Microbial Challenges and Chemical Quality of Traditional Shrimp Paste: A Case Study in West Nusa Tenggara

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Abstract. Shrimp paste, locally known as *terasi* or *belacan*, is an essential condiment in the traditional cuisine of West Nusa Tenggara (NTB), Indonesia; however, its quality varies considerably due to the absence of standardized production processes. This study aimed to evaluate the chemical composition and microbial contamination of shrimp paste produced in Lombok and Sumbawa using an experimental approach based on a randomized block design. Shrimp paste samples, approximately 10 days old, were collected from eight producers (A–H) across both islands. The analyzed parameters included chemical properties (ash, protein, carbohydrate, and salt contents) and microbial characteristics (total microbial count, lactic acid bacteria, molds, and pathogenic bacteria). The results revealed that most samples met the Indonesian National Standard (SNI) requirements for protein and salt contents but exceeded the permissible limits for ash, molds, and pathogenic bacteria such as *Escherichia coli*, *Salmonella Typhi*, *Vibrio cholerae*, and *Staphylococcus aureus*. Producers with poor sanitation and low salt concentrations (<15%) exhibited higher microbial loads, whereas those implementing better hygiene and processing practices produced higher-quality products. These findings highlight that improved sanitation, adequate salt concentration, and stricter regulatory supervision are essential to ensure the safety and quality of shrimp paste produced by Micro Small Medium Enterprises (MSMe) in West Nusa Tenggara.

Keywords: Chemical analysis, culinary, microbial contamination, MSMe, shrimp paste.

1 Introduction

Shrimp paste is a food seasoning made from processed fishery products using fresh or dried *rebon* shrimp as raw materials, with the addition of salt, through fermentation and drying processes. Shrimp paste is characterized by its reddish-brown color and distinc-

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tive umami flavor [1]. Interestingly, in other countries, shrimp paste is known by different names, such as Nappi in Bangladesh, Kapi in Thailand and Cambodia, Belacan in Brunei and Malaysia, and Mamruoc or Mamtom in Vietnam [2]. According to [3], shrimp paste is a type of food flavoring material with a solid, distinctive MSMe, fermented shrimp with salt, with or without other permitted additives. In addition, shrimp paste is a processed fish product or rebon shrimp or fresh shrimp or a mixture of dry ingredients through salting, crushing refining, and fermentation processes with a time range of 2 days to 2 months [4].

Shrimp paste can be produced through fermentation with or without the addition of salt and is classified into two types based on the raw materials used such as shrimp paste and fish paste. The color of shrimp paste varies depending on the raw material and the natural microbes involved during fermentation. Shrimp-based paste typically has a red hue, while fish-based paste tends to be dull gray. Consumers generally prefer the vibrant appearance of shrimp-based paste over fish-based paste, which has prompted the use of coloring agents during processing in some cases [5]. The processing of shrimp paste is generally categorized into fermentation and non-fermentation methods. The choice of processing method plays a crucial role in determining the quality of shrimp paste, particularly its microbial characteristics. Improper fermentation practices and poor sanitation can result in microbial contamination, affecting the safety and quality of the product [1].

West Nusa Tenggara Province, Indonesia, comprising Lombok and Sumbawa islands, is a well-known tourist destination that relies heavily on local resources, including shrimp paste, to enhance its culinary offerings [6]. In NTB, several community groups produce shrimp paste without undergoing a fermentation process. The production involves mixing *rebon* shrimp with salt, crushing, molding, and heating, typically using ovens with uncontrolled temperatures. This method results in shrimp paste products with varying quality depending on the specific processing techniques employed [6].

Shrimp paste generally contains several nutrients and pigments, including carotenoids (0.54–1.97 mg/g sample), which contribute to its characteristic color and nutritional value [2], [7], [8]. Additionally, many volatile compounds are present, especially in paste produced in Central Java. The fermentation process plays a significant role in producing these volatile components, which enhance the taste and aroma of shrimp paste, thereby influencing its use in culinary applications [8].

To ensure the safety and quality of shrimp paste, specific microbial standards have been established. These include a maximum limit of <3 MPN/g for *Escherichia coli*, negative detection for *Salmonella typhi*, a maximum of 1×10^1 CFU/g for *Staphylococcus aureus,* and negative detection for *Vibrio cholerae* (SNI, 2009). Furthermore, the use of hazardous chemicals such as formalin, borax, and rhodamine is strictly prohibited in shrimp paste production [9]. Common microbial challenges include the presence of pathogenic bacteria such as *E. coli, Salmonella, and Vibrio cholerae*, which can pose significant health risks including gastrointestinal damage, vomiting, diarrhea, high fever, and severe dehydration [10]. Additionally, the use of hazardous chemicals in shrimp paste, such as formalin to extend shelf life, persists due to their affordability, accessibility, and weak government enforcement [9], [11].

