Egyptian Journal of Aquatic Biology & Fisheries
Zoology Department, Faculty of Science,
Ain Shams University, Cairo, Egypt.
ISSN 1110 – 6131
Vol. 26(4): 47 – 58 (2022)
www.ejabf.journals.ekb.eg

Determination of Water Quality and Pollution by Micro and Nano Plastics in Water Treatment Plants

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ARTICLE INFO

Article History:
Received: May 20, 2022
Accepted: June 21, 2022
Online: July 9, 2022

Keywords:
Water Quality,
Microplastics,
Treatment,
EDS analysis

ABSTRACT

This study aimed to determine the basic physicochemical measurements and contamination with micro-nano plastics of water of two water treatment plants (Al-Baradi’yah plant and Al-Abbas plant) in Basra governorate. Water samples were passed in the study stations to three sizes of stainless steel sieves, and the suspended materials were subjected to wet peroxide. Micro plastics were identified through the positive visual inspection by dissecting microscope. Energy Dispersive Spectroscopy EDS has been used to estimate the ratio of the elements in the samples. Al-Baradi'yah Water Treatment Plant showed higher values of conductivity of 4.42 mS/cm and salinity of 2.93 g/l at all areas (Raw, Sedimentation basins, and produced water) than the other station. However, the turbidity rate was found to be higher than the permissible limit for both stations. The EDS analysis to tested samples did not confirm the presence of microplastics by not being sensitive to the carbon component of the polymeric chains, the spectrum showed elements used in the experimental examination Na, Cl, O, and S in the samples 0.160 mm sieve in both of treatment plants.

INTRODUCTION

Plastic particles with less than 5 mm in diameter are generally known as microplastics (MPs) while particles with less than 1 µm in diameter are known as nanoplastics (NPs). Recent research has proven that the microplastic content has spread in many environmental places such as ocean water and drinking water (**Barria *et al*., 2020; Mintenig *et al*., 2019**). It is also discovered in seafood (**Bouwmeester *et al*., 2015**) and found in sea salt (**Yang *et al*., 2015**).

Microplastics are classified into primary MPs which are included in the care products as well as used in air-blasting media, and secondary MPs which are generated from the fragmentation of large plastic materials (**Murphy *et al*. 2016**). Plastic food containers and baby bottles shed huge numbers of tiny specks called microplastics, such as granulated polyethylene (PE), polyethylene terephthalate (PET), polystyrene (PS), and polypropylene (PP) particles which are included in content compositions of cleaning

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agents, personal care products and air blasting media for scrubbing agent (**Mintenig *et al*., 2017; Prata, 2018**).

Recent studies confirmed that wastewater treatment plants with domestic grey water were one of the pathways for microplastics that led to its existence in terrestrial and aquatic ecosystems. Polymer fibers from polyester, cosmetic products, nylon, and rayon fabrics could fall through the wearing and laundering of clothes (**Ziajahromi, *et al*., 2017; Raju, *et al*., 2018**). MPs can be eliminated via flotation, sedimentation, screening, filtration and flocculation progressions (**Lares *et al*. 2018**). Microplastics which are became it widespread presence in different aquatic environments involving oceans, estuaries, rivers, and lakes furthermore in wastewater effluent and urban runoff. Microplastics may structure from degradation and fragmentation of plastics by UV (**Eriksen, *et al*., 2013**).

Microplastics have environmental considerations attribute to their ability to chemically or physically damage in aquatic organisms begin from zooplankton to mammals by blocking the gut, furthermore, it can accumulate in tissues and organs of gut, gills and liver in fish exposure to Polystyrene-MPs over two weak (**Ding *et al*., 2018**), as well as MPs can providing an easy pathway for the transport of organic pollutants into the organism's body (**Miranda and de Carvalho-Sousa 2016**). Manufacturers have added some compounds to plastics such as pigments, stabilizers and plasticizers which are considered hazardous substances (**Lim, 2021**).

In addition to MPs have a pathological and cytotoxic impacts on human digestive tract cells with seafood which be absorbed through the gut, different sizes of polystyrene particles have damages to the membranes of epithelial cells in colon and intestine within one day (**Zhang *et al*., 2022**). Pollution by microplastics in freshwater is of global concern, especially when microplastics are broken down into nanoplastics, as they may have higher toxicity due to their greater ability to cross biological membranes (**Li *et al*., 2022**). The Shatt al-Arab river has suffered from many problems related to pollution resulting from domestic waste from industrial activities and, in addition to entering Iraqi marine waters with salt tides therefore, this study aimed to determine the basic physicochemical measurements of water from water treatment plants (Al-Baradi’yah plant and Al-Abbas plant) in Basra governorateas well as determine the contamination with microplastics in the water of these stations.

