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Microplastic Pollution in EU Farmland Soils: Preliminary Findings from Agricultural Soils (Southwestern Poland)

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Abstract: Agricultural soils are considered as "hot-spots" of plastic particles; however, due to a lack of standardized method of microplastic determination in soils, as well as no legal regulations requiring the monitoring of the soil environment in the context of microplastic contamination, the data on MP abundance and occurrence in European soils are very limited. In this first study of MPs pollution in agricultural soils in Poland, we developed a method of microplastic extraction from soil samples with different properties (particle size distribution, clay and organic matter content) and used optical microscopy for MP determination and quantification. In this study, we analyzed 44 soil samples from five sampling site locations with differing soil type, agricultural activity, including farmland soils on floodplains and past records of sewage sludge and compost applications. We found evidence that 93% of cultivated soils in the SW part of Poland contained MPs. The content of MP varied between soil types and present/former use of the land. Loamy and clay soils contained more MPs, 1540 ± 912 particles per kg soil and 933 ± 682 particles per kg, respectively, compared with sandy soils at 383 ± 188 particles per kg of soil. The highest MP concentrations were determined in soils amended with sewage sludge, wastewaters and green-waste composts (up to 4050 ± 2831 particles per kg of soil). The wide distribution of MPs with a dominance of plastic fibers (up to 60% of determined MP types) can be associated with agricultural sources such as soil mulching, the use of organic fertilizers, seed coating or unintentional waste dumping and air deposition.

Keywords: microplastic; contamination; soils; agriculture; occurrence

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1. Introduction

Plastic pollution is considered to be one of today's main environmental problems [1]. In 2022, Europe's plastics production reached 57.2 million tons, while only 31% was recycled and used in new products (PlasticEurope, 2022). The amount of plastic disposed of in the terrestrial environments is largely unknown; however, there are some estimates showing that approximately 32% of plastic wastes is leaking into the soil environment [2]. Agricultural and urban soils are considered as "hot-spots" of plastics in terrestrial ecosystems, and as plastic wastes are accumulated in soil, they undergo several physical, chemical and biological actions, leading to plastic fragmentation into smaller pieces (<5 mm) called microplastics (MPs). Based on estimation, around 80% of plastic in aquatic ecosystems originates from land-based sources [3]. Microplastic (MP) presence in agricultural soils has recently gained more and more attention from researchers and societies due to the unknown risks related to its presence in soil environment and possible transfer in the food chain. Soil represents a large reservoir of microplastics [4], with many different sources such as atmospheric deposition [5], contaminated water courses, plastic mulching [6], fertilizer coatings irrigation [7], flooding, littering, street runoff and soil amendment application, e.g., compost and sewage sludge [8]. Both primary and secondary microplastics can be found in soil; however, the largest pool is represented by synthetic textile fibers from washing and drying clothes [9], wear and tear from car tires [10] and personal care products (PCPs) containing microbeads transferred through wastewaters and sewage sludge [11]. After entering the soil, MPs may accumulate, migrate and diffuse in the environment. Several factors affect these processes, such as anthropogenic activities (e.g., agricultural practices), climatic conditions (e.g., dry and wet depositions, rainfalls, soil freezing), soil type [12] or the presence of soil biota [13]. Soil biota, e.g., earthworms or collembolans, are able to transfer plastic debris in the terrestrial food chain [14]. The presence of MPs in soil has been reported to change soil physicochemical and biological properties [15]. Recent studies have shown that MP contributes to C pools, controlling similar processes to native soil organic matter, e.g., soil pH, bulk density or water retention, thereby affecting plant growth [16]. However, the effect varies based on not only the characteristic and properties of MP (size and shape), but also the quantity and time of residence in the soil environment [17]. It is also difficult at this moment to generalize positive or negative impacts on microbial activity or diversity, as most of the studies were conducted under controlled or limited factors conditions [2]. Finally, MPs are suspected to be toxic compounds in soil, as they release chemical additives, e.g., endocrine-disrupting compounds (EDC), like bisphenol A or phthalates [18], and are able to carry various toxic substances on its hydrophobic surface, e.g., heavy metals, antibiotics, PCBs or PAHs, acting as vectors of chemical contaminants in soil [19]. As MPs impact all functionalities of soil and carry potentially toxic compounds, they affect soil health and pose potential adverse effects to human health and crop production safety.

