TRƯỜNG ĐẠI HỌC SƯ PHẠM TP HỒ CHÍ MINH
TẠP CHÍ KHOA HỌC
KHOA HỌC TỰ NHIÊN VÀ CÔNG NGHỆ
Tập 16, Số 3 (2019): 17-24

HO CHI MINH CITY UNIVERSITY OF EDUCATION
JOURNAL OF SCIENCE
NATURAL SCIENCES AND TECHNOLOGY
Vol. 16, No. 3 (2019): 17-24

ISSN: 1859-3100

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EXTRACTION OF THE ANTHROPOGENIC FIBERS IN THE ATMOSPHERIC FALLOUT IN HO CHI MINH CITY

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Received: 03/11/2018; Revised: 01/12/2018; Accepted: 25/3/2019

ABSTRACT

Up to present, there are only few scientific publications on anthropogenic fibers in atmospheric fallout. There is no well-documented protocol for isolation the fibers from the samples. In this study, two approaches for the isolation of anthropogenic fibers have been proposed. Protocol 1 is just done with only filtration step, without any treatment procedure. Protocol 2 includes several treatment steps before filtration (SDS, Biozyms SE & F, H_2O_2). Two Protocols have been conducted with atmospheric fallout samples taken in an urban location of Ho Chi Minh City. The filters from two approaches are then observed using a stereomicroscope. The stereomicroscopic observation shows that Protocol 2 effectively work for these samples.

Keywords: anthropogenic fibers, atmospheric fallout, microplastic.

1. Introduction

Recently, microplastic - MiP (<5 mm) pollution has become an important issue that attracts a lot of awareness from scientists. Concerning the origins, microplastics can be primary particles produced to use in cosmetics and personal care products, or secondary microplastics which are fragments or fibers formed by fragmentation of bigger plastics by ultraviolet lights or other agents of weathering such as current and wind or by laundry process of synthetic textiles (Cooper and Corcoran, 2010; Napper et al., 2015). Due to their small size and light weight, microplastics can travel a long distance away from the sources and can be eaten by different organisms on their way from rivers to oceans. Therefore, the risk of microplastics being transferred to the food web is absolutely possible (Dris et al., 2015; Carpenter et al., 1972).

From the beginning of the 1970s, there have been warnings on the accumulation of plastic fragments in the sea (Arthur et al., 2008). Microplastics can be found everywhere: along the coastal zones, in seabed sediments, on beaches, on the water surface and even in frozen ice in Arctic and Antarctic regions as well as in continental aquatic system such as lakes, canals, and rivers (UNEP, 2016). The ubiquitousness of microplastics in the aquatic system poses challenges on the world's environment. In addition to causing harm to other animals by blocking the digestive system when being eaten, microplastics may become vectors transporting harmful bacteria, organic and inorganic contaminants adhering to microplastic surface to other places on their way from rivers to the oceans (Fries and Zarfl, 2012; McCormick et al., 2014; Rochman et al., 2014).

In fact, recently, two studies proved the presence of microplastic in the dry and wet atmospheric fallout in urban environment (Cai et al., 2017; Dris et al., 2016), suggesting that the atmospheric microplastics may directly fall into the aquatic system or the ground surface and then washed down to the aquatic system by runoff. In the two urban environments studied, the authors observed the presence of both fibers and fragments of microplastic and estimated concentrations of microplastic of 2 to 355 particles/m^2/day in sampling sites near Paris France and of 175 to 313 particles/m^2/day in Dongguan, China. The existence of microplastics in the atmosphere is assumed to be the result of wind-blowing of microplastics from the ground surface, especially from the landfills before or even after buried and from the waste incinerators (Cai et al., 2017). Presence of microplastics in the atmospheric environment may impose harmful impacts on human health when microplastics are directly inhaled.

