Isolation and identification of salt-tolerant plant-growth-promoting rhizobacteria and their application for rice cultivation under salt stress

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Summary: The salinity level in the coastal ecosystem and agricultural lands is being increased gradually due to the sea-level rise, one of the many effects of climate change. Consequently, a substantial reduction in crop yields is experienced in some South Asian countries threatening their food security. In order to bring the salinity-affected lands under agriculture, the application of salt-tolerant, plant-growth-promoting rhizobacteria (PGPR) as biofertilizer as an alternate technology to genetically-modified crops could improve salt resistance in plants, thereby augmenting plant growth and production.

Here, we isolated 53 PGPR from saline and non-saline areas in Bangladesh where electrical conductivity was measured as >7.45 and <1.80 dS/m, respectively. Bacteria isolated from saline areas were able to grow in up to 2.60 mol/L salt concentration, contrary to the isolates collected from non-saline areas that did not survive beyond 854 mmol/L. Among the salt-tolerant isolates, *Bacillus aryabhattai*, *Achromobacter denitrificans*, and *Ochrobactrum intermedium*, identified by comparing respective sequences of 16S rRNA using the NCBI GenBank, exhibited a higher amount of atmospheric nitrogen fixation, phosphate solubilization, and indoleacetic acid production at 200 mmol/L salt stress. Salt-tolerant isolates exhibited greater resistance to heavy metals and antibiotics too, which could be due to the production of an exopolysaccharide layer outside the cell surface.

While in soil, rice growth under non-saline condition was comparable in between *B. aryabhattai* MS3-fertilized and control pots, the scenario was statistically significant when challenged with 200 mmol/L salts, 42.60% and 8% survival were recorded respectively. Biochemical analyses revealed that *B. aryabhattai* MS3 supported the plants under salinity by increasing the availability of nutrients (Fe, P), accelerating the levels of IAA and chlorophyll content, enhancing proline accumulation and decreasing malondialdehyde formation. Further, rice growth was found to be favoured by enhanced expression of a set of at least four salt-responsive plant genes: *BZ8*, *SOS1*, *GIG*, and NHX1. Fertilization of rice with osmoprotectant-producing PGPR therefore, could be a climate-change-preparedness strategy with a view to building a climate-smart agriculture for coastal ecosystem.