



A microbiological analysis of coliform bacteria in street food around Universitas Prima Indonesia, Medan

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ABSTRACT

Background: Street foods, particularly fried snacks, are highly popular among university students due to their convenience and affordability. However, the safety of such foods is a public health concern, as they are susceptible to contamination by coliform bacteria, which can cause gastrointestinal illnesses such as diarrhea. This study aimed to analyze the total coliform bacteria in fried snacks sold around the Universitas Prima Indonesia campus area in Medan as an indicator of food safety.

Methods: This descriptive laboratory study analyzed fried snack samples of two types (rissole and filled tofu) collected from six street vendors on Jalan Ayahanda, Medan. Samples were obtained using a simple random sampling technique, resulting in a total of 12 samples. The presence of coliform bacteria was determined using the Most Probable Number (MPN) method with a 3-3-3 tube series, which included a presumptive test using Lactose Broth (LB) medium. Data were analyzed descriptively by comparing results with the standard set by the Indonesian Ministry of Health Regulation No. 2 of 2023 (maximum permissible limit <3.6 MPN/gram).

Results: All 12 samples tested negative in the presumptive test, indicated by the absence of gas bubbles in the Durham tubes after 48 hours of incubation. The MPN value for all samples was <3 MPN/gram, confirming they met the required safety standard (<3.6 MPN/gram).

Conclusion: Fried snacks sold around the Universitas Prima Indonesia campus were free from coliform bacterial contamination and are considered safe for consumption based on current regulations. Factors such as the high-temperature deep-frying process (>150°C) and adequately maintained vendor sanitation practices likely contributed to the absence of contamination.

Keywords: coliform, fried snacks, MPN, food safety, *Escherichia coli*

Introduction

Food is a fundamental human necessity, and its safety is paramount. Consumption of contaminated food can lead to foodborne diseases, with diarrhea being a common outcome.¹ Street foods, in particular, pose a potential risk for transmitting such illnesses due to their frequent exposure to environmental contaminants like dust and insects, as well as potentially inadequate handling practices by vendors.^{2,3} Fried snacks are a popular street food choice across various demographics, including university students, owing to their practicality, accessibility, and low cost.⁴ However, their sale in open environments increases the risk of physical, chemical, and biological contamination.⁵ Biological contamination by coliform bacteria is a

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primary concern, as these organisms serve as indicators of fecal pollution and the potential presence of enteric pathogens.²

Coliform bacteria are a group of Gram-negative, rod-shaped bacteria capable of fermenting lactose with gas production within 48 hours at 35–37°C.^{6,7} This group includes genera such as *Escherichia*, *Enterobacter*, *Klebsiella*, and *Citrobacter*. *Escherichia coli* is the species most frequently associated with fecal contamination and can cause diarrhea, urinary tract infections, and even sepsis upon ingestion in sufficient quantities.^{8,9} According to the Indonesian Ministry of Health Regulation No. 2 of 2023, the maximum permissible limit for coliform contamination in ready-to-eat food is <3.6 MPN/gram.¹⁰

Globally, contaminated food is estimated to cause approximately 600 million illnesses and 420,000 deaths annually.¹¹ In Indonesia, diarrhea remains a significant public health issue. Data from the Statistics Indonesia for North Sumatra Province in 2020 reported 70,243 diarrhea cases, with Medan City ranking second with 8,047 cases.¹² The dense activity and high concentration of street vendors around university campuses create potential hotspots for disease transmission if food hygiene is not adequately maintained.²

Previous studies have linked vendor hygiene practices with *E. coli* contamination in street food. Handwashing habits and equipment cleanliness have also been identified as significant factors influencing food contamination.¹³ However, specific data on coliform contamination in fried snacks sold near the Universitas Prima Indonesia campus were lacking prior to this study. Therefore, this research aimed to analyze the total coliform bacteria in fried snacks from this area as an indicator of food safety.

