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DETECTION OF *Salmonella* sp. IN PACKAGED SALMON SASHIMI FROM SEVERAL RETAIL OUTLETS IN BANDUNG CITY

Deteksi Bakteri *Salmonella* sp. Pada Sashimi Salmon Kemasan di Beberapa Lokasi Penjualan di Kota Bandung

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ABSTRACT

Sashimi is a Japanese culinary dish consisting of raw fish slices. This study aims to determine the potential contamination of Salmonella sp. bacteria and the freshness level of packaged salmon sashimi through chemical parameters such as TVB-N and pH, as well as organoleptic characteristics including meat appearance, aroma, and texture as observation parameters. Three samples of packaged salmon sashimi were obtained from three different sales locations in Bandung City. Salmonella sp. bacteria detection was performed using Salmonella Shigella Agar as the bacterial isolation medium. TVB-N was tested using SNI 2354-8-2009 as the testing reference, while pH was measured using a pH meter. Organoleptic characteristics were observed by scoring tests conducted by 20 semi-trained panelists using the SNI 2693:2014 score sheet, and the results were calculated using the scoring test formula in accordance with SNI 01-2346-2006. The results of the Salmonella sp. detection, TVB-N, and pH tests were analyzed descriptively and quantitatively. The results showed that no Salmonella sp. contamination was detected in the three packaged salmon sashimi samples. The pH values ranged from 6.45 to 6.47 and TVB-N from 3.33 to 6.58 mg/100g, with all three samples still in the fresh category. Organoleptically, sample B met the freshness quality standards for sashimi products.

Keywords: Fish Freshness, Food Safety, Salmonella sp., Sashimi

ABSTRAK

Sashimi merupakan kuliner khas Jepang berupa irisan ikan mentah. Penelitian ini bertujuan untuk mengetahui potensi cemaran bakteri *Salmonella* sp. dan tingkat kesegaran *sashimi* salmon kemasan melalui parameter kimia berupa TVB-N dan pH serta karakteristik organoleptik dengan kenampakan daging, aroma dan tekstur sebagai parameter pengamatan. Tiga sampel *sashimi* salmon kemasan diperoleh dari tiga lokasi penjualan berbeda di Kota Bandung. Deteksi bakteri *Salmonella* sp. dilakukan dengan menggunakan media *Salmonella Shigella Agar* sebagai media isolasi bakteri. TVB-N diuji dengan menggunakan SNI 2354-8-2009 sebagai acuan pengujian, sedangkan pH diukur dengan menggunakan pH meter. Karakteristik organoleptik diamati dengan uji skor oleh 20 panelis semi terlatih menggunakan *score sheet* SNI 2693:2014 yang kemudian hasilnya dihitung dengan rumus uji skor sesuai SNI

01-2346-2006. Hasil pengujian deteksi bakteri *Salmonella* sp., TVB-N dan pH dianalisis secara deskriptif kuantitatif. Hasil penelitian menunjukkan bahwa tidak terdeteksi adanya cemaran bakteri *Salmonella* sp. pada ketiga sampel *sashimi* salmon kemasan. nilai pH berkisar 6,45-6,47 dan TVB-N 3,33-6,58 mg/100g, ketiga sampel masih dalam kategori segar. Secara organoleptik, sampel 2 telah memenuhi standar mutu kesegaran untuk produk *sashimi.*
Kata Kunci: Keamanan Pangan, Kesegaran Ikan, *Salmonella* sp., *Sashimi*

INTRODUCTION

Sashimi is a Japanese culinary specialty consisting of fillets of sea fish, mollusks, crustaceans, fish eggs, or other seafood eaten raw (Amelia et al., 2018). Salmon is a common commodity used in making sashimi. Research by Golden et al. (2022) states that the percentage of fish commonly consumed raw is salmon at 42%, tuna at 37.1%, and cod at 11%. Raw salmon is widely preferred for its mami taste and soft, chewy texture. In addition, salmon is known to have quite complete nutritional content. According to research by Aryanta (2023), 100 g of raw salmon contains 20 g of protein, 6.4 g of fat, 30 mg of magnesium, 480-500 mg of potassium, 0.4 mg of zinc, 36.5 µg of selenium, and 25 µg of folate. Salmon is also enriched with amino acids, long-chain omega-3 fatty acids, vitamins A, B vitamins, vitamin D, iron, and calcium.

