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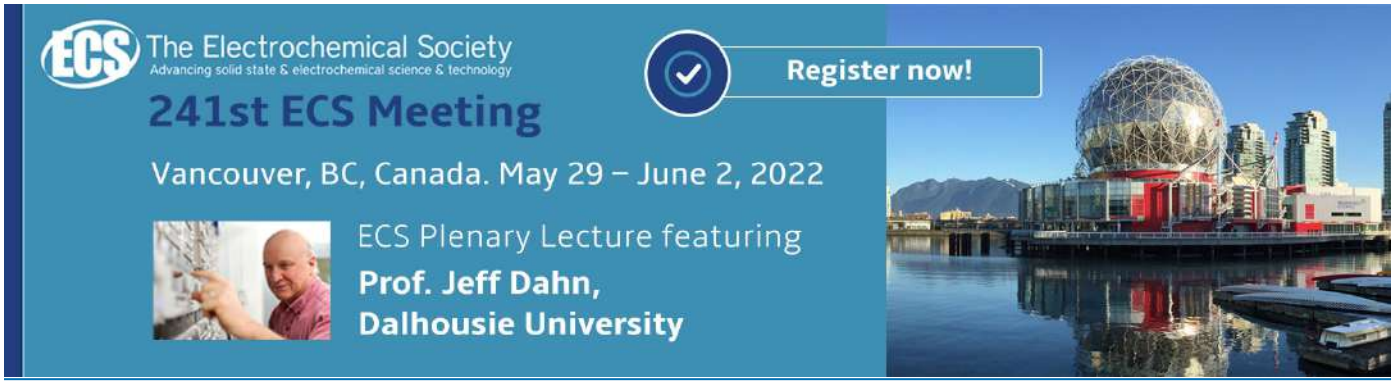

Physicochemical and Microbiological Quality of Goat's Milk Yogurt Added Red Ginger (*Zingiber officinale* var. Rubrum) Extract

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Abstract. This study aims to determine the quality of goat's milk yogurt with red ginger extract addition. This research was conducted experimentally using a completely randomized design with the red ginger extract added (0%, 1%, 2%, 3%, 4%) with four replications. The parameters to be measured are physicochemical quality, namely acidity, pH, viscosity and density, chemical composition, fat content, protein content, water content, and microbiological tests - total lactic acid bacteria (LAB) and total plate count (TPC). The collected data were analyzed by One Way ANOVA. The results showed that the range of fat content was 6.57%-12.51%, protein content 4.78%-7.66%, water content 79.12%-82.45%, acidity 0.1-0.15, pH 3.72-3.83, viscosity 6.86-9.57 CPs, BJ 1.011- 1.035, BAL 11.23-11-85 log cfu/mL, and TPC 11.37-13.17 log cfu/mL. The addition of red ginger extracts significantly affected fat content, protein content, lactic acid content, viscosity, density, LAB and TPC content of goat's milk yogurt. The addition of red ginger extract can increase the fat content and reduce the amount of TPC in goat's milk yogurt.

Keywords: goat milk yogurt, lactic acid bacteria (LAB), physicochemical, red ginger.

1. Introduction

During the current Corona Virus Disease 19 (Covid-19) pandemic, we are encouraged to always maintain a healthy body by increasing the body's immune system. A sound immune system will be formed, one of which is by eating foods that can increase the body's immune system. The development

of sustainable livestock and the use of the naturally available environment can produce food that can be consumed for human health. Foods that increase endurance include probiotic and antimicrobial bacteria, such as yogurt and red ginger.

Yogurt is a dairy product derived from lactic acid bacteria (LAB) fermentation in milk. The milk used in yogurt can come from cow's milk, goat's milk, and buffalo milk. Generally, the milk used as the primary ingredient for making yogurt is cow's milk, but goat's milk can also be used to make yogurt.

