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A sorption study of some metal ions on hydrogels based on Apple Pectin and Acrylamide

Lalit Kumar Guleria

Deptt. Of Chemistry, Govt. College Sarkaghat, Distt. Mandi (H.P.) - 175024INDIA
Email ID: drlalitguleria@gmail.com

ABSTRACT: The apple processing units are likely to be expanded in Himachal Pradesh in future. The industrial by-product pomace a, renewable resource plays an important role in pectin manufacture. The objective of study is the extraction of pectin from apple pomace and to develop a new polymeric backbone. Conditions for optimum yield were evaluated as function of temperature, concentration of monomer, initiator, amount of water and reaction time for pectin with Acrylamide using KPS as initiator by chemical induced method. These hydro gels were used in sorption of Cu^{2+}, Fe^{2+} and Co^{2+} metal ions. These results of ion sorption are reflected in high uptake value for Co^{2+} and Fe^{2+}.

Keywords: Apple Pomace, pectin, optimum yield hydrogels, KPS, uptake capacity.

INTRODUCTION

The removal of metal ions from the waste water of industries is one of the most important concerns for the ecologist due to limitation of conventional water treatment process. The use of hydrogels in treatment of water and the removal of the ions from water is their one of the biggest application. These smart hydrogels provide an environmental friendly, low cost effective technique than other traditional methods. Cellular Phosphate[1] Cellular Cuoxam[2] and ionomers prepared by cross-linked starch with reactive monomers[3] have been reported to remove heavy metal ions from waste water. Cellular graft copolymers of Styrene, Methacrylate, Maleic Anhydride and Acrylonitrile are used in the sorption of Fe^{2+}, Cu^{2+}, and Cr^{2+} ions[4-6]. The Pb^{2+} is absorbed by orange peels, pectin rich by product of fruit juice industry[7]. Although low chemical reactivity limits the industrial application of pectin, but when modified by grafting or by polymer analogous reactions, improves some of these limitations. The pectin interaction with heavy metals ions like Copper[8] Iron[9] and Cadmium[10] have been already be reported by Khan, Kamnev and Dronnet. In the present study attempt has been made to investigate the sorption of Cu^{2+}, Fe^{2+}, and Co^{2+} ions on Acrylamide (AAm) grafted onto apple pectin network.

MATERIAL AND METHODS

Pectin was extracted by the reflux digestion methods[11] ,and other graft network by a chemical induced method[12].Copper Sulphate (S D fine Chemicals), Ferrous Sulphate (SD fine Chemicals) and Cobaltus Chloride (Nice chemicals) were used as received. All weights were taken on the AC-200 balance having minimum readability of 1.0mg.

Sorption Studies: The hydrogels of Acrylamide with pectin were used in ion sorption studies following the earlier reported method[13].

RESULTS AND DISCUSSION

The hydro gels are water insoluble although they provide the large hydrophilic surface area for better solvent interaction. The glycolic groups of theses hydrogels or carboxylic groups of Glacturonic acid provide the binding sites with pectin polymeric frame work and hence responsible for ion exchange and metal ion sorption. The grafting is the best technique that affords the desired properties in the polymeric matrices.

Structural aspects of hydrogels and Sorption Behaviour of Cu^{2+} ion: The Sorption behaviour of the Cu^{2+} ion by the Apple Pectin and the Apple Pectin grafted AAm Hydrogels on different grafting percent as a function of time is presented in Table 1. From the table it is clear that with the increase in the grafting on the Apple Pectin by the AAm the uptake of the Cu^{2+} ion increases. The Cu^{2+} metal ion uptake also increases with the passage of time and after 72 hours the metal ion uptake start decreasing in Apple Pectin and in the low grafted Apple Pectin hydrogels, while in the higher grafted hydrogels it appears almost constant. The increase in the uptake of metal ions takes place in the beginning due to the imbalance in the hydrophilic and hydrophobic forces. The increase in the uptake of the metal ion with the increase in the grafting is due to increase in the high complexing ability of the ligand attached to the parent Apple Pectin due to the grafting.

Sorption Behaviour of Fe^{2+} ion: Fe^{2+} ion sorption behaviour by Apple Pectin and the AAm grafted hydrogels is presented in the Table 2. Again the increase in the metal ion uptake has been observed as in case of the Cu^{2+} ion, but in case of the Fe^{2+} ion the uptake of the metal ion is higher than in comparison to the Cu^{2+} ion.

Sorption Behaviour of Co^{2+} ion: Sorption behaviour of the Co^{2+} ion for the Apple Pectin and the AAm grafted hydrogels is presented in the Table 3. In case of Cobalt the sorption is found to be more in all cases than for Cu^{2+} and Fe^{2+}.

