Microplastics investigation on the popular seafood of Samut Songkhram, Thailand

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Abstract

Microplastic contamination in seafood has become a growing concern now worldwide, particularly in regions with marine fisheries and high seafood consumption. Investigating microplastics in the seafood of Samut Songkhram, a coastal province in Thailand renowned for its seafood, can provide insights into the potential risks to human health and the environment. Short mackerel (platou), Blood cockles, Green mussels and White shrimp from market were microplastic identified under microscopic after treated with 10% KOH and filtrated with filter paper 0.45 µm. The results showed microplastic contamination in short mackerel, with a total of 137 pieces (23%). This equates to 0.075 pieces per gram in the flesh and 0.387 pieces per gram in the giblets. Additionally, 308 pieces of microplastic (47.38%) were found in blood clams, at a concentration of 1.38 pieces per gram. In white shrimp, 227 pieces (19.7%) of microplastic contamination were detected, with 0.69 pieces per gram in the head and 0.145 pieces per gram in the flesh. Finally, microplastic contamination in green mussels was found to be 102 pieces, accounting for 14.57% and 0.143 pieces per gram. Moreover, the sea water sample from Don Hoi found MPs 1.57% and 0.016 pieces/gram of average contaminate rate. The MPs exhibited various shapes including bars, circles and fibers as well as a range of colors such as black, brown, pink, white, red, orange and green. However, all types of seafood samples showed no statistically significant differences in microplastic contamination with *p-value* $\geq$0.05. The results indicate that all seafood samples were contaminated with microplastics, highlighting the need to raise awareness about potential health impacts.

Keywords: microplastics, seafood, Samut Songkhram

1. Introduction

Microplastics (MPs) are tiny plastic particles that are less than 5 millimeters in size, resulting from the breakdown of larger plastic items or as byproducts of industrial processes or household wastewater. It have emerged as a pervasive environmental concern due to their widespread distribution potential for ecological harm and implications for human health. Owing to their prevalence in marine environments, freshwater systems, soil, air, and even food and drinking water. In case marine environments, there are many study on microplastic contamination specially in sea food such as marine fish, cephapods, crustaceans and bivale mollusks with many type of plastics (Visciano, 2024).

Thailand has many coastal provinces, causing a lot of saltwater fishing. Samut Songkhram is one of the provinces that border the Gulf of Thailand, and is a passageway for the Mae Klong River to flow out to the sea. Additionally, Samut Songkhram has famous for the seafood, especially mackerel (platou), which is sold throughout the country with a unique delicious taste. Additionally, the study of Chaiphongpachara and his team were present parasites namely *Anisakis typica* contaminate on mackerel (platou) from Samut Songkhram provinces (Chaiphongpachara et al., 2022). This suggests that mackerel may also be contaminated with other foreign substances. In our country, there are several studies on seafood contaminated by MPs such as edible marine fishes from upper the Gulf of Thailand by study of Srisiri and his coworkers. They found that MPs contaminated 46.9% in gastrointestinal tracts of fishes sampled (collected from 2019 to 2020), with a mean concentration of 1.6 ± 0.5 pieces per fish or 0.04 ± 0.01 pieces/g of fish tissue (Srisiri et al., 2024). Another study along Thailand's eastern coast detected MPs around 13.14% of gills and gastrointestinal tracts of fish sample, with fibrous particles being the most common form (Phaksopa et al., 2021). The southern region of Thailand is bordered by coastal areas along both the Gulf of Thailand and the Andaman Sea. Suratthani Province where located in south region were found with MPs in green mussels (*Perna viridis*) and cockles (*Tegillarca granosa*), reporting higher concentrations in green mussels (Ruairuen et al., 2021). Songkla province as well where researcher survey MPs on blood cockles and shrimps from fishery market that their presented 4.71±0.06 n/g (wet weight) and 2.64±0.01 n/individual on blood cockles, 0.50±0.19 n/g (wet weight) and 3.70±1.12 n/individual on fine shrimp, 0.69±0.48 n/g (wet weight) and 3.45±0.04n/individual on Indian white shrimp (Blair Goh et al., 2021). It can be observed from various studies that microplastics have been detected in seafood from provinces in both the central and southern regions of Thailand. However, as mentioned earlier, Samut Songkhram Province is renowned for its seafood, especially short mackerel and other types of seafood. The research team, therefore, became aware of the potential contamination of microplastics in these foods and conducted an investigation into short mackerel, blood clams, green mussels and white shrimp purchased from markets in the Maeklong District, Samut Songkhram Province. In addition, seawater samples were also collected to analyze for microplastics. This is to understand the current situation of microplastic contamination as a guideline for preventing or reducing the level of contamination in the future.