Goat milk has many beneficial benefits for the health of the human body, including treating asthma, gout, cholesterol, lungs/respiratory and heart. Goat's milk can be drunk by people who are allergic (lactose intolerance) to cow's milk and people who have health problems. Goat's milk has the advantage that it is whiter in color, granules of milk fat with a diameter of 0.73-8.58 m, contains the high minerals calcium, phosphorus, vitamins A, E, and B complex and has a higher fluoride content than cow's milk. Florin is a natural antiseptic that contains elements that prevent the growth of bacteria in the body, thereby increasing immunity [1]. However, goat's milk has a drawback: the smell of prunes, which makes goat's milk less desirable. One way to reduce the smell of goaty is to ferment the milk (yogurt) and add flavors and aromas derived from other natural ingredients, such as red ginger.

Red ginger is a rhizome plant widely used as a cooking spice, fresh preparations, herbal ingredients (herbs), and medicines. Based on previous research, the essential oil derived from red ginger can be developed as a food preservative. This is because red ginger oil has broad-spectrum antimicrobial activity against pathogenic and food-destroying bacteria, namely *B. cereus*, *E. coli*, *S. Typhimurium*, and *P. aeruginosa* bacteria [2] and *S. aureus* [3]. In addition, ginger extract can make yogurt to help form coagulation in the yogurt freezing process because it contains protease enzymes in ginger and removes the aroma from goat's milk [4]. Based on the description above, red ginger extract can be used as an alternative as a food additive which is expected to eliminate "*prengus*" derived from goat's milk which is used as an ingredient for making goat's milk yogurt. Apart from being a food additive, red ginger extract is used because it has antimicrobial benefits. When mixed with goat's milk yogurt, it can be used as a drink to boost the body's immune system during the Covid-19 pandemic. This study aims to determine the physicochemical and microbiological quality of goat's milk yogurt with red ginger extract added treatment.

2. Materials and Methods

Sample

The sample of 20 liters of goat's milk used for making yogurt comes from smallholder farms in Metro City. The selection of goat's milk is cow's milk. Milk samples were taken using a coolbox with an ice cooler. The yogurt starter used was a commercial starter containing *Lactobacillus bulgaricus* and *Streptococcus thermophillus* bacteria. Red ginger was obtained from the primary market of Gintung, Bandar Lampung. Variables measured were physicochemical quality, namely total acid value, pH, viscosity, density, fat content, protein content, moisture content, and microbiological quality, namely LAB and TPC.

Research Design

This research was conducted experimentally using a completely randomized design with five treatments and four replications so that there were twenty experimental units. The treatment was the addition of red ginger extract, T1 (0% red ginger extract), T2 (1% red ginger extract), T3 (2% red ginger extract), T4 (3% red ginger extract), and T5 (4% red ginger extract).

Procedures

Extraction of Red Ginger

The red ginger extract used in this study is the extraction result concerning research [3]. The procedure carried out is red ginger as much as ± 2 kg, cleaned and surface sterilized with 70% alcohol. The red ginger was then peeled and washed with sterile distilled water, mashed, then squeezed and filtered. Then the red ginger extract was put into an Eppendorf tube and centrifuged at 5,000 rpm for 15 minutes.

Goat Milk Yogurt Making

According to research, the procedure for making goat's milk yogurt is heating goat's milk with the high-temperature short time (HTST) pasteurization method at a temperature of 72.2°C for 15 seconds [5]. Goat's milk was then inoculated with bacteria using a commercial starter containing *Lactobacillus bulgaricus* and *Streptococcus thermophilus* bacteria at a 43-45 °C. Then the ginger extract was added according to the treatment and incubated for 24 hours at 27-30°C.

Methods and Analysis

The physicochemical variables observed in this study were the degree of acidity using titrimetry, pH using a pH meter (Smart Sensor brand), consistency and specific gravity using the gravimetric method, fat content using the Soxhlet method, protein content using the Kjeldahl method, and moisture content using the Gravimetric method. The variables observed in this study were total plate count (TPC) and total LAB using the plate count method with MRSA (Oxoid CM0361B) and PCA (Oxoid CM0325B) agar media. The data obtained were analyzed by one-way ANOVA and LSD at the 5% level.