The high protein and fat content of raw salmon makes it susceptible to attack by microorganisms such as bacteria. *Salmonella* sp. is one of the bacteria that commonly contaminates raw salmon. *Salmonella* sp. can cause salmonellosis, a disease that affects the human digestive tract. In 2018, the World Health Organization (WHO) reported that 11-20 million cases of typhoid fever due to *Salmonella* sp. infection in humans worldwide occurred, with 128,000-161,000 deaths (Rizki et al., 2022). Salmonellosis is endemic in almost all major cities in Indonesia. Ilham et al. (2017) stated that the exact incidence of typhoid in Indonesia is unknown, with an estimated 900,000 cases and 20,000 deaths per year.

Salmonella sp. can infect humans through undercooked or raw foods such as sashimi. Sashimi is a fishery product that is susceptible to being a vector for foodborne disease, so two key aspects that must be considered are freshness and microbiological contamination. The freshness of sashimi significantly influences its texture, taste, and aroma, thus determining consumer acceptance. Freshness also plays a crucial role in food safety. Sashimi is generally served directly to buyers/consumers to maintain its freshness. Some places sell pre-made, packaged salmon sashimi, which is then stored in a refrigerated display case so consumers can immediately pick up the sashimi they desire. Packaged sashimi is generally packaged in disposable polystyrene (PS) boxes. Packaging for sashimi products can be both an attractive feature and a protective barrier against external environmental contamination. Research on the potential for *Salmonella* sp. contamination in salmon meat and fillets has previously been conducted by Imani (2018) and Haniya (2023). Based on the results of these two studies, it can be concluded that *Salmonella* sp. bacteria have been detected in salmon fillet samples sold in restaurants in Surabaya and malls in Bandung. So far, no research has discussed *Salmonella* sp. bacterial contamination. and freshness level of packaged salmon sashimi sold in Bandung. There are three locations selling packaged sashimi in Bandung. These three locations are malls located in Bandung. The results of Haniya's (2023) study, which found positive Salmonella in salmon fillets sold at a Japanese restaurant in a Bandung mall, make research on *Salmonella* sp. contamination in packaged salmon sashimi important.

METHODS

The study was conducted in June 2025. Samples were taken from three locations selling packaged salmon sashimi in Bandung. Testing for *Salmonella* sp., Total Volatile Base (TVB), and pH were conducted at the Testing Services Laboratory, Faculty of Agricultural Industrial Technology, Padjadjaran University, while organoleptic characteristics were observed at the

Fisheries Product Processing Laboratory, Faculty of Fisheries and Marine Sciences, Padjadjaran University.

The tools used included knives, measuring cylinders, analytical balances, an autoclave, laminar air flow, a hotplate stirrer, a petri dish, an ose needle, an incubator, a water bath, a coolbox, coarse filter paper, a steam distillation apparatus, a mortar, a pH meter, and an SNI 2693:2014 score sheet. The ingredients used were salmon sashimi, distilled water, Salmonella Shigella Agar (SSA), ice cubes, 6% perchloric acid, 20% NaOH, 3% H_3BO, anti-foaming silicone, Tashiro indicator, blank solution, 0.02N HCl, buffer solutions 4 and 7.

The parameters observed in this study were *Salmonella* sp. bacteria detection results, Total Volatile Base (TVB) pH test results, and organoleptic characteristics. The *Salmonella* sp. bacteria detection test procedure was carried out using SSA as a selective medium and was repeated twice for each sample. The TVB-N test was conducted using SNI-2354-8-2009 as a working reference, while pH was measured using a pH meter. Organoleptic characteristics were assessed by 20 semi-trained panelists using SNI 01-2346-2006 as a working reference and calculation formula, while the score sheet was obtained from SNI 2693:2014.

