Data Article

Dataset on microplastics and associated trace metals and phthalate esters in sandy beaches of tropical Atlantic ecosystems, Nigeria

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ABSTRACT

This article presents data on the occurrence and distribution of phthalate esters and metals associated with microplastics (MPs) (1–5 mm) collected from four beaches in the tropical Atlantic ecosystems, Nigeria, Gulf of Guinea. Information on microplastics extraction by density flotation with saturated NaCl and polymer identification with attenuated total reflectance infra-red spectroscopy (ATR-FTIR) is also provided. Analysis of six phthalate esters (PAEs) (dimethyl phthalate (DMP), diethyl phthalate (DEP), dibutyl phthalate (DnBP), benzyl butyl phthalate (BBP), di (ethyl hexyl) phthalate (DEHP), and di n-octyl phthalate (DnOP)) associated with the microplastics by performed using Gas chromatography–mass spectroscopy (GC–MS). Metals including Ag, Al, As, B, Ba, Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Mn, Mo, Na, Ni, Pb, Sb, Se, Si, Sr, Ti, Tl, V, and Zn were analysed by inductively coupled plasma–optical emission spectrometry (ICP–OES). The data present the separation of microplastics from sediment, extraction with cyclohexane/ethyl acetate (1:1, v/v) and 10% HNO\textsubscript{3} for phthalate esters and metals, respectively, and the determination of target analytes concentrations. The compositional distributions of MPs and levels of carcinogenic and toxic metals and phthalate esters are presented. The dataset

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Specifications table

| Subject | Chemistry |
|---------|-----------|
| Specific subject area | Environmental Chemistry; Analytical Chemistry |
| Type of data | Tables |
| IR Spectra |
| How data were acquired | PerkinElmer Spectrum Two Attenuated Total Reflectance – Fourier Transform Infra-Red Spectrometry (ATR-FTIR) with diamond crystal, Agilent 630 Cary ATR-FTIR with diamond crystal, Agilent 7890A Gas Chromatography with Agilent 5975 Mass Spectroscopy Detector (GC–MS), Agilent 720-ES Inductively Coupled Plasma–Optical Emission Spectrometry (ICP–OES). Data was acquired and processed using Microsoft Office Excel 2016 and AddinSoft XLSTAT 2019. Analytical column was an MS C18 column (Agilent Technologies, Waldbronn, Germany) was used (450 °C: 25 m × 320 μm × 0 μm particle size). |
| Data format | Raw |
| Parameters for data collection | 150 beach surface sediment samples were collected. Microplastics were separated from sediment and analysed for phthalate esters (Dimethyl phthalate (DMP), Diethyl phthalate (DEP), Dibutyl phthalate (DnBP), Butyl benzyl phthalate (BBZP), di (ethyl hexyl) phthalate (DEHP), and Di n-octyl phthalate (DnOP)) and metals (Ag, Al, As, B, Ba, Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Mn, Mo, Na, Ni, Pb, Sb, Se, Si, Sr, Tl, Ti, V and Zn). |
| Description of data collection | Microplastics were separated from sediment by density flotation with saturated sodium chloride solution and extracted with cyclohexane/ethyl acetate (1:1, v/v) by vortex mixing and sonicating for 20 min, concentration to 1 mL and analysis of extracts for phthalate esters was carried out using GC–MS. For metals analysis, microplastics were extracted with 10% nitric acid and analysed using ICP–OES. |
| Data source location | Lagos State/Nigeria |
| Data accessibility | With the article |
| Related research article | [1] Benson, N.U., Fred-Ahmadu, O.H. (2020). Occurrence and distribution of microplastics-sorbed phthalic acid esters (PAEs) in coastal psammitic sediments of tropical Atlantic Ocean, Gulf of Guinea, Science of the Total Environment; 10.1016/j.scitotenv.2020.139013 |

Value of the data

• The dataset provides an insight into the occurrence and distribution of microplastics and associated phthalate esters (n = 6) and metals (n = 26). Both phthalate esters and some metals are inherently loaded in plastics during production however, plastics also sorb these pollutants from the environment causing elevated concentrations.
• Environmental toxicologists, governmental agencies, risk assessment bodies and environmental scientists will find the data useful for toxicological studies and dose–response determination for exposure of marine organisms to metals and phthalate esters associated with microplastics.
• This dataset is useful for further toxicological and safety investigations into the risk posed to the ecosystem and marine organisms when such microplastics are ingested.
• The data may serve as baseline concentrations of microplastics-related phthalate esters and trace metals for tropical Atlantic Ocean.
1. Data description