3. Results and Discussion

Physicochemical Quality of Goat Milk Yogurt with Addition of Red Ginger

The results of the physicochemical study of yogurt with red ginger extract are presented in Table 1. The data shows that the acid content ranges from 0.1 to 0.5, pH ranges from 3.72 to 3.83, viscosity ranges from 6.86 to 9.57 CP, and specific gravity ranged from 1.011-1.035 g/vol, fat content ranged from 6.57%-12.51%, protein content ranged from 4.78%-7.66%, and moisture content ranged from 79.12%-82.45 %.

Tabel 1 Average physicochemical quality of goat's milk yogurt

Variables	The concentration of red ginger				
	0%	1%	2%	3%	4%
Acidity	0.1^{a}	0.1^{a}	0.1^{a}	0.1^{a}	0.15^{b}
pH	3.72	3.79	3.81	3.73	3.83
Viscosity (CPs)	9.57^{c}	8.21^{abc}	6.86^{a}	7.97^{ab}	8.29^{bc}
Density (g/vol)	1.034^{c}	1.029^{b}	1.011^{a}	1.035^{c}	1.035^{c}
Fat (%)	6.57^{a}	7.36^{a}	9.63^{b}	10.48^{b}	12.51^{c}
Protein (%)	6.61^{bc}	7.66^{c}	5.91^{ab}	4.78^{a}	5.45_{ab}
Moisture content (%)	79.12	81.97	82.45	81.13	79.19

Note: the superscript shows a difference between the treatments at the significant level (P<0.05).

The red ginger extract added to goat's milk yogurt significantly affected the total acidity of yogurt. Total acid in goat's milk yogurt with the treatment was lower than SNI [6] in the range of 0.5%-2.0%. This increase in lactic acid levels is due to LAB activity which breaks down lactose and other sugars into lactic acid [7]. LAB activity will affect the acidity of yogurt because its metabolite product is lactic acid [8]. According to [9], the more bacteria that produce lactic acid, the higher the acid formed. The sour

atmosphere in yogurt is created due to the metabolism of lactose by lactic acid bacteria to form a sour taste and deposition of casein.

The treatment in this research did not significantly affect the pH of yogurt. The pH value and total acid are closely related to the manufacture of yogurt because yogurt is a fermented product that produces lactic acid. Therefore, in testing pH and total acid, making yogurt with acidity quality or pH value is an essential indicator of the quality of fermented products because it is closely related to taste and texture. The activity of fermenting lactose into lactic acid causes milk to experience an increase in acidity accompanied by a decrease in the pH value of the product [10]. In the yogurt fermentation process, LAB will utilize the existing lactose to form lactic acid, and then the pH value will decrease, and acidity will increase. A decrease in pH will affect casein, the main protein in milk. If the pH of milk becomes around 4.6 or lower, casein is unstable and agglomerates (clumps) to form a gel in yogurt.

Goat's milk yogurt with red ginger extracts significantly affected yogurt viscosity. Fermented products that refer to yogurt have a thickness between 8.28-13.00 cP. The fermentation process causes casein to undergo structural changes and denaturation to form lumps due to lactic acid produced by *S. thermophilus* and *L. bulgaricus*. According to [11], in making yogurt, the fermentation process from lactose to lactic acid causes the texture of the yogurt to become thick. This is what causes goat's milk yogurt's viscosity to increase with red ginger extract added.

The treatment in this research had a significant effect on the density of yogurt. The lowest particular gravity in the addition of red ginger extract is 2% (1,011 g/vol) and the highest in red ginger extract 3% and 4% (1,035 g/vol). This is related to the high-fat content in the addition of red ginger extract by 3% and 4% (10.48%-12.51%).

