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Consequences of Using Wastewater for Irrigation Purposes and Finding Inexpensive Solutions to Remove its Contaminants for Reusing

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ABSTRACT

In recent years due to the lack of water resources in Egypt, remediation of waste water become necessary. Also, the usage of low cost friendly safe for environment and easily available substances in this remediation is in demand. So, A laboratory experiment was carried out to evaluate wastewaters of five different sources for irrigation purposes and assesses activated charcoal and zeolite in removing the contaminants from these wastewaters. The activated charcoal and zeolite were added each separately at two different concentrations (1.0 and 2.0%) Mixtures of wastewater and used natural ores were placed onto a rotary shaker at room temperature (20 ˚C), where each flask was prepared twice, the1st flask was shaken at 200rpm for one hour, while the 2nd flask was shaken at 200rpm for two hours. Thereafter, samples were filtered where the filtration was one day for the samples shaken for one hour only and two days for the samples shaken for two hours. The filtrate samples were chemically analyzed. The findings showed that the wastewater of Belqas and Batra agricultural drainage water, Sewage water from Station of Mansoura city, disposed of water of Aja Factory for the production of food are valid for irrigation after remediation, while industrial wastewater discharged from Sandoub Oil and Soap Factory is not suitable for agricultural purposes. Also, using zeolite and activated charcoal materials at the two different rates have a high capacity for the remediation of wastewaters, but the concentration of 2.0% was more effective in removing than 1.0%, also shaking for two hours was more effective in removing pollutants than one hour, moreover, the ability of activated charcoal in removing is more efficient than zeolite.

Keywords
Wastewater, remediation, zeolite and activated charcoal.

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Introduction

Life is dependent on water, where it is vital for all life forms in the world. Egypt is facing severe water scarcity and suffering from a freshwater shortage due to fixing its water budget. People in Egypt are under water poverty limit, where it has passed the threshold of absolute scarcity 1000 m3 capita-1year-1. Nile River is the major source of fresh water in Egypt, where it supplies 55.5 BCM year-1 of fresh water that represents 97% of all renewable water resources in the country **(National Water Resources Plan for Egypt, 2017)**. To overcome the gap between the current supplies of water and those demands for the different human activities, some other sources of water should be used. Therefore, finding alternative sources for irrigation water became a necessity **(El-Hadidiet al. 2020).**

Usage of wastewater can be considered as a beneficial partial solution for the reparation of water shortage. Wastewater is the water resulted due to utilization of the fresh water for various purposes such as irrigation, industrial and domestic purposes. There are other criteria commonly used for assessing wastewater quality and its suitability for irrigation purposes and their associated expected hazards on soil and plants grown thereon e.g., salinity, pH and water sodicity. Waste water must be treated before its release into another water body due to possesses negative impacts on the plants irrigated with it due to its contamination with inorganics wastes eg., heavy metals **(111Cd, 118Sn, 45Sc, 47 Ti, 51V, 60 Ni, 88 Sr, 137Ba, 208Pb)** and several organics e.g., viruses, protozoa, pathogenic bacteria and helminths in high concentration. Mostly, the plants irrigated with wastewater causes damage to human and animals feeding on it (**FAO, 2005)**. These hazards forced researchers towards finding out effective ways for removing wastewater pollutants or, at least, reducing their levels.

The issue of how to remove metal ions and pollutants from wastewater has been studied widely, but thus far, findings are disappointing. Therefore, the usage of inexpensive, practical, effective and stable substances to remove and/or degrade those pollutants has become one of the most necessary aims in wastewater remediation. The adsorption method using natural ores is one of the techniques, which is comparatively more economical and useful for

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removal, where dissolved contaminants adhere to the porous surface of used solid particles in this physical process **(Jiuhui, 2008).**

Activated charcoal is the most commonly used adsorbent and it is quite similar to common charcoal. Powdered activated carbon and granular activated carbon are the forms in common use. The activated charcoal efficiency is due to its high porousharacter, whereby Vanderwaals attractive forces pull the contaminates out of the solution and onto active carbon surface. The efficiency of the adsorption depends on the pore size, surface area, nature of the carbon particle, hardness and density as well as the nature of the **contaminants (hydrophobicity, concentration, polarity) (Bauduet al. 1991 and Yang and Benton, 2003).**

Zeolite substance is aluminosilicates with a silicon /aluminum ratio between one and infinity. Its adsorptive property is due to the crystalline nature. The channels in zeolite are cavities. It possesses a surface area of 1–20 m2/g. Natural zeolite usage in the remediation of wastewater is very useful **(Margetaet al. 2013).** It can remove heavy metal, radionuclides, organics and other humic substances, as well as microorganisms capturing and this makes zeolite material is suitable as a biofilter for removal of pathogenic microorganisms (**Karapınar 2009 and Jafarpouret al. 2010).**

Generally, agricultural drainage water, industrial effluents and municipal disposal wastewater may be a potential resource for the partial solution of the irrigation water deficit in Egypt. So, the current investigation aims at evaluating some natural ores i.e. activated charcoal and zeolite in the amelioration of some wastewater samples taken from different drains of El-Dakahlya governorate, Egypt and also assessing criteria controlling the suitability of these water samples for irrigation purposes.

