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Contamination Of *Salmonella sp.* in Broiler meat sold in Traditional Markets of Banjarbaru City

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ABSTRACT

Meat is an important food commodity in meeting nutritional needs. Damage that leads to a decrease in the quality of fresh meat is mainly caused by microorganisms. One of the pathogenic bacteria that can contaminate broiler meat is *Salmonella sp.* This research aims to determine the food safety level of broiler meat sold in traditional markets in the city of Banjarbaru regarding contamination by *Salmonella sp.* bacteria and to prevent the circulation of poultry-origin products (broilers) that do not meet the required standards, which can threaten consumer health. The research method used in this study is a survey and laboratory analysis. This study utilized 56 chicken meat samples from 4 traditional markets using a random sampling method. The test results showed that 18 samples were contaminated with *Salmonella sp.* bacteria out of the 56 samples. This indicates that the quality of chicken meat sold in some traditional markets, 32.14%, does not meet the standards based on the Indonesian National Standard for chicken meat (SNI 7388:2009)

Keywords: Broiler meat, contamination, traditional market, and *Salmonella sp.*

1. Introduction

The broiler meat plays a significant role in meeting the animal protein needs of the Indonesian population. According to available data, the average per capita consumption of broiler meat by the Indonesian population in 2021 was estimated to be around 0.14 kg per week, which is approximately 0.538 kg per capita per month or 6.456 kg per year. This consumption is higher than that of beef, which is 2.2 kg per capita per year (Badan Pusat Statistik, 2022).

Chicken meat is a favored food item among Indonesian people due to its ability to provide animal protein, as it contains a comprehensive range of essential nutrients, including protein, carbohydrates, fats, water, minerals, and vitamins. Broiler chicken, at present, is one of the leading contributors to animal protein, surpassing beef, and remains a prominent commodity (Zelpina *et al*., 2020). Chicken meat is a food commodity rich in protein, fat, minerals, and other essential nutrients required by the human body (Ken *et al*., 2016). The safety of animal food products for consumption relies on the absence of pathogenic microorganisms that could potentially harm the health of those who consume them. *Salmonella sp.* is one such pathogenic microbe commonly transmitted through food, *Salmonella sp.* Outbreaks most commonly found in poultry products like broiler meat (Pires *et al*., 2014)

Controlling microbial contamination in animal-derived foods is of utmost importance to prevent food product spoilage and reduce contamination risks. Therefore, the identification of microbial contamination, especially those that cause foodborne illnesses, is crucial (Ken *et al*., 2016). Salmonellosis is a bacterial infection caused by *Salmonella sp.* bacteria. These bacteria can be found in animals, including chickens and cattle, and can be transmitted to humans through contaminated foods such as improperly processed meat, eggs, and dairy products. Symptoms of salmonellosis in humans include diarrhea, nausea, vomiting, fever, and abdominal pain (Hedican *et al*., 2010 and Bell *et al*., 2016). In severe cases, *Salmonella sp.* infection to the elderly and immunocompromised individuals can lead to the disease becoming invasive and resulting in fatal outcomes due to occurrences such as bacteremia, sepsis, meningitis (Scallan *et al*., 2011) dehydration, bloodstream infections, and even death (Rosso *et al.*, 2023). Hence, it is essential to ensure that consumed food has been properly processed and is free from *Salmonella sp.* bacterial contamination.

The prevalence of non-typhoidal *Salmonella sp.* infections in Indonesia remains significantly concerning. Indonesia ranks among the nations with the highest occurrence of endemic foodborne salmonellosis in Asia, trailing only China and India and surpassing Pakistan and Vietnam (Zelpina *et al*., 2020). Contamination of broiler chicken meat by these bacteria usually occurs in traditional markets because microbial proliferation commonly takes place in these environments. Traditional market settings are often associated with unclean and disorganized conditions, and chicken meat is often displayed without proper hygiene measures, making it susceptible to bacterial contamination (Zelpina *et al*., 2018). Some of the bacteria that can lead to contamination in chicken meat include *Salmonella sp. Campylobacter,* and *Escherichia coli (E. coli)*. Aerita *et al.* (2014) prove that there is a correlation between the hygiene and sanitation levels of vendors and the contamination of *Salmonella sp.* in chicken meat. Therefore, it is crucial to ensure that chicken meat consumed has been processed correctly and is free from bacterial contamination. *Salmonella sp.* is a *Gram*-negative rod-shaped bacterium, classified within the Enterobacteriaceae family. It has a rod shape and does not form spores.

