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Bio-sorption of uranium by saragassum detifolium from the trachytic sills of Wadi El Atshan area, central eastern desert, Egypt

Bio-sorption of uranium by saragassum detifolium from the trachytic sills of Wadi El Atshan area, central eastern desert, Egypt

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Abstract In wadi El Atshan area, Central Eastern Desert of Egypt, the main rock types exposed in that area are the older granites, Hammamat sedimentary rocks, younger granites, trachytic sills and dikes. The Field studies and radiometric survey indicate that the trachytic sills are the main rock type in the investigated area which contain secondary uranium minerals. Sargassum detifolium is used to capture uranium from the trachytic sills. The analysis indicates that this alga absorbs the uranium content by 100% in two samples where happened in the other samples as well as, it changes the chemical composition of some minerals content, while some elements changed while other elements are decreased, Sargassum detifolium has the ability to biosorbe uranium content about 75% as in uranotile mineral {CaU2 $(SiO_4)_2(OH)_6.3H_2O$}.
Keyword: *Sargassum* detifolium, trachytic rocks, uranium.

1. Introduction:

From all microorganisms algae are cheap and efficient there for many researches use it in Bio-sorption of metal which occurs by ion exchange method on the cell surface. Absorption of some metals like La, Cd, and Pb by algae is listed in table 1.

Table 1. Bio-sorption uptake by different types of Algal species.

References	Bio-sorption capacity (mg/g)	Algal species	Metal removed
(5)	140	Spirogyra sp.	Pb
(4)	34.10	Sargassum Detofiulum	Zn
(1)	181.82	Ulva lactuca sp.	Pb
(6)	84.7	Sargassum sp.	Cd
(2)	67.93	Spirulina platensis	Cu
(11)	80.47	Sargassum Detofiulum	La
(11)	84.6	Sargassum Detofiulum	Ce
(11)	86.6	Sargassum Detofiulum	Pr
(11)	86	Sargassum Detofiulum	Nd
(11)	88.7	Sargassum Detofiulum	Sm
(11)	70	Sargassum Detofiulum	Eu
(11)	77.4	Sargassum Detofiulum	Gd
(11)	77.1	Sargassum Detofiulum	Tb
(11)	72.9	Ulva lactuca	La

Bio-sorption by algae requires high metal uptake. The most effective and promising for bio sorption is the brown algae. This behavior is due to its basic biochemical constitution which responsible for the high performance. It is proven that the properties of their cell wall constituents are responsible for metal uptake. Bio-sorption of the metallic cations occurs essentially on the surface of the algal cell wall. There are many chemical groups involved in metallic cation bio-sorption like sulfhydryl, amino, Carboxyl and sulfonate. These groups are part of the algal cell wall structural polymers namely, polysaccharides (alginic acid, sulfated polysaccharides), proteins, and peptide-glycans. Ion exchange is one of the main bio-sorption mechanisms for metal uptake by algae. However other binding mechanisms like micro-precipitation and complexation are also involved in the process of metal uptake [3].

2. General Geology:

El- Atshan area occurs within the central part of the Eastern Desert of Egypt, covering about 120 km^2 of crystalline basement rocks (Fig. 1). It is covered by moderate to low elevated hills of rugged topography, the area mainly includes Hammamat sedimentary rocks that are intruded by syn- and late tectonic Older and Younger granites. All rocks are dissected and traversed by numerous post-orogenic trachyte dykes and sills figure1.

