



Comparison of *Escherichia coli* Bacterial Contamination Levels in Fresh Chicken and Frozen Chicken Meat in Medan City

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ABSTRACT

Chicken meat is one of the animal foods consumed because it contains high nutrients, has a delicious taste and aroma, has a soft texture and is relatively cheap. The research aims to determine the difference in the level of *Escherichia coli* bacterial contamination in fresh chicken meat and frozen chicken meat in Medan City. The number of samples at traditional markets was 20 samples and the number of samples at frozen chicken stalls was 20 samples. The sampling method used in the research was a survey. Data processing uses the t test and the Mann Whitney test. The research results showed that the number of colonies in traditional markets was greater than the number of colonies in frozen chicken stalls. The Maximum Microbial Contamination Limit (BMCM) of all traditional markets studied all exceeded the BMCM, and the Maximum Bacterial Contamination Limit (BMCM) of all frozen chicken stalls studied did not all exceed the BMCM (SNI 01-7388-2009). The percentage level of *Escherichia coli* bacterial contamination in traditional markets is 100% and the percentage of bacterial contamination in frozen chicken stalls is 30%. In conclusion meat that comes from frozen chicken stalls is better because it has bacterial contamination below the Maximum Microbial Contamination Limit (BMCM) so it is safer for public consumption than from traditional markets.

Keywords: *Escherichia coli*, Fresh chicken meat, Frozen chicken meat, Microbial contamination



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1. Introduction

Frozen chicken stalls and traditional markets are popular locations to find chicken meat. In traditional markets, meat is served openly (without a lid) by placing it freely on the table without regard to hygiene requirements, even though it is served in closed food packaging. Chicken meat can be infected with disease bacteria due to customer carelessness and traders' ignorance of correct meat handling procedures. In addition, meat left in the open, in an unhygienic environment, and at room temperature will allow harmful microorganisms to multiply due to high air temperatures [1]. Based on data, broiler chickens account for 60.73% of Indonesia's total meat supply. Along with the increase in income and public understanding of the value of animal protein, the development of broiler chickens is also expanding. The Central Statistics Agency (BPS) projects that Indonesians consume an average of 0.15 kilograms (kg) of chicken meat per week in 2022. Compared to 2021, this number increased by 7.75%.

Escherichia coli is a type of bacteria that can infect and multiply in chicken meat. *Escherichia coli* is a typical component of the gastrointestinal tract microbiota, but if the amount in the colon exceeds normal, it becomes dangerous. Increased amounts of *Escherichia coli* in chicken meat can degrade the quality of the final product and result in diarrhea and other health problems for humans. According to the Indonesian National Standard (SNI), the maximum limit of *Escherichia coli* microbiological contamination (BMCM) in beef is less than 1×10^1 CFU/g. Number 01-7388-2009. The production time of *Escherichia coli* ranges from 30 to 87 minutes, depending on the temperature. *Escherichia coli* is able to withstand high body acidity. The bacterium *Escherichia coli* is about 2 μm long, 0.7 μm in diameter, and 0.4–0.7 μm wide, *Escherichia coli* is a facultative anaerobic. As a result, the colonies are round, convex, smooth and have well-defined boundaries [2]. These bacteria are a typical component of the gastrointestinal microbiota, and if their population in the colon exceeds the threshold, then the bacteria become dangerous. *Escherichia coli* can infect humans, especially when ingested through contaminated food such as raw or undercooked meat, raw milk, or feces that contaminate food and air [3]. Consuming food or drinks contaminated with harmful germs can result in foodborne illness commonly called food poisoning [4]. Because it enters the body through contaminated food, foodborne illnesses such as acute diarrhea (gastroenteritis) are usually dangerous [5].

Traditional markets are high-risk environments where germs can multiply and be contaminated. This is because traders are not aware of the cleanliness and health of the meat they sell, so it can have a bad impact on human health if improper handling occurs. In particular, pathogenic microorganisms can contaminate chicken meat sold [6]. The city of Medan has 53 traditional markets, according to statistics from the Central Market of Medan City (2024). However, the Petisah Main Market is the only traditional market designated as a class 1 A market. Based on the survey results, traders on the quantity of broiler chicken meat available at Petisah Market are 18 traders, traders on the quantity of broiler chicken meat available at the Kampung Lalang market are 45 traders, traders on the quantity of broiler chicken meat available at Sei Sikambing Market are 27 traders, and traders to the quantity of broiler chicken meat available at the Melati Market amounted to 8 traders. Petisah Market is included in the class 1 A market, the Kampung Lalang market is included in the class 2 market, the sei sikambing market is included in the class 2 market, and the jasmine market is included in the class 4 market..

