ORIGINAL PAPER

The particles of microplastics in shrimp paste from the Gulf of Thailand and the Andaman Sea

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Abstract. Microplastics are considered contaminants in marine ecosystems around the world and have been a growing problem. Currently, microplastics are one of the most significant environmental challenges worldwide. Marine organisms such as crustaceans, fish, and mussels can either directly ingest microplastic or accumulate it from the food web. Therefore, fisheries-target species from those groups become a potential source of microplastic contamination for human consumers. This study aimed to examine the microplastic contaminants in shrimp paste in Thailand. Shrimp paste samples were purchased from five provinces, both from the Andaman Sea and the Gulf of Thailand. The abundance of microplastics in the shrimp paste was examined by hydrogen peroxide, analyzed under a stereomicroscope, and later identified by using Fourier Transform Infrared spectroscopy (FTIR). The results showed that the densities of microplastics in shrimp paste varied from 6 to 11.3 particles/10 g. The microplastics were composed of fibers and fragments, ranging from 0.1 to 1.0 mm in length. Five different types of plastic polymer were found, i.e., polyethylene terephthalate, polyurethane, rayon, polystyrene, and polyvinyl alcohol. This study confirmed microplastic presence in shrimp paste, and urgent measures are needed to prevent recurrent contamination of food items produced for human consumption and related health problems. We propose to work in collaboration with local communities to ensure clean fishery products and reducing microplastic contamination.

Keywords: microplastics, fishery products, Gulf of Thailand, Andaman Sea

1. Introduction

Plastic pollution is a problem of the 21st century globally due to the high plastics demanding from numerous industries has led to increased global plastic production, approximately 348 million tons in 2017 (Liu et al., 2018; PlasticsEurope, 2019). The estimation of mismanaged plastic waste is approximately 60-90 million tons per year in 2015 added to the environment and will be increased to 155-265 million tons per year by 2060 (Lebreton and Andrady, 2019). Consequently, it has been estimated that plastics could be entering the marine environment approximately 4.8-12.7 million tons per year (Jambeck et al., 2015).

Microplastics are widely spread in marine environments and are found in many coastal waters such as the Pacific (Desforges et al., 2014), Atlantic (Enders et al., 2015), and the Arctic (Lusher et al., 2015). Microplastics are considered contaminants in marine ecosystems worldwide and have been a growing problem (Cole et al., 2011). Definition of microplastics that the plastic particles are smaller than 5 mm (Thompson et al., 2004; Arthur et al., 2009; Thompson, 2015). Microplastics particles are a threat to marine organisms that they are often mistaken as food because of their small size (Neves et al., 2015). Several marine organisms can either directly ingest microplastic or accumulate it from the food web, such as worms (Wright et al., 2013), larvae of oysters (Cole and Galloway, 2015), fish (Bellas et al., 2016; Barboza et al., 2020), mussels (Van Cauwenberghe et al., 2015), and crabs (Watts et al., 2014). Therefore, fisheries-target species from those groups become a potential source of microplastic contamination for human consumers.

Shrimp pastes are one of the fisheries-target products in Thailand. Those are locally known as Kapi. Shrimp pastes are a crucial ingredient for Thai cuisine especially making shrimp paste chili sauce or dipping sauce when served with sour fruits. Due to shrimp paste made from krills, which present a tiny size. The krills are collected by using a net with a small mesh size. Therefore, microplastics can be contaminants during collected krills, leading to accumulating those of microplastics pass-through shrimp paste to the human consumers. However, there are no data available on microplastics in the shrimp paste. This study aimed to examine the microplastic contaminants in shrimp paste in Thailand.

2. Materials and Methods

2.1 Location of shrimp paste produced

Seven shrimp paste samples were purchased from six local markets in five provinces, both from the Andaman Sea and the Gulf of Thailand, as shown in table 1.