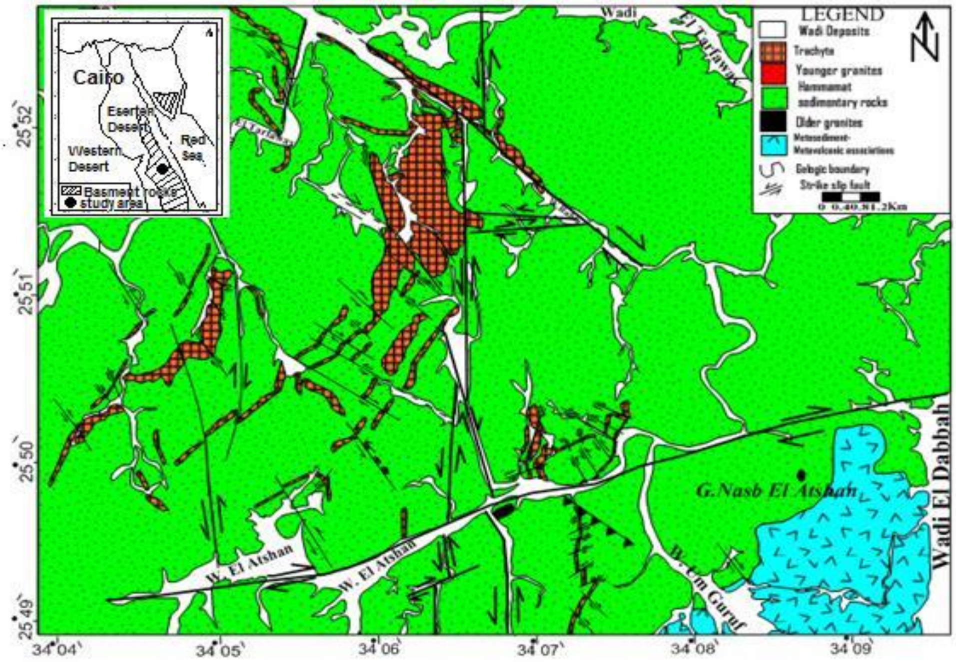

Figure 1. Geological map of El- Atshan area, Central Eastern Desert, Egypt.(Scale 1:40,000). Showing location of study area (after 10)

3. Materials and methods

3.1. Preparation of algal biomass:

Samples of Sargassum *detifolium w*as collected from the beaches of Hurghada. The biomass was washed extensively with de-ionized (DI) water and then dried in oven at 50 °C for 24 hr. The dried biomass was then grounded using blender and sieved subsequently to obtain particles size in the range of 0.85-1mm.

The Bio-sorption experiments were conducted in 250 ml Erlenmeyer flask where 0.5g dry weight of Sargassum detifolium was added with trachyte of El-Atshan samples as outlined in the work of [7]. The flasks were placed on a shaker with constant shaking for 100 rpm, then they were incubated at 30 ºC for 5 days. With variable uranium concentrations, the algal biomass were washed several time to remove any sample particles and then examined using (ESEM) and chemically treated by 0.1N Hcl remove Uranium from the biomass, The samples were examined under Infrared Spectroscopy (IR) using the model Naxux 670 FTIR, in the Central National Research (CNR), Environmental scanning electron microscope (ESEM), field imission gun (FIG) in the Central National Research (CNR) and U measured by Flame Atomic Absorption Spectrometry (FAAS), UNICAM in NMA to determine the Bio-sorption efficiency.

Table 2. Ranges of gamma ray's radioactivity of the different rock types exposed at El-Atshan area.

Field measurements (ppm)			Rock Type
Min.	Max.	Av.	
130	3200	1640	Anomalous trachyte
41	85	63	Trachyte
100	135	117.5	Younger Granite
55	980	517.5	Normal Hammamat sedimentary rocks
15	30	22.5	Hammamat sedimentary rocks
30	62	46	Older Granite

