed ($P < 0.01$), indicating their combined influence on the microbial population. The average total microbial population for each treatment is presented in Table 1 and Figure 1.

Table 1. Total plate count value of dried gouda cheese with different drying methods and drying time (log cfu/g)

Drying method	Drying time (minutes)		Average
	60	120	
Dry roasting	1.58 ± 0.19^a	2.30 ± 0.27^b	1.94 ± 0.44^A
Oven drying	2.66 ± 0.23^c	2.48 ± 0.42^b	2.57 ± 0.33^B
Average	2.12 ± 1.04	2.38 ± 1.35	

¹Data were presented as mean \pm standard deviation from five replicates

^{a-c}Uncommon superscript indicates a significant difference ($P < 0.01$) from the interaction between treatments

^{A-B}Uncommon superscript indicates a significant difference ($P < 0.01$) from the single

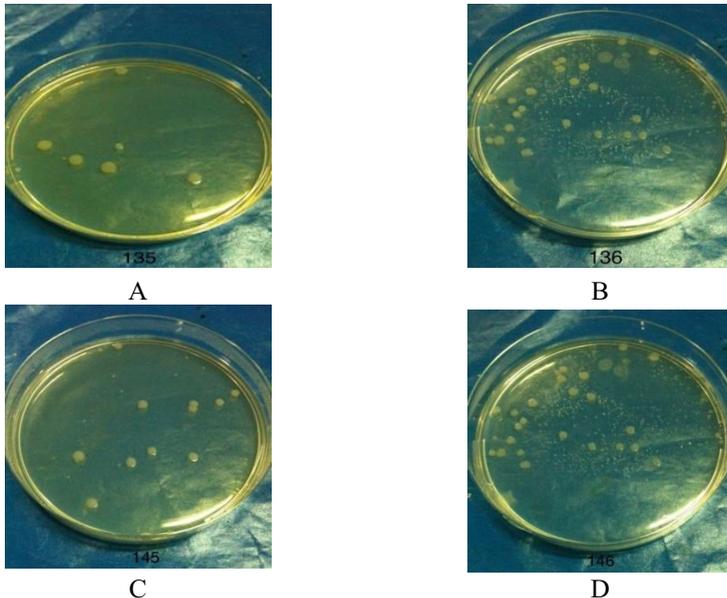


Fig. 1. The colony of microorganisms in the agar medium (A=roasting/60 minutes; B=roasting/120 minutes; C=oven drying/60 minutes; D=oven drying/120 minutes)

Differences in microbial content among drying methods can be attributed to variations in drying temperatures. Higher drying temperatures reduce microbial populations by causing more significant microorganism mortality, as seen in the roasted drying method, which achieved the lowest microbial count. This method's efficiency is due to direct material contact with the roaster and intensive stirring, resulting in more uniform and intense heat exposure than oven drying. In contrast, oven drying exhibited higher microbial counts, likely due to uneven heat distribution, which allowed mesophilic microorganisms to survive [7-9].

Although drying time did not significantly affect the microbial content ($P > 0.05$), longer drying durations tended to increase the total plate count (TPC). Prolonged drying may allow bacteria to adapt to the drying environment, leading to higher survival rates. Additionally, extended drying can influence the microbial ecosystem, altering the complexity and stability of bacterial communities [10]. The interaction between the drying method and time showed that the roasting method with a 60-minute drying duration produced the lowest microbial count (1.58×10^4 CFU/g). Factors such as initial microbial load, heating reactions, contamination during processing, drying method, and final packaging influence the microbiological quality of dry cheese [11].

High-temperature drying combined with extended durations can also affect the physical properties of cheese. The reduced moisture content leads to increased fat concentration, and structural changes in the cheese matrix allow oil to migrate to the surface. This process, driven by lipase-mediated lipolysis, results in free fatty acids and glycerol that serve as nutrients for certain bacteria, potentially increasing microbial counts during prolonged drying [12]. However, the microbial content in all treatments remained below the acceptable standard for food products, typically 10^6 CFU/g, indicating that the drying methods effectively maintained microbial safety [13].

The drying method significantly impacts the microbial quality of dry cheese, with roasting proving the most effective in reducing microbial counts. Understanding these effects is crucial for optimizing drying processes to produce high-quality, microbiologically stable dry cheese while preserving its desired characteristics.

4 Conclusion

Different drying methods and length of time affect the total number of microbes produced in cow Gouda cheese. The best microbiological quality of dry Gouda cheese was produced by the dry roasting method for 60 minutes with a total number of microorganisms of 1.58×10^4 CFU/gram.

Disclosure of Interests. The authors have no competing interests to declare that are relevant to the content of this article.

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