Four designated sampling sites along the Nigerian coastal zone were selected for microplastic survey. The sampling codes, GPS coordinates, and site descriptions are presented in Tables 1 and 2. The quantity of microplastics according to polymeric and plastic types across the sampling locations are shown in Tables 3 and 4, respectively. However, the microplastic abundance of the different types of particles found in the sampling locations is presented in Table 5. On the other hand, Tables 6, 7, 8, and 9 presents the mean concentrations (mg/kg) of phthalate esters detected in microplastics samples collected from Oniru (O), Elegushi (E), Atican (A), and Eleko (K) beaches, respectively. There were variations across microplastics types and the different beaches sampled. The distribution and concentration of major toxic metals is shown in Tables 10, 11, 13, 14, 16, 17, 19 and 20 for Oniru, Elegushi, Atican and Eleko beaches, respectively. The distribution of other metals analysed in each of the listed beaches are shown in Tables 12, 15, 18 and 21. IR spectra showing the absorption bands representing the major polymer types found in the

| Location number | High watermark | Drift line |
|-----------------|----------------|------------|
| **Oniru**       | N06°25’34.0” E003°25’02.7” | N06°25’33.6” E003°26’52.4” |
| 1                | N06°25’34.4” E003°26’53.5” | N06°25’33.2” E003°26’53.2” |
| 2                | N06°25’32.8” E003°26’54.4” | N06°25’32.5” E003°26’54.2” |
| 3                | N06°25’31.9” E003°26’55.9” | N06°25’31.6” E003°26’55.7” |
| 4                | N06°25’31.4” E003°26’56.7” | N06°25’31.0” E003°26’56.5” |
| 5                | N06°25’31.2” E003°26’57.7” | N06°25’30.7” E003°26’57.4” |
| 6                | N06°25’30.9” E003°26’58.4” | N06°25’30.3” E003°26’58.2” |
| 7                | N06°25’30.8” E003°26’59.5” | N06°25’30.4” E003°26’59.4” |
| 8                | N06°25’30.6” E003°26’61.1” | N06°25’30.1” E003°26’61.2” |
| 9                | N06°25’30.9” E003°26’63.1” | N06°25’30.5” E003°26’62.9” |
| 10               | N06°25’20.5” E003°28’34.5” | N06°25’20.1” E003°28’34.0” |

**Elegushi**

| Location number | High watermark | Drift line |
|-----------------|----------------|------------|
| 1                | N06°25’20.8” E003°28’33.5” | N06°25’20.5” E003°28’33.4” |
| 2                | N06°25’20.8” E003°28’32.5” | N06°25’20.4” E003°28’32.6” |
| 3                | N06°25’20.7” E003°28’31.8” | N06°25’20.5” E003°28’31.8” |
| 4                | N06°25’20.4” E003°28’30.6” | N06°25’20.1” E003°28’30.6” |
| 5                | N06°25’20.0” E003°28’29.8” | N06°25’19.7” E003°28’29.8” |
| 6                | N06°25’19.1” E003°28’29.0” | N06°25’19.8” E003°28’28.8” |
| 7                | N06°25’20.2” E003°28’28.1” | N06°25’20.1” E003°28’28.1” |
| 8                | N06°25’20.5” E003°28’27.0” | N06°25’20.4” E003°28’27.0” |
| 9                | N06°25’20.8” E003°28’25.7” | N06°25’20.9” E003°28’25.6” |
| 10               | N06°25’28.9” E003°35’37.9” | N06°25’28.8” E003°35’37.9” |

**Atican**

| Location number | High watermark | Drift line |
|-----------------|----------------|------------|
| 1                | N06°25’29.0” E003°35’39.7” | N06°25’28.8” E003°35’39.7” |
| 2                | N06°25’29.0” E003°35’40.7” | N06°25’28.8” E003°35’40.8” |
| 3                | N06°25’29.1” E003°35’42.1” | N06°25’28.8” E003°35’42.1” |
| 4                | N06°25’29.1” E003°35’43.5” | N06°25’28.9” E003°35’43.6” |
| 5                | N06°25’29.2” E003°35’44.5” | N06°25’29.0” E003°35’44.6” |
| 6                | N06°25’29.3” E003°35’45.3” | N06°25’29.1” E003°35’45.3” |
| 7                | N06°25’29.2” E003°35’46.2” | N06°25’29.0” E003°35’46.2” |
| 8                | N06°25’29.2” E003°35’47.3” | N06°25’29.1” E003°35’47.3” |

**Eleko**

| Location number | High watermark | Drift line |
|-----------------|----------------|------------|
| 1                | N06°26’18.9” E003°51’19.0” | N06°26’18.8” E003°51’19.0” |
| 2                | N06°26’18.9” E003°51’18.7” | N06°26’18.7” E003°51’18.7” |
| 3                | N06°26’18.8” E003°51’18.3” | N06°26’18.8” E003°51’18.3” |
| 4                | N06°26’18.5” E003°51’17.5” | N06°26’18.8” E003°51’17.5” |
| 5                | N06°26’18.9” E003°51’16.9” | N06°26’18.8” E003°51’17.9” |
| 6                | N06°26’18.8” E003°51’16.0” | N06°26’18.9” E003°51’16.0” |
| 7                | N06°26’19.0” E003°51’15.2” | N06°26’18.0” E003°51’15.2” |
| 8                | N06°26’18.9” E003°51’14.8” | N06°26’18.1” E003°51’14.8” |
| 9                | N06°26’18.9” E003°51’14.3” | N06°26’18.0” E003°51’14.3” |
| 10               | N06°26’18.9” E003°51’13.0” | N06°26’18.1” E003°51’13.1” |
### Table 2
Sample codes and their descriptions for microplastic samples.