Min. = minimum Max. = maximum Av. = Average

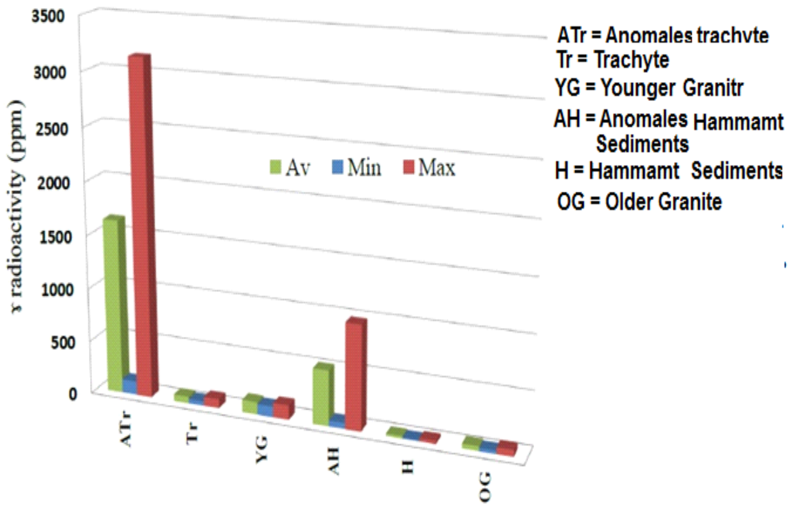

Figure 2. Histogram showing the distribution of normal gamma rays radioactivity in different rock types exposed at El-Atshan area.

4. Bio-sorption of uranium from trachyte of El-Atshan area

Sargassum detifolium has high capacity for Bio-sorption [12; 14; 15; 16; 17]. Further studies of this biosorbent revealed that the ion-exchange nature of the high metal uptakes by Sargassum, for example, of cadmium [14; 15; 16], chromium [8], copper/lead [9] and uranium [14]. Sargassum contains high amounts of alginate, well locked within its cellular structures, with abundant carboxylic groups capable of capturing cations present in solution. It is especially the Glucuronic acid in alginate that offers these functional groups [13] for ion exchange. Because the alginate matrix is present as a gel phase, this material is well penetrable for tiny metallic cations making it thus an acceptable biosorbent with a high sorption potential [11].

5. Discussion and Result:

5.1. Chemical Analysis

Selected samples from EL Atshan area were chosen to carry out treatment of up taking uranium from them. *Sargassum detifolium* were used for this work and lead to decreasing of uranium content in samples shown in table 3, materials and method previously mentioned in the chapter of introduction. The results of chemical analysis for uranium after the action of Sargassum detifolium are given on table 3 the results will be discussed on basis of category of the sample numbers as will be mentioned here.

5.1.1 Sargassum Detifolium:

Sargassum has high capacity for Bio-sorption [12; 14; 15; 17]. Further studies of this biosorbent revealed the ion-exchange nature and the high metal uptakes by *Sargassum*, for example, uranium [14] Chemical analysis for uranium after the action of *Sargassum* detifolium on the fourteen samples gave highest retention effect for uranium in samples A11, A14 and A40. the original uranium content in the three samples was (2002,2002& 2402 ppm) respectively *Sargassum* show higher adsorption in samples A11 than A40 and finally sample A14 (96%, 95% & 87%) while samples A12 (250ppm), A97 (200ppm), A26 (150ppm) and A13 (125ppm) they show moderate concentration of uranium action of *Sargassum* on them verified that it take 78% of the uranium content in samples (A12 , A13, A26 and A99) as shown in figure 3 and table 3. Samples A38, A99and A60 show the same content of uranium (100 ppm). The ability of adsorbing of uranium in the three previous samples are different from A38 which show the maximum adsorption by Sargassum detifolium about 93% while in sample A60 take 75% of uranium and the lowest one is sample A99 about 69%. The content of uranium in samples A15 and A61 is about 75 ppm and 74 ppm respectively. Sargassum take 93% of uranium in the two samples. Finally, the uranium content both in samples A29 and A100 Sargassum was decreased to zero.

Table 3. Chemical analysis of U (ppm) data for El-Atshan samples after treatment by Sargassum detifolium.

