# STATISTICAL REPORT OF MICROPLASTICS (MPS) CONTAMINATING THE COMMERCIAL TABLE SALTS CONSUMED IN TIRANA, ALBANIA

**OLTA ÇAKAJ[1], ERANDA GJEÇI[1], DHURATA PREMTI[2], SEMIRAMIDA PLAKU[1]**

[1]Department of Physics, Faculty of Natural Sciences,

University of Tirana, Albania

[2]Department of Industrial Chemistry, Faculty of Natural Sciences,

University of Tirana, Albania

e-mail: olta.cakaj@fshn.edu.al

***Abstract***

*The first polymer was synthetized in 1907 and nearly a century later the term microplastics (MPs) was used for the first time by Thompson et al, 2004, meaning plastics' fragments with less than 5mm in dimensions. Despite the numerous advantages of polymers, which even led to metal and ceramic substitutions in various applications, a growing risk for living organisms comes from environmental pollution with MPs. Plastic objects break into micro-beads, -fragments, -fibres and -foam during their usage or the deposit period in disposal sites. The most common types of MPs are: high & low-density polyethylene, polystyrene, polyester/polyethylene terephthalate, polypropylene, acrylonitrile butadiene styrene, ethylene-vinyl acetate, polyvinyl chloride and polyurethane. The effects of MPs in humans vary from toxic effects, such as oxidative stress, metabolic disorder, immune response, neurotoxicity to reproductive and developmental toxicity. These health hazards reach humans through air, drinking water and food. One everyday food component, that adds MPs to the diet, is table salt. In this study six commercial table salts' brands consumed in Tirana, Albania, are chosen. They are selected from different countries of origin. Optical microscopy and image analysis are used to identify the shapes and sizes of MPs present in these table salts' samples, for comparisons and statistical evaluations purposes. The table salt from Bosnia & Herzegovina resulted the least contaminated.*

***Key words***: *Microplastics, table salt, optical microscopy, image analysis, Albania*

***Përmbledhje***

*Polimeri i parë u sintetizua në vitin 1907 dhe gati një shekull më vonë termi mikroplastikë (MP) u përdor për herë të parë nga Thompson et al, 2004, duke nënkuptuar fragmente plastike me përmasa më të vogla se 5 mm. Pavarësisht përparësive të shumta të polimerëve, të cilat çuan gjithashtu në zëvendësime të metaleve dhe qeramikave në aplikime të ndryshme, një rrezik në rritje për organizmat e gjallë vjen nga ndotja e mjedisit me MP. Objektet plastike thyhen në mikro-rruaza, -fragmente, -fibra dhe -shkumë gjatë përdorimit të tyre ose periudhës së depozitimit në vendet e grumbullimit. Llojet më të zakonshme të MP janë: polietilen me densitet të lartë dhe të ulët, polistiren, poliestër/polietilen tereftalat, polipropilen, akrilonitril butadien stiren, etilen-vinil acetat, klorur polivinil dhe poliuretan. Efektet e MP tek njerëzit variojnë nga efektet toksike, të tilla si stresi oksidativ, çrregullimi metabolik, përgjigjia imune, neurotoksiciteti deri tek toksiciteti zhvillimor dhe riprodhues. Këto rreziqe shëndetësore arrijnë tek njerëzit përmes ajrit, ujit të pijshëm dhe ushqimit. Një përbërës i përditshëm ushqimor, që shton MP në dietë, është kripa e tryezës. Në këtë studim janë zgjedhur gjashtë marka tregtare të kripërave të tryezës që konsumohen në Tiranë, Shqipëri. Ato janë zgjedhur nga vende të ndryshme origjine. Mikroskopia optike dhe analiza e imazhit janë përdorur për të identifikuar format dhe madhësitë e MP të pranishme në kampionët e këtyre kripërave të tryezës, për qëllime krahasimi dhe vlerësimi statistikor. Kripa e tryezës nga Bosnja dhe Hercegovina rezultoi më pak e ndotura.*

***Fjalë kyçe:*** *Mikroplastika, kripa e tryezës, mikroskopia optike, analiza e imazhit, Shqipëri.*

## Introduction

Bakelite was the first polymer synthetized in 1907, marking the beginning of the polymer science and modern life. The substitution of metal alloys and ceramics with polymers has grown rapidly because of their relatively good mechanical stability, low density, highly versatility, resistance to corrosion, few manufacturing processes, low production cost. All these factors have made polymers present both in everyday life and special applications, from food and cosmetics packaging to medical and technological equipment.

However, this revolutionary material has its own downsides such as environmental pollution. While interacting with surrounding components and organisms of various ecosystems, plastics items degrade and break into smaller pieces. The term microplastics (MPs) was used for the first time in Thompson et al., 2004 while in Arthur et al., 2009 an upper size limit of 5mm was proposed for these fragments. Later on, the term nano-plastics was added for particles with sizes less than 1µm.

Microplastics are commonly split into four different categories:

- Micro-beads - primary microplastics which have been manufactured to be microscopic in size, such as those in exfoliation cosmetics and plastic pellets used for the production of other plastic products.
- Micro-fragments - secondary microplastics fragmented from larger plastics usually as a result of mechanical abrasion, photo-oxidative processes by ultra-violet (UV) radiation, and thermo-oxidative or biological processes.
- Micro-fibers - secondary microplastics in the form of synthetic fibers, such as those broken down from textiles.
- Micro-foam - typically used for products packaging.

According to Cincinelli et al., 2021, the Mediterranean Sea is polluted with 100000 tons of plastic waists every year, where 50% comes from land sources, 30% from river ones and 20% from marine activities. Land plastic waists reach the sea because of sewage streams, stormwater, rains and wind currents. Domestic, industrial, commercial, military and especially tourism consumerism from 21 countries surrounding the Mediterranean Sea are the main activities causing such amounts of waists. (Frias and Nash, 2019; Peixoto et al, 2019; Lee et al, 2021; See et al, 2020; Auta et al, 2017; Cole et al, 2011; Gündoğdu, 2018; Coyle et al, 2020; Karami et al, 2017)

In 2015, UNEP/MAP (Mediterranean Action Plan of the United Nations Environment Programme) published the list of countries with the largest amount of plastic waste disposal in the Mediterranean Sea as follows: Turkey

(144 tons/day), Spain (126 tons/day), Italy (90 tons/day), France (66 tons/day), and Egypt (77 tons/day). In Europe, every year 3500 million plastic bottles, 1500 million plastic cups, 5000 million plastic straws, 207 million single-use containers, such as plastic bags, are used and unfortunately only 35-38% of this plastic is recycled. The result is a very large amount of MPs in the Mediterranean Sea with various shapes such as polyester foam, fibers from textiles, filaments of fishing gears, fragments, films and spheres, with different chemical compositions.

The mostly spread polymers are: high & low-density polyethylene HDPE & LDPE ($(C_2H_4)_n$), polystyrene PS ($(C_8H_8)_n$), polyester / polyethylene terephthalate PET ($(C_{10}H_8O_4)_n$), polypropylene PP ($(C_3H_6)_n$), acrylonitrile butadiene styrene ABS ($(C_8H_8 \cdot C_4H_6 \cdot C_3H_3N)_n$), ethylene-vinyl acetate EVA ($(C_2H_4)_n(C_4H_6O_2)_n$), polyvinyl chloride PVC ($(C_2H_3Cl)_n$) and polyurethane PUR ($(C_{27}H_{36}N_2O_{10})_n$).