| S/N | Sample code | Site description               |
|-----|-------------|--------------------------------|
| 1   | AHF         | Atican beach high waterline foam |
| 2   | ADP         | Atican beach drift waterline foam |
| 3   | AHH         | Atican beach high waterline hard plastics |
| 4   | ADH         | Atican beach drift waterline hard plastics |
| 5   | OHF         | Oniru beach high waterline foam |
| 6   | ORH         | Oniru beach high waterline fibre/ropes |
| 7   | ODH         | Oniru beach drift waterline hard plastics |
| 8   | ODF         | Oniru beach drift waterline foam |
| 9   | ODR         | Oniru beach drift waterline ropes/fibre |
| 10  | OHH         | Oniru beach high waterline hard plastics |
| 11  | EHH         | Elegushi beach high waterline hard plastics |
| 12  | EHF         | Elegushi beach high waterline foam |
| 13  | EDF         | Elegushi beach drift waterline foam |
| 14  | EHP         | Elegushi beach high waterline pellets |
| 15  | EDH         | Elegushi beach drift waterline hard |
| 16  | EDP         | Elegushi beach drift waterline pellets |
| 17  | AHC         | Composite high waterline sample from Atican |
| 18  | ADC         | Composite drift waterline sample from Atican |
| 19  | OHC         | Composite high waterline sample from Oniru |
| 20  | ODC         | Composite drift waterline sample from Oniru |
| 21  | EHC         | Composite high waterline sample from Elegushi |
| 22  | EDC         | Composite drift waterline sample from Elegushi |
| 23  | KHC         | Composite High waterline sample from Eleko |
| 24  | KHH         | High waterline hard plastics from Eleko |
| 25  | KHR         | High waterline fibre from Eleko |
| 26  | KDH         | Drift waterline hard plastics from Eleko |
| 27  | KDR         | Drift waterline fibres from Eleko |
| 28  | KDC         | Composite drift waterline sample from Eleko |
| 29  | KHF         | High waterline foam sample from Eleko |

### Table 3
Microplastics quantification by polymer type.

| Sample sites | PE  | PP  | PS  | PUR | EVA | PET | PA | PVC | Latex | Others | Total  |
|--------------|-----|-----|-----|-----|-----|-----|----|-----|-------|--------|--------|
| Oniru        | 879 | 413 | 322 | 57  | 16  | 2   | 33 | 0   | 3     | 5      | 1730   |
| Elegushi     | 407 | 208 | 491 | 21  | 10  | 4   | 40 | 3   | 1     | 11     | 1196   |
| Atican       | 38  | 22  | 123 | 19  | 9   | 0   | 8  | 2   | 0     | 7      | 228    |
| Eleko        | 107 | 56  | 23  | 9   | 0   | 3   | 22 | 6   | 0     | 8      | 234    |

### Table 4
Microplastics quantification by plastic types.

| Sample site | Pellets | Foam fragments | Fibres | Hard fragments | Total |
|-------------|---------|----------------|--------|----------------|-------|
| Elegushi    | 157     | 522            | 41     | 476            | 1196  |
| Atican      | 5       | 158            | 14     | 51             | 228   |
| Oniru       | 2       | 395            | 46     | 1287           | 1730  |
| Eleko       | 3       | 32             | 19     | 180            | 234   |

### Table 5
Summary of microplastics abundance in the sampling sites.

| Parameters                                | Atican | Elegushi | Eleko | Oniru |
|-------------------------------------------|--------|----------|-------|-------|
| No. of high waterline MPs                 | 187    | 859      | 134   | 832   |
| No. of drift waterline MPs                | 41     | 337      | 100   | 898   |
| No. of current waterline MPs              | 0      | 0        | 0     | 0     |
| No. of sediment samples                   | 30     | 30       | 30    | 30    |
| Mass (g) of MPs collected                 | 3.45   | 12.62    | 3.11  | 10.78 |
| Average no. of MPs/kg of sediment         | 22.8 ± 9.3 | 119.6 ± 38.5 | 23.4 ± 9.2 | 173.0 ± 21.3 |
Table 6
Concentration (mg/kg) of phthalate esters in Oniru beach microplastic samples (n = 8).

| Sample code | DMP | DEP | DnBP | BBZP | DEHP | DnOP |
|-------------|-----|-----|------|------|------|------|
| ODC         | 0.02| 0.02| 0.02 | 0.02 | 0.04 | 0.04 |
| OHC         | BDL | BDL | 4.38 | 4.73 | 0.03 | 0.03 |
| ODF         | 0.01| 0.01| 1.19 | 1.11 | 0.01 | 0.01 |
| ODH         | 0.01| 0.01| 3.01 | 3.07 | 0.02 | 0.02 |
| ODR         | 0.00| 0.00| 1.44 | 1.49 | BDL  | BDL  |
| OHF         | 0.01| 0.01| BDL  | BDL  | 0.02 | 0.02 |
| OHH         | 0.01| 0.01| BDL  | BDL  | 0.01 | 0.01 |
| OHR         | 0.01| 0.01| BDL  | BDL  | 0.01 | 0.01 |

BDL: Below limit of detection (LOD).