Materials and Methods

1. Sources of Wastewater

The wastewater samples used in the current study were collected from five drains of wastewater in the El-Dakahlia governorate i.e.Belqas (sample code, $\mathbf{W_1}$) and Batra (sample code, $\mathbf{W_2}$) agricultural drainage water, sewage water

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from Station of Mansoura city (sample code, **W_3**), disposed water of Aja Factory for the production of food (sample code, **W_4**) and industrial wastewater discharged from Sandoub Oil and Soap Factory (sample code, **W_5**).

2. Adsorbed Natural Ores.

Activated charcoal (powder) was obtained from Al-Jamal Factory Producing activated and granulated carbon powder from rice husk, Damietta governorate, Egypt, while zeolite was obtained from El-Ahram Mining Company, Egypt.

3. Expermintal work.

The wastewater samples taken from the investigated five sources were put in five separated polyethylene bottles, transported immediately to the laboratory of Soil Dep., Agri. Faculty, Mans. Univ, Egypt and analyzed for their chemical characteristics then these samples were evaluated for irrigation purposes according to international standards.

A laboratory experiment was carried to evaluate activated charcoal and zeolite substances in removing the contaminants from the investigated wastewater samples. The activated charcoal and zeolite were added each separately at two different rates [2.5 and 5.0 g (dry basis) equivalent to 1.0 and 2.0 %, respectively] into flasks containing 250 mL of wastewater sample represent the evaluated drains each separately. Mixtures of wastewater and used natural ores were placed onto a rotary shaker at room temperature (20˚C), where each flask was prepared twice, the1st flask was shaken at 200rpm for one hour, while the 2nd flask was shaken at 200rpm for two hours. Thereafter, samples were filtered using nylon membrane filters (0.22 mm pore size), where the filtration was one day for the samples shaken for one hour only and two days for the samples shaken for two hours. The filtrate samples were chemically analyzed.

4. Wastewater properties determined.

The chemical traits of wastewater samples were determined twice, once in their initial status (before treating) and other after treating with natural ores according to the standard methods for examination of waste water in the

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Laboratory of Soil Fertility and fertilizers at Mansoura University (ISO 17025 certified) as follows;

Electrical conductivity (EC) and pH values were determined using EC meter and pH meter, respectively as well ascalcium, magnesium, sodium, sulfate, chloride, potassium, carbonate and bicarbonate were determined according to **Faithfull, (2002**). While, total suspended solids (TSS), total dissolved solids (TDS), biological oxygen demand (BODs), chemical oxygen demand (COD) were measured according to **APHA, (2005**). Total nitrogen (TN), total phosphate (TP) were measured according to **APHA, (1995)**.The residual sodium carbonate (RSC, meq L-1) was calculated using the following formula according to **Gupta and Gupta (1980).**

$$\textbf{RSC} = (\textbf{CO3--}+\textbf{HCO3-})-(\textbf{Ca+2}+\textbf{Mg+2})$$

Micronutrients i.e. B, Cu, Zn, Fe, Mn and heavy metals i.e.47Ti, 88Sr, 51Cr, 59Co, 60Ni, 111Cd, 208Pb were determined using inductively coupled plasma (ICP–OES, Perkin Elmer Optima2100 DV).

5. Removal efficiency of heavy metal.

Removal efficiency of heavy metal and some of contaminants e.g., boron from wastewater was calculated using the following formula;

$$\textbf{Removal effeciency} = \frac{\textbf{Initial concentration} - \textbf{Final concentration}}{\textbf{Initial concentration of wastewater}} \textbf{x 100}$$

Results and Discussion

1. Evaluation in Initial Status

Table1 represents the results obtained at the initial characterization of wastewater samples of Belqas and Batra agricultural drainage water, sewage water of Mansoura city Station, disposed of industrial wastewater of Aja Factory for the production of food and industrial wastewater discharged from

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Sandoub Oil and Soap Factory. The pH values of all studied samples were7.55, 7.50,8.35,8.00 and 12.3 for **W_1, W_2, W_3, W_4** and **W_5**, respectively, which means that the industrial wastewater discharged from Sandoub Oil and Soap Factory (sample code, **W_5**) was only of a pH exceeding the permissible values (6.5-8.4) according to **Ayers and Westcot (1985**). Therefore, the high pH value of this water (**W_5)** is expected to negatively affect the availability of most nutritive elements **(Asano, 1998).** Regarding salinity, the EC values were 3.90, 4.10, 4.75, 2.67 and 8.67 dSm^{-1} for **W_1, W_2, W_3, W_4** and **W_5**, respectively. Except for disposed water of Aja Factory for the production of food (sample code, **W_4**) which may don't cause a problem upon their usage for irrigation purpose since its EC value don't exceed 3 dSm^{-1} according to **Ayers and Westcot (1985)**, the other wastewaters will cause severe problems upon their usage for irrigation purpose especially the industrial wastewater discharged from Sandoub Oil and Soap Factory (**W_5**), which have EC value of 8.67 dSm^{-1}.

