# Extraction of Microplastics from Soil and Bio-composts

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Abstract:

This thesis is about the extraction of microplastics using olive oil, which is one of the most cost effective, efficient, and harmless methods of extraction since no harmful chemicals were used in the process. Microplastics is scientific topic trending around the world, this thesis tries to spread awareness about how it can enter and cause harm to the ecosystem. For the experiments, soil used commercially as a base for a plant and a final stage bio-compost from HSY Ämmässuö were used as samples. The samples were tested by combinations of solvent extraction and density separation techniques in two different apparatus: a polytetrafluoroethylene tube and a sediment microplastic isolation unit with vacuum filtration process to extract microplastics from the samples.

As a result, almost all the plastic pieces mixed with the samples were recovered in the filter paper after filtration.



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## Abbreviations

DEPH: Diethylhexyl Phthalate

HDPE: High Density Polyethylene

$H_2O_2$: Hydrogen Peroxide

LDPE: Low Density Polyethylene

MPs: Microplastics

PBDE: Polybrominated Diphenyl Ether

PET: Polyethylene Terephthalate

PFOS: Perfluorooctanesulfonic acid

PP: Polypropylene

PS: Polystyrene

PTFE: Polytetrafluoroethylene

PVC: Polyvinyl Chloride

SMI: Sediment Microplastic Isolation

V: Vinyl

## FOREWORD

I would like to express my sincere gratitude to my supervisor Stewart Makkonen-Craig for the continuous support and encouragement throughout my thesis and to the researchers of University of Helsinki, Jukka Pellinen and Costanza Scopetani, for giving me the guidelines and direction for my thesis and providing the PTFE tube apparatus used for some of the experiments. Also, I would like to thank Mr. Christoph Gareis from HSY Ämmässuö for providing the samples and giving me the early guidance to start my research work. Without your support my work would not have gone this far.

And I would like to thank, from the bottom of my heart to the teachers, researchers and entire Department of Energy and Materials Technology, Arcada University of Applied Sciences, for their love, support and warm behaviour throughout my study period.

Helsinki, 31 May 2020
Sachu Karki

# 1 INTRODUCTION

## 1.1 Background

Plastics are polymers, which are made up of long chain molecules. The length of molecules and their arrangement patterns or structures makes plastic more strong, light and flexible. Plastics had been introduced centuries ago when ancient humans made it using natural substances like cellulose or plentiful carbon atoms from petroleum and other fossil fuels. However, the first synthetic polymer was invented by John Wesley in 1869 and the first cheap and feasible plastic was invented by Leo Hendrik Baekeland in 1907, which was made up of phenol and formaldehyde. (Institute, 2020)

Since then plastic has been an essential part of everyday life. It is used in almost everywhere which has led in increase of its production. According to the survey of world plastic production, there is rapid increase in production, 335 million tons of plastic were produced in year 2016 whereas 359 million tons of plastics were produced in year 2018. Asia alone produces half of the total production of plastics in the world, Europe produces 18.5%, North America produces 17.7%, Africa 7,71% and, Latin America 4%. Among them, only 10% gets recycled (Poerio, 2019) and rest enters to landfills land which eventually enters to aquatic environment either in macro or in micro form. Plastics take nearly 500 years to decompose (Cho, 13 December 2017) and till then it continuously produces hazardous chemicals. The destructions due to large plastic pieces can be seen in the form of death of animal and birds and dried and unfertilized soil for plants whereas microplastics (MPs) on land affects the entire environment and ecosystem including humans, animals, plants, air, water and so on.

Waste management companies are facing various problems while recycling the wastes. Wastes needs to be sorted properly in order to get recycled properly. For instance, if biowastes collected from households and restaurants get mixed with other non-bio products such as plastics, it can generate contaminated composts containing microplastics after recycling.

## 1.2 Objectives

The world is experiencing plastic pollution and one of the main reasons behind it is unproper sorting of wastes. On an average, only 10 percent of plastic production goes to the recycling centre and rest dumped to the environment which generates microplastics.
The objectives of my thesis were as follows:

- To find a good method (cost-effective, efficient and harmless) for the extraction of microplastic from soil and bio-compost by using olive oil.
- To apply different experimental apparatus such as SMI unit and PTFE tube.
- To get to know about the situation of bio-wastes sorting in Finland’s waste recycling centre, HSY Ämmässuö.
- To create awareness about effects of microplastics in the environment.

Microplastics extraction from the environment is one of the concerned research topics in recent times. There have been many researches done on the extraction of microplastics from marine environment and have discovered various successful experiment processes. Along with marine environment, researches on extraction of microplastics on land is also taking the position since land is badly effected by micro and macro plastics. There are recycling companies all around the world, but due to lack of waste sorting knowledge and awareness, plastics are scattered on the land and there has occurred threat to the entire environment including humans, animals and plants. Therefore, this research had tried to explore the method to extract the microplastic from soil and bio-compost by using olive oil. Moreover, the role of the apparatus SMI unit and PTFE tube are also explained to get the desired results from the sample.

## 1.3 Thesis Structure

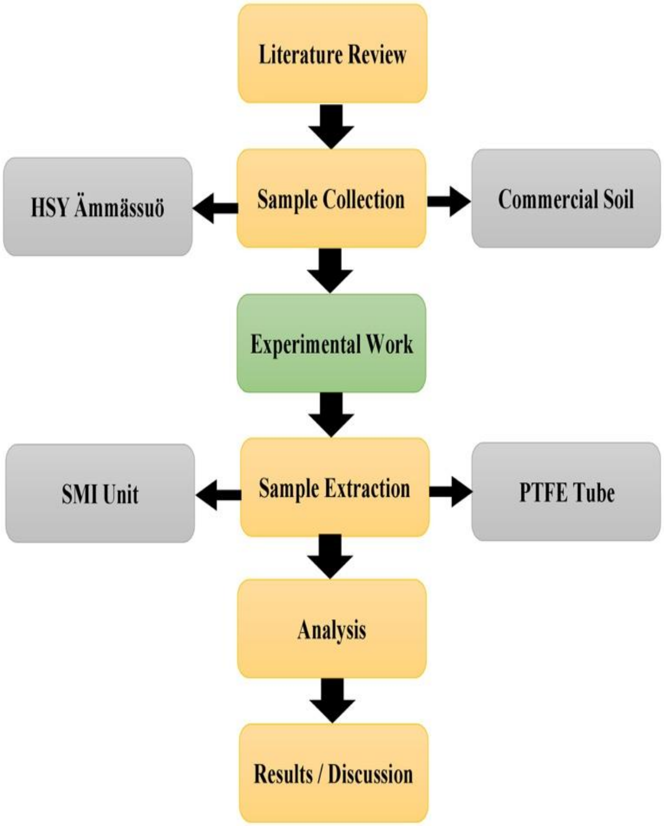



*Figure 1. Thesis Framework*

The first part of this study contains a literature review which explain the ideas and views of various authors and researchers on plastics, microplastics and its extraction methods. The effects of microplastics on environment are also briefly explained in literature review. The literature review was followed by sample collection part where sample was collected from commercial plant and HSY Ämmassuö. During the process, information on Finlans's bio-waste recycling center HSY was collected. After sample collection, experimental work was done under two different apparatus (PTFE tube and SMI unit). The results obtained were visually analyzed and discussed in the last part along with research work closing statement.