2. Methods

The seafood sample which composed of short mackerel, blood clams, mussels and white shrimp (Fig.2) were collected in the period of November 2023 to March 2024 by purchased from markets in the Maeklong District, Samut Songkhram Province (Fig.1) And seawater samples were collected from Don Hoi Lod place where located Gulf of Thailand. The experiment was adapted from Mathalon & Hill (2014) and GESAMP (2019) and all sample were performed triplicate. Briefly, all sample from mackerel, blood clams, mussels and white shrimp were cleaned by tap water and peal off the shell in case of blood clams, mussels and white shrimp. For mackerel and white shrimp, the sample was separated between gastrointestinal tract, head and fresh, respectively. The meat was washed with distilled water and approximately 1 gram of the finely ground tissue was randomly collected and added to the solution 200 ml of 10% KOH, heated to 60 °C, warm the sample until the solution evaporates around 24 hours, then add saturated sodium chloride (NaCl) (250 g/L) 100 ml and stir the

sample using a magnetic stirrer for 1-2 minutes, leave the sample to precipitate, use a pipette to suck the clear part to filter through a 0.45 μm filter paper and bake the filter paper at 50 °C until dried and take the sample to analyze for microplastics. The filter paper is analyzed to identify the physical characteristics of microplastics, including size, amount, shape, and color found using a stereo microscope. The differences in the average number of microplastics in various types of marine animals were tested by analyzing variance using the ANOVA method at a 95% confidence level.

Fig.1 Thailand map illustrate Samut Songkram province where seafood sample purchased from markets in this province. (Map adapted from Senarat et al., 2015)

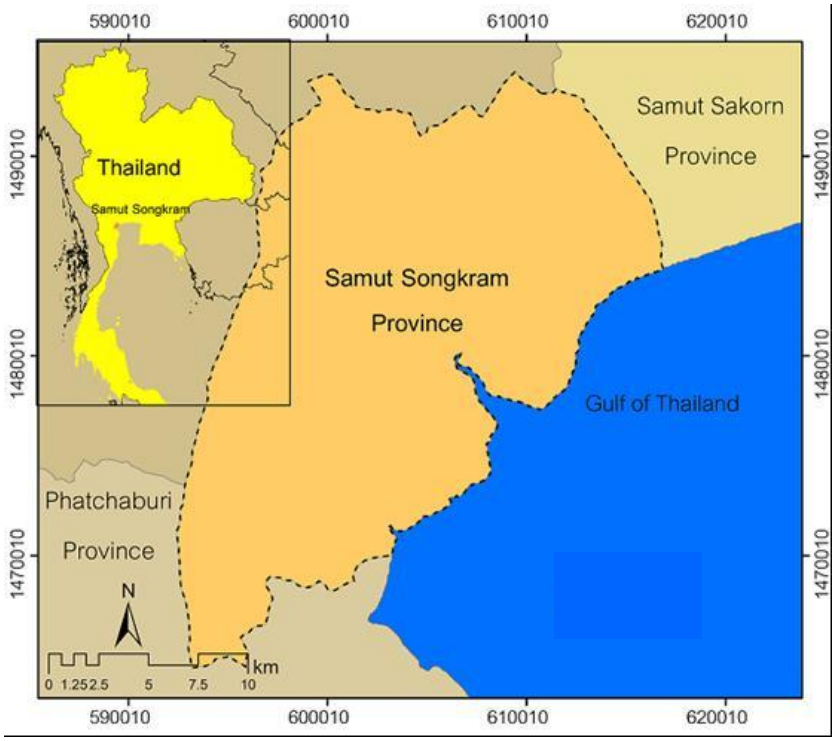


Fig.2 *The picture present seafood sample: short mackerel A), blood clams B), mussels C) and white shrimp D).*

3. Results

From the examination of microplastic contamination in four types of seafood—short mackerel, blood cockles, mussels, and white shrimp—as well as seawater samples from the Don Hoi Lot area, all sourced from Samut Songkhram province.

The results revealed microplastic contamination in mackerel, with a total of 137 pieces (23%), equivalent to 0.075 pieces per gram in the flesh and 0.387 pieces per gram in the giblets. Blood clams showed the highest contamination, with 308 pieces (47.38%) at a concentration of 1.38 pieces per gram. In white shrimp, 227 pieces (19.7%) of microplastics were detected, with contamination levels of 0.69 pieces per gram in the head and 0.145 pieces per gram in the flesh. Mussels contained 102 pieces (14.57%), with a concentration of 0.143 pieces per gram (Table.1). Additionally, microplastic contamination was detected in the seawater sample from Don Hoi Lot, accounting for 1.57% and 0.016 pieces/gram of average contaminate rate (Table.1).

