Review Article

Bio-Science Research Bulletin
Vol. 34 No. 1, January - June 2018: P.27-32
Print version ISSN 0970 0889
Online version ISSN 2320 3161
DOI 10.5958/2320-3161.2018.00003.2

A Review on Enzymes and Substrate Colonization by Microflora

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Received on 20.02.2018,
Accepted on 09.04.2018

Abstract:
The analyses of plant litter revealed that generally cellulose, hemicellulose and lignin are the major constituents, being a part of structural framework. Therefore, carbohydrate biochemistry is likely to be the key factor in ecology. The pectic substances though constitute a little amount, are also important because these act as cementing material. It can be expected that the decomposition of a substrate by a fungus or a fungal community depends upon their capacity to produce enzymes which can degrade cell wall constituents of the substrates. Good enzyme-producing equipment as one of the important characteristic contributing towards successful colonization of a dead organic substrate by the fungi because of invasion of plant tissue by a fungus. The important characteristic is the rate at which it can penetrate successive cell walls in a cellular tissue.

Keywords: Enzymatic activities, Substrate colonization; Microflora, Decomposition.

INTRODUCTION

Though numerous compounds of highly variable chemical structure enter into the constitution of any litter, a major part of the structural framework is comprised of the carbohydrates. Therefore, carbohydrate biochemistry is likely to be the key factor in ecology (Gupta, 1967; Charaya and Singh, 2005; Singh et al. 2015a; Singh et al., 2016a). Melin (1930) and subsequently a number of workers have analyzed numerous substrates which reveal that generally cellulose, hemicellulose and lignin are the major constituents of litter (Subramanian, 1960; Singh and Charaya, 2003; Singh et al., 2015b; Singh et al., 2015c, Singh at al., 2016b, c, d). The pectic substances though constitute a little amount, are also important because these act as cementing material. It can be expected then that the decomposition of a substrate by a fungus or a fungal community depends upon its/their capacity to produce enzyme(s) which can degrade cell wall constituents of the substrates. Garrett (1950) had given "good

enzyme-producing equipment" as one of the important characteristics contributing towards successful colonization of a dead organic substrate by the fungi because for invasion of plant tissue by a fungus, the important characteristic is "the rate at which it can penetrate successive cell walls in a cellular tissue" (Garrett, 1963). Macer (1961), using straw as substrate, also suggested that straw penetration rate might be an important component of competitive saprophytic colonization. Singh and Charaya (2010); Singh et al. (2015d) have studied the effect of nitrogen and phosphorus on the enzymatic activity during decomposition of wheat straw by mycobiota. Cellulase or pectinase enzyme producing fungi also have scope for enhancing the virulence of biological control agents. They increase the process of infection when used in consortia with pathogenic fungi (Kumar and Aneja, 2016).

CELLULOLYTIC ACTIVITIES

Garrett (1966) suggested that the successful saprophytic survival of a fungus depends upon its cellulolytic ability. He has shown that a highly significant correlation exists between straw penetration rate and cellulolysis rate (Garrett, 1967; 1971). He believed that only resistance to hyphal penetration rate is the mechanical resistance of cell walls containing cellulose some of which are lignified. Enzymatic degradation of cell wall around the apical region of a penetrating hypha will, therefore, facilitate and hasten cell wall penetration (Garrett, 1975). Earlier, Bhargava (1972) demonstrated a close correlation between rates of decomposition of filter paper cellulose and of wheat straw. Chesters (1960), Hogg (1966), Rai (1970) as well as Dwivedi and Singh (1974) also believed that successful colonization of litter by fungi, in part, correlates with their cellulolytic ability. Yadav and Madelin (1968) found that all the members of the primary microflora of decaying stems of Heracleum sphondylium and Urtica dioica were able to utilize cellulose as a nutrient. Sharma (1974), Sharma and Panwar (1981) have found that primary colonists possess good cellulolytic ability. But good cellulolytic ability in culture does not mean that these are degrading cellulose in nature also. All the common primary saprophytes are by no means strict "sugar fungi" (Hudson, 1971). These possess cellulolytic abilities to variable extent and some may have no cellulolytic ability at all. Singh et al. (2017a) revealed the cellulolytic activity in microorganisms.

PECTOLYTIC ACTIVITIES

Thus, whether it is the degradation of cellulose only which opens the way for full decomposition is still to be firmly established because of the presence of other contradictory observations. Macauley and Thrower (1966) found that the fungi capable of utilizing cellulose or pectin were important initial colonizers. While Kendrick and Burges (1962) found that the production of good pectolytic enzymes was responsible for initial colonization. Wieringa (1955) also reported that primary colonizers are decomposers of pectin. Aneja (1978) found that all the initial colonizers possess the capacity to produce pectolytic enzymes. Siu (1951) and Domsch (1960) reported that primary colonizers are decomposers of cellulose and/or lignin. Frankland (1969) also found that most of the primary colonisers during the decomposition of *Pteridium* petioles are capable of degrading cellulose and lignin. On the basis of their own observations, as well as the findings of a number of other workers (Charaya and Mehrotra, 1998) concluded that primary colonizers are (i) able to degrade cellulose and

pectin at higher C:N levels; (ii) can grow at a faster rate on comparatively drier resource. Singh et al. (2017b) observe the pectolytic activity in microorganism and their enzyme.

LIGNOLYTIC ACTIVITIES

Since lignin is known to protect cellulose from decomposition by acting as a physical barrier and by physically excluding enzymes (Hartley and Jones, 1977) or by preventing initiation of enzyme hydrolysis due to special covalent linkage with it (Bailey, 1973), its presence slows down the overall rate of decomposition. Thus, the degradation of lignin is essential for continued decomposition of substrate at a rapid rate. A positive relationship between lignolytic activity of fungi and substrate colonization rate by these can be expected. Kshatriya et al. (1992) found that invertase activity is higher at the beginning of the litter decomposition, whereas cellulase and amylase activity increased during litter decomposition. Vares et al. (1995) could purify multiple forms (isoforms) of LiP, MnP and laccase from wheat straw being degraded by *Phlebia radiata.* Rani et al. (2015) and Singh et al. (2015e) established relation between white rot fungi *Coriolus versicolor* and production of laccase enzyme in the substrate.

HEMICELLULOLYTIC ACTIVITIES

Inspite of the great amount of hemicellulose present in the substrates, surprisingly little attention has been devoted to their decomposition with respect to overall decomposition rate. This may be because hemicellulolytic activity is widely distributed among microorganisms and it is not a rare attribute (Alexander, 1977). As early as in 1927, Rege had pointed that the Pentosan: Lignin ratio does influence the rate of decomposition of a substrate. Charaya (1985) had found that initial differences in the rate of decomposition of wheat and paddy crop residues could be correlated with Hemicellulose: Lignin ratio of the substrates. Singh et al. (2017c) find out the hemicellulolytic activities in crop residues.

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