2.2 Microplastics extraction

The shrimp paste samples were digested with 30% hydrogen peroxide (H_2O_2). Moreover, the samples were heated up to 55-65 ºC during the digestion process until they were completely digested. The microplastics in shrimp paste products were separated from the digested shrimp paste samples using a flotation technique with a saturated sodium chloride solution (250 g/ml). After 24 h of floatation at room temperature, the overlying water was vacuum filtered through a 20 µm of pore size filter (Mathalon and Hill, 2014). The samples were compared with blanks, H_2O_2 in an empty vial run to correct potential air-borne particle deposition in the laboratory. Microplastics samples were placed into a clean glass petri dish for observation under a stereoscopic microscope, and photographs were taken using a digital camera.

2.3 Microplastics identification

All plastic particles were visually identified, counted and measured, by classifying them according to four size classes: 101-500 µm; 501-1000 µm; 1001-1500 µm and 1501-2000 µm. The microplastics types in the shrimp paste were identified by using a Fourier transform infrared spectroscopy (FTIR).

2.4 Statistical analysis

The average abundance of microplastics particles in shrimp paste was expressed in particle/10 g shrimp paste. Duncan new multiple range test in R program version 3.3.2 was used to analyze the difference in microplastics accumulation in shrimp paste
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Table 1. Location of shrimp paste purchasing in this study

Samples	Local market	Province
Shrimp paste	Ko Chang	Trat
Shrimp paste	Tha Sea	Chumphon
Shrimp paste	Lanta	Krabi
Shrimp paste	Samut Sakorn	Samut Sakorn
Shrimp paste	Tha Chana	Surat Thani
Shrimp paste (Big krill)	Kanchanadit	Surat Thani
Shrimp paste (Small krill)	Kanchanadit	Surat Thani

3. Results

The results showed that the densities of microplastics in shrimp paste varied from 6 to 11.3 particles/10 g (Figure 1). The highest density of microplastics was found in the shrimp paste from Kanchanadit (Big krill) with 12.66±0.47 particles/10 g but did not significantly different with all samples except the microplastics contamination of shrimp paste from Tha Chana (5.66±2.05 particles/10 g). The highest composition of microplastics size was ranged 501-1000 µm at Tha Sae, Tha Chana, Kanchanadit (Big krill), and Kanchanadit (Small krill), while the highest composition of microplastic size from Ko Chang and Lanta was ranged 100-500 µm in length (Figure 2).

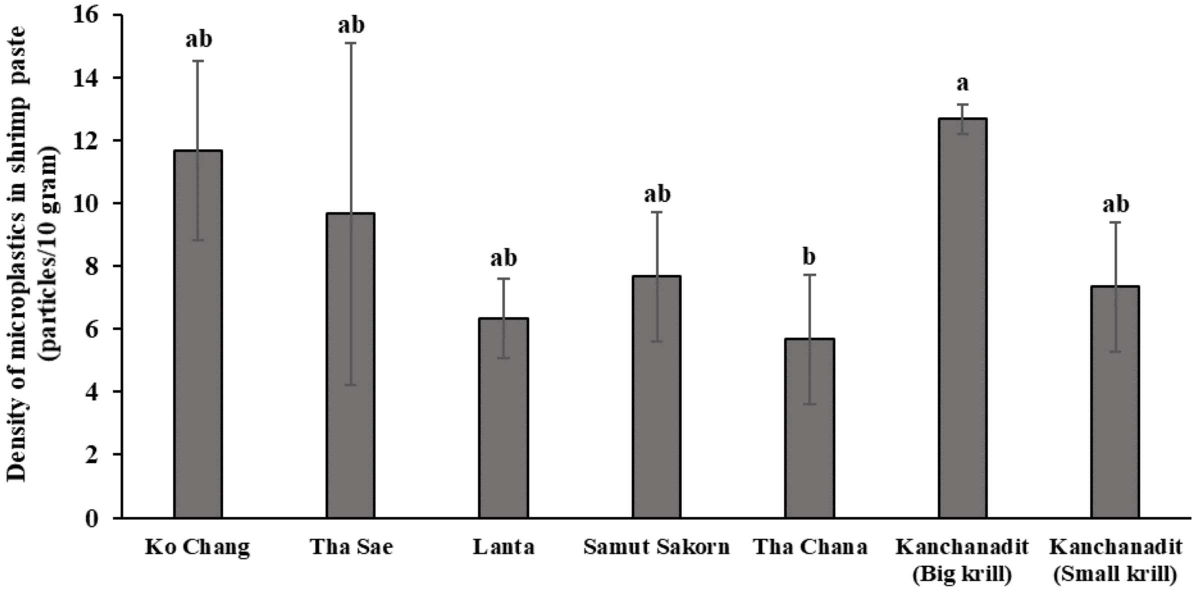

Figure 1. Accumulation of microplastics in shrimp paste from five provinces (Mean±SD)