In West Nusa Tenggara (NTB), shrimp paste (terasi) is an essential ingredient in many traditional dishes, such as *pelecing, beberok, ayam taliwang,* and *ayam rarang*. Its production is primarily managed by micro, small, and medium enterprises (MSMe) located along the coasts of East Lombok, West Lombok, and other regions, including Sumbawa (Empang, Sumbawa Besar), with diverse methods, including non-fermentation processes using uncontrolled temperature ovens. According to [12]–[14] the quality of shrimp paste produced by each producer can be different, and many shrimp paste products from MSMe have not met the Indonesian National Standard (SNI), especially on microbial and chemical parameters. Therefore, a study was conducted to evaluate the chemical and microbial quality of shrimp paste produced by different MSMe on the islands of Lombok and Sumbawa. The research also aimed to investigate potential contamination by pathogenic microbes and hazardous chemicals in these products to ensure consumer safety.

2 Materials and Methods

2.1 Sample Preparation

This study employed a non-probability sampling technique based on the availability and ease of obtaining samples [11]. Shrimp paste samples were collected from various producers located on Lombok and Sumbawa Islands. Three samples were obtained from shrimp paste producers in Jerowaru, East Lombok (Producers A, B, and C). One sample was collected from a producer in Pringgabaya, East Lombok (Producer D). Two samples were collected from producers in the West Lombok area (Producers E and F). Additionally, two samples were obtained from shrimp paste producers on Sumbawa Island (Producers G and H). The appearance of shrimp paste samples from each producer, showing differences in color, texture, and packaging, is illustrated in **Fig. 1**.

Producer A Producer B Producer C

Producer E Producer F Producer D

Fig. 1. Shrimp paste produced by various producers in West Nusa Tenggara, Indonesia

The materials used in this study included distilled water (aquadest), phosphate buffer, Potato Dextrose Agar (PDA), Plate Count Agar (PCA), and de Man, Rogosa, and Sharpe Agar (MRSA). The analyzed shrimp paste samples were approximately 10 days old from the date of production.

2.2 Chemical Parameters

The proximate composition was determined according to the method described by [3]. Carbohydrate content was calculated using the total carbohydrate by difference method. In addition, the salt content was determined following the procedure described by [15].

2.3 Microbial Parameters

The total microbial count, lactic acid bacteria (LAB), and mold counts were determined using the plate count method as described by [3]. Appropriate selective media were used for the enumeration of LAB and molds.

2.4 Pathogenic Bacterial Parameters

Pathogenic bacterial analysis was conducted to detect and quantify the presence of key pathogens in shrimp paste samples. The parameters included *Coliforms*, *Escherichia coli*, *Salmonella Typhi*, *Vibrio cholerae*, and *Staphylococcus aureus*. Detection and quantification were performed using standard microbial methods, including the Most Probable Number (MPN) method for *Coliforms* and *E. coli*, and selective media for *S. Typhi*, *S. aureus*, and *V. cholerae*. All tests were conducted in accordance with the Indonesian National Standards (SNI) to ensure accuracy and compliance with food safety requirements.

2.5 Statistical Analysis

All treatments were performed in triplicate, resulting in a total of 24 experimental units. Data were analyzed using analysis of variance (ANOVA) at a 95% confidence level with Co-Stat software. When significant differences were observed, means were further compared using Tukey's Honest Significant Difference (HSD) test.

3 Results and Discussions

3.1 Chemical Quality

The results of the proximate composition analysis, including ash, protein, carbohydrate, and salt contents of shrimp paste produced by MSMe in West Nusa Tenggara, are presented in **Table 1**.

