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Soil Improvement through Utilization of Calcifying Bhargavaea cecembensis N1 in an Affordable Whey Culture Medium

Authors : Fatemeh Elmi, Zahra Etemadifar

Abstract : Improvement of soil mechanical properties is crucial before its use in construction, as the low mechanical strength and unstable structure of soil in many parts of the world can lead to the destruction of engineering infrastructure, resulting in financial and human losses. Although, conventional methods, such as chemical injection, are often utilized to enhance soil strength and stiffness, they are generally expensive, require heavy machinery, and cause significant environmental effects due to chemical usage, and also disrupt urban infrastructure. Moreover, they are not suitable for treating large volume of soil. Recently, an alternative method to improve various soil properties, including strength, hardness, and permeability, has received much attention: the application of biological methods. One of the most widely used is biocementation, which is based on the microbial precipitation of calcium carbonte crystalls using ureolytic bacteria However, there are still limitations to its large-scale use that need to be resolved before it can be commercialized. These issues have not received enough attention in prior research. One limitation of MICP (microbially induced calcium carbonate precipitation) is that microorganisms cannot operate effectively in harsh and variable environments, unlike the controlled conditions of a laboratory. Another limitation of applying this technique on a large scale is the high cost of producing a substantial amount of bacterial culture and reagents required for soil treatment. Therefore, the purpose of the present study was to investigate soil improvement using the biocementation activity of poly-extremophile, calcium carbonate crystal- producing bacterial strain, Bhargavaea cecembensis N1, in whey as an inexpensive medium. This strain was isolated and molecularly identified from sandy soils in our previous research, and its 16S rRNA gene sequences was deposited in the NCBI Gene Bank with an accession number MK420385. This strain exhibited a high level of urease activity (8.16 U/ml) and produced a large amount of calcium carbonate (4.1 mg/ ml). It was able to improve the soil by increasing the compressive strength up to 205 kPa and reducing permeability by 36%, with 20% of the improvement attributable of calcium carbonate production. This was achieved using this strain in a whey culture medium. This strain can be an eco-friendly and economical alternative to conventional methods in soil stabilization, and other MICP related applications.

Keywords : biocementation, Bhargavaea cecembensis, soil improvement, whey culture medium
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