Values of TSS ranged from 464.10 mgl^{-1} to 5119.5, so the studied wastewaters are expected to cause hazard problems to the soil irrigated with these studied waters due to the values of TSS were more than 50 mgl^{-1} (exceed the permissible ones for the irrigation with wastewater according to **Ayers and Westcot, 1985**). Therefore, using these wastewaters for irrigation purposes may lead to clogging of drippers and sprinkler's nozzles as well as may cause sludge deposition **(Asano, 1998**).Also, the values of TDS were greater than 2000 mgl-1, which means that usage of all studied wastewater for irrigation purposes will lead to severe problems. The values of COD ranged from 90.0 to 1407 mgl-1while BODs values ranged from 55.0 to 920mgl^{-1}. According **WHO, (2000)**, the values of COD and BODs of W5sample are very high, thus it cannot be used for irrigation process because its high values of COD and BOD. Values of soluble Na+ in all studied samples showed that Na hazard is expected as a result of usage of the investigated wastewater for irrigation purpose since the content of all studied samples generally exceeded 13.6 mmol l^{-1}. Likewise, values of chloride, CO3 +HCO3 are far higher than the permissible limits according to **Ayers and Westcot, (1985)**. On the other hand, according to **Richard, (1985**), the RSC value of the wastewater of Belqas (sample code, **W_1**) agricultural drainage water is safe upon usage for irrigation purposes, whereas the samples of other wastewater are of moderate to severe hazard. Values of total nitrogen (IN) ranged from 5.1 to 80.9 mgl^{-1},

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where the values of the wastewater samples that holds code **W**$_4$ and **W**$_5$ exceeded 30 mgl^{-1}, which means that these wastewater may cause severe issues upon utilization for irrigation purposes. Also, values of total phosphorus (IP) ranged from 0.1 to 504mgl^{-1} and the problems were with the same both **W**$_4$ and **W**$_5$ (Shuval,1986).Concerning micronutrients and heavy metals, irrigation purposes require that heavy metals e.g.,Cd, B, Cr, Fe, Mn, Ni, Zn, Cu, Pb concentrations in the wastewater not be more than 0.01, 1.25, 1.0, 5.0, 10, 0.2, 2.0, 5.0 and 5.0 mgL^{-1}, respectively **(Shuval, 1986 and FAO, 2005)** which indicates that the studied wastewaters can be easily used for irrigation after remediation, except for the wastewater that holds code **W**$_3$ and **W**$_5$ which contained many obstacles that make them unfit for irrigation process and require the high-cost method for treating.

Generally, the wastewater of Belqas and Batra agricultural drainage water and disposed of water of Aja Factory for the production of food may be valid under some precautions for irrigation, while sewage water of Station in Mansoura city maybe required a high-cost method for treating. On the contrary, the industrial wastewater discharged from Sandoub Oil and Soap Factory is not suitable for agricultural purposes.

Table1. Characteristics of studied wastewaters in initial status

Sample code	PH	EC, dSm^{-1}	RSC	TSS	TDS	COD	BOD5	Ca	Mg	K	Na	Cl	Co_3 + Hco_3	So_4
				mg l^{-1}				mmol l^{-1}						
W$_1$	7.55	3.90	-10.35	705.20	6500.0	118	75.0	9.5	7.35	1.4	20.75	18.8	6.6	13.6
W$_2$	7.50	4.10	-9.0	464.10	8200.0	90.0	55.0	10.5	5.4	2.35	22.75	17.8	6.9	16.3
W$_3$	8.35	4.75	1.61	921.80	5778.0	280	240	12.03	8.46	0.95	26.06	13.41	22.1	11.99
W$_4$	8.00	2.67	1.95	607.00	6500.0	195	160	6.58	5.35	1.17	13.60	7.50	13.88	5.32
W$_5$	12.3	8.67	1.95	5119.5	18990	1407	920	16.58	15.35	21.17	33.6	37.5	33.88	15.32

Cont. Table1.

Sample code	T.N	T.P	Cd	B	Cr	Fe	Mn	Ni	Sr	Zn	Cu	As	Ti	Co	Pb
	mg l^{-1}														
W$_1$	5.100	0.2300	0.001	0.192	0.096	0.09	0.012	0.020	0.12	0.02	0.089	0.002	0.006	0.00	0.052
W$_2$	5.800	0.1110	0.005	0.138	0.008	0.264	0.120	0.120	0.074	0.015	0.063	0.029	0.006	0.00	0.029
W$_3$	14.10	0.6820	0.05	1.408	1.204	7.708	11.63	0.345	0.669	2.19	6.54	0.1	1.896	0.00	1.043

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			2				6								
W₄	80.90	6.7630	0.001	0.312	0.008	0.264	0.204	0.021	0.075	0.042	0.082	0.016	9.95	0.00	0.364
W₅	65.60	504.254	0.246	9.47	11.991	54.82	2.125	8.119	2.21	4.88	6.996	0.032	391.22	0.263	3.744

