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The Existence, Characteristics, Sources, and Impact of Microplastics in Salt Products in Indonesia

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Abstract

Salt is one of the nine essential commodities in Indonesia and is consumed daily as a crucial household food ingredient. However, the use of contaminated seawater as raw material in salt production has resulted in microplastic pollution, which is categorized as a hazardous contaminant and does not meet food safety standards. This study aims to describe the presence, characteristics, sources, and impacts of microplastics in coastal ecosystems and salt products in Indonesia through a Systematic Literature Review (SLR). Evidence shows that microplastics are consistently found in salt across different regions, with diverse shapes such as fragments, fibers, and films, in various colors and polymer types including Polypropylene (PP), Polyethylene (PE), Polyamide (PA), and Low-Density Polyethylene (LDPE). The main sources of contamination are polluted seawater, conventional evaporation-based salt production, and unmanaged plastic waste. This condition raises serious concerns regarding salt quality and potential risks to human health, while also threatening marine ecosystems and the food chain. In conclusion, microplastics are recognized as significant pollutants in Indonesian salt products. Addressing this issue requires integrated strategies such as improving waste management, adopting sustainable production technologies, monitoring salt quality according to food standards, and enhancing public awareness, and support from government collaboration.

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Introduction

Salt is one of the nine essential food staples for the Indonesian people. Physically, salt appears as white crystals, while chemically it contains more than 80% NaCl compounds, as well as other compounds such as magnesium chloride, magnesium sulfate, calcium chloride, and others. Salt available in the market must meet SNI standards, meaning that all salt sold on the market is salt that has been enriched with iodine compounds (KIO_3) (Baroroh, et al., 2019). Salt provides essential elements for humans. Table salt is a food ingredient that is highly needed by households (Abdullah & Susandini, 2018). Law No. 18 of 2012 explains that food security efforts are needed to prevent food from contamination sources that can disrupt, harm, and endanger human health. The presence of microplastics in salt is categorized as contamination and does not meet food safety standards (Widianarko & Hantoro, 2018).

The main source of salt material comes from the sea, salt lakes, and salt wells. The use of contaminated seawater as a raw material for salt will cause microplastic contamination in the salt (Ramadhanty et al., 2020). The salt production process by local communities almost entirely relies on solar energy. Seawater in salt pans is evaporated by sunlight without any technological intervention. The lack of technological intervention causes the salinity and dissolved pollutants in the produced salt to vary significantly (Junas & Surur, 2020). The environmental conditions of the salt production ponds are crucial in determining the quality of the produced salt as well as the use of plastic packaging (Romdana, 2020).

The phenomenon of microplastics, which are plastic waste smaller than 5 millimeters, has become a serious global environmental issue. These particles are widely dispersed in marine waters and sediments, accumulating due to the movement of currents, winds, and tidal changes. This condition is exacerbated by the fact that nearly half of the total waste disposal from land ends up in the oceans every day. Indonesia, as an archipelagic country with thousands of islands, ironically ranks as the second-largest contributor of plastic waste in the world, significantly adding to the burden of ocean pollution. (Ramadhanty et al., 2020)

The presence of microplastics has become a particular concern in the context of salt production, which generally uses seawater as the main raw material through solar evaporation techniques (Karimah & Alfiah, 2023). Various studies have been conducted to identify microplastic contamination in pond water, raw salt, and commercial salt. Research results consistently show that all salt samples examined contain microplastics (Gadi et al., 2024). The condition of seawater polluted with microplastics raises serious concerns about the quality of salt production consumed by the public (Murpa et al., 2021). The distribution of the shapes and colors of microplastics in salt has also been thoroughly studied in West Sulawesi, finding percentages of 41% fragments, 32% filaments, 22% fibers, and 5% films in salt products (Ramadhanty et al., 2020).