Polymers with density lower than 1.02 - 1.03g/mL (the seawater density), such as LDPE (0.89 - 0.94 g/mL), HDPE (0.94 - 0.96g/mL), PP (0.85 - 0.83g/mL), float on the sea surface, while the ones with a higher density, such as PET (1.29 - 1.40g/mL) and PVC (1.30 - 1.58g/mL), tend to sink and accumulate in sediments. The density of these MPs can change over time due to interaction with seawater, various seawater components or living organisms. (Kazour et al, 2019; de Ruijter et al, 2019; Alimba and Faggio, 2019; Andrady, 2011; Kim et al, 2018; Renzi and Blašković, 2018; Lee et al, 2019; Yang et al, 2015; Iñiguez et al, 2017)

The microplastics distributions and their sizes in table salts from sea, lake and rock of various countries in different continents are presented on table 1. (Zhang et al, 2020) Because of their micro and nano-scale sizes, these plastic pieces can easily reach living organisms through the food chain, water and air. Various reports have shown that microplastics in marine and aquatic creatures have led to malnutrition, inflammation, reduction of fertility and mortality. Though the specific consequences they induce in humans have not been defined yet, there are a lot of experiments showing that the exposure to microplastics leads to toxic effects, such as oxidative stress, metabolic disorder, immune response, neurotoxicity, reproductive and developmental toxicity (figure 1 & 2). (Lee et al, 2023; Li et al, 2023)

The toxic substances present on MPs can be additives or adsorbed. Additives are added during plastic production to improve the performance, functionality and ageing properties, while the second are those absorbed from the surrounding environment. In January 2018, the EU have adopted the "European Plastics Strategy" for the increment of plastic products' recycling and reduction of plastic waste.

The International Organization for Standardization and the Group of Experts on the Scientific Aspects of Marine Environmental Protection, which advice the United Nations Environment Programme, are pushing towards the development of standardized guidelines for microplastics investigation and analysis.

**Table 1.** Microplastics distributions and sizes in table salts from sea, lake and rock of various countries in different continents (UW - Ultrapure Water). (Zhang et al, 2020)

| Country | Extraction | Filters pore size (μm) | Sea salt (items/kg) | Lake salt (items/kg) | Rock salt (items/kg) | MPs size (μm) |
|---|---|---|---|---|---|---|
| Australia | UW | 149 | 0-9 | - | - | 160-980 |
| | 17% $H_2O_2$ | 2.7 | 46 | - | - | 100-5000 |
| Belarus | 17% $H_2O_2$ | 2.7 | - | - | 8 | 100-5000 |
| Brazil | 17% $H_2O_2$ | 2.7 | $2.0 \cdot 10^2$ | - | - | 100-5000 |
| Bulgaria | 17% $H_2O_2$ | 2.7 | 12 | - | - | 100-4000 |
| China | 30% $H_2O_2$ | 5 | $(5.5\text{-}6.8) \cdot 10^2$ | 43-364 | 7-204 | 45-4300 |
| | 17% $H_2O_2$ | 2.7 | $(0\text{-}1.7) \cdot 10^3$ | 28 | 0-14 | 100-4000 |
| | UW | 5 | 9.8 | - | - | 1-1500 |
| Croatia | UW | 0.45 | $(1.4\text{-}2.0) \cdot 10^4$ | - | - | 15-4628 |
| | UW | 0.2 | $(0.7\text{-}2) \cdot 10^2$ | - | - | 10-150 |
| | 17% $H_2O_2$ | 2.7 | 58 | - | - | 100-5000 |
| France | UW | 149 | 0-2 | - | - | 160-980 |
| | 17% $H_2O_2$ | 2.7 | 0 | - | - | - |
| Germany | 17% $H_2O_2$ | 2.7 | - | - | 2 | 100 |
| Hungary | 17% $H_2O_2$ | 2.7 | - | - | 12 | 100-4000 |

| | | | | | | |
|---|---|---|---|---|---|---|
| India | 30% $H_2O_2$ | 0.45 | $(0.6\text{-}1.0) \cdot 10^2$ | - | - | 500-2000 |
| | 17% $H_2O_2$ | 2.7 | $(0.3\text{-}3.7) \cdot 10^2$ | - | - | 1000-5000 |
| Indonesia | 17% $H_2O_2$ | 2.7 | $1.4 \cdot 10^4$ | - | - | - |
| | UW | 0.45 | 6.7-53.5 | - | - | 390-9360 |
| Iran | UW | 149 | - | 1 | - | 160-980 |
| Italy | UW | 0.45 | $(1.6\text{-}8.2) \cdot 10^3$ | - | - | 4-2100 |
| | 17% $H_2O_2$ | 2.7 | 4-30 | - | 80 | 100-5000 |
| | UW | 0.2 | $(1.7\text{-}3.2) \cdot 10^2$ | - | - | 10-150 |
| Japan | UW | 149 | 0 | - | - | - |
| Korea | 17% $H_2O_2$ | 2.7 | $(1.0\text{-}2.3) \cdot 10^2$ | - | - | 100-3000 |
| Malaysia | UW | 149 | 1 | - | - | 160-980 |
| New Zealand | UW | 149 | 0-1 | - | - | 160-980 |
| Pakistan | 17% $H_2O_2$ | 2.7 | - | - | 100 | 100-5000 |
| Philippines | 17% $H_2O_2$ | 2.7 | - | - | 120 | 100-5000 |
| Portugal | UW | 149 | 0-10 | - | - | 160-980 |
| Senegal | 17% $H_2O_2$ | 2.7 | 48 | 800 | - | 100-3000 |
| South Africa | UW | 149 | 1-3 | - | - | 160-980 |
| | UW | 0.2 | - | - | - | 0-2000 |
| Spain | UW | 5 | $(0.5\text{-}2.8) \cdot 10^2$ | - | 115-185 | 30-3500 |
| Thailand | 17% $H_2O_2$ | 2.7 | $(0.7\text{-}4.0) \cdot 10^2$ | - | - | 100-5000 |
| Turkey | 30% $H_2O_2$ | 0.2 | 16-84 | 8-102 | 9-16 | 20-5000 |
| U.S.A. | UW | 11 | $(0.5\text{-}8.0) \cdot 10^2$ | - | 113-367 | 100-5000 |
| | 17% $H_2O_2$ | 2.7 | 32 | - | 5 | 100-1000 |
| U.K. | 17% $H_2O_2$ | 2.7 | $1.4 \cdot 10^2$ | - | - | 100-2000 |
| Vietnam | 17% $H_2O_2$ | 2.7 | 76-88 | - | - | 100-5000 |

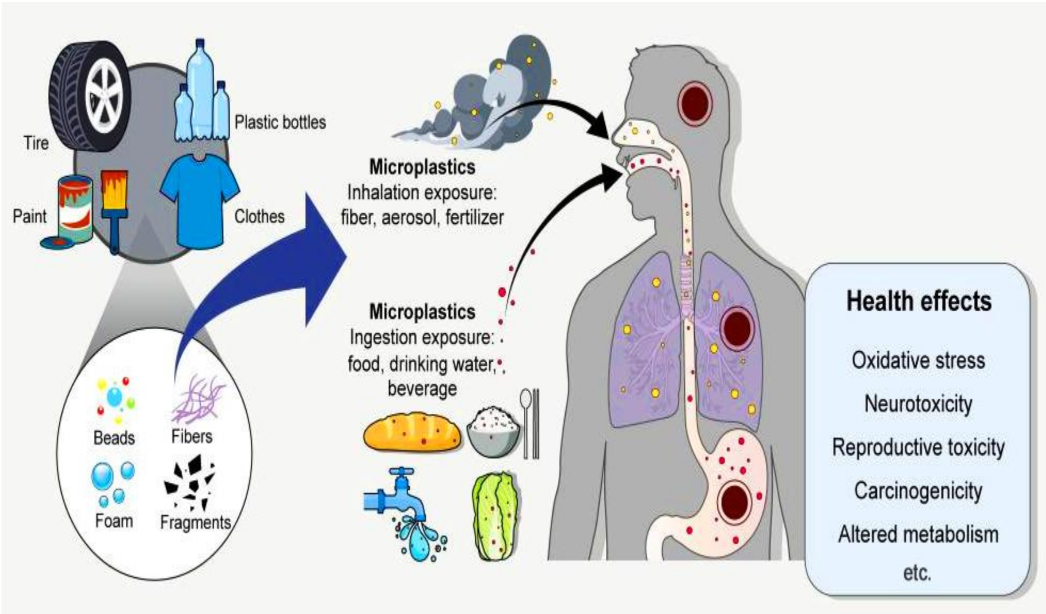



**Figure 1.** Microplastics various sources, shapes after degradation, means they reach up to humans and health effects they cause on them.

