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Environmental Pollution and Challenges of Environmental Sustainability (EPESC),
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Microplastic Pollution in the Coastal Sediments of Derna, Libya: Environmental Assessment and Student Awareness

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***Abstract*:** This study investigates the presence and characteristics of microplastics in the coastal sediments of Derna, Libya, while evaluating university students' awareness of this environmental threat. Sediment samples were collected from two beaches and analyzed using standard sieving and flotation techniques. The findings revealed microplastic concentrations of 0.55 and 1.95 pieces per meter at two distinct sites, respectively. Most microplastics were fragments and films, predominantly blue in color. A student survey highlighted a 75% unfamiliarity with the term "microplastic," particularly among female students. Despite this, most students acknowledged the potential harmful effects. These results emphasize the necessity of raising public awareness and implementing mitigation strategies to address microplastic pollution in Libyan coastal areas.

Introduction

Developments over the past two decades have contributed to the emergence of new lifestyles, leading to an increase and diversification of human needs. This progress has been accompanied by an increase and diversification in the amount of waste, including solid waste, which comprises a large group that varies in quantity and quality from one country to another, and even from one city to another within the same country. As a result, the issue of solid waste has become a global problem shared by all countries due to the enormous quantities produced by societies.

Over the past decades, plastic has become a useful, diverse material utilized in numerous fields, and it is likely to increase further with ongoing development sin the plastic industry and its future applications, consequently increasing the proportion of plastic waste within solid waste (Barnes et al., 2009). This will further complicate the global nature of plastic waste and its continuous movement, especially in the oceans, making it impossible to accurately identify its sources, and expanding the scope of impacts from a specific location to create a global picture of its environmental effects. Plastic production has drastically increased over the past century, contributing to a global waste crisis (Geyer et al., 2017). A significant portion of plastic waste ends up in marine environments, where it breaks down into microplastics through physical, chemical, and biological processes (Andrady, 2011). Microplastics, typically defined as plastic particles smaller than 5 mm (NOAA, 2016), originate from primary sources such as cosmetics or secondary degradation of larger debris (Cole et al., 2011).

Microplastic pollution is widespread across global coastlines (Claessens et al., 2011; Mayoma et al., 2020), with the Mediterranean Sea being particularly vulnerable due to its semi-enclosed nature and high population density (WWF, 2018). In Libya, studies on microplastic pollution remain limited, highlighting the need for localized research to understand and address this emerging threat. It is important to conduct more studies to assess the extent of the impact of microplastics on marine organisms in Libyan waters (Hamid et al.,2022). The research focuses on microplastics in beach sediments in coastal areas around Derna, particularly after the damage caused by the Danielle storm. It aims to quantify and qualitatively assess the density and composition of microplastics in these areas, focusing on their size, color, and type. The study will also contribute to the scientific understanding of microplastic dispersion and its impact on the environment, particularly in regions rich in biodiversity. The research will answer key questions about the abundance of microplastics in the sediments and the predominant shapes and colors of the particles found in the region.

Materials and Methods

Study Area Two beaches west of Derna were selected: The Summer Resort (1805) and Sayyida Khadija. Each site was surveyed over a 100-meter stretch (Figure1).

Figure1. map of the two studies sites

Sample Collection and Analysis: Sediment samples were collected using a 50 x 50 cm quadrat and trowel, and sieved through 4.75 mm and 1.18 mm mesh (ISO 3310-2:1999).

Microplastics were isolated by flotation in distilled water (Calcutt et al., 2018), dried, and identified by visual inspection under a microscope.

Student Survey: A questionnaire assessing awareness, sources, and risks of microplastics was distributed among university students. Responses were analyzed by gender.

Table 1. List of Equipment and Materials Used:

No	Item	Number	Notes
1	GPS Device	1	GARMIN
2	Camera Canon	1	
3	100meter Measuring Tape	1	
4	0.5meter Wooden Stakes	5	
5	0.5 m x0.5 m Quadrat	1	
6	Liter Graduated Cylinder	1	
7	Hand Trowel	1	
8	5 Liter or Larger Bucket	1	
9	Precise Scale	1	
10	4.75 mm Sieve	1	1St.Stper British Standard:ISO3310-2:1999
11	1.18 mm Sieve1	1	St.Stper British Standard:ISO3310-2:1999
12	Sample Storage Containers	20	Glass with metallid,500ml
13	Small Spoon	1	Aluminum or Iron
14	Small Forceps 1	1	Aluminum or Iron
15	15cm Ruler	1	
16	1Liter Basin	1	Transp aren't Glass
17	Petri Dishes	20	

Results

A)-First Site (100-meter area within 165meter):
We meticulously examined a 100-meter stretch of the beach. Within this area,we discovered to tal of 91 microplastic pieces.These fragments varied in size, shape, and polymer type. See identification Table (2).

