## SOLUBILIZATION OF MUSSORIE ROCK PHOSPHATE BY CYANOBACTERIA

P. ROYCHOUDHURY and B. D. KAUSHIK
*National Facility for Blue-Green Algal Collections, Indian Agricultural Research Institute, New Delhi 110 012, India.*

SEVERAL soil bacteria[1-3], and fungi[4,5] have been shown to possess the property of solubilization of tricalcium phosphate in culture. Some strains of cyanobacteria were also shown to solubilize tricalcium phosphate[6]. Mussorie rock phosphate[7] (MRP), a raw material for the fertilizer industry, is a source of $P_2O_5$, although the latter is unavailable unless solubilized microbiologically. The present communication shows how five species of cyanobacteria can solubilize MRP.

All the five strains of nitrogen-fixing cyanobacteria, isolated from saline soils and maintained routinely in Fogg's medium[8], were starved for one month with one subculturing after 2 weeks in a medium devoid of $K_2HPO_4$ (equal amount of K was provided as KCl). The phosphorus-starved cultures were inoculated in a medium supplemented with 0.5 g/l MRP, equivalent to 0.039 g/l phosphorus. Uninoculated growth medium and medium supplemented with 0.2 g/l $K_2HPO_4$ served as controls. The algae were grown in 100 ml growth medium in 250 ml Erlenmeyer flasks at 2000 lux and 30 ± 1°C in a growth room as batch cultures for 4 weeks. The algal mass was separated by filtration through a washed, preweighed Whatman No. 41 filter paper disc. The available phosphorus in filtrate and pellet was determined by standard procedures[9,10].

All the five strains could solubilize MRP and MRP supported luxuriant growth of the cyanobacteria (table 1). Biomass of *Hapalosiphon*, *Westiellopsis*, *Scytonema* and *Calothrix* was more (44.3 to 71.8%) in medium containing MRP compared to medium containing $K_2HPO_4$, the conventional source of phosphorus. Biomass of *Tolypothrix* in presence of $K_2HPO_4$ was more than that in presence of MRP, but only by 27.7%.

In general the uptake of P was greater in presence of MRP than in presence of the readily available source, $K_2HPO_4$ in all the strains examined except *W. prolifica*. This suggests that *W. prolifica* is less efficient in solubilizing MRP compared to the other four strains of cyanobacteria. The accumulation of P per unit of biomass was highest in *C. braunii* and no available P was left in the culture medium.

In general, the pH of the growth medium containing MRP dropped by 0.02–0.24 units from the initial pH of 7.6. These results seem to rule out liberation of organic acid as a mechanism for solubilization of MRP, which is in agreement with results for other micro-organisms[3]. There are no earlier reports on the solubilization of MRP by micro-algae and efforts are under way to understand the mechanism of P solubilization by these micro-algae.

**Table 1** *Solubilization of Mussorie rock phosphate by cyanobacteria*

| Strain | Source[a] of P | Dry wt of algal mass (mg/ml) | Available P (mg) in algal mass | Available P (mg) in filtrate: Observed | Available P (mg) in filtrate: Expected[b] | pH |
|---|---|---|---|---|---|---|
| *Tolypothrix ceylonica* | $K_2HPO_4$ | 0.502 | 0.10 | ND | 3.50 | 7.33 |
| | MRP | 0.393 | 0.22 | 0.14 | 3.54 | 7.46 |
| *Hapalosiphon fontinalis* | $K_2HPO_4$ | 0.196 | 0.35 | ND | 3.25 | 7.20 |
| | MRP | 0.283 | 0.38 | 0.13 | 3.39 | 7.36 |
| *Westiellopsis prolifica* | $K_2HPO_4$ | 0.181 | 0.38 | ND | 3.22 | 7.15 |
| | MRP | 0.309 | 0.31 | 0 | 3.59 | 7.5 |
| *Scytonema cincinnatum* | $K_2HPO_4$ | 0.181 | 0.24 | ND | 3.36 | 7.26 |
| | MRP | 0.311 | 0.27 | 0.16 | 3.47 | 7.43 |
| *Calothrix braunii* | $K_2HPO_4$ | 0.145 | 0.21 | ND | 3.39 | 7.0 |
| | MRP | 0.220 | 0.50 | 0 | 3.40 | 7.58 |

[a] $K_2HPO_4$ 0.2 g/l ≈ 3.6 mg P in medium; MRP 0.5 g/l ≈ 3.9 mg P; ND, Not determined; [b] Figures for expected available P in filtrate for medium with MRP (≈ 3.9 mg P) are total P in medium (assuming total solubilization of MRP) minus P in algal mass and filtrate.

