Research Article

Quality of *Levilactobacillus brevis* DSM02 Fermented Goat Milk with The Addition of Porang Flour (*Amorphophallus oncophyllus*)

Junita Mayasari, Vira Oktavia, Indri Juliyarsi, Ade Sukma, Sri Melia*

Faculty of Animal Science, Universitas Andalas, Jl. Raya Unand, Limau Manis, Padang 25163, Padang, West Sumatra, Indonesia.

Abstract | Porang flour (*Amorphophallus oncophyllus*) contains glucomannan that functions as a thickener and stabilizer with the potential as a prebiotic. This study aimed to determine the effect of adding porang flour on physicochemical properties with total lactic acid bacteria and sensory of *Levilactobacillus brevis* of fermented goat milk DSM02. The addition of porang flour is A (0%), B (0.25%), C (0.50%), D (0.75%), and E (1%). The parameters observed in this study were total titrated acid, pH, dietary fiber content, water content, protein content, viscosity, total lactic acid bacteria, and organoleptic tests. The results showed that adding porang flour to fermented goat milk significantly ($P<0.05$) decreased the total lactic acid bacteria total titrated acid increased the pH value, dietary fiber content, water content, viscosity, texture value, and color value. Still, it had no significant effect ($P>0.05$) on protein content, sensory value of taste, and flavor. The study concludes that adding 0.25% porang flour (B) yields the most favorable results. This treatment resulted in a total titrated acid of 1.21%, a pH value of 4.10, a dietary fiber content of 0.18%, a moisture content of 84.33%, a protein content of 2.77%, and a total viscosity of 6.114 cP. Additionally, the fermented goat milk with *Levilactobacillus brevis* had a lactic acid bacteria count of 19.00 x 10^9 CFU/ml, and it was well-liked by the panelists of sensory evaluation. Adding flour to fermented milk still contains lactic acid bacteria that qualify for probiotics, so it can be recommended as a functional food.

Keywords | Glucomannan, Lactic acid bacteria, Sensory, Viscosity, Prebiotic, Fibre

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***Correspondence** | Sri Melia, Faculty of Animal Science, Universitas Andalas, Jl. Raya Unand, Limau Manis, Padang 25163, Padang, West Sumatra, Indonesia; **Email:** srimelia75@ansci.unand.ac.id
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INTRODUCTION

Technological advancements continue to accelerate, particularly in the food industry. People begin to focus on functional food elements as well. Food is taken for basic survival and nutrition, which has various health advantages, such as enhancing endurance and avoiding sickness. One functional food is goat milk, which is good for humans in many ways. There are many nutrients in goat milk. When compared to cow milk, goat milk is better. The fat globules from goat milk are smaller, so it tends to be easier to digest than cow milk. Goat milk does not last long because of its high nutritional content, which makes it a good source of nutrients for the proliferation of destructive microorganisms. Various methods, including fermentation, are used to maintain and improve milk's quality and nutritional value. Fermentation in milk can inhibit the growth of harmful microorganisms and destructive microorganisms, thereby extending the shelf life of milk. Fermentation enzymatically converts lactose in milk into glucose and galactose, rendering them more easily digestible carbohydrates for individuals with lactose sensitivity.

Lactic acid bacteria (LAB) are microorganisms that are involved in the process of fermentation. LAB has been developed in the process of processing fermented milk. Several previous studies have used goat's milk in the fermentation process. Process goat milk yogurt and add *Pedicoccus acidilactici* (Melia *et al.*, 2020) and cinnamon bark extract (Purwati *et al.*, 2018; Melia *et al.*, 2022). In this study, *Levilactobacillus brevis* DSM02, isolated from dadih, was used to manufacture fermented milk.

