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A SYSTEMATIC APPROACH FOR THE SEPERATION OF IRON PARTICLES IN SOLUBLE STATE USING LEAF EXTRACT

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Abstract:

The discharge of waste water, which contains many minerals like iron, magnesium, zinc etc., from various foundries, steel, dyeing and chemical industries; and treatment plants have substantial effects on the environment and the agricultural lands. Among these metallic elements, iron nanoparticles (FeNPs) have promising advantage that can combat environmental pollution. The interest in nano scale zero-valent iron in environmental remediation is increasing due to the reactivity of nanoscale iron having a large surface area to volume ratio. Though various chemical methods are available for the synthesis of iron nanoparticles, the separation of iron nanoparticles by green route is encouraged as they find various applications in treating the industrial sites contaminated with chlorinated organic compounds and in preventing the ground contaminations. In this project, extracts from various leaves such as Azadirachta indica (neem), Carica papaya (papaya), Punica granatum (pomegranate), Atrocarpus altilis (jackfruit) and Mussaendaerythrophylla (bougainvillea) were used. Randomly, 0.02M ferric chloride solution was prepared as base solution. The reaction between ferric chloride solution and leaf extract have been monitored under UV - Visible spectrophotometer. The effect of various parameters i.e., Dosage, Contact time and pH on the separation of iron nanoparticles in soluble state was studied, by measuring the Absorbance values. The percentage extraction of iron achieved by each leaf extract was determined and finally a comparison among the various leaf extracts used was made and the one which gives the maximum percentage of iron extraction was found out.

Key Words: Iron Nanoparticles, Azadirachta Indica (Neem), Carica Papaya (Papaya), Punica Granatum (Pomegranate), Atrocarpus Altilis (Jackfruit), Mussaenda Erythrophylla (Bougainvillea) & Iron Extraction.

1. Introduction:

Nanotechnology can be defined as the manipulation of matter through certain chemical and physical process to create materials with the specific properties, which can be used in particular applications. In the recent years nanotechnology is fast growing as they have unique optical, thermal, electrical, chemical and physical properties. A nanoparticles can be defined as a microscopic particle with size ranging from 1-100nm.Nanoparticles have got considerable attraction due to their unusual and fascinating properties with various applications over their bulk counterparts. Use of biological organisms such as microorganisms, plants extract or plant biomass is an alternative to chemical and physical methods for the production of nanoparticles in an eco-friendly manner. Waste water effluents from different industries such as foundry ,steel and many treatment plants contain iron in them .The permissible limit of iron in water must be around 3mg/l. Discharge of iron more than the permissible limit can cause various effects on the environment and nearby agricultural lands. Though there are many chemical methods available for the separation of iron nanoparticles, green synthesis of iron nanoparticles is encouraged, as it is non-toxic to the environment.

2. Related Work:

Green synthesis has been considered as one of the promising method for synthesis of nanoparticles because of their biocompatibility, low toxicity and eco-friendly nature (Malik, P., Shankar R., Malik V., Sharma N & Mukherjee T. K., 2014). In producing nanoparticles using plant extracts, the extract is simply mixed with a solution of the metal salt at room temperature. The reaction is complete within minutes. Nanoparticles of silver, gold and many other metals have been produced this way (Li et al., 2011). Processes for making nanoparticles using plant extracts are readily scalable and less expensive (Iravani, 2011). Nanoscalematerials such as nanoadsorbents, nanocatalysts, nanofiltration, and nanobiocides such as metal and metal oxide nanoparticles are currently being employed for remediation of water and wastewater pollutants. Among these metallic nanoparticles, iron nanoparticles (FeNPs) have promising advantages that can combat environmental pollution. The interest in nanoscale zero-valent iron (nZVI) in environmental remediation is increasing due to the reactivity of nanoscale iron having a large surface area to volume ratio (Lin 2008 & Gui 2012).

3. Synthesis of Iron Nanoparticles:

The base solution of 0.02M $FeCl_3$ was prepared. 5 grams of leaves such as Mussaenda erythrophylla, Punica granatum, Carica papaya, Azadirachta indica and Atrocarpus altilis was taken and washed thoroughly using the tap water to remove the dust particles present on them. They were dried seperately and cut into fine pieces and then boiled with 150ml of distilled water at 80-90˚C for 10-15 minutes. Initially, 5ml of each leaf extract was taken and added to 50ml of 0.02M ferric chloride solution separately. The change in the colour indicates the formation of iron nano particles.