3 October 1988; Revised 24 November 1988


1. Goswami, K. P. and Sen, A., *Indian J. Agric. Sci.*, 1962, **32**, 96.
2. Katznelson, H., Peterson, E. A. and Rouatt, J. W., *Can. J. Bot.*, 1962, **40**, 1181.
3. Sperber, J. I., *Nature (London)*, 1957, **180**, 994.
4. Chhonkar, P. K. and Subba Rao, N. S., *Can. J. Microbiol.*, 1967, **13**, 749.
5. Subba Rao, N. S. and Bajpai, P. D., *Experientia*, 1965, **26**, 386.
6. Bose, P., Nagpal, U. S., Venkataraman, G. S. and Goyal, S. K., *Curr. Sci.*, 1971, **40**, 165.
7. Sundaram, K. P. (ed.), *Fertilizer statistics*, The Fertilizer Association of India, New Delhi, 1985, p. 25.
8. Fogg, G. E., *Ann. Bot.*, 1949, **13**, 241.
9. Jackson, M. L., *Soil chemical analysis*, Prentice-Hall, Engle Wood Cliffs, New Jersey, 1958, p. 183.
10. Kaushik, B. D., *Laboratory methods for blue-green algae*, Associate Publishing Co., New Delhi, 1987, p. 118.


## ISOLATION OF PHOSPHATE SOLUBILIZERS FROM DIFFERENT SOURCES

N. S. DARMWAL, R. B. SINGH and RAMAN RAI
*Department of Microbiology, N.D. University of Agriculture and Technology, Kumarganj, Faizabad 224 229, India.*

SOILS generally contain adequate amount of inorganic and organic phosphorous but most of these remain unavailable to plants. The efficiency of water soluble phosphorous is usually low and its recovery does not exceed 20% because soluble phosphorous when added to soil form $Ca_3(PO_4)_2$ in calcareous and alkaline soils and $FePO_4$ and $AlPO_4$ in acidic soils[1]. Several workers[2-4] have proposed the utilization of low grade phosphorous by the use of phosphate dissolving micro-organisms.

In India there are large deposits of phosphatic rock estimated about 140 million tonnes distributed in different states. Most of these deposits are of low grade (<25% $P_2O_5$)[5]. Keeping this in view, the present investigation was carried out to isolate the phosphate solubilizers from different sources and their effects on Mussoorie rock phosphate solubilization.

**Table 1** *Screening of isolates for tricalcium phosphate solubilization*

| Source | No. of isolate | Organism | pH after growth | $P_2O_5$ solubilization (mg/50 ml) |
|---|---|---|---|---|
| Compost material | 4 | *A. niger* | | |
| | As1 | | 3.1 | 22.5 |
| | As2 | | 3.3 | 23.7 |
| | As3 | | 3.0 | 26.9 |
| | As4 | | 3.5 | 22.8 |
| Wheat rhizosphere | 2 | *A. niger* | | |
| | As5 | | 3.2 | 4.9 |
| | As6 | | 3.5 | 10.5 |
| Garden soil | 2 | *Trichoderma* sp. | | |
| | Ts1 | | 3.7 | 3.5 |
| | Ts2 | | 3.9 | 6.2 |
| Gram rhizosphere | 2 | *Penicillium fumiculosum* | | |
| | Pf1 | | 3.3 | 3.4 |
| | Pf2 | | 3.5 | 7.1 |
| Gram rhizosphere | 3 | Gram negative bacteria | | |
| | 1 | | 5.5 | 3.7 |
| | 2 | | 5.3 | 3.2 |
| | 3 | | 5.1 | 2.8 |
| Control (without inoculum) | — | — | 5.0 | — |
| CD at 5% | — | — | 0.31 | 2.62 |