Potensi Terasi Fermentasi Cirebon sebagai Pangan Fungsional: Tinjauan Komprehensif

The Potential of Cirebon Fermented Shrimp Paste as a Functional Food: A Comprehensive Review

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ABSTRACT

Shrimp paste (terasi) is a traditional fermented food widely consumed in Indonesia, especially in Cirebon, West Java. Its unique ingredients, spontaneous fermentation, and local processing techniques contribute to its distinct quality and bioactive potential. This study provides a systematic review of the physicochemical, microbiological, and bioactive properties of Cirebon shrimp paste to explore its potential as a functional food. Literature was collected using the PRISMA method from databases such as Google Scholar, ScienceDirect, and SINTA, with keywords like “Cirebon shrimp paste”, “fermentation”, and “bioactivity”. The results show that terasi contains free amino acids (e.g., glutamate), bioactive peptides, and beneficial microbes that may contribute to antioxidant and antimicrobial activities. The review also highlights the link between fermentation methods and product quality, and emphasizes the need for improved safety and standardization. Cirebon shrimp paste has promising potential for development as a culturally rooted functional food.

KEYWORDS
Cirebon shrimp paste, Fermentation, quality, bioactivity, Functional food.

1. INTRODUCTION

Traditional fermented foods have long served as essential components of local food system, contributing not only to flavour and preservation but also to nutrition and health. In Indonesia, *terasi*-a fermented shrimp paste is widely consumed across the archipelago and holds significant culinary and economic value. Among the major production regions, Cirebon in West Java stands out for its historical continuity, unique fermentation practices, and distinctive product characteristics (Astuti et al., 2018; Helmi et al., 2024).

Terasi is typically produced through spontaneous fermentation involving halophilic and lactic acid bacteria, often under non-standardized and artisanal conditions. Despite its artisanal nature, research indicates that Cirebon shrimp paste contains high levels of free amino acids such as glutamate, as well as bioactive peptides formed during protein hydrolysis (Ali et al., 2025; Herlina & Setiarto, 2024). These compounds are linked to potential antioxidant, antimicrobial, and antihypertensive activities, suggesting that *terasi* may qualify as a functional food (Surya, et al., 2023; Foods MDPI, 2025).

In addition to its nutritional properties, several studies have examined the microbiological composition and safety profile of Cirebon shrimps paste. Setiarto et al. (2023) identified shifts in dominant halophilic bacteria such as *Tetragenococcus* and *Halanaerobium* during spontaneous fermentation time. These microbial dynamics play a critical role in both product safety and the development of bioactive compounds (Helmi et al., 2024). Although research on Indonesia shrimp paste

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has expanded in recent years, no previous review has systematically synthesized finding specific to Cirebon's production, particularly with respect to its quality attributes and functional bioactivity. Therefore, this study aims to provide a systematically review of available scientific literature concerning the physicochemical quality, microbial profile, and bioactive potential of Cirebon shrimp paste. In doing so, we aim to clarify its role as a traditional fermented product with modern functional food value, and to identify key gaps and opportunity for future research and product development.

2. STUDY DESIGN

This study is a systematic literature review conducted to collect, evaluate and synthesize scientific data on the physicochemical quality, microbiological characteristics, and bioactive potential of Cirebon shrimp paste (*terasi*). The review adheres to the PRISMA 2020 guidelines, ensuring a structured and transparent in selecting and analysing the literature.

2.1. Literature Research Strategy

A comprehensive search was performed across the following scientific databases: Google Scholar, ScienceDirect, SINTA (Science and Technology Index-Indonesia), PubMed (for international context) and Garuda (Garba Rujukan Digital). The search was conducted using combinations of the following keywords and Boolean operators: "terasi" or "shrimp paste", "Cirebon", "Fermentation", "bioactivity", or "bioactive compounds", "physicochemical" or "quality" or "proximate analysis", "functional food". The time range for included publications was from 2005 to 2025, and only articles written in Bahasa Indonesia or English were considered.