The abundance and characteristics of microplastics found vary depending on the research location and the type of samples (Amqam et al., 2022). For example, in Surabaya, the abundance of microplastics in aquaculture water is 7.7 particles/L, raw salt is 46 particles/Kg, and commercial salt is 41.5 particles/Kg (Karimah & Alfiah, 2023). Meanwhile, in Jeneponto, the abundance of microplastics in traditional salt reaches 914.67 particles/kg. The forms of microplastics that are often found include fragments, fibers, filaments, and films (Rohmah et al., 2025). Additionally, various colors of microplastics have also been identified, such as black, red, green, blue, transparent, and brown (Supriyo et al., 2024). The method of identifying microplastic polymers in salt is becoming more sophisticated with the use of FTIR spectroscopy to identify the types of polymers in table salt from Pati and Cirebon, revealing the presence of PVC, PU, polyester, nylon 6, and PET G as well as microplastic forms such as fibers, fragments, filaments, and pellets (Supriyo et al., 2024).

Microplastic pollution in aquatic environments, including salt pond areas, primarily originates from land-based plastic waste. The main sources include domestic and industrial activities, as well as improper solid and liquid waste management. These plastics then degrade into microplastic particles that can accumulate in water, sediments, and even within the bodies of organisms (Jambeck et al., 2015). Therefore, effective plastic waste management efforts, through recycling into sellable goods, are essential to reduce the impact of this pollution. This aligns with the concept of blue economy that emphasizes sustainable development by reusing plastic waste in coastal areas (Ramadhanty et al., 2020).

A literature review on microplastic pollution in salt is essential considering that salt is one of the main food ingredients consumed every day. Therefore, the presence of microplastics as a source of long-term exposure for humans must receive serious attention (Karimah and Alfiah, 2023). This study allows for recognizing pollution patterns, properties of microplastics, and differences between regions in Indonesia, thus it can serve as a basis to strengthen food safety regulations and strategies to mitigate environmental impacts (Ramadhanty et al., 2020). The unique contribution of this research is to present a comprehensive map of the origin, types, colors, and microplastic polymers in salt products by comparing a number of recent studies. This method provides a thorough understanding of the critical points of pollution, from the raw material of seawater to its distribution, which can be used as a reference in the formulation of environmental health policies (Supriyo et al., 2024; Rohmah et al., 2025).

From a public health perspective, the consumption of salt contaminated with microplastics can pose a danger of particle accumulation in the body, which can trigger inflammation, oxidative stress, and organ function issues (Khoiriyah, 2023). Although the number of particles in salt is lower compared to other seafood products, its characteristic of being consumed daily makes this issue deserving of serious attention (Nurfadilah et al., 2025). In addition to being found in water, sediments, and living organisms, the presence of microplastics in the sea is suspected to be a cause of pollution in salt products made from seawater. In this regard, this article aims to conduct a literature review of several articles on microplastic contamination in salt in Indonesia.

Methods

This research uses a Systematic Literature Review (SLR) approach with a descriptive design to collect and analyze articles available on the internet. Searching for scientific publications by identifying articles published between 2020-2024 using keywords: microplastics, environment, and salt, from Indonesian electronic databases such as Google Scholar, ResearchGate, PubMed, Neliti, and Garuda Ristek-BRIN. Using PRISMA *(Preferred Reporting Items for Systematic Review and Meta-Analysis)*. Initial searches yielded 30 journals, and after the selection process, 7 journals were obtained that focused on research regarding the presence and identification of microplastic content in salt consumed in Indonesia by identifying articles published between 2020 and 2024, using keywords such as microplastics, environment, and salt.

Table 1. PRISMA Flow Diagram (Literature Selection Process)

Stage	Number of Articles	Explanation
Records identified through database searching (Google Scholar, ResearchGate, 2020–2024)	30	The article was obtained using the keywords: microplastics, environment, salt.
Records after duplicates removed	25	Duplicate and irrelevant articles have been removed.
Records screened (title & abstract)	18	Articles that are not relevant to the topic are filtered out at the initial stage.
Full-text articles assessed for eligibility	12	The article is read in full to assess its feasibility.
Full-text articles excluded with reasons	5	Excluded because: (1) focus on marine biota, not salt; (2) does not research microplastics; (3) methods not appropriate.
Studies included in qualitative synthesis (Systematic Review)	7	Articles that meet the inclusion criteria: researching microplastic content in table salt in Indonesia.

