

# Hydrolytic enzymes of rhizospheric microbes in crop protection

## Abstract

Hydrolytic enzymes produced by rhizospheric microbes inhibit the growth of phytopathogens through hydrolysis of their cell wall, proteins and DNA. Hydrolytic enzyme producing microbes play more promising and sustainable role in controlling phytopathogens vis-à-vis chemicals fungicides. The huge number of microbes has been found as promising biocontrol agent.

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## Introduction

Soil borne phytopathogens are responsible for causing major plant diseases, which causes loss in productivity and ultimately affects the economic values. Use of Plant Growth Promoting Rhizobacteria (PGPR) or fungi to control the phytopathogens is an excellent natural bio-control approach; the bio-control may help to control the growth of phytopathogens as well as it will reduce the use of chemical fungicides which are one of the major factors causing soil infertility.<sup>1,2</sup> The application of hydrolytic enzymes producing rhizospheric microbes is an eco-friendly solution to this issue as they are totally natural and an environmentally friendly. Recent studies on hydrolytic enzymes showed their ability to control plant pathogens.<sup>3,4</sup> A hydrolytic enzyme like chitinase, glucanase, protease and cellulase are able to degrade the fungal cell-wall and causes the cell lysis of fungal pathogens.

## Hydrolytic enzymes of rhizospheric microbes

Bio-control of phyto-pathogens using rhizospheric microbes involves the production of cell wall degrading hydrolytic enzymes.<sup>5</sup> Many rhizobia are capable of synthesizing these extracellular enzymes that hydrolyze the variety of polymeric compounds like chitin, proteins, cellulose, hemicellulose and DNA of phytopathogens. Various microbial strains like *S. marcescens*, *B. subtilis*, *B. cereus*, *B. subtilius*, *B. Thuringiensis* and many more have a potential to produce hydrolytic enzymes for the biocontrol of phytopathogens like *R. solani*, *F. oxysporum*, *S. rolfsii*, *P. ultimum* etc. by swelling in the hyphae and at the hyphal tip, hyphal curling or bursting of the hyphal tip.<sup>6,7</sup> These hydrolytic enzymes affect the structural integrity of the cell wall of the targeted pathogens.<sup>8</sup> Their potential of inhibiting phytopathogens makes them more important in biocontrol process.<sup>9</sup>

## Hydrolytic enzymes and their mechanism of action

### A. Chitinase

Chitinase lyse the fungal cell wall through degradation of chitin polymer present in the cell wall of fungal phytopathogens. The enzyme can either be used directly in the biocontrol on microorganisms, or indirectly by using purified chitinase proteins, or through manipulation of genes coding for chitinase.<sup>10</sup> Degradation of chitin involves splitting of chitin polymer into monomer, random cleavage at internal sites of chitin micro-fibril or progressive release

of diacetylchitobiose in a stepwise manner without releasing monosaccharide or oligosaccharides.<sup>11,12</sup>

### B. Glucanase

$\beta$ -1,3-Glucanases are widely spread in bacteria, fungi and higher plants.<sup>13</sup> The enzyme degrades cell wall of fungi, yeasts.<sup>14</sup> It can be classified either as exo or endo- $\beta$ -1,3-glucanases ( $\beta$ -1,3-glucan:glucanohydrolase). Glucanase causes, degradation of cell wall and further penetration into the host mycelium.<sup>15</sup> These enzymes can hydrolyze the substrate by two possible mechanisms, hydrolysis of the substrate by sequentially cleaving glucose residues from the non-reducing end and cleaving linkages at random sites along the polysaccharide chain, releasing smaller oligosaccharides.<sup>16</sup>

### C. Protease or proteinase

Proteases play a significant role in the lysis of cell wall of phytopathogenic fungi, because chitin and/or fibrils of  $\beta$ -glucan (major constituents of the cell walls) are embedded into the protein matrix. The protease enzyme breaks down major proteins of phytopathogens into peptide chains and/or their constituent amino acids and thereby destroy their capacity of pathogen's protein to act on plant cells. Some of the proteases are involved in inactivating extracellular enzymes of phytopathogenic fungi.<sup>17</sup>

### D. Cellulase

Cellulases hydrolyze the 1,4- $\beta$ -D-glucosidic linkages in cellulose, and play a significant role in nature by recycling this polysaccharide. Cellulose chains form numerous intra and intermolecular hydrogen bonds, which account for the formation of rigid, insoluble, crystalline microfibrils. For the complete degradation of cellulose involves a complex interaction between different cellulolytic enzymes like cellulose / endoglucanases, exo-cellulobiohydrolase / exo-glucanases and  $\beta$ -glucosidases act synergistically to convert cellulose into  $\beta$ -glucose.<sup>18</sup>

## Commercially available bio-fungicides

Protect, Antagon and Procare, Bio Cure are commercially available bio-Fungicides formulated by *Trichoderma* sp. and *P. fluorescens* respectively to control fungal disease and Bacigold is formulated by *B. subtilis* for the biocontrol of bacterial and fungal diseases. Like above FUNGINOL, VENUS, SHARP, Astratop, Astraphil, Astrazeb,

RimZim, Monoclonal, Flick, Target Fungicide Powder, Orgam – F, Spectrum, Oligosaccharins, Bio-Cure-F, Shan-101 Bio Fungicide, Super Rakshak Bio Fungicide etc. are the few Commercially available bio-Fungicides.

## Conclusion

Use of biocontrol agents (BCAs) producing hydrolytic enzymes is one of the best alternative to chemical fungicides for the control of phytopathogens. The mode of action of hydrolytic enzymes on the cell wall of phytopathogen without affecting the plant tissue make them more safer, sustainable and eco-friendly biocontrol agent vis-a-vis chemical fungicides.

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## Conflict of interest

The author declares no conflict of interest.

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