Although MP was detected in terrestrial environments more than two decades ago, to understand microplastic dynamics in soils, we must consider the spatial contexts of microplastics in soils [20], which requires the development of suitable strategies. Study site selection, methods of sampling, sample pre-processing, MP extraction from soil samples or methods of MP quantification in soil have not been fully described and implemented as a standard. The accuracy in MP measurement depends highly upon the consistency and uniformity of the analytical procedure. Generally, the analytical procedure of soil microplastics includes drying, sieving, density separation, extraction, organic matter (OM) digestion and filtration [21]. Hence, the composition of soil, mainly the content of organic matter and clay minerals, may have an impact on the effectiveness of MP extraction and separation from soil, while most of the developed methods are usually insufficient for organic-rich samples, e.g., sewage sludge, compost and organic soils, because the density of soil organic matter (SOM, 1.0–1.4 g/cm^3) is similar to several types of plastic, including PET [22]. Instead, the content of MPs in soil can be predicted based on modeling [23], i.e., estimates of the amounts of MP entering the environment through sewage sludge or compost application per hectare [24] or based on regional use of different plastic polymers and inputs of MPs to surface waters [25,26]. However modeling brings uncertainty associated with each parameter used in the model, wherein overestimations are common and not comparable with field studies. The number of papers reporting the occurrence of microplastics in soil is still very limited.

The aim of this research was to investigate the occurrence, characteristics and potential sources of microplastic pollution in farmland soils in one of the most important agricultural regions of Poland in the central part of Europe.

2. Materials and Methods

2.1. Study Areas and Soil Samples Collection

The Lower Silesia part of Poland is characterized by a great variety of soils, and due to the longest growing season, the main crop production areas are located in this region of the country. Agricultural lands for soil sampling were selected randomly based on the location of cultivated soils. In the study, the following factors of variability were considered: soil type, land use type (farmlands, pastures, urban gardens used for vegetable growth) and type of crop. Figure 1 shows sampling sites (n = 44), collected during field studies 2015–2023. Sampling sites were divided into 5 locations differing in soil type and land use: A—farmlands on loamy soils; B—farmlands on sandy soils; C—farmlands on silty clays and clay soils; D—former floodplains on loamy and clay soils, flooded in 1997 and 2009, nowadays used as pastures and meadows; E—former irrigation fields on sandy clays, used between the years 1881 and 2013 for sewage sludge treatment, nowadays used as pastures and meadows; F—former industrial zones, nowadays allotment gardens on sandy and clay soils, used by Wroclaw city citizens for vegetable and fruit cultivation (Table 1). Triplicate soil samples were collected from a depth of 0 to 25 cm with a stainless steel soil probe. Soil subsamples were mixed together into one homogenized sample. In the lab, collected soils were air dried (10 days at temp. 25 °C) and kept in paper bags for analysis. The particle size distribution of soils was carried out via hydrometer sedimentation method ASTM D7928-21e1.

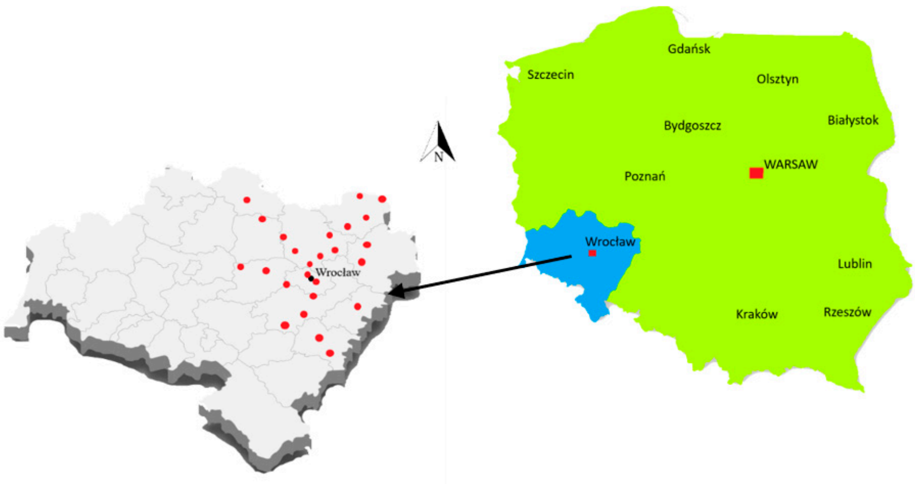

Figure 1. Study sites' localization on the map of the Lower Silesia region of Poland.