The initial search process yielded 30 publications from various databases. After removing duplicates, there were 25 publications which were then selected based on titles and abstracts, resulting in only 18 deemed appropriate. Of that number, 12 publications were read in full to evaluate the feasibility of the methods and relevance of the topics. A total of 5 publications were excluded for not focusing on salt or not directly researching microplastics. Ultimately, 7 publications met the inclusion criteria and were analyzed in this literature review.

Results

Table 2. Systematic Review

No.	Autor / Year	Title	Methods	Results
1	Nabilah Rizqia Ramadhanty, Siswo Hadi Sumantri, Panji Suwarno, Supriyadi/2020	Analysis of Microplastic Content in Coastal Ecosystems and Salt Products in West Sulawesi Province in Support of Blue Economy and Maritime Security	Observational with a descriptive approach	The presence of microplastics is a concern in the context of maritime security and sustainable blue economy, highlighting the need to protect national interests in the maritime sector.
2	Muhammad Ikrar Tri Murpa, Alfina Baharuddin, Abd. Gafur/ 2021	Microplastic Content in Salt at Terong Market, Bontoala Sub-district, Makassar City	Observational with a descriptive approach	All salt samples examined (100%) in Terong Market, Makassar, were found to contain microplastics.
3	Hasnawati Amqam, Nur Afifah, Muh Iqran Al Muktadir, Alika Tasya Devana, Utami Pradana, Zhinta Fitri Yusriani /2022	Abundance and Characteristics of Microplastics in Traditional Salt Products in Jeneponto Regency	Observational with a descriptive approach	All traditional salt samples in Jeneponto Regency contain microplastics, with an abundance of 914.67 particles/kg of salt.
4	Mukhlisoh Nisa'ul Karimah, Taty Alfiah /2023	Analysis of Microplastic Content in Pond Water, Raw Salt, and Commercial Salt in Surabaya	Evaporation technique under sunlight for salt production.	The abundance of microplastics varies: 7.7 particles/L in water ponds, 46 particles/Kg in raw salt, and 41.5 particles/Kg in commercial salt.
5	Dewi Setiyowati Gadi, Umbu Paru Lowu Dawa, Mada Mariana Lakapu, Richardo Emanuel Bulan, Maxi Katanga Teul / 2024	Microplastics in Pond Water and 'Krosok' Salt Particles in Ud. Abraham, Oli'o Village, Kupang Regency	Conventional method	Conventional salt production in Kupang faces the threat of increasing global plastic waste pollution.

No.	Autor / Year	Title	Methods	Results
6	Edy Supriyo, Mohamad Endy Julianto, Anggia Oky Mawarganis /2024	Microplastic Contamination in Table Salt (Microplastics Content in Salt)	Fourier Transform Infrared (FT-IR) Method	Identification using FTIR found various types of microplastic polymers such as Polyvinyl Chloride, Polyurethane, Polyester, Nylon6/Polyamide6, and Polyethylene Terephthalate Glycol.
7	Silfi Maulidatur Rohmah, Haryo Triajie, Hafiludin, AB. Chandra1 /2025	Characteristics of Microplastics in Raw Water Sources and Salt Pond Sediments in Pamekasan Using FT-IR Method	Metode Fourier Transform Infrared (FT-IR).	The forms of microplastics found are fibers, fragments, and films. The types of polymers found in the samples are Polypropylene (PP), Polyethylene (PE), Polyamide (PA), and Low Density Polyethylene (LDPE).

The results from the literature review show that the amount of microplastics in salt in Indonesia varies by location. For example, in Surabaya, 46 particles/kg were detected in raw salt and 41.5 particles/kg in salt sold on the market (Karimah and Alfiah, 2023), while in traditional salt from Jeneponto, the abundance of microplastics reached 914.67 particles/kg (Amqam et al., 2022). In Kupang, conventionally produced salt also showed significant microplastic particles (Gadi et al., 2024). These differences reflect variations in environmental pollution levels and salt production methods in different regions.

