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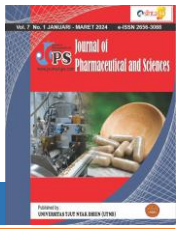

Identification of *Staphylococcus aureus* Contamination in Beef at Binjai City Market

Identifikasi Kontaminasi Bakteri *Staphylococcus aureus* pada Daging Sapi di Pasar Kota Binjai

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Abstract

Livestock products are generally very easily contaminated by bacteria because they contain high nutritional value, especially protein. This study aimed to identify *Staphylococcus aureus* contamination in beef samples taken from traders at Tavip Market and Kebun Lada Market in Binjai City. The study used 13 beef samples collected through a random sampling method. Each sample weighed 100 grams and was taken with sterile equipment, then transported in a cool box at a low temperature of approximately ±4°C. Other materials used included Buffer Peptone Water (BPW), Baird Parker Agar (BPA), and Coagulase Rabbit Plasma (CRP), which are specific media for *S. aureus*. Total Counting of *S. aureus* Bacterial Colonies Using the Total Plate Count (TPC) Method. The results showed that all 13 samples tested positive for *S. aureus* contamination, exceeding the Indonesian National Standard limit of 10^2 CFU/g, with the highest colony count reaching 2.9 × 10^4 CFU/g. This indicates that the level of *S. aureus* bacterial contamination exceeds the Indonesian National Standard (SNI) limit, necessitating improved sanitation and hygiene in the market. Consumers are advised to thoroughly cook meat before consumption.

***Keywords*: Beef, Contamination, Identification, Staphylococcus aureus.**

Abstrak

Produk peternakan umumnya sangat mudah terkontaminasi bakteri karena mengandung nilai gizi yang tinggi terutama protein. Penelitian ini dilakukan dengan tujuan untuk mengidentifikasi kontaminasi bakteri *Staphylococcus aureus* sampel daging sapi yang diambil dari pedagang di Pasar Tavip dan Pasar Kebun Lada Kota Binjai. Sampel yang digunakan pada penelitian ini adalah 13 sampel daging sapi yang diambil dengan metode *random sampling*. Masing-masing berat sampel yang digunakan sebanyak 100 gram dan diambil dengan peralatan yang steril, diangkut menggunakan *coolbox* dan suhu rendah ±4°C. Bahan-bahan lainnya yang digunakan adalah *Buffer Peptone Water* (BPW), *Baird Parker Agar* (BPA), *Coagulase Rabbit Plasma* (CRP) media spesifik bakteri *S. aureus*. Penghitungan Total Koloni Bakteri *S. aureus* menggunakan metode *Total Plate Count* (TPC). Hasil penelitian menunjukkan bahwa 13 sampel uji positif terkontaminasi bakteri *S. aureus*, lebih tinggi dari Standar Nasional Indonesia yang sudah ditetapkan yaitu 10^2 CFU/g dengan jumlah koloni tertinggi sebanyak 2.9 x 10^4 CFU/g. Hal ini menunjukkan bahwa tingkat kontaminasi bakteri *S. aureus* melebihi batas SNI sehingga perlu meningkatkan sanitasi dan higiene di pasar. Konsumen disarankan untuk mengolah daging secara matang sebelum dikonsumsi.

***Kata Kunci*: Daging Sapi, Identifikasi, Kontaminasi, Staphylococcus aureus.**

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Introduction

Meat is a livestock product with high nutritional value and can be obtained from ruminant and/or non-ruminant livestock such as chickens, ducks, goats, sheep, buffalo, and cows[1]. This product is highly sought after by consumers ranging from children to adults because it contains many essential amino acids, iron, and vitamin B complex that can be absorbed by the body[2]. The World Health Organization (WHO) [3] explains that consuming high-quality animal protein can help improve brain function and optimal body development. This has led to an increase in meat sales throughout Indonesia, including in North Sumatra Province.

North Sumatra Province is one of the provinces developing goat, sheep, and cattle farming due to high market demand for these products. Based on data from the North Sumatra Province Food Security and Livestock Service, this province contributed a significant amount of meat production, amounting to 95,000 tons in 2019[4]. BPS data shows that in 2024, beef production in North Sumatra Province reached 18,245.02 tons. At the City Level Based on data from the Binjai City Food Security and Agriculture Service, beef production in Binjai City fluctuated throughout 2018 to 2023. In 2018, production reached 435.9 tons and decreased to 336 tons in 2019. This decline continued until 2022, with production of 222 tons (2020), 186 tons (2021), and 65.34 tons (2022), respectively. However, in 2023, there was a significant surge, with beef production rising sharply to 109.764 tons[5]. Meat can usually be purchased from slaughterhouses, livestock farmers, or, most commonly, markets, whether modern or traditional.

