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Nature's amazing biopolymer: basic mechanical and hydrological properties of soil affected by plant exudates

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Plant exudates are known to have a very large impact on soil physical properties through changes in mechanical and hydrological processes driven by long-chain polysaccharides and surface active compounds. Whilst these impacts are well known, the basic physical properties of these exudates have only been reported in a small number of studies. We present data for exudates obtained from barley roots and chia seeds, incorporating treatments examining biological decomposition of the exudates. When these exudates were added to a sandy loam soil, contact angle and drop penetration time increased exponentially with increasing exudate concentration. These wetting properties were strongly correlated with both exudate density and zero-shear viscosity, but not with exudate surface tension. Water holding capacity and water repellency of exudate mixed soil tremendously increased with exudate concentration, however they were significantly reduced on decomposition when measured after 14 days of incubation at 16C. Mechanical stability greatly increased with increasing exudate amendment to soils, which was assessed using a rheological amplitude sweep test near saturation, at -50 cm matric potential (field capacity) using indentation test, and at air-dry condition using the Brazilian test. This reflects that exudates not only attenuate plant water stress but also impart mechanical stability to the rhizosphere. These data are highly relevant to the understanding and modelling of rhizosphere development, which is the next phase of our research.