Sample number	U (ppm) in mother sample	U (ppm) after treatment by Sargassum
A11	2002	75
A12	250	55
A13	125	27
A14	2002	255
A15	75	5
A26	150	34
A29	25	0
A38	100	7
A40	2402	105
A60	100	25
A61	74	5
A97	200	43
A99	100	31
A100	50	0

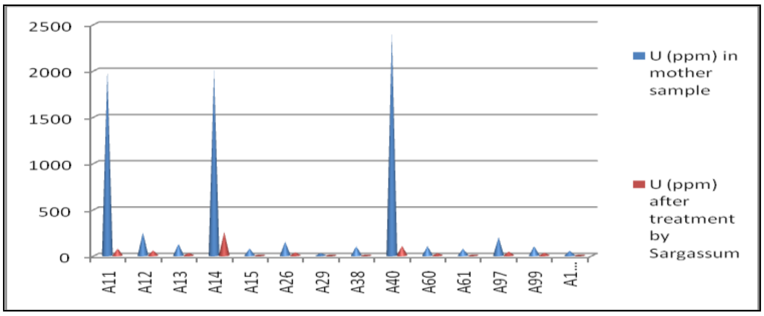

Figure 3. Chemical analysis of U (ppm) data for El-Atshan samples after treatment by *Sargassum detifolium.*

5.2 IR Analysis

IR analysis for, *Sargassum detifolium* before and after treatment in figures 4- to14 gave the characteristic wavelength for sample A11 show different functional group NH , CH aliphatic , , coupling amide and C-O-C after treatment NH, , coupling amide disappeared with the appearance of C=C, OH and CO amide as shown in figure 4 sample A12 treated with Sargassum show OH ,coupling amide , SO_2 and C-O-C after treatment coupling amide and SO_2 disappeared with the appearance of NH,CH aliphatic, , C=C and CO amide as shown in figure 5 sample A14 treated with *Sargassum detifolium* was mention with high amount of uranium show the presence of NH, coupling amide and C-O-C after treatment NH and coupling amide disappeared with the appearance of OH, C=C, CO amide and SO_2 as shown in figure 6. Sample A15 and A29 functional group before treatment with Sargassum detifolium are OH, NH, C=C and C-O-C after treatment NH, C=C disappeared with the appearance of CO amide as seen in figures 7and 8. Sample A38 show the presence of OH , CH aliphatic , , coupling amide and C-O-C after treatment coupling amide disappeared with the appearance of C=C, SO_2, CO amide as seen in figure 9, sample A40 show NH, OH, ,C=c, coupling amide and C-O-C after treatment coupling amide disappeared with the appearance of CH aliphatic , SO_2 and CO amide , CH aliphatic , SO_2 and CO amide as show in figure (10) , sample A60 show the appearance of NH, CH aliphatic , ,CO amide , SO_2 and C-O-C after treatment NH, CO amide , SO_2 disappeared with the appearance of OH and coupling amide as seen in figure 11, sample A61 treated with *Sargassum detifolium* show the presence of OH, ,C=C, CO amide and C-O-C after treatment OH, C=C and CO amide disappeared with the appearance of CH aliphatic , NH and coupling amide as seen in figure 12. Finally, samples A99 and A100 show the appearance of OH, CH aliphatic, coupling amide and C-O-C after treatment NH appeared as shown in figures 13 and 14 respectively.

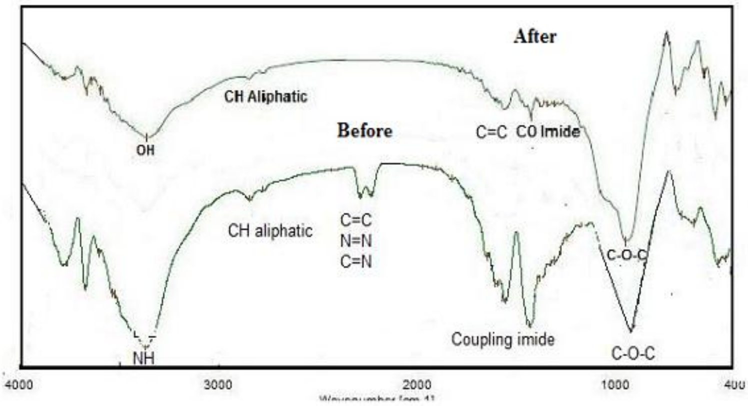

Figure 4. IR analysis data for sample A11 before and after treatment with Sargassum detifolium