4. Fixation of Different Parameters:

The effect of various parameters such as Dosage, Contact time and pH on the separation of iron nanoparticles in soluble state were studied. Effect of dosage was studied by varying the dosage (2, 4, 6, 8, 10ml) of the leaf extracts to the $FeCl_3$ solution and their absorbance concentration was measured. Effect of contact time was studied by measuring the absorption spectra of the solution at time intervals of 10min, 20min, 40min, 1hr and 1.15hrs. Effect of pH was studied by varying the pH (2, 4, 6, 8, and 10) of ferric chloride solution. 0.1N NaOH /0.1N HCL were added to adjust the pH of the solution.

Figure 1: Mussaenda erythrophylla, Punica granatum, Carica papaya, Azadirachta indica and Atrocarpus altilis leaves

5. Characterization of Nanoparticles:

The absorption spectra of iron nanoparticles were analyzed using various parameters like dosage, contact time and pH by UV Visible Spectrophotometer in the wavelength range of 200-700nm. From the absorbance concentration, the percentage extraction of iron in soluble state was calculated separately for each leaf.

6. Results and Discussion:

The samples prepared using the ferric chloride solution of 0.02M and extracts from various leaves were tested using UV Visible spectrophotometer. Absorbance concentrations of each sample was noted separately. Among the five leaf extracts used, the one achieving maximum separation of iron nanoparticles in soluble state was found by calculating the percentage extraction. By varying each parameter separately for each leaf extracts, Azadirachta indica leaf showed the maximum extraction of 88.69% among all.

Effect of Dosage:

By varying the dosage of the leaf extracts such as 2, 4, 8, 10 and 12ml, each leaf extract was made to react with a constant amount of ferric chloride solution. By varying the dosage of leaf extract neem leaf showed the maximum extraction of 88.69% among all.

Table 1: Dosage Vs Percentage Extraction

Dosage	Percentage Extraction (%)				
	Neem	Pomegranate	Papaya	Bougainville	Jackfruit
2ml	56.25	53.4	30	8.56	9.3
4ml	69.6	34	41	11.42	6.3
6ml	59	48.4	50.5	4	7.3

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8ml	88.69	34.2	54.5	3.65	10.6
10ml	48.14	63.8	83	4.47	11.74

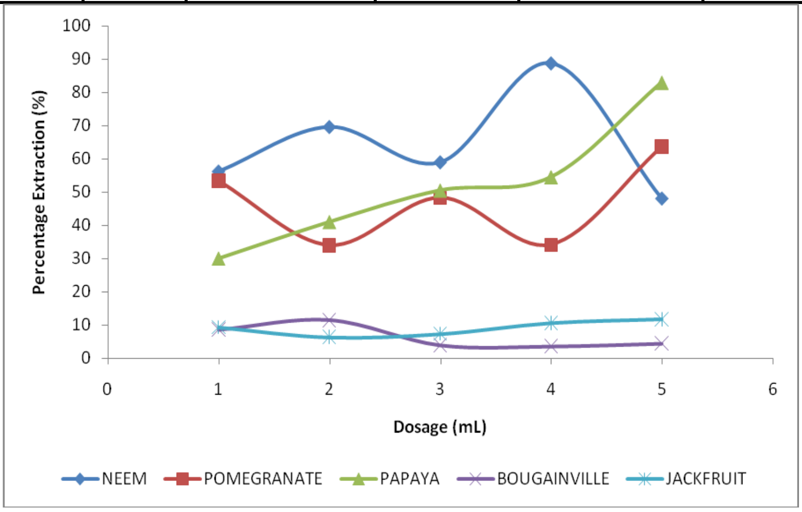

Figure 2: Variation in Dosage of leaf extract

Effect of Contact Time:

From the above study the optimum dosage of leaf extract is made to react with 50 ml of $FeCl_3$ solution and the effect of c ontact time was studied by measuring the absorption spectra of the solution at the time interval of 10 minutes, 20minutes,40 minutes 1 hour and 1.5 hours. By varying the contact time of the sample containing leaf extract and ferric chloride solution neem leaf showed the maximum extraction of 89.3% at 1.5hrs.

Table 2: Contact time Vs Percentage Extraction

Contact Time	Percentage Extraction,%				
	Neem	Pomegranate	Papaya	Bougainville	Jackfruit
10min	63.8	45	72	7	9.4
20min	78.08	52	72	9	10
40min	78.08	55	76	9	10.86
1hr	84.93	61	76	10	14.3
1.5hrs	89.3	62	80	10.3	14.3