# 2 LITERATURE REVIEW

## 2.1 Plastics

Plastics are polymers, made up of raw materials like cellulose, natural gas, coal and crude oil (Plastics Europe, 2020). Plastics are classified into two types, thermosets and thermoplastics.

### Thermosets

Thermosets are a type of polymer commonly found in the form of polyester resin, duroplast, urea-formaldehyde, epoxy, silicone, vinyl ester and so on. These are either liquid or soft solid form which get hard when curing. The main properties of thermoset polymers are that they cannot be melted or reformed once it gets hard in its form.

### Thermoplastics

Thermoplastic polymers are the common polymers such as found in the form of polyethylene, polystyrene, polypropylene and polyvinyl chloride. Unlike thermosets, these polymers can be reformed and melted multiple times and does not change their chemical compositions. (Thermoset vs. Thermoplastics, 2017)

Plastics have become part of daily life. They are used in almost every sector like packaging, household things, automotive and electronics, constructions, and many more. There are seven different types of plastics used in the market where recycling codes (from No.1-7) are indicated in Figure 1. (Polymer and plastics, USA, 2017)


*Figure 2. Plastic resin codes (Polymers and plastics USA, 2017)*

## 2.2 Bioplastics and Biodegradation

Bioplastics are the plastics made up of organic biomass like cellulose and starch, wholly or partially. They are a significant improvement in plastic sectors (Kartik Chandran, 2017) as bioplastics use the organic renewable raw materials like sugarcane and corn which significantly  the carbon atom during polymerization process. Bioplastics own a big space in the market these days since people are becoming aware of hazardous conventional plastics. They are used as disposable items like containers, packaging, bags, bottles, medical implants, cosmetics, phone casings and many more. (Staff, 2016)

Biodegradation is the breaking down of plastics into natural substances like water, carbon dioxide and composts by the microorganisms available in the environment under suitable conditions. There is a fact that not all bioplastics are biodegradable since not all bioplastics are made up of 100 percent biomass (Cho, 13 December 2017). That is the reason why the environment is not completely safe even when we use bioplastics.

## 2.3 Microplastics

Microplastics are found almost everywhere in the environment. Air, surface water, soil, sediments, organisms, everything contains microplastics. They can be defined as polymer particles that are less than 5 mm diameter in size. Polymers below 1mm size are known as nano plastics. The main source of formation of microplastics are the fragmentation of macroplastics. (Li, 2019)
There are further classifications of microplastics, primary and secondary microplastics.

**Primary microplastics**

Primary microplastics are tiny size (< 5 mm) of microbeads which are produced for various sectors like cosmetics and personal care products, medicinal and industrial purposes like tyres, synthetic textiles, road markings, city dusts and many more.

**Secondary microplastics**

Secondary microplastics are formed by the chemical, mechanical and biological degradation of larger plastics. Sunlight, wind, photo oxidation, water are some examples which can weaken the polymer bonds and gets fragmented into microplastics.

The degradation procedure of microplastic has been shown in the figure 2 which clearly explains the sources of primary and secondary microplastics and their changes in properties such as changes in size, density, surface morphology, colour and growth of bio-films after going through degradation process. (Guo X. , 2019)

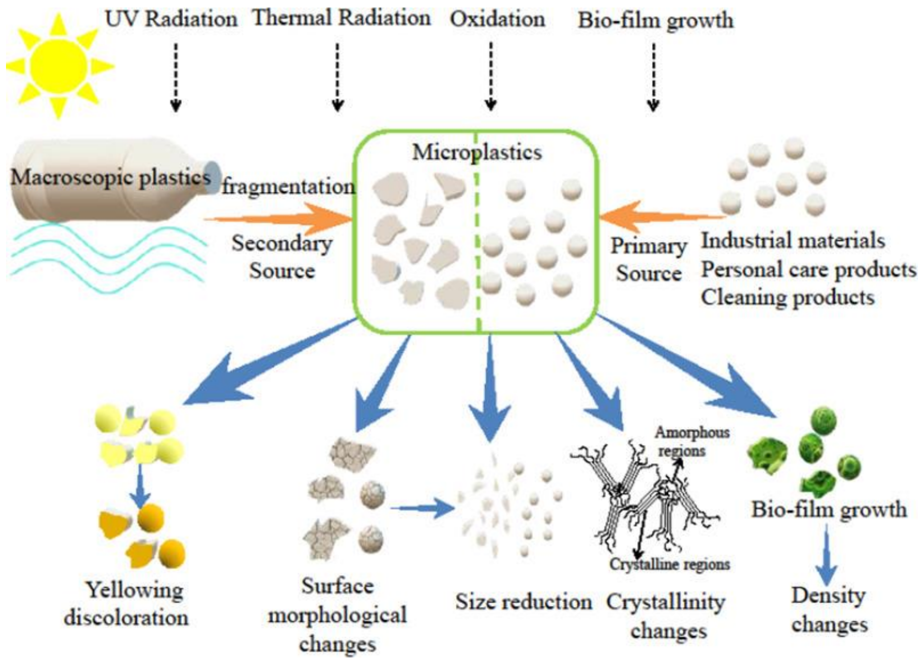



*Figure 3. Properties changes of microplastics after degradation (Xuan Guo., 2019)*

## 2.4 Effects of microplastics in soil

Microplastics is a trending issue around the world. There are millions of tons of plastics produced globally among them 79 percent of wastes are stacked in the landfills and some eventually enters the water resources. Plastics are polymers that cannot be decomposed or digested instead releases harmful chemicals present in them when tried to decompose or digest it. Since microplastics and nano plastics are very small in size, we cannot see them with our bare eyes to get rid of it. Microplastics are produced by breaking down of large plastics particles and production of microbeads, fibres and pellets. Microplastics are present almost everywhere in the environment like land, water, air, plants, human and animals. Microplastics enters in human being through various routes which are shown in figure 3 (Guo J.-J. , 2020). While breathing air and drinking water, microplastics present in them enters in human beings. Besides that, plant and animal have circular food chain, animal eats plants and plants absorbs dead and decayed animals. During this food chain microplastics gets transmitted to one another and eventually enters in human body while consuming the food (vegetables and meats).

Hence, the investigation on microplastics in the terrestrial environment is on rapid process and many researchers are trying various methods for the extraction of microplastics.

