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(Research Article)

The presence and characteristics of microplastics in local salt industry production in Muna Regency in 2025

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Abstract

Microplastics are environmental contaminants increasingly found in seafood-based products, including table salt. This study aims to identify the presence, characteristics, and types of microplastic polymers in salt produced by local industries in Muna Regency in 2025. This study uses a descriptive observational design with laboratory testing and Fourier Transform Infrared Spectroscopy (FTIR) analysis. Sampling was conducted using purposive sampling on 12 salt samples, consisting of nine samples at various stages of processing and three finished salt samples marketed. Analisis data Dila Kukan secure univariate. The research results showed that all salt samples were contaminated with microplastics, with a total of 57 particles found. The microplastic concentration ranged from 0.008–0.04 mg/kg, with an average value of 0.019 mg/kg. The microplastic shapes found were dominated by 29 fragment particles and 28 line particles, indicating secondary microplastics. The most dominant microplastic color was black, followed by transparent and other colors. FTIR analysis results showed that the types of microplastic polymers identified were Polyethylene (PE) and Polypropylene (PP), with PE dominating in most samples. The presence of microplastics in salt is influenced by marine environmental pollution as well as post-production processes such as transportation and packaging, thus efforts are needed to control them in order to minimize exposure risks for consumers.

Keywords: Microplastics; Salt; Polyethylene; Polypropylene; FTIR

1. Introduction

Plastic is a material widely used in everyday life, both for domestic and industrial purposes, due to its lightweight, strong, flexible properties, and low production cost (1). The continuous increase in plastic production is not matched by effective waste management, resulting in environmental pollution, particularly in marine and coastal areas, which has now become a global issue (2). The annual increase in plastic production also exacerbates the accumulation of plastic waste in aquatic environments and threatens marine biodiversity as well as human health through the food chain (3).

In aquatic environments, plastic does not easily biodegrade, but rather undergoes physical degradation due to exposure to sunlight, heat, humidity, air, and catalysts, resulting in small particles less than 5 mm in size known as microplastics (4). Microplastics have the ability to interact with other environmental contaminants, such as Persistent Organic Pollutants (POPs), heavy metals, and pathogens, making them toxic to aquatic organisms (5).

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Salt is a staple food ingredient consumed by all levels of society and plays an important role in human health. However, the process of salt production, especially from marine sources, is susceptible to microplastic contamination through seawater, equipment, production processes, and packaging. Understanding the business flow or salt production process is very important to identify stages, locations, or conditions that have the potential to become sources or pathways for contaminants to enter the final product.

Several studies have proven the presence of microplastics in salt products. Research by Karami et al. (2017) analyzing 39 salt brands from 21 countries showed that sea salt contains up to 1,674 microplastic particles per kilogram (8). Research by Maqam et al. (2022) was conducted in Jene Ponto Regency using five traditional salts obtained from five different salt producers. The microplastic concentration was 914.67 particles/kg of salt. The most common form was microplastic fragments (9). Supriyo et al. (2024) found microplastic contamination in salt samples from Pati and Cirebon. The microplastics were in the form of fibers, fragments, filaments, and pellets, with 208 microplastic particles per kilogram of Cirebon salt and 306.67 microplastic particles per kilogram of Pati salt (10).

According to the research by Karimah and Alfiah (2023), there has been contamination in pond water, raw salt, and commercial salt. Microplastics were found in six different colors: clear, brown, red, green, blue, and black (11). Research by Steyning et al. (2019) found that there is microplastic contamination in salt produced in the coastal areas of Java (12). Research by Asri et al. (2021) shows the presence of polyethylene and polypropylene plastic fragments in table salt (13). These microplastics have the potential to cause toxic effects, such as tissue inflammation, oxidative stress, and endocrine disruption if they accumulate in the human body (14).