Table 1. Sampling points' location and land use type.

Lp	Sampling Point	Sampling Location	Land Use/Main Plant
1	A1	50°49′54.6″ N 17°11′43.2″ E	Farmland/sugar beet
2	A2	50°48′06.8″ N 17°05′57.3″ E	Farmland/barley
3	A3	50°53′38.7″ N 17°00′28.1″ E	Farmland/oats
4	A4	50°48′15.2″ N 17°05′34.4″ E	Farmland/winter wheat
5	A5	50°53′19.1″ N 17°02′14.7″ E	Farmland/maize
6	A6	50°53′02.3″ N 17°02′10.9″ E	Farmland/potato
7	B1	51°27′10.7″ N 16°54′53.5″ E	Farmland/fallow
8	B2	51°30′25.2″ N 16°54′44.3″ E	Farmland/sugar beet
9	B3	51°36′48.9″ N 16°58′41.7″ E	Farmland/rye
10	B4	51°36′21.1″ N 16°54′06.4″ E	Farmland/barley
11	B5	51°36′56.9″ N 17°02′41.3″ E	Farmland/cover crop legumes
12	B6	51°37′54.0″ N 17°09′24.3″ E	Farmland/cover crop legumes
13	B7	51°18′41.8″ N 16°19′45.9″ E	Farmland/rye
14	B8	51°33′18.1″ N 17°15′25.2″ E	Farmland/fallow
15	B9	51°22′23.7″ N 17°09′55.3″ E	Farmland/rapeseed
16	B10	51°16′25.5″ N 17°02′38.4″ E	Farmland/rapeseed
17	B10	51°16′26.9″ N 17°02′20.0″ E	Farmland/rye
18	B11	51°16′26.9″ N 17°02′20.0″ E	Farmland/rye
19	B12	51°20′46.8″ N 17°06′17.6″ E	Farmland/cover crop legumes

Table 1. *Cont.*

Lp	Sampling Point	Sampling Location	Land Use/Main Plant
20	B13	50°53′57.8″ N 17°07′50.4″ E	Farmland/maize
21	C1	51°30′23.1″ N 16°54′11.4″ E	Farmland/cover crop legumes
22	C2	51°23′39.8″ N 16°37′23.3″ E	Farmland/winter wheat
23	C3	51°25′27.7″ N 16°37′28.0″ E	Farmland/winter wheat
24	C4	51°29′12.4″ N 16°37′32.7″ E	Farmland/legumes
25	C5	51°32′48.1″ N 16°40′14.5″ E	Farmland/maize
26	C6	51°37′02.5″ N 16°38′27.1″ E	Farmland/sugar beet
27	C7	51°37′22.7″ N 16°30′39.4″ E	Farmland/rye
28	C8	51°31′18.2″ N 16°32′20.8″ E	Farmland/winter wheat
29	C9	51°26′09.6″ N 16°30′06.2″ E	Farmland/rye
30	D1	51°14′46.1″ N 16°41′12.5″ E	Floodplain/hay meadow
31	D2	51°14′47.0″ N 16°40′47.3″ E	Floodplain/hay meadow
32	D3	51°14′38.9″ N 16°41′01.4″ E	Floodplain/pasture
33	D4	51°14′36.6″ N 16°41′33.6″ E	Floodplain/pasture
34	D6	51°14′41.2″ N 16°41′51.7″ E	Floodplain/hay meadow
35	E1	51°10′26.5″ N 16°58′38.0″ E	Former irrigation fields/hay meadow
36	E2	51°10′21.0″ N 16°58′33.1″ E	Former irrigation fields/hay meadow
37	E3	51°10′50.6″ N 16°58′14.5″ E	Former irrigation fields/hay meadow
38	E4	51°10′53.4″ N 16°58′13.2″ E	Former irrigation fields/hay meadow
39	F1	51°07′53.1″ N 17°03′58.4″ E	Allotment garden/spring onion
40	F2	51°04′07.5″ N 17°04′16.8″ E	Allotment garden/lettuce
41	F3	51°04′0.75″ N 17°04′16.8″ E	Allotment garden/beet root
42	F4	51°06′18.3″ N 16°58′27.0″ E	Allotment garden/carrot
43	F5	51°08′19.2″ N 17°04′57.8″ E	Allotment garden/beet root
44	F6	51°06′18.3″ N 16°58′27.0″ E	Allotment garden/spring onion