The results of *Salmonella* sp. bacteria detection tests, TVB-N values, and pH were analyzed quantitatively. Organoleptic results were calculated using the calculation formula according to SNI 01-2346-2006. Data obtained from the score sheet were tabulated and the quality value was determined by finding the average result for each panelist at a 95% confidence level. The formula for calculating the average quality value interval for each panelist is as follows:

$$p\left(\bar{x} - (1{,}96.\, s/\sqrt{n})\right) \leq \mu \leq (\bar{x} + 1{,}96.\, s/\sqrt{n})) \cong 95\%$$

$$\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n}$$

$$S^2 = \frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n}$$

$$s = \sqrt{\frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n}}$$

Where:

n = Number of panelists
S^2 = Diversity of quality values
1.96 = Standard deviation coefficient level 95%
$\bar{x}$ = Average quality value
x_i = Quality score from panelist i, where i = 1, 2, 3,.....n
s = Standard deviation of quality values

RESULTS

Detection of *Salmonella* sp. Bacteria

Salmonella Shigella Agar (SSA) serves as both a growth medium and a selective medium for *Salmonella* sp. bacteria. Each sample was tested twice to obtain accurate results. The results of the isolation and identification of Salmonella sp. bacteria in packaged salmon sashimi samples in Bandung City are presented in Table 1.

Table 1. Results of *Salmonella* sp. Bacteria Detection in Packaged Salmon Sashimi

Sample	Identification Results	Quality Limits
A1	Negative	Negative /25 g*
A2	Negative	
B1	Negative	

Sample	Identification Results	Quality Limits
B2	Negative	
C1	Negative	
C2	Negative	

Note: *SNI 2693:2014

Based on the test results, all three packaged salmon sashimi samples tested negative for *Salmonella* sp.

Total Volatile Base Nitrogen (TVB-N)

Total Volatile Base Nitrogen (TVB-N) was tested using SNI 2354-8-2009 as the test reference. The TVB-N test results are shown in Table 2.

Table 2. TVB-N Test Results for Packaged Salmon Sashimi

Sample	TVB-N value mg/100 g
A	6.58
B	3.33
C	3.34

The TVB-N test results showed that Sample A had a TVB-N value of 6.58 mg/100 g, Sample B had a value of 3.33 mg/100 g, and Sample C had a value of 3.33 mg/100 g.

Acidity (pH)

The pH test was conducted using a pH meter. The results of the pH test on packaged salmon sashimi samples in Bandung City are shown in Table 3.

Table 3. Acidity (pH) Test Results for Packaged Salmon Sashimi

Sample	pH value
A	6.45
B	6.46
C	6.47

The pH test results showed that Sample A had a pH of 6.45, Sample B had a pH of 6.46, and Sample C had a pH of 6.47.

Organoleptic Characteristics

Meat Appearance

Appearance parameters were assessed by observing the color and white streaks or patterns on the salmon sashimi. The results of the salmon sashimi meat appearance assessment are presented in Table 4.

