BIOACCUMULATION OF FE BY FISH SCALE POWDER FROM A MINERAL INDUSTRY WASTE

Abstract

Fish scale dust had the ability to remove Fe from industry waste. Fe was absorbed by fish scales and was checked for pH, with maximum adsorption (393.61 ± 1.03 ppm) at the adsorbent dose of 5g fish scale powder found in the raw and treated effluent at pH 7. The Fe uptake was maximum at 28°C and 372.37 ± ppm of Fe adsorbed at 5g concentration and increasing temperature decreased the Fe uptake.

Keywords: Bioaccumulation, Fish scale powder, Fe uptake industry waste.

Author

S.M. Jearmeen
Department of Advanced Zoology and Biotechnology
Guru Nanak College
Chennai, Tamil Nadu, India.

I. INTRODUCTION

Heavy metals from effluents were removed using carbon or activated alumina (Ouki *et al.,* 1997; Ali *et al.,* 1998; Hsisheng and Chiento, 1998; Ralph *et al.,* 1999; Shim *et al.,* 2001; Monser and Adhoum, 2002). The biosorption of heavy metals was in wastewater treatment (Volesky, 1990).

Mustafiz *et al*., (2003) used the *Atlantic cod (Gadus morhua* L.*)* scales for removal of Cr, Pb, and As from industrial waste. eggshell and tea waste for chromium removal from wastewater samples (Katha, 2021).

In this study the fish scales helped in removal of heavy metal Fe at various parameters such as pH and temperature.

II. MATERIALS AND METHODS

1. **Preparation of Fish Scales:** Fish scales of different marine fishes were collected from the local fish market. The fish scales were then kept in a hot air oven at 70°C till they became crispy enough to grind. The dried scales were ground in an electric blender. Then the powdered samples were preserved in polythene containers for further use as biosorbent.

2. **Experimental Design:** The powdered adsorbent was mixed with the two different types of effluents (raw untreated and partially treated) in 5 different concentrations (1, 2, 3, 4 and 5 mg/l). The medium was studied at various pH levels (0.5, 2, 4, 7, 8, and 9). The lconcentrations of Fe were calculated in the two different effluents. The treatment was run for a period of one month. The Fe content of the treated effluents was estimated after 30 days of interaction with respect to the adsorbent. The difference between the initial and final metal levels indicated the quantity adsorbed.

   To estimate the effect of temperature, the reaction mixtures were allowed to interact in a 250ml Erhlen-Meyer flask. The flasks were placed inside separate incubators maintained at 42, 32, and 28°C. The experiments were done for a period of 60 days.

3. **Estimation of Heavy Metal (Fe):** The treated and untreated samples were estimated for iron using atomic absorption spectrophotometer. The model 6300 Absorption Spectrophotometer with Air-C2H2 flame type of an average fuel flow rate of between 0.8-4.0 L min-1 and the support gas flow rate between 13.5-17.5 L min-1 was used for sample analysis. The stock solution prepared a series of reference standards -1, 2, and 3 ppm for the metal. The standards were prepared by pipetting 0.1, 0.2, and 0.3 mL of the metal reference standards, made up to 100 mL, and mounted on the automatic sampler for standard calibration curve measurement.

III. RESULTS AND DISCUSSION

The maximum amount of Fe adsorbed at pH 7 was 393.61 ± 0.84 at the adsorbent dose of 5 g fish scale powder, but at 1g adsorbent, the value was 414.36 ± 0.87 ppm of Fe in the raw untreated effluent after the adsorption (Table 1).

The maximum amount of Fe adsorbed at pH 7 was 391.24 ± 0.91 ppm at 5g fish scale powder and at 1g 413.90 ± 0.82 ppm of Fe in the partially treated effluent (Table 2).

When 4g fish scale powder was used at 28°C, 382.33 ± 0.96 ppm, at 32°C, 390.25 ± 0.92 ppm, and at 42°C, 388.48 ± 1.03 ppm of Fe was found in the raw untreated effluent after adsorption. (Table 3).

Biosorption was maximum at 28°C and was 372.37 ± 0.81 ppm of Fe observed at 5g concentration of absorbent in the raw untreated effluent. Biosorption was maximum at 28°C and was 357.97 ± 0.85 ppm of Fe observed at 5g concentration of adsorbent and the minimum value was 382.47±0.52 ppm found in the partially treated effluent after adsorption by fish scale powder (Table 4).