2. Removal by adsorption

Data of Tables from 2 to 6 show the role of natural ores i.e. zeolite and activated charcoal substances in removing the contaminants from the investigated wastewater samples. It was found that using zeolite and activated charcoal materials at two different rates [2.5 and 5.0 g ores per 250 ml wastewater] have a high capacity for the remediation of wastewaters, but the quantity of 5.0 g ores was more effective in removing than 2.5g, also shaking for two hours was more effective in removing than one hour, moreover the ability of activated charcoal in removing pollutants is more than zeolite and this may be attributed to the surface area of carbonaceous sorbents is largely bigger than zeolite as mentioned by **Mosaet al. (2020).** It can be said that both zeolite and activated charcoal substances could relatively remediate thewastewater of Belqas and Batra agricultural drainage water, disposed of water of Aja Factory for the production of food and make them valid for irrigation purposes. On the other hand, although both zeolite and activated charcoal substances removed contaminants from the wastewater of **W_3, W_5**, they cannot make them valid for irrigation purposes.

Sewage water of Station in Mansoura city maybe required a high-cost method for treating, but industrial wastewater discharged from Sandoub Oil and Soap Factory still not suitable for agricultural purposes after remediation so, it is not recommended for irrigation purposes completely by using studied materials.

Table 2. Characteristics of studied wastewater of Belqas agricultural drainage water (sample code, **W_1**) after remediation and percentage reduction of some contaminants.

Treatments			PH	EC, dSm^{-1}	RSC	TSS	TDS	COD	BOD5	Ca	Mg	K	Na	Cl	$Co_3 + Hco_3$	So_4
Natural ores	Dose (%)	Shaking time (h)				mg l^{-1}				mmol l^{-1}						
Zeolite	*1%*	1	7.50	3.82	-10	80	1970	80	65	9.3	7.2	1.30	20.4	18.6	6.5	13.1
		2	7.30	3.66	-9.9	76	1900	75	61	9.2	7.0	1.25	19.15	17.9	6.3	12.4
	2%	1	7.10	3.47	-9.7	71	1810	69	56	9.0	6.7	1.15	17.85	17.0	6.0	11.7
		2	6.95	2.99	-8.8	55	1570	55	43	8.1	5.8	1.05	14.95	14.8	5.1	10.0
Activate charcoal	*1%*	1	7.00	3.25	-9.3	63	1690	63	50	8.6	6.3	1.10	16.5	16.0	5.6	10.9
		2	6.90	2.70	-8.1	45	1400	45	35	7.5	5.1	1.00	13.4	13.5	4.5	9.00
	2%	1	6.85	2.38	-7.3	34	120	35	26	7.0	4.3	0.9	11.5	12.	4.0	7.80

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							0					5	5	0		
		2	6.66	2.01	-6.3	21	1000	22	16	6.4	3.3	0.90	9.5	10.0	3.4	6.70

Cont. Table 2.

Treatments			T.N	T.P	Cd	B	Cr	Fe	Mn	Ni	Sr	Zn	Cu	As	Ti	Co	Pb
Natural ores	**Dose (%)**	**Shaking time (h)**	**mg l^{-1}**														
Zeolite	**1%**	**1**	5.0	0.23	0.0	0.124	0.093	0.089	0.010	0.011	0.120	0.010	0.0	0.001	0.005	0.0	0.050
		2	4.8	0.22	0.0	0.120	0.091	0.087	0.007	0.010	0.110	0.005	0.0	0.000	0.004	0.0	0.040
	2%	**1**	4.5	0.21	0.0	0.110	0.088	0.082	0.006	0.010	0.095	0.000	0.0	0.000	0.001	0.0	0.025
		2	3.4	0.18	0.0	0.088	0.078	0.065	0.006	0.008	0.080	0.000	0.0	0.000	0.000	0.0	0.009
Activate charcoal	**1%**	**1**	4.0	0.20	0.0	0.096	0.084	0.075	0.003	0.009	0.088	0.000	0.0	0.000	0.000	0.0	0.000
		2	2.7	0.16	0.0	0.052	0.070	0.054	0.001	0.006	0.071	0.000	0.0	0.000	0.000	0.0	0.000
	2%	**1**	2.0	0.13	0.0	0.035	0.060	0.042	0.00	0.004	0.061	0.000	0.0	0.000	0.000	0.0	0.000
		2	1.2	0.09	0.0	0.015	0.047	0.029	0.00	0.002	0.050	0.000	0.0	0.000	0.000	0.0	0.000

Cont. Table2.

