QUALITY OF GOAT MILK CHEESE WITH ADDITION OF RICE BRAN OIL RIPENED USING \textit{Lactobacillus casei} AND \textit{Streptococcus thermophilus}

Nurliyani*\(^{1)}\), Indratiningsih\(^{1)}\), Widodo\(^{1)}\), Endang Wahyuni\(^{1)}\)

\(^{1)}\)Department of Animal Products Technology, Faculty of Animal Science, Universitas Gadjah Mada
Jl. Fauna 3, Bulaksumur, Yogyakarta, Indonesia 55281
E-mail: nurliyani@ugm.ac.id

Submitted 13 December 2019; Accepted 29 February 2020

ABSTRACT

This study aimed to determine the effect of rice bran oil (RBO) addition on the microbiological, chemical, physical and sensory qualities of goat milk cheese ripened using \textit{Lactobacillus casei} FNCC 0090 and \textit{Streptococcus thermophilus} FNCC 0040. Cheese was prepared from goat's milk with a starter of \textit{Lactobacillus casei} and \textit{Streptococcus thermophilus} and rennet as coagulant. Cheese was divided into four groups: 1) ripened cheese without RBO stored for 0 d, 2) ripened cheese without RBO stored for 30 d, 3) ripened cheese + RBO stored for 0 d and 4) ripened cheese + RBO stored for 30 d. The results showed that the addition of RBO and ripening did not affect the total number of lactic acid bacteria (LAB) of the cheese (their total number were in the range of $2.60-4.21 \times 10^7$ CFU/g). The acidity of cheese without RBO after ripening was higher ($p<0.05$) than without ripening. Therefore, the pH value of cheese with the addition of RBO was higher than the cheese without RBO. The addition of RBO had no effect on moisture content of cheese, but the moisture content decreased ($p<0.05$) after ripening. Meanwhile, the addition of RBO could reduce their soluble protein. Cheese added with RBO had a harder texture ($p<0.05$) than cheese without RBO. Sensory quality of cheese was not influenced by the addition of RBO, but the saltiness of cheese with RBO was higher than without RBO and had no bitter in taste. In conclusion, RBO had no negative effect on the flavor and acceptability of the cheese and the growth of LAB, could increase cheese hardness, but could decrease the acidity and soluble protein in the cheese. However, the cheese with the addition of RBO ripened using starter consisting of \textit{Lactobacillus casei} FNCC 0090 and \textit{Streptococcus thermophilus} FNCC 0040 could be potentially classified as probiotic cheese which is beneficial for health.

Keywords: Cheese; microbiological quality; physicochemical quality; rice bran oil; sensory quality
INTRODUCTION

Dairy goat farms have started to develop, especially Ettawah crossbred goat in several regions in Indonesia. Generally goat milk is marketed in frozen form, while some are marketed in the form of fermented milk products such as yogurt, kefir and cheese on a small scale and a limited market. Recently, the development of functional food has also been growing, due to the increasing public awareness of the importance of maintaining the health. Sources of functional food can be originated from vegetable or animal sources. The use of vegetable oils that contain many essential fatty acids has been studied in various dairy products including cheese. Recently, to change the organoleptic properties, nutritional value and to decrease cholesterol and also to reduce the cost of cheese production can be use vegetable oil as a substitute for milk fat. It was reported that characteristic of physicochemical, textural and organoleptic properties in kashar cheese not influenched by palm oil (Kavak and Karabiyik, 2019).

Because of the characteristics of various cheese that has a higher pH and fat content, and a denser texture, the cheese can provide protection against the survival of probiotics in the digestive tract. Therefore, cheese can be used as a great vehicle for delivering probiotics compared to other products (Gheisari et al., 2014). Cheese is one of the dairy products that are rich in nutritional value, especially protein. In addition, there are various type of cheese in the world that consumed by many people, thus enabling the development of a market for probiotic cheese. The prerequisite for probiotic microorganisms is that they must survive in sufficient quantities in food until they are ready for consumption and do not reduce their organoleptic properties. Organoleptic characteristics of dairy products such as aroma, taste, texture and appearance can be influenced by probiotic microorganisms, so that the organoleptic properties of dairy products is widely used as a subject for various study (Karimi et al., 2011). Consumption of cheese enriched with probiotics microorganism can improve the human health including enhancing the body's immune system, increasing oral health and digestive tract in the elderly and strengthen the intestinal immunity (Yerlikaya and Ozer, 2014).

The nutritional and antioxidant content in rice bran allows the use of bran in the food industry is quite promising, even though bran which is a byproduct of rice milling, is generally only used for animal feed. Besides that it is important as a food ingredient (Ardali et al., 2013, Abbas et al., 2016). Rice bran has been used in food as a full-fat, defatted bran, bran oil, and protein concentrate, and is used for baked goods, snacks, crackers, breads, cereals, pastries, pancakes, noodles, muffins, biscuits (Abbas et al., 2016). The percentage of rice bran ranges from 10% of the total grain with oil content of 18-22%. The oil is clear yellow at 20°C, odorless, acidic index <0.50 and density at 20°C in around of 0.920-0.930 (Chou et al., 2009).