Higher dosages of the absorbent removed more quantities of Fe compared to low dosages. But the effect of the adsorbent is more in lower dosages. Fish scale powder was also a good adsorbent of Fe. Fish scale powder was also pH sensitive, highly effective at pH 7 at 28° C.

Vera *et al.* (2021) reported that using an adsorbent derived from the *Labeo rohita* fish scales waste. Prabu *et al*. (2012) worked (fish scales of *Catla catla* Hamilton) the chromium was reduced to 2.9mg/ml from the initial *Catla catla* concentration of 50mg/1 than other doses.

Sharma and Forstner (1993) found good adsorption potential (132 mg/g)of sphagnum peat moss in removing Cr was reported at pH 1.5 to 3.0.

Amjad *et al.* (2008) pointed iron absorbed by fish scales was optimum at pH 4.8, the slow equilibration of metal ions on fish scale is probably due to the lack of accessibility of binding sites on this rigid fibrous protein sorbent. Amjad *et al.* (2008) reported that at pH 7.0 both Cd (1I) and Pb (1I) reached equilibrium in 50 minutes with 96.8 and 88.6 percent recovery with fish scales (adsorbent).

Table 1: Adsorption of Fe from raw untreated mineral industry effluent by fish scale dust (pH)

Serial No	**fish scale powder (gms)**	**Fe (ppm)**			**Fe (ppm)**			
						pH		
			0.5	**2**	**4**	**7**	**8**	**9**
1	1		430.21 ± 0 .83	428.67 ± 0 .56	425.49 0.87	414.36 + 0.87 (-8.34)*	416.45±0.97	420.39 ±0.93
2	2		426.09 ± 0.85	423.89 ± 0 .81	421.56 + 0.95	407.34 ±0.96 (-9.88)	409.73 ± 0.89	412.18 ±0.87
3	3	452.25 ± 1.02	419.54 ±0.97	415.79 ± 0.92	412.17 ±0.99	403.20 ± 0.92 (-10.79)	404.41 ± 0.62	407.23 ±0.98
4	4		414.22 ± 0 .92	413.20 ±0.63	409.25 ±0.90	398.17 ± 0.77 (-11.89)	402.40 ± 0.92	404.41 ±0.75
5	5		413.25 ± 0 .87	412.22 ± 0.87	399.85±0.87	393.61 ± 0 .84 (-12.90)	397.17± 0.83	400.24± 0.77

Note: Percent decrease in Fe concentration in parentheses
*Deviation not significant; all other deviations significant at $P \leq 0.05$ (t.test)

Table 2: Fe adsorption from partially treated mineral industry effluent by Fish scale powder

Serial No	**fish scale powder (gms)**	**Fe in the effluent (ppm)**	**Fe concentration (ppm) in effluent**					
			pH					
			0.5	**2**	**4**	**7**	**8**	**9**
1	1	434.67±1.08	427.25 ±0.93	425.48 ±0.90	424.21±0.92	413. 90 ± 0.82(4.78)*	415.99±0.98	419.63 ±0.65
2	2		425.06 ±0.84	422.21 ±1.03	418.48 +0.80	402.85 + 0.57 (7.32)*	407.20 ± 0.82	411.63 ±0.65
3	3		414.93 ±0.93	412.38 ±0.71	409.16±0.80	400.37 + 0.98 (7.89)*	403.66 + 0.76	407.37 ± 1.04
4	4		413.42 ±0.96	410.34 ±0.63	407.24 +0.87	397.53 + 0.98 (8.54)*	401.45 + 0.87	405.*83* ± 1.06
5	5		410.49 ± 0.89	409.66 + 0.85	396.38 + 1.05	391.24 + 0.91 (9.98)	396.53 + 0.88	397.*35* ± 1.01

Note: Percent decrease in Fe concentration in parentheses
*Deviations not significant: all other deviations significant at $P \leq 0.05$ (t-test)

Table 3: Adsorption of Fe from raw untreated mineral industry effluent at pH7 by fish scale powder at different temperature levels

S.No	Amount (in g) of fish scale powder	Fe (ppm)	Fe concentration (ppm) in effluent		
			Temperature (° C)		
			28	32	42
1	1	452.25 ± 1.02	398.34 ±0.91 (-11.86)	401.19 ± 0.81	403.32±0.93
2	2		386.19 ±0.80 (-15.19)	397.10 ± 0.75	398.42 ±0.82
3	3		385.87 ±0.99 (-15.27)	391.11 ±0.88	394.09 ±0.78
4	4		382.33 ± 0.96 (-16.08)	390.25 ± 0.92	388.48 ± 0.87
5	5		372.37 ± 0.81 (-17.57)	382.69 ±0.66	384.88±0.68

Note: decrease Fe concentration in parentheses
Deviations are significant at $P<0.05$(t-test).