2.2. Extraction of Microplastics Using a Flotation Method

Density separation is a commonly used step of microplastic extraction from soil and sediment samples. Effective extraction using a floatation technique depends on the sample mass, mixing method and sample: volume (floatation solution) ratio [27]. In the study, a high-density solution of NaCl was used to detect microplastics, ranging from 0.8 to 1.2 g/cm^3, after sample pre-treatment (Figure 2). The method was adopted from previous protocols described in other studies [8,22,28–30] and modified to increase the efficiency of organic matter removal and clay separation from tested soils. All reagents and filter materials were purchased from Sigma-Aldrich (Saint Louis, MI, USA). Figure 2 shows the main steps of the microplastic extraction procedure performed in this study.

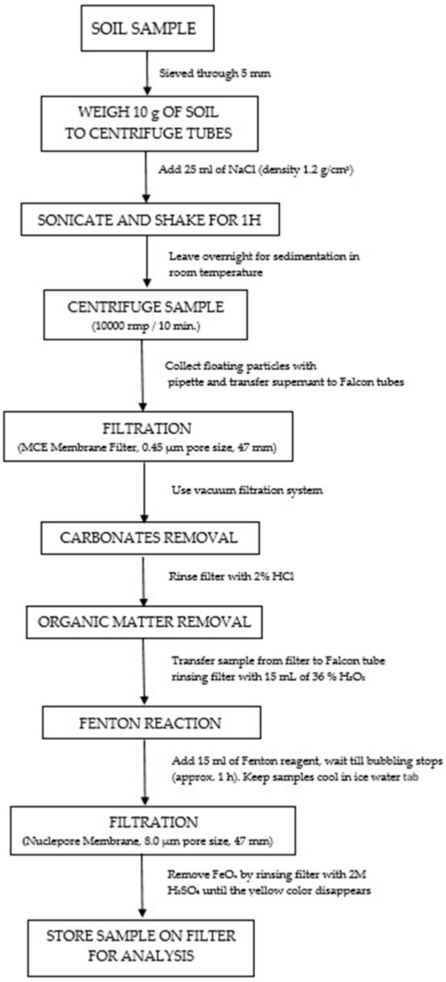

Figure 2. Extraction of MPs via density method.

2.3. Validation of Extraction Method

The accuracy and precision of the separation method was tested using recovery experiments of soil samples spiked with a known number of MP particles (fibers, glitters and PET bottle particles cut into pieces < 2 mm). To avoid additional plastic contamination, soils were collected from a 2 m depth. All spiking was performed in triplicates. For fibers and glitters with approx. a diameter of 1 mm, recovery was 90%, 9 out of from 10 particles were detected in blank samples, and for PET bottle particles with larger diameter sizes, the recovery was 80%.

2.4. Identification of Microplastics under the Microscope

The optical microscope is useful and widely used for the identification of MPs whose dimensions fall within the range of hundreds of microns [31]. Possible microplastic particles were examined under a Nikon Eclipse 400 microscope (Tokyo, Japan) coupled with a digital camera and an image capturing software ToupView (Touptek Photonics's, Hangzhou, China) used for recording size, shape and color of each particle. Samples were examined under 5× and 10× magnification. For particle identification, we used the "Guide to microplastic identification" [32]. Numbers of fibers, microbeads and plastic fragments with irregular shapes were counted separately in each sample to determine the occurrence of different microplastic types in studied soils. Whole filter surface (Ø47 mm) was analyzed for MP particles.

2.5. Statistical Analysis

The results taken from each sampling site were averaged and standard deviation was calculated. The microplastic counts from the repeatability trial were analyzed after grouping different microplastic types in a sample. Tukey ($p > 0.05$) test was performed to determine significant difference between studies. All analyses were performed using STATISTICA version 13.2.