Based on the reason above, it is necessary to conduct research to detect the presence or absence of *Salmonella sp.* contamination in broiler chicken meat sold in the traditional markets of Banjarbaru. Information about the presence of *Salmonella sp.* contamination in broiler chicken products sold in the traditional markets of Banjarbaru can increase public awareness when buying and consuming such products.

2. Research Methods

Materials

The material consisted of 25 grams of skinless broiler chicken meat taken from the thigh portion of each of the 56 chickens sold in four different traditional markets in Banjarbaru. The collected meat was placed in transparent plastic bags, labeled, and stored in a cooling container. It was subsequently transported to the Veterinary Centers Banjarbaru laboratory for microbiological examination.

Method

The research method was conducted at the Veterinary Centers Banjarbaru laboratory. Each sample was tested in triplicate (three replicates) to ensure the accuracy and consistency of the microbiological examination. The sample coding system (e.g., STP 1–STP 24) was used to uniquely identify each meat sample based on its market location and sequential number, ensuring traceability and consistency during laboratory analysis. For example, 'STP1' refers to the first broiler meat sample collected from Market 'K', while 'STP24' refers to the 24th sample from Market 'P'.

Observations during the sampling process showed that chicken meat in traditional markets was often placed on open tables, frequently near internal organs or unclean tools. These handling practices were consistent across all sample locations.

The prevalence of *Salmonella* sp. contamination in the collected samples was determined as the proportion of positive samples relative to the total number of samples tested. Prevalence was calculated using the formula:

$$\text{Prevalence } (\%) = \left(\frac{\text{Number of Positive Samples}}{\text{Total Number of Samples}}\right) 100\%$$

Analysis of the meat samples involved several steps, including pre-enrichment, enrichment, isolation and identification, biochemical testing, and biochemical identification using the API 20 E test (ISO 6579-1:2017).

Pre-enrichment. A 25 g sample of broiler chicken thigh was weighed and placed in a sterile container. 225 ml of Lactose Broth (LB) was added, and the mixture was homogenized using a bellyer for 1 minute. The sample was then incubated at 35°C for 24 hours.

Enrichment. 0.1 ml of the pre-enrichment culture was transferred to 10 ml of Rappaport Vassiliadis Broth (RV) medium. The mixture was homogenized using a vortex for 30 seconds and then incubated at 42°C for 24 hours.

Isolation and Identification. Colonies from the Rappaport Vassiliadis Broth (RV) were inoculated onto Hektoen Enteric Agar (HE) and Xylose Lysine Deoxycholate Agar (XLD) using the streaking method with an inoculating loop. The Petri dishes containing the streaked agar media were then incubated at a temperature of 35°C for 24 hours. After the 24-hour incubation period, colonies on the HE and XLD media suspected to be *Salmonella sp.* exhibited distinct characteristics. On HE, *Salmonella sp.* colonies appeared bluish-green with black centers (indicating H2S production), while on XLD, most colonies were pink, and nearly all had black centers. These distinctive colony characteristics aided in the identification of *Salmonella sp.* bacteria.