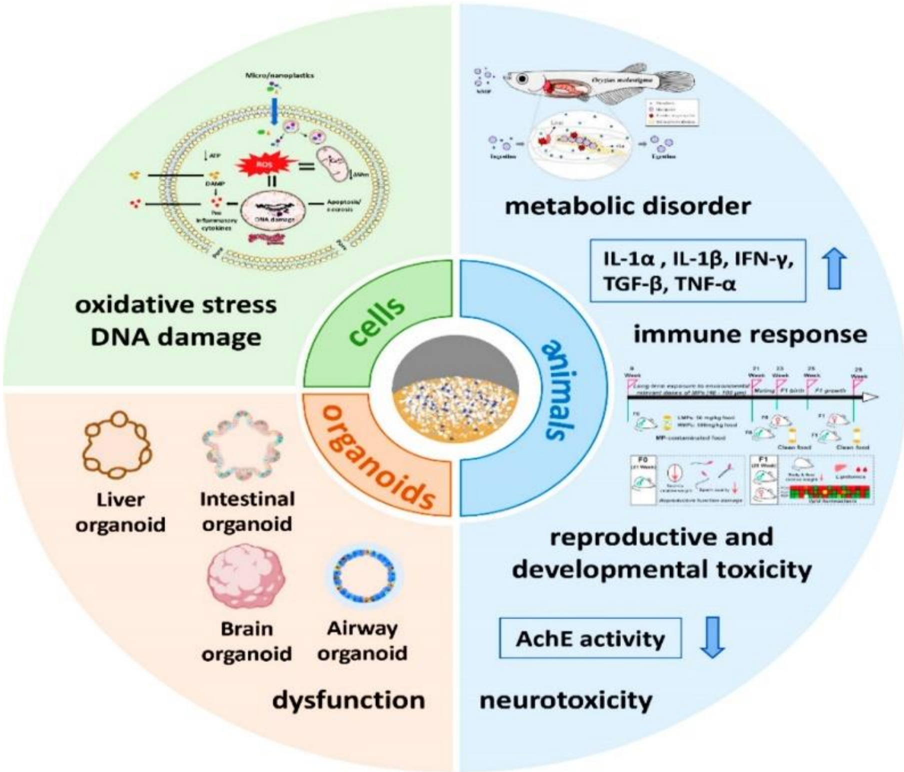



**Figure 2.** Toxicity mechanism of microplastics. Cells: oxidative stress and DNA damage. Organoids: dysfunction. Animals: metabolic disorder, immune response, neurotoxicity, as well as reproductive and developmental toxicity

The main production steps of table salt originating from the sea are as follow:

- Collecting seawater – the seawater is collected from the ocean or sea; the quality and mineral content of the seawater affects the flavor and purity of the salt.
- Evaporation – the seawater is left to evaporate naturally from the sun and wind in shallow ponds or using heaters or fans, in case of mechanical evaporation; in both cases leaving behind the brine.
- Crystallization – the salt crystals begin to form from the concentrated brine; their size depends on temperature, humidity, brine's

concentration, etc. The salt crystals are collected manually or using machineries.

- Washing and purification – the collected salt is rinsed using fresh water to remove impurities and excess minerals, and then is dried in air or using ovens.
- Grinding and grading – the dried salt is grounded to the desired size, ranging from coarse crystals to fine table salt, and then it is sorted by size and quality.
- Additives (optional) – in many commercial table salts, anti-caking agents like calcium silicate are added to prevent clumping or iodine to help prevent iodine deficiency.
- Packaging and distribution – the final product is packaged into boxes, plastic bags, or jars; its quality is controlled and at the end the packages are distributed to retailers, wholesalers, or directly to consumers. (Yang et al, 2022; Rocha-Santos et al, 2022; Bergmann et al, 2015; Crawford and Quinn, 2017; Hashmi, 2022; He and Luo, 2020; Mancuso et al, 2023)

In this study we included six commercial table salts brands consumed in Tirana, Albania, that can be found in every supermarket in the city. They were selected from different countries of origin and were chosen among the most widespread and used from consumers in Tirana. Optical microscopy and image analysis are used to identify the shapes and sizes of the microplastics present in these table salts samples, for comparisons and statistical evaluations purposes.

## Methodology

The optical examinations in this study are performed using Kozo XJP304 optical microscope (OM, halogen light source; 12V tension; 50W power), the images are acquired with Sony TCC-8.1 digital camera and View Version 7.3.1.7 software is used for the image analysis.

The samples of this study have been prepared mixing 100g of salt, 240ml of distilled $H_2O$ and 60ml of $H_2O_2$ (20% $H_2O_2$ solution). According to the literature, $H_2O_2$ is used to dissolve organic residues that table salt may contain. Six different commercial table salts brands, easily found in supermarkets in Tirana, have been selected. They have different countries of origin. The dilution of each salt was done in glass jars with metal lids and the mixing was performed with a glass rod, to avoid any contamination from plastic. In order to achieve complete dissolution, the salts solutions were continuously mixed and heated up to 35°C.

The solutions were stored in the laboratory, away from the direct sunlight, at a temperature of 25°C. The filtration process was performed using MCE (mixed cellulose ester) filters with a pore size of 3-5 µm (FILTRAK no 390) and an air pump with 0.012MPa of pression. Based on the literature, MCE filters are more recommended, compared to GF (glass fiber) ones, since they have a structure with lower capillarity, so they absorb less water. At the end, the filters were dried for approximately 30 minutes, at 35°C. (Zobkov and Esiukova, 2018; Peiponen et al, 2019; Kalaronis et al, 2022; Wang et al, 2017) Table 2 presents information of the selected salts while figure 3 shows steps and equipment of the sample preparation process.

**Table 2.** Ordinal number and country of origin of the selected salts.

| Ordinal no | Type of salt and country of origin |
|---|---|
| 1 | Fine white salt from Greece |
| 2 | Coarse pink Himalayan salt |
| 3 | Fine white salt from Germany |
| 4 | Fine white salt from Italy |
| 5 | Coarse black salt from Vlora, Albania |
| 6 | Fine white salt from Bosnia & Herzegovina |
| 7 | White sample (240ml distilled $H_2O$ + 60ml $H_2O_2$) |

a)


b) 

c) 


d) 

e) 

f) 


**Figure 3.** a) weighing process for three of the salts, b) the salts solutions after dilution, c) the MCE (mixed cellulose ester) FILTRAK no 390 used for filtration, d) the filtration process using the air pump, e) the oven where the filters were dried and f) the dried filters ready for the OM examinations.