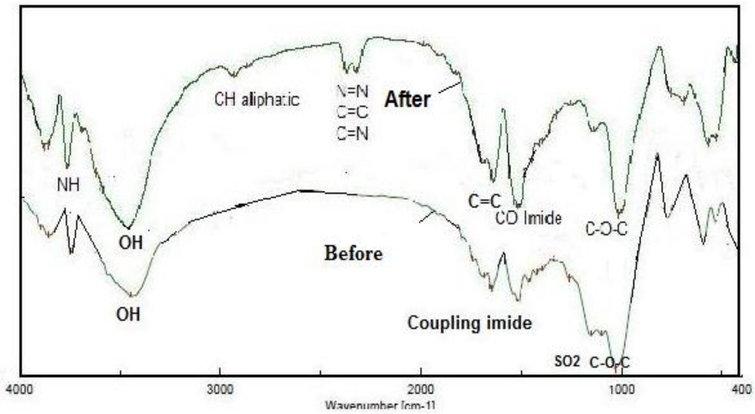

Figure 5. IR analysis data for sample A12 before and after treatment with Sargassum detifolium

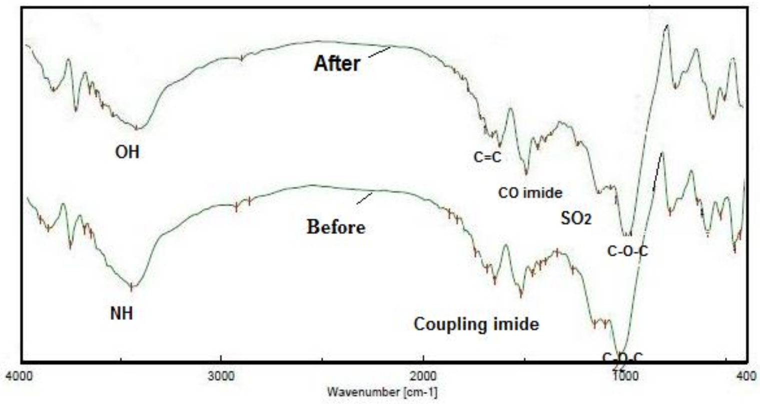

Figure 6. IR analysis data for sample A14 before and after treatment with Sargassum detifolium

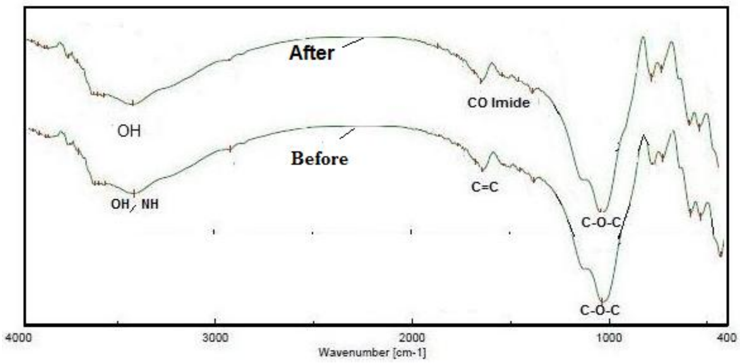

Figure 7. IR analysis data for sample A15 before and after treatment with *Sargassum detifolium*