Table 1: Metal ion Sorption Study for Pectin and its Graft copolymer at different Grafting (Percentage for Cu^{2+} at pH = 6.24)

S.N.	Pectin	Time (in Hr)	Cu^{2+} (g/1)	Uptake	%
	0%		(rejected)	(g/lt)	Uptake
1.	20mg	12 (0.5 day)	16.61	3.39	16.95
2.	20mg	24 (01 day)	16.40	3.60	18.00
3.	20mg	48 (02 day)	16.30	3.70	18.50
4.	20mg	72 (03 day)	16.00	4.00	20.00
5.	20mg	96 (04 day)	16.25	3.75	18.75
S.N.	**Graft Co-polymer**	**Time (in Hr)**	**Cu^{2+} (g/1)**	**Uptake**	**%**
	17%		**(rejected)**	**(g/lt)**	**Uptake**
1.	20mg	12 (0.5 day)	16.34	3.66	18.30
2.	20mg	24 (01 day)	16.33	3.67	18.35
3.	20mg	48 (02 day)	16.21	3.79	18.95
4.	20mg	72 (03 day)	16.25	3.75	18.75
5.	20mg	96 (04 day)	16.60	3.40	17.00
S.N.	**Graft Co-polymer**	**Time (in Hr)**	**Cu^{2+} (g/1)**	**Uptake**	**%**
	32%		**(rejected)**	**(g/lt)**	**Uptake**
1.	20mg	12 (0.5 day)	16.01	3.99	19.95
2.	20mg	24 (01 day)	16.20	3.80	19.00
3.	20mg	48 (02 day)	16.05	3.95	19.75
4.	20mg	72 (03 day)	15.87	4.13	20.65
5.	20mg	96 (04 day)	16.09	3.91	19.55
S.N.	**Graft Co-polymer**	**Time (in Hr)**	**Cu^{2+} (g/1)**	**Uptake**	**%**
	51%		**(rejected)**	**(g/lt)**	**Uptake**
1.	20mg	12 (0.5 day)	16.00	4.00	20.00
2.	20mg	24 (01 day)	15.92	4.08	20.40
3.	20mg	48 (02 day)	15.86	4.14	20.70
4.	20mg	72 (03 day)	15.94	4.06	20.30
5.	20mg	96 (04 day)	15.94	4.06	20.30
S.N.	**Graft Co-polymer**	**Time (in Hr)**	**Cu^{2+} (g/1)**	**Uptake**	**%**

	66%		**(rejected)**	**(g/lt)**	**Uptake**
1.	20mg	12 (0.5 day)	15.97	4.03	20.15
2.	20mg	24 (01 day)	15.89	4.11	20.55
3.	20mg	48 (02 day)	16.04	3.96	19.80
4.	20mg	72 (03 day)	15.90	4.10	20.50
5.	20mg	96 (04 day)	15.90	4.10	20.50

Table 2: Metal ion Sorption Study for Pectin and Graft copolymer at different Grafting (Percentage for Fe^{2+} at pH = 6.24)

S.N.	**Pectin**	**Time (in Hr)**	**Fe^{2+} (g/1)**	**Uptake**	**%**
	0%		**(rejected)**	**(g/lt)**	**Uptake**
1.	22.66 mg	12 (0.5 day)	17.99	4.278	19.21142
2.	22.66 mg	24 (01 day)	18.10	4.168	18.71744
3.	22.66 mg	48 (02 day)	18.01	4.258	19.12161
4.	22.66 mg	72 (03 day)	17.82	4.448	19.97485
5.	22.66 mg	96 (04 day)	18.00	4.268	19.16652
S.N.	**Graft Co-polymer**	**Time (in Hr)**	**Fe^{2+} (g/1)**	**Uptake**	**%**
	17%		**(rejected)**	**(g/lt)**	**Uptake**
1.	22.66 mg	12 (0.5 day)	17.85	4.418	19.84013
2.	22.66 mg	24 (01 day)	17.81	4.458	20.01976
3.	22.66 mg	48 (02 day)	17.755	4.518	20.28920
4.	22.66 mg	72 (03 day)	17.82	4.448	19.97485
5.	22.66 mg	96 (04 day)	18.04	4.228	18.98689
S.N.	**Graft Co-polymer**	**Time (in Hr)**	**Fe^{2+} (g/1)**	**Uptake**	**%**
	32%		**(rejected)**	**(g/lt)**	**Uptake**
1.	22.66 mg	12 (0.5 day)	17.68	4.588	20.60356
2.	22.66 mg	24 (01 day)	17.78	4.488	20.15448
3.	22.66 mg	48 (02 day)	17.78	4.488	20.15448
4.	22.66 mg	72 (03 day)	17.78	4.488	20.15448
5.	22.66 mg	96 (04 day)	17.63	4.638	20.82809
S.N.	**Graft Co-polymer**	**Time (in Hr)**	**Fe^{2+} (g/1)**	**Uptake**	**%**
	51%		**(rejected)**	**(g/lt)**	**Uptake**
1.	22.66 mg	12 (0.5 day)	17.58	4.688	21.05263
2.	22.66 mg	24 (01 day)	17.50	4.768	21.41189
3.	22.66 mg	48 (02 day)	17.44	4.828	21.68134
4.	22.66 mg	72 (03 day)	17.49	4.778	21.45680
5.	22.66 mg	96 (04 day)	17.62	4.648	20.87300
S.N.	**Graft Co-polymer**	**Time (in Hr)**	**Fe^{2+} (g/1)**	**Uptake**	**%**
	66%		**(rejected)**	**(g/lt)**	**Uptake**
1.	22.66 mg	12 (0.5 day)	17.63	4.638	20.82809
2.	22.66 mg	24 (01 day)	17.53	4.738	21.27717
3.	22.66 mg	48 (02 day)	17.63	4.638	20.82809
4.	22.66 mg	72 (03 day)	17.52	4.748	21.32208
5.	22.66 mg	96 (04 day)	17.55	4.718	21.18735

