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Abundance and composition of microplastics in dried anchovy products from the Western Gulf of Thailand

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Abstract. Plastic waste has been a global environmental concern as it enters the sea, becoming plastic debris. The plastic waste can be broken down into small pieces called microplastics, generally less than 5 mm in size. Microplastics can be transferred to marine food webs through ingestion and accumulation of marine organisms. This study quantifies the abundance and composition of microplastics in dried anchovy products bought from the local fishing markets in the Western Gulf of Thailand. The samples were digested with 30% hydrogen peroxide solution, then filtered with a filter paper. The density and characteristics (color, shape, and size) of microplastic particles were assessed under a stereomicroscope. The plastic particles were then classified using a Fourier transform infrared spectroscopy (FTIR). The samples from five dried anchovy products showed that the abundance of microplastics in dried anchovy fishes ranged from 0.47 - 3.18 particles per gram with the size of microplastics range of 109-1,006 microns. This study suggests the contamination of microplastics in dried anchovies, linking to the concerns on seafood safety and human health.

Keywords: Microplastics, Western Gulf of Thailand, Dried anchovy, Seafood safety

1. Introduction

Microplastics are defined as plastic fragments that are less than five millimeters long and have various shapes and types that can be harmful to our ocean and various aquatic organisms. Plastics have been widely used in many industries to produce most products for daily life. Currently, plastics are produced more than a million tons per year, corresponding to an increase in plastic consumption around the world. Plastic waste has been growing across the world due to insufficient and ineffective waste management systems. Unmanaged plastic waste generated from various anthropogenic activities pollutes the oceans (Betts 2008; Hidalgo-Ruz et al. 2012; Wright 2013). Most characteristics of microplastics detected in the marine environment include spheres, pellets, irregular fragments, and fibers (Horsman 1982). Anthropogenic activities have long been generating plastic wastes to water resources and coastal and marine ecosystems, such as sandy beaches and coral reefs. These ecosystems are inevitably affected by microplastics. Microplastics contaminating marine ecosystems are generated from land-based sources such as water treatment plant effluents, fishing gears, shipping and maritime activities, agricultural, domestic, and industrial sewage discharge. Plastic wastes are fragmented via the natural weathering process, becoming smaller in size and contaminating the marine and coastal ecosystems (Horsman 1982; Galgani 2000; Thompson et al. 2004; Ng and Obbard 2006; Fendall and Sewell 2009; Andrady 2011; Browne et al. 2011).

Bioaccumulation and biomagnification of microplastics can potentially occur along the food chain. This potential is a critical concern because toxic compounds in microplastics may have several negative impacts on marine ecosystems and human health. Currently, the impacts of microplastics on the marine environment and organisms have been interested worldwide, particularly microplastic ingestion by marine organisms such as plankton, benthic organisms, crustaceans, fish, filter feeders, sea turtles, seabirds, and marine mammals (Wright 2013; Farrell and Nelson 2013; Ivar do Sul and Costa 2014).

Several studies showed that microplastics could contaminate in various commercial marine organisms like sessile invertebrates, gastropods, bivalves, fishes, and crustaceans (Fendall et al. 2013; Mathalon and Hill 2014; Avio et al. 2015; Gall and Thompson 2015; Neves et al. 2015; Danopoulos et al. 2020; Dawson et al. 2020; Yu et al. 2020). Sutthacheep et al. (2021) studied the accumulation of microplastics particles in shrimp paste products, which are made from krill Acetes spp., from each local community on the coast of the Gulf of Thailand and the Andaman Sea. The dominant microplastics in shrimp paste products were composed of fibers and fragments, consisting of four plastic polymers (polyethylene terephthalate, polyurethane, polystyrene, and polyvinyl alcohol). However, few studies report the contamination of microplastics in Thai seafood products. There is still a huge research gap on this topic; thus, in this study, we quantify the abundance and composition of microplastics in dried anchovy products bought from the local fishing markets in the Western Gulf of Thailand.

2. Materials and Methods

Five dried anchovy products were obtained from local markets in the Western Gulf of Thailand to assess microplastics contamination. Each sample was digested with 30% hydrogen peroxide in a water bath at 60 degrees Celsius. Then, the sample was diluted with distilled water and filtered with glass microfiber filters. After that, the density, color, shape, and size of microplastics were observed under a stereomicroscope. Finally, the types of microplastics were identified using Fourier Transform Infrared (FTIR) spectroscopy.