Table 1. Results of the 5% Tukey HSD Test on Ash, Protein, Carbohydrate and Salt Levels of Shrimp Production of MSMEs in NTB

Shrimp Paste Producers	Ash content (%)	Protein Content (%)	Carbohydrate Content (%)	Salt Content (%)
Producer A	21.27±4.32^{bc}	35, 21±0, 18^{e}	1.78±0.11^{cd}	16.55±0.33^{b}
Producer B	27.32±4.28^{ab}	39.91±0.35^{d}	2.12±0.15^{bc}	19.48±0.74^{a}
Producer C	24.29±0.34^{abc}	35.05±0.27^{e}	2.67±0.1^{b}	13.73±0.28^{c}
Producer D	20.4 ± 1.94^{bc}	47.38±0.21^{b}	1.35 ±0.27^{cd}	11.31±0.17^{e}
Producer E	21.30 ± 7.64^{bc}	42.85±0.62^{c}	1.93±0.55^{bcd}	8.69±0.57^{f}
Producer F	35.21±0.1 ^{a}	49.55±0.27^{a}	3.75±0.19^{a}	11.24±0.11^{e}
Producer G	13.31± 0.6 ^{c}	39.50±0.35^{d}	1.27±0.2^{d}	12.10±0.38^{de}
Producer H	21.98±2.86^{abc}	33.41±0.46^{f}	1.19±0.17^{d}	13.36±0.29^{cd}
Tukey HSD 5%	13.29	1.17	0.83	1, 44

Description: - Data is the mean of 3 replications ± standard deviation
The numbers followed by the same letters in the same column show no significant difference at the 5% level of significance

Ash Content. The ash content showed an inverse relationship with the moisture content, indicating that higher water levels corresponded to lower concentrations of ash and other dissolved solids such as proteins, carbohydrates, and salts. According to the Indonesian National Standard (SNI 2716:2016), the maximum permissible ash content in shrimp paste is 1.5%. However, all shrimp paste samples produced by MSMe in West Nusa Tenggara exceeded this limit (Table 1).

The ash contents observed in this study were comparable to those reported by [16], who found values ranging from 19.84% to 23.79% in *rebon* shrimp paste sold in the Kendari City market. Differences in ash content among samples are influenced by several factors, including the type and quality of raw materials, the washing process, and the drying conditions (time and temperature) applied during processing [5].

Protein Content. The protein content of shrimp paste produced by all MSME producers in West Nusa Tenggara ranged from 33.41% to 49.55% (Table 1). These values were considerably higher than the minimum requirement specified in the Indonesian National Standard (SNI 2716:2016), which is 15%. Similar findings were reported by [7], who observed that shrimp paste products from various markets in Thailand contained protein levels ranging from 29.45% to 53.17% (dry weight basis).

These results indicate that shrimp paste is a rich source of dietary protein. The relatively high protein content in the samples analyzed was attributed to the use of *rebon* shrimp (*Acetes* spp.) as the sole raw material by producers in West Nusa Tenggara. *Rebon* shrimp contains approximately 59.4% protein on a dry weight basis, which contributes significantly to the overall protein content of the final product.

Carbohydrate Content. According to the Indonesian National Standard (SNI 01-2716.1-2009), the carbohydrate content in shrimp paste should be less than 2%. Almost all shrimp paste products produced by MSMe in West Nusa Tenggara met this requirement, except for those from Producers C and F (Table 1). The higher carbohydrate content observed in the product from Producer F was attributed to the addition of sugar during processing. Since sugar is a carbohydrate source, its inclusion increases the total carbohydrate level in the final product. Similarly, elevated carbohydrate levels have also been reported in fermented shrimp paste products from Thailand, ranging from 4.27% to 17.96% [17] and from 4.58% to 24.70% [18].

Salt Content. According to the Indonesian National Standard (SNI 2716:2016), the salt content of shrimp paste should range between 12% and 20%. Based on this criterion, shrimp paste samples produced by Producers A, B, C, G, and H met the standard requirements. In contrast, the products from Producers D, E, and F contained salt concentrations below the SNI threshold (Table 1). However, when referring to the previous standard (SNI 01-2716.1-2009), the permissible maximum salt content was 10%. Under this version, nearly all shrimp paste products produced by MSMe in West Nusa Tenggara except for the product from Producer E exceeded the allowed limit.

The variation in salt content among producers is primarily influenced by the amount of salt added during processing. MSMe in West Nusa Tenggara typically add salt to enhance preservation and flavor during shrimp paste fermentation. This finding aligns with the results reported by [11], who observed that the salt content in *rebon* shrimp paste increased by approximately 8%–14% following salt addition. Salt plays a crucial role in fermented fish products, as it inhibits the growth of pathogenic microorganisms while promoting the proliferation of lactic acid bacteria (LAB) essential for the fermentation process. This observation is consistent with [19], who stated that salt exhibits antibacterial properties against pathogenic bacteria while stimulating LAB growth.