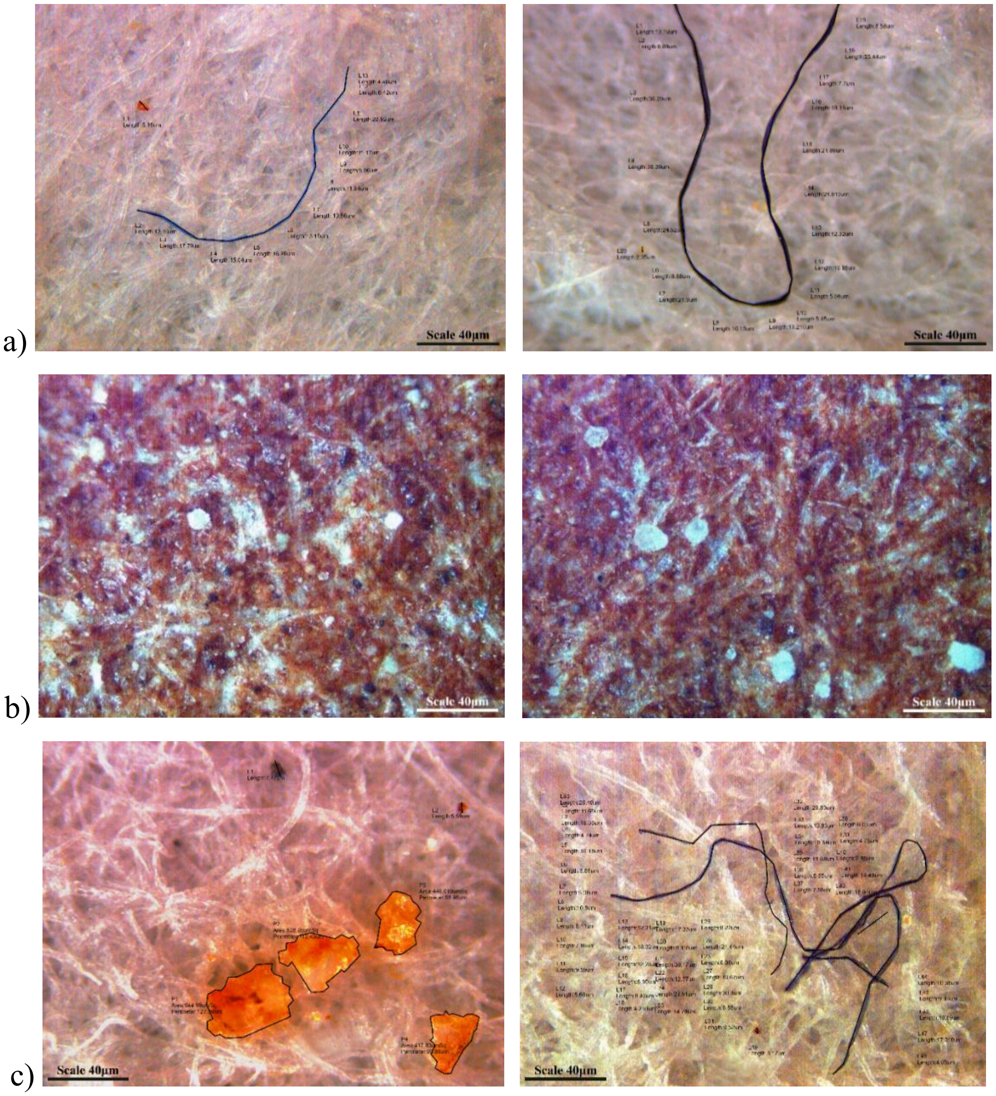
The table salts samples are studied with image analysis. Since the resolution of the optical microscope is about 200 nm, then the absolute error of this analytical equipment is ±200 nm. Random errors, which are difficult to evaluate, can come from:

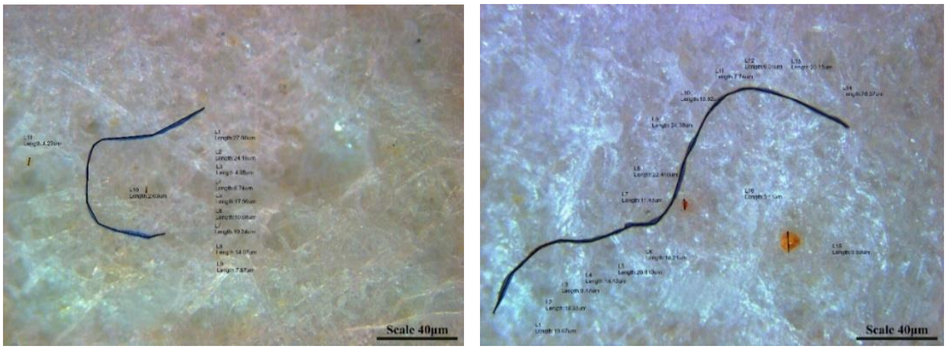
- Low resolution: details are lost or elements are not distinguished.

- Small number of pixels: small features may not be accurately represented if they are located between pixels.
- Calibration errors: if the image analysis system is not calibrated correctly, the measurements will be inaccurate.
- Unstable lighting and low contrast: difficulty in distinguishing edges and details.
- Noise and artifacts: imperfections such as scratches, dust, or changes in pixel values can introduce false elements into the image.
- Segmentation: dividing a single object into multiple parts can lead to inaccurate measurements.
- Overlapping: overlapping objects can be mistakenly identified as a single one.
- Chromatic aberration: different wavelengths of light are focused at different distances, causing uncertainties in colors around objects.
- Human error: different individuals may interpret images differently, leading to different measurements.
- Software algorithms: algorithms used for image analysis may have limitations in handling complex images or specific types of data.
- Environmental factors: changes in temperature and physical vibrations can affect the performance of imaging devices and blur the image. (Mariano et al, 2021; Zhang et al, 2018; Girão, 2020; Hawkes and Spence, 2019; Cruz-Orive, 2024)

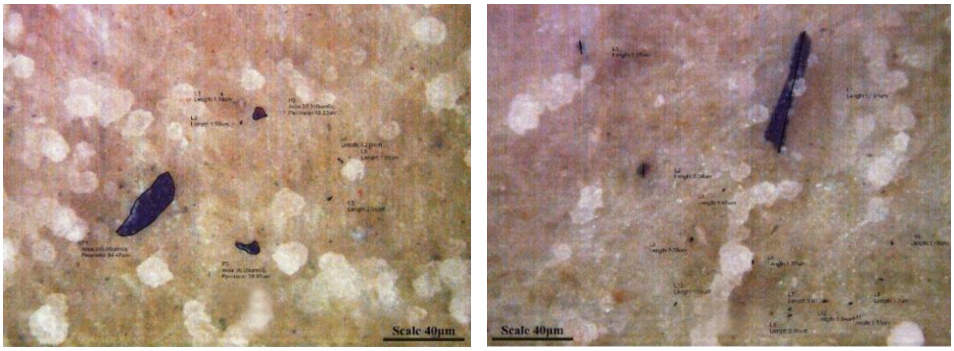
**Analysis and discussion**

Twenty random fields of view were chosen on each of the filters (magnification of all optical images is 40X). Calculations and measurements such as microplastics surface density (numbers of MPs / $\mu m^2$), fibers lengths, fragments dimensions and surfaces were performed on all images. In figure 4, two images from each sample along with respective measurements are displayed. Filter of sample no. 2 was excluded from the measurements due to image ambiguity caused by the red / pink salt color (figure 4 b).