Types of polymers found in salt products include Polyvinyl Chloride (PVC), Polyurethane (PU), Polyester, Nylon6/Polyamide6, and Polyethylene Terephthalate Glycol (PET G), which have been identified using Fourier Transform Infrared (FTIR) methods (Supriyo et al., 2024; Rohmah et al., 2025). Other detected polymers include Polypropylene (PP), Polyethylene (PE), Polyamide (PA), and Low Density Polyethylene (LDPE) (Rohmah et al., 2025). The variation in these types of polymers indicates that the sources of contamination come from various human activities and the degradation of plastics in marine ecosystems.

Regional variations also affect the properties of microplastics detected. In West Sulawesi, the most common types are fragments (41%) and fibers (32%) (Ramadhanty et al., 2020), while in Pamekasan, the existing microplastics consist of fibers, fragments, and thin films (Rohmah et al., 2025). The observed colors also vary, ranging from black, red, blue, green, to transparent, indicating plastic sources from various types of products (Supriyo et al., 2024). These differences indicate that the situation of microplastic pollution in salt in Indonesia is not uniform, but rather influenced by local pollution levels, production methods, and environmental management practices.

Discussion

Microplastics, as plastic fragments measuring less than 5 millimeters, have become a widespread pollutant in marine environments and sediments. (Ramadhanty et al., 2020). The presence of these particles in ocean waters is caused by the movement of currents, winds, and tides, aggravated by significant contributions of land-based waste to the oceans every day. (Ramadhanty et al., 2020). Salt production, which generally utilizes seawater as the main raw material, is inherently vulnerable to microplastic contamination. (Karimah & Alfiah, 2023).

Various studies have confirmed microplastic contamination in water and salt samples from different locations (Karimah & Alfiah, 2023). Research conducted in the city of Surabaya showed a microplastic abundance of 7.7 particles/L in pond water, 46 particles/Kg in raw salt, and 41.5 particles/Kg in commercial salt (Karimah & Alfiah, 2023). Meanwhile, traditional salt from Jeneponto recorded a much higher abundance, reaching 914.67 particles/kg (Amqam et al., 2022). This difference in abundance indicates variations in environmental pollution levels and salt production methods in each area (Karimah & Alfiah, 2023; Amqam et al., 2022).

The consistent discovery of microplastics in shrimp farming water and salt products in various areas such as Kupang, Makassar, and Pamekasan shows that this issue is widespread (Gadi et al., 2024; Murpa et al., 2021; Rohmah et al., 2025; Supriyo et al., 2024). The presence of microplastics in the salt consumed by the public raises significant concerns about food product quality and potential health risks (Gadi et al., 2024). Therefore, continuous monitoring and efforts to mitigate microplastic pollution in the salt production chain are crucial to ensure food safety and environmental sustainability. (Karimah & Alfiah, 2023; Ramadhanty et al., 2020).

Microplastic contamination in table salt is an increasingly concerning issue due to its implications for human health and environmental sustainability (Khoiriyah, 2023). Sea salt, which is produced through the evaporation of seawater, is highly susceptible to microplastic pollution stemming from human activities in coastal areas (Nurfadilah et al., 2025). Sources of these pollutants include plastic waste disposal, fishing activities, domestic waste, and industrial discharges that flow into the sea (Khoiriyah, 2023). Microplastic particles are formed as larger plastic materials degrade into smaller fragments due to exposure to ultraviolet light, ocean waves, and other physical processes, which then mix with seawater and settle in salt production areas (Nurfadilah et al., 2025).

The analysis of microplastic characteristics in water and salt samples shows diversity in their shapes (Karimah & Alfiah, 2023). The most commonly identified shapes include fibers, fragments, filaments, and films, reflecting various sources and plastic degradation processes (Karimah & Alfiah, 2023; Supriyo et al., 2024). Among these shapes, fragments often become the most dominant form, as found in traditional salt in Jeneponto Regency (Amqam et al., 2022). In addition to shape, microplastics are also found in various color variations, including black, red, green, blue, transparent, and brown (Karimah & Alfiah, 2023; Supriyo et al., 2024). This diversity of colors provides clues about the origins of the plastics that pollute the environment, as different plastic products have different color pigments (Amqam et al., 2022). The color of microplastics may also be related to the type of polymer or the level of degradation it has experienced in the environment (Karimah & Alfiah, 2023).