Biochemical Test. In the biochemical testing phase, colonies suspected of being *Salmonella sp.* from HE and XLD media are transferred to Nutrient Broth (NB) for 24-hour incubation. Subsequently, they are moved to Bismuth Sulfite Agar (BSA) for another 24 hours at 37°C. BSA is used for further testing with the API 20E Kit, MacConkey, and Oxidation-Fermentation (OF). Following the incubation, the colonies are introduced to MacConkey (MC) and Oxidation-Fermentation (OF) media. OF media has two variations, one with added paraffin oil (OF-F) and one without (OF-O), both incubated at 37°C for 24 hours. In MC media, positive *Salmonella sp.* colonies become transparent, and the media turns yellow, indicating lactose non-fermentation. On OF-O, a yellow color signifies oxidative carbohydrate metabolism, and on OF-F, it indicates fermentative carbohydrate metabolism. A positive result on OF-F or OF-O shows a yellow color change, while negative results remain green or unaltered. The oxidase test involves taking a colony using an inoculating loop and placing it on an oxidase test paper. A color change to purple signifies a positive result. These biochemical tests are vital for confirming the presence of *Salmonella sp.* bacteria in the samples.

Biochemical Identification. The API 20E test was used for biochemical identification. A suspension was created by taking suspected *Salmonella sp.* colonies from Blood Agar (BA) media and introducing them into a 5 ml suspension medium with ose. The suspension was mixed until homogeneous. A syringe was used to extract the suspension and gently place it into each well of the strip, taking care to avoid bubbles. The following wells were filled halfway: O-nitrophenyl-beta-D-galactopyranoside (ONPG), Tryptophan Deaminase (TDA), Indole (IND), Glucose (GLU), Mannitol (MAN), Sorbitol (SOR), Rhamnose (RHA), Sucrose (SAC), Melibiose (MEL), Amygdalin (AMY), and Arabinose (ARA). For abbreviations with underlines, the wells were filled halfway and paraffin oil was added, including Arginine Dihydrolase (ADH), Lysine Decarboxylase (LDC), Ornithine Decarboxylase (ODC), Hydrogen Sulfide (H2S), and Urea (URE). Once all wells were filled, the strip was incubated for 24 hours at 37°C. After incubation, the strip was read according to the API 20E reading table. For TDA, IND, VP, and GLU, additional reagents were needed. To perform an additional NO2 test, one drop of NIT1 and NIT2 reagents was added to GLU, and the mixture was allowed to react for 2 to 5 minutes. A red color indicated a positive result (Nitrogen Dioxide - NO2). A negative reaction (yellow color) suggested nitrogen gas (N2) reduction. For the oxidase test, API 20E oxidase test paper was used by placing BA media on the paper. A positive result was indicated by a purple color. The obtained results were compared with positive controls and referred to the API 20E reading table. All positive and negative data were entered into the apiwebTM software for identification results. This detailed process ensured accurate detection and identification of *Salmonella sp.* bacteria in the sample (bioMérieux, 2024)

Data Analysis

Data analysis involves a descriptive approach to interpreting the test results of the samples. The reference used in this study is in accordance with SNI 7388:2009, which specifies the maximum permissible limits for microbial contamination in food. According to this standard, *Salmonella sp.* bacteria should be absent/negative per 25g of the sample.

3. Results and Discussion

The samples were collected from four different traditional markets in Banjarbaru with the condition shown in Table 2.

Table 1. Overview of the Market

Location	Condition			
	Sales Area	Drainage	Good Display	Storage
K	Dirty and wet	None	Open on table	Room temperature
S	Dirty and wet	None	Open on table	Room temperature
B	Moderately Clean	Available	Open on table	Room temperature
P	Dirty and wet	None	Open on table	Room temperature

The testing was conducted at the Laboratory of the Banjarbaru Veterinary Center. The results indicate that out of the 56 samples tested, 18 samples were found to be positive for *Salmonella sp.* After being tested through several stages, including isolation, identification, biochemical tests, and the API 20E KIT, it was observed that the positive results remained consistent across all test stages. The data can be seen in Table 2.

