CHAPTER-V

Recovery of gold

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RECOVERY OF GOLD FROM ELECTROPLATING WASTES USING EGGSHELL MEMBRANE

5.1. Introduction

According to the World Gold Council, the demand for gold has shown an increasing trend during the last decade [1]. This increase is not only due to the jewelry market, but also due to the increasing uses of gold in industrial, as well as in medical applications [2]. This has shifted attention toward the development of novel methods of gold recovery, not only from its ore, but also from industrial wastes and mine tailings. Gold recycling from scraps and leach residues has also raised much interest [3]. Several of these processes involve the use of chloride media, such as chlorine leaching [2, 3]. In addition, most of these liquors are known to be composed of complex mixtures of several metal ions. For example, gold mine tailings have been known to contain different ions such as: copper (Cu), lead (Pb), iron (Fe), and zinc (Zn), as well as calcium (Ca) and magnesium (Mg), and it is not unusual for other metal mine tailings to contain gold (Au) [4-6]. Thus, there is the need to develop an economical, efficient and environmentally safe process to recover gold from such solutions.

Hydroprocessing has been widely utilized for the recovery of gold from electronic scrap and includes (i) adsorption by ion exchange resin [7-8], (ii) solvent extraction [9-10] and (iii) gold precipitate reduced by reagents. However, these current recovery processes require much labor and time at high cost. Furthermore, a large amount of secondary wastes is generated, resulting from the addition of chemical agents for precipitation and reduction in the processes. Therefore, there is a need to develop a low-cost system, generating little secondary waste, to recover gold from scrap/wastes.

There has lately been a growing interest in biosorption, which is a property of certain types of inactive, dead, microbial biomass materials to bind and concentrate metal ions from aqueous solutions [11, 12] These biomass materials are relatively inexpensive and available in large quantities worldwide.

Earlier investigations have shown that eggshell membrane (ESM) is capable of binding various metal ions from aqueous solutions [13, 14]. The ESM (consisting of protein fibers) resides between the egg white and the inner surface of the eggshell. The ESM is an intricate lattice network of stable and water-insoluble fibers and has very high surface area with homogeneity [13, 15]. The ESM is suggested to be the part where eggshell formation occurs, and it is thought to be a model for biomineralisation [16]. Since the ESM materials are available in large quantities as a by-product of egg industry, its potential utilization as a metal biosorbent is of interest.

In this study, sorption of gold by the ESM was examined. In addition, selective gold recovery from electroplating waste solutions was investigated in a flow through sorption column and batch system.

5.2. Materials and methods

5.2.1. Preparation of ESM particles

ESM was mechanically stripped from the shell after immersion of the hen eggshell, which was obtained commercially, in 0.5M HCl overnight to form milky white colour solution and then further in 0.1 M NaOH for 1 h followed by rinsing with distilled water 10 times.

In the case of column and batch experiments, dried materials was ground in the mortar in presence of liquid nitrogen and sieved. Three different fractions were collected: fraction 1 (<425 microns), fraction 2 (<355 microns) and fraction 3 (>425microns). The dry weight samples (fraction 1-3) were used as the adsorbents.

5.2.2. Chemicals and metal solutions

The electroplating gold bath containing 700mg/l was used for the gold removal studies using ESM as the adsorbent.

5.2.3. Sorption experiments

Two approaches were made in the recovery procedure namely batch and column methods.

In the "column" procedure, the crushed ESM powder-packed mini column (diameter 1.5 cm, length 5 cm) with 425 microns particles were tried. A flow rate of 0.5 ml/min was maintained and the effluent was analyzed. The column sorption experiments were performed at 25°C.

The concentration of gold was determined by Atomic Absorption Spectrophotometer (Perkin Elmer Analyst 800).

5.3. Results and Discussion

Sorption ability of eggshell membrane (ESM) for gold has been tried through batch and column method and the results are presented in Tables

5.1-5.4. In the case of batch adsorption eggshell membrane filled to a horizontal length of 5cm with different size of ESM, around 83% gold removal is obtained with <325 microns filled ESM. However with the bigger ESM size particles the adsorption is only 72.5% and 57.15% for <425 and >425 micron particles.

Similar results with 10 cm horizontal length batch cell indicate the same trend but with more efficiency of gold removal. The results are explained in terms of increased surface area and longer contact times. Similarly the results for column method are presented in Tables 5.3 and 5.4. The column method seem to be less effective under the experimental conditions than the batch method.

Similar type of recovery process of gold from plating bath will be highly useful and can be concentrated and reused by proper incineration of the ESM [17].

Table 5.1 Effect of powdering of ESM and its particle size on the sorption of gold by batch method (5cm length)

S.No	*Particle size (microns)*	*% of removal of gold*
1	<325	83.38
2	<425	72.53
3	>425	57.15

Table 5.2 Effect of powdering of ESM and its particle size on the sorption of gold by batch method (10cm length)

S.No	Particle size (microns)	% of removal of gold
1	<325	95
2	<425	84
3	>425	63

Table 5.3 Effect of powdering of ESM and its particle size on the sorption of gold by column method (5cm length)

S.No	Particle size (microns)	% of removal of gold
1	<325	62
2	<425	50
3	>425	42

Table 5.4 Effect of powdering of ESM and its particle size on the sorption of gold by column method (10cm length)

S.No	Particle size (microns)	% of removal of gold
1	<325	69
2	<425	61
3	>425	56

Reference

1. World Gold Council, 2001. Gold Demand Trends, February, 23, pp. 34.
2. Pethkar, A.V., Paknikar, K.M., J. Biotechnol. 63, 121–136 (1998).
3. Iglesias, M., Antico, E., Salvado, V., Anal. Chim. Acta 381, 61–67 (1999).
4. Hulsof, A., Mcdonald, A., Atl. Geol. 34, 64–65 (1998).
5. Rampe, J.J., Runnells, D.D., Appl. Geochem. 4, 445–454 (1989).
6. Biney, C.A., Environ. Monit. Assess. 18, 123–128 (1991).
7. Sanchez, J.M., Hidalgo, M., Salvado, V., Solvent Extr. Ion Exch. 18 (6), 1199–1217 (2000).
8. Gomes, C.P., Almeida, M.F., Loureiro, J.M., Sep. Purif. Technol. 24, 35–57 (2001).
9. Martinez, S., Navarro, P., Sastre, A.M., Alguacil, F.J.,.Hydrometallurgy 43, 1–12 (1996)
10. Akita, S., Yang, L., Takeuchi, H., Hydrometallurgy 43, 37–46 (1996).
11. Volesky, B., Holan, Z.R., Biotechnol. Progr. 11, 235–250 (1995).
12. Romero-Gonzalez, M.E., Williams, C.J., Gardiner, P.H.E., Gurman, S.J., Habesh, S., Environ. Sci. Technol. 37, 4163–4169 (2003).
13. Suyama, K., fukazawa, Y., Umetsu, Y., Appl. Biochem. Biotechnol. 45, 871-879 (1994).
14. Ishikawa, S., Suyama, K., Appl. Biochem. Biotechnol. 70/72, 719-728 (1998).
15. Creger, C.R., Phillips, H., Scott, J.T., Poult. Sci. 55, 1717-1723 (1976).
16. Carrino, D.A., Dennis, J.E., Wu, T.M., Arias, J.L., Fernandez, M.S., Rodriguez, J.P., Fink, D.J., Heuer, A.H., Caplan, A.I., Connect. Tissue Res. 35, 325-329 (1996).
17. Shin-ichi Ishikawa, Kyozo Suyama, Keizo Arihara, Makoto Itoh., Bioresource Technology 81, 201-206 (2002).