Table 7
Concentration (mg/kg) of phthalate esters in Elegushi beach microplastic samples (n = 8).

| Sample Code | DMP | DEP | DnBP | BBZP | DEHP | DnOP |
|-------------|-----|-----|------|------|------|------|
| EHH         | BDL | BDL | 0.03 | 0.03 | BDL  | BDL  |
| EDC         | 0.01| 0.01| 1.81 | 1.30 | 0.01 | 0.01 |
| EHC         | 0.01| 0.02| 1.89 | 1.77 | 0.01 | 0.01 |
| EDF         | 0.01| 0.01| 1.55 | 1.51 | 0.02 | 0.02 |
| EDH         | 0.00| 0.00| 1.51 | 1.58 | 0.02 | 0.02 |
| EDP         | 0.01| 0.01| 1.71 | 1.54 | BDL  | BDL  |
| EHF         | 0.00| 0.00| 0.00 | 0.00 | 0.01 | 0.01 |
| EHP         | BDL | BDL | 0.01 | 0.01 | 0.03 | 0.03 |

BDL: Below limit of detection (LOD).

Table 8
Concentration (mg/kg) of phthalate esters in Atican beach microplastic samples (n = 6).

| Sample Code | DMP | DEP | DnBP | BBZP | DEHP | DnOP |
|-------------|-----|-----|------|------|------|------|
| ADF         | 15.16| 15.01| 0.01 | 0.00 | BDL  | BDL  |
| ADH         | 0.08 | 0.08 | BDL  | BDL  | 1.07 | 0.97 |
| AHF         | BDL  | BDL  | 0.00 | 0.01 | BDL  | BDL  |
| AHH         | 0.00 | 0.00 | 1.71 | 1.88 | BDL  | BDL  |
| ADC         | 0.05 | 0.05 | BDL  | BDL  | 0.00 | 0.00 |
| AHC         | BDL  | BDL  | BDL  | BDL  | 0.01 | 0.01 |

BDL: Below limit of detection (LOD).

beaches is presented in Fig. 1. In addition, GC–MS chromatogram representing phthalate ester concentrations and distribution is depicted in Fig. 2.

2. Experimental design, materials, and methods

2.1. Collection of samples

Sandy sediments (n = 150) were collected from four beaches namely Oniru, Elegushi, Atican and Eleko, in the coastal city of Lagos, Nigeria between August and November, 2019. Each beach was divided into three transects (High (HW), drift (DW), and current (CW) waterlines) and psammitic sediment samples were taken from ten points (about 100 m apart) per transect using a 0.5 × 0.5 × 0.2 m quadrat.
Table 9
Concentration (mg/kg) of phthalate esters in Eleko beach microplastic samples (n = 5).

| Sample Code | DMP Conc 1 | DMP Conc 2 | DEP Conc 1 | DEP Conc 2 | DnBP Conc 1 | DnBP Conc 2 | BBZP Conc 1 | BBZP Conc 2 | DEHP Conc 1 | DEHP Conc 2 | DnOP Conc 1 | DnOP Conc 2 |
|-------------|------------|------------|------------|------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| KDF         | 0.00       | 0.00       | 0.00       | 0.01       | 0.26        | 0.26        | BDL         | BDL         | 2.94        | 2.64        | 0.01        | 0.01        |
| KDH         | BDL        | BDL        | BDL        | BDL        | 0.00        | 0.01        | 0.00        | 0.01        | 0.17        | 0.22        | BDL         | BDL         |
| KFH         | BDL        | BDL        | BDL        | BDL        | 0.01        | 0.00        | 0.01        | 0.01        | 0.44        | 0.41        | BDL         | BDL         |
| KHF         | 0.00       | 0.00       | BDL        | BDL        | 1.09        | 1.11        | 0.01        | 0.01        | 4.67        | 4.67        | BDL         | BDL         |
| KHH         | 0.01       | 0.00       | BDL        | BDL        | 1.61        | 1.56        | BDL         | BDL         | 4.94        | 4.84        | BDL         | BDL         |

BDL: Below limit of detection (LOD).