Tabel 2. Sample Test Results in 4 Traditional Markets

No	**Location Code**	**Animal Sample**	**Code**	**Results**
1	K1	Broiler meat	STP1	Negative
2	K2	Broiler meat	STP2	Negative
3	K3	Broiler meat	STP3	Negative
4	K4	Broiler meat	STP4	Positive
5	K5	Broiler meat	STP5	Positive
6	K6	Broiler meat	STP6	Negative
7	K7	Broiler meat	STP7	Positive
8	K8	Broiler meat	STP8	Positive
9	K9	Broiler meat	STP9	Negative
10	S1	Broiler meat	STP1	Negative
11	S2	Broiler meat	STP2	Negative
12	S3	Broiler meat	STP3	Negative
13	S4	Broiler meat	STP4	Negative
14	S5	Broiler meat	STP5	Negative
15	S6	Broiler meat	STP6	Negative
16	S7	Broiler meat	STP7	Negative
17	S8	Broiler meat	STP8	Positive
18	S9	Broiler meat	STP9	Negative
19	B1	Broiler meat	STP1	Positive
20	B2	Broiler meat	STP2	Negative
21	B3	Broiler meat	STP3	Positive
22	B4	Broiler meat	STP4	Positive
23	B5	Broiler meat	STP5	Positive
24	B6	Broiler meat	STP6	Positive
25	B7	Broiler meat	STP7	Negative
26	B8	Broiler meat	STP8	Negative
27	B9	Broiler meat	STP9	Negative
28	B10	Broiler meat	STP10	Negative
29	B11	Broiler meat	STP11	Negative
30	B12	Broiler meat	STP12	Negative
31	B13	Broiler meat	STP13	Positive
32	B14	Broiler meat	STP14	Negative
33	B15	Broiler meat	STP1	Negative
34	P1	Broiler meat	STP2	Negative
35	P2	Broiler meat	STP3	Negative
36	P3	Broiler meat	STP4	Negative

37	P4	Broiler meat	STP5	Negative
38	P5	Broiler meat	STP6	Positive
39	P6	Broiler meat	STP7	Negative
40	P7	Broiler meat	STP8	Negative
41	P8	Broiler meat	STP9	Negative
42	P9	Broiler meat	STP10	Positive
43	P10	Broiler meat	STP11	Positive
44	P11	Broiler meat	STP12	Negative
45	P12	Broiler meat	STP13	Positive
46	P13	Broiler meat	STP14	Positive
47	P14	Broiler meat	STP15	Positive
48	P15	Broiler meat	STP16	Negative
49	P16	Broiler meat	STP17	Positive
50	P17	Broiler meat	STP18	Negative
51	P18	Broiler meat	STP19	Positive
52	P19	Broiler meat	STP20	Negative
53	P20	Broiler meat	STP21	Negative
54	P21	Broiler meat	STP22	Negative
55	P22	Broiler meat	STP23	Negative
56	P23	Broiler meat	STP24	Negative

Notes : K, S, B, P: Location code for sampling.
STP: Sample Code.

According to Table 2, The presence of *Salmonella sp.* in the samples indicates that during sample collection at four different market locations, the following findings were observed: In the market with code K, there were 4 positive *Salmonella sp.* samples out of 9 tested. In the market with code S, 1 sample tested positive for *Salmonella sp.* out of 9. Market code B had 5 positive *Salmonella sp.* samples out of 15. Market code P had 8 positive *Salmonella sp.* samples out of 24. Based on the calculation, out of the total 57 samples tested, 18 samples were found to be positive for *Salmonella sp.* with a prevalence of approximately 32.14%. Another research also showed that contamination is reported to be prevalent in chicken meat, constituting 46.1% in 168 sample (Pavelquesi *et al.,* 2023). The proximity of clean chicken meat to internal organs in the markets surveyed presents a significant risk for bacterial contamination. Internal organs, especially the digestive tract, are known reservoirs of Salmonella sp. and other pathogenic bacteria (Rivera-Perez et al., 2014). The observed practice of displaying meat in open areas, often on unclean surfaces, creates conditions conducive to cross-contamination. Addressing these issues through proper hygiene protocols, such as segregating meat from organs and maintaining clean handling surfaces, can reduce the prevalence of Salmonella sp. contamination, as suggested by Sartika et al. (2016). The health status of poultry plays a crucial role in contamination levels. Salmonella spp. can colonize the gastrointestinal tracts of apparently healthy poultry, turning them into carriers that shed the bacteria into the environment. Poor health monitoring and biosecurity measures in poultry farms exacerbate this risk, as noted by Shah et al. (2012). This observation complies with the National Standard of Indonesia (SNI) ICS 67.120.20 from 2009, which mandates that fresh chicken meat must be free of Salmonella sp. contamination with a requirement that every 25 g sample representing one fresh chicken should not contain *Salmonella sp.* bacteria. However, according to the National Standard of Indonesia (2000), the maximum allowable limit for *Salmonella sp.* bacterial contamination in consumable meat is 1 x 10^4 CFU g^-1 (wherein 1 g of the sample should not contain more than 1.000 bacterial colonies).