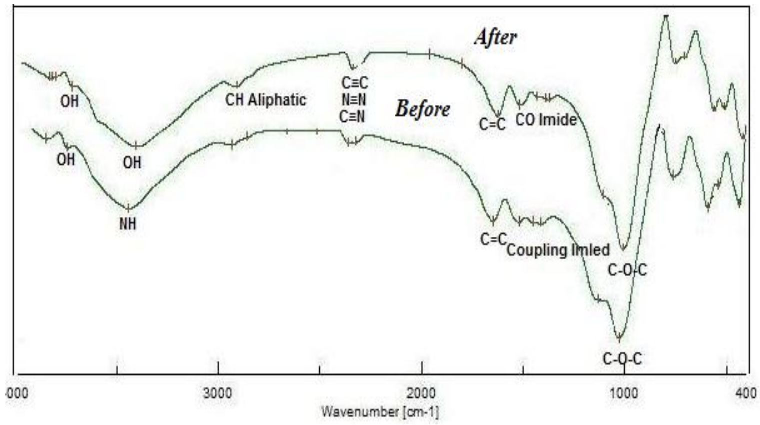

Figure 8. IR analysis data for sample A38 before and after treatment with Sargassum detifolium

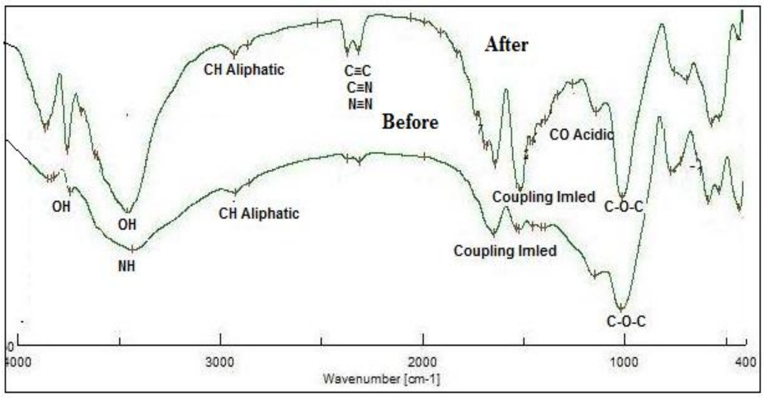

Figure 9. IR analysis data for sample A29 before and after treatment with Sargassum detifolium

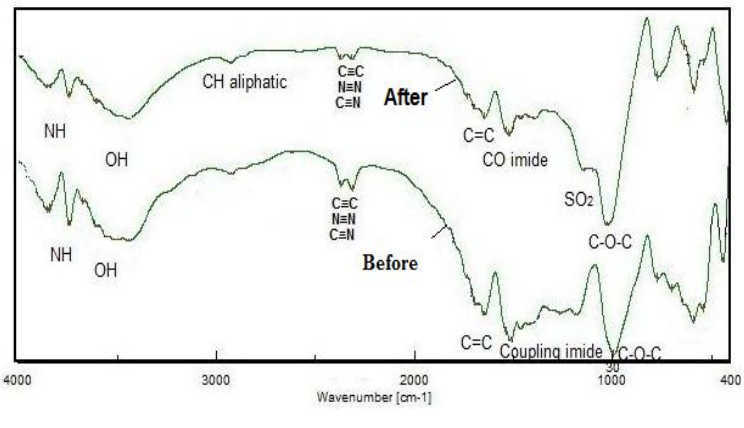

Figure 10. IR analysis data for sample A40 before and after treatment with *Sargassum detifolium*

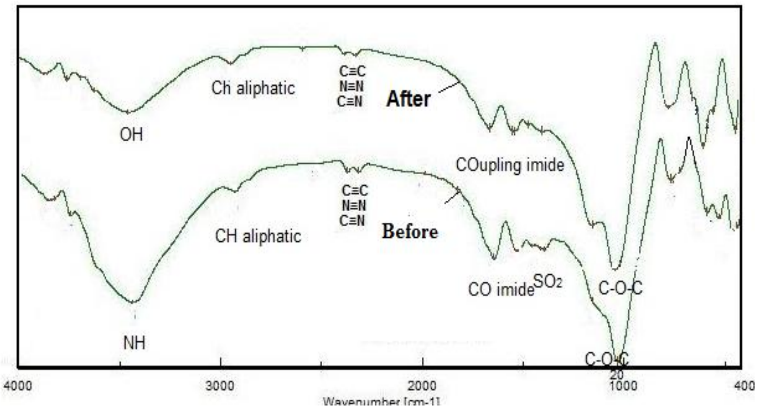

Figure11. IR analysis data for sample A60 before and after treatment with Sargassum detifolium