Traditional markets are a central shopping hub for both the lower and upper classes. However, they are notorious for their lack of hygiene due to their proximity to other product vendors, garbage dumps, and even poor waste disposal. For example, meat is often sold on tables, with low storage temperatures often ignored, making it highly susceptible to contamination[6]. Unhygienic environments can trigger the growth of contaminating bacteria, such as *Staphylococcus aureus.*

S. aureus is a pathogenic bacterial contaminant of meat that is often found in unclean environments, places, and even workers. This bacteria can cause a decrease in product quality and can even cause product spoilage if not handled quickly. The presence of bacteria in meat products is also triggered by the meat's high nutritional content, such as water and protein. Bacteria are the most common contaminants in livestock products, reducing their nutritional value[7]. Many studies have been conducted to examine the effect of bacterial contamination on the durability of meat products, showing significant results. Damage to meat products can be seen through organoleptic changes in the smell, taste, and texture of the meat[8]. From various previous studies, it appears that the level of *S. aureus* contamination in beef in traditional markets is quite high and this is a serious concern for national food security.

Various previous studies have shown that the level of *S. aureus* contamination in beef in traditional markets is quite high and this is a serious concern for national food security. Rahmawati [9] found that 16.7% of chicken meat samples taken from the Palangkaraya City Big Market along Jalan Jawa were contaminated with *S. aureus* bacteria due to factors such as customer density, personal hygiene of traders and length of serving. In addition, Dorjgochoo et al. [10] in their study found that contamination in meat is caused by sales areas such as markets. Not only in raw meat, but even *S. aureus* bacterial contamination was found in processed products such as beef floss as a study by Widianingsih and Setyorini (2019) that 90% of samples taken were contaminated with *S. aureus* bacteria. Although several studies have been conducted in other areas, data on the level of *S. aureus* contamination in beef in traditional markets in Binjai City are not yet available. Therefore, this study aims to identify and quantify *S. aureus* contamination as a basis for evaluating hygiene practices in these markets.

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Materials and Apparatus

The materials used in this study were 13 samples of beef thigh meat which were sold open and placed on the table, *Buffer Peptone Water* (BPW), *Baird Parker Agar* (BPA), and *Coagulase Rabbit Plasma* (CRP). Apparatus that used on this study were cool box, ice gel, laminar air flow, testube, flask, petridish, micropipette, tip pipette, incubator, autoclave, and vortex.

Research Procedure

This research used 100 grams of beef per sample, which was then placed in sterile, labeled plastic bags and transported to the laboratory in a cool box for analysis. Pre-enrichment was carried out by weighing 25 grams of beef samples, placing them in sterile bags, and grinding them using a mortar until they were finely ground. The ground samples were then placed in tubes containing peptone buffer water and incubated at 37°C for 24 hours. After 24 hours, single colonies were collected using a loop needle from each incubated enrichment medium and inoculated onto BPA medium at 37°C for 24 hours under aerobic conditions. After 24 hours, bacterial growth was observed. Bacterial colonies that grew after 24 hours were re-inoculated onto BPW medium for 24 hours at 37°C. Bacterial growth was observed after 24 hours of incubation in an incubator at 37°C and using total plate count (TPC). For confirmation, CRP is used to see the coagulation that has formed [11–17].

Data Analysis Method

The sample analysis used was descriptive analysis, observing the growth of *S. aureus* bacteria on specific CRP media. The laboratory analysis data will then be processed using t-test statistical analysis to calculate the standard error in this study.

Results and Discussion

This study used 13 meat samples taken from Binjai City Market: 10 from Tavip Market and 3 from Kebun Lada Market. The samples taken from the market were first tested for bacterial colonies using the Total Plate Count (TPC) method. The results of observations on the total bacterial count (CFU/g) are shown in Table 1 below.