Table 4. Average Results of Packaged Salmon Sashimi Meat Appearance

Sample	Average	Median
A	6.30	6
B	8.60	9
C	6.95	7

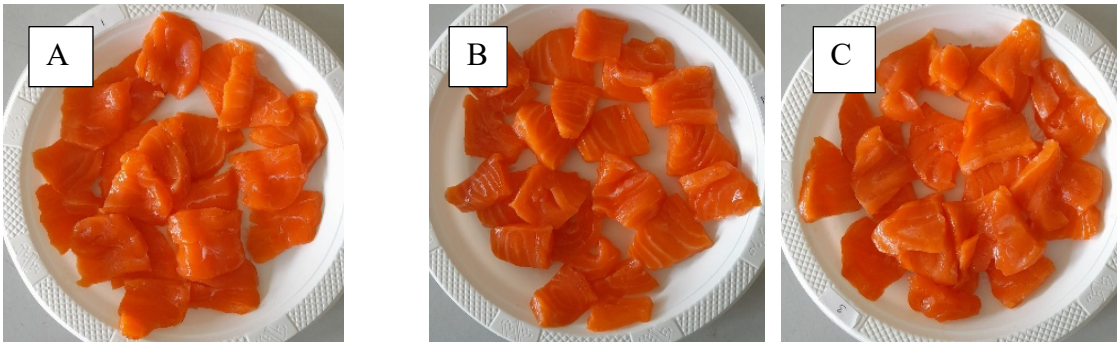

Figure 1. Appearance of Packaged Salmon Sashimi Meat

Aroma

Aroma parameters were assessed by sniffing the sashimi in turn. The results of the aroma parameter assessment for each packaged salmon sashimi sample are shown in Table 5.

Table 5. Average Aroma Values for Packaged Salmon Sashimi

Sample	Average	Median
A	6.65	7
B	7.85	8
C	6.90	7

Texture

The texture parameters of packaged salmon sashimi samples were assessed by pressing the sashimi, observing fingerprints on the sample, and then pressing the sample again to determine its firmness. The results of the texture parameter assessment are shown in Table 6.

Table 6. Average Texture Values of Packaged Salmon Sashimi

Sample	Average	Median
A	4.90	5
B	8.10	8
C	5.70	6

Freshness Level Calculations Using SNI 01-2346-2006

The freshness level of packaged salmon sashimi can be determined using a scoring test. This scoring test, also known as a score test, is conducted by assigning a numerical value or assigning a sensory quality score to the quality being tested (Hidayati et al. 2022). The results of each panelist's observations are then averaged. The obtained average is then entered into the calculation formula in SNI 01-2346-2006 concerning sensory assessment of frozen fish to determine the final quality score for each sample. The quality scores are then compared with the standards set in SNI 2693:2014 to determine the freshness and suitability of the sashimi. The final result of the scoring test calculation stipulated in SNI 01-2346-2006 is the rounded-off value for each packaged salmon sashimi sample. The results of the scoring test for the packaged salmon sashimi samples are shown in Table 7.

Table 7. Final Results of the Freshness Level of Packaged Salmon Sashimi

Parameter	Sample		
	A	B	C
Meat Appearance	6.30	8.60	6.95
Aroma	6.65	7.85	6.90

Parameter	Sample		
	A	B	C
Texture	4.90	8.10	5.70
Mean Value Interval	$5.15 \leq \mu \leq 6.08$	$7.96 \leq \mu \leq 8.43$	$6.19 \leq \mu \leq 6.84$
Smallest Value Interval	5	8	6

DISCUSSION

Detection of *Salmonella* sp. Bacteria

Table 1. Shows the results of Salmonella sp. bacteria detection in packaged salmon sashimi using Salmonella Shigella Agar (SSA). The results showed that all three packaged salmon sashimi samples from several sales locations in Bandung were negative for *Salmonella* sp. The negative results in this study demonstrate that the salmon used as the raw material, as well as the equipment and facilities used for handling and packaging, are free from *Salmonella* sp. bacteria contamination. Kowalska (2023) stated that the source of pathogenic microorganisms, including Salmonella bacteria, in the environment is wastewater discharged into water bodies. Generally, waters susceptible to Salmonella bacteria contamination are those close to the initial source of contamination, such as farms near rivers. *Salmonella* sp. bacteria live and reproduce in the digestive tract of animals and are then excreted through feces (Widianingsih & Dewi, 2017). This feces can be carried into water bodies and contaminate the aquatic biota. Salmon obtained from waters far from livestock farming activities or waste disposal is potentially free of *Salmonella* sp.