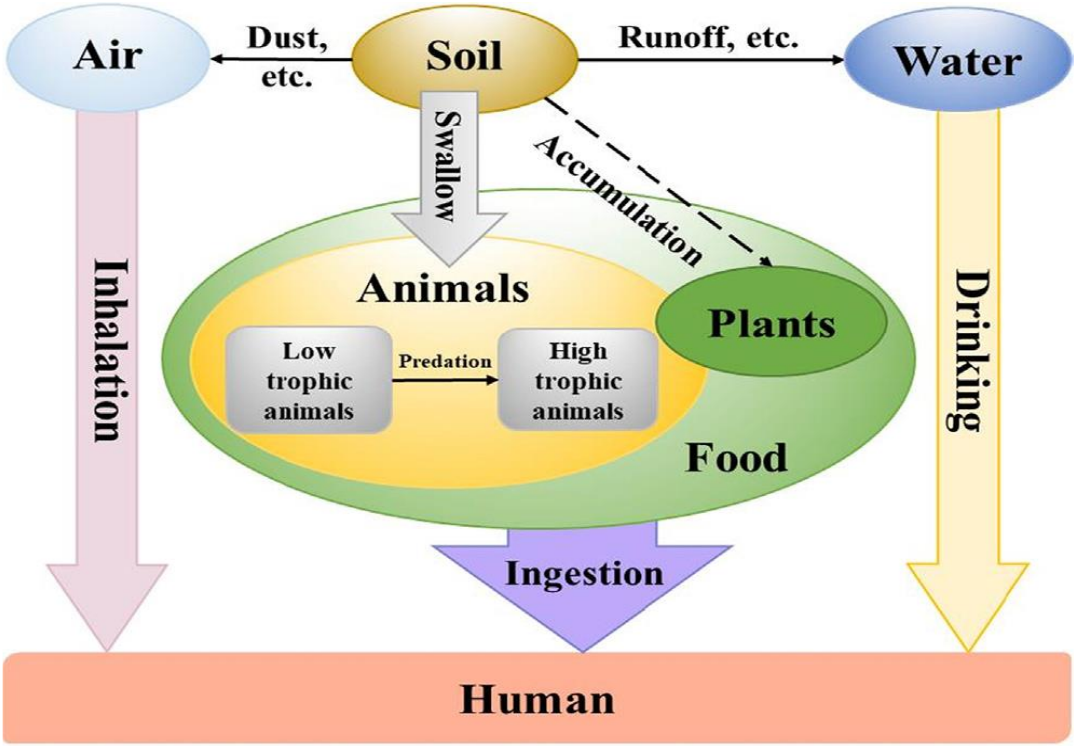



*Figure 4. Human exposure to microplastics through different routes (Jing-Jie Guo, 2020)*

## 2.4.1 List of major effects

Microplastics present in soil change the physical and chemical properties of soil which leads to numerous problems. Some of the problems are listed below.

### Soil structure and contamination:

Microplastics from various polymers cause soil aggregations and cracking, decreases bulk density and water holding capacities. They contain additives like diethylhexyl phthalate (DEPH) which further absorbs other toxic chemicals like polybrominated di-phenyl ether (PBDE) and Perfluorooctanesulfonic acid (PFOS), zinc, lead, copper and other antibiotics which contaminates the soil and eventually affects the environment. (Wang, 2019)

## Soil fertility and nutrients:

There are various nutrients of soil like C, N and P which are responsible for producing enzymes that boost the fertility of soil. The high amount of carbon present in microplastics harms the soil nutrients which ultimately affects the growth of plants and crops.
Soil animals like earthworms, snails and insects helps to make soil soft and suitable for agricultural purposes. But due to ingestion of microplastics by these animals, they become unable to function. (Jing-Jie Guo, 2020)

## Soil microbes:

Bacteria, fungi, protozoa, actinomycetes and nematodes are the types of microbes present in the soil which are important to boost the soil and plant health by decomposing organic matters, cycling nutrients and fertilizing the soil. Due to the toxic chemical release of microplastics in the soil, these microorganisms cannot perform their function appropriately. (Jing-Jie Guo, 2020)

## Effects in plants:

Plant growth becomes difficult in contaminated soil. Due to the toxic chemicals released by plastic particles, the photosynthesis process also gets disturbed. Roots of the plant gets contaminated water sources which in returns gives fruits, vegetable and crops with microplastics. (Jing-Jie Guo, 2020)

## Effects in animals:

Animals are also affected by ingestion of microplastics. Animals eat plants and other animals, and plants eat decayed animals through which microplastics gets transmitted form one another. Besides the food chain, MP also enters in animals from water and air also. The ingested microplastic causes various problems in animals like blockage of digestive tracts and alter their feeding behaviour which results in growth and reproductive disorders. (Jing-Jie Guo, 2020)

### Effects in humans:

Human needs food, air and water to survive and microplastics are present everywhere. We ingest microplastics every single day and the ingested microplastics tend to release toxic chemicals which can damage human organs, weaken the immune system, and stymie the growth and reproduction in humans. Air, water, soil, plants and animals everything is getting contaminated very rapidly due to huge production of plastics because of this, the health of human beings are very affected.
(Jing-Jie Guo, 2020)

## 2.5 HSY, Finland's waste management organization

HSY Ämmässuö is a waste recycling centre in Espoo, Finland, where different types of wastes are processed. The sample for my thesis was collected from their bio-waste treatment plant. It represented the final product of bio-waste treatment which was ready to be used as a compost for agriculture purposes.
HSY Ämmässuö's bio-waste plant follows various processes.

- Handling Capacity
- Pre-treatment of bio-wastes
- Digestion of Biowastes in a biogas plant
- Composting process.

HSY has a capacity to handle 60,000 tons of biowaste per year and the current supply of wastes is 51,000 tons per year. Among the 51,000 tons of bio-wastes, 35,000 tons goes for biogas production.
The biowastes after entering the treatment plant go through various processes. Wastes are crushed and screened properly, any metallic objects presented there are attracted towards

huge magnets and lightweight materials like plastics are blown away through the strong wind transmission. After following these procedures, the fine particles (less than 60-80mm size) which is around 70 percent of the result is transferred to digestion process for the production of biogas whereas the remaining 30 percent of the materials goes for direct composting.

The fine materials of biowastes is stored in interim storage where microorganisms like anaerobic microbes breakdown the biowaste in the absence of oxygen which results in the formation of biogas. The biogas produced from the process is transferred to the gas storage which is used for production of heat and electricity. The remaining wastes or leftovers from the process, known as digestate, are forwarded to the composting section since it contains valuable nutrients beneficial for the plants.

The digestate and remaining 30 percent of biowaste undergoes the composting process for 2 to 3 weeks. There are 15 composting tunnels where these wastes are stored simultaneously. Harmful bacteria and viruses immersed are killed here and biofilter purifies the smell of biowastes. After completing the composting process, the composts are taken to outside environment and can be used as soil for landscaping. (HSY, 2018). The various work process involved in bio-waste treatment at HSY is shown in the figure 4. (Mönkäre, 2015)

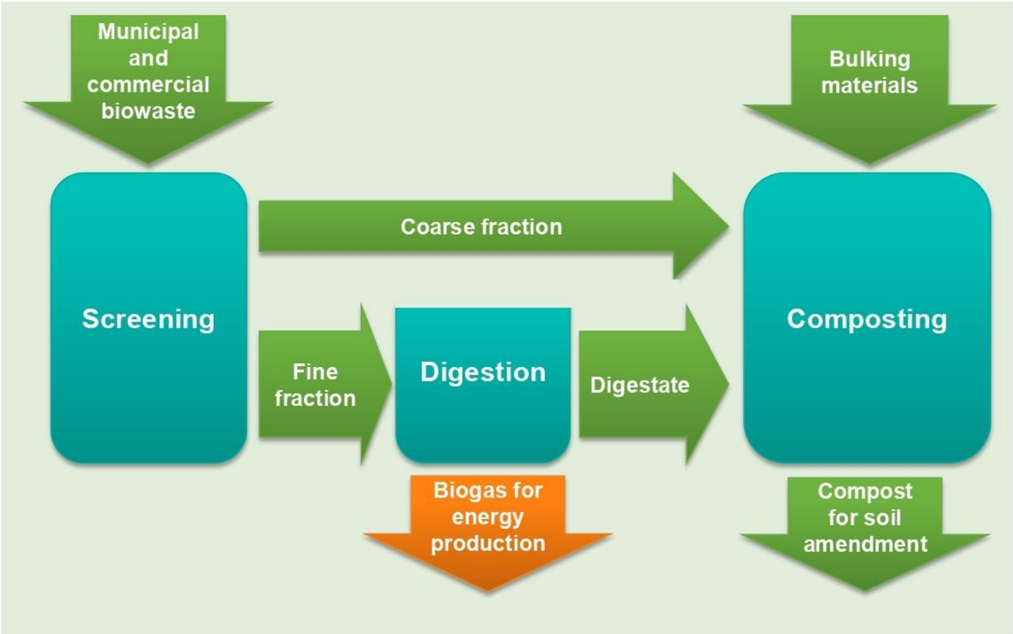



*Figure 5. Bio-waste digestion flow chart at HSY Ämmässuö*

## 2.6 Various methods of extraction of microplastics

There are various methods practiced for the extraction of microplastics in soil environments among which density separation, chemical digestion and filtration are the mostly used procedure.