Table 10
Concentration (mg/kg) of major toxic metals in Oniru beach microplastic samples (n = 8).

| Sample ID | As | Cd | Cr | Co | Cu | Fe | Pb | Ni | Zn |
|-----------|----|----|----|----|----|----|----|----|----|
| OHC       | 0.12 | 0.10 | 0.10 | 0.03 | 0.09 | 11.70 | 0.33 | 0.05 | 21.74 |
| OHH       | 0.10 | 0.04 | 0.06 | 0.03 | 0.09 | 6.48 | 0.20 | 0.04 | 31.47 |
| OHF       | 0.10 | 0.05 | 0.08 | 0.03 | 0.09 | 1.57 | 0.08 | 0.03 | 18.96 |
| OHR       | 0.09 | 0.04 | 0.06 | 0.04 | 0.07 | 1.80 | 0.09 | 0.03 | 15.82 |
| ODC       | 0.10 | 0.09 | 0.08 | 0.03 | 0.12 | 7.52 | 0.16 | 0.04 | 22.44 |
| ODH       | 0.10 | 0.04 | 0.06 | 0.03 | 0.08 | 2.01 | 0.09 | 0.03 | 24.75 |
| ODR       | 0.09 | 0.04 | 0.06 | 0.04 | 0.07 | 1.77 | 0.10 | 0.04 | 26.62 |
| ODF       | 0.09 | 0.04 | 0.07 | 0.03 | 0.09 | 3.02 | 0.15 | 0.04 | 24.49 |

Table 11
Concentration (mg/kg) of major toxic metals in Oniru beach microplastic samples (n = 8).

| Sample ID | Al | Mn | Sb | Ba | Mo | Se | Sr | Ti | V |
|-----------|----|----|----|----|----|----|----|----|----|
| OHC       | 5.17 | 5.28 | 0.08 | 0.18 | 0.09 | 0.08 | 1.12 | 0.18 | 0.08 |
| OHH       | 1.79 | 0.10 | 0.06 | 0.12 | 0.07 | 0.09 | 0.05 | 0.06 | 0.06 |
| OHF       | 4.06 | 0.40 | 0.07 | 0.16 | 0.07 | 0.06 | 0.49 | 0.14 | 0.07 |
| OHR       | 1.68 | 0.09 | 0.06 | 0.14 | 0.07 | 0.09 | 0.04 | 0.06 | 0.06 |
| ODC       | 3.72 | 0.90 | 0.06 | 2.84 | 0.08 | 0.09 | 0.24 | 0.12 | 0.07 |
| ODH       | 2.35 | 0.23 | 0.06 | 0.13 | 0.07 | 0.09 | 0.05 | 0.06 | 0.06 |
| ODR       | 2.45 | 0.07 | 0.07 | 0.12 | 0.07 | 0.09 | 0.05 | 0.06 | 0.06 |
| ODF       | 2.54 | 0.26 | 0.07 | 0.14 | 0.07 | 0.08 | 0.31 | 0.08 | 0.06 |

Table 12
Concentration (mg/kg) of other metals in Oniru beach microplastic samples (n = 8).

| Sample ID | B  | Ca | Mg | K  | Si | Ag | Na | Ti |
|-----------|----|----|----|----|----|----|----|----|
| OHC       | 0.31 | 7.58 | 7.91 | 3.60 | 6.93 | 0.07 | 45.68 | 0.15 |
| OHH       | 0.16 | 6.79 | 2.18 | 1.26 | 0.86 | 0.06 | 19.77 | 0.07 |
| OHF       | 0.23 | 7.39 | 21.48 | 5.78 | 3.24 | 0.06 | 49.51 | 0.07 |
| OHR       | 0.13 | 6.57 | 2.07 | 1.15 | 1.04 | 0.07 | 16.70 | 0.07 |
| ODC       | 0.21 | 7.67 | 6.81 | 3.47 | 3.13 | 0.06 | 37.06 | 0.07 |
| ODH       | 0.13 | 7.03 | 3.93 | 1.62 | 0.93 | 0.06 | 20.00 | 0.07 |
| ODR       | 0.16 | 7.99 | 4.12 | 1.76 | 1.07 | 0.06 | 14.20 | 0.10 |
| ODF       | 0.17 | 7.59 | 19.70 | 2.53 | 2.06 | 0.06 | 25.02 | 0.06 |

2.2. Sample treatment

Prior to analysis, microplastics were separated from sediment by density flotation in saturated NaCl [2–4]. Separated debris which was a mixture of plastic particles and organic matter was viewed under a stereomicroscope for selection of MPs. The selected MPs were further characterised using ATR-FTIR for polymer identification. MPs were grouped into four classes, namely hard plastics (H), foam (F), pellets (P), and fibres/ropes (R), and 0.3 g of each class was analysed...
### Table 13
Concentration (mg/kg) of major toxic metals in Elegushi beach microplastic samples (n = 8).