Based on the survey results, the chicken meat was placed on the table for customers to choose by simply touching the appropriate portion of meat. There are still many chicken meat marketing places that are in poor condition, including floods, muddy roads, flooded air, and scattered garbage. Contamination Meat is most likely caused by the environment and market activities, especially those carried out by customers and visitors [7]. Frozen chicken stall Frozen chicken meat sellers come from the slaughter of Chicken Slaughterhouses (RPA). Meat that is in Frozen Chicken Stalls It has been neatly wrapped, and clean, so that it can be consumed by consumers. Frozen chicken stall Frozen chicken maintains the cleanliness of the place of sale, and sanitation in the Frozen chicken stall Frozen chicken is well maintained, there is no garbage and stagnant water, no dirty and flooded roads. So that the potential for meat contaminated with bacteria *Escherichia coli* small.

2. Method

2.1. Place and Time of Research

This research was carried out at Kampung Lalang Market, Petisah Market, Sei Sikambing Market and Melati Market and 20 frozen chicken stalls in Medan City. Microbial testing was carried out at the Veterinary Public Health Laboratory, Medan Veterinary Center located on Jl. Gatot Subroto No. 255-A, Medan Sunggal District, Medan City, North Sumatra 20123. This research started from April to May 2024.

2.2. Research Sample Size

The size of the research sample was calculated using a descriptive survey formula [8]:

$$n = \frac{Z^2 \alpha^2 \times s}{d^2}$$

$$n = \frac{(1,96)^2 \times 1,506}{(0,537)^2}$$

$$n = \frac{3,84 \times 1,506}{0,2883}$$

$$n = \frac{5,76}{0,2883} = 19,97 \approx 20$$

Information:

α : koefisien

S: Standard Deviation

d: the estimated mean difference

The number of samples used was 20 samples from traditional markets and 20 samples from frozen chicken stalls.

2.3. Research Methods

The research design used is a type of survey research with a sampling technique, namely *purposive sampling*, namely by determining or deliberately selecting the population to be selected and using the t-test. Microbial testing using the *Most Probable Number* (MPN) enumeration method and using chromogenic media in the form of *Chromocul Coliform Agar* (CCA). Sampling at traditional markets and frozen chicken stalls is carried out in the morning using *styrofoam cooling boxes*.

Table 1. Sampling technique

Total Selected Population	Sample of Traditional Market	Total Selected Population	Sample of frozen chicken stall
1	Petisah	1	Petisah
2	Kampung Lalang	2	Sunggal
3	Sei Sikambing	3	Helvetia
4	Jasmine	4	Tuntungan
Total Overall Population	53	Total Overall Population	20

The population selected in the traditional market is 4 traditional markets, namely the petisah market, the village lalang market, the sei sikambing market, and the jasmine market out of the total of 53 traditional markets in Medan City (PD Pasar Sentral Kota Medan 2016). The number of samples of traditional markets taken was 20 samples. The samples selected at the frozen chicken stall were 4 frozen chicken stalls, the selection of the frozen chicken stall location was in a location adjacent to the selection of traditional market locations. The number of samples of frozen chicken stalls taken was 20 samples.

Based on the survey results, 18 traders selling broiler chicken meat at the petisah market, 45 traders selling broiler chicken meat at the kampung lalang market, 27 traders selling broiler chicken meat at the sei sikambing market, and 8 traders selling broiler chicken meat at the jasmine market.

Table 2. The population and sample selection table is as follows

Traditional Market	Lots of Samples	Frozen Chicken Kiosk	Lots of Samples
Petisah	5	Petisah	5
Kampung Lalang	5	Sunggal	5
Sei Sikambing	5	Helvetia	5
Jasmine	5	Tuntungan	5
Total Sample Overall	20	Total Sample Overall	20

Each traditional market selection took 5 samples from each traditional market, and each self-service selection took 5 samples from each frozen chicken stall. So that a total of 20 samples were obtained at the traditional market and at the frozen chicken stall as many as 20 samples.