### Density separation:

Density separation is a process in which substances gets separated from one another based on their densities. This is a very common and efficient process used for the extraction of microplastics.

For the process of extraction of microplastics from solid substances like soil, high density solutes like sodium chloride, zinc chloride and sodium iodide are used so that microplastics present in soil sample gets floated on the solution. Since the time needed for the sample to get separated from one another is little higher, there are few methods to boost the separation time like centrifugation and ultrasound bath. These are the instruments which creates vibrations in the sample so that density process gets faster.

### Chemical Digestion:

The sample for the extraction of microplastics like soil usually contains large amount of organic materials whose densities are relatively similar than that of plastics. As a result, organic particles get mixed with plastics pieces during extraction so chemical digestion process is used to get efficient result. Chemical digestion process uses chemicals like hydrogen peroxide and potassium hydroxide which dissolves the organic materials present in the sample. The process is also known as wet peroxide oxidation. Since strong chemicals are used in the process, some plastic types like PS, PVC and PET gets effected. (Thiele., 2019)

### Filtration:

Filtration is very simple process where solid particles gets separated from liquid through filter. During any high-volume sample experiments, the natural filtration process would be slow so in order to make the process fast, vacuum filtration process is used. Vacuum filtration procedure includes vacuum adapter which helps to create pressure so that solute

gets sucked faster from the sample solution leaving behind the solid particles in filter paper.
These are the most common extraction process used for the extraction of microplastics from environment. However more new processes are also developing these days like electrostatic separation and elutriation column optimization. (Nguyen, 2019)

After the extraction of microplastics from various methodologies, the sample goes through analysis process so that proper evaluation of the extraction process and results could be done. There are various ways of analysis such as visual analysis (microscope, scanning electron microscopy), vibration spectroscopy (Raman microscopy and Fourier transform infrared spectroscopy) and mass spectroscopy (thermal desorption-gas chromatography-mass spectrometry and pyrolysis gas chromatography-mass spectrometry).

# 3 EXTRACTION OF MICROPLASTICS FROM OLIVE OIL

This section describes the process and methodology for the extraction of microplastics using an immiscible mixture of olive oil in water. This process of extraction using oil was used being motivated by an ongoing research work carried by Costanza Scopetani, S. Pflugmacher and Jukka Pellinen in the University of Helsinki, Lahti, Finland (Scopetani, A method for the extraction of microplastics from solid samples using olive oil, 2019). Later, at the time of completion of this thesis work, the ongoing research was also completed and had been published (Scopetani, 2020). Their support and motivation led the direction of my experiments. The guidelines and apparatus used in this experiment, including the PTFE tubes, were provided by them.
In addition to the various methods used for the extraction of microplastics described in chapter 2, this method is a novel one and is based upon solvent extraction. The method of using olive oil is one of the convenient methods since the rate of floating particles in this oil is higher than other oil like rapeseed oil, coconut oil and sunflower oil. The soil samples used in this study were collected from two places: compost from HSY Ämmässuo bio-waste recycling center and horticultural soil from a supermarket. During

the test, plastics and other particles (soil, organic material) included in the samples were not harmed since no chemical reaction were performed in this method. Unlike some methods where chemicals are used to proceed, the reaction mechanism might affect the end product. Besides that, this method is very effective and cost efficient.

The experiments were carried out in two different apparatus: a PTFE tube and in a sediment microplastic isolation (SMI) unit, to analyse the results and its differences.

There were researches carried out for the extraction of microplastics from soil through chemical reactions which are expensive to implement and might be harmful for the nature. Therefore, new researches are on the way among which extraction of microplastics from olive oil is one. Researchers from University of Helsinki, Lahti, are working under this research. It is cost effective, simple and harmless method to be practiced.

## 3.1 Experiment and Methodology

### 3.1.1 Sample collection

- Sample 1: Soil collected from the root of small decorative flower plant brought from a normal shop in Finland.

*Figure 6. Soil collected from the root of decorative plant.*

- Sample 2: A final stage recycled bio waste (composts) from HSY Ämmässuö, Espoo, Finland

*Figure 7. Compost collected from HSY.*

*Figure 8. HSY building for waste management, Espoo, Finland*

- Polyethylene plastic

Extraction of microplastics from olive oil was an ongoing research so the result and its success rate were unknown. Due to this reason, plastic pieces were added in the sample despite of the suspect that microplastics and nano plastics are already present in the sample in order to make the sample known. The success rate of the sample can be easily analysed on known sample rather than unknown sample so additional plastic pieces were mixed with the soil and compost samples. The plastic used was polyethylene which is most common in everyday life and is chemical resistance also. Three different colour of polyethylene (red, blue and white) were used so that visual inspection of the experiment would be easier with multicolour particles. The plastics were cut into tiny pieces so that it gets
evenly miscible with soil sample.

*Figure 9. Different colour polyethylene bags from grocery store.*

### 3.1.2 Materials and equipment

In this study two different processes were used for separation of MPs from soil samples and the different equipment's were used accordingly.

**For oil extraction process in PTFE tube:**

- Weighing balance
- PTFE Tube (250 mm length, 40 mm external diameter and 30 mm inner diameter)
- Extra virgin olive oil
- Test tubes
- PVC square plate and pipet
- Spoon and spatulas
- Beakers (500 mL, 100 mL and 50 mL)
- Ultra-pure water
- Distilled water bottle

**For vacuum filtration:**

- Vacuum adaptor

- Rubber pipe
- Grease
- Buchner funnel
- Metal forceps
- Glass fibre filter paper
- Rubber hose
- Filtration flask (with side arm)
- Clamp and clamp holder

### 3.1.3 Sample testing

Since the process of extraction of MPs from olive oil was very new idea, a few sample tests were done to get answers of few questions like:
Does the soil stay down to the bottom or does a portion of it float on the water?
Will plastic particles floats on the water?
How does soil and plastic behave with the oil?

**Preparation for sample testing**

Soil from the root of plant: **1 g**
Ultra-pure water: **6.5 mL**
Extra virgin olive oil: **1 mL**
Plastic pieces: **~ 10 pieces**

1 g of soil sample was taken in a test-tube and added around 10 pieces of plastics (PE). After that, 6.5 mL of ultra-pure water was poured in it and shaken them well for couple of minutes, and 1 mL of extra virgin olive oil was added on top of it. The mixture of soil, water and oil were shaken well again and stood aside. After 20 hours, it seemed that the separation process was a bit slow, so the sample was placed in a bath where ultrasound vibrations made the process a bit faster. The layers of particles were visible where soil

particles stayed at the bottom, oil with plastic pieces and other organic particles were floating on top of the water level below the oil.