3. Results

Overall, the average abundance of microplastics in dried anchovy products ranged from 0.00 - 13.89 particles per gram of dry weight, with an average of 3.60 particles per gram of dry weight. The highest abundance of microplastics was found in dried anchovy of product E (3.18 particles per gram of dry weight), while the lowest one wasfound in dried anchovy of product A (0.47 particles per gram of dry weight). A total of six colors of microplastic fibers include black, dark blue, red, yellow, purple, and blue. The fibers with black and dark blue were mainly detected at all products. The microplastic size found in this study ranged from 100 to 1,000 μm. Four types of microplastics were found, including Polyethylene (PE), Polyethylene terephthalate (PET), Rayon, and Polypropylene (PP). Polyethylene (PE) was a major type of microplastics, 33% and 67% of which were found in Product A and B, respectively.

4. Discussion

Anthropogenic activities create various sources of pollution that affect many ecosystems and marine organisms, which further generate long-term effects on human health (Lebreton et al. 2017; Khalik et al. 2018; Smith et al. 2018; Tang et al. 2018). This study provides the first assessment of the occurrence of microplastics in dried anchovy products in Thailand. The abundance of microplastics varied considerably among the products, which may be due to the different processes used in each dried anchovy product. In this study, the result of the FTIR test revealed that most samples had polyethylene (PE) as a major plastic type. Several studies in anchovies caught from different regions had PE as a major plastic type which is in accordance with the present study (Tanaka and Takada 2016; Collard et al. 2017; Murphy et al. 2017; Ningrum and Patria 2019; Hardianti et al. 2021). Microplastics with blue color were the most dominant particles found in dried anchovy products. In addition, fibers were the most common form of microplastics, supporting the claim that most plastic particles that are blue and fibrous are the most common form of plastic particles found in other species of pelagic fish (Boerger et al. 2010; Reisser et al. 2013; Rochman et al. 2015; Azad et al. 2018; Gago et al. 2018; Wu et al. 2020; Zheng et al. 2020; Phaksopa et al. 2021).

Micro and nanoplastics could also be translocated and accumulated in several organisms, particularly the ones at lower trophic levels and food webs through bioaccumulation and biomagnification (Rochman et al. 2013; van Cauwenberghe et al. 2015; Saley et al. 2019). Collard et al. (2017) also

