（学位第３号様式）

学 位 論 文 要 旨	
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題　目	**Phosphorous Solubilizing Fungi Isolated from Soils in Subtropical Okinawa, Japan** **（亜熱帯に属する沖縄県の土壌より分離されたリン可溶化真菌）**

Abstract: Phosphorus is the second most important nutrient element required for plant growth and development. Phosphorus forms insoluble complexes with aluminum and iron in acidic soil and with calcium in alkaline soil. For sustenance of crop production, farmers rectify phosphorus deficiency by applying large amounts of phosphate fertilizers to the soil, but a small fraction of the applied phosphate is available to plants and the rest of the portion becomes immobilized which increases production costs and leads to environmental pollution. Furthermore, phosphorus pollution sometimes occurs not only with damage of salts by high tide waves but also by desertification accompanied with global warming. On the other hand, some bacteria have ability to dissolve insoluble phosphorus compounds in soil, however, there are a few reports on fungal species with phosphorus solubilizing abilities. The present study aimed to isolate efficient phosphate solubilizing fungi that could be utilized as potential bio inoculants for resolving the phosphorous deficiency in subtropical soil as well as industrial benefits.

Sixteen strains from the grey soil (pH 7.9), dark-red soil (pH 6.7) and red soil (pH 6.1) correspondent to the typical Okinawan soils so-called as Jaagaru, Shimajiri maaji and Kunigami maaji having solubilizing ability of insoluble $Ca_3(PO_4)_2$, $AlPO_4$ and $FePO_4$ were isolated from Okinawa, Japan located at subtropical area cultured on phosphorus agar plates at 25ºC for 1 week. The colonies with the transparent zone on the medium were picked up and used for the investigations. Based on morphological and the molecular biological identifications using β-tubulin and/or Calmodulin sequences, the isolates were confirmed as *Aspergillus* spp., *Penicillium* spp. and *Talaromyces* spp. Four representative *Aspergillus* spp. isolates showed higher phosphate solubilization ability followed by another genus regardless of phosphate substrates.

Phosphate solubilization ability was evaluated using $Ca_3(PO_4)_2$, $FePO_4$ and $AlPO_4$.The highest quantity of organic acids was found when $Ca_3(PO_4)_2$ was used as substrate followed by $FePO_4$ and $AlPO_4$. The phosphate solubilization ability was influenced by the potential of hydrogen (pH). Some isolates showed strong phosphate solubilization ability in lower pH.

The salt and high osmophilic stresses on the fungal strains were evaluated in order to correlate to the salt damages and or desert soil contaminated with phosphate. A series of salt concentration from zero to 20%, and that of sucrose one from 0 to 50% supplemented on routine culture media were evaluated. Interestingly, 3 isolates could grow at 12% of salt concentration, and 5 ones at 10%. Furthermore, all isolates survived with 35% sucrose in medium, and 5 isolates could grow on 50% sucrose condition.

The mechanism of phosphorus solubilization by the fungi mostly depend on the synthesis of organic acids (mainly oxalic, tartaric, malic, citric, acetic, tartaric and formic acids). The acid productions are depending on both phosphate minerals and the strains of fungi. In this study, 16 fungal strains have been identified from the soils in subtropical Okinawa for phosphorous solubilization. There were some candidate isolates for industrial use, such as an isolate of *A. niger* and 2 of *P. oxalicum*. On the other hand, considering both salt tolerance and phosphorous solubilizing abilities, a *Panicillium* sp. isolate was considered to be the candidate for industrial usage. The application for industrial usages of the isolates showing higher phosphorous solubilizing abilities in or not in the salt-rich conditions could be the further studies.

In conclusion, industrially important fungal strains were isolated from the subtropical soils in Okinawa, Japan.