| Sample ID | As | Cd | Cr | Co | Cu | Fe | Pb | Ni | Zn |
|-----------|----|----|----|----|----|----|----|----|----|
| EHC       | 0.12 | 0.08 | 0.18 | 0.04 | 0.11 | 13.49 | 0.51 | 0.07 | 24.02 |
| EHH       | 0.11 | 0.04 | 0.06 | 0.04 | 0.07 | 2.52 | 0.12 | 0.03 | 18.70 |
| EHF       | 0.11 | 0.04 | 0.16 | 0.03 | 0.08 | 8.32 | 0.56 | 0.04 | 15.81 |
| EHP       | 0.09 | 0.04 | 0.06 | 0.03 | 0.07 | 3.19 | 0.12 | 0.04 | 26.98 |
| EDC       | 0.09 | 0.07 | 0.09 | 0.03 | 0.09 | 7.29 | 0.24 | 0.05 | 22.07 |
| EDH       | 0.09 | 0.04 | 0.06 | 0.03 | 0.07 | 2.46 | 0.10 | 0.03 | 16.75 |
| EDF       | 0.10 | 0.04 | 0.08 | 0.03 | 0.07 | 4.66 | 0.15 | 0.04 | 21.24 |
| EDP       | 0.10 | 0.04 | 0.06 | 0.03 | 0.06 | 1.90 | 0.09 | 0.04 | 12.05 |

### Table 14
Concentration (mg/kg) of major toxic metals in Elegushi beach microplastic samples (n = 8).

| Sample ID | Al | Mn | Sb | Ba | Mo | Se | Sr | Ti | V |
|-----------|----|----|----|----|----|----|----|----|----|
| EHC       | 4.41 | 0.77 | 0.07 | 0.21 | 0.10 | 0.09 | 0.16 | 0.17 | 0.09 |
| EHH       | 2.26 | 0.19 | 0.07 | 0.16 | 0.07 | 0.08 | 0.03 | 0.16 | 0.07 |
| EHF       | 4.35 | 0.55 | 0.07 | 0.17 | 0.08 | 0.09 | 0.03 | 0.12 | 0.06 |
| EHP       | 2.93 | 0.11 | 0.06 | 0.14 | 0.07 | 0.09 | 0.06 | 0.05 | 0.07 |
| EDC       | 3.28 | 0.26 | 0.07 | 0.15 | 0.08 | 0.07 | 0.05 | 0.10 | 0.06 |
| EDH       | 2.27 | 0.10 | 0.07 | 0.13 | 0.07 | 0.07 | 0.06 | 0.06 | 0.07 |
| EDF       | 3.49 | 0.29 | 0.06 | 0.14 | 0.07 | 0.09 | 0.05 | 0.10 | 0.06 |
| EDP       | 1.82 | 0.07 | 0.05 | 0.14 | 0.07 | 0.10 | 0.22 | 0.10 | 0.06 |

### Table 15
Concentration (mg/kg) of other metals in Elegushi beach microplastic samples (n = 8).

| Sample ID | B | Ca | Mg | K | Si | Ag | Na | Ti |
|-----------|---|----|----|---|----|----|----|----|
| EHC       | 0.43 | 7.80 | 7.64 | 3.41 | 5.28 | 0.07 | 47.57 | 0.09 |
| EHH       | 0.21 | 4.81 | 3.36 | 4.34 | 1.37 | 0.07 | 38.27 | 0.10 |
| EHF       | 0.27 | 7.73 | 11.65 | 2.84 | 4.75 | 0.07 | 47.42 | 0.08 |
| EHP       | 0.14 | 6.48 | 2.71 | 1.69 | 1.56 | 0.06 | 16.18 | 0.09 |
| EDC       | 0.20 | 6.10 | 3.91 | 2.50 | 3.27 | 0.06 | 33.15 | 0.05 |
| EDH       | 0.15 | 7.56 | 1.58 | 1.26 | 1.07 | 0.06 | 18.71 | 0.08 |
| EDF       | 0.15 | 5.01 | 2.99 | 1.85 | 2.18 | 0.07 | 35.36 | 0.06 |
| EDP       | 0.13 | 7.61 | 0.92 | 1.04 | 1.18 | 0.07 | 15.25 | 0.07 |

### Table 16
Concentration (mg/kg) of major toxic metals in Atican beach microplastic samples (n = 6).

| Sample ID | As | Cd | Cr | Co | Cu | Fe | Pb | Ni | Zn |
|-----------|----|----|----|----|----|----|----|----|----|
| AHC       | 0.09 | 0.10 | 0.15 | 0.04 | 0.16 | 4.90 | 0.36 | 0.05 | 19.17 |
| AHH       | 0.10 | 0.04 | 0.06 | 0.03 | 0.08 | 1.95 | 0.10 | 0.04 | 25.00 |
| AHF       | 0.10 | 0.04 | 0.12 | 0.03 | 0.08 | 4.89 | 0.37 | 0.04 | 25.35 |
| ADC       | 0.10 | 0.08 | 0.10 | 0.03 | 0.24 | 4.04 | 0.20 | 0.06 | 14.77 |
| ADH       | 0.09 | 0.08 | 0.06 | 0.04 | 0.08 | 1.14 | 0.09 | 0.04 | 19.45 |
| ADF       | 0.09 | 0.06 | 0.06 | 0.04 | 0.08 | 1.81 | 0.11 | 0.04 | 24.92 |