Treatments			Percentage reduction (removal efficiency),%														
Natural ores	**Dose (%)**	**Shaking time (h)**	**EC, dSm^{-1}**	**TSS**	**TDS**	**T.N**	**T.P**	**B**	**Cr**	**Fe**	**Mn**	**Ni**	**Sr**	**Zn**	**As**	**Ti**	**Pb**
Zeolite	**1%**	**1**	2.0	88.6	69.6	1.96	0.00	35.4	3.125	1.1	16.6	45	0.0	50	50	16.6	3.8
		2	6.1	89.2	70.7	5.88	4.34	37.5	5.20	3.3	41.6	50	8.30	75	100	33.3	23.0
	2%	**1**	11.0	89.9	72.1	11.7	8.69	42.7	8.3	8.8	50.0	50	20.8	100	100	83.3	51.9
		2	23.3	92.2	75.8	33.3	21.73	54.1	18.7	27.7	50.0	60	33.3	100	100	100	82.6
Activate charcoal	**1%**	**1**	16.6	91.0	74.0	21.5	13.04	50.0	12.5	16.6	75.0	55	26.6	100	100	100	100
		2	30.7	93.6	78.4	47.0	30.43	72.9	27.08	40.0	91.6	70	40.8	100	100	100	100
	2%	**1**	38.9	95.1	81.5	60.7	43.47	81.7	37.5	53.3	100	80	49.1	100	100	100	100
		2	48.4	97.0	84.6	76.4	60.86	92.1	51.04	67.7	100	90	58.3	100	100	100	100

Table 3. Characteristics of studied wastewater of Batra agricultural drainage water (sample code, **W_2**) after remediation and percentage reduction of some contaminants.

Treatments			PH	EC, dSm^{-1}	RSC	TSS	TDS	COD	BOD_5	Ca	Mg	K	Na	Cl	$Co_3 + Hco_3$	So_4
Natural ores	Dose (%)	Shaking time (h)				mg l^{-1}				mmol l^{-1}						
Zeolite	1%	1	7.45	3.9	-8.7	60	3600	88	53	10.3	5.2	2.30	21.5	17.6	6.8	14.90
		2	7.38	3.7	-8.5	58	3525	86	52	10.1	4.9	2.23	20.0	17.4	6.5	13.33
	2%	1	7.28	3.4	-8.1	54	3360	81	49	9.7	4.5	2.13	18.0	17.1	6.1	11.13
		2	7.00	2.7	-7.0	40	2850	66	37	8.5	3.5	1.85	13.5	15.5	5.0	6.85
Activate charcoal	1%	1	7.15	3.1	-7.65	49	3150	74	44	9.2	4.05	2.00	16.0	16.5	5.6	9.15
		2	6.80	2.24	-5.8	30	2400	55	30	7.7	2.6	1.65	10.5	14.3	4.5	3.65
	2%	1	6.65	1.76	-4.9	19	1725	43	22	6.8	2.0	1.40	7.40	11.7	3.9	2.00
		2	5.68	1.22	-3.7	8.0	975	28	13	5.7	1.3	1.10	4.10	7.8	3.3	1.10

Cont. Table3.

Treatments			T.N	T.P	Cd	B	Cr	Fe	Mn	Ni	Sr	Zn	Cu	As	Ti	Co	Pb
Natural ores	Dose (%)	Shaking time (h)	mg l^{-1}														
Zeolite	1%	1	5.6	0.10	0.03	0.132	0.006	0.220	0.11	0.09	0.070	0.013	0.060	0.02	0.004	0.0	0.02
		2	5.3	0.09	0.01	0.082	0.004	0.200	0.10	0.08	0.066	0.011	0.055	0.01	0.004	0.0	0.01
	2%	1	4.9	0.07	0.0	0.040	0.003	0.150	0.09	0.04	0.060	0.007	0.004	0.005	0.001	0.0	0.004
		2	3.8	0.00	0.0	0.0	0.000	0.060	0.07	0.01	0.050	0.002	0.002	0.00	0.000	0.0	0.000
Activate charcoal	1%	1	4.4	0.03	0.0	0.0	0.001	0.110	0.03	0.00	0.025	0.00	0.00	0.00	0.000	0.0	0.000
		2	3.1	0.00	0.0	0.0	0.000	0.010	0.00	0.00	0.010	0.00	0.00	0.00	0.000	0.0	0.000
	2%	1	2.1	0.00	0.0	0.0	0.000	0.007	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.0	0.000
		2	1.0	0.00	0.0	0.0	0.00	0.002	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.0	0.000

Cont. Table3.

Treatments			Percentage reduction (removal efficiency),%														
Natural ores	Dose (%)	Shaking time (h)	EC, dSm-1	TSS	TDS	T.N	T.P	B	Cr	Fe	Mn	Ni	Sr	Zn	As	Ti	Pb
Zeolite	1%	1	4.8	87.0	56.0	3.4	9.9	4.3	25	16.6	8.3	25	41.6	13.3	31.0	33.3	31.0
		2	9.7	87.5	57.0	8.6	18.9	40.5	50	24.2	16.6	33.3	45	26.6	65.5	33.3	65.5
	2%	1	17.0	88.3	59.0	15.5	36.9	71.0	62.5	43.1	25.0	66.6	50	53.3	82.7	83.3	86.2
		2	34.1	91.3	65.2	34.4	100	100	100	77.2	41.6	91.6	58.3	86.6	100	100	100
Activate charcoal	1%	1	24.3	89.4	61.5	24.1	72.9	100	87.5	58.3	75.0	100	79.1	100	100	100	100
		2	45.3	93.5	70.7	46.5	100	100	100	96.2	100	100	91.6	100	100	100	100
	2%	1	57.0	95.9	78.9	63.7	100	100	100	97.3	100	100	100	100	100	100	100
		2	70.2	98.2	88.1	82.7	100	100	100	99.2	100	100	100	100	100	100	100

Table 4. Characteristics of studied sewage waste water of Station in Mansoura city (sample code, **W_3**) after remediation and percentage reduction of some contaminants.