2.4. Data Analysis

The data obtained was analyzed using descriptive statistics, to present data in the form of averages and standard deviations (frequency of bacteria per trader), and using the t-test and followed by the Mann Whitney test. Data processing uses software, namely SPSS.

3. Result and discussion

3.1. General Conditions at the Sampling Location

Table 3. The difference in the sales conditions of chicken meat in the traditional market and in the Frozen Chicken Stalls

Traditional Market	Frozen Chicken Kiosk
1. Chicken slaughter <ul style="list-style-type: none"> - Done in traditional markets - Less hygienic cutting process - Using infrequently replaced cutting wash water - Using unhygienic equipment 	1. Chicken slaughter <ul style="list-style-type: none"> - Done at RPU - Awakened cutting process - Using standards in RPU - Using more hygienic equipment in RPU
2. Condition of the carcass <ul style="list-style-type: none"> - Offal and meat brought together - Can be sold in whole form 	2. Condition of the carcass <ul style="list-style-type: none"> - Only sell meat - Can be sold in whole or fillet form
3. Packing/freezing <ul style="list-style-type: none"> - Not using a refrigerator - The meat sold is only placed on the sales table 	3. Packing/freezing <ul style="list-style-type: none"> - Using a refrigerator - The meat sold is packaged in whole plastic
4. Sanitary hygiene <ul style="list-style-type: none"> - Has a low level of hygiene - Cleanliness is not maintained 	4. Sanitary hygiene <ul style="list-style-type: none"> - Have a level of hygiene that is maintained - Cleanliness is better maintained at RPU

Based on table 3, it shows that chicken sourced from traditional markets is fresh meat, while chicken sourced from frozen chicken stalls is not fresh meat because chicken meat from supermarkets is not sold directly during the cutting process compared to chicken meat from traditional markets. As a result, meat from the market without a refrigerator has a shorter shelf life than meat from frozen chicken stalls equipped with refrigerators using a refrigeration machine to freeze, the level of hygiene in the market is low, because the slaughter process is carried out manually making chicken meat more susceptible to bacteria and usually fresh chicken still contains blood from the rest of the slaughter while the hygiene level in frozen chicken stalls is high because the frozen chicken goes through the process Modern processing and before the chicken is fertilized, the chicken will be drained first until the blood that sticks to it is completely exhausted so that the growth of bacteria can be minimized.

3.2. Results of *Escherichia coli* Bacterial Contamination

Table 4 can be seen the resultsof testing *Escherichia coli* *bacteria* at traditional markets and frozen chicken stalls.

The data in Table 4 shows that the level of *Esherichia coli* contamination from traditional markets has more bacteria contaminated than from frozen chicken stalls, colonies of the amount of *Esherichia coli* contamination of broiler chicken meat in the traditional market of Medan City, namely Pasar Kampung, Pasar Melati, Pasar Petisah, and Sei Sikambing Market all exceed the threshold set by SNI, the value of *Esherichia coli* contamination in the lowest traditional market, which is 3×10^1 CFU/g from the Kampung

Lalang Market and the highest value of *Escherichia coli* contamination, which is 1×10^6 CFU/g from the Melati Market.