A part from that, MPs morphology were observed in various shapes, including bars, circles, and fibers, and in multiple colors such as black, brown, pink, white, red, and orange which presented on Figure 3. However, when comparing the differences in microplastic contamination among the four types of seafood samples, no statistically significant difference was found at a *p-value* ≥ 0.05 (Table. 2).

Table. 1 The table present Microplastics contamination on short mackerel, blood cockles, mussels, white shrimp and seawater sample from Samut Songkhram provice.

	Short mackerel		**Blood clams**	**Green mussels**	**white shrimp**		**Seawater**
	Flesh	**Giblets**			**Head**	**Flesh**	
% MPs contamination	23%		47.38%	14.57%	19.7%		1.57%
Average contaminate rate (pieces/gram)	0.075	0.387	1.38	0.143	0.69	0.145	0.016
Bar	✓	✓	✓	✓	✓	✓	✓
Circle	✓	✓	✓	✓	✓	✓	✓
Fiber	✓	✓	✓	✓	✓	✓	✓
Unidentified	✓	✓	✓	✓	✓	✓	✓

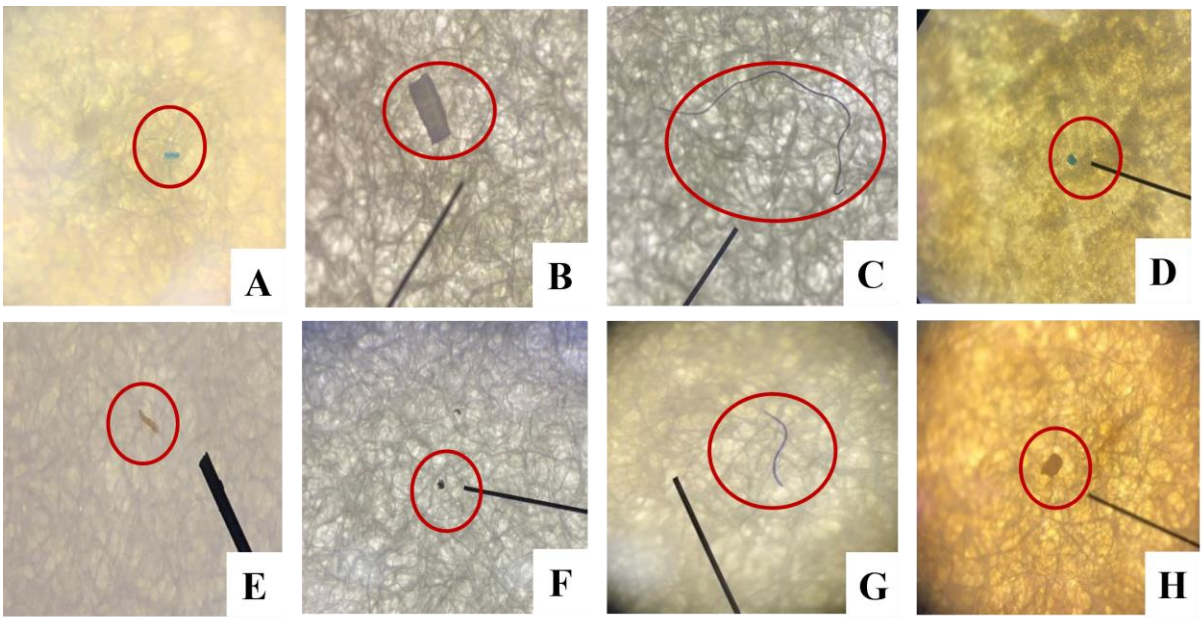
* Note, The symbol ✓ present MPs shape were found on our sample.

Table. 2 Illustration comparing the statistical analysis of microplastic contamination among four types of seafood samples, represented by p-value.

	Short mackerel	Blood clams	Green Mussels	White shrimp
Short mackerel	-	0.275	0.751	0.651
Blood clams	0.275	-	0.201	0.711
Mussels	0.751	0.201	-	0.471
White shrimp	0.651	0.711	0.471	-

* Note, Statistical significant differently at a *p-value* ≥ 0.05.