2.2. Inclusion and Exclusion Criteria

Some Inclusion criteria used were such as primary research articles or review that focus on shrimp paste, specially produced in or referencing Cirebon, studies analysing physicochemical, microbiological, or bioactive compound properties, article published in peer-reviewed journals and studies available in full-text. Besides, three exclusion criteria used were article not specifically referring to Cirebon or where region was unspecified, publications focused solely on sensory analysis without quality or bioactivity parameters, and abstract-only paper, editorials, theses, or preprints not peer- reviewed.

2.3. Data Extraction

Relevant data were extracted manually and organized in a structured Excel spreadsheet. Extracted information included authors, year of publication, study location with scope and type of analysis (physicochemical, microbiological, bioactivity) and main findings (e.g., microbial species, fermentation conditions, antioxidant values).

2.4. Risk of Bias Assessment

To evaluate the reliability of included studies, a qualitative risk of bias assessment was conducted based on clarity of methods, validity of measurement (standardized or validated instrument), adequacy of replication or sampling and peer-review status and journal accreditation (SINTA or Scopus- indexed).

3. RESULT AND DISCUSSION

3.1. Study Quality Assessment

The quality of included studies was evaluated using a structured risk of bias matrix, comprising four key indicators: clarity of methodology, measurement validity, sampling adequacy, and peer-review status. Each indicator was scored on a scale from 0 to 2, with maximum possible total score of 8 points per study. The assessment results indicated that four studies, Helmi et al. (2024) Ali et al. (2025), Foods MDPI (2025), and Surya et al. (2023) achieved the highest scores (7-8 points), reflecting high methodological quality and a low risk of bias. These studies provided clear experimental procedures, employed validated analytical instruments (e.g., 16S rRNA gene sequencing, DPPH and FRAP assays), and were published in reputable peer-reviewed journals indexed in Scopus or SINTA 1. These high-quality sources formed the backbone of the review's findings related to bioactivity and microbial succession. Meanwhile, Herlina & Setiarto (2024) received a total score of 6 points, due to the narrative and semi-review nature of the study. Although it did not present original experiment data, the study comprehensively summarized microbial characteristics, fermentation methods, and safety issues across various regions of Indonesia, including Cirebon. Its inclusion was valuable in contextualizing *terasi* as an ethic fermented food with both culinary and functional relevance.

Tabel 1. Risk of Bias Assessment of Included Studies

No	Study	Method Clarity (0-2)	Measure ment Validity (0-2)	Sampling Adequacy (0-2)	Peer Review Quality (0-2)	Total Score (Max=8)
1	Helmi et al., 2024	2	2	2	2	8
2	Ali et al., 2025	2	2	2	2	8
3	Surya et al., 2023	2	2	1	2	7
4	Foods MDPI, 2025	2	2	2	2	8
5	Herlina & Setiarto, 2024	2	1	1	2	6
6	Astuti et al., 2018	2	2	1	2	7
7	Setiarto et al., 2017	1	2	1	2	5
8	Nugroho & Mulyani, 2014	2	1	1	1	5
9	Ismail et al., 2013	2	2	1	1	5
10	Wardhana et al., 2011	1	2	1	1	5
11	Lestari et al., 2010	2	1	1	1	5
12	Wijayanti et al., 2009	2	2	1	1	5
13	Hartanto et al., 2007	2	2	1	1	6
14	Putri & Wahyuni, 2006	2	1	1	1	5
15	Utami et al., 2005	1	1	1	1	4

*Note: Each study was assessed based on four indicators. Scores range from 0 (low) to 2 (high) per category. Higher total scores indicate lower risk of bias.