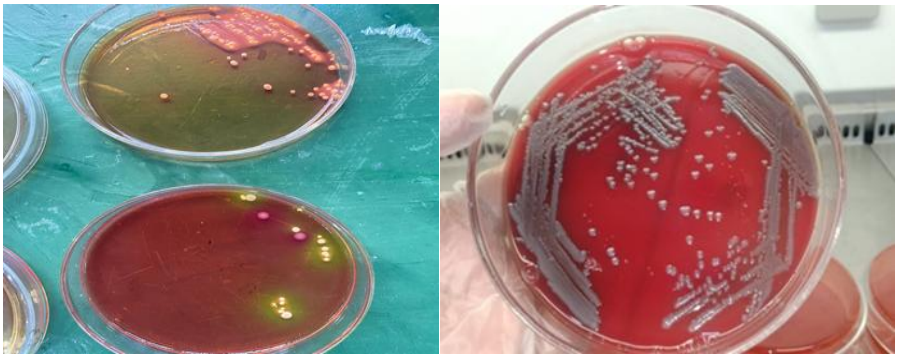

Figure 1. BSA media with Positive *Salmonella sp.*

Figure 1 illustrates the colony morphology of Salmonella sp. on Bismuth Sulfite Agar (BSA) media, characterized by a metallic sheen with brown or black centers and a surrounding brown coloration resembling a 'rabbit's eye'. These distinct features confirm the presence of Salmonella sp. and align with previous findings on the specific growth characteristics of this bacteria (Irianton, 2006)

Figure 2. KIT API 20E with positive *Salmonella sp.*

To further ensure accuracy, additional testing was conducted using the API 20E kit. The choice of identification method using the API 20E kit was made due to its speed and ease of use. All the data obtained from the 20 mini-tubes or wells were entered into an identification table, allowing the bacterial species to be determined. After the incubation was completed, the strip was read based on the provided reading table in the API 20E kit. The addition of reagents was performed for the TDA, IND, VP, and GLU tests, and a positive result was indicated when the color turned purple. After all procedures were completed, a nine-digit numerical profile was obtained.

The traditional markets surveyed in this study exhibited suboptimal hygiene conditions, which contribute significantly to the contamination of broiler meat with *Salmonella* sp. Observations revealed that chicken meat was often displayed on open tables without protection, increasing exposure to contaminants from the environment and handling practices. According to Rortana *et al.* (2021) *Salmonella sp* contamination was more common in humid areas and this aligns with the perspective of Nugroho (2005), who pointed out that dirty, humid, and odorous places can become breeding grounds for diseases caused by pathogenic bacteria. Thus, maintaining cleanliness in the selling areas is crucial. Figure 3 depicts the typical conditions of traditional markets in Banjarbaru, where chicken meat is displayed without adequate protection or cooling measures. The figure highlights key risk factors for contamination, such as dirty and humid surroundings, open displays, and lack of refrigeration storage. These unhygienic conditions create an environment conducive to bacterial growth, emphasizing the need for improved market infrastructure and handling practices.

