Enhancement of solubility of Eppawala Rock Phosphate through Bioleaching

T.C. Senevirathna*, C.M. Peries and J.T. Cooray
Uva Wellassa University, Badulla, Sri Lanka

Introduction

Phosphorus (P) plays an indispensable biochemical role in photosynthesis, respiration, cell division and several other processes in the living plant (Grover, 2003). An inadequate supply of phosphorus in the early stages of plant growth reduces most of these physiological functions and ultimately reduces the crop productivity. Therefore, external applications of P fertilizers is necessary in terms of better crop production. Locally available P resources like Eppawala Rock Phosphate (ERP) deposits are now highly concerned due to the environmental effects and the high cost of imported P fertilizers. However, the ERP is considered as less applicable local P resource for short term cultivations due to the low solubility. Although chemical treatments are highly available to solubilize ERP, the cost of application is fairly high. In that sense, the inoculation of naturally existing P-solubilizing microorganisms is considered as a promising technique to solubilize P sources due to the low application cost and giving a thrust to economic development without disturbing ecological balance (Reyes *et al*., 2002). Thus, this study was focused on screening the P solubilizing microorganisms (PSM) from ERP deposit and apply them to enhance the solubility of ERP and High-Grade Eppawala Rock Phosphate (HERP).

Methodology

Powdered Rock Phosphate samples were collected from the rock phosphate stockpile of phosphate mine of Lanka Phosphate Limited, Eppawala. Microbial isolation were performed from the obtained Phosphate samples using standard microbiological techniques. Isolated microbial strains were inoculated on PVK medium, a selective medium to screen PSM. Thereafter, screened microbial strains were inoculated in PVK broth media containing either ERP or HERP separately. P content in each sample was determined using UV spectrophotometric method after 1 , 2 st nd, 4th and 7th days of inoculation.

Result and Discussion

Four bacterial strains and four fungal strains were initially isolated using the rock phosphate samples obtained from phosphate mine of Lanka Phosphate Limited, Eppawala, Sri Lanka. Out of them, two bacterial strains (B1 and B2) were selected as potential phosphate solubilizers based on the development of clear halo zone on PVK agar medium due to the P solubilization in the surrounding medium (Fig. 1 a and b).

1a 1b.

Figure 1- Different bacterial strains exhibiting halo zones on PVK medium due to the P solubilization. (a)- Halo zone observed due to the bacterial strain B1. (b)- Halo zone observed due to the bacterial strain B2.

It has been reported that the PVK medium can be used to isolate PSM based on the formation of clear halo zone on Calcium Triphosphate of PVK medium due to the organic acid production by PSM (Sharma, 2005).

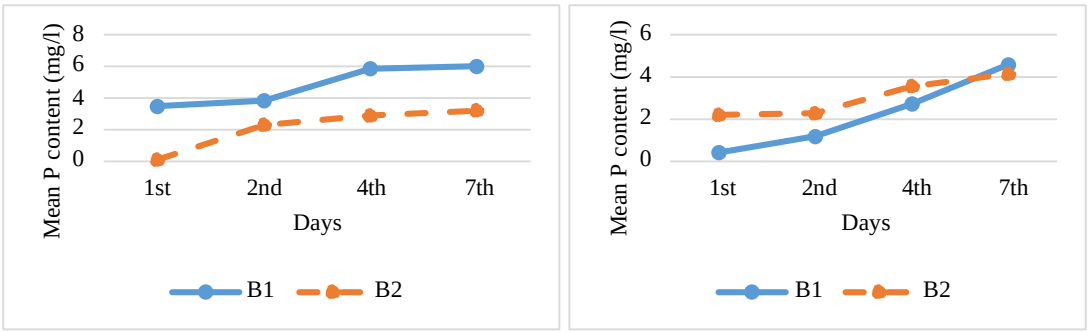

Figure 2- The effect of the bacterial strains on P solubilization of different Phosphate sources. (a)- The effect of bacterial strains on HERP. (b)- The effect of bacterial strains on ERP. Phosphate concentration was measured different days with in a week.

According to the statistical analysis, a significant correlation was observed between the type of the phosphate and the bacteria ($P< 0.05$). Further, the pH of the media after the bacterial inoculation were changed to the acidic range (pH 3-5) after seven days. It has been reported that the PSM solubilize soil P by the production of low molecular weight organic acids such as gluconic and keto gluconic acids, thereby reducing the pH. Furthermore, these PSM have the capability of tolerating harsh conditions like high acidic environments (Nautiyal *et al*, 2000).

Bacterial strain B1 showed higher P solubilizing ability on HERP compared to the bacterial strain B2 (Fig. 2a). It was observed that the P solubilization rate in both bacterial types was enhanced up to the fourth day and after that the rate become constant (Fig. 2a). This might be due to the limitation of nutrient and accumulation of metabolites with the time in the growth media. Further, bacterial strain B1 showed lower P solubilizing effect on ERP phosphate type compared to the strain B2. It has been reported that ERP contains great amount of impurities compared to HERP (Hewawasam, 2013). Therefore, these impurities might have an effect on the efficacy of B1 activity at the initial growth period. However, it was clearly observed that the P solubilizing rate

by the bacterial strain B1 on ERP was extremely enhanced after first day and the B1 strain showed the highest solubilized P content compared to the strain B2 at the seventh day (Fig. 2b).

Conclusions

It can be concluded that the bacterial strains B1 and B2 have positive effects on solubilizing ERP and HERP sources. Bacterial strain B1 has higher efficiency on solubilizing HERP. The effect of B1 and B2 on P solubilizing should be further evaluated at the field conditions.

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References

Grover, R. (2003). Rock phosphate and phosphate solubilizing microbes as a source of nutrients for crops. MSc. Thesis. Thapar Institute of Engineering and Technology, Patiala.

Hewawasam, T. (2013). Tropical weathering of apatite-Bearing Rocks of Sri Lanka: major element behaviour and mineralogical changes. Journal of Geological Society of Sri Lanka. 15, 31-46.

Nautiyal, C. S., Bhadauria, S., Kumar, P., Lal, H., Mondal, R., and Verma, D. (2000). Stress induced phosphate solubilization in bacteria isolated from alkaline soils. FEMS Microbiology Letters. 182, 291-296.

Reyes, I., Bernier, L. and Antoun, H. (2002). Rock phosphate solubilization and colonization of maize rhizosphere by wild and genetically modified strains of *Penicilliumrugulosum*. Microbial Ecology. 44, 39-48.

Sharma, S., Kumar, V. and Tripathi, R.B. (2011). Isolation of Phosphate Solubilizing Microorganisms (PSMs) from soil. J. Microbiol. Biotech. Res. 1(2), 90-95.