B6. Brassinosteroid Biosynthesis and Metabolism

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INTRODUCTION

The sessile nature of plants requires distinctive regulatory mechanisms to meet the demands of development and environmental challenges. Various plant hormones that act alone or in concert underpin these mechanisms. Brassinosteroids (BRs) collectively refers to naturally-occurring 5α cholestan steroids that elicit growth stimulation in nano- or micromolar concentrations (15). BRs that are biosynthesized using sterols as precursors are structurally similar to the cholesterol-derived, human steroid hormones and insect molting hormones. BRs have been known for decades to be effective in plant growth promotion. However, definitive evidence for their roles in growth and development remained unclear until the recent characterization of BR dwarf mutants isolated from Arabidopsis and other plants. This chapter aims to provide a cohesive summary of information about progress made in the molecular genetic characterization of mutants that are defective in sterol and BR biosynthetic pathways.

HISTORICAL BACKGROUND AND NATURAL OCCURRENCE

A variety of plant growth regulators are involved in the intricate processes of reproduction. Thus, plant scientists recognized that pollen could be a rich source of phytohormones. A search for novel plant hormones from pollen was begun in the 1960s by a United States Department of Agriculture (USDA) group (35). This led to the discovery of a substance, named Brassin, from rape (Brassica napus) pollen that stimulated growth in a bean second internode bioassay (35). The first characterized BR, brassinolide (BL), was discovered from bee-collected rape pollen at a concentration of 200 parts per billion (23). The BL structure elucidated by X-ray diffraction technology was (22R,23R,24S)-2α,3α,22,23-tetrahydroxy-24-methyl-B-homo-7-oxa-5α-chol.

1Abbreviations: 22-OHCR, 22-hydroxycampestero; BL, brassinolide; BRs, brassinosteroids; CN, campestanol; CR, campesterol; CS, castasterone; CT, cathasterone; MVA, mevalonic acid; SR, sitosterol; TE, teasterone; TY, typhasterol.
In addition to BL, at least 50 additional BR structures have been identified from various species in the plant kingdom examined to date (20). These include one species of algae (*Hydrodictyon reticulatum*), a pteridophyte (*Equisetum arvense*), 5 species of gymnosperms, and 37 different species of angiosperms (18). Thus, it is conceivable that BRs are ubiquitous in the plant kingdom.

Figure 1. Structural variation in brassinosteroids. Brassinosteroids share structural similarities with the human steroid hormone progesterone and the insect molting hormone ecdysone in that they all have a 4-membered steroid ring backbone and multiple oxidations. Structural variations are primarily based on the different status of oxidation at ring A, B, and the side chain. Different combinations of each element in the three variable regions are reflected in the approximately 50 BRs identified to date. The BR names in the side chain box are applicable when the BL side chain is replaced with one of the structures in the box.

estan-6-one (Fig. 1).