The main source of microplastics in salt comes from seawater that is contaminated due to household activities, industry, and poor waste management in coastal areas (Ramadhanty et al., 2020). In addition, traditional methods of salt production that rely on the evaporation of seawater in open ponds can increase the risk of plastic particles being trapped in salt crystals (Karimah and Alfiah, 2023; Gadi et al., 2024). Other aspects such as the use of plastic for packaging also worsen this contamination problem (Amqam et al., 2022).

The microplastic levels in salt found in Indonesia show a significant difference across regions. Research in Surabaya found 46 particles/kg in raw salt and 41.5 particles/kg in commercially sold salt (Karimah and Alfiah, 2023), whereas in Jeneponto, the microplastic count was much higher, reaching 914.67 particles/kg (Amqam et al., 2022). Several types of polymers detected include PVC, PU, polyester, Nylon-6, PET-G, PP, PE, PA, and LDPE, with the most common forms being fragments, fibers, and films (Supriyo et al., 2024; Rohmah et al., 2025). The main causes of this pollution mainly stem from seawater contaminated with household and industrial waste, traditional production methods using open ponds, and the use of plastics for packaging (Ramadhanty et al., 2020; Gadi et al., 2024).

When compared to findings in other countries, the concentration of microplastics in Indonesia is within the global range. Research conducted in China recorded 550–681 particles/kg in sea salt and 43–364 particles/kg in lake salt (Yang et al., 2015), while other international studies reported variations between 1–10 particles/kg in several brands of commercial salt, reaching hundreds or even thousands of particles/kg in unrefined products (Karami et al., 2017). This difference indicates that geographical elements, production methods, and levels of pollution in local areas play a significant role in determining the microplastic content in salt available in the market.

However, until now, epidemiological research that directly evaluates the impact of consuming salt contaminated with microplastics on human health is still very limited. The majority of the evidence is derived from toxicological studies on animals or laboratory experiments indicating the potential for inflammation, oxidative stress, and disruption of liver and kidney function due to the accumulation of plastic particles (Khoiriyah, 2023). Epidemiological studies on humans have been rare, so the causal relationship cannot be established yet, although exposure estimates suggest that salt consumption could be one of the main ways microplastics enter the body (Nurfadilah et al., 2025).

Further research using methods such as Fourier-transform infrared spectroscopy (FT-IR) has successfully identified the types of polymers that make up microplastics (Supriyo et al., 2024; Rohmah et al., 2025). Some types of polymers detected include Polyvinyl Chloride, Polyurethane, Polyester, Nylon6 or Polyamide6, and Polyethylene Terephthalate Glycol. (Supriyo et al., 2024; Rohmah et al., 2025). The sizes of microplastics found generally range from less than 5 millimeters, with a specific range such as 0.017-4.534 mm. (Ramadhanty et al., 2020; Amqam et al., 2022). A deep understanding of these characteristics is crucial for tracking pollution sources and designing more effective mitigation strategies (Supriyo et al., 2024).

Plastic waste originating from land is a major source of microplastic pollution in the marine environment (Jambeck et al., 2015; Ramadhanty et al., 2020). These sources include daily domestic activities, industrial processes, and inadequate waste management practices (Amqam et al., 2022). Ironically, Indonesia ranks second as the largest contributor of plastic waste in the world, significantly worsening the condition of marine pollution (Ramadhanty et al., 2020).

