

UTILIZATION OF VARIOUS MICROORGANISMS IN CHEESE MAKING AS AN APPLICATION OF INDUSTRIAL BIOTECHNOLOGY

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Abstract

*Cheese is a type of food produced by separating solid substances in milk through a process of thickening or coagulation. The cheese-making process generally involves the use of bacteria from the Actinobacteriaceae group. This study utilizes a literature review method, including the analysis of several relevant articles, and is further analyzed using a descriptive-analytical approach. The methodological steps involved searching Google with the keywords "cheese making" and "cheese microorganisms." Based on the discussion results, cheese production is not limited to cow's milk; cheese can also be processed from corn, soybeans, and red beans. The cheese-making process utilizes several probiotic bacteria such as *Lactobacillus bulgaricus*, *Lactobacillus casei*, and *Streptococcus*. The use of different starter bacteria can influence the characteristics of the resulting cheese. This research includes a total of 13 articles, comprising 5 articles on *Lactobacillus bulgaricus*, 5 articles on *Lactobacillus casei*, and 5 articles on *Streptococcus*.*

Keywords: Production, Cheese, Microorganisms.

Introduction

Cheese is one of the biotechnology products derived from the coagulation of milk proteins, offering high nutritional value, making it one of the most essential and widely consumed dairy products. According to the Central Statistics Agency (2015), the per capita cheese consumption in Indonesia reached 10.5 grams per year in 2014. The average growth rate of per capita cheese consumption is 9.125 grams per year, resulting in a total annual cheese consumption of 2,281.25 tons. This indicates a substantial cheese consumption, presenting an opportunity for the industry in Indonesia.

Cheese is a solid and acidic food made from milk, with rennet added to coagulate milk casein. The stages of cheese making include milk preparation, coagulation, pressing and separation, curd handling, and ripening (Inayati, 2015). The thickening process during cheese making is facilitated by specific bacteria or enzymes, commonly known as rennet. Rennet is an enzyme capable of coagulating proteins.

Typically, cheese products are made through fermentation with the assistance of microorganisms such as *Streptococcus thermophilus*, *Lactococcus lactis*, and *Leuconostoc mesenteroides* (Geantaresa et al., 2010). Fermentation, according to Endah Retno (2005), is the breakdown of sugar into alcohol and CO₂, such as the conversion of lactose into lactic acid by bacteria under anaerobic conditions.

However, in a study by Pardede (2023), cheese is made through the activity of *Lactobacillus Bulgaricus* bacteria. This implies that cheese production requires lactic acid bacteria, including *Lactobacillus Bulgaricus*. These bacteria influence the speed of lactose conversion into lactic acid and affect the rate of pH decrease and acid concentration in the cheese. According to Hadju (2017), the level of lactic acid content significantly affects cheese both chemically and biologically. Nevertheless, cheese production can also use other lactic acid bacteria. Therefore, the purpose of this literature review is to identify various microorganisms used in cheese making. This is crucial for examination because biotechnology is currently applied in various aspects, including food, agriculture, livestock, medicine, and pharmacy. Food biotechnology is a topic that needs to be explored more deeply as an effort to meet human needs for food products (Bartholomaeus et al., 2013). Biotechnology involves the utilization of microorganisms to produce a product for human use.

Research Method

This research employs a literature review that includes the analysis of several articles. The document review activities involve discussing and evaluating previous research similar to the utilization of microorganisms in cheese making. Several stages of the literature review method include: 1) Selection of manuscripts; analyzed articles were obtained through Google Scholar research related to cheese utilization, resulting in 15 articles used. Out of these 15 articles, a clear overview of the microorganisms

used in cheese making was obtained. Journal articles were selected and examined based on their titles and abstracts. 2) Analysis of the articles is conducted using qualitative content analysis, examining the correlation between content and context. Subsequently, the analysis is performed using a descriptive-analytical approach and presented in a narrative form (Ifa et al., 2023).

Result and Discussion

This research is based on articles that examine the utilization of various microorganisms in cheese making as an application of industrial biotechnology. The utilization of microorganisms in cheese making has been widely practiced. Cheese is considered one of the products of biotechnology, and its production is an example of conventional biotechnology. According to Endah Rita et al. (2021), the development of conventional biotechnology is inseparable from a technology called fermentation, which originates from the coagulation of milk proteins. Therefore, in this article, the author synthesizes several uses of microorganisms in cheese making based on existing research, as outlined in Table 1.

Table 1. Cheese making using *Lactobacillus bulgaricus* bacteria.