In Vietnam, more than 80 percent of the plastic industry production is localized in the South, near Ho Chi Minh City (HCMC) – the economic center of the country. Unfortunately, limitations in solid waste management have pushed Vietnam to top 4 countries in the world that discharge the greatest amount of plastic waste into the oceans (Jambeck et al., 2015). Recent research on the floating debris collected on the Nhieu Loc – Thi Nghe canal by the municipal waste management service showed that the plastic mass is estimated to be about 11%-43% of the total floating debris mass, and land-based plastic debris entering the river of 0.96 to 19.91 g/inhabitant/day (Kieu-Le et al., 2016; Lahens et al., 2018). The concentrations of microplastics in the water of HCMC's canals and Saigon river varied for fibers from 270 to 518×10^3 fibers/m^3 and for fragments from 7 to 223 fragments/m^3 (Lahens, 2018), which are the same level as that of untreated water from WWTP of Paris' megacity.

The high concentrations of microplastics observed in the aquatic environment of Saigon River system and present mismanagement of solid waste raise a question about the presence of high concentration of atmospheric microplastics in HCMC. However, so far there are very few published papers on microplastic pollution in the atmospheric environment (Cai et al., 2017; Dris et al., 2016) and effective method for extraction of microplastics from the atmospheric fallout has not been found in available publications.

From the atmospheric fallout, many fibers can be found including natural (cotton) and synthetic fibers (also called anthropogenic fibers). Microplastics is one of the forms of synthetic fibers. In order to identify microplastics among synthetic fibers, FTIR analysis needs to be carried out. Therefore, the protocol for extraction of synthetic fibers from the samples needs to be well-established for further assessment of microplastics in the atmospheric fallout. This paper aims at proposing a protocol for isolation anthropogenic fibers from the atmospheric dry and wet fallout sample collected in the urban area of HCMC.

2. Extraction of anthropogenic fibers from the atmospheric fallout

The aim of this step in MiP research is to isolate the anthropogenic fibers on the filter for further stereomicroscopic observation. The criteria for choosing anthropogenic fibers isolation protocols are based on two requirements (1) simple protocol with the least use of chemicals in sample treatment steps, and (2) the fibers on the filters can be easily observed by a stereomicroscope to reduce observation effort. In this study, two protocols have been carried out as follows:

2.1. Protocol 1: Filtration only

Following the protocol for analysis of POC (Particulate Organic Carbon) from an unpublished paper done by the authors' colleagues, **Protocol 1** was done by simply filtrating the sample through several Whatman GF/A filters 1.6 µm after checking the volume of rainwater of the sample to know the precipitation. The fibers on the filters were then observed from a stereomicroscopic S6D integrated with a MC170 camera.

2.2. Protocol 2: Filtration after laboratory treatment

It is expected that in the samples there will be a lot of organic fibers which can be mis-identified as anthropogenic fibers such as microplastic fibers and cellulose. The **Protocol 2** followed the microplastic isolation protocol for water samples utilized in (Lahens et al., 2018) with some adaptation.

- **Materials:** sieve (1-mm pore size), glass bottle, glass filtration unit, 50-mL measuring tube, 1-mL Eppendorf pipette, vacuum filtration equipment, GF/A filters (1.6 µm porosity, Whatman®), petri dishes, laboratory oven, milli-Q water, SDS (Sodium Dodecyl Sulfate, Merck®), biozym SE (protease and amylase, Spinnrad®), biozym F (lipase, Spinnrad®), H_2O_2 (Hydrogen Peroxide, Merck®).
- **Method:** the laboratory process is shown in **Figure 1** and described in detail including the following steps:

  Step 1: sieving 1 mm and primary filtration

  The sample was first sieved through a 1-mm sieve to remove the big pieces of organics in the samples. At the same time, if there were long fibers (more than 1 mm), those fibers were kept in separate filter for further stereomicroscopic observation. If the sample volume was more than 350 mL, a primary filtration step was gently carried out after 24 hours so that all the particles in the sample settled down. The sample volume after primary filtration of about 350 mL was stored in a glass bottle.

Step 2: SDS (1 g), 24 h, 50°C

For 350 mL of sample, 1 g SDS was added into the sample. Agitation was gently done to make sure SDS was thoroughly diluted then the sample bottle was kept in the laboratory oven at 50°C for 24 hours.