Figure 10. Ultrasound Bath

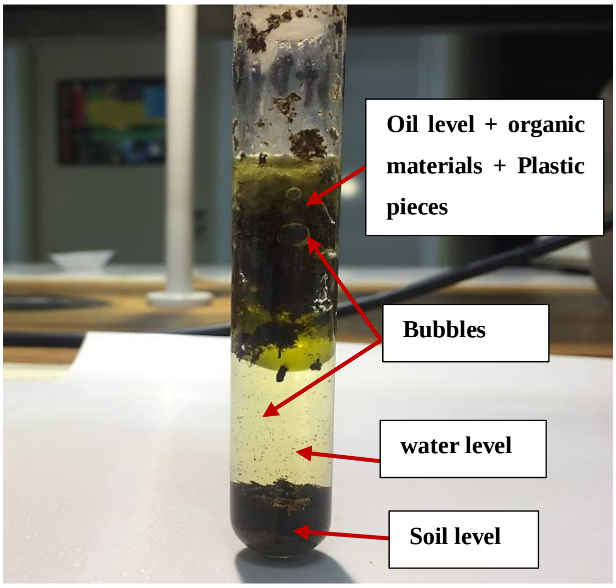



*Figure 11. MP extraction test of Sample 1.*

Since the soil sample was collected from the root of a decorative plant, it contained huge amount of organic materials and sand. The soil might have been mixed with other materials to make a readymade base for the plants.

The same process of sample testing was repeated for the second sample, compost collected from HSY Ämmässuö. The test was performed in three test tubes keeping the amount of sample and process same to see if there occurs any dissimilarities.

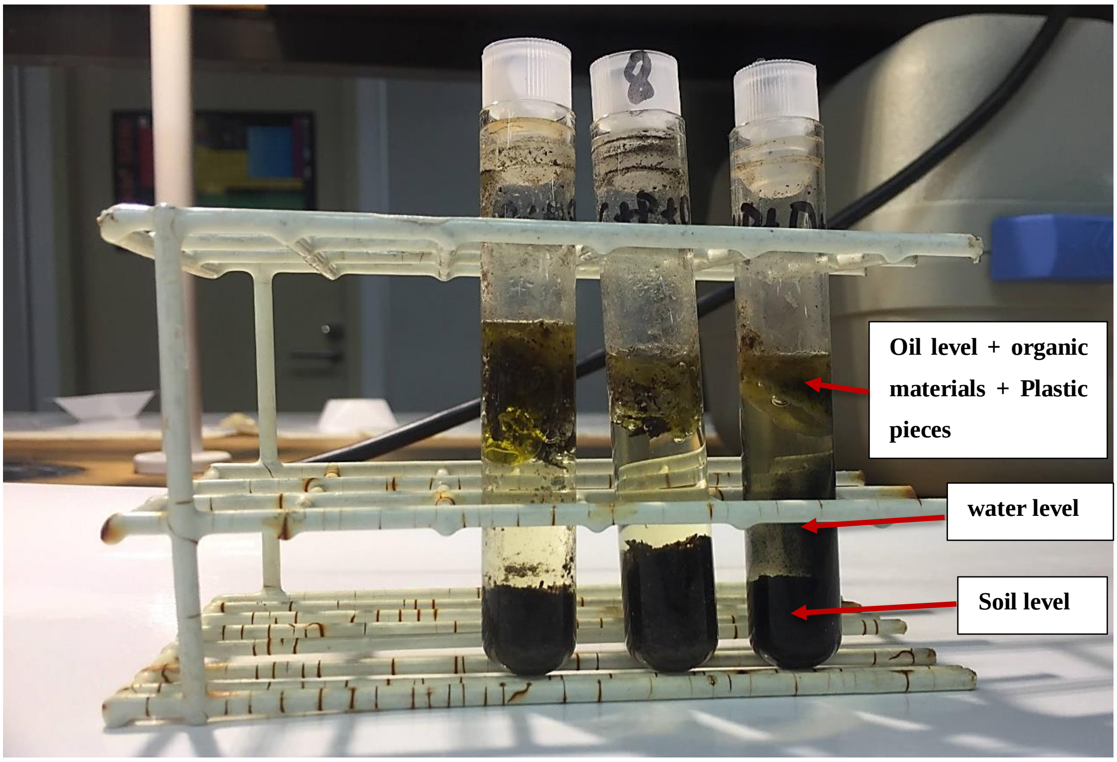



*Figure 12. MP extraction test for sample 2 (×3)*

The result was similar in all three test tubes. Oil had separated plastic pieces and organic materials from the soil but there were lots of bubbles present all over the sample which made the visibility of the layers quite unclear. So, the sample was processed for centrifugation for the density separation of all the mixed particles.


*Figure 13. Centrifugation Machine*

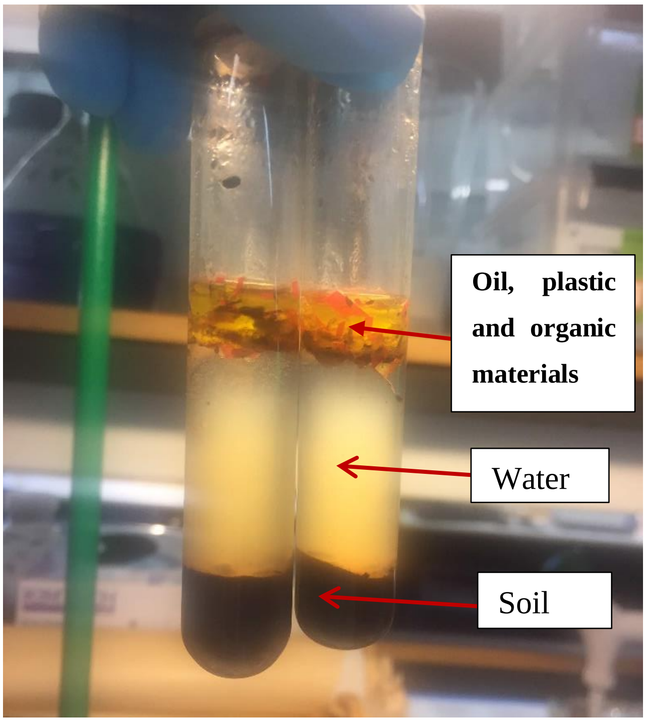



*Figure 14. Result after centrifugation of sample 2*

After centrifugation process, the result was very clear. The layers were separated based on the density of particles presented inside it.

## 3.2 Extraction of microplastics in PTFE tube

After completion of sample testing, more quantity of samples were tested in the PTFE tube.