MATERIALS AND METHODS

Water samples collection

Water samples were collected from Al-Baradi'yah Water Treatment Plant and Al-Abbas Water Treatment Plant that located within the region in Basra governorate (Figure, 1). The samples were collected from three places in each treatment plant. The first station collected raw water represented by the water of the Shatt Al-Arab river, sedimentation basins and the produced water from the plant. In the second station, raw water samples were collected from the water coming from the Euphrates River, (the Al-Bidaa region), the sedimentation basins water and the produced water from this plant. The current experiment extended from October 2021untel April 2022. Water samples were placed in 500 ml glass bottles in three replicates. Figure 1 showing the map of sampling sites of water.

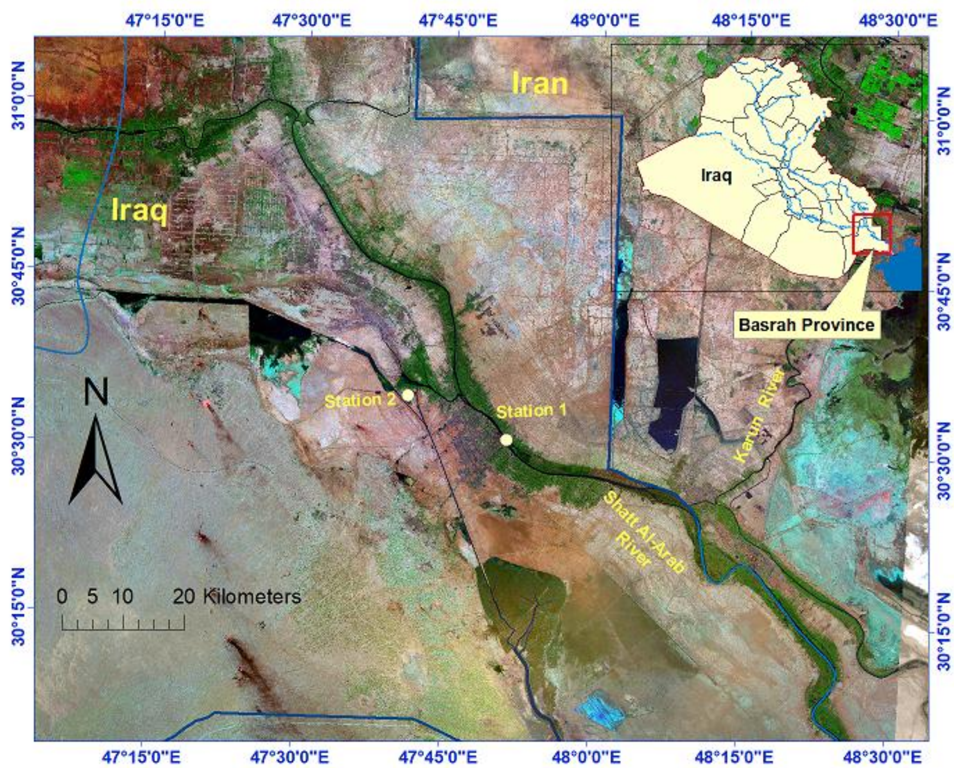

Fig. 1. A map of the sampling sites of water locations

Physico-chemical parameters

Physicochemical measurements such as temperature (°C), electrical conductivity (mScm-1), salinity (g/l) and total dissolved solids (TDS) were investagated using multimedia water checker (YASI) model 556 MPS, as well as turbidity testing is carried out by MicroTPI Field Portable Turbidimeter while concentration of hydrogen ions (pH) is measured using pH meter type SensoDirect 150 Lovibond.

Analysis of microplastics

A 20 liters of water samples were passed in the study stations to three sizes of stainless steel sieves (0.160, 090, and 0.038 mm), Test sieve Retsch, Germany, and the solid masses were collected are well washed by distilled waterand were kept in 50 ml glass containers.**Masura *et al*. (2015)** method was used for the analysis the plastic debris that suspended in the water samples. The sieved material was dried befor undegro solids for wet peroxide oxidation (WPO) with use Fe (II) catalyst to digest the changeable organic matter. The floating matters is collected in the density separator and then positive visual inspection by dissecting microscope with magnification of 40X. Microplastics were identified visually based on their colour, texture, and shape. Industrial polyethylene was also milled by a heavy mill to prepare microplastics particles for the control sample for the purpose of examining and comparing it with the samples. A profile (colour, shape, and size) of microplastics has been determined similar to the blue polyethylene particles found in toothpaste formulations (**Carr, *et al*., 2016**).