Step 3: Biozyms SE and F (1mL for each), 48 h, 40°C

1 mL biozym SE and 1mL of biozym F were added into the sample using an Eppendorf pipette. After agitation, the sample was then kept in the laboratory oven at 40°C for 48 hours.

Step 4: H_2O_2 30% (15 mL), 48 h, 40°C

15 mL H_2O_2 was added to the sample. After agitation, the sample was then kept in the laboratory oven at 40°C for 48 hours.

Step 5: Filtration

The sample was filtrated through several GF/A filters using a glass filtration unit. All the filters were kept in petri dishes for further stereomicroscopic observation.

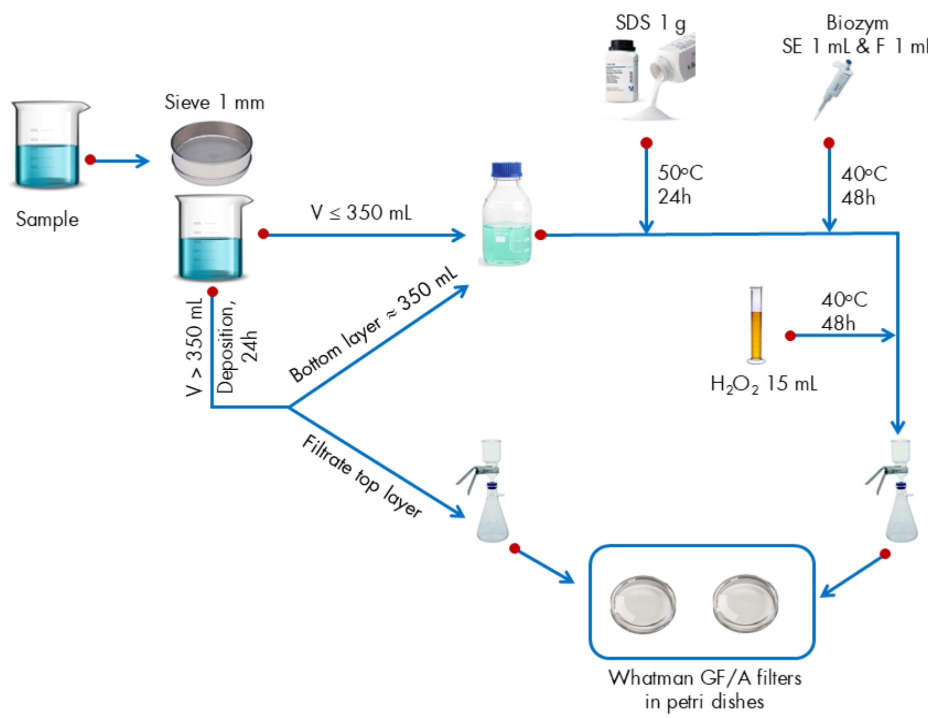

***Figure 1.** Protocol for extraction of microplastic fibers from atmospheric fallout samples*

During laboratory treatment steps, milli-Q water was used for cleaning the sieve or the glass filtration unit.

3. Results and discussions

To check the effectiveness of two approaches, the atmospheric fallout sample was collected in 3 days from 30th June to 2nd July 2018 in District 10, HCMC, using a glass funnel 250 mm diameter (area of 490.9 cm^2). All the rainwater and dust from the atmosphere fell down to the area of 490.9 cm^2 of the funnel and then went into the a 10-L glass bottle below the funnel. Two anthropogenic fibers isolation Protocols described above were carefully carried out in the lab and the filters were then observed with the stereomicroscopic S6D integrated with a MC170 camera. The filter images taken from the stereomicroscope are shown in **Figure 2**.