Goat milk yogurt with the red ginger extract added based on ANOVA significantly affected fat content. The fat content in goat's milk yogurt increased based on red ginger extract concentration. This increase in fat content is probably due to the increase in fat content resulting from red ginger concentration. The results of this study are not by the research results by [12], namely, increasing the concentration of elephant ginger extract reduces the fat content of yogurt. The fat content based on the results of this study is by the requirements for yogurt fat content in SNI 2981 [6] which is at least 3%.

The treatment in this research significantly affected yogurt protein content. The protein content based on the results of this study is by the requirements for the protein content of yogurt in SNI 2981:2009 [6], which is at least 2.7%. The highest protein content was found in goat's milk yogurt with a 1% red ginger extract concentration (7.66%) and the lowest red ginger concentration 3% (4.78%). The results of this study are not by the research results by [12], namely, increasing the concentration of elephant ginger extract increases the protein content of yogurt.

Based on ANOVA, Goat's milk yogurt with red ginger extract had no significant effect on moisture content. The water content in goat's milk yogurt increased at 2% red ginger extract concentration and decreased at 3% and 4% red ginger extract concentrations. Increased solids caused the decrease in moisture content at 4% ginger extract concentration in yogurt (fat and lactose content).

Microbiological Quality Goat Milk Yogurt

The study results on the microbiological quality of yogurt with the addition of red ginger extract are presented in Table 2. The data shows that the average LAB is 11.23-11.85 log cfu/mL, and the TPC is 11.37-13.17 log cfu/mL.

Table 2 Average microbiological quality of goat's milk yogurt

Variables	The concentration of red ginger				
	0%	1%	2%	3%	4%
BAL (log cfu/mL)	11.80^{c}	11.67^{abc}	11.23^{ab}	11.72^{bc}	11.85^{a}
TPC (log cfu/mL)	13.17^{c}	12.81^{c}	12.17^{b}	11.94^{ab}	11.37^{a}

Note: the superscript shows a difference between the treatments at the significant level ($P<0.05$).

The red ginger extract added to goat's milk yogurt had a significant effect on the LAB of goat's milk yogurt. According to [13], ginger has antimicrobial compounds that can be bactericidal (kills bacteria) bacteriostatic (inhibits microbial growth). Antimicrobial activity in ginger causes a decrease in total lactic acid bacteria. These antimicrobials are sesquiterpenoids with zingiberene as the main component [14]. Bacterial cell membranes consist of proteins and lipids that are very susceptible to compounds contained in red ginger extract, namely Gingerol. Gingerol is an essential compound in red ginger. This is because a phenol derivative can interact with bacterial cells through an adsorption process involving hydrogen bonds. Phenol can interact with proteins at low levels to form phenol protein complexes. The bond between protein and phenol is weak and breaks down quickly. Free phenol will penetrate cells, causing precipitation and protein denaturation. At the same time, protein coagulation can occur and cause cell membranes to undergo lysis at high phenol levels. Damaged cell membranes disrupt nutrient transport (compounds and ions), so bacterial cells experience a lack of nutrients needed for growth [3].

The treatment in this research had a significant effect on the total plate count (TPC) of goat's milk yogurt. Adding red ginger extract into goat's milk yogurt in each treatment can reduce the total number of microbes. TPC decreases with increasing levels of red ginger extract. Complete microbial analysis shows the microbiological quality of a food ingredient. It is necessary to know the quality of microbiology to see the level of microbial contamination in processed food products so that the level of safety can be known for further consumption.

The addition of ginger extract effectively inhibits other microbes that are potential contaminants, evidenced by the decrease in the number of different microbes in each treatment. The microbes decreased with the addition of a dose of ginger extract. According to [15], ginger rhizome contains antimicrobial compounds from the phenol, flavonoid, terpenoid, and volatile oil groups included in the ginger extract, a group of bioactive compounds that can inhibit microbial growth.

4. Conclusions

The red ginger extract added did not affect the pH and moisture content. The addition of section 2% red ginger reduced the viscosity, density and LAB. The protein content decreased at 3% red ginger extract added. The fat content is getting higher with the increasing dose of red ginger extract, but the lower the TPC.

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