Microbially Induced Calcite Precipitation based Sequestration of Strontium

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Introduction.

Contamination by radioactive strontium (^{90}Sr) is a significant environmental problem. Calcite forming bacteria has also been the basis for a promising *in-situ* containment method for sequestration of divalent radionuclide and trace metal ions. In this study, ten strains were selected and identified by 16S rDNA sequencing. One of these latter stains, *Sporosarcina pasteurii* WJ-2 was further selected for subsequent study. Microbially induced calcite precipitation (MICP) by *S. pasteurii* WJ-2 strain was evaluated for its potential to counteract Sr contamination in column experiments using natural sand. *S. pasteurii* WJ-2 induced Sr containment by successfully sequestrating approximately 80% of Sr from the soluble fraction of sand.

Methods.

1. **Isolation and identification**: Urease producing bacteria were isolated from the abandoned expressway sites (Gangwondo, Korea). Then 16s rDNA sequencing was analyzed.
2. **Urease activity assay**: The determination of the urease activity was based on the phenol-hypochlorite assay method.
3. **Sr sequestration of sand:** Sand slurry containing killed or live cells was packed into a 50 mL plastic syringe column. Columns were fed once by gravity with 20 mL of the urea and calcium chloride solution. The columns were set aside for 24 h to allow maximum crystal growth and to let excess water drip. The columns were then dried at 45°C for 24 h to facilitate evaporation of excess water. Columns were added by gravity with 20 mL of $SrCl_2$. The Sr concentrations of the eluents were analyzed by inductively coupled plasma mass spectroscopy (ELAN 6100, PerkinElmer, USA).

Results.

1. Isolation and identification

Table 1. Identification of several strains by 16S rRNA sequencing

NO.	Area	strains	Homologous microorganism
1	WonJu, GangWon	WJ-1	*Sporosarcina luteola*
2	WonJu, GangWon	WJ-2	*Sporosarcina pasteurii*
3	WonJu, GangWon	WJ-3	*Sporosarcina pasteurii*
4	WonJu, GangWon	WJ-4	*Sporosarcina pasteurii*
5	WonJu, GangWon	WJ-5	*Sporosarcina pasteurii*
6	WonJu, GangWon	WJ-6	*Lysinibacillus* sp.
7	WonJu, GangWon	WJ-7	*Lysinibacillus* sp.
8	WonJu, GangWon	WJ-8	*Lysinibacillus sphaericus*
9	WonJu, GangWon	WJ-9	*Lysinibacillus sphaericus*
10	WonJu, GangWon	WJ-10	*Lysinibacillus sphaericus*

2. Urease activity assay

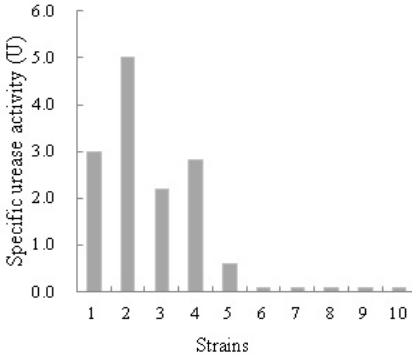

Fig.1 Specific urease activity of isolated strains. One unit of urease is defined as the amount of enzyme hydrolyzing 1 μmol urea min−1.

3. Sr sequestration of sand

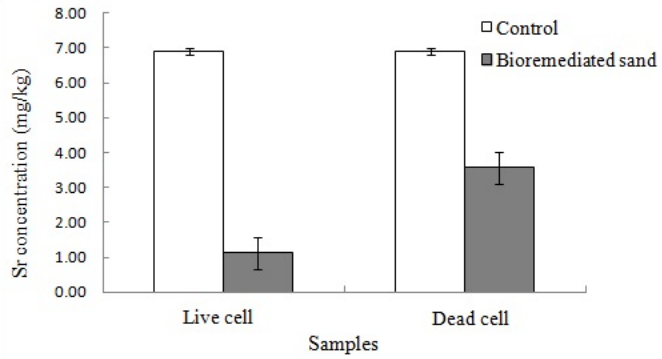

Fig.2 Sr concentration in the residual solution for dead bacterial (WJ-2) treated sand compared live bacterial (WJ-2) treated sand.

Conclusions. The bacterial isolate produced a significant amount of calcite precipitating enzyme, urease. Further effectiveness of MICP was demonstrated for successful sequestration of Sr.

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References.

1. Weatherburn, M. W. (1967). *Anal. Chem*. 39: 971–974.
2. Abdel-Sabour, M. F. (2007). *J. Agric. Food Chem.* 6: 2009-2023.
3. Bachmeier, K. L., Williams, A. E., Warmington, J. R., and Bang, S. S. (2002). *J. Biotech*. 93: 171-181.