Levilactobacillus brevis DSM02 is a type of lactic acid bacteria (LAB) isolated from dadih from Payakumbuh, West Sumatra. According to Marsova *et al.* (2020), *Lactobacillus brevis* 47 f grows under anaerobic conditions (10% CO_2) at a growth temperature of 37°C isolated from human feces. According to Somashekaraiah *et al.* (2021), *Levilactobacillus brevis* MYSN105 is a gram-positive bacterium with a rod-like shape classified as a heterofermentative lactic acid bacterium. *Levilactobacillus brevis* MYSN105 has probiotic properties that can live well in acidic conditions and bile salts. The bacterium *Levilactobacillus brevis* MYSN105 is isolated from a fermented food from India, namely pozha.

Fermented milk uses one type of bacteria that tend to be runnier, unlike yogurt, which uses two classes, *Streptococcus thermhopillus,* and *Lactobacillus bulgaricus*, so it is thicker. Therefore, additional ingredients are added to increase the thickness of the fermented milk, namely by adding porang flour.

A native perennial in Indonesian woodlands is called porang (*Amorphophallus oncophyllus*). The tubers are rich in glucomannan, which can provide many benefits as a food ingredient and functional food. Porang has been widely exported to China and Japan, but it has low value because it is sold as chips. So, exploring the beneficial properties or effects of porang glucomannan is essential to increase its value (Harmayani *et al.*, 2014).

The benefits of konjac glucomannan include gel formation and high viscosity, which can be used to create products for food manufacture, such as sausage binders, jellies, noodles, and syrup thickeners (Akesowan, 2002). Porang flour glucomannan has been developed in food and medicine (Yanuriati *et al.*, 2017). The viscosity of porang flour is very high, and it is very beneficial for health by slowing the rate of digestion and absorption of carbohydrates so that it affects insulin activity and can be used as a functional food (Harmayani *et al.*, 2014). Suryana *et al.* (2022) Research states that the higher the porang flour addition to a yogurt drink, the higher the viscosity and pH of the yogurt drink. Based on the description above, it is necessary to research to determine the effect of adding porang flour on the quality of *Levilactobacillus brevis* DSM02 fermented goat milk.

MATERIALS AND METHODS

Materials

The milk from an Indonesian dairy goat farm in Padang City, West Sumatra, was utilized in this investigation. Milk is brought from the farmer using a cool box and then stored at 4°C until used. The probiotic bacteria *Levilactobacillus brevis* DSM02, which was stored at -20°C, was obtained from the Animal Products Technology Laboratory, Faculty of Animal Sciences, Andalas University. Porang flour (particle size: 60 mesh and moisture content: 9.73%) was obtained from the Faculty of Agricultural Technology, Gadjah Mada University, Yogyakarta.

Methods

This research used an experimental design, with 5 treatments adding porang flour and four replications. Porang flour (*Amorphophallus oncophyllus*) was added at the following concentrations: 0%, 0.25%, 0.50%, 0.75%, and 1%.

Fermented milk manufacturing process

Porang flour was incorporated into 100 ml of goat milk in a container, with the amount varying based on the treatment group (0%, 0.25%, 0.50%, 0.75%, or 1.00%). Subsequently, the mixture underwent pasteurization at 85°C for 15 minutes.

Total lactic acid bacteria

Every sample containing 1.0 mL was mixed with 9.0 mL of de Mann Rogosa Sharpe (MRS, NEOGEN) Broth and subsequently diluted as required. The spread plate method was used to measure the population of LAB in fermented goat milk and assess the overall bacterial count using the previously outlined procedure (Downes *et al.*, 2001). The process of anaerobic incubation was conducted at a temperature of 37 degrees Celsius for a duration of 72 hours. The microbial counts were conducted with samples having 30-300 colonies, and the results were reported as a logarithmic number of colony-forming units per milliliter (CFU/mL).