### Table 17
Concentration (mg/kg) of major toxic metals in Atican beach microplastic samples (n = 6).

| Sample ID | Al | Mn | Sb | Ba | Mo | Se | Sr | Ti | V |
|-----------|----|----|----|----|----|----|----|----|----|
| AHC       | 3.02 | 0.35 | 0.07 | 0.35 | 0.09 | 0.09 | 0.34 | 0.09 | 0.07 |
| AHH       | 2.04 | 0.11 | 0.06 | 0.11 | 0.08 | 0.07 | 0.02 | 0.06 | 0.06 |
| AHF       | 4.78 | 0.37 | 0.07 | 0.19 | 0.08 | 0.10 | 0.19 | 0.12 | 0.07 |
| ADC       | 2.31 | 0.22 | 0.06 | 0.18 | 0.20 | 0.08 | 0.24 | 0.10 | 0.07 |
| ADH       | 2.06 | 0.06 | 0.08 | 0.15 | 0.07 | 0.09 | 0.04 | 0.06 | 0.06 |
| ADF       | 2.89 | 0.09 | 0.06 | 0.16 | 0.07 | 0.10 | 1.78 | 0.06 | 0.07 |
Table 18
Concentration (mg/kg) of other metals in Atican beach microplastic samples (n = 6).

| Sample ID | B  | Ca | Mg  | K  | Si  | Ag  | Na  | T   |
|-----------|----|----|-----|----|-----|-----|-----|-----|
| AHH       | 0.58 | 7.67 | 9.19 | 3.72 | 2.16 | 0.07 | 45.72 | 0.10 |
| AHF       | 0.16 | 5.75 | 2.15 | 1.72 | 0.94 | 0.06 | 14.98 | 0.11 |
| ADC       | 0.19 | 7.60 | 15.25 | 2.79 | 3.29 | 0.06 | 37.74 | 0.10 |
| ADH       | 0.48 | 7.91 | 5.66 | 2.40 | 1.85 | 0.07 | 37.96 | 0.08 |
| ADF       | 0.14 | 4.82 | 2.11 | 1.32 | 0.97 | 0.06 | 12.49 | 0.10 |

Table 19
Concentration (mg/kg) of major toxic metals in Eleko beach microplastic samples (n = 8).

| Sample ID | As | Cd | Cr | Co | Cu | Fe | Pb | Ni | Zn |
|-----------|----|----|----|----|----|----|----|----|----|
| KDC       | 0.09 | 0.04 | 0.11 | 0.03 | 0.11 | 4.04 | 2.51 | 0.06 | 19.77 |
| KHC       | 0.09 | 0.04 | 0.06 | 0.04 | 0.08 | 1.35 | 0.15 | 0.05 | 21.93 |
| KHH       | 0.09 | 0.04 | 0.07 | 0.04 | 0.07 | 1.53 | 0.31 | 0.15 | 17.65 |
| KHR       | 0.10 | 0.04 | 0.07 | 0.04 | 0.07 | 1.04 | 0.47 | 0.03 | 18.67 |
| KHF       | 0.09 | 0.04 | 0.06 | 0.04 | 0.08 | 1.50 | 0.21 | 0.04 | 18.22 |
| KDF       | 0.10 | 0.04 | 0.08 | 0.03 | 0.11 | 4.17 | 0.52 | 0.06 | 23.91 |
| KDR       | 0.09 | 0.04 | 0.07 | 0.04 | 0.08 | 1.18 | 1.00 | 0.05 | 18.12 |
| KDF       | 0.10 | 0.04 | 0.08 | 0.03 | 0.08 | 3.43 | 0.29 | 0.06 | 20.00 |

Table 20
Concentration (mg/kg) of major toxic metals in Eleko beach microplastic samples (n = 8).

| Sample ID | Al  | Mn  | Sb  | Ba  | Mo  | Se  | Sr  | Ti  | V   |
|-----------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| KDC       | 3.27 | 0.24 | 0.07 | 0.17 | 0.07 | 0.10 | 0.05 | 0.09 | 0.06 |
| KHC       | 2.30 | 0.06 | 0.06 | 0.16 | 0.07 | 0.10 | 0.04 | 0.06 | 0.06 |
| KHH       | 2.07 | 0.08 | 0.06 | 0.15 | 0.07 | 0.09 | 0.03 | 0.07 | 0.06 |
| KHR       | 1.99 | 0.05 | 0.06 | 0.11 | 0.07 | 0.08 | 0.03 | 0.06 | 0.06 |
| KHF       | 3.34 | 0.07 | 0.06 | 0.13 | 0.07 | 0.09 | 0.09 | 0.06 | 0.06 |
| KDF       | 3.02 | 0.19 | 0.06 | 0.15 | 0.07 | 0.09 | 0.05 | 0.09 | 0.06 |
| KDR       | 2.76 | 0.08 | 0.06 | 0.19 | 0.07 | 0.09 | 0.18 | 0.06 | 0.06 |
| KDF       | 2.45 | 0.09 | 0.06 | 0.19 | 0.07 | 0.09 | 0.04 | 0.07 | 0.06 |