Rice bran oil contains bioactive components that can reduce cholesterol, as antioxidants and antiinflammation such as oryzanol, phytosterols, tocopherol, tocotrienols, squalene, policosanol, and ferulic acid. Gamma oryzanol is an essential micronutrient in cooking oil obtained from RBO as a by-product of the rice milling.

*Corresponding author:
Nurliyani
Email: nurliyani@ugm.ac.id
Department of Animal Product Technology, Faculty of Animal Science, Universitas Gadjah Mada. Jl. Fauna 3, Bulaksumur, Yogyakarta, Indonesia 55281

How to cite:
Nurliyani., Indratiningsih., Widodo., & Wahyuni, E. (2020). Quality of Goat Milk Cheese with Addition of Rice Bran oil Ripened Using Lactobacillus casei and Streptococcus thermophilus. Jurnal Ilmu dan Teknologi Hasil Ternak, 15 (1), 1-12
Goat Milk Cheese Added with Rice Bran Oil

process. The presence of balanced fatty acids in RBO makes the oil popular (Al-Okbi et al., 2014; Pal and Pratap, 2017). This study aimed to determine the effect of addition of RBO on the microbiological, chemical, physical and sensory qualities of goat milk cheese ripened with Lactobacillus casei and Streptococcus thermophilus. The cheese in this study is expected to provide information for the food industry to develop functional food that has health benefits.

MATERIALS AND METHODS

Cheese preparation

Goat milk cheese was prepared from goat milk obtained from Ettawah Crossbred goat at “Bumiku Hijau” Farm, Sleman, Jogjakarta. Rice bran oil was obtained from local market in Jogjakarta, Indonesia. Fluid microbial rennet was obtained from New England Cheesemaking Supply. Lactobacillus casei FNCC 0090 and Streptococcus thermophilus FNCC 0040 were obtained from Center for Food and Nutrition Studies, Universitas Gadjah Mada.

The steps in cheese making were: Goat milk as much as 4 L was divided into 4 groups. Group 1) ripened cheese without RBO stored for 0 d, 2) ripened cheese without RBO stored for 30 d, 3) ripened cheese + RBO stored for 0 d and 4) ripened cheese + RBO stored for 30 d. Milk was pasteurized by high temperature short time (HTST) method (72°C, 15 sd), then added with emulsifier (disodium hydrophosphate) as much as 0.3%. The temperature was lowered to 37°C, then a starter of 2.5% Lactobacillus casei FNCC 0090 (v/v) was inoculated 2 h earlier, then inoculated with starter culture of 2.5% Streptococcus thermophilus FNCC 0040 at 40°C for 1 h.

Pasteurized milk was added with rennet as much as 0.02% (v/v) of total volume, then incubated for 1 h until curd formed, and then cut the curd for draining whey. Separation of curd from whey was carried out by filtering it with cheese cloth, and then adding 2% NaCl, and left for 2 h in refrigerator. Curd was pressed for 5 min with a weight of 5 kg, then wrapped in aluminum foil.

Cheese was stored in a refrigerator at 4°C for 0 and 30 d. After pressed, curd was weighed. The yield of curd in control cheese was 32.11%, and the yield of curd in the cheese with RBO was 25.53%. Cheese was analyzed for microbiological (total lactic acid bacteria), physical (texture), chemistry (pH, acidity, soluble protein, fat and moisture content), and sensory (texture, saltiness, acidity, bitterness, flavor, acceptance) quality.

Total lactic acid bacteria analysis

Total lactic acid bacteria were determined on deMan, Rogosa and Sharpe (MRS) agar (Merck) media containing 100 ppm NaN₃ (Mundt et al., 1967) and 100 ppm CaCO₃ (Hwanhlem et al., 2011). To determine the number of bacteria, the cheese sample was weighed as much as 1.0 g, then dissolved into 9.0 mL of physiological NaCl solution. The dilution series were made to the final dilution 10⁻⁶. Dilution series 10⁻⁵ and 10⁻⁶ were pipetted as much as 0.1 mL, and then spread on the surface of each medium in Petri dish. Furthermore, the Petri dish was incubated for 48 h at 37°C. The total amount of lactic acid bacteria was calculated based on colonies growing on the surface of medium and expressed in log CFU/g sample (Roostita et al., 2011).

pH and titratable acidity analysis

The pH value of cheese was measured using a pH-meter (HANNA-HI 98103), whereas the cheese acidity was determined by titratable acidity as lactic acid according to Hashim et al. (2009). The percentage of lactic acid was carried out by titration of 9 g of cheese using alkali (0.1 N NaOH) with phenolphthalein as an indicator to an endpoint of faint pink color.