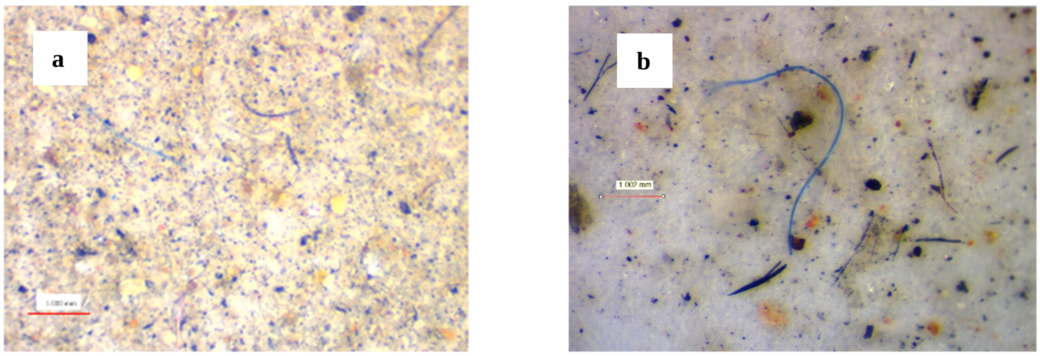

Figure 2. *Stereomicroscopic images of the GF/A filters taken by the S6D integrated with a MC170 camera for samples from: (a)* ***Protocol 1****; (b)* ***Protocol 2***

Filters of **Protocol 1** is full of fibers and organic matter and therefore it is difficult to count the number of fibers on the filters and measure their dimensions. With filtration step only, this Protocol can be done quickly in the lab without using any chemicals for treatment. However, it takes too long time for the stereomicroscopic observation step. And the most important is that it is impossible to define anthropogenic fibers among all of the fibers. This approach may be only effective for the sample taken in the region where there are not so many fibers in the samples.

For the filter of the **Protocol 2**, anthropogenic fiber abundance, shapes and colors and measurements of their sizes can be observed easily (**Figure 2**) since there are less organic matter found on the filters. The stereomicroscopic observation time is also considerably reduced saying that this protocol can be used for atmospheric fallout samples.

The summarization of stereomicroscopic observation for one atmospheric fallout sample taken from 30^{th} June to 2^{nd} July 2018 in District 10, HCMC showed that there were 56 fibers found in the sample and the fibers' size ranged from 251 μm to 22 mm. The dominant size (31 fibers) were found mainly to be small size (less than 2 mm) and at the same time 12 long fibers (more than 5 mm) were also found (**Figure 3**).

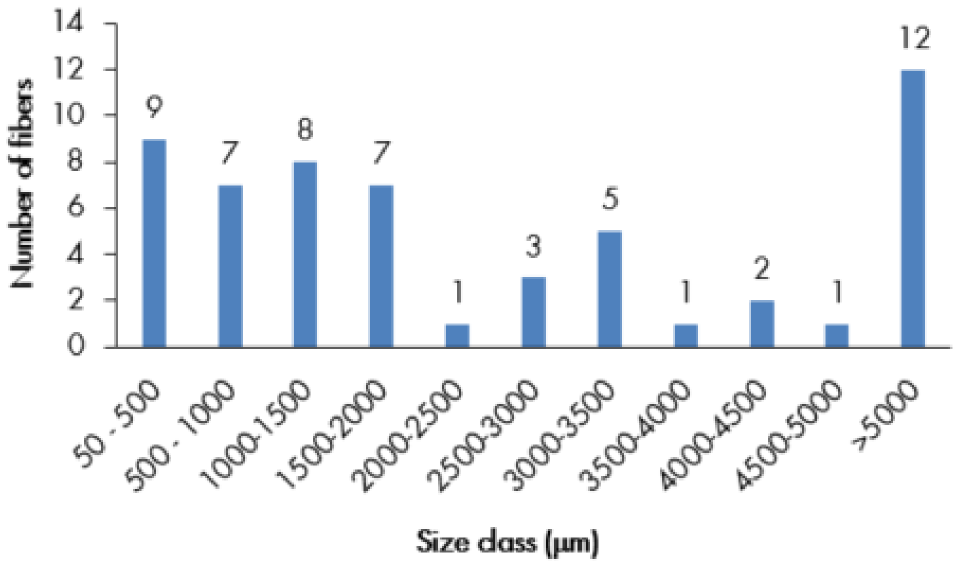

Figure 3. *Anthropogenic fiber concentrations in an atmospheric fallout sample taken in 3 days (30/06-02/07/2018) in District 10, HCMC*

Although the fibers' colors may be faded due to the effect of the sun light and other agents of weathering, observation of fibers' colors is also necessary. The reason is that fibers' colors may partly help to explain the origins of the fibers, i.e. natural or anthropogenic, in further analyses for microplastic contamination assessment. The observation of fibers' colors in the sample showed the predominance of blue fibers in the samples (**Figure 4**).

