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Release of Potassium Ions from Feldspar by Organic Acids Present in Potassium-Solubilizing Bacteria

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Abstract

Agricultural production and quality are determined by the nutrient levels in the soil. Permanent agricultural lands are usually nutrient deficient and it is compensated by fertilization. Recent studies have found that potassium-bearing chemical fertilizers caused some environmental issues and these fertilizers are expensive. Therefore, the development of a new method for supplying potassium to plants using ingredients found in Sri Lanka is important. In this respect, the bioconversion of feldspar using biotechnological processing to obtain potassium fertilizers is very promising. The overall objective of this study is to explore the release of potassium ions from feldspar (Microcline-$KAlSi_3O_8$) found in Sri Lanka by organic acids present in potassium-solubilizing bacteria to improve the efficiency of these minerals to use in more sustainable agricultural practices. In this research, the solubilization of feldspar with citric, oxalic, succinic, and tartaric acids (the main acids that are produced by potassium solubilizing bacteria) was studied, concerning the effect of acid type, the effect of each acid concentration, the effect of particle size of feldspar, the effect of incubation time, and the changes in pH over time. Ground feldspar (0.150–0.300 mm and 0.075–0.150 mm) was separately shaken with 0.01, 0.02, 0.03, 0.04 and 0.05 M of each organic acid for different periods (1, 2.5 and 4 hours) and the released potassium ion concentration was measured using a flame photometer and pH change was measured using a pH meter. The extent of solubilization of feldspar was shown to be influenced by the type of organic acid used. In comparison to inorganic acids (H_2SO_4), some organic acids were more successful in solubilizing feldspar. Both oxalic and tartaric acids showed a higher capability of releasing potassium from the feldspar than other acids by up to 9 folds. The solubilization was insignificant for the same acid when the acid concentration was changed. The solubility of feldspar in all acids increased as the particle size decreased. The solubilization of feldspar was increased practically in almost all acids as time increased. pH was increased in almost all acids when the reaction time was increased. These findings show that both oxalic and tartaric acids are the most successful acids in solubilizing feldspar. Finding bacteria that secrete these acids as their major byproducts and conditions that secrete these acids would be beneficial for agriculture and feldspar can be used to supply potassium to agricultural lands.

Keywords: Organic acids, Feldspar, Solubilization