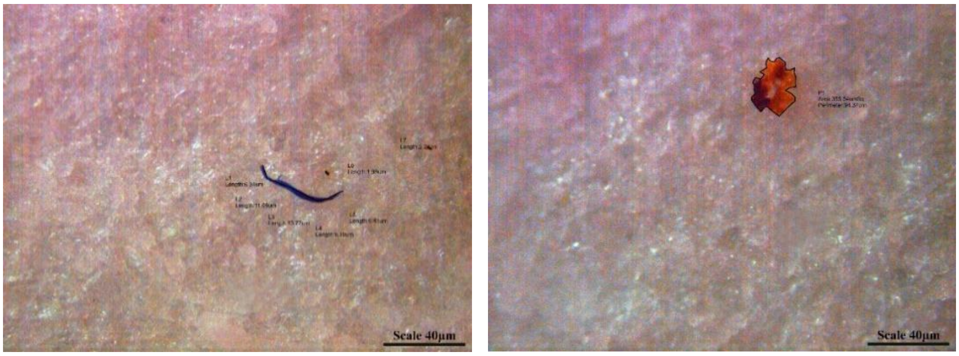

a)
Scale 40μm
Scale 40μm
b)
Scale 40μm
Scale 40μm
c)
Scale 40μm
Scale 40μm


Scale 40µm
Scale 40µm

d)


Scale 40µm
Scale 40µm

e)


Scale 40µm
Scale 40µm

f)

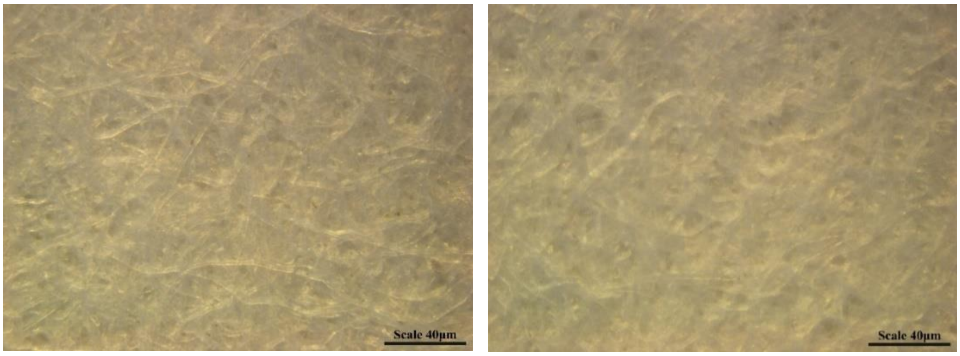
g) 


**Figure 4.** Two images from each sample, along with the measurements, from: a) fine white salt from Greece, b) coarse pink Himalayan salt (excluded from the measurements), c) fine white salt from Germany, d) fine white salt from Italy, e) coarse black salt from Vlora, Albania, f) fine white salt from Bosnia & Herzegovina, g) white sample (filtered 240ml distilled $H_2O$ + 60ml $H_2O_2$).

Table 3 presents the number of microplastics counted for each image of every sample analyzed. Then the average number of MP/image, the average surface density per μm$^2$ and per mm$^2$ were calculated, knowing that the image has a surface area of 213.5μm x 159.5μm = 34053.25μm$^2$. Figure 5 shows the average surface density of the microplastics per mm$^2$ of the filter. It is clear that the sample from Vlora, Albania has the highest MP density (564 MP/mm$^2$) while all the other samples have microplastics densities between 100 and 200 MP/mm$^2$.

**Table 3.** Number of fibers present in all sample images and the calculated average values.

| Image no. | Sample from Greece | Sample from Bosnia & Herzegovina | Sample from Italy | Sample from Vlora, Albania | Sample from Germany |
|---|---|---|---|---|---|
| **1** | 2 | 3 | 6 | 21 | 4 |
| **2** | 1 | 2 | 4 | 24 | 3 |
| **3** | 2 | 4 | 9 | 25 | 8 |

| | | | | | |
|---|---|---|---|---|---|
| **4** | 1 | 3 | 11 | 23 | 10 |
| **5** | 1 | 2 | 10 | 26 | 3 |
| **6** | 2 | 9 | 7 | 28 | 2 |
| **7** | 2 | 6 | 6 | 20 | 5 |
| **8** | 5 | 6 | 4 | 17 | 10 |
| **9** | 24 | 3 | 6 | 29 | 1 |
| **10** | 13 | 4 | 7 | 23 | 4 |
| **11** | 6 | 1 | 11 | 22 | 8 |
| **12** | 10 | 3 | 7 | 15 | 7 |
| **13** | 1 | 4 | 4 | 25 | 2 |
| **14** | 2 | 3 | 7 | 19 | 1 |
| **15** | 4 | 6 | 5 | 10 | 5 |
| **16** | 7 | 5 | 2 | 9 | 1 |
| **17** | 1 | 4 | 3 | 15 | 4 |
| **18** | 2 | 3 | 4 | 8 | 4 |
| **19** | 4 | 3 | 8 | 9 | 3 |
| **20** | 1 | 6 | 7 | 16 | 5 |
| **Average number of MP/image** | 4.55 | 4 | 6.4 | 19.2 | 4.5 |
| **MP/µm$^2$** | 0.000134 | 0.000117 | 0.000188 | 0.000564 | 0.000132 |
| **MP/mm$^2$** | 134 | 117 | 188 | 564 | 132 |

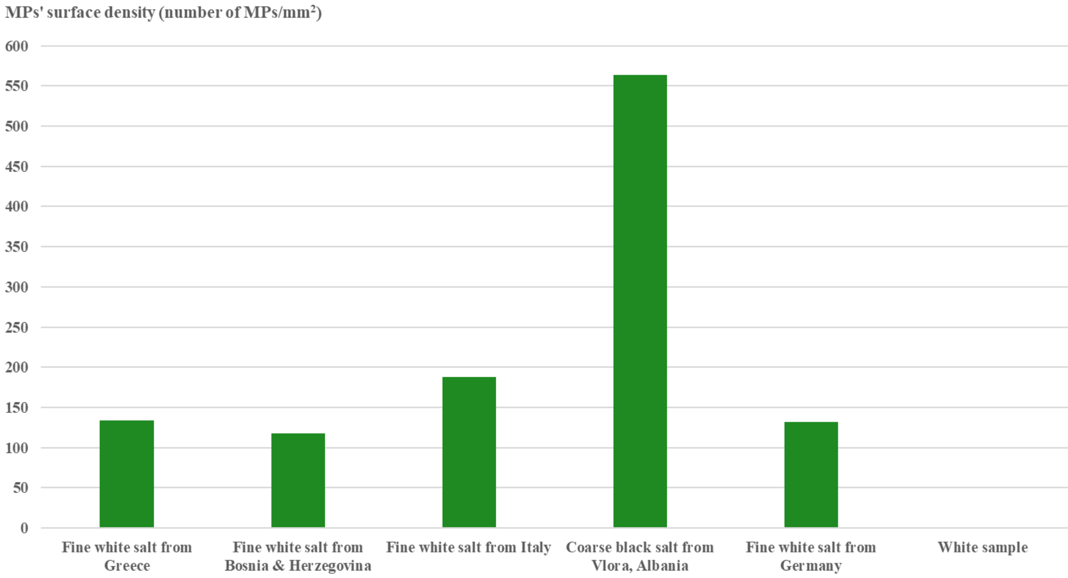



**Figure 5.** Average surface density of the microplastics per $mm^2$ of the filter.

In each of the twenty randomly selected images, for every salt filter, the total length of the fibres (table 4) and the dimensions / surfaces of the fragments were measured. Then, for every type of measurement, the corresponding dimensions interval was determined and their distribution is displayed in table 5. Most of the fibres have a total length in the range of 0 - 200 µm. There are fewer fibres with a length between 200 and 400 µm (sample from Greece, Bosnia & Herzegovina, Italy) and in the range 400 - 610 µm there is only one fibre (sample from Bosnia & Herzegovina). This is the only case where a fibre exceeds the length of 600 µm, among the samples included in this study (figure 6 a).