Author	Title	Journal
Betti Ernawati et al.,(2023)	Pemanfaatan Enzim Papain dari Getah Buah Pepaya (<i>Carica Papaya L</i>) dalam Pembuatan Keju Cottage Menggunakan Bakteri <i>Lactobacillus Bulgaricus</i>	JKK, tahun 2013, volume 2(3), halaman 163-168
Endah Retno et al., (2005)	Pembuatan Keju dari Susu Kacang Hijau dengan Bakteri <i>Lactobacillus bulgaricus</i>	EKUILIBRIUM.vol 4 no 2. 2005
Ayu Arsyi et al, (2017)	Pengaruh Kombinasi BAL Pada Pembuatan Keju Kedelai (soy cheese)	Jurnal Biotropika Vol. 5 No.03
Egrina Gentarasa et al.,(2010)	Pemanfaatan Ekstrak KasarPapain sebagai Koagulan pada Pembuatan Keju Cottage Menggunakan Bakteri <i>Streptococcus thermophilus</i> , <i>Lactococcus</i>	Jurnal sains dan teknologikimia VOL 1 no 1

	<i>lactis</i> , dan <i>Leuconostoc mesenteroides</i>	
Mustakim et al., (2009)	Pembuatan Keju dengan Menggunakan Enzim Renin Mucor Pusillus Amobil	Jurnal Ilmu-ilmu Peternakan19(2): 137 -149

The use of bacteria plays a role in cheese making. *Lactobacillus bulgaricus* bacteria contribute to the formation of fermented milk. However, in a study conducted by Pardede et al. (2023), it was found that cheese making using *Lactobacillus bulgaricus* bacteria can be done with the assistance of the papain enzyme. The addition of papain enzyme aims to coagulate the casein micelles in milk. Papain enzyme will alter the kappa casein part located on the surface of casein micelles, forming para-kappa-casein. The presence of calcium in milk will aid the coagulation process, acting as a bridge between micelles (Aehle, 2004). Similar research has also been conducted by Geantaresa (2010), utilizing papain enzyme as a coagulant in cheese making with *Lactobacillus bulgaricus* bacteria.

In addition to using papain enzyme, cheese making can also involve renin enzyme with the use of *Lactobacillus bulgaricus* bacteria as a starter. This aligns with the research conducted by Mustakim (2009), stating that microbial renin can coagulate milk similar to bovine renin enzyme. Typically, cheese is made using cow's milk, but in a study by Arsyi Anggraini (2017), soy milk extract was used as a raw material for cheese making with the assistance of *Lactobacillus bulgaricus* bacteria. The use of soy serves as an alternative to replace cow's milk due to its high-fat content, making it unsuitable for individuals on a diet. According to Arsyi Anggraini (2017), *Lactobacillus bulgaricus* is classified as homofermentative as it only produces lactic acid from glucose fermentation. Its proteolytic enzyme activity is higher compared to other lactic acid bacteria, resulting in fermented products with high taste and nutritional value. This indicates that the use of *Lactobacillus bulgaricus* bacteria is well-suited for cheese making.

Similar research has also been conducted by Endah Retno (2005), who used green bean milk as the base material for cheese making. The use of green bean milk is due to its high protein content, as green beans are a plant-based protein source containing essential amino acids, fats, carbohydrates, and minerals (Soeprapto, 1992).

Table 2. Cheese making using *Lactobacillus casei* bacteria.

Author	Title	Journal
Baiq Mahraini et al., (2015)	Pengaruh Penambahan Probiotik (<i>Lactobacillus Casei</i>) dan Lama Penyimpanan Terhadap Sifat Kimia Keju Mozarella Dari Susu Kerbau Sumbawa	Pro Food (Jurnal Ilmu dan Teknologi Pangan) Vol 1 No. 1 Mei 2015
Rohmatussolihat et al.,(2015)	Pemanfaatan Milk Clotting Enzyme dari <i>Lactobacillus Casei</i> D11 untuk Pembuatan Keju Mozzarella	J. Teknol, dan industri Pangan Vol. 26(1): 63-71 Th. 2015
Kourkoutas et al., (2006)	Produksi Keju Probiotik Menggunakan Sel <i>Lactobacillus casei</i> yang Diimobilisasi pada Potongan Buah	J. Ilmu Pengetahuan Ternak Perah. 89:1439-1451
Nur Kusmiyati et al., (2022)	Analisis Potensi Whey Keju sebagai Media Alternatif Pertumbuhan untuk Kelompok <i>Lactobacillus casei</i>	Jurnal Biologi Vol 8:136-147
Chen et al., (2019)	Aktivitas antioksidan keju Cheddar selama masa pematangan dan setelah simulasi pencernaan gastrointestinal yang dipengaruhi oleh bakteri probiotik	Jurnal Internasional Properti Pangan 2019, Vol. 22, No. 1, 218-229

Cheese is a food product derived from the coagulation of milk proteins. Besides casein (milk protein), other components of milk such as fats, minerals, and fat-soluble vitamins are also carried in the coagulated particles of casein (Baiq Mahraini Yulia, M. Abbas Zaini, 2015). Bacteria are known to be used in cheese making, and one example is the bacterium *Lactobacillus casei*. *Lactobacillus casei* helps limit the growth of pathogenic bacteria in the intestines (Widiyaningsih, 2011). It is known that cheese whey contains many organic substances and lactose, which is a primary energy source for the genus *Lactobacillus*. *Lactobacillus* possesses the enzyme lactase, which can break down lactose into glucose and galactose. Therefore, cheese whey can be utilized by *Lactobacillus* as a growth substrate. One of the most extensively studied members of the *Lactobacillus* genus is the *Lactobacillus casei* group, indicating that

cheese whey media can be used as an alternative medium for the growth of *L. casei* (Kusmiyati et al., 2022).

