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Biogels in the rhizosphere: Plant mucilage as a biofilm matrix that shapes the rhizosphere microbial habitat

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Mucilage is a gelatinous high-molecular-weight substance produced by almost all plants, serving numerous functions for plants and soil. To date, research has mainly focused on the hydraulic and physical functions of mucilage in the rhizosphere. Studies on the relevance of mucilage as a microbial habitat are scarce. Microbial research has largely focused on extracellular polymeric substances (EPS), gelatinous high-molecular-weight substances produced by microorganisms. In soil, EPS support the establishment of microbial assemblages by providing a moist environment, a protective barrier, and serving as carbon and nutrient sources. Our analyses show that mucilage shares the physical and chemical properties of EPS. Mucilage covers large extents of the rhizosphere and could function similarly to the biofilm matrix. Our laboratory and theoretical analyses largely confirmed similar viscosity and surface tension as important physical properties and polysaccharide, protein, neutral monosaccharide, and uronic acid composition as major chemical properties. Our study suggests that mucilage provides functions of EPS required for biofilm formation. Mucilage offers a protected habitat optimized for nutrient mobilization and provides carbon and nutrients. We suggest that the function of mucilage as a biofilm matrix and enabler of high rhizo-microbial abundance and activity has been strongly underestimated, and should be considered as an essential component of conceptual models of the rhizosphere.