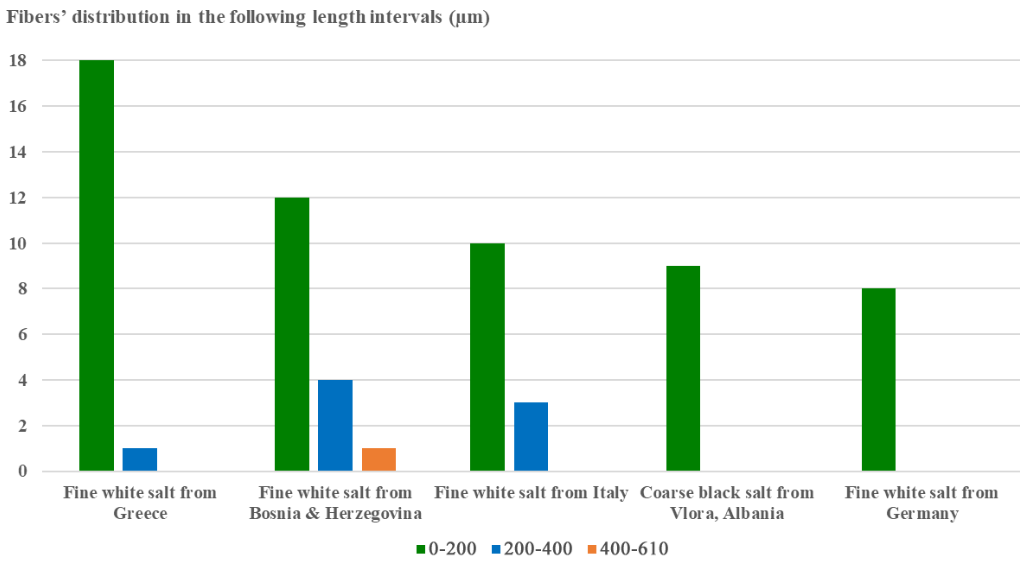
The fragments dimensions and most of their surfaces belong to the interval 0-200 (µm and $µm^2$), while very few of them have surfaces greater than 200 $µm^2$ (figure 6 b) & c). The sample from Vlora, Albania has the highest amount of fragments (0-200 µm), which is simultaneously very high compared with its amount of fibres (0-200 µm). This trend is also visible in the case of the Greece sample, Italy and Germany (figure 6 b). The smallest amount of fragments is detected in the sample from Bosnia & Herzegovina (figure 6 b).

**Table 4.** Length of fibres present in all samples' images.

<table>
<tr><th></th><th colspan="2">Sample from Greece</th><th colspan="2">Sample from Bosnia & Herzegovina</th><th colspan="2">Sample from Italy</th><th colspan="2">Sample from Vlora, Albania</th><th colspan="2">Sample from Germany</th></tr>
<tr><th>Image no.</th><th colspan="10">Fiber's length (μm)</th></tr>
<tr><td>1</td><td colspan="2">-</td><td colspan="2">-</td><td colspan="2">118.74</td><td colspan="2">-</td><td colspan="2">-</td></tr>
<tr><td>2</td><td colspan="2">-</td><td>61.94</td><td>80.88</td><td colspan="2">-</td><td colspan="2">-</td><td colspan="2">25</td></tr>
<tr><td>3</td><td>170.69</td><td>147.84</td><td colspan="2">68.52</td><td colspan="2">-</td><td colspan="2">-</td><td colspan="2">-</td></tr>
<tr><td>4</td><td colspan="2">318.11</td><td>154.74</td><td>12.8</td><td colspan="2">32.14</td><td colspan="2">-</td><td colspan="2">48.84</td></tr>
<tr><td>5</td><td colspan="2">173.68</td><td colspan="2">-</td><td colspan="2"></td><td colspan="2">50.34</td><td colspan="2">-</td></tr>
<tr><td>6</td><td>166.08</td><td>118.87</td><td colspan="2">-</td><td colspan="2">126.53</td><td colspan="2">-</td><td colspan="2">-</td></tr>
<tr><td>7</td><td colspan="2">113.55</td><td colspan="2">158.63</td><td colspan="2">-</td><td colspan="2">-</td><td colspan="2">-</td></tr>
<tr><td>8</td><td colspan="2">61.22</td><td colspan="2">-</td><td colspan="2">-</td><td colspan="2">-</td><td colspan="2">-</td></tr>
<tr><td>9</td><td colspan="2">-</td><td colspan="2">332.35</td><td colspan="2">-</td><td>81.34</td><td>30.05</td><td colspan="2">47.63</td></tr>
<tr><td>10</td><td>76.23</td><td>88.39</td><td colspan="2">52.49</td><td colspan="2">-</td><td colspan="2">-</td><td colspan="2">-</td></tr>
<tr><td>11</td><td colspan="2">-</td><td colspan="2">602.89</td><td>39.27</td><td>2.41</td><td colspan="2">-</td><td colspan="2">-</td></tr>
<tr><td>12</td><td colspan="2">21.58</td><td colspan="2">166.52</td><td>379.92</td><td>139.3</td><td colspan="2">-</td><td colspan="2">21</td></tr>
<tr><td>13</td><td colspan="2">66.96</td><td colspan="2">15.49</td><td>96.88</td><td>148.74</td><td colspan="2">-</td><td>3.73</td><td>41.85</td></tr>
<tr><td>14</td><td colspan="2">85.52</td><td colspan="2">375.31</td><td colspan="2">204.26</td><td colspan="2">143.93</td><td colspan="2">-</td></tr>
<tr><td>15</td><td colspan="2">19.77</td><td colspan="2">-</td><td colspan="2">-</td><td>34.61</td><td>64.34</td><td colspan="2">-</td></tr>
<tr><td>16</td><td colspan="2">-</td><td colspan="2">295.11</td><td colspan="2">174.07</td><td colspan="2">-</td><td colspan="2">-</td></tr>
<tr><td>17</td><td colspan="2">16.34</td><td colspan="2">235.44</td><td colspan="2">13.03</td><td>33.69</td><td>17.03</td><td colspan="2">-</td></tr>
<tr><td>18</td><td colspan="2">152.57</td><td colspan="2">28.91</td><td colspan="2">224.37</td><td colspan="2">-</td><td colspan="2">48.4</td></tr>
<tr><td>19</td><td>35.98</td><td>19.61</td><td colspan="2">-</td><td colspan="2">-</td><td colspan="2">-</td><td colspan="2">-</td></tr>
<tr><td>20</td><td colspan="2">25.3</td><td>57.85</td><td>113.34</td><td colspan="2">-</td><td colspan="2">13.73</td><td colspan="2">76.57</td></tr>
</table>

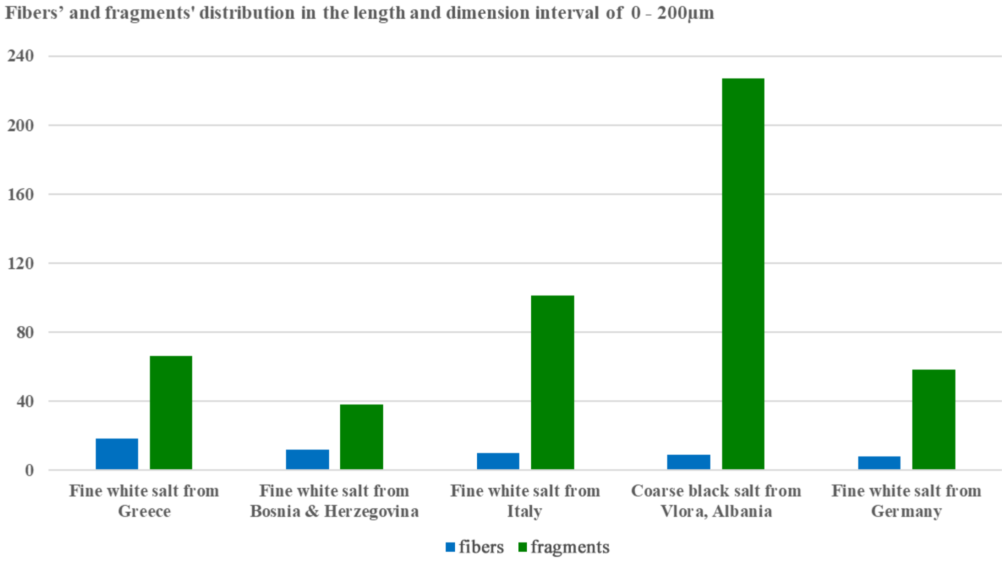
**Table 5.** Fibres' and fragments' distribution in the following length, dimension and surface intervals (µm, µm²).