Soil sample collected from HSY: **10 g**

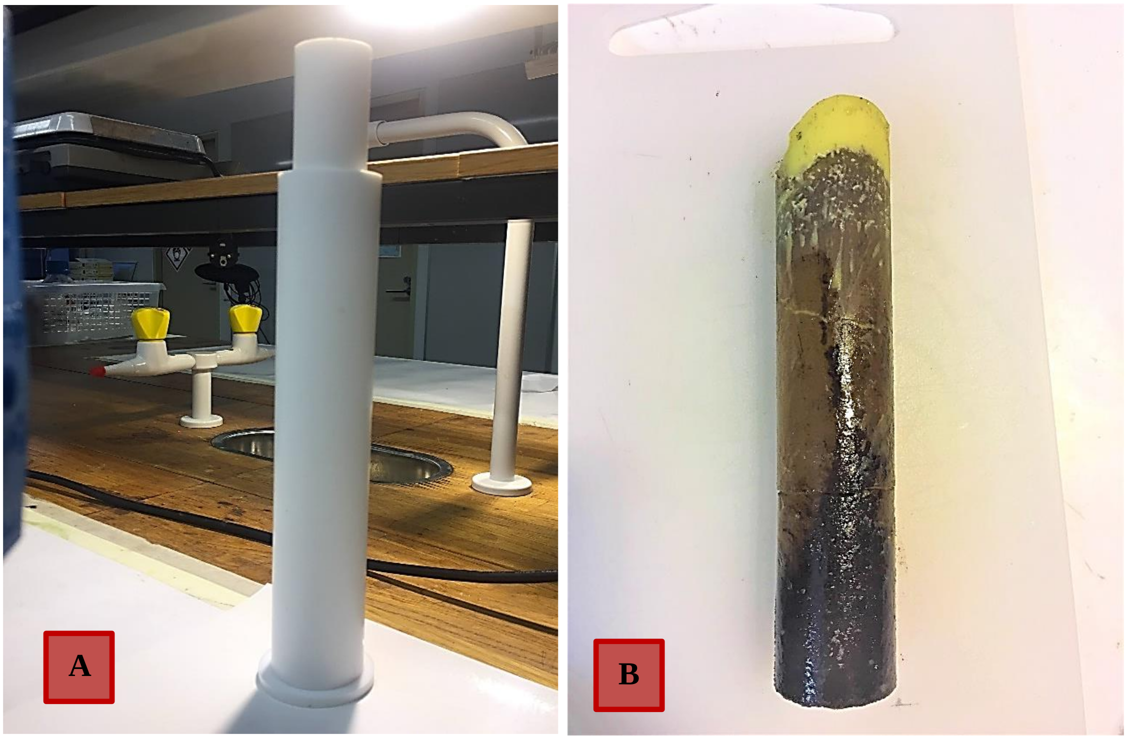
Ultra-pure water: **70 mL**

Extra virgin olive oil: **5 mL**

Plastic pieces: **~ 20 pieces**

### 3.2.1 Methodology

10 gm of sample was taken in a PTFE tube and added 70 mL of ultra-pure water and few pieces of polyethylene. The sample was shaken well for 3-5 minutes and then added 5 mL of oil in the tube. The mixture was mixed well by shaking well for couple of minutes and the tube was kept in a freezer overnight. Since oil sticks on the wall of tube with other materials floating with it, it would be difficult to pour the floating parts of the sample, so the sample was frozen. After about 24 hours of freezing the sample, it was placed to warm a bit and popped out of the PTFE tube by pushing it through its end.



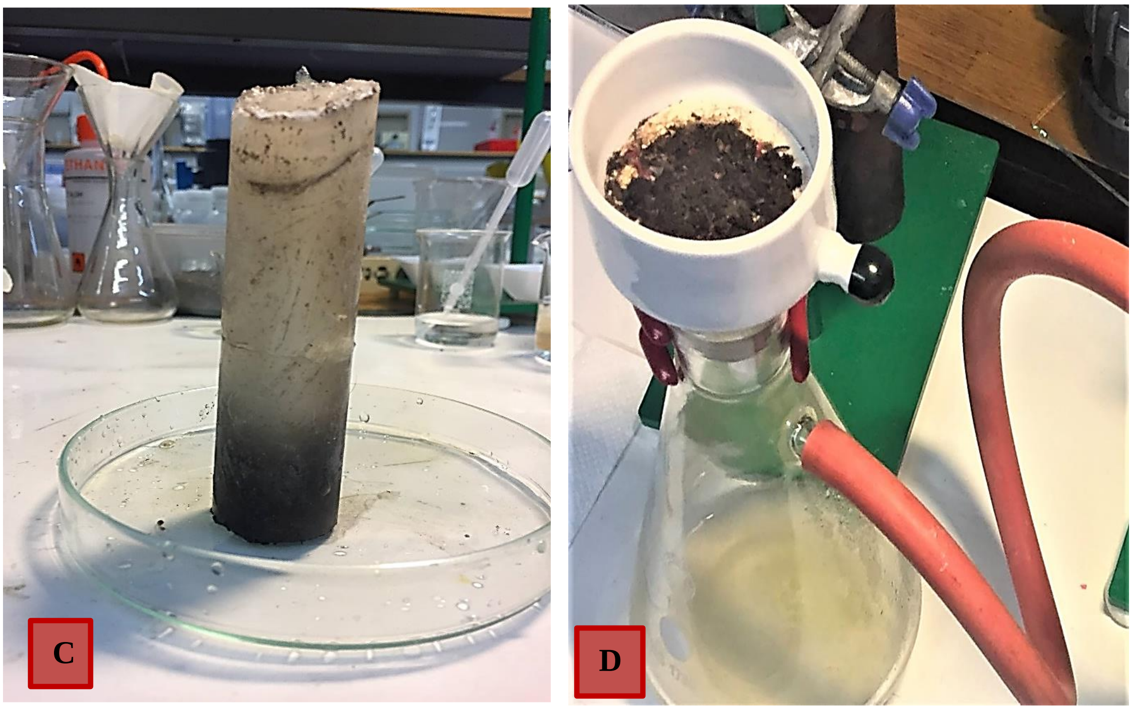



*Figure 15. (a) PTFE Tube (b) Frozen sample taken out from the PTFE Tube (c) remaining sample after removing oil parts (d) Filtration of oil part of the sample*

The step-by-step procedure illustrated in Figure 14, was as follows:

**Figure A**: Sample mixture of compost, water, plastic pieces, and oil was measured and mixed in the tube.

**Figure B:** After freezing overnight, the frozen sample was popped out of the tube. We can see the layers separated according to the density.

**Figure C**: The oil level part was separated away by pouring hot water from a wash bottle. The hot water cut the frozen sample below the oil level. The remaining sample (water and soil) was used for repeating the reprocess, the whole methodology.

**Figure D**: The removed oil level part of sample mentioned in figure C process was placed for filtration. Filtration process was done through vacuum filtration and glass fibre filter paper (Grade 692, 7 cm diameter) was used for filtering. Organic materials and plastic pieces were collected in the filter paper.