Physicochemical examination

Titratable acidity, pH, and proximate analysis (water content, protein, and dietary fiber)

Samples of fermented milk with the addition of porang flour were analyzed including titratable acidity (TTA), measured by mixing fermented milk with 5 mL of distilled water and titrated with 0.1 N NaOH using the phenolphthalein indicator until it showed a pink color. Using a pH meter (Hanna Instruments, Romania), the sample's pH was determined by adding approximately 10 milliliters to a beaker. The electrode was immersed into a cup of fermented milk and let to stand while the pH meter was adjusted with a buffer solution at pH 4 and 7. The values listed on the measurement did not change anymore. The water, protein, and dietary fiber content were analyzed using the AOAC (2012).

Viscosity

The viscosity of fermented milk was measured using the NDJ-8S Viscometer (Made in China). Fermented milk was put in as much as 100 ml in a container. The viscometer was operated at 50 rpm with spindle number 3 and was repeated 3 times (Room temperature) (Cinbas and Yazici, 2008).

Sensory test

Sensory testing used a panel of 60 people (30 men and 30 women, aged 20-23 years old, not trained) from laboratory members at the Faculty of Animal Husbandry. After the samples were stored for 24 hours at 4°C, tests were carried out. Fermented milk was tested using the hedonic method for color, taste, flavor, texture, or overall acceptability. Score 5 (very like), 4 (like), 3 (neutral), 2 (somewhat like), and 1 (dislike).

RESULTS AND DISCUSSION

Total lactic acid bacteria

Table 1 showed that the addition of porang flour (*Amorphophallus oncophyllus*) 1.00% significantly ($P<0.05$) reduced the LAB in fermented goat milk. The addition of porang flour up to 0.75% did not affect the growth of lactic acid bacteria but decreased significantly after the addition of 1.00%. The reduction in LAB was attributable to the presence of glucomannan in porang flour, which gels when mixed with water. It may cause a decrease in the water content of fermented goat milk. The decrease in water content in fermented goat milk causes the free water content used by bacteria to grow to be reduced, thus inhibiting the growth of lactic acid bacteria. It is supported by research Suryana *et al.* (2022) that protein can form gels where polymer chains create networks and then trap water to form a strong and rigid structure. The ability of proteins to bind water in substantial amounts may constrict the interparticle space, thereby entrapping and solidifying the water within the solution. It is the opinion Behera and Ray (2016) that glucomannan is hydrophilic, and Koesoemawardani *et al.* (2021) reported that the reduced water activity in the substance leads to a decline in the available water content necessary for the proliferation of LAB, resulting in a drop in their growth rate.

Moisture is crucial for the proliferation of lactic acid bacteria during the fermentation procedure. Water is used by lactic acid bacteria as a medium for transporting nutrients into cells, removing metabolites from outside the cell, where the enzymatic reactions take place, as a medium for cellular complement synthesis, and playing a role in biochemical processes such as hydrolyzing polymers into monomers (Parasthi *et al.*, 2020). Susmiati *et al.* (2022) argue that the growth of bacterial cells is significantly impacted by the presence of nutrition in the media, which allows them to develop and survive optimally. The total lactic acid bacteria in fermented milk are being researched (Melia *et al.*, 2020).

Titratable acidity

Table 1 shows that the addition of porang flour (*Amorphophallus oncophyllus*) significantly ($P<0.05$) decreased the titratable acidity (TTA) of fermented goat milk. There was a decrease in titratable acidity of 28% with the addition of 1% porang flour when compared to the control (without the addition of porang flour). The decrease in total titrated acid is caused by a decrease in the total lactic acid bacteria, so the organic acids produced also decreased and reduced the total acidity. It is supported by the opinion (Koesoemawardani *et al.*, 2021) that reduced growth of lactic acid bacteria will reduce total acidity.

The acidity of fermented milk is caused by the breakdown of lactose by lactic acid bacteria. The total titrated acid was determined by acid-base titration to measure the total acid concentration (Andriani *et al.*, 2020). The titratable acidity of fermented milk results from this study is almost the same as research conducted by (Susmiati *et al.*, 2022), and Melia *et al.* (2021).