Table 3: Metal ion Sorption Study for Pectin and Graft copolymer at different Grafting (Percentage for Co^{2+} at pH = 6.24)

S.N.	Pectin	Time (in Hr)	(g/1)	Uptake	%
	0%		**(rejected)**	**(g/lt)**	**Uptake**
1.	22.55 mg	12 (0.5 day)	15.92	4.626	22.51533
2.	22.55 mg	24 (01 day)	15.80	4.746	23.09939
3.	22.55 mg	48 (02 day)	15.87	4.676	22.75869
4.	22.55 mg	72 (03 day)	15.77	4.776	23.2454
5.	22.55 mg	96 (04 day)	15.87	4.676	22.75869
S.N.	**Graft Co-polymer**	**Time (in Hr)**	**Co^{2+} (g/1)**	**Uptake**	**%**
	17%		**(rejected)**	**(g/lt)**	**Uptake**
1.	22.55 mg	12 (0.5 day)	15.76	4.786	23.29407
2.	22.55 mg	24 (01 day)	15.79	4.756	23.14806
3.	22.55 mg	48 (02 day)	15.77	4.776	23.2454
4.	22.55 mg	72 (03 day)	15.84	4.706	22.9047
5.	22.55 mg	96 (04 day)	15.63	4.916	23.9268
S.N.	**Graft Co-polymer**	**Time (in Hr)**	**Co^{2+} (g/1)**	**Uptake**	**%**
	32%		**(rejected)**	**(g/lt)**	**Uptake**
1.	22.55 mg	12 (0.5 day)	15.53	5.016	24.41351
2.	22.55 mg	24 (01 day)	15.55	4.996	24.31617
3.	22.55 mg	48 (02 day)	15.60	4.946	24.07281
4.	22.55 mg	72 (03 day)	15.70	4.846	23.5861
5.	22.55 mg	96 (04 day)	15.79	4.756	23.14806
S.N.	**Graft Co-polymer**	**Time (in Hr)**	**Co^{2+} (g/1)**	**Uptake**	**%**
	51%		**(rejected)**	**(g/lt)**	**Uptake**
1.	22.55 mg	12 (0.5 day)	15.94	4.606	22.41799
2.	22.55 mg	24 (01 day)	15.87	4.676	22.75869
3.	22.55 mg	48 (02 day)	15.67	4.876	23.73211
4.	22.55 mg	72 (03 day)	15.67	4.876	23.73211
5.	22.55 mg	96 (04 day)	15.61	4.936	24.02414
S.N.	**Graft Co-polymer**	**Time (in Hr)**	**Co^{2+} (g/1)**	**Uptake**	**%**
	66%		**(rejected)**	**(g/lt)**	**Uptake**
1.	22.55 mg	12 (0.5 day)	15.73	4.816	23.44009
2.	22.55 mg	24 (01 day)	15.73	4.816	23.44009
3.	22.55 mg	48 (02 day)	15.51	5.036	24.51085
4.	22.55 mg	72 (03 day)	15.73	4.816	23.44009
5.	22.55 mg	96 (04 day)	15.64	4.906	23.87813

CONCLUSION

From above discussion it can be concluded that these hydrogels have high retention capacity. Absorption of Fe^{2+} ions by these hydrogels is appreciable. The ion uptake is almost independent to amount of AAm incorporated and glycolic groups and glacturonic acid. Hence sorption order is $Co^{2+} > Fe^{2+} >> Cu^{2+}$.

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