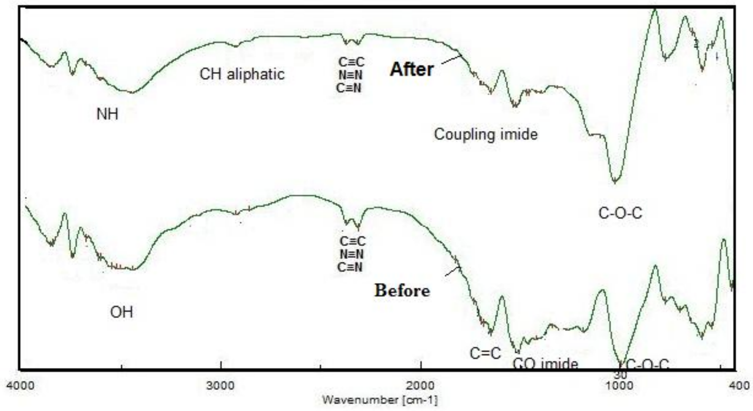

Figure 12. IR analysis data for sample A61 before and after treatment with Sargassum detifolium

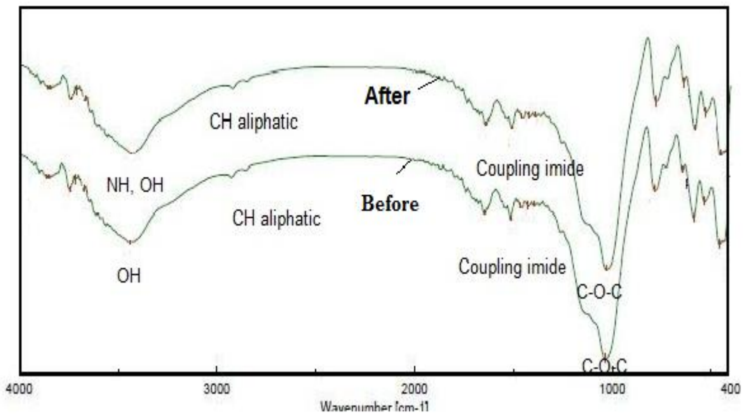

Figure 13. IR analysis data for sample A99 before and after treatment with Sargassum detifolium

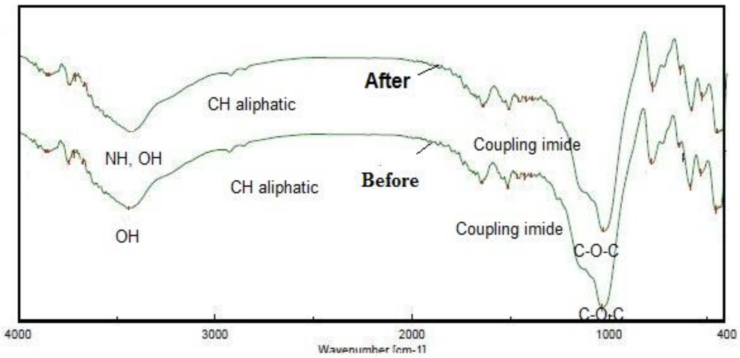

Figure 14. IR analysis data for sample A100 before and after treatment with Sargassum detifolium

5.3. Field Emission Gun (FIG) data analysis

The Environmental Scanning Electron Microscopy (ESEM) model (FIG) gave the *Sargassum* change in the chemical composition of the mineral content; some elements disappeared or decreased while other elements increased.