Then analytical technique by Energy Dispersive Spectroscopy (Zeiss Supra 55VP, Germany) (SEMEDS to confirm the presence or absence of microplastics and element for all samples and for easily identify as plastic.

RESULTS AND DISCUSSION

Physico-chemical parameters

Physico-chemical parameters are listed in Table 1. The pH values were in alkaline direction ranged from 7.25 to7.96 for both treatment plants. However, pH in water from all sources areas (Raw, Sedimentation basins and produced water) was with permissible level for human uses. Obtained results of raw water from Shatt Al-Arab River in Al-Baradi'yah plant were acceptable level and agree with study of **Aldoghachi, (2022)** in assessment of pH parameter in this River which was reported in range (7.3-7.9). As for the water temperatures, they were within the guidelines for the acceptable level (<35 ºC), the values ranged from 20.15 to20.84 ºC during studied period (Table 1).

Al-Baradi'yah Water Treatment Plant showed higher values of conductivity of 4.42 mS/cm compared by A-Abbas plant water which that was 1.00 mS/cm. were in Furthermore, the salinity concentrations of Al-Baradi'yah station recorded 2.93 g/l which was higher than the other station of 0.56 g/l for the produced water. Higher value of conductivity and salinity was due to the decrease of water discharge of the Tigris and Euphrates rivers. Moreover, the salt tide is coming from the Arabian Gulf during that period (**Aldoghachi and Altamimi, 2021**).

Forthermore, Al-Baradi'yah station appeared higher TDS value of2566 mg/l than Al-Abbas station that showed TDS value of 766 mg/l in raw water. However, the found values of conductivity, salinity and TDS in both stations are higher than the permissible values for drinking water are 1, 0.1 and 500, respectively according to **CCME (2022)**. Figure 2 shows the conductivity and salinity of both Al-Baradi'yah and Al-Abbas Water Treatment Plant are measuered from October 2021 until April 2022

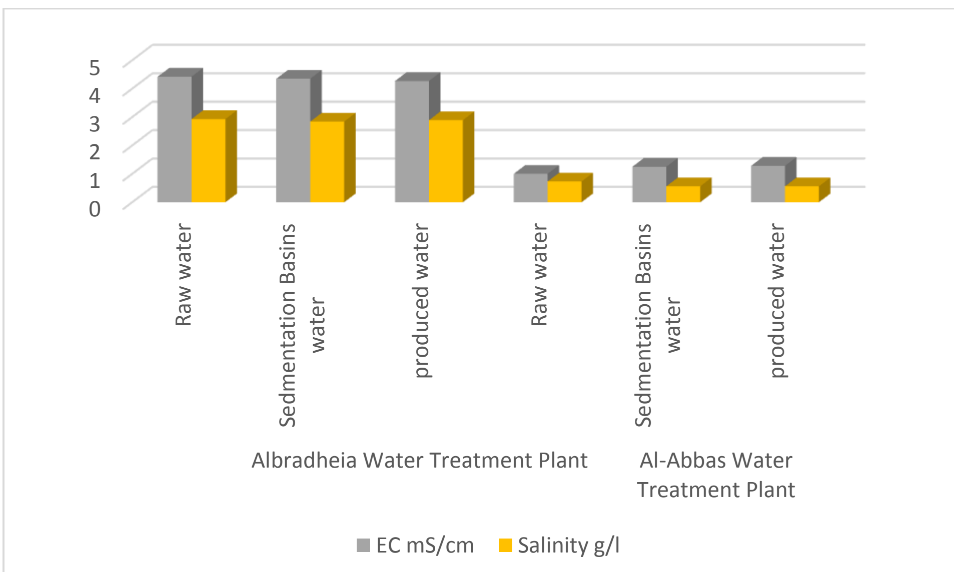

Fig. 2: Conductivity (mS/cm) and salinity (g/l) of Al-Baradi'yah Water Treatment Plant and Al-Abbas Water Treatment Plant during October 2021- April 2022

The water turbidity of Al-Abbas plant ranged from 2.22 NTU for produced water and 10.84 NTU for raw water (Table 1). The water turbidity variation in various sources could be attributed to the changes of the quantity of suspended materials. However, the high turbidity ratio may be due to excessive dust into surface water which was effected by sandstorms which was common in the region especially during the summer and autumn season. Moreover, the results are confirmed that the average turbidity valueswere higher than Canadian guidelines of environmental quality (5 NTU). The obtained results were agreed with those thatrecorded by of **Mohammad *et al*. (2021)** in some areas of Basra city that ranged from1.12 to 215.0 NTU). However, higher turbidity value in the water provides the proper conditions for the growth of water bacteria that causes many skin and intestinal diseases on humans (**WHO, 2017**).