Treatments			PH	EC, dS m-1	RSC	TSS	TDS	COD	BOD 5	Ca	Mg	K	Na	Cl	Co_3 + Hco_3	So_4
Natural ores	Dose (%)	Shaking time (h)				mg l-1				mmol l-1						
Zeolite	1%	1	8.25	4.59	1.7	190	1700	116	100	12.0	8.3	0.90	24.7	12.5	22.0	11.4
		2	8.15	4.47	1.6	176	1660	110	99	11.8	8.1	0.88	23.92	12.2	21.5	11.0
	2%	1	7.90	4.34	1.8	168	1600	106	94	11.2	7.9	0.85	23.45	12.0	20.9	10.5
		2	7.15	4.09	2.9	147	1420	100	80	9.70	7.2	0.75	23.25	11.1	19.8	10.0
Activate charcoal	1%	1	7.55	4.24	2.5	163	1520	104	88	10.7	7.6	0.80	23.3	11.6	20.8	10.0
		2	6.65	3.84	2.9	145	1290	99	70	9.00	6.7	0.72	21.98	10.4	18.6	9.40
	2%	1	6.05	3.50	3	117	1100	92	60	8.20	6.2	0.70	19.9	9.40	17.4	8.20
		2	5.50	3.13	3.6	110	800	89	50	7.10	5.3	0.62	18.28	8.20	16.0	7.10

Cont. Table4.

Treatments			T.N	T.P	Cd	B	Cr	Fe	Mn	Ni	Sr	Zn	Cu	As	Ti	Co	Pb
Natural ores	Dose (%)	Shaking time (h)	mg l-1														
Zeolite	1%	1	14.0	0.622	0.050	1.390	1.20	7.50	11.60	0.320	0.60	2.10	6.00	0.090	1.85	0.00	0.99
		2	13.2	0.600	0.048	1.30	1.18	7.45	11.45	0.300	0.58	2.00	5.6	0.080	1.82	0.00	0.92
	2%	1	12.0	0.570	0.04	1.28	1.16	7.32	11.3	0.29	0.54	1.95	5.4	0.05	1.80	0.00	0.90

					5				0	8				0			
		2	9.80	0.460	0.030	1.10	1.12	7.00	11.11	0.282	0.52	1.82	4.8	0.008	1.73	0.00	0.80
Activate charcoal	1%	1	11.0	0.520	0.040	1.20	1.14	7.21	11.15	0.290	0.54	1.90	5.1	0.020	1.78	0.00	0.84
		2	8.80	0.400	0.020	0.95	1.08	6.80	10.8	0.270	0.50	1.74	4.6	0.004	1.68	0.00	0.71
	2%	1	7.6	0.320	0.015	0.75	1.06	6.50	10.6	0.230	0.46	1.70	4.2	0.001	1.61	0.00	0.54
		2	5.00	0.200	0.010	0.45	1.02	6.10	10.3	0.200	0.40	1.60	3.6	0.000	1.50	0.00	0.25

Cont. Table4.

Treatments			**Percentage reduction (removal efficiency),%**														
Natural ores	**Dose (%)**	**Shaking time (h)**	**EC, dSm^{-1}**	**TSS**	**TDS**	**T.N**	**T.P**	**B**	**Cr**	**Fe**	**Mn**	**Ni**	**Sr**	**Zn**	**As**	**Ti**	**Pb**
Zeolite	1%	1	3.3	79.3	70.5	0.7	8.79	1.27	0.332	2.6	0.30	7.2	10.31	4.109	10	2.42	5.081
		2	5.9	80.9	71.2	6.3	12.02	7.67	1.993	3.3	1.5	13.0	13.30	8.675	20	4.00	11.79
	2%	1	8.6	81.7	72.3	14.8	16.42	9.09	3.654	5.0	2.8	13.6	19.28	10.95	50	5.06	13.71
		2	13.9	84.0	75.4	30.4	32.55	21.87	6.976	9.1	4.5	18.2	22.27	16.89	92	8.75	23.29
Activate charcoal	1%	1	10.7	82.3	73.6	21.9	23.75	14.77	5.315	6.4	4.1	15.9	19.28	13.24	80	6.11	19.46
		2	19.1	84.2	77.6	37.5	41.34	32.52	10.29	11.7	7.1	21.7	25.26	20.54	96	11.3	31.92
	2%	1	26.3	87.3	80.9	46.0	53.07	46.73	11.96	15.6	8.9	33.3	31.24	22.37	99	15.0	48.22
		2	34.1	88.0	86.15	64.5	70.67	68.03	15.28	20.8	11.4	42.0	40.20	26.94	100	20.8	76.03

Table 5. Characteristics of disposed water of Aja Factory for the production of food (sample code, W_4) after remediation and percentage reduction of some contaminants.