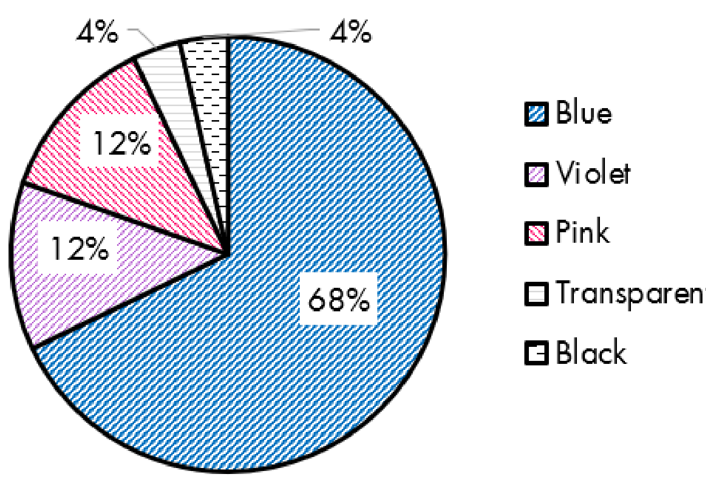

Figure 4. *Colors of the anthropogenic fiber concentrations in an atmospheric fallout sample taken in 3 days (30/06-02/07/2018) in District 10, HCMC*

4. Conclusions

Two protocols for extraction of anthropogenic fibers from atmospheric fallout samples were carried out in this study: (1) **Protocol 1** with filtration step only, (2) **Protocol 2** with some laboratory treatment steps. For one atmospheric fallout sample taken in July 2018 in District 10, HCMC, the **Protocol 2** proved to be a better approach for extraction of the anthropogenic fibers.

- ***Conflict of Interest:*** *Authors have no conflict of interest to declare.*
- ***Acknowledgement:*** *This research is funded by Ho Chi Minh City University of Technology, VNU-HCM, under grant number **Tc-ĐCDK-2018-01**.*

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QUY TRÌNH TÁCH SỢI NHÂN TẠO TRONG MẪU NƯỚC MƯA VÀ BỤI KHÔNG KHÍ Ở THÀNH PHỐ HỒ CHÍ MINH

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Ngày nhận bài: 03-11-2018; ngày nhận bài sửa: 01-12-2018; ngày duyệt đăng: 25-3-2019

TÓM TẮT

Cho đến thời điểm hiện tại, trên thế giới, có rất ít ấn bản khoa học nghiên cứu về sự tồn tại của sợi nhân tạo trong các mẫu nước mưa và bụi không khí. Hơn nữa, quy trình tách sợi nhân tạo từ các mẫu này trong phòng thí nghiệm vẫn chưa được nghiên cứu bài bản. Bài báo này đề xuất hai quy trình: Quy trình 1 được thực hiện đơn giản chỉ bằng việc lọc mẫu không xử lí; Quy trình 2 bao gồm một số bước xử lí mẫu trước khi lọc (SDS, men vi sinh SE & F, H_2O_2). Hai quy trình này được thực hiện thử trên mẫu nước mưa và bụi không khí lấy ở nội thành Thành phố Hồ Chí Minh. Màng lọc chứa sợi từ hai quy trình sẽ được quan sát dưới kính hiển vi lập thể. Kết quả quan sát từ kính hiển vi lập thể cho thấy Quy trình 2 khá hiệu quả và có thể được sử dụng để tách sợi nhân tạo từ mẫu.

Từ khóa: sợi nhân tạo, nước mưa và bụi không khí, vi hạt nhựa.