Occurrence of microplastics in cosmetic products collected from Myanmar

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Abstract. Plastics pollution in the ocean is an area of growing concern, with research efforts focusing on the cosmetic products of the microplastic (<5mm) fractions. Cosmetic products, such as facial scrubs, have been identified as potentially important primary sources of microplastics to the marine environment. In my study, I observed microplastic beads found in eight facial scrub cleansers that listed polyethylene as an ingredient. They are ingested by diverse marine fauna, including zooplanktons, mussel, oyster, shrimp, fish etc. They can enter human food chains via several pathways. Marine scientists need to educate the public to the dangers of using products that pose an immediate and long-term threat to the health of the oceans and the food we eat.

1. Introduction

Plastics are a ubiquitous part of modern life, encountered on a daily basis in the packaging of foods and drinks, in household items such as combs, toothbrushes and pens, and shopping bags. A large proportion of marine debris consists of plastics which source from land use, wastewater and industrial treatments, waste disposal, and shipboard dumping [3]. The final destination of many large plastic items is dumped to the oceans. Plastic pollution in the ocean area is growing concern with research efforts focusing on both the macroplastic (>5mm) and microplastic (<5mm) fractions. The microbeads used in cosmetic products are less than 1 millimeter in size. However, in the last few years, there has been a major change in the potential for microplastic (<5mm), [4] pollution in the oceans, with the shift from natural to microplastic exfoliators in skin cleansers. Nearly all countries and regions contribute to the release of primary MPs from the use of personal care and cosmetic products (PCCPs), and regional release of primary MPs follows the order: South Asia (18.3%) > North America (17.2%) > Europe and Central Asia (15.9%) > China (15.8%) > East Asia and Oceania (15.0%) > South America (9.1%) > Middle East (8.7%) [1].

Microbeads (micro plastic) are used as scrubbing agents in commercial products such as toothpaste and facial cleansers. In my study, toothpaste, cleanser marketed at stores in Pathein, Myingyan, New York and Tainan cities were obtained and bought items that were available in stores, the included scrub agents were analyzed. In some of these products, twenty-six can see microbeads which are classified as microplastics. In this study, PCCPs collected in Myanmar, Taiwan and U.S to identify their materials
by using FT-IR. There is an umpteen number of studies, globally, to warn us about the use of microplastics in PCCPs and to determine the impact of plastic from facial cleansers and toothpaste. However, no studies have examined primary MPs released from the daily use of facial cleanser and toothpaste in Myanmar. In the present study, facial cleanser and toothpaste containing MPs were investigated in local supermarkets in Pathein and Myingyan, Myanmar. The physical properties of MPs were identified using Fourier transform infrared spectrometry (FT-IR). The present study will be helpful to take actions in Myanmar and other countries to phase-out MPs in coming years, as has already performed in several countries.

2. Materials and Method

2.1. Sample collection
The analysis samples are a total of 2 samples of commercially available products purchased from market and department store in Pathein, Myingyan, Tainan and US city in 2015–2017 (toothpaste: n = 3, face cleanser: n = 23). Provided details of the samples are shown in Table 1. In addition, regard to some face wash samples, scrub agents in products have been improved and marketed after analysis, so they were purchased multiple times from 2015 to 2017, and changes over time in the composition and content of the scrub agents were examined.

| Category          | Sample No. | Country of manufacture |
|-------------------|------------|------------------------|
| Facial cleanser   | F-1        | India                  |
|                   | F-2        | Indonesia              |
|                   | F-3        | Indonesia              |
|                   | F-4        | Thailand               |
|                   | F-5        | Myanmar                |
|                   | F-6        | Myanmar                |
|                   | F-7        | Indonesia              |
|                   | F-8        | Indonesia              |
|                   | F-9        | Thailand               |
|                   | F-10       | Thailand               |
|                   | F-11       | Thailand               |
|                   | F-12       | Indonesia              |
|                   | F-13       | Malaysia               |
|                   | F-14       | Thailand               |
|                   | F-15       | Indonesia              |
|                   | F-16       | Malaysia               |
|                   | F-17       | Thailand               |
|                   | F-18       | U. S. A                |
2.2. Analytical procedures of microplastic in commercial products

The analysis procedure of the commercial product are as follows, 1 g of sample was weighted and sieves with particle sizes of 1,000 µm, 250 µm, and 63 µm were put in series and passed through. After sorting by particles size, it was put into an oven at 35°C for 24 hours and dried. Thereafter, the particles size distribution was grasped by measuring the weight. For some samples, the same operation was performed by adding a 20 µm sieve. A Fourier transform infrared spectrophotometer (FT-IR) was used to identify small particles of each particle size. The measurement of each sample was performed by the ATR method.