Table 1. Physico-chemical parameters of water samples collected from Al-Baradi'yah Water Treatment Plant and Al-Abbas Water Treatment Plant during October 2021- April 2022

Areas	Water Source	pH	Water Temp.	EC mS/cm	Salinity g/l	Turbidity NTU	TDS mg/l
Al-Baradi'yah Water Treatment Plant	Raw water	7.5±0.3	20.84±1.04	4.42±0.47	2.93±0.13	5.83±0.51	2423±1165
	Sedimentation Basins water	7.43±0.13	20.31±1.36	4.35±0.43	2.84±0.14	8.09±3.04	2470±1100
	produced water	7.60±0.04	20.24±1.66	4.27±0.48	2.89±0.29	6.96±0.05	2566±1229
Al-Abbas Water Treatment Plant	Raw water	7.73±0.57	21.15±3.15	1.00±0.40	0.73±0.03	10.84±7.16	766±216
	Sedimentation Basins water	7.96±0.46	21.55±2.55	1.25±0.09	0.56±0.20	8.16±2.33	774±222
	produced water	7.25±0.15	21.35±1.75	1.28±0.07	0.56±0.19	2.22±0.72	775±206
	Permissible limit for drinking water*	6.5 - 8.5	<35 ºC	1.00	0.1	5	500
	Permissible limit for industrial water*	6.5 – 8.5	Over 5ºC	7.00	--	5	5000

*Canadian environmental quality guidelines (CCME,2022)

Microplastics examination

The microscope images of samples showed that the microplastics of prepared control sample contains irregularly shaped particles and tilted to a light blue color (Fig. 3a). However, microplastics did not appear in each of the samples that measuerd in the initial examination by the dissecting microscope of both water treatment plants. Most of the samples showed regular and cubic shaped salt crystals (Fig. 3b) which were mainly from the salts originally present in the water samples that collected from both stations. In addition to the materials that used in the analysis such as ferrous sulfate. Moreover, crystals can be formed from sodium chloride salt and ferrous sulfate which added in the analysis (Fig. 3c). In addition to regular cubic and elongated salt crystals , other shapes of crystals are appeared such as tapered needle-shaped, with serrated edges with snow-color.