Table 1: Total LAB and physicochemical of fermented goat milk.

Items	Control (Without Porang flour)	0.25% Porang flour	0.50% Porang flour	0.75% Porang flour	1.00% Porang flour
Total LAB (10^9 CFU/ml)	$21.78^{a}\pm9.59$	$19.00^{a}\pm4.17$	$15.35^{ab}\pm10.58$	$15.18^{ab}\pm7.09$	$6.33^{b}\pm2.15$
TTA (%)	$1.37^{a}\pm0.10$	$1.21^{b}\pm0.05$	$1.11^{c}\pm0.08$	$1.07^{c}\pm0.07$	$0.99^{d}\pm0.03$
pH	$4.08^{d}\pm0.05$	$4.10^{cd}\pm0.04$	$4.13^{bc}\pm0.04$	$4.16^{b}\pm0.05$	$4.21^{a}\pm0.06$
Water content (%)	$84.48^{a}\pm0.56$	$84.33^{a}\pm0.14$	$83.41^{b}\pm0.15$	$82.95^{b}\pm0.23$	$82.31^{c}\pm0.59$
Protein content (%)	2.98±0.19	2.77±0.21	2.81±0.14	3.03±0.38	2.74±0.23
Dietary fiber content (%)	$0.16^{c}\pm0.005$	$0.18^{b}\pm0.008$	$0.18^{b}\pm0.005$	$0.19^{ab}\pm0.010$	$0.19^{a}\pm0.010$
Viscosity (cP)	$4172^{c}\pm0.59$	$6114^{c}\pm0.24$	$10295^{c}\pm1.16$	$54000^{b}\pm10.69$	$87987^{a}\pm17.18$

^{abcd}Different superscript in the same column showed significant differences ($P<0.05$)

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pH

The addition of porang flour causes changes in the pH of fermented goat milk. Table 1 indicated a significant (P<0.05) increase in the pH level of fermented goat milk upon the inclusion of porang flour (*Amorphophallus oncophyllus*). An increase in the pH value began to occur with the addition of 0.5% - 1.00% porang flour. However, the pH of fermented goat's milk was still in the range of 4.00. The increase in pH value was due to the decrease in total titrated acid in *Levilactobacillus brevis* DSM02 of fermented goat milk, where the total organic acids produced decreased so that H+ ions became reduced. In line with research by Saloko *et al.* (2022), an increase in the pH value goes hand in hand with a decrease in the total titrated acid value. The increase in pH was caused by the buildup of H+ ions from lactic acid generated by the fermentation metabolism of LAB.

The pH level is changed by lactic acid bacteria that make lactic acid (Hartati *et al.*, 2012). According to the opinion (Utami *et al.*, 2015), when the number of lactic acid bacteria grows, the total acidity also grows, which makes the pH drop. In the opinion of Nasution and Wahyuni (2020), the pH number is linked to the quantity of acid in yogurt. This study agrees with Matela *et al.* (2019) and Sarwar *et al.* (2019) about the pH of soured milk.

Dietary fiber content

Table 1 above showed that the addition of porang flour (*Amorphophallus oncophyllus*) significantly (P<0.05) increased the dietary fiber content of fermented goat milk. The increase in dietary fiber levels in fermented goat's milk started with an addition of 0.25% compared to the control but was not significant with 0.5% and 0.75% porang flour. Furthermore, there was a significant increase when adding 1.00% porang flour. The increase in fiber content in fermented goat's milk with the addition of 1% porang flour was only 16% when compared to without the addition of porang flour (control). The increase in dietary fiber content along with the addition of porang flour to *Levilactobacillus brevis* DSM02 fermented goat milk is due to the presence of dietary fiber in the porang flour used of 3.31%, so the higher the addition of porang flour, the higher the dietary fiber content in fermented goat milk. Research (Herawati and Kamsiati, 2022) supports the fact that porang flour has a dietary fiber content of 3.55%. This study's dietary fiber amount is consistent with studies by Suryana *et al.* (2022), which found that jelly drinks containing porang powder had a fiber content of about 0.145%. According to (Aller *et al.*, 2011), glucomannan in porang flour is a source of dietary fiber and may increase viscosity (Herawati and Kamsiati, 2022; Aller *et al.*, 2011), crude dietary fiber is part of food that cannot be digested by the body or hydrolyzed by chemicals such as strong acids and bases. According to Chavhan and Muratkar (2020), Lignin, cellulose, and certain minerals make up crude dietary fiber. In line with this opinion of Madhu *et al.* (2017), crude dietary fiber consists of 60-80% cellulose, 4-6% lignin, and several other mineral substances.