Treatments			**PH**	**EC, dSm^{-1}**	**RSC**	**TSS**	**TDS**	**COD**	**BOD 5**	**Ca**	**Mg**	**K**	**Na**	**Cl**	**Co_3 + Hco_3**	**So_4**
Natural ores	**Dose (%)**	**Shaking time (h)**				**mg l^{-1}**				**mmol l^{-1}**						
Zeolite	1%	1	7.8	2.5	1.57	70	1960	80	78	6.53	5.3	1.16	12.66	7.1	13.4	5.15
		2	7.7	2.5	1.4	68	1900	76	73	6.5	5.3	1.15	12.15	6.8	13.2	5.1
	2%	1	7.5	2.4	1.5	63	1820	72	67	6.3	5.2	1.13	11.69	6.72	13	4.6
		2	7.0	2.2	1.7	49	1550	58	51	5.6	4.8	1.04	10.96	6.3	12.1	4
Activat	1%	1	7.3	2.3	1.65	56	169	66	60	6.1	5.05	1.09	11.2	6.52	12.8	4.2

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							0						8			
		2	6.5	2.1	1.7	41	1430	48	42	5.1	4.5	0.98	10.52	6	11.3	3.8
	2%	1	6.0	1.9	1.6	30	1220	36	31	4.5	4.2	0.75	9.95	5.5	10.3	3.6
		2	5.4	1.7	1.7	19	1010	23	19	3.9	3.6	0.6	9.2	4.8	9.2	3.3

Cont. Table 5.

Treatments			T.N	T.P	Cd	B	Cr	Fe	Mn	Ni	Sr	Zn	Cu	As	Ti	Co	Pb
Natural ores	Dose (%)	Shaking time (h)	mg l^{-1}														
Zeolite	1%	1	80.50	6.76	0.001	0.300	0.005	0.220	0.200	0.02	0.045	0.020	0.061	0.008	9.00	0.00	0.300
		2	79.60	6.50	0.000	0.259	0.003	0.200	0.19	0.01	0.030	0.010	0.040	0.000	8.8	0.00	0.295
	2%	1	75.8	6.42	0.000	0.220	0.000	0.139	0.15	0.000	0.015	0.005	0.030	0.000	8.4	0.00	0.272
		2	68.3	5.86	0.000	0.150	0.000	0.051	0.090	0.000	0.000	0.000	0.009	0.000	7.2	0.00	0.200
Activate charcoal	1%	1	72.3	6.15	0.000	0.200	0.000	0.092	0.12	0.000	0.000	0.000	0.004	0.000	8.0	0.00	0.215
		2	60.0	5.23	0.000	0.100	0.000	0.022	0.05	0.000	0.000	0.000	0.000	0.000	6.0	0.00	0.150
	2%	1	49.6	4.50	0.000	0.090	0.000	0.000	0.02	0.000	0.000	0.000	0.000	0.000	4.9	0.00	0.130
		2	38.5	3.20	0.000	0.030	0.000	0.000	0.01	0.000	0.000	0.000	0.000	0.000	3.9	0.00	0.100

Cont. Table 5.

Treatments			Percentage reduction (removal efficiency),%														
Natural ores	Dose (%)	Shaking time (h)	EC, dSm^{-1}	TSS	TDS	T.N	T.P	B	Cr	Fe	Mn	Ni	Sr	Zn	As	Ti	Pb
Zeolite	1%	1	6.3	88.4	69.84	0.49	0.04	3.84	37.5	16.66	1.960	4.76	40	52.38	50	9.54	17.5
		2	6.3	88.7	70.76	1.60	3.80	16.9	62.5	24.24	6.862	52.3	60	76.19	100	11.5	18.9
	2%	1	10.1	89.6	72.00	6.30	5.07	29.4	100	47.34	26.47	100	80	88.09	100	15.5	25.2
		2	17.6	91.9	76.15	15.5	13.35	51.9	100	80.68	55.88	100	100	100	100	27.6	45.0
Activate charcoal	1%	1	13.8	90.7	74.00	10.6	9.06	35.8	100	65.15	41.17	100	100	100	100	19.5	40.9
		2	21.3	93.2	78.00	25.8	22.66	67.9	100	91.66	75.49	100	100	100	100	39.6	58.7
	2%	1	28.8	95.0	81.23	38.6	33.46	71.1	100	100	90.19	100	100	100	100	50.7	64.2
		2	36.3	96.8	84.4	52.4	52.68	90.3	100	100	95.0	100	100	100	100	60.	72.5

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Table 6. Characteristics of industrial wastewater discharged from Sandoub Oil and Soap Factory(sample code, **W_5**)after remediation and percentage reduction of some contaminants.