Table 4. Results of *Escherichia coli* bacteria test

Sample	Traditional market (logCFU/g)	Threshold (BMCM)	Frozen Chicken Kiosk (logCFU/g)	Threshold (BMCM)
1	2.8×10^2	Exceed	1.5×10^3	Exceed
2	1.4×10^2	Exceed	2.4×10^4	Exceed
3	1×10^3	Exceed	0.85×10^1	Not exceeding
4	3×10^1	Exceed	7×10^2	Exceed
5	1.1×10^3	Exceed	0.78×10^1	Not exceeding
6	1.16×10^4	Exceed	0.85×10^1	Not exceeding
7	1×10^4	Exceed	0.70×10^1	Not exceeding
8	1×10^6	Exceed	0.70×10^1	Not exceeding
9	7.8×10^3	Exceed	1.4×10^2	Exceed
10	7.6×10^3	Exceed	4×10^4	Exceed
11	1.4×10^4	Exceed	0.78×10^1	Not exceeding
12	2.2×10^4	Exceed	0.85×10^1	Not exceeding
13	3×10^4	Exceed	2.2×10^3	Exceed
14	2.5×10^4	Exceed	0.60×10^1	Not exceeding
15	2.2×10^3	Exceed	0.85×10^1	Not exceeding
16	7.8×10^2	Exceed	0.90×10^1	Not exceeding
17	3.7×10^3	Exceed	0.85×10^1	Not exceeding
18	1.1×10^4	Exceed	0.78×10^1	Not exceeding
19	1.2×10^4	Exceed	0.70×10^1	Not exceeding
20	1×10^4	Exceed	0.78×10^1	Not exceeding
Total		20/20		6/20
Percentage		100%		30%

Maximum limit of microbiological contamination *Escherichia coli* (BMCM) on fresh chicken meat less than 1×10^1 CFU/g, according to SNI 01-7388-2009 concerning the Maximum Limit of Microbiological Contamination in Food. High frequency *Escherichia coli* on all the meat offered by traders in the traditional market of Medan City is most likely due to the lack of freshness of the meat. The number of samples of the traditional market exceeds the BMCM of bacteria *Escherichia coli*. There were 20 samples out of 20 overall samples taken, so that the percentage level that exceeded BMCM SNI in the traditional market was 100% and the number of samples of frozen chicken stalls exceeded the bacterial BMCM *Escherichia coli*. There were 6 samples out of 20 total samples taken, so that the percentage that exceeded the BMCM SNI at the frozen chicken stall was 30%. *Escherichia coli* It can be found in chicken meat sold in traditional markets for several reasons, including the use of non-sterile wheelbarrows and locations where chicken meat is still sold on tables with inadequate bottoms, which can lead to excessive quantities. bacteria in the meat as a whole. Other problems are inadequate clean water facilities, locations where chicken meat is still sold with other traders, poor cleanliness of sellers, and the growth of natural pathogens in the animal's body.

The colony counter determines how many bacterial colonies there are. The following table 5 shows the number of bacterial colonies in the traditional market group and frozen chicken stalls.

Table 5. Number of bacterial colonies of *Escherichia coli* traditional market and frozen chicken stalls

Traditional Market (logCFU/g)	Frozen Chicken Kiosk (logCFU/g)
2,45	3,18
2,15	4,38
3,00	,85
1,48	2,85
3,04	,78
4,06	,85
4,00	,70
6,00	,70
3,89	2,15
3,88	4,60
4,15	,78
4,34	,85
4,48	3,34
4,40	,60
3,34	,85
2,89	,90
2,57	,85
4,04	,78
4,08	,70
4,00	,78
Avg. 3.6120	1,5735

*The real difference between the number of bacterial colonies between traditional markets and frozen chicken stalls

Based on Table 5, the number of bacterial colonies in the traditional market can be obtained of 3.6120 CFU/g. The highest data was obtained at the Melati Market, which is 6.00, this is because in the Melati Market the sword still does not apply and does not understand the importance of the application of sanitation in trading, such as one of the traders using an apron, but not using gloves which can cause contamination of bacteria from the trader's hands to the meat products sold (direct contamination), found traders who are smoking while selling which can cause Contamination of meat with cigarettes, unclear cutting tools, non-replacement of washing water from chicken slaughter, there are still many traders who do not use gloves. The lowest data was obtained at the Kampung Lalang Market, which is 1.48, this is because at the Kampung Lalang Market because most traders in the Kampung Lalang Market are aware of the implementation of good sanitation, such as the traders use gloves, use aprons, the pedestals where chicken meat is sold have used a cement system (ceramic) and no longer use a base made of wood, washing hands before and after the process of cutting meat, and have distinguished the place of sale of products such as offal and meat, and although there are some traders who still ignore the importance of implementing good sanitation in trading to minimize bacterial contamination in the products sold.