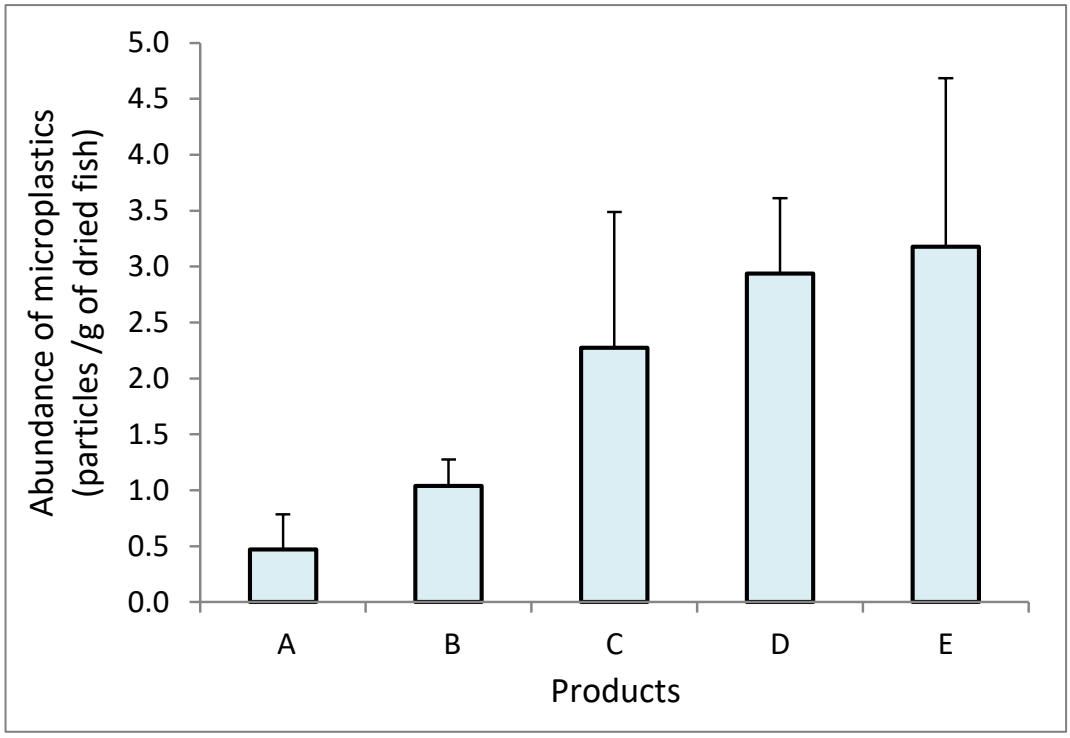

Figure 1. Microplastics abundance in dried anchovy fish from products

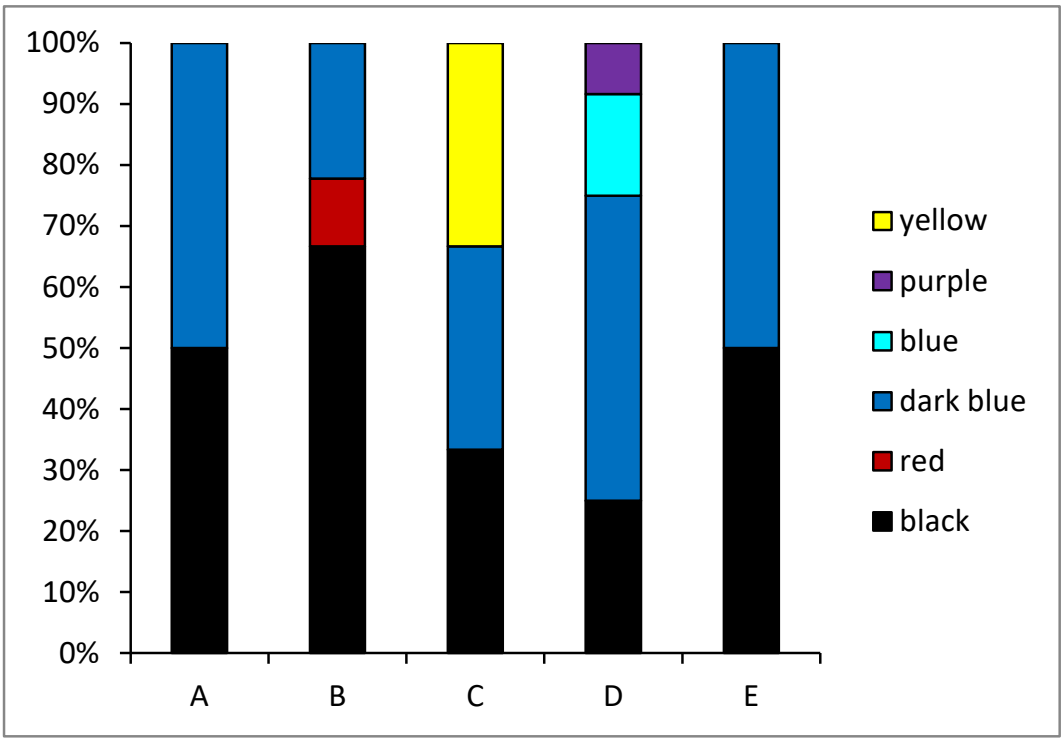

Figure 2. Color composition of microplastic fibres found in dried anchovy fish products