According to Kourkouas et al. (2006), fruit pieces have been proven to be highly effective supports for the survival of *L. casei* cells during cheese maturation. *L. casei* immobilized on fruit pieces reactivated after storage for 7 months, showing promise for the survival of probiotic bacteria in acidic environments like cheese. Adding additional probiotic cultures (*Lactobacillus casei* and *Lactobacillus plantarum*) to Cheddar cheese can enhance its antioxidant activity during maturation and after simulated digestion, promoting protein and peptide hydrolysis, especially for mixed probiotic bacteria (Chen et al., 2019). According to Rohmatussolihat et al. (2015), *Lactobacillus casei* has Milk Clotting Enzyme (MCE) activity of 8,471 Soxhlet Units with protease activity of 3.28 U/mL, significantly influencing curd production in the mozzarella cheese-making process.

Table 3. Cheese making using *Streptococcus* bacteria.

Author	Title	Journal
Dian Triana et al., (2021)	<i>Cheese analog basis susu jagung manis dan susu kedelai sebagai keju rendah lemak</i>	<i>Journal of Agritechonolgy and Food Processing</i>
Dian Rahmawati et al., (2014)	<i>Pengaruh Metode Pasteurisasi dan Jenis Starter yang Berbeda Terhadap pH, Kadar Air dan Total Solid Keju Lunak Susu Kambing Peranakan Etawa</i>	<i>Jurnal Ilmu Ternak</i> Vol. 1 No. 9, 46-51
Hanlon et al., (2022)	<i>Microbial and Chemical Composition of Cheddar Cheese Supplemented With Prebiotics From Pasteurized Milk to Aging</i>	<i>Journal of Dairy Science</i> Vol. 105 Issue 3
Dan Tong et al., (2023)	<i>Production and Evaluation of a Mutant Galactose-Utilizing Strain of <i>Streptococcus thermophilus</i> for Application in Milk Fermentation</i>	<i>Journal Food Science and Technology</i>
Anggraini, A. A., & Ardyati, T. (2017)	<i>Pengaruh Kombinasi Starter Bakteri Asam Laktat (BAL) pada Pembuatan Keju Kedelai (Soy Cheese)</i>	<i>Biotropika: Journal of Tropical Biology</i> , 5(3), 83-85

Lactic acid bacteria commonly used as a culture for cheese starter are species within the *Streptococcus* genus. *Streptococcus* plays a role in rapidly converting lactose into lactic acid during the milk fermentation process (Dan et al., 2023). Lactose, a disaccharide, is metabolized into glucose and galactose. The primary ingredient used for cheese making typically involves cow's milk; however, in other studies, alternative raw materials have been explored. Supported by research (Daulima et al., 2021), this study utilized sweet corn and soy milk as base ingredients, combined with a starter culture of probiotic bacteria, *Lactobacillus*, and *Streptococcus thermophilus*, resulting in an analog cheese product with a soft texture, unlike traditional hard-textured cheese.

Streptococcus thermophilus bacteria can be used as a producer of lactic acid, serving as a coagulant in coagulating the protein in soy milk (Arsyi et al., 2017). In the study by Rahmawati et al. (2014), the use of a dual starter (*Lactobacillus bulgaricus* and *Streptococcus thermophilus*) with LTLT pasteurization in soft cheese production resulted in soft cheese characteristics with low water content, specifically 39.82%. This indicates that the use of different starter bacteria can influence the characteristics of the produced cheese.

As demonstrated in the research by Hanlon et al. (2022), cheese microorganisms are crucial in the dairy industry because specific microorganisms or chemical components in the product contribute to sensory aspects, while others contribute to taste or may reduce quality through spoilage. *Streptococcus* bacteria can also reduce lactose content, making them suitable for biotechnological applications in the dairy industry for cheese production.

Research by Dan et al. (2023) revealed that galactose fermentation by mutated *Streptococcus thermophilus* decreased by 55.4%. This result indicates that the processed dairy product exhibits excellent characteristics. This is attributed to the fact that higher galactose levels in cheese lead to a browning color change. *Streptococcus thermophilus* is a round-shaped lactic acid bacterium that forms chains. It is classified as homofermentative, producing over 85% lactic acid during fermentation, with an optimum growth temperature of 37-42°C, optimum pH of 6.5, and an inability to grow at pH 10 or withstand high salt concentrations. *Streptococcus thermophilus* can be used to produce lactic acid, serving as a coagulant in coagulating soy milk proteins (Anggraini, 2017).

Conclusion

Based on the discussion results, cheese production doesn't only originate from cow's milk, but cheese can also be processed from corn, soybeans, and green beans. The cheese-making process utilizes several probiotic bacteria such as *Lactobacillus bulgaricus*, *Lactobacillus casei*, and *Streptococcus*. The use of different starter bacteria can influence the characteristics of the resulting cheese.

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