Water content

The water content of fermented milk with the addition of 0.25% porang flour was not significantly different from the control but began to decrease significantly (P<0.05) after adding 0.5% porang flour to 1.00% (Table 1). The decrease in the water content of *L.brevis* DSM02 fermented goat milk, along with the addition of the concentration of porang flour (*Amorphophallus oncophyllus*), is due to the presence of glucomannan in porang flour. The more porang powder (*Amorphophallus oncophyllus*) added, the more glucomannan (which binds water) is present in the fermented milk. According to Suryana *et al.* (2022), proteins are able to bind significant volumes of water into gels, which narrows the gaps among particles and increases the amount of water that is bound and entrapped. Handayani *et al.* (2022) that state the activity of microorganisms in the breakdown of starch that causes water bound to the material to be free. So that the measured free water content in fermented goat milk will decrease, the water content of fermented milk as a result of this study is in line with (Kurnia *et al.*, 2021).

Protein content

The addition of porang flour to fermented goat's milk does not significantly affect (P>0.05) the protein content, which ranges between 2.74-3.04% (Table 1). The study's findings indicated that the protein content was unaffected by adding porang flour (*Amorphophallus oncophyllus*). It can happen because there is only a little protein in porang flour, so it does not provide additional fermented milk protein until adding 1% porang flour. Based on laboratory analysis, porang flour (*Amorphophallus oncophyllus*) used in this study had a protein content of 1.14%. So it had no significant effect on the protein content of *L.brevis* fermented goat milk. The protein levels in this study were almost the same as in the research (Melia *et al.*, 2022).

Viscosity

The viscosity of fermented goat's milk with porang added from 0.25% to 1.00% significantly (P<0.05) increased compared to the control. The increase in viscosity with the addition of porang flour is quite large, this is due to porang flour contains glucomannan. Glucomannan is soluble in water and can form a gel. It is supported by the opinion of Suryana *et al.* (2022), who show that proteins can create gel-like substances where polymer chains interconnect to create a network. This network effectively captures water molecules, resulting in the formation of a robust and inflexible structure. The Porang plant's capacity to effectively retain significant amounts of water results in tighter interparticle spaces. Consequently, more water is

Table 2: Fermented goat milk sensory value.

Sensory	Control (Without Porang flour)	0.25% Porang flour	0.50% Porang flour	0.75% Porang flour	1.00% Porang flour
Taste	3.08±1.05	3.28±0.78	3.40±0.94	3.33±0.90	3.35±1.12
Flavor	3.80±0.82	3.85±0.71	3.70±0.72	3.85±0.78	3.82±0.85
Texture	4.00^{a}±0.71	3.92^{a}±0.70	3.63^{b}±0.76	3.38^{bc}±0.92	3.28^{c}±0.85
Color	4.10^{a}±0.51	4.03^{a}±0.49	3.97^{ab}±0.45	3.77^{c}±0.65	3.80^{bc}±0.71

^{abc}Different superscript in the same column showed significant differences (P<0.05)

bound and trapped, leading to a denser consistency and higher viscosity value in fermented milk. It is the opinion of Aller *et al.* (2011) that glucomannan in porang flour may increase the viscosity. The viscosity of this fermented milk is almost the same as that of research (Saloko *et al.*, 2022).