In addition, analysis was carried out using an infrared microscope (AIM-9000) for some face cleanser samples. The analysis conditions for FT-IR are shown in Table 2. Regarding identification, the one with the highest match rate among the search results in the library was adopted. Furthermore, with regard to the same sample, in order to check the ingredients contained in the scrub agent, a small amount of the scrub agent was added to the 0.15 ml scale of the condenser tube, then 2 ml of hexane was added and extracted for several days. Thereafter, the characterization was performed using a gas chromatograph mass spectrometer (GC-MS). The analysis conditions for GC-MS are shown in Table 3.

Table 2. Analytical conditions of FT-IR.

| IRAffinity-1S (SHIMADZU) |  |
|--------------------------|--|
| Wavenumber range         | 600 - 4,000 cm-1 |
| Mode                     | Attenuated total reflection (ATR) |
| Resolution               | 4 cm-1 |
| Cumulated number         | 20 scans |
| Analysis software        | LabSolutions IR |
| Infrared microscope: AIM-9000 (SHIMADZU) |  |
| Wavenumber range         | 700 - 4,000 cm-1 |
| Mode                     | Transmission |
| Resolution               | 8 cm-1 |
| Cumulated number         | 40 scans |
| Analysis software        | LabSolutions IR |
Table 3. Analytical conditions of GC-MS.

| Parameter                     | Specification                                      |
|-------------------------------|----------------------------------------------------|
| GC: Agilent 7890B             | MS: Agilent 5977                                   |
| Column                        | HP-5MS (30 m×0.25 mm i.d.×0.25 µm f.t.)            |
| Temperature graduation        | 80 °C - [10 °C/min] - 160 °C (10 min) - [3 °C/min] - 300 °C (10 min) |
| Injection mode                | Splitless mode                                     |
| Injection volume              | 2 µL                                               |
| Injection temperature         | 250 °C                                             |
| Transfer line temperature     | 250 °C                                             |
| Carrier gas                   | He, 1 mL/min (constant flow mode)                  |
| Ion energy                    | 70 eV                                              |
| MS acquisition mode           | Scan mode (SCAN)                                   |

3. Results and discussion

3.1. Concentration and specific profiles of MP in commercial products
In the present investigation, 3 toothpaste from 3 brands, 23 facial cleanser from 13 brands were identified. I observed that the variations of microplastic bead size. Microplastic sizes range from 250-63 µm and 63-20 µm in diameter. The sample weight ratio of scrub in commercial products shows in (Fig. 1). We identified that the following bead size in our samples facial cleanser which contained 16% (20 -1000 µm), 52% (63-250 µm) and 52% (20-63 µm). Moreover, toothpaste contained 43% (63-250 µm) and 57% (63-250 µm) bead size. In my study, the major dominant bead sizes were 63 µm and 20 µm in all facial cleanser and toothpaste (Table 4). From the FT-IR spectra, we found the following plastic types in our facial cleanser and toothpaste such as polyethylene (PE) [Fig 2. (a)], polyethylene oxidized [Fig 2(b)], Calcium carbonate (CaCO₃) [Fig 2(c)] and Silica gel (Table 4).
PE is identified in particles of eight facial cleansers. The microplastics beads contained in eight brands (Sample F-8, 12, 13, 16, 17, 18, 19, and 20) of facial cleansers which were not smooth and spherical but show a variety of irregular shapes that contain white, orange and blue beads. Other brands contained polyethylene oxidized polymer compounds fairly uniform in shape and different color white and black. In toothpaste (Sample T-1, 2 and 3), microbeads were found but the component was calcium carbonate (CaCO₃) and T-2 brands sample was observed as two types of microbeads. They are silica and CaCO₃, it is also not plastic.
Table 4. Concentration of scrub in commercial products.