The low environmental sanitation conditions in coastal areas of Indonesia increase the risk of microplastics entering the salt production chain (Rahman & Isnaeni, 2025). Research shows that coastal areas face challenges in solid and liquid waste management, limited access to sanitation facilities, and low public awareness in maintaining environmental cleanliness (Rahman & Isnaeni, 2025). Poorly managed plastic waste will undergo photodegradation into microplastics, which are then carried by ocean currents to water intake areas for salt production (Nurfadilah et al., 2025). The presence of microplastics in table salt can serve as an indicator of the level of marine water pollution in the surrounding production areas (Nurfadilah et al., 2025).

After entering the marine environment, larger plastic waste will degrade into smaller microplastic particles (Supriyo et al., 2024). These microplastic particles then contaminate seawater, which is the main raw material in the salt production process (Karimah & Alfiah, 2023; Gadi et al., 2024). The conventional salt production method that relies on the evaporation of seawater in open ponds increases the risk of direct contamination from the surrounding environment, allowing microplastics to easily get trapped in salt crystals (Gadi et al., 2024).

In addition to contamination from seawater, other pathways such as the use of plastic packaging and storage conditions also have the potential to increase the microplastic content in salt products (Amqam et al., 2022). The diversity of pollution sources results in varied characteristics of microplastics, making it difficult to identify a single source (Amqam et al., 2022). Therefore, comprehensive efforts, including improved waste management and recycling initiatives, are needed to prevent the entry of microplastics into the ecosystem and, ultimately, into food products such as salt (Ramadhanty et al., 2020).

Critically, the main shortcomings of the existing research are the varied methods of sample collection and analysis, the absence of international standards for measurements, unmanaged laboratory contamination threats, and the limited sample coverage confined to specific locations (Supriyo et al., 2024; Ramadhanty et al., 2020). These conditions complicate comparisons between studies and diminish the ability to generalize results. Therefore, consistent methodological guidelines, stricter quality control, and large-scale epidemiological studies are needed to strengthen the evidence of the impact of microplastics in salt on public health.

From a public health perspective, exposure to microplastics through the continuous consumption of table salt has the potential to cause accumulation in the body (Khoiriyah, 2023). The accumulation of microplastics has been linked to the occurrence of inflammation, oxidative stress, liver and kidney function disorders, as well as potential endocrine system disruptions (Khoiriyah Maha, 2023). Although the amount of microplastics in salt is relatively lower compared to other seafood products such as fish and shellfish, their presence still requires serious attention (Nurfadilah et al., 2025). Control efforts can be made through improving plastic waste management in coastal areas, tightening quality regulations for salt raw materials, and conducting ongoing research to monitor trends in microplastic contamination in marine-based food (Khoiriyah, 2023).

Conclusion

Based on the analysis conducted, it can be concluded that microplastics have now become a significant pollutant in salt products in Indonesia, with various forms, colors, and types of polymers originating from plastic waste, polluted marine waters, and traditional salt production methods. This situation impacts the quality of consumed salt, poses risks to human health, and threatens marine ecosystems and the food chain. To mitigate these effects, an integrated approach is needed through improved plastic waste management in coastal areas, the application of cleaner and more environmentally friendly salt production technologies, monitoring salt quality according to food safety standards, and raising public awareness about the importance of reducing single-use plastic consumption. Cooperation between the government, academia, industry, and the community is also crucial to support environmental sustainability and public health.

References

Abdullah, Z. A., & Susandini, A. (2018). Media Produksi (Geomembrane) Dapat Meningkatkan Kualitas Dan Harga Jual Garam (Study Kasus: Ladang Garam Milik Rakyat Di Wilayah Madura). Eco-Entrepreneur, 4(1), 21-36. DOI: https://doi.org/10.21107/ee.v4i1.3998

Amqam, H., Afifah, N., Al Muktadir, M. I., Devana, A. T., Pradana, U., & Yusriani, Z. F. (2022). Kelimpahan Dan Karakteristik Mikroplastik Pada Produk Garam Tradisional Di Kabupaten Jeneponto. Promotif: Jurnal Kesehatan Masyarakat, 12(2), 147-154. DOI: https://doi.org/10.56338/promotif.v12i2.2885

Baroroh, I., Sulestiani, A., Munazid, A., & Suwasono, B. (2019). Teknologi Mekanik Dasar Pemurnian Garam.