Moisture, soluble protein and fat analysis

The cheese samples were analyzed for moisture content in a drying oven at 105°C
and gravimetrically determined according to AOAC (1995). Soluble protein was determined by Lowry method (Plummer, 1987). Cheese samples of ± 0.5 g were diluted with distilled water to the range of protein content between 30-300 µg/mL, and added with 1.0 mL of Lowry B reagent (consisting of a mixture of 0.75 mL of 1% CuSO₄ solution; 75 mL of 2% K-Na-Tartrate; 15.0 mL of 2% Na₂CO₃ solution in 0.1 N (NaOH), then homogenized. The mixture of solution was incubated at room temperature for 10 min, and added with 3.0 mL of Lowry A reagent (consisting of a mixture of Folin-ciocalteau reagent and distilled water in a ratio of 1:1), then homogenized. The mixture of solution was incubated at room temperature for 20 min. The absorbance was measured with a spectrophotometer (Spectronic 21D) at a λ of 750 nm. The levels of dissolved protein were obtained by entering the absorbance value of the sample in the standard protein (bovine serum albumin) regression equation. Standard albumin solutions were prepared by dissolving 7.5 mg albumin with distilled water up to 25 mL, then obtained stock solution with a concentration of 0.3 mg/mL. Ten sets of albumin solution were prepared with a concentration range from 0.03-0.3 mg/mL or 30-300 µg/mL.

Fat was analyzed by Babcock method (Lampert, 1975). A sample of 18 g was weighed in a Babcock bottle and added 17.5 mL of concentrated H₂SO₄ (in an ice bath). Samples were centrifuged for 5 min. Warm water (60°C) was added to the sample to the mouth of the tube neck and centrifuged again for 2 min. Warm water (60°C) was added again until the fat was raised on the scale, then centrifuged again for 1 min. The scale on the tube was read (in water bath, temperature of 55-60°C).

Texture analysis
The measurement of cheese texture was done by cutting the cheese sample into a cube, then measuring it using Brookfield CT3 Texture Analyzer, No. M08-372-E0315 (Brookfield Engineering Laboratories, Inc., USA) at temperature of 27°C. Test standard using compression with probe type TA44 cylinder 4 mm D, pre-load 0.02 N, pre-load speed 50 mm/min and test speed 10 mm/min.

Sensory analysis
Sensory characteristics of cheese after 30 d ripening were carried out by 10 panelists of untrained students in Department of Animal Products Technology, Faculty of Animal Science, Universitas Gadjah Mada. The scale of evaluation for cheese according to (Jeon et al., 2012) with modifications was listed in Table 1.

| Score | Texture | Saltiness | Acidity | Bitterness | Flavor | Acceptance |
|-------|---------|-----------|---------|------------|--------|------------|
| 1     | Not very soft | Not very salty | Not very sour | Not very bitter | Not highly flavorful milk | Very dislike |
| 2     | Not soft | Not salty | Not sour | Not bitter | Not flavorful milk | Dislike |
| 3     | Rather soft | Rather salty | Rather sour | Rather bitter | Rather flavorful milk | Rather like |
| 4     | Soft | Salty | Sour | Bitter | Flavorful milk | Like |
| 5     | Very soft | Very salty | Very sour | Very bitter | Highly flavorful milk | Really like |

Statistical analysis
The data of cheese quality, including microbiological, chemical, physical and sensory quality were presented as mean with standard deviations. Replication in each treatment was 3 times. The mean between treatments were analyzed by two-way ANOVA (cheese treatment vs. ripening time treatment). If there were difference between treatments, it was continued with the
Duncan’s Multiple Range Test (DMRT) and were considered to be significantly different if \( p < 0.05 \). Statistical analysis using the Statistical Package for Social Sciences (SPSS) program, version 17.

**RESULTS AND DISCUSSION**

**Total lactic acid bacteria**

Table 2 shows that there was no significantly differences between total lactic acid bacteria (LAB) in cheese with RBO and cheese without RBO after ripening for 30 d and also before ripening. Hence, RBO had no adverse effect on microbiological quality of cheese during ripening for 30 d. In the present study, rice bran oil that added as much as 2.5% showed had no negative effect on the growth of lactic acid bacteria. In a previous study, the lactobacilli were the most abundant lactic acid bacteria, followed by enterococci and lactococci found in Serrano cheese (de Souza et al., 2003). Lactobacilli microorganisms dominate during process of cheese production and ripening, mainly in the final stages of the process, which indicate that lactobacilli play a vital role in cheese manufacturing and are part of the lactic culture. However, the addition of salt in the process of cheese production can inhibit the growth of microorganism, thus reducing the ratio of lactococci and leuconostoc in the isolate of lactic bacteria (de Souza et al., 2003).

