STUDIES ON THE MUCILAGINOUS LAYER OF BARLEY (HORDEUM VULGARE) ROOTS

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ABSTRACT

The nature and composition of the external, mucilaginous layer of barley roots was studied by extraction methods and electron microscopy.

Barley roots were extracted with chloramphenicol-supplemented water at 35°C, with NH₄Cl at various concentrations and with pectinase solutions. The kinetics of transfer of bacteria, total and reducing sugars, proteins, Ca⁺⁺ and K⁺ was studied, and the removal of the mucigel from the extracted roots was followed under the electron microscope.

Within 2 to 3 hours of treatment with water, the rate of release of sugars, ions, proteinaceous material and bacteria, was reduced to almost zero. Increasing concentrations of ammonium chloride enhanced transfer of ions to the extracting solution but affected sugar extraction to a lesser extent. Electron micrographs of ammonium chloride-extracted roots revealed that the amorphous, rather than the fibrillar fraction of the mucigel was removed. At 10⁹ meq of NH₄Cl, distortion of the epidermal layer of the extracted roots was observed. With pectinase as an extractant, there was some enhancement of sugars and ions transfer from the roots to the extracting solution. Electron micrographs showed that the main site of extraction of pectinase was the boundary layer between the root surface and the mucigel. Paper chromatography of the acid hydrolyzate of the water extracted, ethanol-precipitated fraction showed the presence of compounds identical in Rf values to D-glucose, D-arabinose, D-glucuronic acid and D-galacturonic acid. Present methods available for the extraction of the mucigel do not allow the differentiation between extracted pectic compounds which originate from the internal root tissue, and the mucigel.

INTRODUCTION

The roots of many plants are covered with a thin layer of mucilaginous material called 'mucilage' or 'mucigel'. The mucigel may have an important function in root-soil interface.
Generally, the mucigel appears as a transparent, colourless layer, scarcely visible under the light or phase contrast microscope unless stained or bound by colloidal solutions. Dart and Mercer studied the ultrastructure of the mucigel of alfalfa using electron microscopy. They demonstrated a multilayer, fibrillar structure with a definite membrane, in which bacterial cells are embedded. In axenic plants the mucigel is less conspicuous than in plants grown in non-sterile media. However, at least part of the mucigel has a plant origin. Its rate of excretion and the amounts excreted depend on plant age, temperature, moisture and mineral nutrition. Information concerning the exact chemical composition of the mucigel is meager. This arises from the difficulties encountered in the selective extraction, separation and distinction of the mucigel components from pectic polysaccharides present in root cell walls, middle lamellae and in intercellular spaces. The mucigel is a highly hydrated, negatively charged polysaccharide and the following compounds have been reported to be associated with it: pectin, hemicelluloses, cellulose microfibrils, non-reducing sugars, proteins, nucleotides, nucleic acids and enzymes, organic chelates and amino acids. In mucigels of mustard, radish and alfalfa, lipid-like droplets which take up Sudan III stain were found. In general, the information available on the chemical composition relies either on extraction procedures or on histochemical data. The finding of this variety of compounds raises the question of whether they really represent only the outer, mucilagenous layer of the root, or also internal tissue components released by the extraction treatment. It was hypothesized that by following the rate of appearance of various compounds in the extraction solution one can distinguish between those coming mainly from the outer layer, which will be rapidly released at the first stage of extraction, and those that diffuse from the interior of the root which will continue to appear at a slow and constant rate for longer periods of time. Based on this hypothesis, the purpose of this work was to examine the structural changes in barley roots, using electron microscopy, due to gradual and mild extraction of their mucigel with water, NH₄Cl and pectinase solutions, and determine the rate of release of several mucigel components.