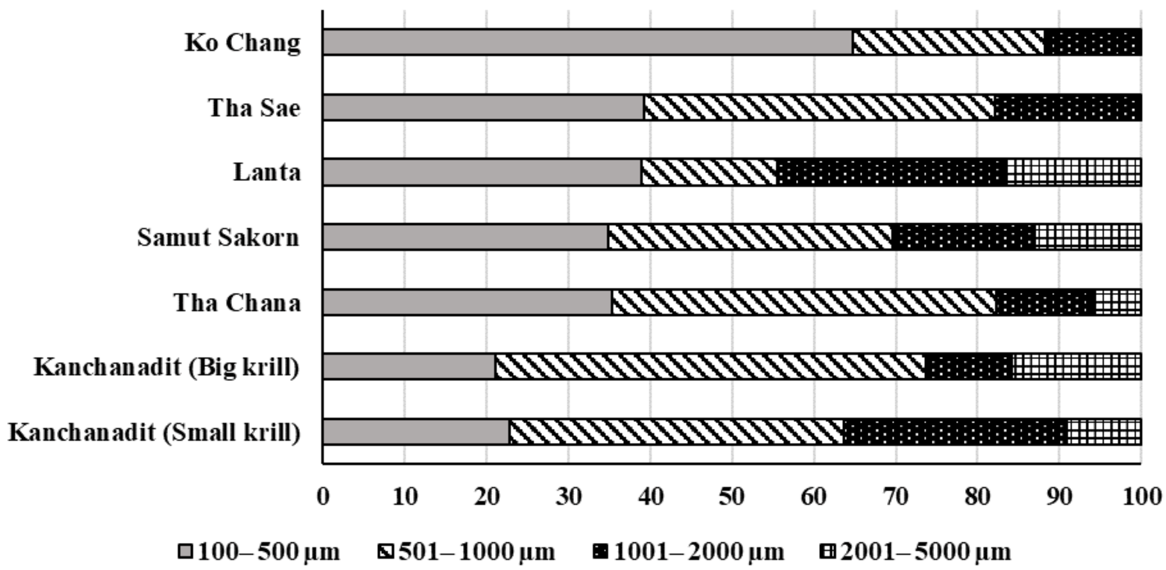

Figure 2. Accumulation of microplastics in shrimp paste from five different provinces

The microplastics were composed of fibers and fragments, ranging from 0.1 to 5.0 mm in length. Most microplastics found in this study were blue filamentous microplastics and followed by red filamentous microplastics (Table 2.and Figure 3.). The chromatogram of microplastics samples showed that four different types of plastic polymers (polyethylene terephthalate, polyurethane, polystyrene, and polyvinyl alcohol) were found in this study (Figure 4.)

Table 2. Percentage of forms and color of microplastics found in shrimp paste

Location	Forms (%)		Colours (%)					
	Fragment	Filament	Red	Blue	Black	Grey	White	Green
Ko Chang	45.71	54.29	5.71	94.29	0.00	0.00	0.00	0.00
Tha Sae	7.14	92.86	7.14	89.29	0.00	0.00	3.57	0.00
Lanta	0.00	100.00	11.11	88.89	0.00	0.00	0.00	0.00
Samut Sakorn	0.00	100.00	8.70	86.96	0.00	0.00	4.35	0.00
Tha Chana	17.65	82.35	17.65	52.94	23.53	5.88	0.00	0.00
Kanchanadit (Big krill)	0.00	100.00	21.05	71.05	5.26	0.00	0.00	2.63
Kanchanadit (Small krill)	0.00	100.00	18.18	81.82	0.00	0.00	0.00	0.00