In order for chicken meat to have quality worthy of human consumption, it must be processed, cut, packaged, stored, and handled with care. Whole meat and fillet meat are two animal products that are widely found in supermarkets and obtained by slaughtering chickens. Due to its extreme susceptibility, the whole chicken meat and chicken fillets sold immediately cause odors and irritation. It is infested with many microorganisms, especially at the time of direct slaughter of Slaughterhouse (RPH) workers. Equipment

such as knives, cutting boards, and other cutting tools, as well as employees' unsterile hands, are likely to be the first source of cross-contamination of chicken meat with bacteria *Escherichia coli*. Many customers buy products made from ground chicken meat to be used as raw materials for other processed meat, including sausages, meatballs, nuggets, and others. Poor sanitation and worker equipment can be a source of chicken meat contamination. Therefore, eating ground chicken meat can be dangerous and may be contaminated with bacteria.

Frozen chicken stalls can be identified as one of the modern markets that have implemented good sanitation principles. The production of chicken meat products must also pay attention to good sanitation in order to produce quality and hygienic products. The hygienic condition of the chicken meat processing process is one of the characteristics that distinguishes supermarkets from traditional markets. Frozen chicken stalls provide a variety of processed chicken meats that are packaged in plastic wrap and stored in a controlled storage environment. Frozen chicken stall employees wear special clothes, and the meat flour is then sold in containers on refrigerated shelves while the temperature is monitored. When the frozen chicken stall is filled with customers, there is a chance of contaminated air due to the large number of people and employees passing by. This can lead to an increase in microorganisms in the air, which can then cause germs to multiply in meat product storage.

The following steps in the processing of chicken carcasses in RPU can result in microbial cross-contamination: slaughter, heating and feather removal, offal removal, cooling, grading, and cutting. If chicken meat comes into contact with the contents of the chicken's intestines and the hands of the workers who process the meat, *Escherichia coli* can infect the intestinal meat because the bacteria mostly inhabit the organs of the offal. Microbial contamination or also known as cross-infection can occur during the procedure of hair removal from one carcass to another or from a hair removal device. At the time of feather removal, the number of *Escherichia coli* on the chicken skin will increase [9]. To prevent buildings, equipment, and equipment from becoming a source of disease transmission in chicken meat, hygienic criteria are important in the chicken slaughtering industry. Cleaning using detergents and disinfectants is one of the sanitation techniques. Usually, RPU rooms and equipment are cleaned using a combination of disinfectant and detergent. *Good Manufacturing Practices* (GMP) and *Hazard Analysis and Critical Control Points* (HACCP) are two food safety systems that must be implemented by producers and processors to ensure that the chicken produced is safe and healthy for consumption [10].

The process of good production implementation, the process of implementing, controlling, and monitoring the implementation of the production process is known as GMP (*Good Manufacturing Practices*). The processing stage is a major problem because food processing relies heavily on the hygiene of personnel and processing equipment to produce safe and high-quality goods. Increasing customer trust, corporate image and competence, enabling domestic workers to enter global markets with products and packaging that are free from chemical, physical, and biological toxins, and increasing product insights and knowledge are just some of the advantages of implementing GMP in the food processing business [11].

A monitoring system called HACCP can guard against potential food poisoning or the spread of disease-causing bacteria [12]. Until the end of the production process, the raw materials are analyzed using HACCP. The HACCP system aims to ensure that the products produced are safe and meet the safety requirements that have been set. HACCP is a control system in an effort to prevent problems in food quality based on critical points that have been reviewed in the handling and production process stages [13]. HACCP is applied to prevent biological, chemical, and physical contamination hazards and minimize risks.

4. Conclusion

4.1 Conclusion

Based on the results of the study, the level of contamination exceeded the Maximum Limit of Microbial Contamination (BMCM) in the traditional market by 100% while the Maximum Limit of Microbial Contamination (BMCM) in frozen chicken stalls was 30%. The average level of *Escherichia coli* bacterial contamination in the traditional market (3.6120 logCFU/g) was higher compared to the average level of *Escherichia coli contamination* in frozen chicken stalls (1.5735 logCFU/g).

4.2 Suggestions

For consumers who buy chicken meat from traditional markets, they need to pay attention to how to process chicken meat correctly with a sufficient level of maturity so that people can consume chicken meat that is healthy for the body, for traders must carry out good sales sanitation such as using tables made of

ceramics, the existence of adequate clean water facilities, and the distance between the barn and the point of sale should not be nearby.

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