Method

This descriptive laboratory study was conducted in December 2025 at the Microbiology Laboratory, Faculty of Medicine, Dentistry and Health Sciences, Universitas Prima Indonesia. The study population comprised fried snacks (rissole and filled tofu) sold by street vendors along Jalan Ayahanda, Medan. Samples were collected using a simple random sampling technique from six different vendors, with two types of fried snacks (rissole and filled tofu) obtained from each vendor, resulting in a total of 12 composite samples. Each composite sample consisted of five individual pieces of the respective snack type, which were homogenized for analysis.

The primary variable was the presence of coliform bacteria, quantified using the Most Probable Number (MPN) method with a 3-3-3 tube series. Equipment included test tubes, an incubator, Petri dishes, a microscope, an autoclave, and standard glassware. Media and reagents comprised Lactose Broth (LB), Brilliant Green Bile Broth (BGBB), Eosin Methylene Blue Agar (EMBA), 0.9% NaCl solution, and 70% alcohol.

Sample collection involved placing fried snacks into sterile plastic bags, which were then stored in a cool box with ice packs and transported immediately to the laboratory. For analysis, 25 grams of each composite sample were homogenized with 225 mL of sterile water (10^{-1} dilution), followed by serial dilution to 10^{-2} . The MPN procedure consisted of three stages. First, for the presumptive test, 1 mL from each dilution (10^{-1} , 10^{-2} , 10^{-3}) was inoculated into three tubes containing LB broth and an inverted Durham tube, after which the tubes were incubated at 37°C for 24–48 hours, and gas production within a Durham tube indicated a positive result. Second, for the confirmed test, which was performed only if the presumptive test was positive, 1 mL from positive presumptive tubes was inoculated into BGBB medium and incubated at 37°C for 24–48 hours, with gas production confirming the presence of coliform bacteria. Third, for the completed test, which was performed if the confirmed test was positive, a loopful from positive BGBB tubes was streaked onto EMBA plates and incubated at 37°C for 24 hours, where colonies with a characteristic metallic green sheen were presumptive for *E. coli*, and Gram staining and IMViC biochemical tests were performed for confirmation.

Data were analyzed descriptively. MPN values were determined using standard MPN tables for three serial dilutions. Results were compared against the maximum permissible limit for coliforms in ready-to-eat food set by the Indonesian Ministry of Health Regulation No. 2 of 2023 (<3.6 MPN/gram).

Results

A total of 12 fried snack samples, comprising six rissole samples (coded A1–A6) and six filled tofu samples (coded B1–B6) from six different vendors, were analyzed. The presumptive test results showed that none of the samples produced gas in the LB medium after 48 hours of incubation. Consequently, no tubes

were positive across any of the dilution series for any sample, yielding an MPN value of <3 MPN/gram for all samples (Table 1).

Table 1. MPN test results for coliform bacteria in fried snack samples

Sample Code	Snack Type	Positive Tubes (3-series)	MPN Value (MPN/gram)	Maximum Limit*	Status
A1	Rissole	0-0-0	<3	<3.6	Pass
A2	Rissole	0-0-0	<3	<3.6	Pass
A3	Rissole	0-0-0	<3	<3.6	Pass
A4	Rissole	0-0-0	<3	<3.6	Pass
A5	Rissole	0-0-0	<3	<3.6	Pass
A6	Rissole	0-0-0	<3	<3.6	Pass
B1	Filled Tofu	0-0-0	<3	<3.6	Pass
B2	Filled Tofu	0-0-0	<3	<3.6	Pass
B3	Filled Tofu	0-0-0	<3	<3.6	Pass
B4	Filled Tofu	0-0-0	<3	<3.6	Pass
B5	Filled Tofu	0-0-0	<3	<3.6	Pass
B6	Filled Tofu	0-0-0	<3	<3.6	Pass

*Based on Indonesian Ministry of Health Regulation No. 2 of 2023 concerning Food Safety Standards for Ready-to-Eat Food.

Pass = Meets the standard.

According to the standard set by the Indonesian Ministry of Health Regulation No. 2 of 2023 (maximum permissible limit <3.6 MPN/gram for ready-to-eat food), all samples met the required safety criteria. Due to the absence of positive tubes in the presumptive test, the analysis did not proceed to the confirmed and completed stages.

