

**Bateman D F & Millar R L.** Pectic enzymes in tissue degradation.

*Annu Rev. Phytopathol* 4:119-46, 1966.

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This paper reviews the role and significance of the pectic enzymes in the processes of plant tissue maceration and pathogenesis. In addition, a dichotomous key useful in identifying the various types of pectic enzymes is presented. The evidence summarized revealed that the process of tissue maceration could be accounted for by the random cleavage of the  $\alpha$ -1,4 galacturonide bonds in the pectic fraction of plant cell walls by endo forms of either poly- $\alpha$ -1,4-D-galacturonide glycanohydrolase-3 2 1 15 or poly- $\alpha$ -1,4-D-galacturonide lyase-4 2 99 3 [The SCI<sup>®</sup> indicates that this paper has been cited in over 240 publications since 1966]

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When I joined the plant pathology faculty at Cornell University in 1960, I was charged with establishing a program in the area of disease and pathogen physiology. I chose to focus my effort in the area of the enzymology of plant tissue breakdown by pathogens. This readily led to emphasis on plant cell-wall polysaccharides, cell-wall structure, and the role of pathogen enzymes in plant cell-wall dissolution and pathogenesis. An early effort in this program was the characterization of the pectic enzymes produced by a number of pathogens *in vitro* and *in vivo* and the elucidation of their impact on plant tissues.

When James G. Horsfall asked me in 1965 to prepare a review for the *Annual Review of Phytopathology* on the subject of pectic enzymes in tissue degradation, I readily accepted since this offered an opportunity to summarize my work and thoughts on this subject and to integrate them with relevant

efforts in pectin chemistry, plant physiology, and plant pathology. I wisely invited my close colleague Roy Millar to join me in this effort. He and his students were also involved in work on pectic enzymes and disease processes. This move enabled a more comprehensive treatment of the subject.

This paper brought together a summary of the knowledge of the pectic substances, the pectic enzymes, pectic enzyme production by pathogens *in vitro* and *in vivo*, alterations of cell walls by these enzymes, factors influencing enzyme action *in vivo*, and the relationship of pectic enzymes to the processes of tissue maceration and pathogenesis. We were so bold as to suggest the future directions research should take in this area of work.

Aside from bringing together a large volume of information from numerous sources to bear on the question proposed, the formulation of a dichotomous key to the diverse group of pectic enzymes was a contribution useful to many people working in physiological plant pathology and related areas. This key no doubt accounts in part for the wide citation of this paper. Demain and Phaff<sup>1</sup> proposed a key to the pectic enzymes in 1957, but at the time of their effort, the enzymatic *trans*-eliminative cleavage of the  $\alpha$ -1,4 glycosidic bond in pectic substances was unknown. By using the information generated between 1957 and 1965, it was possible to devise a scheme to identify the major groups of pectic enzymes using three major criteria: (a) the mechanism by which the  $\alpha$ -1,4 glycosidic bond is split (i.e., hydrolytic or *trans*-eliminative cleavage), (b) enzyme "preference" for a substrate (i.e., pectin or pectic acid), and (c) position in the pectic chain at which cleavage occurred (i.e., random or terminal point of attack). This system of enzyme identification proved to be easy to use and is effective even when only crude enzyme preparations are available.

The experience gained in preparing this review helped direct a significant amount of my effort as well as that of several of my students for a decade.<sup>2</sup>

1 Demain A L & Phaff H J. Recent advances in the enzymatic hydrolysis of pectic substances *Wallerstein Lab Commun* 20 119-40, 1957 (Cited 95 times)

2 Bateman D F & Basham H G. Degradation of plant cell walls and membranes by microbial enzymes (Heitefuss R & Williams P H, eds) *Physiological plant pathology* Berlin Springer-Verlag, 1976. p 316-55