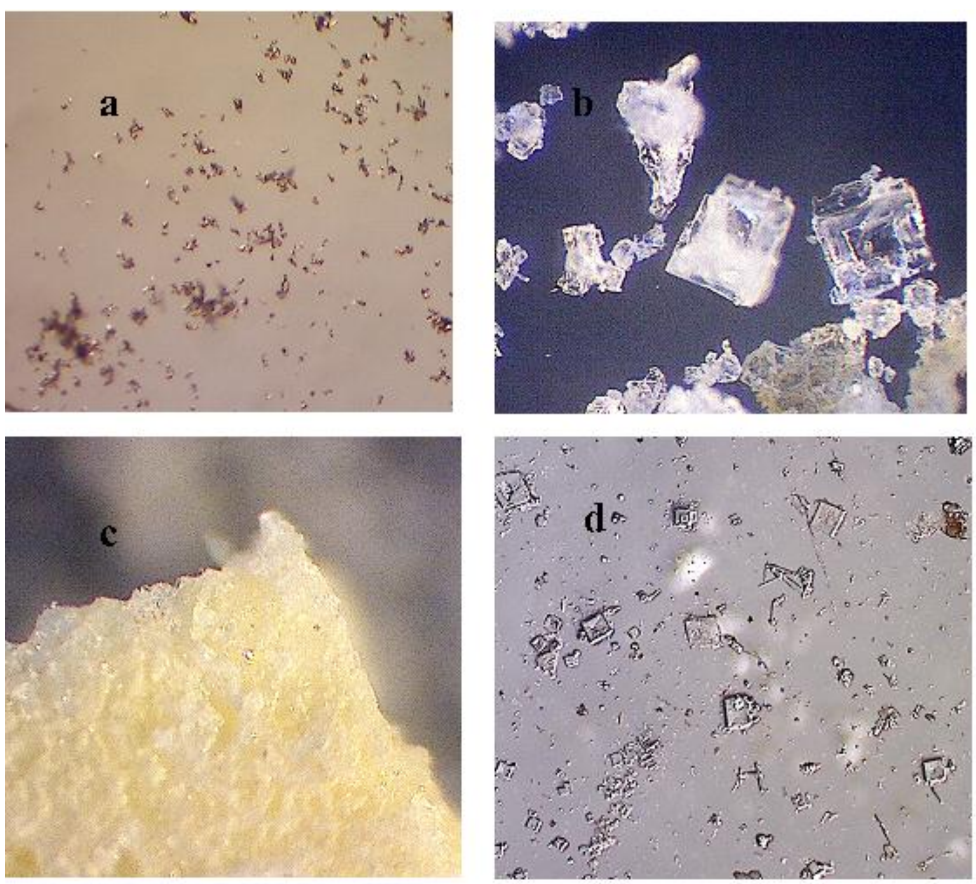

Fig. 3. a: Plastic control sample, b: Cubic and regular shaped salt crystals, c: Crystals formed from sodium chloride salt and ferrous sulfate added in the analysis, d: Regular cubic and elongated salt crystals.

The EDS results showed the presence of a spectrum of carbon (Fig. 4) while it did not appear in the remaining samples (Fig. 5 and 6). Samples did not confirm the presence of microplastics by not being sensitive to the carbon component in the spectrum while showed the elements which were used in the experimental examination such as Na, Cl, O, and S in the samples 0.160 mm sieve from Al-Abbas water treatment (Fig. 5) and Al-Baradi'yah Water Treatment Plant (Fig. 6). These results are in agreement with the study by **Eriksen**, ***et al*., (2013**) they sieved facial cleansers comprising microbeads of polyethylene and examined with SEM/EDS technique to assess their structure. And compared to the multicolored microplastics and they found spheres in the samples which were similar in colour, shape, size, and elemental arrangement, as well as analysis of several particles < 1 mm of their samples confirmed the suspected particles were not polymeric and had an identical fingerprint for some elements and were excluded from the microplastics count.

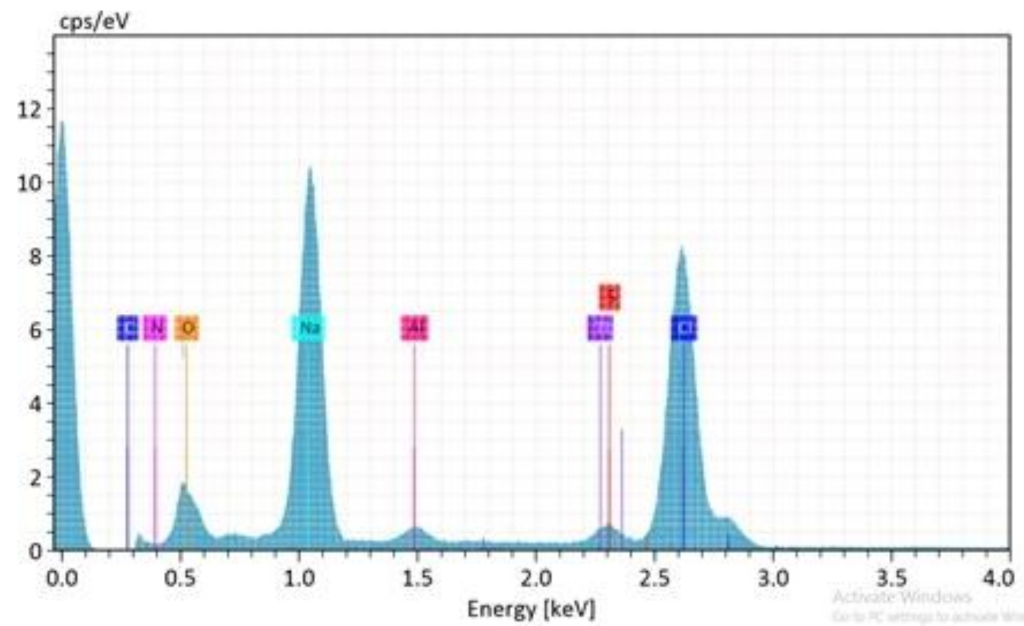

Fig. 4: EDS of the plastic control sample, spectrum shows elements which used in the experimental examination Na, Cl, S and detecting of C (Carbone element)