Table 4: Adsorption of Fe from partially treated mineral industry effluent at pH7 by fish scale powder at different temperature levels

Serial. N o	Amount (in g) of fish scale powder	Fe in the effluent (ppm)	Fe concentration (ppm) in effluent		
			Temperature (° C)		
			28	32	42
1	1	434.67 ± 1.08	395.21 ±0.96 (-9.08)	398.23 ± 0.89	401.49±0.86
2	2		390.80 ±0.89 (-10.09)	395.24 ± 0.98	396.51 ±0.94
3	3		383.23 ±0.96 (-11.83)	391.01 ±0.99	394.18 ±0.95
4	4		377.05 ± 0.86 (-13.25)	389.11 ± 0.94	388.26 ± 0.91
5	5		357.97 ± 0.85 (-14.91)	379.57 ±0.95	382.47±0.52

Note: Percent decrease in Fe concentration in parentheses
Deviations are significant at $P \leq 0.05$(t-test).

REFERENCES

[1] Ali, A., Bradley, A.K. and Duong, D.D. 1998. Comparison of equilibria and kinetics of high surface area activated carbon produced from different precursors and by different chemical treatments. *Ind. Eng. Chem. Res.,* 37(4): 1329-1334.

[2] Amjad, FH., Sheikh, E. and Swileh, A.J. 2008. Sorption of trace metals on fish scales and application for lead and cadmium pre-concentration with flame atomic absorption determination. *Jordan Journal of Chemistry,* 3 (1): 87-97.

[3] Hsisheng, T. and Chiento, H. 1998. Influence of surface characteristics on liquid phase Adsorption phenol by activated carbon prepared from bituminous coal. *Ind. Eng. Chem. Res.,* 37(9): 3618-3624.

[4] Katha, P.S. 2021. Efficiency analysis of eggshell and tea waste. South African *Journal of Chemical Engineering.* 37: 186 – 195.

[5] Monser, L. and Adhoum, N. 2002. Modified activated carbon for the removal of copper, zinc, chromium, and cyanide from separation and wastewater. *Purification Technology,* 26(2-3): 137-146.

[6] Mustafiz, S., Rahman, M.S., Kelly, D., Tango, M. and Islam, M.R. 2003. Removal of Cr, Pb, and As from industrial waste using *Atlantic cod* scales. *Energy Sources,* 25: 905-916.

[7] Otokanefor, T.V. and Obiukwu, C. 2005. Impact of refinery effluent on the physic-chemical properties of a water body in the Niger Delta. *Applied Ecology and Environmental Research,* 3(1): 61-72.

[8] Prabu, Shankarlal, S. and Natarajan, E. 2012. A biosorption of heavy metal ions from aqueous solutions using a fish scale (*Catla. catla*). *World Journal of Fish and Marine Sciences,* 4(1): 73-77

[9] Ralph, T.Y., Richard, Q.L., Joel, P., Tomonori, T. and Akira, T. 1999. Adsorbents for dioxins, a new technique for sorbent screening for low-volatile organics. *Ind. Eng. Chem. Res.,* 38(7): 2726-2731.

[10] Rana, M.S., Halim, M.A., Safiullan,. and Mollah, M.M. 2009. Removal of heavy biopolymer crab shell chitosan. *Journal of Metal from contaminated water by Dipolymer of Applied Sciences,* 9 (5): 2762-2769,

[11] Sharma, D.C. and Forstner, C.F. 1993. Cr (VI) was removed by sphagnum peat moss, a good biosorbent. *Water Res.,* 27: 1201

[12] Shim, J.W., Park, S.J. and Rju, S.K. 2001. Effect of modification with HNO3 and NaOH by pitch-based activated carbon fibers. *Carbon,* 39: 11.

[13] Veera, B.M. 2021. Defluoridation of water using adsorbent. *Sustainable Chemistry and Pharmacy,* 23: 128 – 136.