Discussion

This study demonstrated that all fried snack samples collected from vendors around the Universitas Prima Indonesia campus were free from detectable coliform contamination. This finding suggests that vendor hygiene and sanitation practices in this area are relatively adequate and that the food preparation process effectively prevented bacterial contamination. The absence of coliforms indicates a low risk of exposure to enteric pathogens such as *E. coli* for consumers, supporting the safety of these snacks for consumption.

Several factors likely contributed to these negative results. Primarily, the deep-frying process, which typically uses oil temperatures between 150–180°C, plays a critical role. This temperature is substantially higher than the thermal death point of coliform bacteria, which are generally inactivated at 60–70°C within minutes. Uniform heating throughout the food item effectively eliminates biological contaminants. Secondly, observations suggested reasonably good vendor sanitation practices. These included washing utensils, storing batter in covered containers, and using clean water during food preparation. Vendors were observed frying the snacks fresh and did not hold finished products for extended periods before sale.

The results align with a study by See, who also reported negative coliform findings in street food samples.¹⁴ Lauryl Sulfate Tryptose Broth (LSTB) has been standard for coliform presumptive tests since the 1930s-1940s; no gas production in Durham tubes indicates negatives, skipping confirmation. A 1941 validation confirmed LSTB's reliability for water but applicable to foods, with gas absence negating further steps.¹⁵ Good hygiene consistently yields low/no coliforms in street foods, as seen in sites with >50% uncontaminated samples linked to GHP compliance. This supports that practices like proper handling prevent contamination, mirroring the original claim.²

Conversely, these results contrast with reports from other locations. Hidayati et al.¹⁶ found that four mixed rice samples from a university canteen in Ambon exceeded coliform standards. Yulistiani et al.¹⁷ reported that 41.67% of food samples from a culinary center in Surabaya failed to meet safety requirements due to coliform contamination exceeding 1×10^4 CFU/g. This aligns with another study in Surabaya which reported that 40% of snack food samples were contaminated with Coliform (>10 counts/gram) and 12% with *E. coli*. Statistical findings from the latter study highlighted significant differences in Coliform levels based on the type and location of snacks, particularly noting high contamination in one-dish meals and wet snacks like meatballs served in school canteens.¹⁸ These discrepancies may be attributed to differences in food type and processing. Unlike fried snacks, which undergo high-temperature treatment just before serving, mixed rice is often served without further reheating.^{17,19} Furthermore, variations in environmental conditions and vendor adherence to hygiene principles likely exist across different locations.¹⁷

Coliform contamination in food can originate from multiple sources, including contaminated raw ingredients, unclean water, improperly sanitized equipment, and poor personal hygiene of food handlers. For

instance, research on dairy processing highlighted coliforms as indicators of unsanitary farm practices, inadequate refrigeration, and equipment issues like milking machine failures.²⁰ Similar findings from snack vendor analyses around that time linked high coliform levels (>1,100 J/ml/g in 40% of samples) to hygiene behaviors and sanitation lapses.²¹ In the present study, although the vending locations were adjacent to a busy, dusty main road, the use of covered food displays by vendors likely minimized direct environmental exposure. This practice, combined with the lethal effect of frying, appeared sufficient to prevent contamination.^{20,22}

A limitation of this study was that all samples tested negative in the presumptive stage; therefore, no confirmatory tests were performed to identify specific bacterial species. Additionally, the sample size was relatively small and limited to two types of fried snacks. Future research should include a wider variety of food items and conduct more in-depth risk factor analysis, such as testing water sources, swabbing equipment and food handler hands. Despite these limitations, this study provides initial, positive evidence regarding the microbiological safety of fried snacks in this specific campus environment.

Conclusion

All fried snack samples (rissole and filled tofu) collected from vendors around the Universitas Prima Indonesia campus in Medan tested negative for coliform bacterial contamination. The MPN values for all samples were <3 MPN/gram, thereby complying with the safety standards stipulated in the Indonesian Ministry of Health Regulation No. 2 of 2023. These findings indicate that the snacks are safe for consumption from a microbiological perspective. The high-temperature frying process and reasonably good vendor sanitation practices were likely instrumental in achieving this outcome. Continued monitoring with more diverse samples and detailed risk factor assessments is recommended to sustain food safety quality in this area.

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