| Sample | Analysed weight (g) | Particle size (µm) | Scrub weight (g) | Concentration (%) | Total concentration (%) |
|--------|---------------------|--------------------|-----------------|------------------|------------------------|
| F-1    | 1.01                | >1,000             | n.d             | 0.00             | 25.20                  |
|        | 250-1,000           | 0.2021             | 20.00           |                  |                        |
|        | 63-250              | 0.0521             | 5.20            |                  |                        |
| F-2    | 1.04                | >1,000             | n.d             | 0.00             | 16.40                  |
|        | 250-1,000           | 0.0805             | 8.00            |                  |                        |
|        | 63-250              | 0.0847             | 8.40            |                  |                        |
| F-3    | 1                   | >1,000             | n.d             | 0.00             | 19.30                  |
|        | 250-1,000           | 0.1368             | 13.50           |                  |                        |
|        | 63-250              | 0.0583             | 5.80            |                  |                        |
| F-4    | 1                   | >1,000             | n.d             | 0.00             | 4.00                   |
|        | 250-1,000           | 0.0805             | 8.00            |                  |                        |
|        | 63-250              | 0.0406             | 4.00            |                  |                        |
| F-5    | 1.03                | >1,000             | n.d             | 0.00             | 26.90                  |
|        | 250-1,000           | 0.2718             | 26.90           |                  |                        |
|        | 63-250              | 0.0002             | 0.00            |                  |                        |
| F-6    | 1.06                | >1,000             | 0.1031          | 10.20            | 17.10                  |
|        | 250-1,000           | 0.0228             | 2.30            |                  |                        |
|        | 63-250              | 0.0466             | 4.60            |                  |                        |
| F-7    | 1                   | >1,000             | 0.0127          | 1.30             | 21.10                  |
|        | 250-1,000           | 0.1975             | 19.60           |                  |                        |
|        | 63-250              | 0.0034             | 0.30            |                  |                        |
| F-8    | 1.08                | >1,000             | 0.0051          | 0.50             | 27.20                  |
|        | 250-1,000           | 0.2270             | 22.50           |                  |                        |
|        | 63-250              | 0.0422             | 4.20            |                  |                        |
| F-9    | 1                   | >1,000             | n.d             | 0.00             | 22.80                  |
|        | 250-1,000           | 0.2300             | 22.80           |                  |                        |
|        | 63-250              | n.d                | 0.00            |                  |                        |
| F-10   | 1.11                | >1,000             | 0.0100          | 1.00             | 26.70                  |
|        | 250-1,000           | n.d                | 0.00            |                  |                        |
|        | 63-250              | 0.2600             | 25.70           |                  |                        |
| F-11   | 1.04                | >1,000             | n.d             | 0.00             | 15.80                  |
|        | 250-1,000           | 0.0700             | 6.90            |                  |                        |
|        | 63-250              | 0.0900             | 8.90            |                  |                        |
| F-12   | 1.19                | >1,000             | 0.0190          | 1.90             | 29.80                  |
|        | 250-1,000           | 0.2437             | 24.10           |                  |                        |
|        | 63-250              | 0.0382             | 3.80            |                  |                        |
| F-13   | 1.07                | >1,000             | 0.0400          | 4.00             | 11.90                  |
|        | 250-1,000           | 0.0600             | 5.90            |                  |                        |
|        | 63-250              | 0.0200             | 2.00            |                  |                        |
| F-14   | 1.04                | >1,000             | 0.0669          | 6.60             | 19.40                  |
|        | 250-1,000           | 0.0596             | 5.90            |                  |                        |
|        | 63-250              | 0.0692             | 6.90            |                  |                        |
| F-15   | 1.09                | >1,000             | 0.0770          | 7.60             | 41.60                  |
|        | 250-1,000           | 0.0770             | 7.60            |                  |                        |
|        | 63-250              | 0.2659             | 26.30           |                  |                        |
| F-16   | 1.01                | >1,000             | 0.0856          | 8.50             | 20.40                  |
|        | 250-1,000           | 0.0606             | 6.00            |                  |                        |
|        | 63-250              | 0.0600             | 5.90            |                  |                        |
The facial cleanser and toothpaste brands are made in India, Indonesia, Thailand, Malaysia, USA, Vietnam, Taiwan and China, and Myanmar. In my study, Myanmar people is using a facial cleanser. Moreover, other USA and Tainan people are also using a facial cleanser. It is unlikely that there is a common source for the polyethylene oxidized and polyethylene scrub which contained in these cleansers.