Tabel 1. Beef *Total Bacteria Plate Count* Test (CFU/g)

No.	Sample	*Total Plate Count* (CFU/g)
1.	PT 1	1.2×10^4
2.	PT 2	7.2×10^4
3.	PT 3	5.5×10^4
4.	PT 4	9.6×10^5
5.	PT 5	4.9×10^5
6.	PT 6	1.5×10^6
7.	PT 7	2.7×10^5
8.	PT 8	4.7×10^5
9.	PT 9	1.4×10^6
10.	PT 10	7.9×10^5
11.	PKL 1	5.3×10^5
12.	PKL 2	8.9×10^5
13	PKL 3	5.8×10^5

Based on the table above, it can be seen that 11 test samples still meet the TPC test standard requirements in the Indonesian National Standard for meat 7388:2009, which is 10^6 CFU/g. However, there are 2 samples taken from Tavip Market that do not meet the criteria because they have a TPC of 1.4×10^6 and 1.5×10^6 CFU/g, which does not comply with the standard, which is exceeding 10^6 CFU/g. [18]. This shows that the test samples are still very safe and far below the specified standard figures. However, in addition to the TPC test, one of the very important microbiological tests besides the Salmonella test is the *Staphylococcus aureus* bacteria test.

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The number of colonies categorized as good for this bacterial test is 10^2 CFU/g or 100 colonies per gram of sample. Sample testing has been carried out in this study with results as in Table 2 below.

Table 2. Identification of *Staphylococcus aureus* in Beef (CFU/g)

No.	Sample	*Staphylococcus aures* (CFU/g)
1.	PT 1	8.9×10^3
2.	PT 2	1.07×10^3
3.	PT 3	$6.5 \times 10^-$
4.	PT 4	1.21×10^3
5.	PT 5	7.2×10^3
6.	PT 6	8.9×10^3
7.	PT 7	3.4×10^3
8.	PT 8	4.7×10^3
9.	PT 9	2.9×10^4
10.	PT 10	3.7×10^3
11.	PKL 1	2.8×10^3
12.	PKL 2	5.7×10^3
13	PKL 3	4.2×10^3

The table above shows that 13 beef samples tested in the laboratory tested positive for *S. aureus* contamination. *S. aureus* contamination can be caused by several factors, both external and internal. External factors that can contribute to high levels of product contamination include the lack of sanitation and hygiene in handling and the hygiene of traders at Binjai Market. The cleanliness of the equipment used by traders at these two markets is not guaranteed. Furthermore, the water source and water quality are also not very clean or contaminated in the storage containers. The beef at these markets comes from local slaughterhouses (RPH) supervised by the Department of Agriculture, so the risk of contamination from slaughter should be lower. However, during the transportation process, the equipment used to transport the meat to the market was inadequate, and the storage temperature conditions during transportation did not meet established standards. This is in line with research showing that strict supervision at slaughterhouses and equipment cleanliness can reduce the prevalence of bacteria to below 5% in beef samples from traditional markets. Additionally, good hygiene practices, such as handwashing of vendors and separation of equipment, have been shown to significantly reduce the risk of contamination, even to zero under optimal conditions.

The Total Plate Count (TPC) analysis (Table 1) revealed that the bacterial load ranged from 1.2×10^4 to 1.5×10^6 CFU/g**.** A total of 11 samples (84.6%) met the maximum limit set by SNI 7388:2009 ($\leq 1 \times 10^6$ CFU/g), while two samples from Tavip Market exceeded this threshold. Although the majority of samples were still within the TPC safety limit, the presence of high bacterial load indicates inadequate temperature control and hygiene practices during display and handling.

Further identification on Baird Parker Agar followed by coagulase confirmation showed that all 13 samples (100%) were positive for *S. aureus* contamination**,** with values ranging from 1.07×10^3 to 2.9×10^4 CFU/g (Table 2). These levels far exceed the SNI maximum allowable limit of 1×10^2 CFU/g**,** indicating a significant public health risk.

As shown in Figure 1, beef from Tavip Market exhibited a higher mean contamination (8.12×10^3 CFU/g) compared to Kebun Lada Market (4.23×10^3 CFU/g). The higher bacterial load at Tavip Market may be attributed to denser crowds, longer exposure time, inadequate sanitation, unprotected display surfaces, and poorer temperature management.

These findings are consistent with prior studies reporting that unhygienic traditional market environments are major contributing factors to S. aureus contamination in meat products. Poor vendor hygiene, cross-contamination from utensils, and contaminated water sources play an essential role in bacterial proliferation. Inadequate cold-chain distribution further accelerates microbial growth during transportation and storage.

The mean *Staphylococcus aureus* contamination in beef sold at Tavip Market and Kebun Lada Market was 7.46×10^3 CFU/g and 4.23×10^3 CFU/g, respectively. Both values exceeded the maximum limit of 1×10^2 CFU/g established by SNI 7388:2009. The comparison of contamination levels between the two markets is presented in Figure 1.