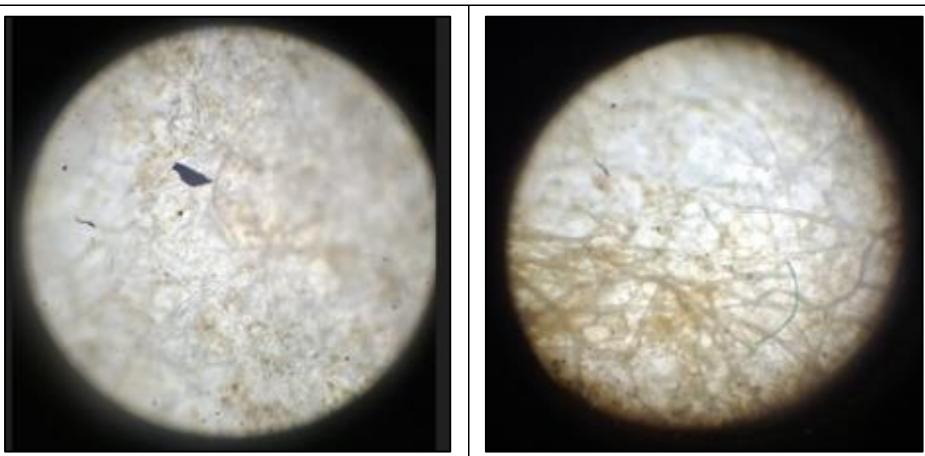
Muna Regency has three salt processing industries, but their product marketing is still limited to markets and shops within the regency, making it difficult to reach consumers from outside the area. In addition, the raw salt for these three industries is obtained from Bima City, West Nusa Tenggara Province, via sea routes (15) Based on a preliminary study conducted by the researcher, the process of transporting salt raw materials begins with the preparation and packaging of the raw materials in Bima City. The salt is packed in sacks of a certain capacity to minimize the risk of contamination and changes in moisture content during delivery.

Therefore, based on these issues, it becomes an important reason for researchers to conduct a study on the microplastic content in salt produced by local industries in Muna Regency. This research is expected not only to have an impact on the development of scientific knowledge but also to serve as a basis for public health risk management efforts, consumer education, and the development of sustainable food policies in the region.

2. Methods

This research is descriptive in nature, using observation methods, laboratory testing to examine microplastic characteristics, and FTIR (Fourier Transform Infrared Spectroscopy) analysis to identify polymer types. The sampling technique used is purposive sampling. The population in this study is salt produced by three local industries in Muna Regency. The total number of samples in this study is 12 samples, consisting of 9 samples from various stages of the salt processing in the three industrial locations, and 3 finished salt samples produced by these three industries and marketed in Muna Regency. The research was conducted in December 2025. The data analysis method used is univariate analysis.

3. Results and discussion



Microplastics in the form of fragments	Microplastics in the form of line

Figure 1 Types of microplastics found in salt samples in Muna Regency in 2025.

Tabel 1 Distribution based on particle count and microplastic concentration in salt in Muna Regency in 2025

Salt sampling point	Number of MPs Particles Found	Microplastic Concentration
Salt 1	10	0.04
Salt 2	2	0.008
Salt 3	5	0.02
Salt 4	9	0.036
Salt 5	3	0.012
Salt 6	2	0.008
Salt 7	2	0.008
Salt 8	2	0.008
Salt 9	5	0.02
Salt 10	10	0.04
Salt 11	2	0.008
Salt 12	5	0.02

Source: Secondary Data 2025

Table 1 showing the number of microplastics in salt amounted to 57 MP items collected from 12 sampling points located in 3 (three) local salt industries in Muna Regency. The highest number of microplastic particles was found in samples 1 and 10, and the highest microplastic concentration was found in samples 1 and 10, at 0.04 mg/kg each, while the lowest concentration was found in samples 2, 6, 7, 8, and 11, at 0.008 mg/kg.

Tabel 2 Forms of microplastics in salt in Muna Regency in 2025.

Salt sampling point	Form			
	Line	Fragment	Pellet	Film
Salt 1	4	6	-	-
Salt 2	1	1	-	-
Salt 3	3	2	-	-
Salt 4	7	2	-	-
Salt 5	2	1	-	-
Salt 6	1	1	-	-
Salt 7	1	1	-	-
Salt 8	1	1	-	-
Salt 9	3	2	-	-
Salt 10	1	9	-	-
Salt 11	-	2	-	-
Salt 12	4	1	-	-
Amount	28	29	-	-

Table 2 shows that the forms of microplastics in salt from 57 MP items are of the line and fragment types, collected from 12 sampling points located in 3 local salt industries in Muna Regency. The absence of line-shaped microplastics in salt during the iodization stage is not caused by the chemical effect of iodine on microplastics, but is more influenced by technical factors and salt processing procedures such as crystallization, filtration, and other production stages that have the potential to reduce microplastic concentrations or alter the detection characteristics of these particles.

Tabel 3 The color of microplastics in salt in Muna Regency in 2025.