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Table 2. field data table and classification data of microplastic samples local name of the beach: sayyid khaidij anoighb or thood

Number according to appearance						Number according to colours							Total number	Weight of microplastic	Dry weight of sample	Sample number	The location	Local name of the beach	Season of the year
Other	spherical	Fragments	Foam	Films	Filaments	transparent	green	yellow	red	blue	black	white							
		✓					1			1		13	15	0.39	130.1	1	Derna	Sayyida Khadija neighborhood	The spring
		✓		✓		4		4		1	1	11	21	0.33	130.61	2			
		✓	✓						2	9		18	29	0.59	560.98	3			
		✓		✓		1		9		2	1	3	16	0.35	219.98	4			
		✓				6				2		2	10	1.60	153.75	5			
						11	1	19	2	15	2	47	91	3.26	1195.42	total			

The average microplastic concentration in this site was approximately 0,55pieces per meter. Notably, most of the microplastics were broken down into smaller fragments, likely originating from larger plastic items that degraded over time.

B) Second Site (100-meter sectionfroma 200-meterbeach):

At the second site, we focused on a100-meter section within a longer 200- meter beach. This allowed us to assess microplastics in a different context, we collected five discrete samples, each spanning 20 meters. The total microplastic count across all samples was 195 pieces, see identification Table (3).

$$\text{Concentration} = \frac{\text{Number of microplastics}}{\text{Total beach length}} = \frac{91}{165} \approx 0.55 \text{ pieces/meter}$$

Table 3. field data table and classification data of microplastic samples local name of the beach: summer resort 1805

Number according to appearance						Number according to colours								Total number	Weight of microplastic	Dry weight of sample	Sample number	The location	Local name of the beach	Season of the year
Other	spherical	fragment	Foam	Films	filament	pink	transparent	green	yellow	red	blue	black	white	orange						
		✓				1		7	11	3	21	3	19	3	68	1.51	470.42	1	Derna	A SUMMER RESORT 1805	The spring
	✓	✓				1	1	5	13	6	26	3	16		76	2.09	483.365	2			
		✓							2		2		8		12	0.33	14.8	3			
		✓						2			6		1	1	10	0.16	335.66	4			
		✓						4	13		10		10	2	29	0.63	317.97	5			
						2	1	18	39	9	65	6	54	6	195	4.72	1622.215	total			

The overall average concentration in this site was approximately 1.95 pieces per meter. Interestingly, this site exhibited a higher concentration than the first site. As with the first site, we emphasize the need to consider additional factors beyond concentration. Particle size, polymer composition, and potential ecological impacts play crucial roles in understanding microplastic pollution.

Microplastic Identification:
On April 19, 2024, a microplastic survey was conducted at two distinct locations, we collected 5 Samples from each site, after leaving the study samples to dry at room temperature for a period ranging from day to three days, each beach and sample was weighed using sensitive electronic scale to determine its dry weight.

A SUMMER RESORT 1805, collected a total of 69 microplastic samples. The breakdown of these samples by appearance included 12 other spherical types,30 fragments,7foam pieces,15films, and 5 filaments. See (figure 2) In terms of color, there were 10 yellow, 14 transparent green, 8 red, 20 blue, 5 black, and 12 white microplastics. The total weight of the microplastics was 5.2 grams, with the dry weight of the sample recordedat50grams.

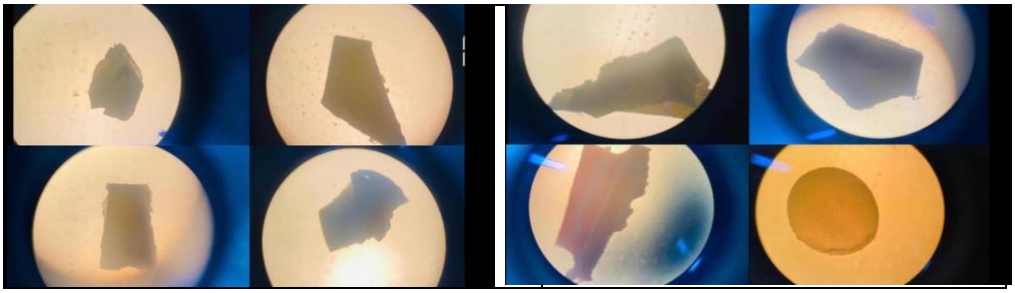

Figure 2. Show the shapes of microplastic under microscope

The Sayyida Khadija neighborhood, the team found a slightly higher total of 74 microplastic samples. This collection consisted of 20 other spherical types,25 fragments,10 foampieces,18 films, and 2 filaments. Color-wise, the samples included 15 yellow, 9 transparent green, 12 red, 22 blue, 6 black, and 10 white microplastics. The total weigh of the samples was 6.1 grams, and the dry weight was 52 grams.