3. Results

3.1. Abundance of Microplastics in Soils

In 41 out of 44 tested samples, microplastic contamination was found in the microscope study. In typical farmland areas (A, B, C), the concentrations of microplastic varied between soil types. The content of MPs was statistically higher ($p = 0.0379$) in loamy soils from sampling site A (average 1540 ± 912 particles per kg soil) compared with sandy soils from sampling site B (average 383 ± 188 particles per kg of soil), but not statistically different from clay soils in sampling site C (933 ± 682 particles per kg of soil) (Table 2). Floodplain soils and former wastewater irrigation fields used as meadows contained much more MPs compared to typical arable soils with no records of sediments or sewage sludge deposition in the past. The average content of MPs in floodplain soils from site D was 1200 ± 234 particles per kg of soil, while in sewage-treated soils to MP concentrations reached 4050 ± 2831 particles per kg of soil. Also, a high content of microplastics was determined in urban soils of Wrocław city (site F). The average content of MPs reached values of 2116 ± 614 particles per kg of soil, indicating that the content of the pollution was much higher compared to arable and floodplain soils.

Table 2. Soil texture and concentration of microplastics in tested soils.

Sampling Point	Soil Texture	Abundance (Particles per kg)	Sampling Point	Soil Texture	Abundance (Particles per kg)
A1	loam	2400	B3	sand	400
A2	loam	1100	B4	loamy sand	<100
A3	loam	2600	B5	sand	300
A4	loam	1100	B6	sand	<100
A5	loam	500	B7	sand	400
A6	clay loam	<100	B8	sand	800
			B9	sand	400
B1	loamy sand	600	B10	sand	200
B2	loamy sand	200	B10	sand	400
B11	sand	200			
B12	sand	400			
B13	loamy sand	300	E1 (2)	sandy clay	3600
			E2	sandy clay	9600
C1	loamy sand	1600	E3	sandy clay	1400
C2	silty clay	800	E4	sandy clay	1600
C3	loamy sand	300			
C4	silty clay	<100	F1 (3)	loamy sand	1400
C5	loamy sand	200	F2	loamy sand	3200
C6	silty clay	<100	F3	loamy sand	2200
			F4	silty clay	2000
D1 (1)	sandy clay	1400	F5	loamy sand	1700
D2	sandy clay	1000	F6	silty clay	2200
D3	silt loam	1000			
D4	silt loam	1500			
D5	silt loam	1100			

(1) Soils flooded in the years 1997 and 2009; (2) soils treated with sewage sludge in the past; (3) urban soils, mainly Technosols in the city center.

3.2. Spatial Variability of the Contamination

Spatial variability of MP content showed clear dependencies with anthropogenic activity in the studied area.

The content of MPs decreased with the distance from urban areas (Figure 3). More MPs were found in soils close to river banks and floodplains, which can be associated with sediment deposition during floods and the deposition of plastic litter from surface waters. Soils treated with sewage sludge were also highly impacted. With less anthropogenic activities (no sewage sludge deposition, urbanization, waste dumping) and a restricted use of the land due to law protection of the areas, e.g., NATURE 2000 Dolina Baryczy in the northeastern part of the region, the content of microplastics in soils decreased.

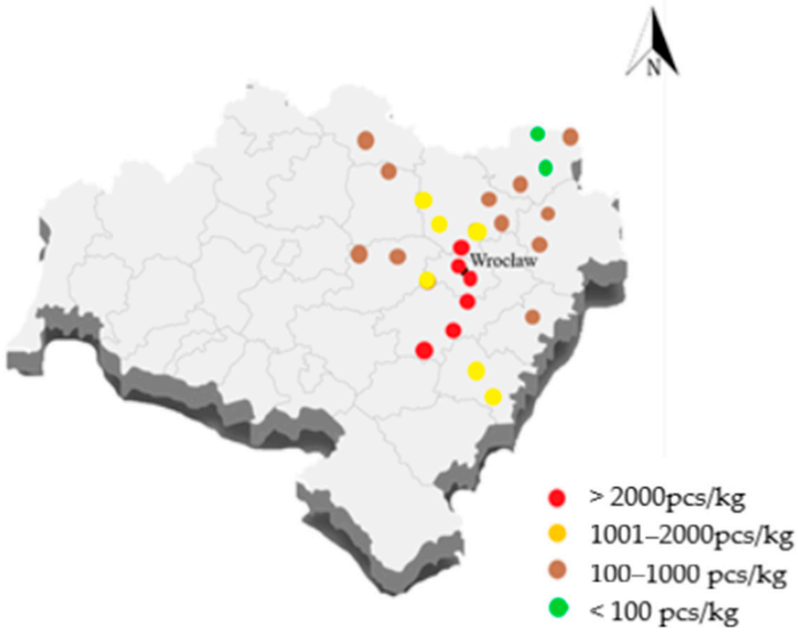

Figure 3. Spatial variability of microplastic concentrations in sampled soils.

