Improvement of Cellulose, Hemicellulose and Phytate Degradation Rates
by Microorganisms Associated with Composting Process

Different types of organic wastes accrue yearly all over the world. Utilization and recycling of organic wastes as nutrient resources is essential for sustainable and environmentally conscious agriculture. Composting of organic wastes is one of the most reasonable answers. The persistent lignocellulosic materials in plant derived wastes require long time to be degraded. Moreover, phytate is the primary source of inositol and storage phosphorus in plant. However, phytate is strongly fixed to soil and form hardly-degradable complexes preventing phosphorus supply to plant. Decomposing phytate during composting could improve phosphorus utilization.

During composting process, microorganisms play the major role in degradation of organic wastes and its components. The degradation of organic waste components by microorganisms achieves by secretion of different types of enzymes. Cellulase, xylanase, β-glucanase, mannanase, protease and phytase are important enzymes in degradation of cellulose, hemicellulose and phytate. In this study, sawdust compost (SDC) and coffee residue compost (CRC) were selected due to their high cellulose and hemicellulose content, and also their low degradation rates. In the present study the cellulolytic
and hemicellulosic fungi dominant in sawdust and coffee residue composts were isolated and their enzymatic activities were evaluated. The cellulolytic bacteria inhabiting sawdust and coffee residue composts and their role in the biodegradation process were also determined. Furthermore, the phytate degrading microorganisms associated with compost and their phytate degradation efficiency were investigated.

In total, 18 isolates from SDC and 29 isolates from CRC were isolated, identified and evaluated for their cellulolytic and hemicellulolytic activities. Four genera (Aspergillus, Galactomyces, Mucor, and Penicillium) and five genera (Aspergillus, Coniochaeta, Fusarium, Penicillium, and Trichoderma/Hypocrea) were dominant in SDC and CRC, respectively. Penicillium sp., Trichoderma sp., and Aspergillus sp. displayed high cellulolytic and hemicellulolytic activities, while Mucor isolates exhibited the highest β-glucanase and mannanase activities. Notably, isolates SDCF5 (P. crustosum), CRCF6 (P. verruculosum), and CRCF2 and CRCF16 (T. harzianum/H. lixii) displayed high activity regarding cellulose and hemicellulose degradation, which indicates that these species could be beneficial for the improvement of biodegradation processes involving lignocellulosic materials.

Cellulolytic and hemicellulolytic activities of bacteria isolated SDC and CRC were investigated. In total 11 isolates from SDC and 10 isolates from CRC were isolated, identified and their enzymatic activities were evaluated. The SDC isolates were belonging to genera Streptomyces, Microbispora and Paenibacillus, while the CRC isolates were classified as Streptomyces, Microbispora and Cohnella. Microbispora was the most dominant genera in SDC and CRC. The results of enzymatic activities indicated that Microbispora (SDCB8 and SDCB9) and Paenibacillus (SDCB10, SDCB11) may contribute effectively to the biodegradation process in SDC, whereas Microbispora (CRCB2) Cohnella (CRCB9, CRCB10) could be important for enhancement of cellulose and hemicellulose bioconversion during composting of CRC. The application of these affective isolates could be contribute to improve degradation rate with effective fungi.
The phytate degrading fungi and bacteria were isolated from SDC and CRC. The phytase activity and phytate degradation ability of selected fungal and bacterial isolates were investigated. The phytate degrading fungi isolated from SDC were belonging to genera of *Mucor, Penicillium*, and *Galactomyces*, while *Coniochaeta, Fusarium, Penicillium*, and *Aspergillus* were isolated from CRC. Furthermore, the phytate degrading bacteria were belonging to 4 genera (*Pseudomonas, Enterobacter, Luteiflora* and *Rahnella*). Bacterial isolates showed very low activity towards the degradation of phytate-P and increase of IP content. The most active strains concerning the degradation of phytate phosphorus (phytate-P) and increment of inorganic phosphorus (IP) level were *Penicillium* isolates SDCF5 and SDCF3. The reduction of the phytate-P concentration by the above-mentioned strains reached 99.3 % and 98.9 %, respectively. Inoculation with fungal isolate increased the phytate degradation rate. *Penicillium* sp. isolates were the most effective phytate degrading fungi. In actual composting process, highly efficient phytate decomposing fungi such as *Penicillium* isolates (SDCF3 and SDCF5) could contribute to degradation of phytate P and increasing the phosphorus availability.