Several previous or regionally focused studies, such as those by Ismail et al. (2013), Wardhana et al. (2011), and Putri Wahyuni (2006), scored below 6 points. These studies were limited by less rigorous methodologies, small or unreported sample sizes, and the absence of standardized procedures. As such, their findings were used cautiously and primarily to support historical and contextual discussion. Overall, the majority of high-quality studies support the conclusion that Cirebon shrimp paste holds potential as a functional food, owing to its microbial and biochemical properties. Nonetheless, the findings also highlight a pressing need for future studies to adopt standardized protocols, expand sampling frameworks, and implement functional efficacy testing to validate health-related claims.

3.2. Physicochemical Quality of Cirebon Shrimp Paste

The physicochemical characteristics of Cirebon shrimp paste (*terasi*) are key indicator of its quality, safety, and nutritional value. Several studies report variations in moisture content, protein levels, salt concentration, pH, and nitrogen compounds, influenced by traditional processing methods. The moisture content of Cirebon terasi typically range from 18% to 28%, depending on drying and storage conditions (Ismail et al., 2013). Lower moisture levels are preferred for product stability and microbial safety. Protein content is generally high, between 38% and 45%, as a result of protein concentration and partial degradation during fermentation (Surya et al., 2023; Ali et al., 2025). This process releases amino acids and small peptides that contribute to nutritional value and flavour. Salt content, usually between 10% and 20%, plays a dual role in preservation and microbial selection (Helmi et al., 2024). Excessive salting, however, may reduce digestibility and protein solubility (Wijayanti et al., 2009). The PH of terasi ranges from 5.2 to 6.4, suitable for the growth of halophilic lactic acid bacteria and inhibition of pathogens (Astuti et al., 2018). This mild acidity supports fermentation and improves safety.

Some studies measured total volatile nitrogen (TVN) and histamine levels to evaluate freshness and spoilage. While most samples comply with safety limits, histamine spikes can occur under poor temperature control (Wardhana et al., 2011). In summary, Cirebon shrimp paste generally meets acceptable physicochemical standards, but variations among producers suggest the need for standardized quality control, particularly in moisture, salt, and protein levels.

Tabel 2. Summary of Physicochemical Parameters of Cirebon Shrimp Paste from Selected Studies

No	Study	Moisture (%)	Protein (%)	Salt (%)	pH	TVN Histamine	Notes
1	Ismail et al., 2013	20-28	38-45	Not reported	5.9	5	Trational drying, small procedures
2	Surya et al., 2023	21-25	41.2	13-17	5.5-6.3	7	Mixed shrimp & fish ingredient
3	Helmi et al., 2024	18-22	42.5	10-15	5.5-6.0	8	Controlled salt variation
4	Ali et al., 2025	24.7	44.0	Not reported	5.6	8	Measured glutamate release
5	Wijayanti et al., 2009	23.0	39.0	10-25	5.2-6.2	5	Salt > 20% reduces digestibility
6	Wardhana et al., 2011	Not reported	Not reported	Traditional use	Not report ed	5	Hot season (high histamine)

3.1. Bioactivity Potential and Functional Properties

The fermentation process of terasi (shrimp paste) plays a crucial role not only in developing its flavour and texture but also in generating bioactive compounds that may contribute to its potential as a functional food. Bioactive compounds, including peptides, amino acids, and microbial metabolites, are formed through enzymatic and microbial degradation of proteins and other macromolecules during fermentation. These compounds have been associated with health-promoting effects such as antioxidant, antimicrobial, and antidiabetic activities.

One of the primary bioactive constituents reported in Cirebon shrimp paste is glutamic acid, a free amino acid that contributes to umami flavour and serves a precursor for several biologically active peptides. Ali et al. (2025) and Helmi et al. (2024) observed that glutamic levels increase significantly within the first 5 to 7 days of fermentation, coinciding with intense protein hydrolysis. This increase enhances not only the sensory appeal of terasi but also provides potential antioxidant capacity through peptide activity.

Several studies have evaluated the antioxidant properties of shrimps paste using assay such as DPPH (2,2-diphenyl-1-picrylhydrzil) and FRAP (Ferric Reducing Antioxidant Power). Food MDPI (2025) reported that terasi fermented with Tertagenecoccus halophilus as a starter culture showed significantly improved antioxidant activity, with DPPH values reaching 3.90 mg AEAC/g and FRAP up to 8.67 mg AEAC/g. These results indicate that both natural and controlled fermentation can produce compounds capable of neutralizing free radicals.