3.3. Microplastic Morphology

With the microscopy method, we were able to distinguish the shapes and forms of MPs present in soil samples. Pellets, fibers, films, microbeads and irregularly shaped fragments were easy to distinguish in the sampled materials. However, density separation with NaCl and Fenton organic matter removal was not fully satisfying, especially in samples with a high organic matter content. Moreover, at times, burned pieces of wood cellulose fibers, charcoals or silica would be present in the analyzed samples, making appropriate particle identification more difficult. For example we were unable to distinguish microplastics from tires, as both charcoal, wood chips and tire particles looked like black dots with irregular shapes. Despite this, the most isolated microplastic form was fiber, accounting for 60% of the total types of microplastics indicated in the microscope study (Figures 4 and 5). In second place were the irregularly shaped plastic fragments (ISFs), which were probably secondary MPs from PET, HPLE and LDPE defragmentation in soil. Primary microplastics like microbeads (MBs) and micropellets (MPTs) were also found (Figure 4); however, the content of these particles in the studied soils was highly variable. The highest content of MBs and MPTs was found in loamy soils, but also in urban soils, and this contamination can be associated with microplastic deposition from air or water.

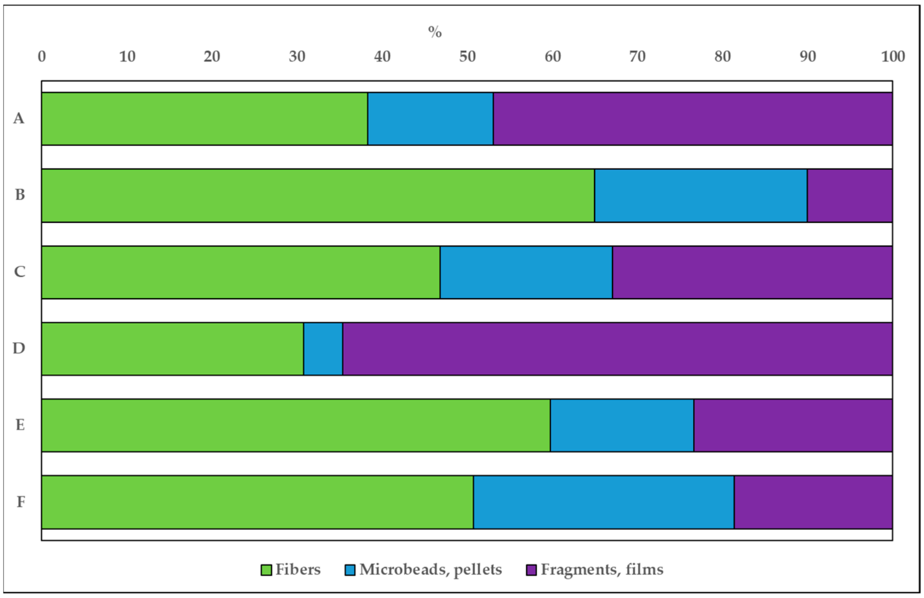

Figure 4. Percentage of microplastic shapes isolated from soil samples collected at different sampling sites. Capital letter (A–F) mean study site.

