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Novel use of microdialysis for high frequent phosphate sampling in xylem sap of beech trees

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Understanding of mass fluxes in ecosystems is important for better understanding of plant physiological processes and the prediction of species behavior under changing environmental conditions. Sampling of various chemical compounds from the xylem sap has been a matter of interest in plant physiology and hydrology but is difficult to undertake. Conventional methods are often destructive and prevent consecutive sampling from a single location. Microdialysis (MD) is a well-established method in neuroscience or pharmacokinetics and has recently also been used in soil science studies. In this contribution we present a novel use of MD for xylem sap sampling. MD may potentially overcome disadvantages of the conventional methods such as twig sampling. With MD the active xylem sap collection is avoided thanks to passive diffusion nature of the MD sampling. Performance of MD is, among others, affected by the xylem sap flow velocity, therefore MD needs calibration. In our case, the calibration was done under laboratory conditions utilizing young beech tree stem segments and a simulated xylem flow that was manipulated by applying a hydraulic head at the top end of the stem segment. The results of the calibration procedure exhibited large variability in recovery rates which was attributed to the effect of simulated xylem flow rate, perfusate P-concentration, aging of the tree and of the MD probe properties. However, when calibrated to known P concentrations the MD probes were capable to measure the diurnal dynamics of P concentration. We present results of a 24h measuring campaign undertaken in spring 2018 using MD in two beech trees (Fagus sylvatica) in the Conventwald experimental site in the Black Forest, Baden-Württemberg, Germany. Both trees exhibited daily patterns with P concentrations peaks in the sampling periods 4:00 – 6:00 and 12:00 – 14:00. Phosphate concentrations were higher in a young beech tree compared to a mature tree. MD calibrated in the laboratory underestimated the actual xylem sap concentration (obtained with gravitational method ca. 2 hours after the end of the MD measurement), but obtained P-concentrations were in the same order of magnitude. We conclude that MD could be a tool to determine high frequent patterns of xylem sap concentration dynamics but still might require restricted destructive sampling to obtain the accurate absolute values.