Figure 3. *Picture show Microplastics morphology on filtered paper from our seafood sample. A) and B) present bar character. C) and G) show fiber character. D), F) and H) illustrate circle shape and E) display unidentified morphology.*



4. Discussion

The survey results on microplastic contamination revealed that blood cockles had the highest contamination rate at 47.38% compared to other seafood samples, followed by mackerel at 23%. Since blood cockles feed on diatoms, phytoplankton, and certain types of zooplankton that live in muddy sediments, which serve as their habitat, they have a higher chance of ingesting microplastics from the sediment compared to other our seafood samples. Our data of blood cockles that have 1.38 pieces/gram of Average contaminate rate were in line with Blair Goh and colleges which high average contaminate rate at 4.71±0.06 n/g (wet weight) where area in this study is Songkla province located South Thailand (Blair Goh et al., 2021). However, the other one province of South Thailand, Surattani, give the opposite result

by green mussels higher than blood cockles both of dry and wet season (Ruairuen et al., 2021).

For mackerel, which ranked lower than blood cockles in the test results, the flesh and internal organs were separated. It was found that the internal organs were more contaminated with MPs than the mackerel flesh. Align with the results of Phaksopa and college that found MPs contaminated in the gastrointestinal tract of 274 fish from Thailand's eastern coast in 2020 (Phaksopa et al., 2020). As well as with the study of Azad and his team which study on the stomach of Mackerel net and small traditional fishing boats found that their sample were contaminated with MPs around 66.67% (Azad et al., 2018). Short mackerel inhabit coastal areas with a water depth of no more than 30 meters. They forage at night, feeding on plankton and small aquatic organisms that more chance expose and ingest microplastics which reasonably found more in gastrointestinal tract of mackerel.

In the sample of white shrimp , the head and body were separated as same as short mackerel. Head of white shrimp were revealed average contaminate rate (0.69 peices/gram) higher than their flesh or body and giblets of short mackerel. Due to at head of white shrimp composed of digestive system organ that more chance to ingest MPs. There are several research that have investigated MPs contamination in white shrimp and consistency with our result. For example, the study on white shrimp of Nakhon Pathom Province, Central Thailand found 27.36±2.28 number/tissue in head which higest than another part of them (Vitheepradit & Prommi, 2023). In addition, there were 3.50 ± 0.34 microfibers in the head of giant freshwater prawns per 5 g weight that study of Tee-ho and co-workers in 2024 (Tee-ho et al.,2024). Part of green mussels, our result present MPs contaminated 14.57% which lowest between our seafood sample at 0.143 pieces/gram. Result show in line with many studies such as the study of AT Ta in 2022 display the number of MPs from the Talaad Thai market and the Sriracha fisheries research station was 96 ± 19 and 11 ± 7 particles/individual, respectively (Ta et al., 2022). Furthermore, the investigation of Imasha and Babel in 2021 and 2023 also exhibit the average abundance of MPs in green mussels was quantified as 7.32 ± 8.33 items/mussel and 1.53 ± 2.04 items/g (wet weight) in year 2021 and 3.2 ± 1.6 items/individua in year 2023 (Imasha & Babel, 2021 and 2023). For the sea water sample from Don Hoi found MPs 1.57% and 0.016 pieces/gram of average contaminate rate as indicate on table 1. From this data illustrated correlation with our seafood sample that come from same province. The MPs exhibited various shapes including bars, circles and fibers as well as a range of colors such as black, brown, pink, white, red, orange and green. However, it shoud be more in-depth identify with structure and type of MPs for more information. Predominantly, several research type of MPs found in seafood such as polyethylene terephthalate (PET), polyvinyl acetate (PVAc), polyethylene (PE), polystyrene (PS), polyvinyl chloride (PVC), polytetrafluoroethylene (PTFE) and polypropylene (PP) and cellulose acetate butyrate (CAB) *etc*. However, all types of seafood samples reveal no statistically significant differences in MPs contamination between them with *p-value* ≥ 0.05 as indicate on table 2. The results indicate that all seafood samples were contaminated with MPs, emphasizing the need to raise awareness about the potential health impacts.

5. Conclusion

Microplastics (MPs) contamination was found in various our seafood samples. By short mackerel contained a total of 137 pieces (23%), equating to 0.075 pieces per gram in the flesh and 0.387 pieces per gram in the giblets. Blood clams had 308 pieces (47.38%) of microplastics, with a concentration of 1.38 pieces per gram. In white shrimp, 227 pieces (19.7%) of microplastic contamination were detected, with 0.69 pieces per gram in the head and 0.145 pieces per gram in the flesh. Green mussels showed 102 pieces of microplastics, accounting for 14.57%, with a concentration of 0.143 pieces per gram. Additionally, sea water samples from Don Hoi contained microplastics at a contamination rate of 1.57% and an average of 0.016 pieces per gram. The MPs found exhibited various shapes, including bars, circles, and fibers, as well as a range of colors such as black, brown, pink, white, red, orange, and green. However, no statistically significant differences in microplastic contamination were observed among the seafood samples, with a p-value ≥ 0.05. These results indicate that all seafood samples were contaminated with MPs, emphasizing the need to raise awareness about potential health impacts.