Treatments			PH	EC, dS m^{-1}	RSC	TSS	TDS	COD	BOD 5	Ca	Mg	K	Na	Cl	Co_3 + Hco_3	So_4
Natural ores	Dose (%)	Shaking time (h)				mg l^{-1}				mmol l^{-1}						
Zeolite	1%	1	12.0	8.30	2.05	3051.0	18800	1357	880	16	14.95	20.75	31.62	37	33	13.32
		2	11.8	8.16	2.06	3005.7	18400	1300	850	15.68	14.6	20.33	31.04	36.26	32.34	13.05
	2%	1	11.5	7.82	2	2979.9	13520	1190	760	15.21	14.16	18.3	30.53	35.17	31.37	11.66
		2	10.9	6.90	1.76	2288.2	11280	1138	744	13.44	12.51	16.17	26.88	31.07	27.71	10.22
Activate charcoal	1%	1	11.3	7.42	1.9	2954.0	12040	1145	751	14.45	13.45	17.39	28.95	33.41	29.8	11.03
		2	10.7	6.36	1.6	2798.9	11120	1135	740	12.23	11.38	14.71	25.34	28.27	25.21	10.18
	2%	1	10.6	5.72	1.44	2650.2	10960	1005	655	11.01	10.24	13.24	22.8	25.44	22.69	9.16
		2	10.4	5.04	1.269	2243.0	9680	998	650	9.69	9.011	11.65	20.07	22.39	19.97	8.06

Cont. Table 6.

Treatments			T.N	T.P	Cd	B	Cr	Fe	Mn	Ni	Sr	Zn	Cu	As	Ti	Co	Pb
Natural ores	Dose (%)	Shaking time (h)	mg l^{-1}														
Zeolite	1%	1	63.6	489.1	0.24	9.20	11.63	53.20	2.06	7.88	2.17	4.7	6.9	0.031	379.4	0.25	3.6
		2	57.8	459.8	0.22	8.60	10.93	50.00	1.94	7.40	2.01	4.45	6.4	0.029	356.7	0.23	3.4
	2%	1	57.23	432.2	0.21	8.12	10.30	46.98	1.82	6.96	1.89	4.18	5.9	0.020	335.3	0.22	3.20
		2	44.50	342.3	0.16	6.40	8.18	37.20	1.40	5.50	1.49	3.36	4.6	0.015	265.5	0.17	2.50
Activate charcoal	1%	1	51.64	388.9	0.19	7.30	9.27	42.28	1.60	6.28	1.70	3.76	5.3	0.018	301.7	0.19	2.88
		2	32.49	256.7	0.12	4.82	6.50	27.90	1.081	4.20	1.12	2.49	3.5	0.011	199.1	0.13	1.90
	2%	1	24.90	187.4	0.09	3.52	4.48	20.37	0.78	3.05	0.82	1.86	2.8	0.008	145.3	0.09	1.37
		2	21.55	149.9	0.05	2.81	3.62	16.29	0.63	2.42	0.66	1.46	2.0	0.000	116.3	0.07	1.11

Cont. Table 6.

Treatments			Percentage reduction (removal efficiency),%														
Natural ores	Dose (%)	Shaking time (h)	EC, dSm^{-1}	TSS	TDS	T.N	T.P	B	Cr	Fe	Mn	Ni	Sr	Zn	As	Ti	Pb
Zeolite	1%	1	4.3	40.4	1.0	3.048	3.00	2.85	3.01	2.95	3.05	2.94	1.80	3.68	3.125	3.02	3.846
		2	5.9	41.2	3.1	11.89	8.81	9.18	8.84	8.79	8.70	8.85	9.04	8.81	9.375	8.82	9.188
	2%	1	9.8	41.7	28.8	12.75	14.28	14.25	14.10	14.30	14.35	14.27	14.47	14.34	37.5	14.2	14.52
		2	20.4	55.3	40.6	32.16	32.11	32.41	31.78	32.14	34.11	32.25	32.57	31.14	53.12	32.1	33.22
Activate charcoal	1%	1	14.4	42.2	36.5	21.28	22.87	22.91	22.69	22.87	24.70	22.65	23.07	22.95	43.75	22.8	23.07
		2	26.6	45.3	41.4	50.47	49.09	49.10	45.79	49.10	49.12	48.26	49.32	48.97	65.62	49.1	49.25
	2%	1	34.0	48.2	42.2	62.04	62.83	62.82	62.63	62.84	63.29	62.43	62.89	61.88	75.0	62.8	63.40
		2	41.9	56.1	49.02	67.14	70.27	70.32	69.81	70.28	70.35	70.19	70.13	70.08	100	70.2	70.35

Conclusion

This research presents an effective approach for contaminants removal in aqueous environments using natural ores. It was found that using activated charcoal and zeolite materials have a high capacity for the treatment of wastewater, which has high concentrations of heavy metals and other contaminants; this ability increases with increasing the amount used from both activated charcoal and zeolite and shaking time, moreover the ability of activated charcoal in removing is more than zeolite.

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