Salt sampling point	Warna Microplastic							
	Blue	Transparent	Black	Red	Purple	White	Yellow	Green
Salt 1	-	3**	4*,2**	1**	-	-	-	-
Salt 2	-	-	1*	1**	-	-	-	-
Salt 3	-	1**	1*	-	-	-	1**	2*
Salt 4	2*	1**	3*,1**	1*	-	-	1*	-
Salt 5	1*	-	1*,1**	-	-	-	-	-
Salt 6	-	-	1*,1**	-	-	-	-	-
Salt 7	-	-	1*,1**	-	-	-	-	-
Salt 8	-	-	2**	-	-	-	-	-
Salt 9	-	-	2*,2**	1*	-	-	-	-
Salt 10	-	5**	1*,1**	1**	-	-	1**	1**
Salt 11	-	-	2**	-	-	-	-	-
Salt 12	1*	-	3*,1**	-	-	-	-	-
Amount	4	10	32	5	-	-	3	3

Description: *Line; **Fragment

Table 3 shows the colors of microplastics in salt taken from 12 sample points located at 3 (three) local salt industries in Muna Regency, with the most frequently found color being black, totaling 32.

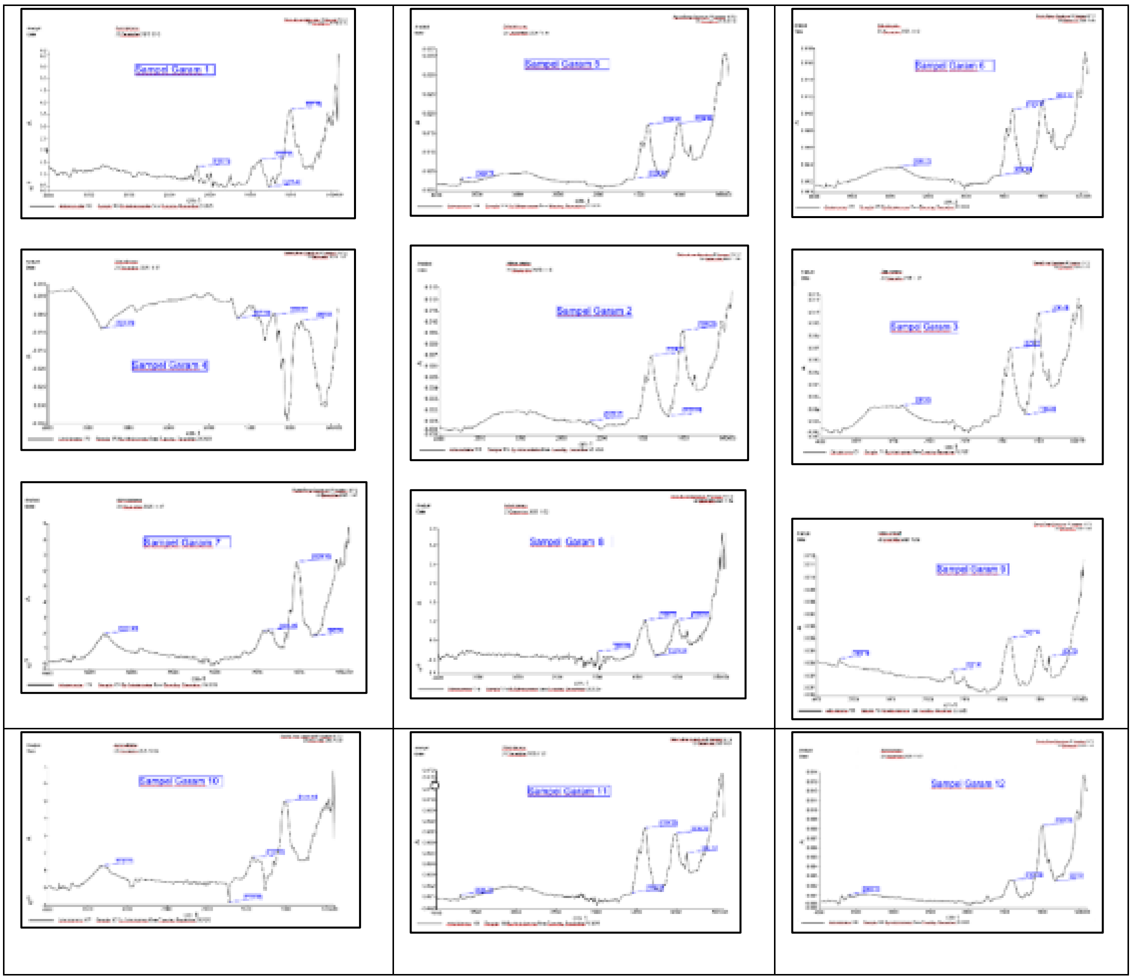


Figure 2 Types of microplastics found in salt samples in Muna Regency in 2025

Figure 2 shows the results of the FT-IR wavelength analysis conducted to determine the type of microplastic polymer in salt. The FT-IR analysis results indicate that the identified microplastic polymers are Polyethylene (PE) and Polypropylene (PP) based on their spectra and wavelengths.