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References

Azad, S. M. O. Towatana, P. Pradit, S. Patricia, B. G. Hue, H. T. T. Jualaong, S. (2018). First evidence of existence of microplastics in stomach of some commercial fishes in the lower gulf of Thailand, *Applied Ecology and Environmental Research*, 16(6):7345-7360. Available: http://dx.doi.org/10.15666/aeer/1606_73457360

Blair Goh, P. Pradit, S. Towatana, P. Khokkiatwong, S. (2021). Microplastic Abundance in Blood Cockles and Shrimps from Fishery Market, Songkhla Province, Southern Thailand, *Sains Malaysiana*, 50(10):2899-2911. Available: http:// doi.org/10.17576/jsm-2021-5010-05

Chaiphongpachara, T. Adisakwattana, P. Suwandittakul, N. (2022). Intraspecific Genetic Variation of *Anisakis typica* in Indian Mackerel Caught from the Gulf of Thailand, Samut Songkhram Province, *The Scientific World Journal*,Vol. 2022, Article ID 2122619. Available: https://doi.org/10.1155/2022/2122619

GESAMP. (2019). Guidelines for the monitoring and assessment of plastic litter in the ocean. London: GESAMP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection.

Imasha, H U E and Babel, S. (2021). Microplastics Contamination in Commercial Green Mussels from Selected Wet Markets in Thailand, *Archives of Environmental Contamination and Toxicology*, volume 81, pages 449–459.

Imasha, H U E and Babel, S. (2023). Microplastics contamination in the green mussels (*Perna viridis*) cultured for human consumption in Thailand, *Regional Studies in Marine Science*, volume 67,103203. Available: https://doi.org/10.1016/j.rsma.2023.103203

Mathalon, A., & Hill P. (2014). Microplastic fibers in the intertidal ecosystem surrounding Halifax Harbor Nova Scotia, *Marine Pollution Bulletin, 81*(1), 69-79. Available: http:// doi.org/10.1016/j.marpolbul.2014.02.018

Phaksopa, J. Sukhsangchan, R. Keawsang, R. Tanapivattanakul, K. Thamrongnawasawat, T. Worachananant, S and Sreesamran, P. (2021). Presence and Characterization of Microplastics in Coastal Fish around the Eastern Coast of Thailand, *Sustainability*, 13, 13110. Available: https://doi.org/10.3390/su132313110

Ruairuen, W. Chanhun, K. Chainate, W. Ruangpanupan, N. Thipbanpot P and Khammanee N. (2021). Microplastic Contamination in Blood Cockles and Mussels in Bandon Bay, Suratthani Province, Thailand, *Trends in sciences*, 19(7): 3073. Available: https ://doi. org/ 10.48048 /tis.2022.3073

Senarat, S. Kettratad, J. Jiraungkoorskul, W. (2015). Morpho-histology of the Reproductive Duct in Short Mackerel *Rastrelliger brachysoma* (Bleeker, 1865*). Advances in Environmental Biology*, 9(8) Pages: 210-215.

Srisiri, S. Haetrakul, T. Dunbar, S G. And Chansue, N. (2024). Microplastic contamination in edible marine fishes from the upper Gulf of Thailand, *Marine Pollution Bulletin*, Vol. 198, 115785. Available: https://doi.org/10.1016/j.marpolbul.2023.115785

Ta, At. Pupuang, P. Babel, S. Wang, LP. (2022). Investigation of microplastic contamination in blood cockles and green mussels from selected aquaculture farms and markets in Thailand, *Chemosphere*, volume 303, Part 1,134918. Available: https://doi.org/10.1016/j.chemosphere.2022.134918

Visciano, P. (2024). Environmental Contaminants in Fish Products: Food Safety Issues and Remediation Strategies, *Foods*, vol.13, 3511. Available: https: //doi.org /10.3390/ foods 13213511

Vitheepradit, A and Prommi, T. (2023). Microplastics in surface water and tissue of white leg shrimp, *Litopenaeus vannamei,* in a cultured pond in Nakhon Pathom Province, Central Thailand, *AIMS Environmental Science*,10(4): 478–503. Available: https: //doi.org /10.3934/environsci.2023027

Vidmar, R. J. (August 1992). On the use of atmospheric plasmas as electromagnetic reflectors. IEEE Trans. Plasma Sci. [Online]. 21(3). pp. 876-880. Available: http://www.halcyon.com/pub/journals/21ps03-vidmar