**Table 2.** Average of total lactic acid bacteria in cheese with and without addition of rice bran oil (RBO) before and after ripening for 30 d

| Cheese  | Ripening (d)       |
|---------|--------------------|
|         | Before ripening    |                                    |
|         | After ripening     |
| Without RBO | 3.11 x 10^7 CFU/mL | 2.97 x 10^7 CFU/mL |
| or 7.41±0.31 Log CFU | or 7.29±0.49 Log CFU |
| RBO | 4.21 x 10^7 CFU/mL  | 2.60 x 10^7 CFU/mL   |
| or 7.25±0.85 Log CFU | or 7.14±0.64 Log CFU |

ns: not significant

Prerequisites as probiotic food according to the Japanese fermented milk and lactic acid bacteria beverages association are food ingredients must containing a minimum of \( 10^6-10^7 \) viable microorganisms per gram or milliliter (Ishibashi and Shimamura, 1993). In this study, total lactic acid bacteria in the cheese ripened with *Lactobacillus casei* FNCC 0090 and *Streptococcus thermophilus* FNCC 0040 and added with RBO showed in the range of \( 10^7 \) CFU/g. Therefore, the cheese in this study could be potentially classified as probiotic food. According to Tarrah et al. (2018), two strains of *S. thermophilus* from dairy environment in Italy, namely M17PTZA496 and TH982 possess probiotic activity *in vitro*, although many *S. thermophilus* strain have very serious problem when passage through the human gastrointestinal tract. While, strain of *Lactobacillus casei* FNCC 0090 have been known as probiotic (Suseno et al., 2000; Aini and Hariani, 2019). Results are in accordance with a previous study that incorporated 1-3% RBO in yoghurt had a range bacteria in recommended level (\( 10^6-10^7 \) CFU/g) (Abbas et al., 2017).

**Acidity and pH**

Cheese added with 2.5% RBO after 30 d ripening had a lower pH (4.98) than unripened cheese. Cheese without RBO both before and after ripening, had no pH differences. Cheese without RBO after 30 d ripening had higher acidity compared to cheese without RBO before ripening and cheese with RBO both before ripening and after ripening. The pH and acidity of cheese were shown in Table 3.

There were no differences on the pH of the cheese before and after ripening. The increase in acidity of the cheese after ripening, due to the measure of acidity is...
only expressed in lactic acid, whereas to
determine of pH value is originated from
several organic acids as metabolic products.
The concentration of lactose, citrate and pH
value of kefir will decrease and an increase
in concentration of lactic acid, acetate,
butyrate and propionate as well as glucose
and galactose during fermentation process
and storage of kefir at 4°C for 7 d (Leite et al.,
2013).

Moisture, soluble protein and fat

The average moisture and soluble
protein content were not significantly
different in cheese without RBO before and
after ripening, whereas cheese with RBO
after ripening had lower moisture content
compared to cheese before ripening
(Table 4). However, soluble protein content
in cheese with RBO did not show any
differences before and after ripening
(Table 4). Soluble protein of cheese without
RBO both before and after ripening was
higher than the cheese with RBO both
before and after ripening. Therefore, RBO
added into the cheese processing could
decrease the soluble protein content, which
might be caused by inhibition of the growth
of proteolytic bacteria during cheese
ripening. Table 2 shows a decrease in total
number of LAB in the cheese with RBO
more than without RBO after ripening,
eventhough the effect was not significantly
different. Rice bran is highly nutritious
because it has various antioxidants that
impart beneficial effects on human health
such as γ-orizanol, tocotrienols, ferulic
acid, and phenolic compounds (Wanna et
al., 2016). However, the phenolic
substances found to inhibit Gram positive
and Gram negative pathogenic bacteria
(Chen and Bergman, 2005).

| Table 3. Average acidity and pH of cheese with and without addition of rice bran oil (RBO) before and after ripening for 30 d |
|-----------------|-----------------|-----------------|-----------------|-----------------|
|                 | Cheese without RBO | Cheese with RBO  |                 |                 |
|                 | Before ripening   | After ripening  | Before ripening | After ripening  |
| Acidity         | 0.90±0.07        | 1.13±0.06      | 0.64±0.11      | 0.88±0.14      |
| pH              | 4.88±0.17        | 4.79±0.22      | 5.08±0.38      | 4.98±0.10      |

abc Different letters in the same row indicate significantly different (p<0.05)

| Table 4. Moisture, soluble protein and fat content of cheese with and without addition of rice bran oil (RBO) before and after ripening for 30 d |
|-----------------|-----------------|-----------------|-----------------|-----------------|
|                 | Cheese without RBO | Cheese with RBO  |                 |                 |
|                 | Before ripening   | After ripening  | Before ripening | After ripening  |
| Moisture (%)    | 52.60±4.49       | 37.89±1.20      | 56.32±2.08      | 26.23±1.78      |
| Soluble protein (%) | 4.13±0.07       | 4.15±0.78       | 4.07±0.78       | 4.03±0.74       |
| Fat (%)         | 16.50±1.22       | 29.16±4.15      | 20.33±2.21      | 36.23±4.47      |

ab Different letters in the same row indicate significantly different (p<0.05)

Lactic acid bacteria are a group of
Gram-positive, non-spore forming, cocci or
rods, catalase-negative, and fastidious
organisms, with high tolerance for low pH
(Mokoena, 2017). Intra and extracellular
proteolytic activity including X-prolyl-
dipeptidyl aminopeptidase is classified as
particular peptidase which split amino acid
sequences containing proline, producing
various peptides that generated in increased
cell growth. Two strains of bacteria that
have unique peptidase activity are
Goat Milk Cheese Added with Rice Bran Oil

Lactobacillus acidophilus (L10 and La 4962), Bifidobacterium spp. (B. lactis B94 and B. longum Bl 536), and Lactobacillus casei (L26 and Lc 279), Streptococcus thermophilus (St 1342) and Lactobacillus delbrueckii ssp. bulgaricus (Lb 1466) (Donkora et al., 2007).