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In addition, according to research[19] that one of the recommended risk mitigation strategies, where temperature control during distribution can reduce the pathogen load by up to 45% in meat products. The results of this study are in line with Rahmawati that the possibility of *S. aureus* bacterial contamination in chicken meat is also influenced by visitor density, personal hygiene of traders and serving time. *S. aureus* can contaminate raw meat at various stages of processing, from infected animals during slaughter to improper skinning, cleaning, storage, and distribution. Non-compliance with hygiene standards, unhygienic conditions in slaughterhouses, and inadequate transportation and sterilization of equipment can contribute to contamination[20] strengthening also explains that stricter hygiene measures and better control in meat processing, transportation, and retail environments to reduce contamination and antibiotic-resistant strains in the food supply chain [21].

The integrated graphical (Figure 1.) comparison of TPC and S. aureus levels between Tavip Market and Kebun Lada Market highlights an important discrepancy between general microbial quality and specific pathogenic contamination. While mean TPC values in both markets remain close to, but still under, the SNI limit of 1 × 10^6 CFU/g, the mean S. aureus levels substantially exceed the maximum allowable threshold of 1 × 10^2 CFU/g. This pattern suggests that the hygienic conditions along the meat handling chain may be sufficient to control the overall bacterial load in most cases, but are inadequate to prevent contamination by S. aureus, which is closely associated with human contact, improper handling, and cross-contamination from equipment and surfaces. Therefore, interventions should not only focus on general sanitation and temperature control, but also specifically target personal hygiene of vendors, utensil disinfection, and separation of clean and contaminated areas at the market level.

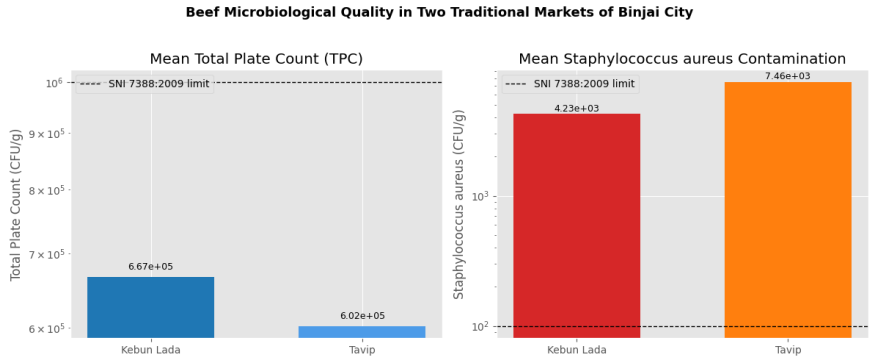

Figure 1. Mean Total Plate Count and Staphylococcus aureus contamination in beef sold at Tavip Market and Kebun Lada Market, Binjai City.

The figure presents the mean Total Plate Count (TPC) and *Staphylococcus aureus* contamination levels (CFU/g) in beef samples collected from two traditional markets in Binjai City. Both markets showed mean TPC values close to the maximum permissible limit of 1 × 10^6 CFU/g set by SNI 7388:2009, with Tavip Market at 6.02 × 10^5 CFU/g and Kebun Lada Market at 6.67 × 10^5 CFU/g. In contrast, the mean S. aureus contamination levels were markedly higher than the SNI limit of 1 × 10^2 CFU/g, reaching 7.46 × 10^3 CFU/g in Tavip Market and 4.23 × 10^3 CFU/g in Kebun Lada Market. These findings indicate that, although the general bacterial load (TPC) remains within acceptable limits for most samples, the specific contamination by S. aureus has exceeded the safety threshold in both markets.

Conclusions

Based on the results of the research conducted, as many as 13 beef samples from the two markets, namely Tavip Market and Kebun Lada Market showed levels of *Staphylococcus aureus* contamination that exceeded the safe limit of SNI 7388: 2009 (10^2 CFU/g), with a range between 1,21 x 10^3 to 2,9 x 10^4 CFU/g. This finding indicates the need for intervention to improve personal hygiene of sellers and sanitation of the market environment. In addition, it is recommended that the Binjai City Health Office provide regular guidance and supervision for traders in traditional markets and consumers must process meat in accordance with processing standards to minimize negative effects on health.

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Conflict of Interest

The authors declare no conflicts of interest regarding this manuscript.

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