Figure 3. Banjarbaru Traditional Market Condition

The placement of broiler meat for sale, without proper treatment or storage conditions, can lead to significant contamination and bacterial growth. For example, leaving the meat on sales tables exposes it to various sources of contamination, including cross-contamination from unhygienic equipment like chopping boards, knives, and other contact surfaces. Such conditions can amplify contamination, as these surfaces can harbor harmful bacteria that may transfer to the carcass (Nidaullah et al., 2017). Additionally, the evisceration process presents another risk for cross-contamination, as it involves handling fluids from the digestive tract of the chickens. During this process, bacteria from the intestines can spread to the carcass, further contaminating it and potentially transferring to other carcasses during subsequent washing procedures from the rinse water (Rivera-Perez et al., 2014; Yulistiani *et al.,* 2019). Therefore, improving sanitation is crucial to mitigate these risks. Practices such as providing clean water for all handling activities, frequently replacing washing water, ensuring proper disposal of waste, and maintaining the cleanliness of tools like knives and cutting boards are essential for reducing contamination (Aerita et al., 2014).

In addition to sanitation practices, proper storage and temperature control are vital for preventing the growth of harmful bacteria like *Salmonella sp*. Broiler meat's high water content (approximately 0.98-0.99), pH range of 5.7-6.7, and rich nutrient profile, including proteins, amino acids, and nitrogen compounds, create a favorable environment for bacterial growth. Prolonged storage without refrigeration decreases the pH, further promoting bacterial growth (Banerjee et al., 2019; Putri et al., 2022; Bhaisare et al., 2014). According to Trimoulinard et al. (2017), *Salmonella* spp. can survive at temperatures up to 60°C. Therefore, for food items like chicken, if not processed immediately, it is advisable to store them in the freezer. Afrianti et al. (2013) emphasized that the duration of storage plays a significant role in the decline of meat pH, with longer storage periods leading to progressively lower pH levels. Fresh chicken left without proper cooling promotes bacterial growth. *Salmonella* spp. thrives in temperatures between 20-45°C, with water activity (Aw) levels of 0.945-0.999, and is highly resistant to desiccation, allowing it to survive in dry environments with a low Aw of 0.200 (Trimoulinard et al., 2017). Temperature control is important to prevent the growth of *Salmonella sp.* bacteria. Food should be stored under appropriate conditions because incorrect temperatures can allow *Salmonella sp.* bacteria to proliferate. Therefore, refrigerated food products should be stored below 5°C, while heated or warm food products should be stored above 60°C.

Contamination can also occur in the early stages of the supply chain, particularly at the slaughterhouse. As noted by Vestby et al. (2009), *Salmonella sp.* contamination can arise at various points in the food supply chain, including transportation. Poor transportation conditions, such as inadequate refrigeration or improper handling during transit from the slaughterhouse to the market, can lead to microbial contamination (Wibisono et al., 2023). Muhaimi and Haifan (2019) recommended the use of specialized, enclosed, refrigerated transport to minimize the risk of external contamination.

Disease prevention in livestock can be achieved through good sanitation, transportation, providing a comfortable environment, vaccination programs, and biosecurity if practiced properly in the lengthy procedure of broiler meat process.

4. Conclusion

Based on the discussion, it can be concluded that chicken meat from several traditional markets in the city of Banjarbaru tested positive for *Salmonella sp.* bacteria, with a prevalence of approximately 32.14%. This result indicates that the quality of chicken meat sold in several traditional markets does

not meet the standards outlined in the Indonesian National Standard for chicken meat (SNI 67.120.20, 2009), as nearly one-third of the samples were found to be contaminated with *Salmonella sp.*

Suggestion

It is hoped that the government will provide a policy regarding strict supervision of food sold to ensure food safety for consumers. As well as providing policies regarding improving good and healthy market infrastructure to minimize the amount of microbial contamination in chicken meat so that its safety is guaranteed. Further research needs to be carried out regarding *Salmonella sp* bacterial contamination, but samples are taken from Chicken Slaughterhouses (RPA) and Chicken Slaughterhouses (TPA) in order to find out where the source of contamination comes from

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