3.2 Microbial Quality

The results of microbial analysis, including the total microbial count, lactic acid bacteria (LAB), and mold counts of shrimp paste produced by MSMe in West Nusa Tenggara, are presented in **Table 2**. These data illustrate the variability in microbial populations among producers, reflecting differences in processing hygiene, fermentation conditions, and raw material handling.

Table 2. Microbial Quality of Shrimp Paste Produced by MSMe in West Nusa Tenggara

Shrimp Paste Producers	Microbial Quality		
	Total Microbes (CFU/g)	Total LAB (CFU/g)	Total Mold (CFU/g)
Producer A	2.4×10^9	3.5×10^9	1.3×10^4
Producer B	6.1×10^7	$<1.0 \times 10^6$	$<1.0 \times 10^1$
Producer C	$<1.0 \times 10^7$	$<1.0 \times 10^6$	8.1×10^3
Producer D	$<1.0 \times 10^6$	$<1.0 \times 10^6$	$<1.0 \times 10^2$
Producer E	2.7×10^8	3.8×10^9	1.0×10^5
Producer F	2.4×10^9	2.3×10^9	2.0×10^4
Producer G	7.7×10^7	3.2×10^7	$>1.0 \times 10^3$
Producer H	$<1.0 \times 10^6$	$<1.0 \times 10^6$	2.2×10^4

Total Microbes. According to the Indonesian National Standard (SNI 7388:2009) concerning the maximum limit of microbial contamination in dried or fermented fish and fishery products, with or without added salt, the permissible limit for total microbial count is 1×10^5 CFU/g [20]. Based on this standard, all shrimp paste products produced by MSMe in West Nusa Tenggara exceeded the allowable microbial limit (Table 2). The highest total microbial counts were recorded in the products from Producers A and F, reaching 2.4×10^9 CFU/g, while the lowest counts were found in the products from Producers D and H, with values of $<1.0 \times 10^6$ CFU/g.

The total microbial counts in shrimp paste from West Nusa Tenggara were also higher than those reported for similar products from other regions. For instance, shrimp paste from Kendari City contained 1.75×10^4 to 2.96×10^4 CFU/g [16], shrimp paste from Sungsang, South Sumatra Province contained 10^4 to 10^5 CFU/g [21], and traditional Thai shrimp paste contained 1.3×10^3 to 2.9×10^5 CFU/g [22]. The microbial population in shrimp paste typically consists of lactic acid bacteria, halophilic bacteria, and molds, which play important roles in the fermentation process.

The relatively high microbial counts in some NTB shrimp paste samples may be attributed to higher water content, particularly in Producer A's product, which contained 37.55% moisture. Water availability promotes microbial growth since water activity is one of the key factors determining microbial proliferation in food products [21].

The total microbial counts in most shrimp paste samples (five producers) were relatively high, which was consistent with the elevated numbers of lactic acid bacteria (LAB). The lowest total microbial count was observed in the shrimp paste produced by Producer D. The low microbial level in this sample was likely due to the heating process, in which the product was oven-dried at 260 °C for one hour. Such a high-temperature treatment can significantly reduce microbial populations. Previous studies have shown that microbial counts decrease with increasing heating duration and temperature above 100 °C [6]. This finding is further supported by [23], who reported that exposure to temperatures exceeding 121 °C for a certain period causes a marked reduction in total microbial load. Heat treatment not only lowers the moisture content of the material but also inhibits microbial growth, thereby reducing the total number of microorganisms in the final product [24].

Total Lactic Acid Bacteria. As shown in Table 2, the highest total lactic acid bacteria (LAB) count was observed in the shrimp paste produced by Producer E (*rebon* shrimp paste), reaching 3.8×10^9 CFU/g. The lowest LAB counts ($<1.0 \times 10^6$ CFU/g) were recorded in the shrimp paste produced by Producers B, C, D, and H. The high LAB population in Producer E's product was likely related to the addition of approximately 25% salt, which can stimulate LAB growth during fermentation.

This observation is consistent with the findings of [25], who reported that the total LAB count in salted chili paste initially decreases during fermentation but subsequently increases with higher salt concentrations. Similarly, [26] explained that the addition of salt can promote the growth of lactic acid bacteria in fermented products. The LAB counts in shrimp paste produced by MSMe in West Nusa Tenggara were substantially higher than those reported in Thailand, where total LAB counts were below 10^3 CFU/g [7]. According to [27], 16S rRNA gene analysis of lactic acid bacteria isolated from local shrimp paste (*Mysis relicta*) identified two isolates belonging to *Enterococcus faecalis* and one isolate identified as *Weissella cibaria*, both of which are commonly associated with fermentation and acid production in salted seafood products.

