MULTI-METAL RESISTANCE AND PLANT GROWTH PROMOTION POTENTIAL OF A WASTEWATER BACTERIA AND ITS SYNERGISTIC BENEFITS

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Introduction

Heavy metal pollution has become a global environmental concern owing to their toxicity even at low concentrations. Increasing metal concentrations in the ecosystem arise from a vast array of sources ranging from agricultural and household activities to industrial processes. For plants heavy metals like Cu, Zn and Ni are essential micronutrients, but are toxic to organisms at high concentrations (Munzuroglu and Geckil, 2002). When exposed to non-essential heavy metals and metalloids, like Hg, Cd, Pb and As many toxicological symptoms manifest in plants in the form of delay in germination, disruption of mitosis, inhibition of the enzymatic activity, induction of chlorosis, reduction in rate of photosynthesis and plant growth. Although many metals play vital roles in metabolic processes of microorganisms they show adaptation under metal stress situation (Beveridge and Doyle, 1989). Several heterotrophic bacteria develop the capability to grow even in presence of multiple heavy metals (Sulowicz et al., 2011). This property of metal resistant bacteria offers great potential in bioremediation of environmentally stressed soil heavily contaminated with heavy metals. Besides some plant growth-promoting bacteria are in agronomic use as substitutes of chemical fertilizers and as agents of environmental cleanup. Plant growth promotion by bacteria may be mediated through enhanced production of Indole-3-acetic acid (IAA) and gibberellic acid (GA3) (Neeru et al., 2000). The objective of the present study was to isolate and characterize multiple heavy metal resistant bacteria and to exploit its potential to promote plant growth and bioremediation of heavy metals.

Methods

Multiple heavy metal resistant bacteria were isolated from Kalyani Sewage Treatment Plant, West Bengal, India. The bacterial isolates were screened on glucose minimal salt agar plates supplemented with heavy metal following the standard spread plate technique. Maximum tolerance limit of the screened bacterial strain was determined against respective heavy metals. Optimal growth conditions (temperature and pH) and biochemical characteristics (like Gram staining, IMViC, amylase, catalase, urease, lipase, gelatin hydrolysis and motility) of the isolate were analyzed (Hemraj et al., 2013). The bacterial sample was supplemented with multiple heavy metals (Cd, Co, Cu, Ni and Zn) in a medium to determine the multiple heavy metal resistance pattern. IAA (at 1, 2, 5 and 10 mg/L tryptophan concentrations) and GA_3 production capacity and seed germination enhancement potential (Lentil, *Lens culinaris*) was estimated. A Pot experiment was conducted to examine physiological alterations of lentil in presence/absence of heavy metals (AsIII, AsV, Cd, Co, Cr, Cu, Ni and Zn) and with/without bacterial strain.

Results

The isolated strain (KUJM) is a Gram-negative, rod shaped, non-spore forming, non-motile bacterium. It showed optimum growth at 37°C and pH 7.0 and a broad range of heavy metal resistance. The strain exhibited metal tolerance limit up to 8, 18, 7, 3, 2.5 and 14 mM of Cd, Co, Cu, Ni, Cr and Zn, respectively. Maximum tolerance was demonstrated against arsenic with 50 mM of AsIII and 800 mM of AsV. When supplemented with selected metals in the medium the strain was proved as resistant to five heavy metals (2mM of Cd, Co, Cu, Zn and 1mM of Ni). Further it promoted production of GA_3 and IAA while the latter was observed as a direct function of tryptophan concentration. The organism induced seed germination rate (13%). In pot experiment plant growth was promoted in presence of heavy metals when the soil was enriched with the organism.

Conclusion

The bacterial strain (KUJM) manifested multi-metal tolerance and plant growth promotion potential. With a broad spectrum of heavy metal resistance it showed significantly higher resistance against As-III and As-V. KUJM induced plant growth promotion modulating IAA production and enhancing seed germination rate. Such bacteria can be applied as a promising tool for addressing twin issues of metal contaminated waste management and enhancement of agricultural productivity in metal contaminated agricultural field.

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