Other studies observed that the inhibitory effect of phenolic compounds on Lactobacillus casei BL23 has been determined, and phenolic compounds may disturb protein structure and also affect the properties of the cell membrane (Rivas-Sendra et al., 2011). In the present study, there were no differences on the soluble protein before and after ripening, which might be caused by shorter ripening time and without additional proteases. Karaca and Güven (2018) reported that soluble nitrogen and 12% TCA soluble nitrogen contents of the cheese supplemented with protease were higher than the control cheese (without protease addition) after 90 d of ripening. Various factors that influence proteolytic activity are pH of curd, plasmin, chymosin, starter and non starter proteases, ratio of salt to water, storage time, temperature and humidity (Park, 2001). The fat content increased when the moisture content decreased (Table 4).

This result in accordance with a previous study by Arslan et al. (2014), when the fat content clearly decreased, the moisture content increased, and also reported by Banks et al. (1994) in Cheddar cheese, Mozzarella cheese (Rudan et al., 1999), and Indian cheese (panee) (Kumar et al., 2011) that as fat content decreased, moisture content increased. Fat content in the cheese with RBO was higher than without RBO (Table 4) as also reported in a previous study that corn oil substitution significantly affected the levels of fat in dry matter (Arslan et al., 2014). Fat plays a major role in texture and flavor of the food products (Eswarapragada et al., 2010).

**Texture**

The texture was not significantly different in cheese without RBO before and after ripening, whereas cheese with RBO after ripening had higher texture compared to cheese before ripening (Table 5).

Table 5. Texture (N) of cheese with and without addition of rice bran oil (RBO) before and after ripening for 30 d

| Cheese | Ripening | Before       | After (30 d) |
|--------|----------|--------------|--------------|
| Without RBO |          | 8.52 ±0.88   | 8.49 ±0.89   |
| With RBO    |          | 9.11 ±1.02   | 14.80 ±2.16  |

*Different letters in the same row and column indicate significantly different (p<0.05)*

The texture of the cheese is influenced by various factors including: the manufacturing process, variations in the method, changes in composition and biochemical during ripening.

Texture can be detected by the sense of sight, hearing, touch, and kinesthetic, because texture is a sensory and functional manifestation of the structural, mechanical and surface characteristics of food (Enab et al., 2012). The increase in texture of the cheese after ripening in the present study, may be caused by low proteolytic activity. In addition, the salt that added in cheese processing also inhibits the proteolytic activity during ripening. According to Fredrick et al. (1986), the hardness of cheese was influenced by proteolysis, where proteolytic activity was inhibited by salt (Guinee and Fox, 1983).

In the present study, the harder cheese texture was found in the cheese supplemented with RBO at higher fat content after ripening due to a decrease in moisture content. Characteristics of cheese texture are influenced by the interaction and cross-linking of the casein protein matrix and fat phase due to the effect of fat
plasticization (Madadlou et al., 2007). Texture which is one of the physical characteristics of cheese in addition to the melt properties and color can be influenced by the initial milk composition as raw material of cheese, processing procedures, and ripening conditions (Lucey et al., 2003).

**Sensory quality**

Sensory evaluation showed that there were no significant differences of cheese before ripening on texture, acidity, flavor, and acceptability. The salt level of cheese with RBO was higher than without RBO, while cheese with and without RBO had no bitter taste (Table 6). Because the texture of cheese with RBO after ripening has greater hardness (Table 5) and tends to have a lower moisture content (Table 4) than cheese without RBO, the cheese feels more salty (Table 6), although the sensory analysis of the texture showed no significantly different with score of 3.00-3.07 (rather soft). The cheese saltiness without RBO had a score of 2.73 (rather salty), while cheese with RBO had a score of 3.80 (salty). However, rice bran oil did not cause bitter taste and could not affect on cheese flavor (Table 6).

**Table 6.** Descriptive score and acceptance of cheese with and without addition of rice bran oil (RBO) before and after ripening for 30 d

| Sensory      | Cheese without RBO | Cheese with RBO |
|--------------|--------------------|-----------------|
| Texture      | 3.00±0.85          | 3.07±1.03       |
| Saltiness    | 2.73a ±0.46        | 3.80b ±0.56     |
| Acidity      | 2.93±0.80          | 2.47±0.74       |
| Bitterness   | 1.80b ±0.56        | 1.67a ±0.62     |
| Flavor       | 2.67±0.92          | 2.67±0.98       |
| Acceptance   | 3.00±0.85          | 3.07±0.88       |

^a,b^ Different letters in the same row indicate significantly different (p<0.05)

