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# Impact of chitinases in biological control

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**Abstract:** Fungal pathogens cause many serious diseases and result significant agricultural losses around the world. Most of the diseases are caused by insect and fungal pathogens. Chitin is frequently used as a carbon source for fungi that have many chitinases. Chitin is an abundant biopolymer that is relatively resistant to degradation. Chitinases are capable of degrading fungal cell walls and are therefore thought to play a major role in the plant's response. A number of chitinases have been shown to inhibit fungal growth of various fungi *in vitro*. The present review describes the properties of chitinase with respect to plant resistant improvement.

**Key words:** Fungal pathogen, chitinase, transgenic plant

**Kitinazların Biyolojik Mücadeledeki Etkisi**

**Özet:** Fungal patojenler bitkilerde ciddi hastalıklara yol açarak tüm dünyada ekonomik kayıplara neden olurlar. Bu hastalıkların çoğu böcekler ve fungal patojenler tarafından kaynaklanmaktadır. Kitin doğada en bol bulunan biyopolimerlerdendir. Bazı bitkiler tarafından üretilen kitinaz enzimi tarafından katalize edilerek yıkılabilirler. Kitinazlar fungusların hücre duvarının parçalanmasını sağladıkları için bitki savunmasında önemli bir rol oynadığı düşünülmektedir. Kitinazların çoğu *in vitro* şartlar altında fungal patojenlerin gelişmesini engellemektedirler. Bu derlemede fungal patojenlere karşı dayanıklı bitkilerin geliştirilmesi açısından kitinazların özellikleri sunulmuştur.

**Anahtar Kelimeler:** Fungal patojen, kitinaz, transgenik bitki

## 1. INTRODUCTION

Chitinases play an important role in plant resistance especially in the of up-regulation of plant defense genes. Chitinases have been studied extensively in mature higher plants and in pathogen infected plants. Several studies examine the antifungal activities of chitinases show ing that it is locally increased in many plants infected by fungal pathogens (Metraux 1986; Schlumbaum et al; 1986 Punja and Zhang 1993). For example, Huynh et al., (1992) reported two purified 28kDA chitinases (*chi*A and *chi*B) from maize seeds exhibiting *in vitro* antifungal activity against the growth of *Trichoderma reesei, Alternia solani* and *Fusarium oxysporum.* Robert and Selitrennikoff (1988) isolated two antifungal proteins from barley grains. Antifungal chitinases isolated from the barley, wheat and maize functioned as endochitinases and inhibition hyphal elongation of test fungi. Measurements of steady-state mRNA levels have indicated that expressions of the plant chitinases are induced in response to fungal infection and treatment with fungal elicitors, and in the case of cucumber and tobacco infection with viral agents (Pegg and Young 1982; Chappell et al 1984; Roby and Esquerre-Tugaye 1987). Where, upon elicitor treatment, only the mRNA of one chitinase form is induced. Chitinase activity is markedly increased by ethylene, pathogen attack, or treatment with microbial elicitor preparations (Boller, 1993). Thus, chitinase appears to be one of a number of inducible defense responses involved in the expression of various forms of plant disease resistance. Disease resistance is an active process dependent on RNA and protein synthesis (Ebel 1986). Recent studies have shown that fungal elicitor or pathogen attacks cause massive changes in the pattern of host RNA synthesis. These include transcriptional activation of defense genes that encode cell wall hydroxyproline-rich glycoproteins, the so-called pathogenesis-related proteins and enzymes involved in the synthesis of lignin and phytoalexins (Chappel et al 1984). Accumulation of transcripts of these defense genes leads to marked stimulation of the synthesis of the encoded proteins and expression of the corresponding defense responses.

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**Chitinase in nature:** Chitinases are common in nature where play important role in degradation in chitin, a natural polymer second in abundance only to cellulose. The availability of C, N and energy in bacteria is attributed to the nutritional role chitinase contributes. Ecologically chitinase is involved in the removal and recycling of the second most abundant biopolymer produces in continents and oceans likewise for fungi, chitinases softens it cells walls enabling growth, hyphal branches initiation and separation of fungi cell corresponding defence responses (Chen et al 2009). Khachatourians (1991) showed that chitinase helps insects cuticle infections and degradation for entomopathogenic fungi, chitinase also aids in degradation of the 90% cuticle of insects (Mommsen 1980).

**Chitinase in plant defence:** The role of chitinase in plant defense against fungal attack has been very well documented (Lawrence and Novak, 2006; Adams, 2004). This enzyme is a glycanohydrolase which limits fungal growth by degrading poly [β-1,4-N-acetyl-b-D-glucozamine], i.e., chitin, the major structural polysaccharide of the fungal cell wall of *V. dahliae* (Adams, 2004). Basic chitinases isolated from bean (Schlumbaum et al., 1986) and acidic ones isolated from cucumber (Zhang and Punja 1994) have shown fungicidal activity *in vitro*. Hence, chitinases hydrolyze the chitin in fungal hyphae and kill the fungus without causing damage to the plant cell. Several studies have demonstrated that enhanced chitinase levels in transgenic plants increase the resistance of plants to fungal pathogens (Nandakumar et al., 2005; Rajasekaran et al., 2005; Tohidfar et al., 2005; Lorito et al., 1998; Tabei et al., 1998;). It was achieved by manipulating the activitiy of extracellular enzyme through construction of over producing mutant, enzyme negative mutants or even transgenic plant expressing the enzyme. Bezirganoglu et al (2013) showed an increase ability to survive in melon plants in *Rhizoctonia solani* infected soil and delayed development of disease symptoms in transgenic melon by expressing antifungal protein and chitinase. Li et al (2009) also confirmed the reduction in occurrence of *Magnaporthe grisea* and *Rhizoctonia solani* infection in transgenic rice plants in which class I chitinase gene were over expressed at high levels. Besides the resistance against fungal pathogen, overexpression of chitinase was also found be effective to improve resistant against other disease factors such as bacterial pathogen, salinity stress, heavy metal stress (Dana et al 2006). It is only the plant chitinase, but the insect chitinase had been also used to improvement plant health by various researchers. Transgenic tomato plant expressing poplar chitinase showed inhibition of development in colorado potato beetle (Lawrence and Novak 2006). Wasano et al (2009) observed that the presence of 56-kDa defense protein consisted of chitin like domain in mulberry latex was responsible to provide strong insect resistance to lepidopteran caterpillars, including, the cabbage armyworm, *Mamestra brassicae*, and the Erisilkworm, *Samia ricini*. Similarly Kitajima et al (2010) also reported two chitinase like protein LA-a and LA-b from latex of Mulberry and found them associated with insecticidal activities against larvae of *Drosophila melanogaster*.

## 2. CONCLUSION

Chitinases are prime molecules of interest for genetic transformation research and can be utilized by variety of ways to develop resistant plant against fungal pathogen. The enzyme is classified into various types on the basis of the structural and functional properties. Chitinase appears to be involved in either constitutive or induced resistance against pathogenic fungal attack. Overexpression of chitinase encoding genes in plants has been shown to improve their defense response against various fungal pathogens. Plant protection was the primary goal of transgenic plant studies that focuses on few strategies to combat pathogens and other disease causing factors. The combined expression of chitinases with the other-plant defense proteins such as glucanases and ribosome-inactivating proteins further improves the plants resistance against pathogen attack. Therefore, chitinase is considered as one important enzyme and prime candidate for further plant defense against fungal disease.

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