Total Mold. As shown in Table 2, shrimp paste products produced by all MSMe contained varying levels of molds. The highest total mold count was observed in the shrimp paste from Producer E (*rebon* shrimp paste), reaching 1.0×10^5 CFU/g. This high mold count was likely associated with the elevated moisture content (35.58%) of the product. A high-water content provides favorable conditions for fungal growth during storage [28]. In addition to its high moisture level, the absence of a heating or oven-drying process in the production of *rebon* shrimp paste by Producer E may have further contributed to the proliferation of molds.

The lowest mold counts were observed in the shrimp paste produced by Producers B and D. This reduction in mold load is likely attributed to the heating conditions applied during processing. Producer B's shrimp paste was oven-dried for 2 hours at 150 °C, while Producer D's product was heated for 1 hour at 260 °C. Oven treatment at elevated temperatures can significantly reduce microbial populations, including molds [6]. Similarly, heating at 80 °C for 21.6 minutes has been reported to effectively reduce fungal contamination in shrimp paste [29]. Most molds are not heat-resistant; therefore, their presence in food products is often associated with inadequate thermal processing or recontamination after heating [29]. Based on the Indonesian National Standard (SNI 7388:2009), the shrimp paste from Producers B and D met the maximum allowable mold limit of 2×10^2 CFU/g [20].

3.3 Pathogenic Bacteria

The results of pathogenic bacterial analysis in shrimp paste samples produced by MSMe in West Nusa Tenggara are summarized in **Table 3**. The analysis included the detection of *Coliforms*, *Escherichia coli*, *Salmonella* Typhi, *Vibrio cholerae*, and *Staphylococcus aureus* to evaluate the microbial safety of the products.

Table 3. Pathogenic Bacteria Detected in Shrimp Paste from MSMe in West Nusa Tenggara

Shrimp Paste Producers	Pathogenic bacteria				
	Coliform (APM/g)	*Escherichia coli*	*Salmonella Thypi*	*Vibrio cholera*	*Staphylococcus aureus*
Producer A	29	29	+	+	+
Producer B	43	43	+	+	+
Producer C	<3	<3	+	-	-
Producer D	460	460	+	+	+
Producer E	<3	<3	+	+	-
Producer F	<3	<3	-	+	+
Producer G	>1100	>1100	+	+	+
Producer H	9.2	9.2	+	-	+

"+" indicates the presence of pathogenic bacteria, and "–" indicates the absence.

Coliform. As shown in Table 3, the highest *Coliform* count (>1,100 MPN/g) was found in the shrimp paste produced by Producer G. This contamination is likely due to the use of dug well water located only 8–9 meters away from the septic tank, which is closer than the minimum safe distance of 11 meters recommended by [30]. Well water contaminated with domestic wastewater is a major source of *Coliform* bacteria.

In addition, the salt content of shrimp paste also influences *Coliform* levels. The salt content in Producer G's shrimp paste was 12.11%, which is below the optimal 15% recommended for maintaining good microbial quality. Insufficient salt concentration, which does not meet the Indonesian National Standard (SNI), may contribute to the elevated *Coliform* count observed in this product [1,12].

Escherichia coli. As shown in Table 3, the highest *Escherichia coli* count (>1,100 MPN/g) was detected in the shrimp paste produced by Producer G. In contrast, the products from Producers C, E, and F complied with the Indonesian National Standard (SNI 01-2716:2009), which specifies a maximum allowable limit of <3 MPN/g. The contamination observed in Producer G's product is likely due to the use of well water situated near residential areas, making it susceptible to pollution from domestic waste, including human fecal matter.

Furthermore, the raw material storage area at Producer G was found to be unhygienic, characterized by open and humid conditions, with materials stored in contact with other substances. Such environments facilitate the entry of dust, dirt, and microorganisms from the surroundings [31]. In contrast, Producers C and F implemented more hygienic storage practices, which contributed to significantly lower *E. coli* counts.