Potential *Salmonella* sp. bacteria contamination. The contamination of packaged salmon sashimi is not limited to the living environment of the salmon used as raw material. The potential for Salmonella bacterial contamination can occur if post-harvest handling, distribution, and sashimi-making processes are not carried out hygienically, thus allowing cross-contamination. Negative results in the salmon sashimi samples in this study indicate that the entire production chain is carried out properly and hygienically. The use of freezing methods in the post-harvest process can inhibit the growth of *Salmonella* sp. Fish to be used for sashimi production must be frozen at -20°C for 7 days or -35°C for 15 hours in a blast freezer (Novo Scotia Department of Environment, 2018). Research by Kumar et al. (2015) explained that using a temperature of -20°C can reduce cell count and cause Salmonella bacteria to become non-viable on the 5th day of incubation.

Total Volatile Base Nitrogen (TVB-N)

The TVB-N values obtained in this study were 6.58 mg/100 g (A), 3.33 mg/100 g (B), and 3.34 mg/100 g (C). Based on these values, all three samples were categorized as very fresh fish. Fadhli et al. (2022) stated that fish with TVB-N values below 10 mg/100 g are categorized as very fresh fish, while TVB-N values >30 mg/100 g are categorized as spoiled fish and no longer suitable for consumption. These results may indicate that the sashimi samples used have a short shelf life. TVB-N values will increase with increasing storage time. The increase in TVB-N values in fish during storage is due to protein degradation by spoilage microorganisms that produce volatile bases such as trimethylamine (TMA), ammonia, and H_2S (Nareswari et al., 2022). The TVB-N test results in this study indicated that the packaged salmon sashimi samples used contained low levels of volatile nitrogen-containing base compounds.

Temperature during handling and storage also significantly influences TVB-N values. Low temperatures can reduce microbial activity because they suppress metabolic rates and inhibit bacterial growth (Budiman et al., 2016). The packaged salmon sashimi samples in this study had TVB-N values that were not significantly different and remained at the same freshness level, namely the very fresh category. This may occur due to the similar storage

temperatures for both raw materials and packaged salmon sashimi products in the chiller display case. Packaged salmon sashimi is generally stored at temperatures below 5°C.

Acidity (pH)

The pH values obtained were 6.45 (A), 6.46 (B), and 6.47 (C). The pH values of the three samples indicate that the packaged salmon sashimi samples in this study were classified as fresh. Fish that are no longer fresh generally have a pH that tends to be alkaline, at >7 (Untari et al., 2023). Liviawaty and Afrianto (2014) stated that the pH value immediately after fish die is close to neutral, at around 6.8. Glycogen breakdown occurs, producing lactic acid, increasing acidity and lowering the flesh's pH. Fish with a pH above or above neutral pH are susceptible to spoilage due to low glycogen reserves in the flesh (Anggraini, 2018).

Storage time and temperature can affect the pH value of fresh fish. An increase in pH can occur with increasing storage time due to the increase in the number of spoilage microorganisms. Using low temperatures during storage can inhibit the activity of spoilage microorganisms. Research by Camacho et al. (2021) showed that the pH of tilapia stored at 0°C and 5°C decreased until the fifth day of storage and then increased thereafter. This temperature is the same as the temperature used in the chiller display case for packaged salmon sashimi.

Organoleptic Characteristics

Meat Appearance

The sample with the highest score in the meat appearance assessment of packaged salmon sashimi was sample B, with an average score of 8.60 and a median of 9. Based on score sheet 2693:2014, a score of 9 indicates a very bright cut, species-specific color, and very strong meat tissue. Each sashimi piece appeared firm and the meat color was uniform, bright orange with clearly visible white streaks or lines. Sample C had an average score of 6.95 with a median of 7. Sample C was a salmon sashimi sample with good appearance. The condition of sample C, as described in score sheet 2693:2014, had a slightly less bright cut with species-specific color and strong meat tissue. The sample with the lowest score was sample A, with an average of 6.30 and a median of 6. Salmon sashimi sample A had a fairly good flesh appearance. The flesh appearance of the sample was described as less vibrant, the color somewhat specific to the species, and the flesh tissue slightly firm.