Sensory of fermented milk

Taste

The sensory value for the taste of fermented goat milk with the addition of porang flour ranged from 3.08 to 3.40 (Table 2). The present study's findings indicated that the inclusion of porang flour did not have a significant impact (P>0.05) on the flavor of fermented goat milk. It can happen because porang flour has a neutral taste. The taste of fermented dairy is more dominant than the sour taste. Lactic acid bacteria convert lactose into organic acids, giving fermented milk its sour flavor. It is supported by the opinion that Merla *et al.* (2018) state that the taste of fermented milk is dominated by a sour taste caused by the activity of lactic acid bacteria that arise in the lactose fermentation process by the starter. Furthermore, Gad *et al.* (2010) states that panelists prefer fermented milk that is neither too sour nor sweet.

Flavor

Incorporating porang flour into fermented goat milk resulted in flavor values ranging from 3.70 to 3.85 (Table 2). According to the study's findings, the flavor of fermented goat milk was not significantly affected (P>0.05) by adding porang flour, according to the study's. It can occur due to the treatment (porang flour) of fermented goat milk in concentrations between 0.25-1%, so it did not significantly affect the flavor of fermented goat milk. As well as porang flour having a neutral taste, the resulting flavor may go hand in hand with the resulting taste. The flavor of porang flour can be balanced by the sour flavor of lactic acid bacteria in fermented milk. It is supported by the opinion of Merla *et al.* (2018) that a sour flavor is caused by the activity of LAB in the lactose fermentation process by fermented goat milk starter.

Texture

Adding porang flour significantly (P<0.05) decreased the texture value. The texture value of fermented goat milk ranged from 3.28 to 4.00 (Table 2). The decrease in texture value with the addition of porang flour to fermented goat milk was caused by the higher the addition of porang flour, the thicker the texture of *L. brevis* fermented goat milk produced. The addition of porang flour (up to 1%) resulted in a decrease in the panelist preference level. Panelists did not like the texture of fermented goat milk with high viscosity according to the viscosity measured in this study. Adding porang flour (1%) in this study had the highest viscosity, 87987cP.

The decrease in texture value is in line with the increase in the concentration of the addition of porang flour because the glucomannan in porang flour absorbed water so that the fermented milk produced would be thicker. The opinion Suryana *et al.* (2022) supports it, stating that people could form gels. Also, the ability of people to bind water in large quantities may cause the space between particles to be narrower, so more water is bound and trapped, making the fermented milk thicker.

Color

Adding porang flour significantly decreased the preference for the fermented milk color value. The color value of fermented goat milk ranged from 3.77 to 4.10 (Table 2). The decrease in color value with the addition of porang flour to fermented goat milk is caused by more porang flour added that may cause a yellowish to brownish yellow color in the fermented milk.

CONCLUSIONS AND RECOMMENDATIONS

The research results showed that the addition of porang flour up to 0.75% did not affect the growth of lactic acid bacteria and still met the probiotic requirements, namely a minimum of 10^7 CFU/ml, as well as the nutritional composition of *L. brevis* DSM02 fermented milk. Adding porang flour can increase fermented milk's viscosity and dietary fiber content. Based on sensory evaluation, it was still preferred by the panelists. Thus, fermented milk with the addition of porang flour can be recommended as a probiotic drink that is beneficial for health.

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NOVELTY STATEMENT

The addition of porang flour (*Amorphophallus oncophyllus*) to the fermented milk of *Levilactobacillus brevis* DSM02 still meets the criteria of probiotics that have the potential to be functional foods and are beneficial for health.

AUTHOR'S CONTRIBUTION

SM and AS: Data conceptualization and curation. MJ and OV: Data curation, formal analysis. SM and IJ: Writing editor.

Conflict of interest

The authors have disclosed no conflict of interest.

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