Gadi, D. S., Dawa, U. P. L., Lakapu, M. M., Bulan, R. E., & Teul, M. K. (2024). Mikroplastik Pada Air Tambak Dan Partikel Garam “Krosok” Di Ud. Abraham Desa Oli’o Kabupaten Kupang. Journal Of Marine Research, 13(3), 587-594. DOI: https://doi.org/10.14710/jmr.v13i3.44202

Innas, S. A. (2021). Analisis Kandungan Mikroplastik Pada Sedimen Pantai Sukaraja Kota Bandar Lampung (Doctoral Dissertation, Uin Raden Intan Lampung).

Jambeck, J. R., Geyer, R., Wilcox, C., Siegler, T. R., Perryman, M., Andrady, A., ... & Law, K. L. (2015). Plastic waste inputs from land into the ocean. Science, 347(6223), 768-771. DOI: 10.1126/science.1260352

Junas, S., & Surur, F. (2020). Arahan Kesesuaian Lahan Pertambakan Garam Di Kecamatan Bangkala Kabupaten Jeneponto. Optima, 3(2), 17-23. DOI: https://doi.org/10.33366/optima.v3i2.1757

Karimah, M. N., & Alfiah, T. (2023). Analisis Kandungan Mikroplastik pada Air Tambak, Garam Mentah dan Garam Komersil di Surabaya. Jurnal Kelautan: Indonesian Journal of Marine Science and Technology, 16(2), 65-74. DOI : https://ejurnal.itats.ac.id/sntekpan/article/view/5208/3576

Khoiriyah Maha. (2023). Analisis kontaminasi mikroplastik pada garam laut di wilayah pesisir. Jurnal Kelautan dan Perikanan, 15(2), 87–96.

Murpa, M. I. T., Baharuddin, A., & Gafur, A. (2021). Kandungan Mikroplastik Pada Garam di Pasar Terong Kelurahan Bontoala Kota Makassar. Higiene Jurnal Kesehatan Lingkungan, 7(1), 1-4.

Nurfadilah, S., Pratama, A., & Rasyid, M. (2025). Kadar mikroplastik pada garam konsumsi di Indonesia: Studi kasus wilayah pesisir. Jurnal Sains Lingkungan, 20(1), 45–56.

Rahman, A., & Isnaeni, A. (2025). Pengelolaan sanitasi lingkungan pesisir dan kaitannya dengan pencemaran mikroplastik pada garam. Jurnal Kesehatan Lingkungan, 12(1), 12–21.

Ramadhanty, N. R., Sumantri, S. H., & Suwarno, P. (2020). Analisis Kandungan Mikroplastik Pada Ekosistem Pesisir Dan Produk Garam Di Provinsi Sulawesi Barat Dalam Mendukung Blue Economy Keamanan Maritim. Jurnal Education And Development, 8(4), 48-48.

Rohmah, S. M., Triajie, H., Hafiludin, & Chandra, A. B. (2025). Karakteristik Mikroplastik pada Sumber Air Baku dan Sedimen Tambak Garam di Pamekasan dengan Metode FT-IR. Journal of Indonesian Tropical Fisheries (JOINT-FISH): Jurnal Akuakultur, Teknologi dan Manajemen Perikanan Tangkap dan Ilmu Kelautan, 8(1), 12-27. DOI: https://doi.org/10.33096/joint-fish.v8i1.572

Romdana, R. (2020). Kondisi Lingkungan Dan Persepsi Masyarakat Perairan Di Dusun Ageng Desa Pinggir Papas, Sumenep Madura (Doctoral Dissertation, Universitas Islam Malang).

Supriyo, E., Julianto, M. E., & Mawarganis, A. O. (2024). Kandungan Mikroplastik Pada Garam Dapur (Microplastics Content In Salt). Innovative: Journal Of Social Science Research, 4(4), 1642-1652.

Widianarko, Y. B., & Hantoro, I. (2018). Mikroplastik Dalam Seafood Dari Pantai Utara Jawa.