Tabel 4 FTIR analysis of microplastics in salt in Muna Regency in 2025

No	Sample	Form	Color	Types of Polymers
1	Salt 1	Line, Fragment	Black, Transparent, Red	Polyethylene (PE), Polypropylene (PP)
2	Salt 2	Line, Fragment	Black, Red	Polyethylene (PE), Polypropylene (PP)
3	Salt 3	Line, Fragment	Yellow, Transparent, Green, Black	Polypropylene (PP)
4	Salt 4	Line, Fragment	Black, Yellow, Blue, Red, Transparent	Polyethylene (PE)
5	Salt 5	Line, Fragment	Black, Red	Polyethylene (PE)
6	Salt 6	Line, Fragment	Black	Polypropylene (PP)
7	Salt 7	Line, Fragment	Black	Polyethylene (PE), Polypropylene (PP)
8	Salt 8	Line, Fragment	Black	Polyethylene (PE)
9	Salt 9	Line, Fragment	Black, Red	Polyethylene (PE)

10	Salt 10	Line, Fragment	Black, Yellow, Green, Transparent, Red	Polyethylene (PE) Polyethylene Terephthalate (PET)
11	Salt 11	Fragment	Black	Polyethylene (PE) Polyethylene Terephthalate (PET)
12	Salt 12	Line, Fragment	Black, Blue	Polyethylene (PE)

Source: Secondary Data 2025

Table 4 explains the results of microplastic identification in 12 salt sample points, showing that the most dominant polymer is Polyethylene (PE). The Polyethylene (PE) polymer type was detected in 11 salt sample points.

3.1. Characteristics of Microplastics in Salt Samples

The salt analyzed in this study is crystal salt originating from Bima City, West Nusa Tenggara, which is then distributed to local salt industries in Muna Regency for iodization, packaging, and marketing stages, without involving the initial production process from seawater. Besides the quality of the raw material, the transportation and packaging stages of crystal salt from the place of origin are also important factors that could potentially affect the presence of microplastics in the final product. The distribution process, which generally uses sacks or synthetic plastic packaging, as well as loading, unloading, and storage activities during transportation, has the potential to cause additional contamination due to mechanical abrasion and packaging material degradation.

The research results showed that all salt samples from three salt industries in Muna Regency were contaminated with microplastics, with a total of 57 microplastic particles found across 12 sampling points. This finding indicates that microplastics have become a common contaminant found in salt products, especially salt produced from seawater.

The presence of microplastics in salt cannot be separated from the salt production process or the environmental conditions of its processing, in addition to coastal water pollution as the source of raw materials. This study's findings are in line with those of Kim et al. (2022), who stated that microplastics are consistently detected in various brands and types of salt, both sea salt and salt that has undergone further production processing stages (16). Furthermore, this study is in line with the findings of several previous studies which indicate that the type and amount of microplastics in food products are influenced not only by the environmental conditions of the raw materials but also by the stages of production, packaging, and distribution of the goods (17).

3.2. Identification of Microplastic Morphology in Salt Samples

Based on the results of morphological identification, the microplastics found in the salt samples in this study consisted of only two main forms, namely lines, totaling 28, and fragments, totaling 29. The absence of pellet- or film-shaped microplastics indicates that microplastics in salt are generally the result of secondary plastic fragmentation, not primary plastics. This finding is in line with various previous studies, which also reported the dominance of fragment and line forms in salt. Research in Parmesan shows that the forms of microplastics found in the raw water sources of salt ponds and their sediments include fibers, fragments, and films, with polymers such as PE and PP, which is consistent with the pattern of marine environmental contamination in Indonesia (18).

In addition, research on the Abundance and Characteristics of Microplastics in Traditional Salt Products in Jene Ponto Regency found that fragments are a more dominant morphology compared to other forms, and showed a variety of colors and sizes of microplastics that reflect the environmental conditions and local salt production processes (19). A study in Surabaya also reported that microplastics in pond water, raw salt, and commercial salt were found primarily in the form of fibers and fragments in various colors, further reinforcing that the pattern of microplastic forms not only occurs globally but is also consistent in Indonesia (20).