Uranotile $\{CaU_2(SiO_4)_2(OH)_6.3H_2O\}$ with bright color figure 15 and EDX figure 16 show U concentration of (61.8%) before treatment with Sargassum detifolium and after treatment the bright color disappear figure17, and the U content decreased to 15.55% figure18.

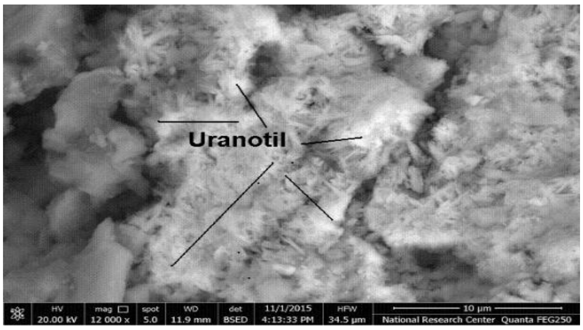

Figure 15. FIG image showing uranotile mineral before treatment by Sargassum

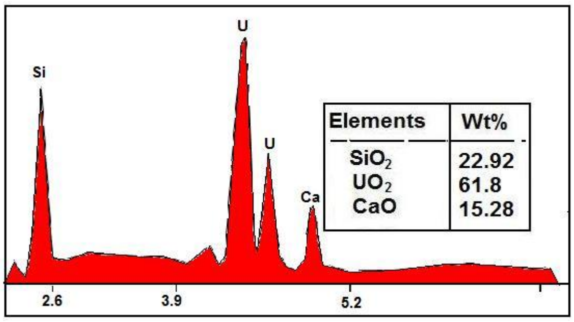

Figure 16. EDX chart for uranotile before treatment by Sargassum detifolium

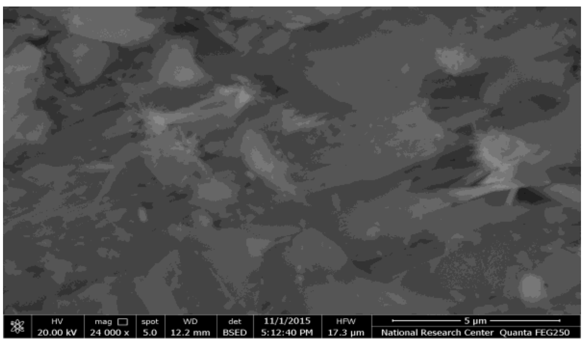

Figure 17. FIG image showing disappear bright color (uranotile) after treatment

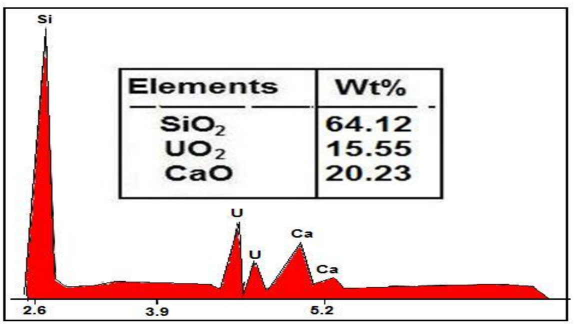

Figure 18. EDX chart for uranotile showing decreasing of UO_2after

6. Conclusion

Sargassum detifolium has been known for its high cation sorption as shown in the uranium mineralized samples in trachytic rocks from wadi El Atshan area, this area is characterized by its high U of secondary uranium mineralization such as uranophane and uranotile.

Chemical analysis of the fourteen samples gave highest retention effect for uranium in samples (A11,A14,A15,A38 and A40) uranium content Bio-sorption reach to (96%, 95%,93%,93% & 87%) respectively, while samples (A12 , A97 , A26 and A13) they show moderate Bio-sorption by Sargassum detifolium about 78% of the uranium content in the four samples , A60 sample show low Bio-sorption capacity about 75% . on the other hand, samples A29 and A100 show vanishing of the uranium content by Sargassum detifolium.

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Acknowledgment
The authors are grateful to NMA , Egypt to the facilities in laboratory services for this research work.