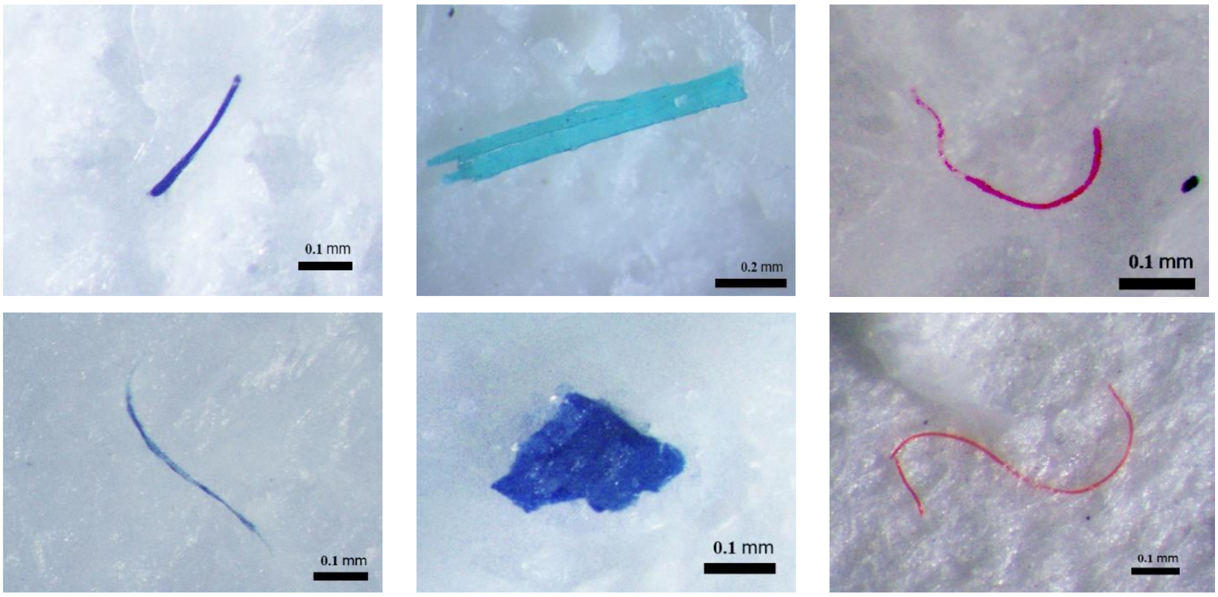

Figure 3. Microplastics particles found in shrimp paste

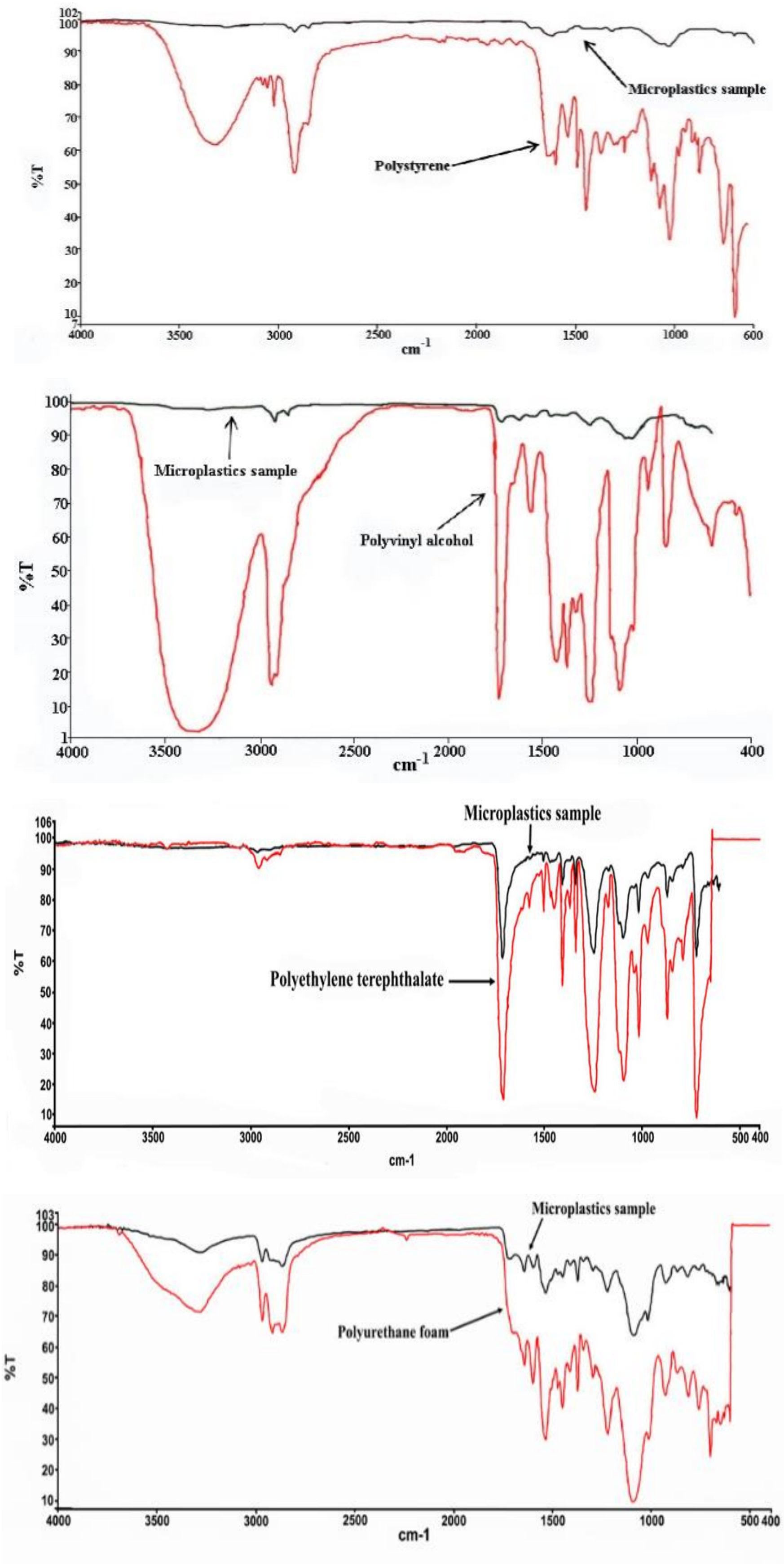

Figure 4. Chromatogram of microplastics samples compared to the standard chromatogram of microplastics

4. Discussion

Microplastics have been reported in several products such as sea salt, beer, honey, sugar, canned fish (Liebezeit and Liebezeit, 2013; Liebezeit and Liebezeit, 2014; Iniguez et al., 2017; Karami et al., 2018; Kosuth et al., 2018; Lira et al., 2020). Moreover, the microplastics accumulation of honey and beers has been overestimated (Lachenmeier et al., 2015; Mühlschlegel et al., 2017). There are several studies on dietary intake of microplastics, particularly drinking water and seafood products (Lusher et al., 2017; WHO, 2019). Unfortunately, the number of publications on the occurring of microplastics in the shrimp paste is very limited (Lira et al. 2020) when compared to the number of papers investigating the presence in the shrimp or krill (Devriese et al., 2015; Bordbar et al., 2018; Bergami et al., 2020; Dawson et al., 2020).

Microplastics in seafood are concerned due to their impact on human health (Sharma and Chatterjee, 2017; Smith et al., 2018). Shrimp paste is prepared by sea salt, and krill fermented that making three possible ways of microplastics ingestion are microplastics from krill, sea salts, and water used. All the processes to make shrimp paste products are the possible route of microplastic ingestion to humans frequently discussed in the relative human health and food security (Barboza et al., 2018; Smith et al., 2018; Cox et al., 2019). Lassen et al. (2015) revealed that the human gastrointestinal tract could absorb ingestion of microplastic particles from toothpaste. However, the fate of microplastics from ingested seafood in humans is not verified.

This study confirmed microplastics presence in shrimp paste, and urgent measures are needed to prevent recurrent contamination of food items produced for human consumption and related health problems. We propose to work in collaboration with local communities to ensure clean fishery products and reducing microplastic contamination. Further work will study methods of reducing microplastics contamination in products to be a guideline for other areas.

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