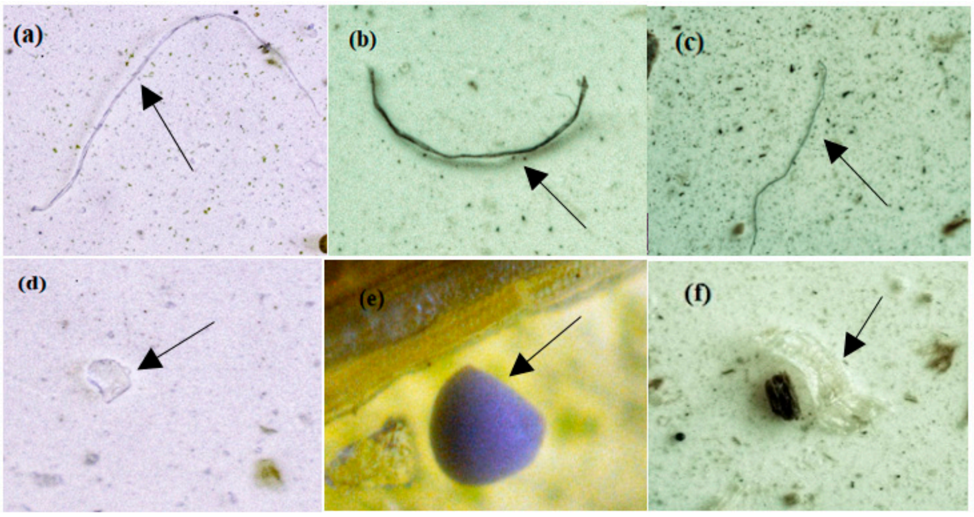

Figure 5. Microplastic particles captured with optical microscope (10× magnification). Fibers (**a**–**c**); microfragments (**d**) (size 1000 µm); microbeads (**e**) and films (**f**) (size 500 µm).

