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*NOTE*

# Study on Binding of Ferrous Ions by Methi Stem

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•The presence of heavy metals such as $Cu^{2+}$, $Pb^{2+}$, $Cd^{2+}$, $Hg^{2+}$ and $Fe^{2+}$ in waste water has been a matter of considerable concern in recent years because of their toxic properties. There are various methods such as precipitation, adsorption, ion exchange, etc. available to remove them from the effluent but all these methods are comparatively expensive. These heavy metals can be removed by using cheap agricultural waste products. In this communication use of stem of Fenugreek Methi (*Trigonella foenum graecum*) for binding of $Fe^{2+}$ ions has been investigated. The effect of pH, temperature and contact time has been thoroughly studied.

Various researchers studied the binding properties of metal ions on cheap agricultural waste products.[1–3] Literature survey reveals that some workers used tree bark, leaves, cotton capsule shells, husk[4–5] etc. for removal of such metals.

In the present study we used agricultural waste products like methi stem which bind the iron metal ions and will help in minimizing the hazardous effect of pollution and in monitoring them in an eco-friendly manner.

Chemicals of AR grade manufactured by S.D. Fine were used without further purification. Solutions were prepared in double distilled water. Ferrous ammonium sulphate, $H_2SO_4$ and sodium acetate were prepared as described in literature.[6]

**Preparation of Substrate:** The waste stems of methi were collected locally and dried in air. They were ground and powder was obtained. 32 mL of 2N $H_2SO_4$ solution was taken in a 250 mL capacity beaker and 40 mL formaldehyde solution was added to it and stirred thoroughly. About 50 g of the powder was added to this mixture separately in small portions while stirring. The beaker containing the syrupy mass thus obtained was kept in an oven at 50°C and ground to fine powder. The substrate thus prepared was used for the present study.

**Batch experiment:** Batch adsorption was carried out by mixing 2 g of methi stem powder with aqueous solution of $Fe^{2+}$ of desired concentration at different step and pH at different intervals of time.

**Preparation of adsorption column:** 2 g of substrate was transferred to a beaker and 25 mL of distilled water was added to it. It was allowed to stand for

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15 min. The slurry was then transferred to a glass column of length 60 cm and inner diameter 1 cm which was provided with a stopper at the bottom. After the substrate settled uniformly in the column, it was washed with 25 mL of 1 : 2 HCl solution at a rate of 5 mL/min. The column was then washed free of acid using distilled water. Care was taken that sufficient quantity of distilled water is present in the column, so that no air bubbles are there in the column after the introduction of the adsorbent.

**Calibration curve:** A calibration cuve was plotted by using different concentrations of ferrous ammonium sulphate with the help of spectrophotometer[4, 7] using diphenyl carbazide as a reagent.

**Procedure:** Now 50 mL of 100 ppm metal ion solution was passed through the column for different lengths of time at different temperatures and pH. The fraction of the metal ion adsorbed was determined by the difference in the initial and final concentrations of the solution.

**Effect of contact time:** The effect of contact time on the uptake of iron from solution was studied by treating 1 g of the substrate for different lengths of time with 50 mL of iron solution.

**Effect of pH:** Adsorption was studied over a wide range of pH from 1 to 4. The contact time was kept 1 h and temperature 25°C.

**Effect of temperature:** The effect of temperature on the adsorption of iron by different substrates has been studied at 25, 40, 50 and 60°C.

| EFFECT OF CONTACT TIME | | EFFECT OF pH | | EFFECT OF TEMPERATURE | |
|---|---|---|---|---|---|
| pH | 2.4 | Contact time | 15 min | Contact time | 20 min, |
| Temperature | 25°C | Temperature | 25°C | pH | 2.4 |
| Initial conc. of $Fe^{2+}$ | 100 ppm | Initial conc. of $Fe^{2+}$ | 100 ppm | Initial conc. of $Fe^{2+}$ | 100 ppm |
| Time (min) | Adsorption Methi stem (%) | pH | Adsorption Methi stem (%) | Temperature (0°C) | Adsorption Methi stem (%) |
| 15 | 77 | 1.0 | 83 | 25 | 82 |
| 30 | 82 | 2.0 | 84 | 40 | 78 |
| 45 | 82 | 3.0 | 86 | 50 | 78 |
| 60 | 85 | 4.0 | 88 | 60 | 75 |

The calibration curve shows that the Beer-Lamberts law is valid for these concentrations of ferrous ammonium sulphate. The concentration of $Fe^{2+}$ in the effluent is determined by colorimetric method. To study the binding of $Fe^{2+}$ in the effluent by the stem of *Trigonella foenum graecum,* various parameters have to be studied. The parameters are: effect of contact time, effect of pH and temperature.

At room temperature 100 ppm solution of ferrous salt was passed through the column containing the powder of methi stem. It was observed that 77% adsorption takes place after 15 min. After 30 min the adsorption slightly increased up to 82% and at about 1 h the adsorption was found to be 85% and then it became constant.

At pH 1 the binding of $Fe^{2+}$ by methi stem was 83%. As pH increases the adsorption property increases. At pH 4 the adsorption is 88% . The effect of pH

may be due to three causes: the hydrophobicity of the surfactant, the solubility of surfactant and ions of the buffer solution. Adsorption is affected by hydrophobicity since it increases accumulation of the surfactant on the particle interface. For the effect of pH only acidic medium was selected because $Fe^{2+}$ may get precipitated in alkaline medium prior to adsorption.

As temperature increases the adsorption property decreases. At 25°C it shows 82% adsorption whereas at 60°C the adsorption decreases up to 75%. This shows the exothermic nature of the process. The decrease in adsorption with rise of temperature may be due to the enhanced escaping tendency of the $Fe^{2+}$ ions from the surface of adsorbent.

## Conclusion

Methi stem (*Trigonella foenum graecum*) is an excellent adsorbent and can be used to remove $Fe^{2+}$ from waste water or from effluent. The proper pH is 4 and the suitable temperature for maximum adsorption is 25°C. The removal takes place *via* ion-exchanger process.

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