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The swelling of biochar-amended soil can be crucial mechanism decreasing saturated hydraulic conductivity and increasing water-holding capacity at saturation

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The biochar application to soil can change soil hydraulic properties (SHP). The intensity of the changes depends on both the soil properties and the biochar characteristics. Therefore, for the complex understanding of the biochar-amendement effect, it is essential to describe mechanisms controlling the change in SHP instead of quantifying magnitude of the change in specific cases only. In the presented research, two contrasting soils (sandy loam vs. secondarily clayed-sandy loam) were enriched by 0 (control), 2 and 5% of grape stalks biochar (< 0.50 mm, representing high cation exchange capacity) in order to prepare soil samples for 14-days continual saturated flow laboratory experiment. Saturated hydraulic conductivity (Ks) was repeatedly measured during this experiment. Swelling of the samples, bulk density, water holding capacity at saturation (WHCS), and carbon loss were also measured. Additionally, chemical bonds of water molecules to the biochar surface were measured using the Fourier Transform Infra-Red spectroscopy. Water molecules were bound to biochar through the polar hydrogen bonds to O-H and C-O-H. These interactions probably cause 1) intensive swelling of biochar-amended soil (up to 10% of soil sample volume) and 2) increase in WHCS (up to 5%). The significant decreasing effect of presented biochar on Ks (maximum difference by 82.6 %) was noted in case of both contrasting soils. For the tested biochar and contrasting soils, the swelling is obviously important mechanism decreasing Ks and increasing WHCS. The presented results are biochar specific, however, the swelling mechanism can be also important for other biochars exhibiting different characteristics.