| Sample from | Fibers' distribution in the following length intervals (µm) | | | Fragments' distribution in the following dimension interval (µm) | Fragments' distribution in the following surface intervals (µm²) | |
|---|---|---|---|---|---|---|
| | 0 - 200 | 200 - 400 | 400 - 610 | 0 - 200 | 0 - 200 | 200 - 1200 |
| Greece | 18 | 1 | 0 | 66 | 66 | 0 |
| Bosnia & Herzegovina | 12 | 4 | 1 | 38 | 32 | 6 |
| Italy | 10 | 3 | 0 | 101 | 101 | 0 |
| Vlora | 9 | 0 | 0 | 227 | 223 | 4 |
| Germany | 8 | 0 | 0 | 58 | 57 | 1 |
| White sample | 0 | 0 | 0 | 0 | 0 | 0 |




a)

b)




c)

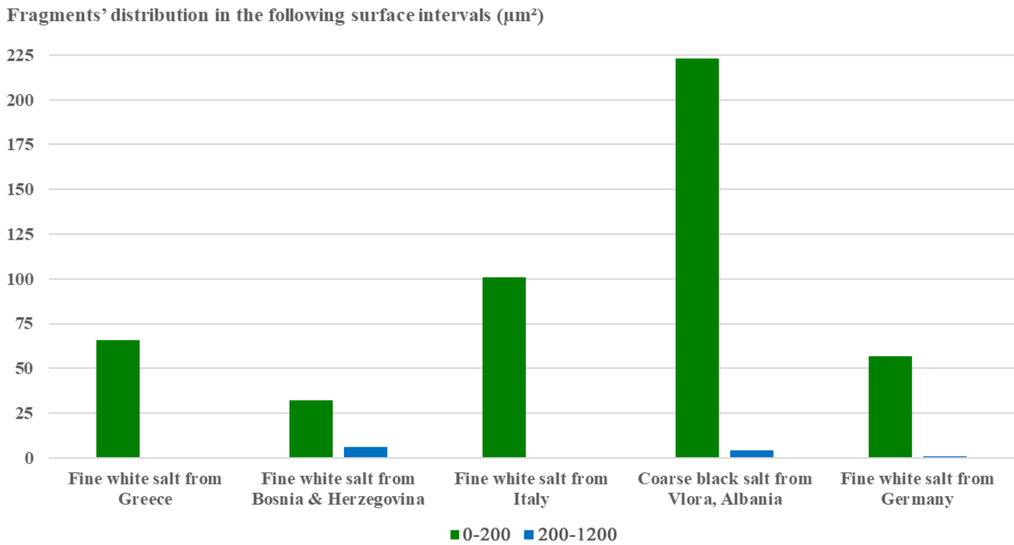



**Figure 6.** a) Fibres distribution in length intervals (µm); b) comparison between fibres and fragments distribution in length and dimension interval 0 - 200µm); c) fragments distribution in surface intervals (µm²).

The total number of microplastics counted from the twenty images (tab. 3), for each sample, is greater than the sum of fibres and fragments (tab. 4) since not all of them had clearly visible borders. The dimensions of these fibres / fragments were not measured because the measurement error would have been high.

Comparing the results of table 1 with those obtained in this study, it is clear that the MPs' dimensions in table salts consumed in Tirana are within the intervals of the majority of other countries, except for one studied case in Croatia and Italy.

Microplastics fibres, because of their shape and durability, are more likely to induce harm in the respiratory system, where they can become trapped and cause chronic inflammation or fibrosis. On the other hand, microplastics fragments may pose a more systemic risk, especially if they enter the bloodstream, due to their small size and potential to carry chemical loads.

## Conclusion

Environmental pollution is not just an ecological issue but a profound threat to public health, economic stability, social equity, and the sustainability of life on Earth. Microplastics are a significant contributor to environmental pollution, with widespread and lasting effects on ecosystems, wildlife, and human health.

In this study five table salts were chosen from various countries of origin, the most widespread and used from consumers in Tirana, Albania. The majority amount of fibres and fragments in all samples resulted in the intervals 0-200 µm. The number of fragments is greater compared to the one of fibres, about 2 to 25 times. The table salt from Vlora, Albania was the most contaminated (density 564 MP/mm$^2$), while the least one resulted the sample from Bosnia & Herzegovina (density 117 MP/mm$^2$). Fibres are more likely to cause respiratory issues while fragments can enter the bloodstream and lead to systemic damages in the human body.

There are a lot of experiments that show the toxic effects and health risks of MP in living organisms, making the reduction of plastic wastes a worldwide priority.

## Acknowledgment

The authors are very grateful for the support given by the Department of Physics and the Department of Industrial Chemistry, Faculty of Natural Sciences, University of Tirana, Albania.

### References

Alimba Ch. G. and Faggio C., (2019) "Microplastics in the marine environment: Current trends in environmental pollution and mechanisms of toxicological profile," Environmental Toxicology and Pharmacology 68, 61-74, (2019). https://doi.org/10.1016/j.etap.2019.03.001

Andrady A. L., "Microplastics in the marine environment," Marine Pollution Bulletin 62 (8), 1596-1605, (2011). https://doi.org/10.1016/j.marpolbul.2011.05.030

Arthur C., Baker J. E. and Bamford H. A., Proceedings of the International Research Workshop on the Occurrence, Effects, and Fate of Microplastic Marine Debris, NOAA Technical Memorandum NOS-OR&R-30, Washington, USA, (2009).

Auta H. S., Emenike C. U. and Fauziah S. H., "Distribution and importance of microplastics in the marine environment: A review of the sources, fate, effects, and potential solutions," Environment International 102, 165-176, (2017). https://doi.org/10.1016/j.envint.2017.02.013

Bergmann M., Gutow L. and Klages M. (editors), Marine Anthropogenic Litter, Springer, London, 1-74, 185-342, (2015). ISBN 978-3-319-16510-3 (eBook)

Cincinelli A., Scopetani C., Chelazzi D., Martellini T., Pogojeva M. and Slobodnik J., "Microplastics in the Black Sea sediments," Science of The Total Environment 760, 143898, (2021). https://doi.org/10.1016/j.scitotenv.2020.143898

Cole M., Lindeque P., Halsband C. and Galloway T. S., "Microplastics as contaminants in the marine environment: A review," Marine Pollution Bulletin 62 (12), 2588-2597, (2011). https://doi.org/10.1016/j.marpolbul.2011.09.025

Coyle R., Hardiman G. and Driscoll K. O', "Microplastics in the marine environment: A review of their sources, distribution processes, uptake and exchange in ecosystems," Case Studies in Chemical and Environmental Engineering 2, 100010, (2020). https://doi.org/10.1016/j.cscee.2020.100010

Crawford Ch. B. and Quinn B., Microplastic Pollutants, Elsevier, 39-56, (2017). ISBN: 978-0-12-809406-8