4. Discussion

Most of the results describing microplastic abundance in soils come from China and Eastern Asia. On the other hand, on the European continent, the data about MP concentrations on soil are very limited, and only some countries (e.g., Switzerland, Germany, Netherlands, Italy and Norway) published data [1,33–35] about MP concentrations in soil, but were mainly based on modeling, e.g., inputs of microplastics through sewage sludge, compost or mulching. Results from 11 studies in China, focused on mixed-origin soils, showed that the number of MP particles detected in soil with similar methods (density separation and microscopy) may vary from 78 particles per kg, up to 2500 particles per kg, or even in some extreme cases, 69,000 particles per kg, when soils receive plastic mulching [36] and sewage sludge applications [37]. Our results are below-average values indicated for European soils at 2914 particles per kg (based on 30 studies). However, results vary depending on the method of measurements. Scheurer and Bigalke [33] studying Swiss floodplains at 29 sites across Switzerland indicated MP concentrations between 55.5 and 593 particles per kg—less in mountain and non-inhibited areas. Dahl et al. [38] studying soils located in the Almería region of Spain indicated an increase in MP accumulation of surface soil layers following the intensification of the agricultural industry in the area (average content of MPs: 3819 particles per kg). Findings of both studies remain in agreement with our results. However, some published data and estimations show thousands or even millions of greater magnitude of MP occurrence in soils. In Austrian soils, the average content of MPs is 12.7 million particles per kg of soils [39], while in Danish farmlands, the average content of MPs is 236,000 particles per kg of soil [40]. Studies comparing the content of MPs in soils with different particle size distributions are rare; therefore, our results indicate significant differences in the accumulation of microplastics in soils of different texture. The spatial distribution of MP concentrations varied between soil types, and as expected, loose sandy soils contained less microplastics than soils with a more fine structure like loamy and clay soils. This evidence suggests that MPs in soils with more clay fractions and more stable aggregates are less prone to the leaching process. In sandy soils with more macropores (pores > 0.08 mm), the movement of MP particles is enhanced, causing quick vertical transport to deeper soil layers [15], reducing their content in the surface layers. On the other hand, microplastics may affect soil physical properties, i.e., aggregation, bulk density, porosity or water-holding capacity, changing plastic particle distribution in soil profile with time. As microplastic particles are able to imitate some soil actions performed by organic matter, i.e., influence soil aggregation and aggregate stability [41], possible interactions between microplastic particles and the soil matrix cannot be ignored. It is highly likely that some microplastic shapes and sizes will contribute more to the process. At present, the information is very limited; however, some authors suggest that microplastic fibers [42], detected in tested soil in the highest amounts, likely disturb soil aggregate formation more than other MPs. The concentration of MPs in 0–20 cm can be also correlated with former use of the area, the impact of flooding or multisource impact of urban areas. Use of biosolids as agricultural amendments or for the deposition of bottom sediments during floods contribute to the release of plastic particles into the soil, but also affect soil texture, which in turn affects MP displacement in the soil profile, causing an increased MP accumulation in the surface layer. The results of our study showed that in farmland soils (sites A, B, C) with no land use changessince the plastic revolution beganand no additional inputs of microplastics typical to urban and industrial areas were less impacted by microplastic contamination. Past and present human activities, i.e., the use of farmland soils for wastewater treatment, sewage sludge and compost application, contributed more to the process of soil contamination with microplastics. Floodplain soils (study site D) and soils irrigated with wastewaters (study site E) contained more MPs than less-impacted farming areas in the northeastern part of the Lower Silesia region. Also, allotment gardens (study site F), formerly agricultural soils located at the suburbs of Wrocław city, contained more microplastics, which can be associated with intensive soil fertilization, mainly with compost, but also with air and water deposition from urban areas. van Schothorst et al. [35], studying the impact of long-term compost application and mulching on MP concentrations in soil, found that samples from both Spanish and Dutch soils contained 2242 $\pm$ 984 particles per kg and 888 $\pm$ 500 particles per kg of microplastics, respectively. The findings of our study are similar, showing an average of 2116 $\pm$ 614 particles per kg in compost-amended soils. It has been suggested that compost from bio-waste particularly contains plastic, which originates from improper disposal and insufficient waste separation [22]. This finding was confirmed by our own observations made during garden and green waste collection in Wrocław city. Approximately 1–2% of compost mass was fragmented plastic from grass cutting and accidental plastic waste shredding, from throwing kitchen wastes in plastic bags or the accidental placement of plastics in biodegradable wastes bins. A majority of microplastics found in tested samples were fibers (up to 60%). Recent studies suggest that the main sources of synthetic fibers in soil come from sewage sludge application [34,43] and synthetic fabric fibers have been proposed as indicators of the past spreading of wastewater sludge [44]. However, due to the law regulations in the EU, sewage sludge application is not a common form of agronomic practices in the Polish farming system; therefore, other sources of microplastic fibers should be considered. Landfills and urban and industrial centers contribute to the process of soil microplastic contamination by the accidental loss of particles, illegal waste disposal and improper landfill leachates utilization [13]. The sources of microplastics in Poland are not well recognized; however, based on environmental management characteristics, we suggest that the main sources of soil microplastic contamination in Poland are depositions from the air and surface runoffs. However, we should not avoid linking emissions with other sources, such as agricultural activity and the use of mineral and organic fertilization (mainly the use of coated granulates and manures) and polyethylene mulches for crop covering. Plastic films are widely used because they could regulate soil temperature and increase water use efficiency, thereby promoting and improving crop growth and quality [45]. Although some commercially available mulches are biodegradable, a large amount of plastic textiles is disposed in soil during soil tillage and during the in-soil degradation of plastic mulches, which depends on soil biota. However plastic biodegradation depends on soil biological activity and optimal for decomposers moisture and nutrients conditions [46]. It is also suggested that film-coatings applied to agronomic seeds can contribute to the process of soil contamination with MPs. Accinelli et al. [47] found that the degradation of microplastic coating fragments detached from seeds coated with polymer mixtures have a low degradation rate.

5. Conclusions

Results from our investigation showed that microplastic is a ubiquitous contaminant of farmland soils in this region, posing a possible threat to human health and crop production. The concentrations of MPs varied between soil types and present/former land use. Sandy soils contained less MPs compared to silty and clay soils, suggesting that microplastics are more prone to leaching in loose soils, with low clay minerals and organic matter content. The accumulation of microplastics was higher in soils impacted by flooding, wastewaters and sewage sludge application, but also those which were impacted by some present activities, e.g., the use of compost or plastic mulching for plant cultivation. These findings were supported by further analysis, showing that the most common MP types found in farmland soils were fibers, followed by defragmented plastics with irregular shapes, probably deposited into soil from agronomic activities, runoffs and air deposition. Despite the ubiquity of microplastics in agricultural soils used for food production, very few large-scale monitoring data from European soils are available. This is partially due to the lack of standardized methods for MP analysis in soil and sediment samples, as well as the absence of law regulations. As microplastics have become an emerging contaminant in soils, more actions should be taken by the EU authorities to report environmental microplastic and possible threats.

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