Removal of dissolved Chromium (VI) by adsorption onto Elaeagnus angustifolia fruit charcoal, Jujube fruit charcoal and comparison with Granular Activated Carbon (GAC)

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Abstract
Chromium (Cr) is one of the elements presents in crust of the earth. Due to its toxicity, chromium is considered as water contaminant that may disturb metabolic activity. In the present study, adsorption of dissolved Chromium (VI) onto Elaeagnus angustifolia fruit charcoal, Jujube fruit charcoal and the standard granular activated carbon (GAC) has been investigated and compared. The effect of contact time, pH value, initial concentration of dissolved Chromium and amount of adsorbent on the adsorption of Cr were investigated by the mentioned adsorbents. Results showed that the adsorption process was highly dependent on pH. Maximum Cr removal was achieved when the pH of the mixture fell within 2. Adsorption test results revealed that Cr adsorption on the studied adsorbents could be better described by Longmuir isotherm. Maximum Cr removal efficiencies were obtained by Elaeagnus angustifolia fruit charcoal, Jujube fruit charcoal and GAC 1.66 mg/g, 35 mg/g, 66 mg/g. Based on Cr (VI) removal efficiency, it is concluded that jujube powder could be considered as one of the natural and inexpensive adsorbent to remove Cr (VI) from aqueous solution.

Introduction
The use of metals and chemicals in process industries has resulted in the generation of large quantities of effluent that contain high levels of toxic heavy metals. It is well known that the presence of heavy metals such as cadmium, chromium, copper, nickel and manganese has harmful effects on human physiology and other biological systems, even at low concentrations. This is because of their bioaccumulation, non-biodegradable properties and toxicities. Thus, the removal of heavy metals, such as hexavalent chromium from water has recently attracted considerable attention. The conventional technologies for the removal of heavy metal ions from aqueous solutions include chemical precipitation, ion exchange, reverse osmosis, electrochemical treatment and adsorption. A number of common adsorbents are primarily including activated carbon, carbon nanotubes, chitosan, lignocelluloses, synthetic porous inorganic materials, natural inorganic materials and so on. Conventional treatment technologies utilized in electroplating and metal finishing plants suffer from disadvantages such as high disposal and chemical costs and incomplete reduction of Cr (VI). Therefore, cost effective treatment technologies are needed to meet these requirements. Recently, a variety of low cost materials have been studied for their ability to remove Cr (VI) from aqueous solution and promising results are shown. Some of these low cost adsorbents are dead microorganisms, clay minerals, agricultural wastes, industrial wastes and etc. Many studies have been conducted on the agricultural wastes as cheap and environmentally friendly natural materials as well as on certain wastes from agricultural operations that are very abundant. Considerable attention has been devoted to the study about removal of heavy metal ions from solution by adsorption using agricultural materials such as waste wool, nut wastes, tree bark, modified cotton, sawdust, sunflower, Almond and apricot shells, groundnut shell, corn cob powder, almond green hull, coir pith and peanut husks carbon. In

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the present work, we describe the use of Elaeagnus angustifolia fruit charcoal, Jujube fruit charcoal and compression with granular activated carbon (GAC).

Materials and methods

Bio absorbent without activation has been used to remove hexavalent chromium from aqueous solution. The effects of adsorbent dose, pH, contact time and initial metal ion concentration on the adsorption capacity were investigated. The equilibrium of adsorption was modeled by using the Langmuir and Freundlich isotherms. Core samples was collected and rinsed with distilled water. Then, the samples were put in the oven at 700 ^{c} for 1 hour after the crushing of carbon burned beneath the porcelain mortar with 18 mesh sieve, and sift the remaining carbon in the grain diameter ranging from 0.5-to 1.8 millimeter. A granular activated carbon with quality laboratory (GAC) was purchased from Merck, Germany Company. All solutions were prepared from analytical grade chemicals. One mill molar of Cr (VI) stock solution was prepared by dissolving 0.1471 g of $K_2Cr_2O_7$ (from Merck) with 99% purity, by dissolving in distilled water. The pH of the solution was adjusted by using 0.1N NaOH or 0.1N HNO_3. After mixing, Cr (VI) concentrations in the solutions were determined by the standard colorimetric method using a spectrophotometer at 540 nm.

Results and discussion

Fig. 1 shows the adsorption of Cr (VI) by Elaeagnus angustifolia fruit charcoal, Jujube fruit charcoal, and granularactivated carbon as a function of time. Effect of contact time on the removal efficiency in systems was studied by changing exposure time from 10 minutes to 240 minutes. In pH = 3, amount of adsorbent 1.5gr/l and the initial concentration of hexavalent chromium 0.5 mg/l were evaluated. Contact the optimum time to measure the Elaeagnus angustifolia fruit charcoal, Jujube fruit charcoal, and granular activated carbon in 240, 210 and 150 minutes, respectively. The experimental data indicate that Cr (VI) ion adsorption increases by increasing time.