Table 21
Concentration (mg/kg) of other metals in Eleko beach microplastic samples (n = 8).

| Sample ID | B  | Ca | Mg  | K  | Si  | Ag  | Na  | Tl  |
|-----------|----|----|-----|----|-----|-----|-----|-----|
| KDC       | 0.28 | 7.37 | 2.81 | 1.37 | 2.38 | 0.07 | 4.11 | 0.06 |
| KHC       | 0.18 | 6.28 | 1.48 | 1.11 | 1.46 | 0.10 | 3.52 | 0.08 |
| KHH       | 0.23 | 7.35 | 1.30 | 1.06 | 1.76 | 0.06 | 3.44 | 0.06 |
| KHR       | 0.15 | 5.79 | 1.05 | 0.84 | 1.44 | 0.10 | 2.56 | 0.08 |
| KHF       | 0.17 | 7.83 | 2.08 | 1.24 | 1.71 | 0.06 | 5.09 | 0.08 |
| KDF       | 0.18 | 7.28 | 2.81 | 1.55 | 2.16 | 0.06 | 5.02 | 0.05 |
| KDR       | 0.20 | 7.74 | 1.75 | 1.16 | 1.80 | 0.07 | 4.35 | 0.08 |
| KDF       | 0.20 | 7.04 | 2.11 | 1.22 | 1.92 | 0.07 | 4.88 | 0.09 |

Accordingly. Composite samples (0.5 g), comprising a selection of all classes of MPs were also analysed. Samples were examined under a dissecting microscope, BMS 74,957 (WF10 × 22) at × 40 magnification. The categories of polymer types and physical classifications have been reported in a related study [2].
2.3. Sample extraction

The extraction for microplastic-sorbed phthalate esters was carried out as reported by Benson and Fred-Ahmadu [1]. Three aliquots of 5 mL of a mixture of cyclohexane (CHX) and ethyl acetate (EA), in the ratio 1:1 was added to each microplastic sample (0.25–0.5 g) in amber glass vials, previously rinsed with CHX:AE (1:1). The vials were vigorously shaken on a vortex machine and placed in an ultrasonic bath for 20 min. Then the samples were placed on an orbital
Fig. 2. Representative chromatogram for microplastic samples phthalate esters.
rotor for 24 h to allow the samples to soak in the solvent. After centrifugation, the extract was transferred to a new vial, and the extraction process was repeated two more times. After 72 h, a total volume of 15 mL had been recovered which contained the PAE congeners adsorbed to the plastics [5]. The extract was concentrated to 1 mL, transferred to amber GC vials and stored in the fridge at 4 °C prior to GC–MS analysis. Metal extractions of microplastics was carried out two times using 10 mL of 10% HNO₃ each time and rotating on the orbital shaker for 2 h at 150 rpm [6]. The extracts were filtered in clean glass vials and taken to ICP–OES for analysis.

2.4. Polymer analysis with FTIR

The resolution of the ATR-FTIR equipment was 8 cm⁻¹, 32 sample scans and a range of 4000–650 cm⁻¹. The absorption bands of each polymer were studied and matched with Agilent polymer ATR library with acceptable match quality set at ≥ 80% and further confirmed using validated polymer spectral data [7].

2.5. GC–MS and ICP–OES analysis

Sample extracts were analysed using an Agilent 7890A Gas Chromatography with Agilent 5975 Mass Spectroscopy Detector (GC–MS) for phthalate esters (in duplicates) and Agilent 720-ES Inductively Coupled Plasma–Optical Emission Spectrometry (ICP–OES) metals (in triplicates). Agilent 7890A Gas Chromatography with Agilent 5975 Mass Spectroscopy Detector (GC–MS) oven equilibration was 1 min at maximum temperature of 450 °C. The oven program was 100 °C for 0 min, 20 °C/min to 180 °C for 0 min and 10 °C/min to 280 °C for 2 min with run time set at 16 min. The carrier gas was helium and injection was by front SS splitless mode. Heat was set at 250 °C, pressure at 8.5635 psi and total flow rate at 54.659 mL/min. Septum surge flow was 3 mL/min for 2 min. The analytical column MS C18 (Agilent Technologies, Waldbronn, Germany) 25 m × 320 μm × 0 μm particle size temperature at 450 °C with initial temperature of 100 °C, pressure at 8.5636 psi, flow rate 1.6595 mL/min, average velocity of 32.774 cm/s and hold up time 1.2713 min, run time of 16 min and 1 min post run 0.57353 mL/min. The column Data acquisition and processing was carried out using Microsoft office excel and AddinSoft XLSTAT 2019. The analytes were eluted singly from the column after optimising the chromatographic parameters and their retention time obtained. Standards mix of the different phthalate esters were prepared with a concentration range of 0–100 ppm. The % recovery of matrix spikes ranged between 71.50% and 119.70%.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships which have, or could be perceived to have, influenced the work reported in this article.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi: 10.1016/j.dib.2020.105755.

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