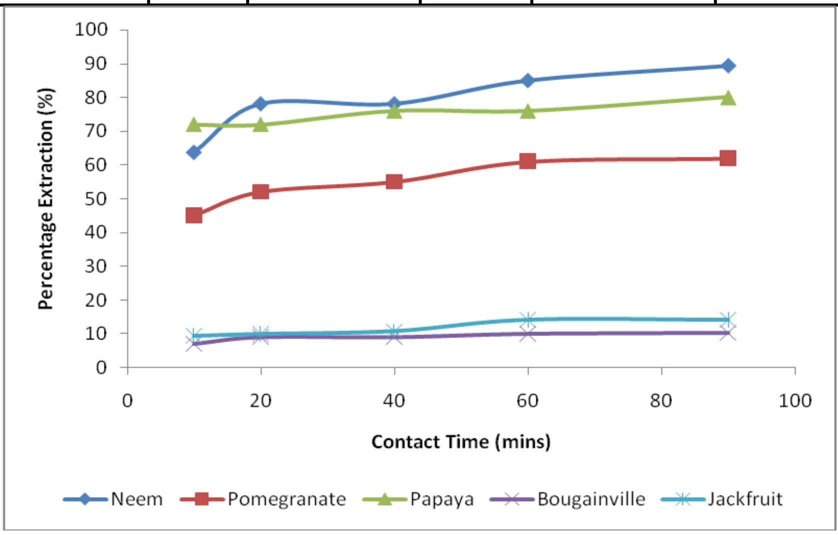

Figure 3: Variation in Contact time between Base solution and Extract

Effect of pH:

From the above study the optimum dosage and the optimum contact time for each leaf extract is taken and the pH of the $FeCl_3$solution was varied. 0.1N NaOH and 0.1N HCL is added to adjust the pH of the solution. From the variation in pH, it is incurred that the neem leaf showed the maximum extraction of 84.75% when the pH of ferric chloride was maintained at 6.

Table 3: pH vs Percentage Extraction

pH	**Percentage Extraction (%)**				
	Neem	**Pomegranate**	**Papaya**	**Bougainvillea**	**Jackfruit**
2	81.9	15	15.54	3.67	11.26

4	83.74	20.15	33.46	4.56	11.61
6	84.75	29.82	57.76	4.83	8.9
8	79.75	26.27	35.9	6.8	5.8
10	64.83	30.89	17.37	7.26	4.26

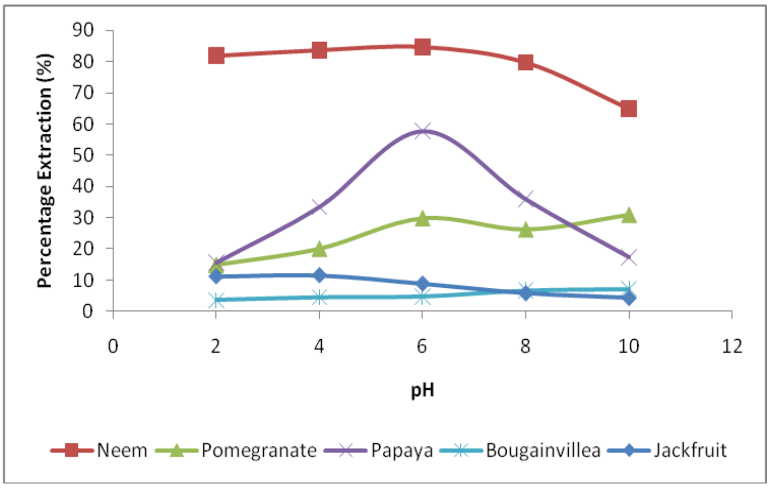

Figure 4: Variation in pH of Base Solution

7. Conclusion:

The iron nanoparticles were successfully synthesized using extracts from leaves like *Azadirachta indica (*neem*), Carica papaya (*papaya*), Punica granatum (*pomegranate*), Atrocarpus altilis (*jackfruit*) and Mussaenda erythrophylla* (bougainvillea). The absorbance concentration values have been recorded through UV Visible Spectrophotometer and the percentage extraction of iron achieved by each leaf extract was found. The UV analysis showed the absorbance spectra at 385nm. In this study the effect of various parameters such as dosage, contact time and pH on the separation of iron nanoparticles were studied. The effect of dosage on each leaf extract was studied among which the neem leaf showed the maximum extraction of about 88.69% when 8ml of its leaf extract was made to react with 50ml of ferric chloride solution. By varying the contact time of the sample solution it was observed that the contact time and the percentage extraction are directly proportional to each other. As the contact time increases the extraction percentage also increases. Lastly the attempt was made to vary the pH of the ferric chloride solution and was made to react with each leaf extracts. It was observed that the neem leaf showed the maximum percentage extraction of 84.75% when its leaf extract was made to react with ferric chloride solution of pH 6.From the overall study, the neem leaf showed the maximum extraction of iron nanoparticles in soluble state by green synthesis process.

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