The dominance of these fragments is also ecologically consistent with the mechanisms of plastic degradation in the ocean due to physical and chemical environmental exposure (21). Meanwhile, the linear form in this study indicates the contribution of materials such as plastic ropes, synthetic fibers, and fishing nets dispersed in coastal waters, as described by studies on microplastic morphology in marine environments (22). The absence of certain microplastic forms during the iodization stage relatively reflects the technical characteristics of the salt production process, which is more influenced by physical stages such as filtration and drying rather than the chemical reaction of iodine with the chemically inert microplastic polymer structure (23).

3.3. Color and Polymer of Microplastics in Salt Samples

In terms of color, the research results show that the most dominant color of microplastics found is black, with 32 pieces, followed by transparent with 10 pieces, as well as other colors such as red, yellow, and green. The dominance of black color in microplastics is often associated with the degradation of plastics originating from industrial materials, dark-colored plastic bags, and plastic materials that have undergone oxidation and aging due to exposure to ultraviolet light and mechanical abrasion in the marine environment (24).

These findings are in line with global studies showing that more than 90% of salt samples in various countries contain microplastics, with dark and transparent colors being the most frequently encountered, reflecting the high contribution of secondary plastics that have fragmented in aquatic environments (25). In addition, a literature review on edible salt in Indonesia identified the presence of various microplastic colors, including black, transparent, red, blue, green, and purple, indicating a similar contamination pattern in different coastal regions of Indonesia (9).

Based on the examination results and the polymer type identification using FTIR analysis, it was shown that the types of microplastic polymers identified in the salt samples are Polyethylene (PE) and Polypropylene (PP), with Polyethylene (PE) being dominant, detected in 11 out of 12 samples. This finding is in line with various previous studies that reported PE and PP as the most commonly found polymers in microplastics in sea salt, both globally and in Indonesia. The study by Zhang et al. (2020) found a dominance of PE in consumption salt samples in China (26), whereas the research by Kim et al. (2022) reported that PE and PP were frequently found in sea salt from various international brands (16). The study by Li et al. (2021) also confirmed that PE and PP are the most stable and widespread polymers in coastal waters, making them easily transported and trapped in salt products (21).

In addition to originating from aquatic environments, the presence of PE and PP microplastics is also influenced by the post-salt production stages, such as the use of plastic containers, plastic sacks, and synthetic polymer packaging during drying, storage, and distribution of salt. Mechanical abrasion and degradation of plastic packaging can potentially release additional microplastics, which further contaminate the final product (27).

3.4. Microplastic Concentration in Salt Samples

The analysis results showed that the concentration of microplastics in salt ranged from 0,008-0,04 mg/kg, with an average of 0.019 mg/kg. Most of these microplastics come from seawater as the raw material, because the ocean is a global reservoir of microplastics due to the accumulation of plastic waste that has fragmented into microplastic particles (<5 mm) that are carried into the salt through the evaporation process (28). Variations in concentration among salt samples are influenced by the production process, including the method of seawater extraction, evaporation techniques, and filtration or washing stages (29). Salt produced through traditional processes without filtration tends to have higher microplastic concentrations, as particles remain trapped with the salt crystals, whereas salt that undergoes industrial processes with additional filtration shows a decrease in the number of microplastic particles in the final product (30).

In addition, the source location of seawater also plays an important role, as areas near river mouths or zones with high human activity have higher microplastic contamination (31). The packaging and marketing stages of salt also affect the amount of microplastics, especially if the salt is packaged in non-sterile plastic or if the process is carried out in a dusty environment. The distribution of bulk salt in traditional markets also has the potential to increase microplastic contamination, although its contribution is smaller compared to that from raw materials and production (32).

4. Conclusion

All salt samples produced by local industries in Muna Regency were proven to be contaminated with microplastics, with the dominant forms being fragments and lines. The most commonly identified polymer types were Polyethylene (PE), followed by Polypropylene (PP), indicating that the microplastics originated from the degradation of secondary plastics commonly found in the marine environment as well as from post-production processes. Although the microplastic concentrations found were relatively low, their consistent presence in all samples indicates a potential for continuous exposure for consumers. Therefore, improvements in raw material management, production processes, and packaging and distribution systems are needed to reduce the risk of microplastic contamination in table salt.

Compliance with ethical standards

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Disclosure of conflict of interest

There is no conflict of interest in this research

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