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Selective Recovery of Rare Earths from Environmental Water Using Phosphorylated Yeast

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Summary

In previous research, a metal-adsorbing yeast with chemically modified phosphate groups (Phosphorylated yeast) was developed. Phosphorylated yeast achieved selective recovery of rare earth ions from a metal ion mixed solution. Therefore, in this study, in order to verify the practicality of this phosphorylated yeast, we investigated the selective concentration and recovery of rare earth ions contained in environmental waters such as seawater and hot spring water. Phosphorylated yeast was created by reacting commercially available baker's yeast with cyclo-triphosphate. In an adsorption experiment using synthetic seawater, 5 ppm of the rare earth dysprosium ion Dy^{3+} was added to a solution prepared to simulate the cation composition of seawater (Na^{+} 10,000 ppm, Mg^{2+} 1,000 ppm, K^{+} and Ca^{2+} 500 ppm). Selective recovery of Dy^{3+} from synthetic seawater was examined using phosphorylated yeast. It was revealed that when hydrochloric acid was added to synthetic seawater to a concentration of 0.01 M, other metal ions were not adsorbed and only Dy^{3+} was adsorbed to phosphorylated yeast due to the difference in valence. Furthermore, by increasing the amount of phosphorylated yeast, we were able to selectively recover the whole amount of Dy^{3+} from synthetic seawater. Next, rare earth ions contained in the Tamagawa hot spring water were targeted for adsorption. Hot spring water contains Al^{3+} and Fe^{2+}, which are approximately 20,000 times more concentrated than rare earths in terms of molar concentration. A part of Al^{3+} and Fe^{2+} was removed as a precipitate after pH adjustment while 60-80% of rare earth ions remained in the solution. When pretreated hot spring water was adsorbed using phosphorylated yeast, in addition to rare earths such as Dy^{3+} and La^{3+}, remaining Al^{3+} was also adsorbed at the same time. When we desorbed metal ions from the adsorbed yeast using hydrochloric acid, only rare earth ions were desorbed with high efficiency. Therefore, rare earth ions could be concentrated 10-19 times with a recovery of 20-37%. It was strongly suggested that phosphorylated yeast is a practical microbial adsorbent, as selective adsorption and concentration were achieved even in environmental water, which has a low concentration of target metal ions.