Assessment of Student Knowledge – Scientific Summary

The survey results revealed notable gender-based differences in students' awareness of the term "microplastic." Overall, 75% of the surveyed students were unfamiliar with the term, with female students showing a significantly higher level of unfamiliarity (62.50%) compared to male students (12.50%). This indicates a potential gender disparity in environmental awareness, with male students demonstrating greater familiarity with the concept. Regarding students' understanding of microplastic pollution sources, the majority correctly identified that all listed sources contribute to microplastic pollution, particularly among female students (62.50%). This suggests that most students possess a comprehensive understanding of the multifaceted origins of microplastic pollution. In terms of perceptions of microplastic harm, the vast majority of students—25% of males and 71.88% of females—correctly indicated that microplastics are harmful. Only a small fraction of female students (3.13%) selected the incorrect response. These findings reflect a high level of awareness about the dangers of microplastics, particularly among female respondents.

Finally, responses regarding interest in learning more about microplastics revealed a mixed pattern. While 25% of male and 34.38% of female students expressed interest in further

information, 40.63% of female students reported no interest. Notably, no male students selected this option. This may point to a gender difference in attitudes towards environmental education, with males showing relatively higher motivation to engage further with the topic.

Discussion

The present study offers significant insights into microplastic pollution along the coastline of Derna, Libya, and highlights the level of awareness among students regarding this environmental concern. The results point to several key findings worthy of further discussion. The study confirms the presence of microplastics in beach sediments at both surveyed sites in Derna, with concentrations ranging from 0.55 pieces per meter at Site 1 to 1.95 pieces per meter at Site 2. This variation likely reflects local environmental factors such as beach morphology, nearshore currents, and proximity to pollution sources, all of which may influence the accumulation of microplastics. The notably higher concentration at Site 2 may be attributed to its enclosed topography, which facilitates the retention of plastic debris. These findings are consistent with studies from other regions of the Mediterranean and beyond. For example, Aslam et al. (2020) reported microplastic densities of 66–253 pieces per sample in the northern Gulf of Mexico, while Pradit et al. (2020) documented tens to hundreds of particles per kilogram of dry beach sediment in Thailand. Although the units of measurement differ, the level of contamination in Derna is comparable, affirming the global nature of microplastic pollution.

The widespread detection of microplastics in all collected samples reinforces the growing body of evidence indicating the pervasive contamination of marine and coastal environments. This is particularly alarming due to the ecological risks associated with microplastics, such as ingestion by marine organisms and their potential to enter and bioaccumulate through food webs (Nelms et al., 2018; Steer et al., 2017).

The assessment of student awareness revealed a substantial knowledge gap concerning microplastics. Notably, 75% of surveyed students had never heard the term "microplastic"—a concerning figure given the increasing global focus on this environmental issue. This lack of awareness was particularly evident among female students, with 62.5% reporting unfamiliarity, compared to only 12.5% of male students.

Despite this initial gap, the study found that after being informed, 96.88% of students acknowledged the potential harmful effects of microplastics. This suggests that awareness-raising initiatives could play a pivotal role in improving environmental literacy among young populations. The observed gender disparity in awareness underscores the importance of inclusive and targeted educational programs that ensure equal access to environmental knowledge. This trend mirrors findings from previous studies, such as Zelezny et al. (2000), which reported gender-based differences in environmental awareness and attitudes, reinforcing the need for customized educational strategies.

The presence of microplastics in Derna’s coastal sediments poses serious concerns regarding the health of marine ecosystems and potential risks to human well-being. Microplastics can be ingested by a wide range of marine organisms, leading to internal injuries, false satiation, or even death. Furthermore, they may act as carriers for toxic substances, thereby compounding their ecological impact (Wright et al., 2013; Vethaak & Leslie, 2016).

Given the ecological importance of Derna's coastal zones for biodiversity, tourism, and fisheries, the presence of microplastic contamination may have far-reaching environmental and socio-economic consequences. Additionally, the recent flooding event caused by Storm Daniel which resulted in large quantities of plastic waste being washed into the marine environment demonstrates the dynamic and exacerbating role that extreme weather events can play in pollution levels.

These findings highlight the urgent need for continuous monitoring, improved waste management, and the implementation of adaptive, climate-resilient strategies to mitigate the impacts of plastic pollution in vulnerable coastal areas. In recent years, pollutant levels have increased along the Libyan coast, causing physiological and behavioral harm to fish and posing a direct threat to public health through the food chain. This necessitates the enhancement of environmental monitoring and the development of effective strategies for pollution management and the protection of marine biodiversity in Libya (Saad et al., 2025).

Conclusion and Recommendations

This study confirms the presence of microplastics in beach sediments along the Derna coastline, with higher concentrations at certain sites likely due to localized environmental or human activities. The findings are consistent with regional data from the Mediterranean, emphasizing the growing concern of microplastic pollution. Furthermore, the assessment of student awareness revealed a significant knowledge gap, particularly among female students, with 75% initially unfamiliar with the term "microplastics." Despite this, most students recognized the potential harm once informed. The research provides vital baseline data for future monitoring and highlights the need for immediate action. Key recommendations include expanding sampling efforts, conducting polymer analysis to trace pollution sources, assessing ecological impacts, and improving environmental education. Community participation through clean-up initiatives and citizen science is also encouraged. Lastly, source-reduction strategies, including limiting single-use plastics, are essential to address this issue sustainably.

Conflict of Interest: The authors declare that there are no conflicts of interest.

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