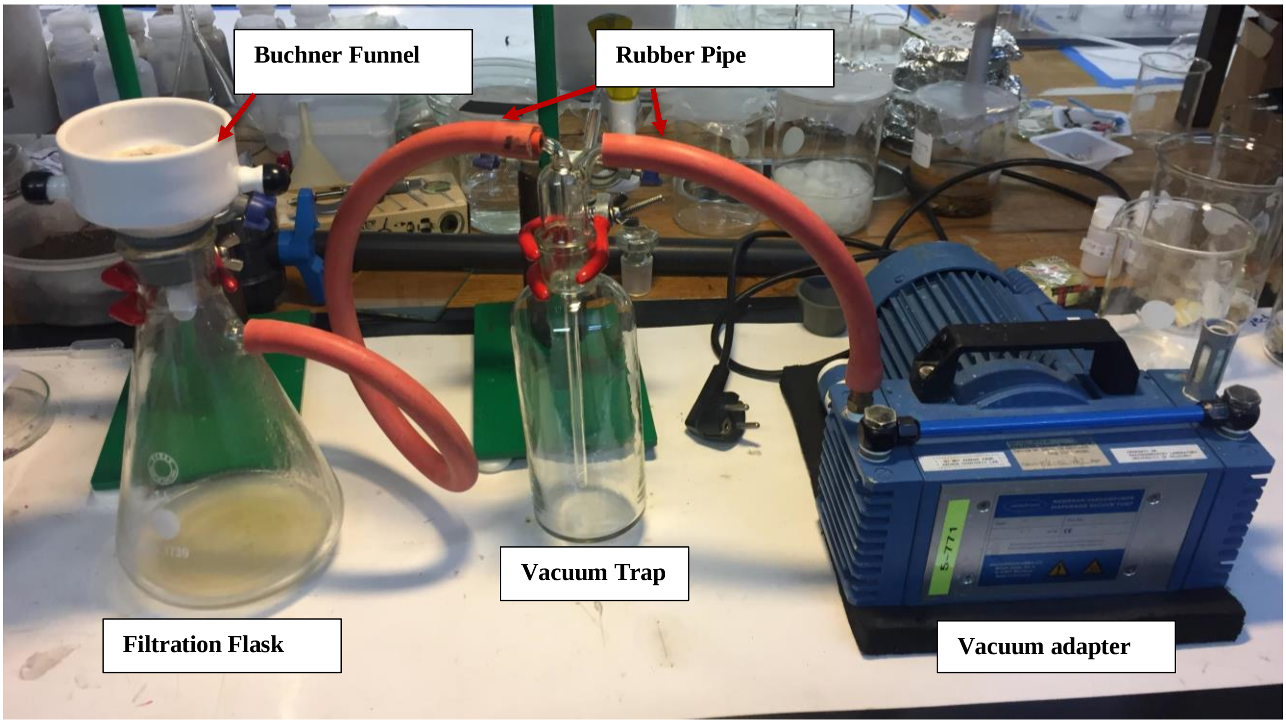



*Figure 16. Vacuum filtration process*

For the vacuum filtration apparatus setup, rubber hose was greased and attached to the flasks so that it would be easy to remove when needed. The cylindrical two-armed flask was used as a vacuum trap to avoid any sort of possible problem caused by the air pressure or reverse flow of water to the adapter. Glass fibre filter paper was used for the experiment since it can hold good amount of particles in it and can still make the water flow faster through it. The vacuum filtration is a very fast filtration process and all the plastic pieces were recovered in filter paper along with other organic materials and oil traces.

## 3.3 Extraction of microplastics by density flotation in SMI unit

The process of extracting microplastics through density flotation using sediment micro-plastic isolation (SMI) unit is commonly used for sand sediments samples in marine environment. There are some researches based on density flotation techniques for extraction of microplastics where light density materials float in the solution. The reason behind using SMI unit is to make the experiment perform faster. Unlike PTFE tube experiment, the sample had to be frozen and later melted for filtration process (in order to prevent loss of sample while directly pouring into filter paper) which is comparatively slower procedure. SMI unit has a ball valve in it which can be opened and closed when needed. After density separation of samples, the valve can be closed, and the floating samples could be poured in filter paper without getting messed with bottom residues.

### 3.3.1 Materials and equipment

- PVC ball valve of 50 mm diameter
- 118 mm size of transparent PVC pipe (× 2) with 50 mm diameter
- PVC glue
- Pipe caps
- Weighing balance
- PVC square plate
- Spoon and spatula
- Beakers

### 3.3.2 Construction of SMI unit

SMI unit is a simple and portable apparatus designed by Coppock for the density flotation process. The unit consists of a pipe and ball valve with no protruding surfaces which allows the smooth movement of samples while performing the experiment. The material used for the making of this unit was PVC. During the construction of SMI unit, Coppock used two transparent PVC pipe of equal length and diameter and a ball valve with same diameter. The two pipes were glued with the two ends of the ball valve, then one end was sticked with a base plate whereas another end was covered with a cap. The ball valve had a key attached with it which was used to open and close the valve when needed.

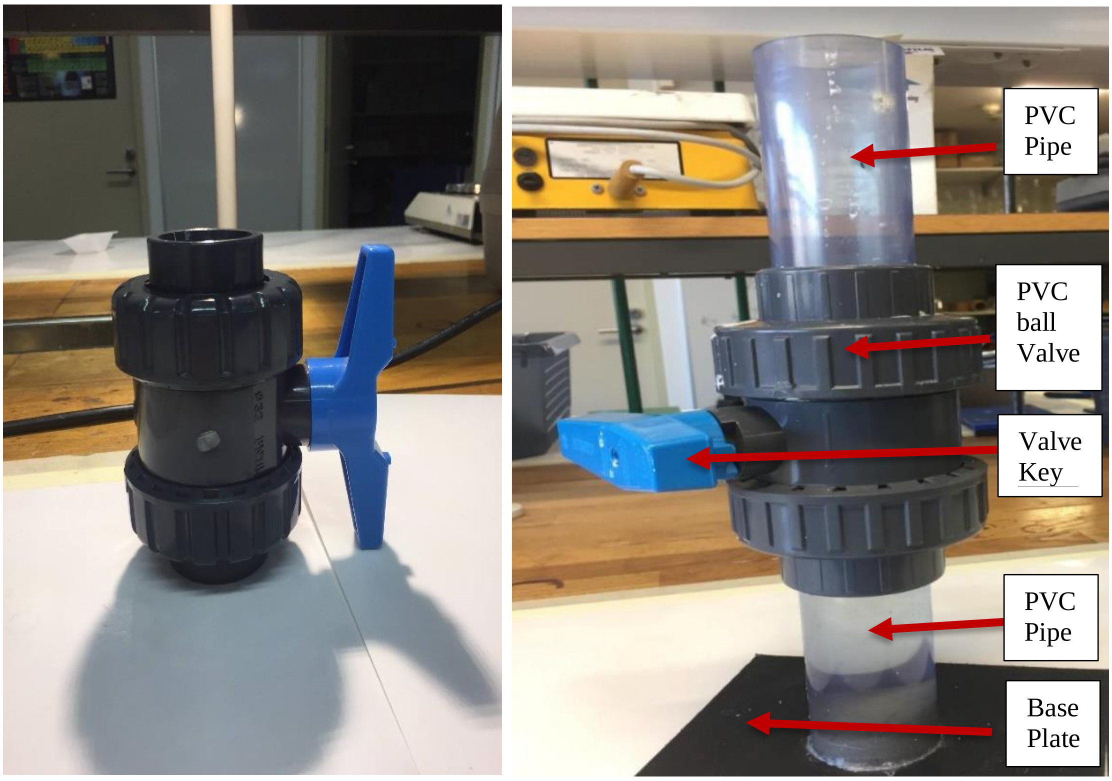



*Figure 17. (a) PVC Valve* *(b) SMI Unit construction*

For my experiment, the construction process of SMI unit was interrupted since transparent pipe was not available at that moment. So, a pre-made SMI unit by my colleague Deepa Bhandari was used for the experiment. She had constructed the unit for her thesis work titled 'Extraction of microplastics from beach sediments using principle of density floatation in SMI unit and microscopic analysis' (Bhandari, 2019).