Fresh salmon has bright orange to reddish flesh with white stripes. The white stripes in salmon flesh are called myosepta. Myosepta are connective tissue that appear as white lines and separate the salmon muscle. Guo et al. (2025) stated that myosepta are the primary intramuscular fat storage sites in salmon. High fat content in fish is a major factor that can cause fat oxidation (Herc et al. 2023). Fat oxidation will reduce fish quality and affect the structure, color, and other sensory characteristics of fish flesh (Bobko et al. 2015).

Aroma

Sample B was the salmon sashimi sample with the highest score, with an average of 7.85 and a median of 8. This score indicates that sample B had a fresh aroma and a strong species-specific aroma. Samples A and C had final scores that were not significantly different, with averages of 6.65 and 6.90, respectively, with the same median of 7. Samples A and C were considered fresh aromas, but the species-specific aromas were less pronounced. All three samples' aromas were considered good and fresh, with no foul or rancid odor typical of spoiled fish. Jeong et al. (2023) explained that based on the volatile compounds produced by salmon, the specific aromas of salmon can be described using a chemometric approach as fishy, salty, savory, sweet, sour, oily, and slightly nutty and grassy.

Sample B had the best aroma compared to samples A and C. This can occur if the sashimi used in sample B is consistently stable at low temperatures throughout distribution, storage, and processing. Low temperatures (below 5°C) can inhibit the spoilage process caused by fatty acid oxidation, which can cause fish to develop a rancid odor. Storage time also affects the aroma of fresh fish products. Research conducted by Pennisi et al. (2022) found that the aroma of raw anglerfish decreased to neutral or less noticeable on days 2 to 3 of storage, and after day 5, the aroma had changed to fishy at a storage temperature of 2°C.

Texture

The results of the texture parameter assessment, shown in Table 6, indicate that sample B was the salmon sashimi sample with the highest score, with an average of 8.10 and a median of 8. This value indicates that the BIP sample has a dense, compact, and elastic texture. Sample C received an average score of 5.70 with a median of 6, indicating that sample C had a slightly soft and slightly less elastic texture. Sample A had the lowest score, with an average score of 4.90 and a median of 5. Sample A had a slightly soft and less elastic texture.

The texture of fresh salmon sashimi is soft and dense. Storage time and temperature play a crucial role in maintaining the soft and firm texture of salmon sashimi. Significant differences in values between samples may indicate temperature fluctuations during storage. Frequent temperature fluctuations from frozen (below 0°C) to thawed (above 0°C) can cause changes in the meat tissue due to repeated freezing and thawing of ice crystals. This temperature fluctuation is common when sashimi is frequently refrigerated and removed. Szymczak et al. (2020) stated that temperature fluctuations can alter muscle tissue structure and increase the concentration of protein hydrolysis.

Organoleptic Freshness Level with SNI 01-2346-2006 Calculation

Based on calculations, the three samples had varying quality levels. The final score for sashimi sample A was 5, sashimi sample B was 8, and sashimi sample C was 6. The packaged salmon sashimi sample that met the requirements for consumption according to the standards stipulated in SNI 2693:2014 was sample B, with a final score of 8. One of the requirements for sashimi product quality and safety, according to SNI 2693:2014, is a minimum score of 8 for organoleptic parameters.

The significant differences in scores between samples may indicate differences in the production chain conditions of each sashimi. Handling immediately after harvesting salmon can affect its organoleptic properties. Hansen et al. (2012) explained that improper and stressful handling of salmon harvests can increase stress in salmon, which can then result in a more rapid decline in fresh flavor and aroma compared to more careful harvesting. Zhang et al. (2023) also added that stress in live fish before harvest generally leads to decreased muscle quality, such as fat oxidation, muscle fiber disruption, softening of texture, and lower sensory quality.

CONCLUSION

Three packaged salmon sashimi samples from several retail locations in Bandung City did not detect *Salmonella* sp. The TVB-N and pH values for the three samples indicated that the packaged salmon sashimi samples were still considered fresh. Meanwhile, based on the organoleptic characteristic score calculation, sample B met the minimum organoleptic standards for sashimi according to SNI 2693:2014 with a final score of 8.

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