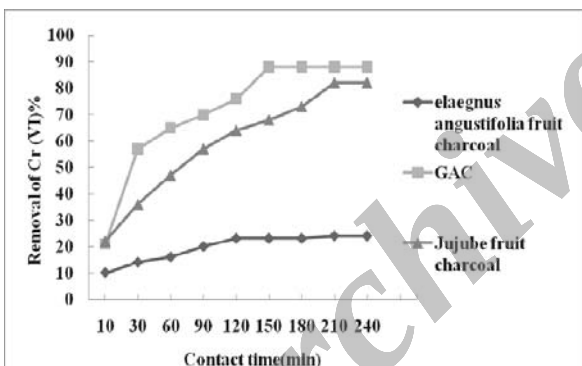

Fig 1. The effect of contact time on Cr (VI) removal

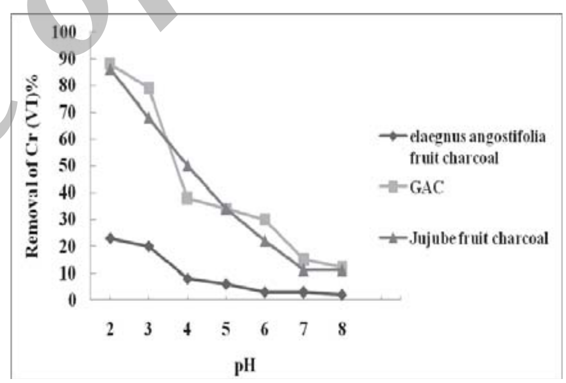

Fig 2: The effect of solution pH on Cr (VI)

Earlier studies have dempnstrated that solution pH is an important parameter influencing the biosorption of metal ions. Fig. 2 illustrates the removal of Cr (VI) versus the pH at a constant Cr (VI) concentration of 0.5 mg/L, adsorbent concentration of 1.5 g/L and contact time of 240 min for Elaeagnus angustifolia fruit charcoal, 210 min for Jujube fruit charcoal and 150 min for GAC. It was observed that the adsorption capacity of the prepared adsorbent was highly dependent on the pH of the solution. As results show, the optimum initial pH was observed at pH 2.0.

The effect of sorbent variation on the removal of Cr (VI) ion by Elaeagnus angustifolia fruit charcoal, Jujube fruit charcoal and granular activated carbon (GAC) is represented in Fig. 3.The effect of adsorbent dose on Cr (VI) uptake was investigated by varying the adsorbent dose (0.3, 0.5, 1, 1.5, 2, 2.5 and 3 g/l) for an optimum time for any adsorbent. Experimental results showed that the percentage removal of Cr (VI) increases with the increasing amount of adsorbent up to 1.5 g/l for granular activated carbon (GAC), 2.5 g/l for Jujube fruit charcoal and 3g/l for Elaeagnus angustifolia fruit charcoal.

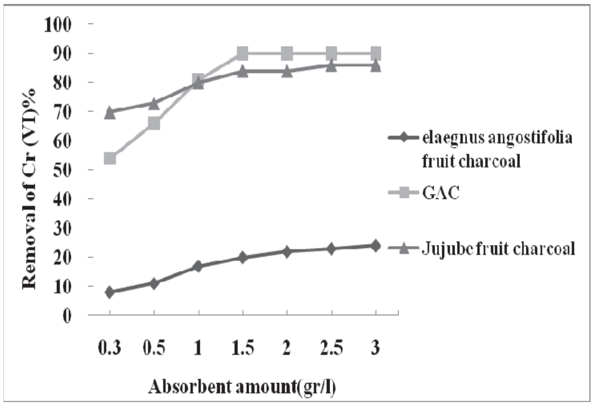

Fig3. The effect of sorbent amount on Cr (VI) removal

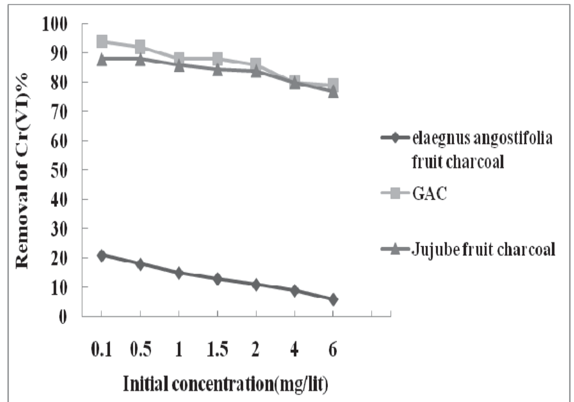

Fig4. The effect of initial concentration on Cr (VI) removal

The effect of Cr (VI) concentration on the sorbent with variation of the initial Cr (VI) concentration (0.1, 0.5, 1, 1.5, 2, 4 and 6 mg/L) in optimum value of time for any adsorbent interval is illustrated in Fig. 4. The percentage removal was decreased with increase in Cr (VI) concentration. In changing the initial concentration from 0.1 to 6 mg/l, the percentage removal decreased from 94 to 79 percent for granular activated carbon, 88 to 77 percent for Jujube fruit charcoal and 21 to 6 percent for Elaeagnus angustifolia fruit charcoal.

Conclusion:

The absorbents and adsorbents will be increased by reducing the concentration of chromium adsorption. In fact, it can be said that the difference in percentage removal of heavy metal chromium in ion concentration of the initial amount of adsorbent and contact time may be similar to the difference in chemical affinity and ion-exchange capacity, in relation to their chemical functional groups. The capacity to exchange ion on the adsorbent surface in chemical functional groups depends on time metal ion hydrolysis rates of hydrolysis and solubility.

Keywords: adsorption, Elaeagnus angustifolia fruit charcoal, granular activated carbon, Hexavalent chromium, Jujube fruit charcoal.