Cruz-Orive L. M., Stereology: Theory and Applications, Springer, (2024). ISBN 978-3-031-52451-6 (eBook)

de Ruijter V. N., Milou A. and Costa V., "Assessment of microplastics distribution and stratification in the shallow marine sediments of Samos island, Eastern Mediterranean Sea, Greece," Mediterranean Marine Science 20 (4), 736-744, (2019). https://doi.org/10.12681/mms.19131

Frias J. P. G. L. and Nash R., "Microplastics: Finding a consensus on the definition," Marine Pollution Bulletin 138, 145-147, (2019). https://doi.org/10.1016/j.marpolbul.2018.11.022

Girão A. V., "SEM/EDS and Optical Microscopy Analysis of Microplastics", In: T. Rocha-Santos, M. Costa and C. Mouneyrac (editors), Handbook of Microplastics in the Environment, Springer, (2020). https://doi.org/10.1007/978-3-030-10618-8_7-1
Gündoğdu S., "Contamination of table salts from Turkey with microplastics," Food Additives & Contaminants: Part A, 35 (5), 1006-1014, (2018).
https://doi.org/10.1080/19440049.2018.1447694
Hashmi M. Z. (editor), Microplastic Pollution Environmental Occurrence and Treatment Technologies, Springer, 3-446, (2022). ISSN 2524-6410 (eBook)
Hawkes P. W. and Spence J. C. H. (editors), Handbook of Microscopy, Springer, (2019). ISBN 978-3-030-00069-1 (eBook)
He D. and Luo Y., Microplastics in Terrestrial Environments: Emerging Contaminants and Major Challenges, Springer, 3-384, (2020). ISSN 1616-864X (eBook)
Iñiguez M. E., Conesa J. A. and Fullana A., "Microplastics in Spanish Table Salt," Sci Rep 7, 8620, (2017). https://doi.org/10.1038/s41598-017-09128-x
Kalaronis D., Ainali N. M., Evgenidou E., Kyzas G. Z., Yang X., Bikiaris D. N. and Lambropoulou D. A., "Microscopic techniques as means for the determination of microplastics and nano-plastics in the aquatic environment: A concise review," Green Analytical Chemistry 3, 100036, (2022). https://doi.org/10.1016/j.greeac.2022.100036
Karami A., Golieskardi A. and Keong Choo C., "The presence of microplastics in commercial salts from different countries," Sci Rep 7, 46173, (2017). https://doi.org/10.1038/srep46173
Kazour M., Terki S., Rabhi K., Jemaa Sh., Khalaf G. and Amara R., "Sources of microplastics pollution in the marine environment: Importance of wastewater treatment plant and coastal landfill," Marine Pollution Bulletin 146, 608-618, (2019).
https://doi.org/10.1016/j.marpolbul.2019.06.066
Kim J. S., Lee H. J., Kim S. K. and Kim H. J., "Global Pattern of Microplastics (MPs) in Commercial Food-Grade Salts: Sea Salt as an Indicator of Seawater MP Pollution," Environmental Science & Technology 52 (21), 12819-12828, (2018).
Doi: 10.1021/acs.est.8b04180
Lee H. J., Song N. S., Kim J. S. and Kim S. K., "Variation and Uncertainty of Microplastics in Commercial Table Salts: Critical Review and Validation," Journal of Hazardous Materials 402, 123743, (2021). https://doi.org/10.1016/j.jhazmat.2020.123743
Lee H., Kunz A. and Shim W. J., "Microplastic contamination of table salts from Taiwan, including a global review," Sci Rep 9, 10145, (2019). https://doi.org/10.1038/s41598-019-46417-z
Lee Y., Cho J., Sohn J. and Kim C., "Health Effects of Microplastic Exposures: Current Issues and Perspectives in South Korea," Yonsei Med J. 64 (5): 301-308, (2023).
https://doi.org/10.3349/ymj.2023.0048
Li Y., Tao L., Wang Q., Wang F., Li G. and Song M., "Potential Health Impact of Microplastics: A Review of Environmental Distribution, Human Exposure, and Toxic Effects," Environment & Health 1 (4), 249-257, (2023). Doi: 10.1021/envhealth.3c00052
Mancuso M., Porcino N., Blasco J., Romeo T., Savoca S., Spanò N. and Bottari T., Microplastics in the Mediterranean Sea: Impacts on Marine Environment, Springer, (2023). ISSN 2191-5555 (eBook)

Mariano S., Tacconi S., Fidaleo M., Rossi M. and Dini L., “Micro and Nanoplastics Identification: Classic Methods and Innovative Detection Techniques,” Front. Toxicol. 3, 636640, (2021). Doi: 10.3389/ftox.2021.636640

Peiponen K. E., Räty J., Ishaq U., Pélisset S. and Ali R., “Outlook on optical identification of micro- and nano-plastics in aquatic environments,” Chemosphere 214, 424-429, (2019). https://doi.org/10.1016/j.chemosphere.2018.09.111

Peixoto D., Pinheiro C., Amorim J., Oliva-Teles L., Guilhermino L. and Vieira M. N., “Microplastic pollution in commercial salt for human consumption: A review,” Estuarine, Coastal and Shelf Science 219, 161-168, (2019). https://doi.org/10.1016/j.ecss.2019.02.018

Renzi M. and Blašković A., “Litter & microplastics features in table salts from marine origin: Italian versus Croatian brands,” Marine Pollution Bulletin 135, 62-68, (2018). https://doi.org/10.1016/j.marpolbul.2018.06.065

Rocha-Santos T., Costa M. F. and Mouneyrac C. (editors), *Handbook of Microplastics*, Springer, Switzerland, 1-502, 755-1068, (2022). ISBN 978-3-030-39041-9 (eBook)

See M., Gilchrist C., Cooper N., Ratcliffe D. and Siddle R., “Microplastics in the marine environment: a literature review and northeast England case study,” Water and Environment Journal 34 (3), 489-505, (2020). https://doi.org/10.1111/wej.12615

Thompson R. C., Olsen Y., Mitchell R. P., Davis A., Rowland S. J., John A. W. G., McGonigle D., and Russell A. E., “Lost at Sea: Where Is All the Plastic?” Science 304 (5672), 838, (2004). Doi: 10.1126/science.1094559

Wang Zh. M., Wagner J., Ghosal S., Bedi G. and Wall S., “SEM/EDS and optical microscopy analyses of microplastics in ocean trawl and fish guts,” Science of The Total Environment 603-604, 616-626, (2017). https://doi.org/10.1016/j.scitotenv.2017.06.047

Yang D., Shi H., Li L., Li J., Jabeen K. and Kolandhasamy P., “Microplastic Pollution in Table Salts from China,” Environmental Science & Technology 49 (22), 13622-13627, (2015). Doi: 10.1021/acs.est.5b03163

Yang X., Man Y. B., Wong M. H., Owen R. B. and Chow K. L., “Environmental health impacts of microplastics exposure on structural organization levels in the human body,” Science of The Total Environment 825, 154025, (2022). https://doi.org/10.1016/j.scitotenv.2022.154025

Zhang J., Tian K., Lei C. and Min S., “Identification and quantification of microplastics in table sea salts using micro-NIR imaging methods,” Anal. Methods 10, 2881-2887, (2018). DOI: 10.1039/C8AY00125A

Zhang Q., Xu E. G., Li J., Chen Q., Ma L., Zeng E. Y. and Shi H., “A Review of Microplastics in Table Salt, Drinking Water, and Air: Direct Human Exposure,” Environ. Sci. Technol. 54, 3740-3751, (2020). https://dx.doi.org/10.1021/acs.est.9b04535

Zobkov M. B. and Esiukova E. E., “Microplastics in a Marine Environment: Review of Methods for Sampling, Processing, and Analysing Microplastics in Water, Bottom Sediments, and Coastal Deposits,” Oceanology 58, 137-143, (2018). https://doi.org/10.1134/S0001437017060169