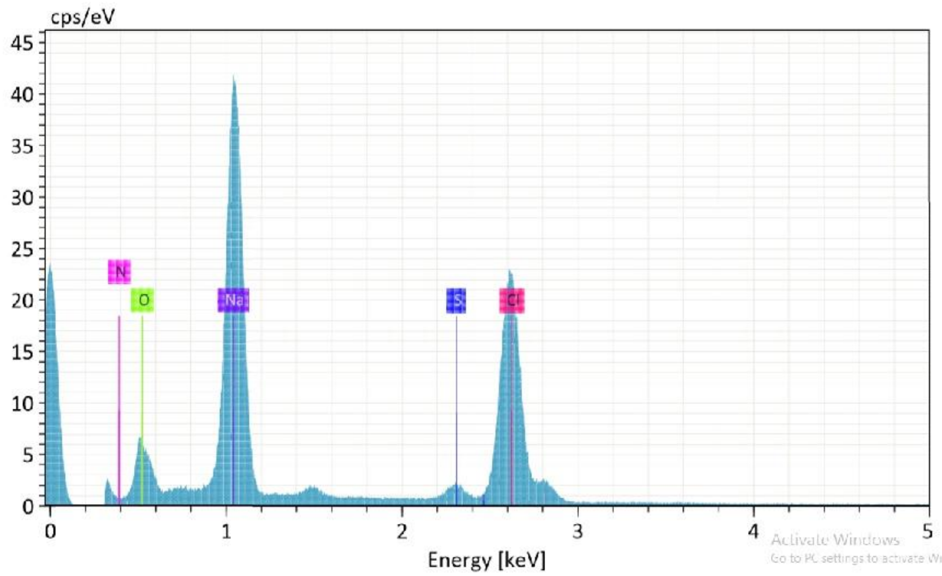

Fig. 5: EDS spectrum of the sample 0.160 mm sieve from Al-Abbas water treatment, spectrum shows elements which used in the experimental examination Na, Cl, S and O but not detecting of C (Carbone element)

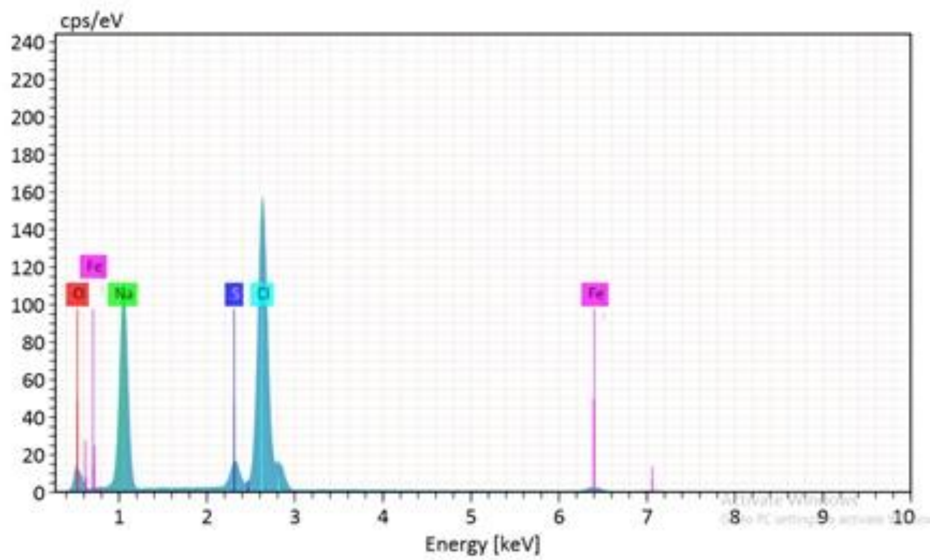

Fig. 6: EDS spectrum of the sample 0.160 mm sieve from Al-Baradi'yah Water Treatment Plant, spectrum shows elements which used in the experimental examination Na, Cl, S and O but not detecting of C (Carbone element)

CONCLUSION

The current study concluded that the values of salinity, conductivity and turbidity of produced water from Al-Baradi'yah and Al-Abbas Water Treatment Plant stations at Basra governorate-Iraq were higher than the permissible limits for drinking or industrial uses.However, microplastics particles did not appear in the water produced from these stations.

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