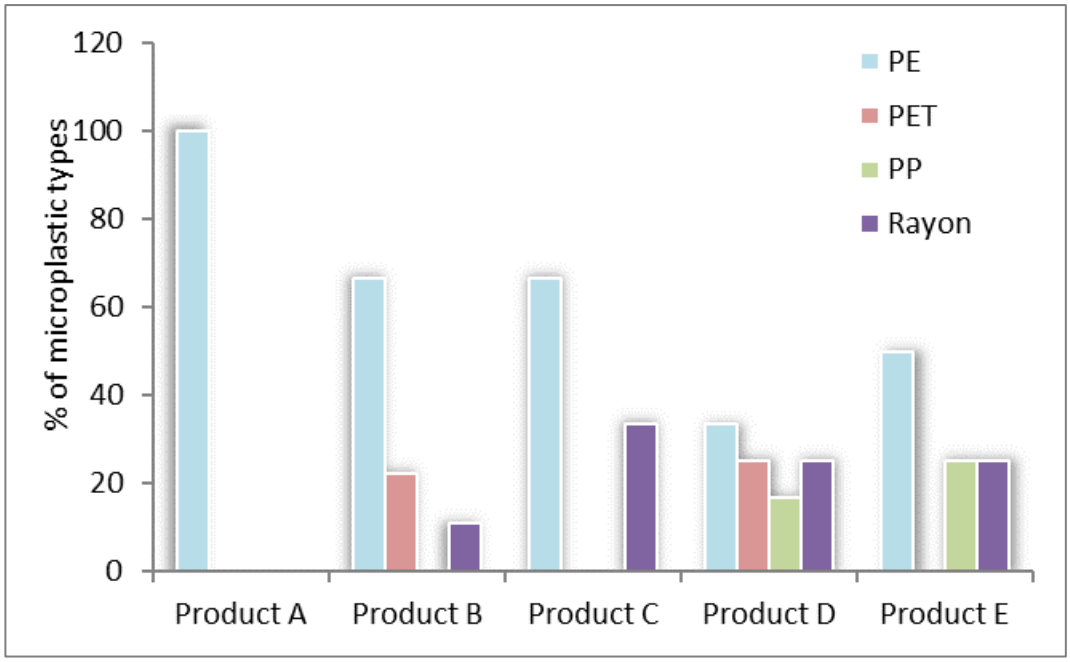

Figure 3. Types of microplastics found in dried anchovy fish products

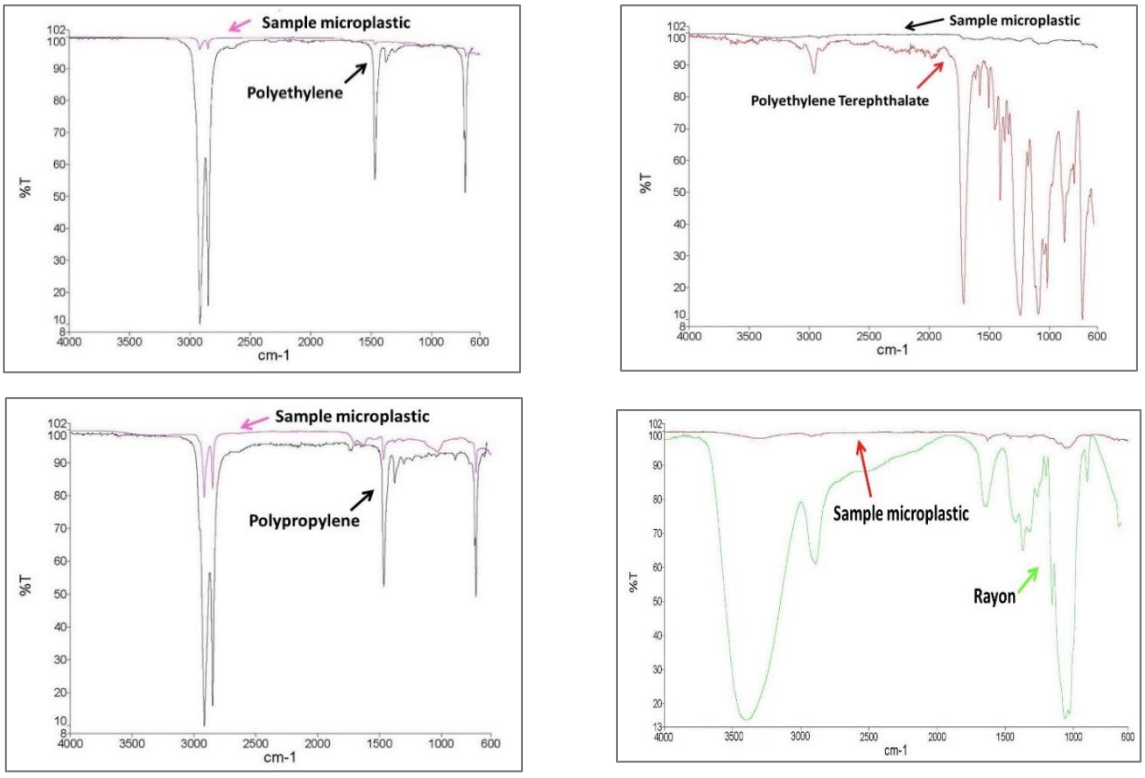

Figure 4. FTIR spectra of the fibrous microplastics

found the accumulation of microplastics in the European anchovy (*Engraulis encrasicolus*), the European pilchard (*Sardina pilchardus*), and the Atlantic herring (*Clupea harengus*) collected in the English Channel. For anchovies, about 80 percent of their livers contained large particles of microplastics, illustrating a high level of contamination.

A wide variety of marine animals cannot avoid feeding on microplastics as they are unable to distinguish between their foods and microplastics. Considering seafood consumption trends and

microplastic contamination reported in marine organisms in literatures, there is some evidence of the potential link between and contamination of seafood and human consumption. Shrimp paste products are an essential ingredient of many local dishes in Thailand and the products are contaminated by microplastics, making more concerns on health issues of Thai people in the future (Sutthacheep et al. 2021). Several studies assessed and quantified microplastic contamination in seafood, revealing that diverse commercial organisms had been contaminated (Danopoulos et al. 2020; Dawson et al. 2021). Microplastic accumulation in marine organisms becomes a threat to human health via seafood consumption. (Rochman et al. 2015; Smith et al. 2018; Ningrum Patria 2019).

Based on our findings, it is obvious that microplastic contamination can be found in dried anchovy fish products. Microplastics can be accumulated in humans via the consumption of dried anchovy fish, causing health problems. Therefore, reducing microplastics contamination in fishery products is essential to prevent impacts on consumers' health. (Farrell et al., 2009; 2013; Bissen et al., 2020; Sutthacheep et al., 2021). This study provides important baseline data on microplastics accumulations in seafood products. A long-term monitoring program for microplastics accumulations in seafood products in Thailand is still needed to monitor, manage and consider for reducing microplastics in the marine environment and seafood products.

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