In a previous study, there were no significance difference in flavor (odor and taste) of the kashar cheese supplemented with palm oil and the control cheese, due to palmitic and oleic acids in the palm oil can not contribute to cheese odor and taste as much as short- and medium-chain fatty acids (Kavak and Karabiyik, 2019). Therefore, oleic, linoleic and palmitic acids - rich RBO (Oluremi et al., 2013), also had no effect on cheese flavor. Food quality parameters and representation of consumer preferences for food that are very important are sensory properties. Some previous studies, supplementation of probiotics in cheese does not seem to affect its sensory characteristics (Albenzio et al., 2013). In addition, Escobar et al. (2013) reported that probiotic supplementation of panela cheese had no effect on perceived taste or appearance. However, cheese produced with *Streptococcus thermophilus* plus *Lactobacillus casei* showed highest sensory quality compared to combination of other probiotic bacteria, mainly in taste or appearance (Yerlikaya and Ozer, 2014).

**CONCLUSION**

Rice bran oil (RBO) had no negative effect on the flavor and acceptability of cheese and the growth of lactic acid bacteria, could increase cheese hardness, but could reduce the acidity and soluble protein in the cheese. However, the cheese with the addition of RBO ripened by using starter of *Lactobacillus casei* FNCC 0090 and *Streptococcus thermophilus* FNCC 0040 could be potentially classified as probiotic cheese which is beneficial for health.

**Conflict of Interest**

There are no conflict of interest including personal researchers or other
relationships with other personal or organizations that can influence their work.

ACKNOWLEDGMENTS

The authors gratefully acknowledge Faculty of Animal Science, Universitas Gadjah Mada through “Hibah Penelitian Pascasarjana”.

REFERENCES

Aini, N., & Hariani, D. (2018). Effect of pineapple peel filtrate and probiotic Lactobacillus casei FNCC 0090 on catfish growth (Clarias gariepinus). In AIP Conference Proceedings (p. 060001). https://doi.org/10.1063/1.5061910

Abbas, H., Ahmed M. S. Hussien, A. M., & Gamil E. Ibrahim, G. (2016). Changes in antioxidant activity and volatile compounds of functional yoghur fortified with rice bran during storage. Journal of Chemical and Pharmaceutical Research, 8(7), 761–766.

Abbas, H. M., Shahein, N. M., Abd-Rabou, N. S., Fouad, M. T., & Zaky, W. M. (2017). Probiotic-fermented milk supplemented with rice bran oil. International Journal of Dairy Science, 12(3), 204–210. https://doi.org/10.3923/ijds.2017.204.210

Al-Okbi, S., Mohamed, D., Hamed, T., & Esmail, R. (2014). Rice bran oil and pumpkin seed oil alleviate oxidative injury and fatty liver in rats fed high fructose diet. Polish Journal of Food and Nutrition Sciences, 64(2), 127–133. https://doi.org/10.2478/pjfn-2013-0002

Albenzio, M., Santillo, A., Caroprese, M., Braghieri, A., Sevi, A., & Napolitano, F. (2013). Composition and sensory profiling of probiotic Scamorza ewe milk cheese. Journal of Dairy Science, 96(5), 2792–2800. https://doi.org/10.3168/jds.2012-6273

AOAC (Association of Official Agricultural Chemist). (1995). Official Methods of Analysis. Washington, DC.

Ardali, F., Hojjatoleslamy, M., & Shariaty, M. (2013). Production of a new functional rice bran beverage. African Journal Science Research, 2, 20–23.

Arslan, S., Topcu, A., Saldamli, I., & Koksal, G. (2014). Use of corn oil in the production of Turkish white cheese. Journal of Food Science and Technology, 51(10), 2382–2392. https://doi.org/10.1007/s13197-012-0752-6

Chen, M.-H., & Bergman, C. J. (2005). A rapid procedure for analysing rice bran tocopherol, tococtrenol and γ-oryzanol contents. Journal of Food Composition and Analysis, 18(2–3), 139–151. https://doi.org/10.1016/j.jfca.2003.09.004

Chou, T.-W., Ma, C.-Y., Cheng, H.-H., Chen, Y.-Y., & Lai, M.-H. (2009). A rice bran oil diet improves lipid abnormalities and suppress hyperinsulinemic responses in rats with streptozotocin/nicotinamide-induced type 2 diabetes. Journal of Clinical Biochemistry and Nutrition, 45(1), 29–36. https://doi.org/10.3164/jcbn.08-257

Donkor, O. N., Henriksson, A., Vasiljevic, T., & Shah, N. P. (2007). Proteolytic activity of dairy lactic acid bacteria and probiotics as determinant of growth and in vitro angiotensin-converting enzyme inhibitory activity in fermented milk. Le Lait, 87(1), 21–38. https://doi.org/10.1051/lait:2006023

Enab, A., Fatma, A., Hassan, Mona, A., & El. Gawad, A. (2012). Effect of manufacture steps on cheese structure
(review). *International Journal of Academic Research Part A*, 4(6), 79–89.