During her construction of the unit, a 50 mm diameter PVC valve was glued with the two transparent PVC pipes 60 mm long each at its two ends and covered the bottom end with a base plate and top end with a cap.

### 3.3.3 Methodology

Compost sample collected from HSY: **30 g**

Ultra-pure water: **210 mL**

Extra virgin olive oil: 1**5 mL**

Plastic pieces: **~ 20 pieces**

In a SMI unit, 30 grams of sample and around 20 pieces of microplastics was taken and poured 210 mL of ultra-pure water. The mixture was shaken well for couple of minutes and then 15 mL of olive oil was added and mixed well again. The sample was left for density flotation for about 30 hours.

The mixture of sample was separated according to their separation properties such as soil, water and oil got separated according to their densities whereas plastics present in the sample due to hydrophobicity because of which the layers of materials were formed. Soil particles deposited down in the bottom and organic materials and plastic pieces were floating with the oil on the top level.

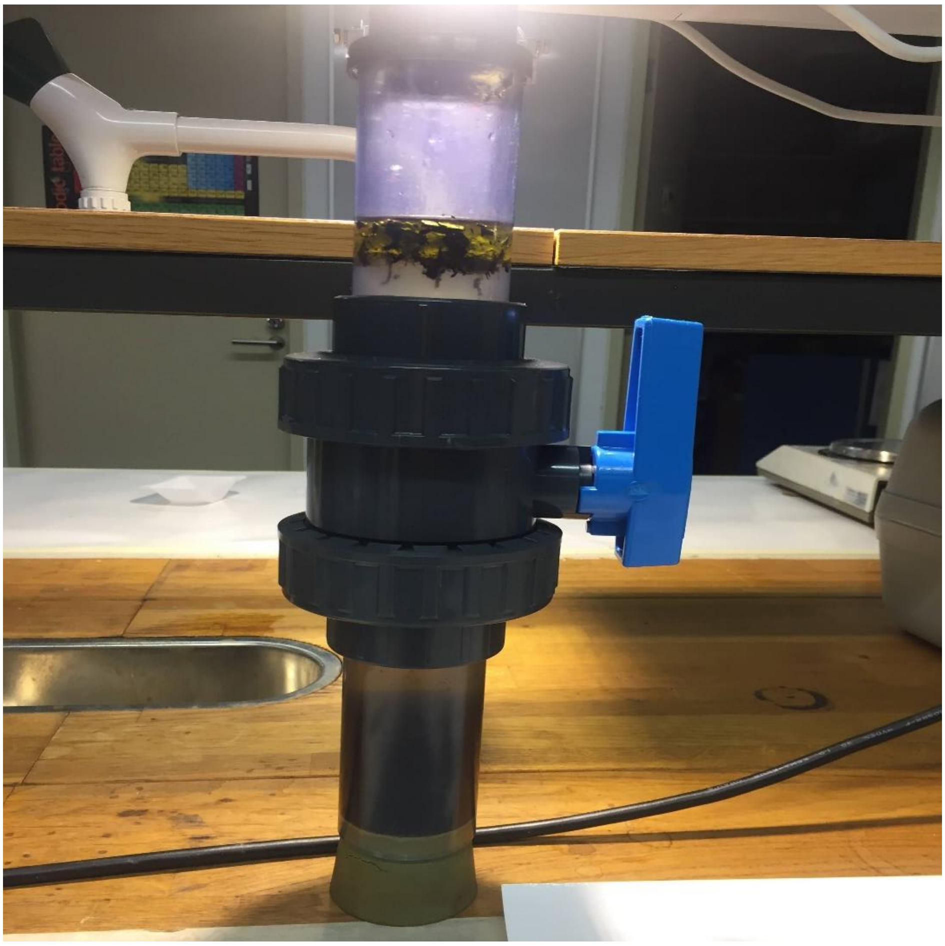


*Figure 18. Sample testing in SMI unit*

In the picture, there is a clear view of flotation of plastic pieces and organic particles with the oil.

# 4 RESULTS AND ANALYSIS

Sample 1, soil collected from the root of horticultural plant

After the first test experiment performed in test tube, large amounts of low-density particles appeared to be floating on the layer of oil. The soil on the bottom of the apparatus also contained equal amount of sand, visually seen. Plastic pieces mixed with the sample were fully recovered on the oil layer. The results of the experiment were visually analyzed.

Sample 2, compost from HSY Ämmöässuo

From the experiment of HSY compost sample performed in PTFE tube, all the plastic pieces were recovered. The sample inside the tube had to be left to freeze since oil could stick on the wall of tube along with plastic and other organic pieces which might affect the extraction results. After freezing and later melting for filtration process all the particles were recovered in the filter paper.

After the experiment of HSY compost sample performed in SMI unit, all the low-density particles were found floating on the top surface with oil layer. Comparatively low amounts of organic materials seemed to be floating than that of sample 1. All the pieces of plastics were found floating on the oil level whereas the soil stayed on the bottom of the apparatus.

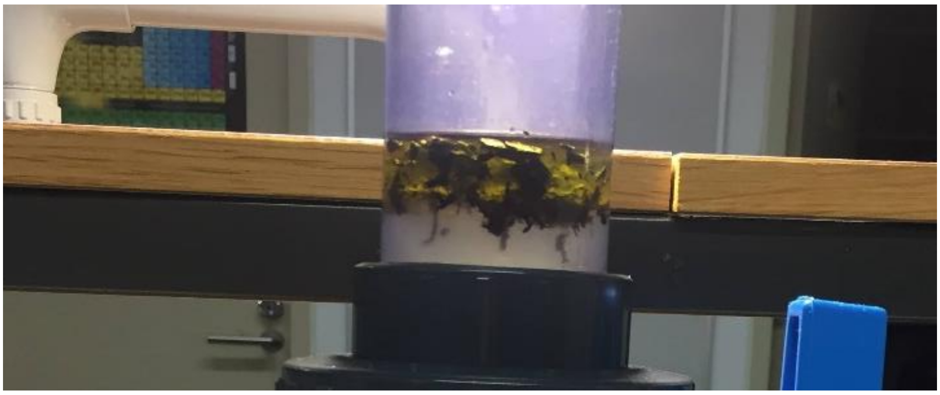


*Figure 19. Top level view of experiment on SMI unit*

# 5 CONCLUSION AND DISCUSSION

The main aim of the thesis was to extract microplastics from compost and soil using olive oil since the rate of particles partitioning in this oil was higher than other oils tested in the literature. A PTFE tube was used so that it does not contaminate the plastic samples during the test. The vacuum filtration and glass fibre filter paper helped to procced the experiment faster.

All the plastics pieces were recovered from the mixture which shows the efficacy of the experimental method but there are still some limitations listed below which could be overcome if further research is carried out.

- The experiment does not cover microscopic view of particles floating on the surfaces so study of particles could be done.
- The study and identification of the organic materials and other materials floating on the surface of oil could be done.
- Removing oil particles from the filtrate can be done to get clear microscopic result of the experiment.
- The test of compost without adding extra plastic pieces can be done so that the exact microplastic presented on the sample could be examined.
- The experiment using SMI unit could be further elongated.
- Identification of all particles present on the sample could be done through various measures like FTIR and Raman spectroscopy.

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