Microplastic in the facial cleansers showed a wide size range with a few small than 1mm. Eight brands the majority of microplastics were smaller than 1.0 mm and in the fifteen brands (F-1 to F-7, F-9, F-10, F-11 and F-14, F-15 and F-21 to F-23 and T-1 to T-3) was <0.1 mm. Fifteen brands have the longest films, these were generally very thin and their thin surface area would make them likely to be quickly broken to smaller fragments. In addition to the microplastics, all included colour material that did not appear to be construct from plastic contained large beads > 0.1 mm which burst during face-washing. The product label on brand F-1 referred to these as “instant whitening”, however, F-2 “oil control”, F-3 “energy charge”, F-4 “total anti-acne” that contains magnolia and volcanic mud, F-5 “white” that licorice acid, F-6 “anti-acne” that contains Japanese kaolin clay, F-7 “oil control” that contains natural charcoal, F-8 “double white” that contains black charcoal and icy clay complex, F-9 “white pearl” that contains pearl extract, F-10 “white oil control” that contains pearly white and glabra root extract, F-11 “white repair pore minimizer”, F-12 “anti-acne” that contains salicylic acid, F-13 “white fresh”, F-14 “anti-aging, whitening, pore minimizing, moisturizing, rejuvenating, cleansing, F-15 “white perfect and anti-dullness”, F-16 “nano cell renewing technology”, F-17 “brightening and oil...
control”, F-18 “black head eraser” that contain salicylic acid acne medication, F-19 “deep cleans pores and smooth skin” that contains salicylic acid and acne treatment/ oil free, F-20 “invigorating”, F-22 “remove horny and washing pores” and F-23 “remove oil in pores” that contains charcoal. The toothpaste brands T-1 referred to these as “strengthen teeth and freshen breath” that contain fluoride and unique liquid calcium, T-2 contain micro calcium and T-3 contain calcium and fluoride.

Research on plastics pollution in the ocean has focused on the microplastics fraction which affects at least 267 marine species by ingestion or entanglement [2]. Although microplastics in the oceans are broken down into smaller pieces and therefore become available to more organisms for ingestion, here we have highlighted that the average consumer is directly releasing the microplastics which cannot degrade and are a suitable size for ingestion or marine organisms. Polyethylene in facial scrubs as a source of microplastic marine pollution is poorly understood. By characterizing the physical properties of microplastic beads found in a sample of products, I found little variation in size and colour across brands. In my study, I found that though some sample population was using the microplastic containing a cleanser, many samples that did not include microplastics. The majority of my survey population used a facial cleanser but were not aware that it contained plastic particles. Now that facial cleanser is recognized as potential sources of microplastics pollution with the risk of ingestion by marine organisms, wastewater facilities should take note and adjust their filtering practices accordingly. Consumers should aware of themselves and avoid microplastic-containing cleansers to minimize their contribution to plastic pollution. Plastic affects marine biota and takes a long time to degrade. Further investigation is necessary to understand the status of microplastic contamination in the environment in Myanmar country.

3.2 Risk ingredient of microplastic in commercial products
In my study, fifteen brands observed white and black film. FT-IR results, polyethylene oxidized is identified in particles of fifteen facial cleansers. Myanmar sample black and white film were analyzed by using the GC-MS. White fragment contained alkane such as Tetracosane, Nonadecane, Hexacosane, Octacosane. Moreover, black fragment contained Dodecanoic acid, Tetradecanoic acid, Hexadecanol, n-Hexadecanoic acid, and Octadecanoic acid. In my white and black film samples were contained the different alkane chemical compounds. The chemical compounds may be safe for use in facial cleanser. From the above, it can be seen that microplastic contamination in Myanmar cosmetic products and the possibility concentration is low.

4. Conclusions
The concentration and components of scrub agents contained in commercial products such as face wash, and toothpaste. The use of microplastic (polyethylene oxidized and polyethylene) was confirmed in 26 samples of facial wash and toothpaste products subjected to analysis. Eight facial wash found polyethylene bead but fifteen facial wash found polyethylene oxidized. Calcium carbonate and silica were identified in toothpaste. Microplastics are difficult to remove during the waste-water treatment process because they are small, buoyant, and easily carried with wastewater to water bodies. Microplastics are consumed by a wide range of organisms, impairing the ability of organisms to eat and causing harm. In Myanmar, infrastructures of sewage treatment plant are insufficient and black and grey water have been discharged into river and lake without any treatment. The occurrence of plastic scrubs in commercial cosmetics implies the direct output into the aquatic environment, resulting in serious pollution of MPs in Myanmar. Microplastics are reported for the first-time information on background concentration that is size distribution and composition of microplastic in the Myanmar facial cleanser and toothpaste. Our results provide useful information for the evaluation of the microplastic pollution levels and environmental risks in Myanmar. In addition, work is needed to reduce eliminate sources and pathways of microplastic exposure. Many environmental monitoring studies have been done in Asian countries but little information on microplastic concentrations in environmental media is available for Myanmar. To the best of our knowledge, this is the first time microplastic concentrations and distributions in environmental samples form Myanmar have been investigated.
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