Escobar, M. C., Van Tassell, M. L., Martínez-Bustos, F., Singh, M., Castaño-Tostado, E., Amaya-Llano, S. L., & Miller, M. J. (2012). Characterization of a Panela cheese with added probiotics and fava bean starch. *Journal of Dairy Science*, 95(6), 2779–2787. https://doi.org/10.3168/jds.2011-4655

Eswarapragada, N. M., Reddy, P. M., & Prabhakar, K. (2010). Quality of low fat pork sausage containing milk-co-precipitate. *Journal of Food Science and Technology*, 47(5), 571–573. https://doi.org/10.1007/s13197-010-0086-1

Fernandes, À., Barreira, J. C. M., Barros, L., Mendonça, À., Ferreira, I. C. F. R., & Ruivo de Sousa, F. (2018). Chemical and physicochemical changes in Serrana goat cheese submitted to extra-long ripening periods. *LWT*, 87, 33–39. https://doi.org/10.1016/j.lwt.2017.08.071

Fredrick, I. A., Atson, J. W., Nottingham, S. M., & Dulley, J. (1986). Effect of neutral fungal protease in cheddar cheese ripening. *New Zealand J. Dairy Sci. Tech.*, 21(1), 9–20.

Gheisari, H., Aminlari, M., Sabbagh, N., & Moraveji, M. (2014). Chemical and microbiological changes during ripening of Iranian salt-substituted probiotic white cheese. *Carpathian Journal of Food Science and Technology*, 6(2), 102–115.

Guinee, T. P., & Fox, P. F. (1983). Sodium chloride and moisture changes in Romano-type cheese during salting. *Journal of Dairy Research*, 50(4), 511–518. https://doi.org/10.1017/S002202990003274X

Hashim, I. B., Khalil, A. H., & Afifi, H. S. (2009). Quality characteristics and consumer acceptance of yogurt fortified with date fiber. *Journal of Dairy Science*, 92(11), 5403–5407. https://doi.org/10.3168/jds.2009-2234

Hassanien, M. F. R., Mahgoub, S. A., & El-Zahar, K. M. (2014). Soft cheese supplemented with black cumin oil: Impact on food borne pathogens and quality during storage. *Saudi Journal of Biological Sciences*, 21(3), 280–288. https://doi.org/10.1016/j.sjbs.2013.10.005

Hwanhlem, N., Buradaleng, S., Wattanachant, S., Benjakul, S., Tani, A., & Maneerat, S. (2011). Isolation and screening of lactic acid bacteria from Thai traditional fermented fish (Plasom) and production of Plasom from selected strains. *Food Control*, 22(3–4), 401–407. https://doi.org/10.1016/j.foodcont.2010.09.010

Ishibashi, N., & Shimamura, S. (1993). Bifidobacteria: research and development in Japan. *Food Technology*, 47, 126–135.

Jeon, S.-S., Lee, S.-J., Ganesan, P., & Kwak, H.-S. (2012). Comparative study of flavor, texture, and sensory in cream cheese and cholesterol-removed cream cheese. *Food Science and Biotechnology*, 21(1), 159–165. https://doi.org/10.1007/s10068-012-0020-6

Kalit, S., Matić, A., Salajpal, K., Sarić, Z., & Kalit, M. (2016). Proteolysis of Livanjski cheese during ripening. *Journal of Central European Agriculture*, 17(4), 1320–1330. https://doi.org/10.5513/JCEA01/17.4.1852

Karaca, O. B., & Güven, M. (2018). Effects of proteolytic and lipolytic enzyme supplementations on lipolysis and proteolysis characteristics of white cheese.
cheeses. *Foods, 7*(8), 1–14. https://doi.org/10.3390/foods7080125

Karimi, R., Mortazavian, A. M., & Da Cruz, A. G. (2011). Viability of probiotic microorganisms in cheese during production and storage: a review. *Dairy Science & Technology, 91*(3), 283–308. https://doi.org/10.1007/s13594-011-0005-x

Kavak, D., & Karabiyik, H. (2019). Quality evaluation of kashar cheese: influence of palm oil and ripening period. *Food Science and Technology, 1–7*. https://doi.org/10.1590/fst.39618

Kongo, J., & Malcata, F. (2016). Cheese: Chemistry and Microbiology. In *Encyclopedia of Food and Health* (pp. 735–740). Elsevier Ltd.

Kumar, S. S., Balasubramanian, S., Biswas, A. K., Chatli, M. K., Devatkal, S. K., & Sahoo, J. (2011). Efficacy of soy protein isolate as a fat replacer on physico-chemical and sensory characteristics of low-fat paneer. *Journal of Food Science and Technology, 48*(4), 498–501. https://doi.org/10.1007/s13197-010-0193-z

Kumari, A. G. I., Ranadheera, C., Prasanna, P. H., Senevirathne, N., & Vidanarachchi, J. (2015). Development of a rice incorporated synbiotic yogurt with low retrogradation properties. *International Food Research Journal, 22*(5), 2032–2040.