The identification test confirmed that the *E. coli* strain isolated belonged to biotype I, based on the results of several biochemical tests: turbidity and gas production in the LTB test, pink coloration in the MR test, and colony growth on PV and SCA media. The high *E. coli* count observed in Producer G's shrimp paste thus reflects poor sanitation and inadequate hygiene practices compared to the other producers.

Salmonella Thypi. As shown in Table 3, all shrimp paste samples tested positive for *Salmonella Typhi* except for the product produced by Producer F. This finding indicates that most shrimp paste products manufactured by MSMe in West Nusa Tenggara did not comply with the Indonesian National Standard (SNI 2716:2009) concerning shrimp paste quality. *Salmonella* contamination is closely associated with inadequate worker hygiene and poor processing sanitation practices. Proper sanitation measures, including effective handwashing, have been demonstrated to significantly reduce microbial contamination in food products [32]

Producer F successfully avoided *Salmonella* contamination by implementing strict sanitation management practices, such as separating raw material storage areas from processing zones and maintaining regular cleaning of equipment. Furthermore, workers were required to wash their hands with soap before and after handling materials and after using the restroom. These practices highlight the critical role of sanitation management in ensuring product safety and compliance with food hygiene standards.

Vibrio cholerae. As shown in Table 3, all shrimp paste samples produced by MSMe in West Nusa Tenggara tested positive for *Vibrio cholerae* except for those produced by Producers C and H. This finding violates the Indonesian National Standard (SNI 01-2716:2009), which requires that shrimp paste products be free from this bacterium. *V. cholerae* contamination is commonly associated with unhygienic processing practices and the use of raw materials sourced from waters polluted by domestic or industrial waste [33]. For instance, fish samples collected from Manado Bay were reported to contain *V. cholerae* at levels of 2.4×10^5 MPN/100 g due to contamination from domestic sewage [34].

Producers C and H successfully avoided contamination by implementing effective sanitation measures. Producer C maintained the cleanliness of the grinding equipment and ensured a clear separation between washing and storage areas. Meanwhile, Producer H washed the shrimp thoroughly with clean running water prior to processing to remove debris and reduce microbial load. Washing raw materials with clean, flowing water has been proven effective in lowering the risk of microbial contamination in fermented fishery products.

Staphylococcus aureus. Table 3 indicates that shrimp paste produced by Producers A, B, D, F, G, and H exceeded the contamination limit for *Staphylococcus aureus* established by the Indonesian National Standard (SNI 01-2716:2009), which allows a maximum of 1×10^1 CFU/g. The primary cause of this contamination is direct contact between workers and the product during processing without the use of personal protective equipment (PPE), such as gloves and masks. In addition, poor packaging and storage practices further contribute to contamination. Producers A and B, for instance, stored shrimp paste at room temperature (20–26 °C) in open display cases, creating an environment favorable for *S. aureus* proliferation to levels of 10^5–10^6 CFU/ml, which can lead to the production of harmful exotoxins [35]. Such storage conditions increase the risk of cross-contamination, which could be minimized through the consistent use of PPE—particularly gloves, masks, and aprons—during packaging and handling [36].

Salt concentration also plays an important role in controlling *S. aureus* contamination. The low salt levels (<15%) observed in the shrimp paste produced by Producer D (*rebon* shrimp paste) and Producer F facilitated bacterial growth. Although *S. aureus* can tolerate salt concentrations up to 7.5% [37], higher salt levels create greater osmotic pressure that inhibits microbial activity and toxin formation [38]. These findings emphasize the importance of maintaining adequate salt concentrations and good hygiene practices to effectively limit *S. aureus* growth and ensure the microbial safety of shrimp paste.

4 Conclusion

Shrimp paste production on Lombok and Sumbawa Islands exhibits considerable variation in chemical composition, including ash, protein, carbohydrate, and salt contents. Most producers met the Indonesian National Standards (SNI) for protein and salt levels.

However, many MSME products did not comply with SNI 01-2716 (2009) due to contamination by *Salmonella Typhi*, *Vibrio cholerae*, *Staphylococcus aureus*, and *Escherichia coli*. These contaminations are primarily associated with poor sanitation practices, the use of contaminated water sources, improper storage conditions, and low salt concentrations (<15%), which favour microbial proliferation.

Producers such as C, F, and H demonstrated effective control through good sanitation management, regular cleaning of equipment, and thorough washing of raw materials prior to processing. To enhance the microbial safety and overall quality of shrimp paste, strengthened hygiene education, implementation of good manufacturing practices (GMP), and stricter regulatory supervision are strongly recommended.

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