In addition to antioxidant properties, antidiabetics activity has also demonstrated. The same study reported that fermented terasi exhibited inhibition of carbohydrate-hydrolysing enzymes, with IC50 values of 1.95 mg/mL for alpha amylase and 7.24 mg/mL for alpha glucosidase. These findings suggest potential in supporting blood glucose regulation, particularly relevant for populations at risk of metabolic disorders.

The antimicrobial potential of Cirebon shrimp paste has also been explored. Putri & Wahyuni (2006) found that ethanol extracts of terasi could inhibit the growth of Staphylococcus aureus and Escherichia coli, two common foodborne pathogens. Similarly, Foods MDPI (2025) reported inhibition zones of up to 32.8 mm against E. coli and 30.9 mm against S. aureus. These results indicate that terasi contains natural antimicrobial compounds, likely derived from microbial fermentation products such as bacteriocins or organic acids.

Additional evidence from related shrimp paste products in Southeast Asia strengthens this perspective. Studies on Thai fermented shrimp paste (kapi) has identified short-chain peptides such as Ser-Val with ACE-inhibitory activity and antioxidant effects (Kleekayai et al., 2015). Although such specific peptide identification has not yet been widely applied to Cirebon terasi, these findings offer promising directions for further investigation.

Table 3. Summary of Bioactive Compounds and Functional Properties of Cirebon Shrimps Paste from Selected Studies

No	Study	Assay Used	Bioactive Compounds/ Findings	Functional Properties
1	Ali et al., 2025	20-28	38-45	Not reported
2	Helmi et al., 2024	21-25	41.2	13-17
3	Helmi et al., 2022	18-22	42.5	10-15
4	Putri & Wahyuni	24.7	44.0	Not reported
5	Literature on *kapi*	23.0	39.0	10-25

Despite these encouraging results, most studies to date have relied on in vitro assays, and only a few have investigated bioavailability, in vivo efficacy, or long-term safety. Moreover, differences in raw material quality, fermentation duration, salt concentration, and microbial diversity contribute to variability in results and limit reproducibility. Standardizing fermentation conditions and exploring the use of selected starter cultures may improve the consistency of bioactive compound production.

In summary, Cirebon shrimp paste exhibits promising functional food properties, including antioxidant, antimicrobial, and antidiabetic activities, primarily due to the presence of bioactive peptides and microbial metabolites. However, further research—particularly involving compound isolation, mechanism elucidation, and in vivo validation—is needed to substantiate its role as a functional fermented product and to support its commercial development as a health-oriented traditional food.

4. CONCLUSIONS

Cirebon shrimp paste (*terasi*) represents a traditional Indonesian fermented product with notable physicochemical quality and growing evidence of functional potential. This systematic review demonstrates that *terasi* generally meets acceptable nutritional and safety standards, with high protein content, moderate pH, and favourable salt levels for fermentation. However, variation in moisture content, histamine formation, and sensory attributes among producers highlights the need for improved standardization in processing and quality control. In addition to its nutritional value, *terasi* exhibits functional properties linked to its fermentation-derived bioactive compounds. Studies have reported antioxidant activity, enzyme-inhibitory effects, and antimicrobial properties, particularly associated with glutamic acid release, microbial metabolites, and specific peptides. Although these findings are promising, most current data remain limited to in vitro assays, with minimal exploration of bioavailability, toxicity, or in vivo efficacy. To fully establish *Cirebon shrimp, paste* as a functional fermented food, future research should prioritize compound isolation, standardized fermentation protocols, and validation through animal or clinical studies. Strengthening scientific evidence will support not only the health-oriented repositioning of *terasi* but also its potential for innovation and commercialization as a culturally significant food with modern functional value.

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