Lampert, L. (1975). *Modern Dairy Products*. New York: Chemical Publishing Company, Inc.

Leite, A. M. O., Leite, D. C. A., Del Aguila, E. M., Alavares, T. S., Peixoto, R. S., Miguel, M. A. L., Paschoalin, V. M. F. (2013). Microbiological and chemical characteristics of Brazilian kefir during fermentation and storage processes. *Journal of Dairy Science, 96*(7), 4149–4159. https://doi.org/10.3168/jds.2012-6263

Lucey, J. A., Johnson, M. E., & Horne, D. S. (2003). Invited review: perspectives on the basis of the rheology and texture properties of cheese. *Journal of Dairy Science, 86*(9), 2725–2743. https://doi.org/10.3168/jds.S0022-0302(03)73869-7

Madadlou, A., Khosrowshahi asl, A., Mousavi, M. E., & Farmani, J. (2007). The influence of brine concentration on chemical composition and texture of Iranian White cheese. *Journal of Food Engineering, 81*(2), 330–335. https://doi.org/10.1016/j.jfoodeng.2006.11.010

Mokoen, M. P. (2017). Lactic acid bacteria and their bacteriocins: classification, biosynthesis and applications against uropathogens: a mini-review. *Molecules, 22*(8), 1–13. https://doi.org/10.3390/molecules22081255

Muir, D. D., Hunter, E. A., Banks, J. M., & Horne, D. S. (1995). Sensory properties of Cheddar cheese: changes during maturation. *Food Research International, 28*(6), 561–568. https://doi.org/10.1016/09639969(95)00039-9

Mundt, J. O., Graham, W. F., & McCarty, I. E. (1967). Spherical lactic acid-producing bacteria of southern-grown raw and processed vegetables. *Applied Microbiology, 15*(6), 1303–1308. https://doi.org/10.1128/AEM.15.6.1303-1308.8.1967

Pal, Y. P., & Pratap, A. P. (2017). Rice bran oil: a versatile source for edible and industrial applications. *Journal of Oleo Science, 66*(6), 551–556. https://doi.org/10.5650/jos.ess17061

Park, Y. W. (2001). Proteolysis and lipolysis of goat milk cheese. *Journal of Dairy
Nurliyani et al., 2020

Plummer, D. (1987). *An Introduction to Practical Biochemistry*. London: McGraw-Hill Book Company.

Raymond Chia, T. W., & Dykes, G. A. (2010). Antimicrobial activity of crude epicarp and seed extracts from mature avocado fruit (*Persea americana*) of three cultivars. *Pharmaceutical Biology, 48*(7), 753–756. https://doi.org/10.3109/13880200903273922

Rivas-Sendra, A., Landete, J. M., Alcántara, C., & Zúñiga, M. (2011). Response of *Lactobacillus casei* BL23 to phenolic compounds. *Journal of Applied Microbiology, 111*(6), 1473–1481. https://doi.org/10.1111/j.1365-2672.2011.05160.x

Roostita, L., Fleet, G., Wendry, S., Apon, Z., & Gemilang, L. (2011). Determination of yeasts antimicrobial activity in milk and meat products. *Advance Journal of Food Science and Technology, 3*(6), 442–445.

Rudan, M. A., Barbano, D. M., Joseph Yun, J., & Kindstedt, P. S. (1999). Effect of fat reduction on chemical composition, proteolysis, functionality, and yield of mozzarella cheese. *Journal of Dairy Science, 82*(4), 661–672. https://doi.org/10.3168/jds.S0022-0302(99)75282-3

Souza, C. F. V. de, Dalla Rosa, T., & Ayub, M. A. Z. (2003). Changes in the microbiological and physicochemical characteristics of Serrano cheese during manufacture and ripening. *Brazilian Journal of Microbiology, 34*(3), 260–266. https://doi.org/10.1590/S1517-83822003000300016

Suseno, T. I., Sutarjo, S., & Anita, K. (2000). Minuman probiotik nira siwalan: kajian lama penyimpanan terhadap daya anti mikroba *Lactobacillus casei* pada beberapa bakteri patogen. *Jurnal Teknologi Pangan Dan Gizi, 1*(1), 1–13.

Tarrah, A., Castilhos, J. de, Rossi, R. C., Duarte, V. da S., Ziegler, D. R., Corich, V., & Giacomini, A. (2018). In vitro probiotic potential and anticancer activity of newly isolated folate-producing streptococcus thermophilus strains. *Frontiers in Microbiology, 9*, 1–11. https://doi.org/10.3389/fmicb.2018.02214

Wanna, A., Singanusong, R., Wichaphon, J., & Klangpetch, W. (2016). Determination of antioxidant and antimicrobial properties of hommil rice bran extracted by organic solvents. In *Proceedings of The IRES 30th International Conference*. Tokyo.

Yerlikaya, O., & Ozer, E. (2014). Production of probiotic fresh white cheese using co-culture with Streptococcus thermophilus. *Food Science and Technology (Campinas), 34*(3), 471–477. https://doi.org/10.1590/1678-457x.6365