Advantages of compound specific stable isotope measurements over bulk measurements in studies on plant uptake of intact amino acids

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Uptake of intact amino acids from soil by plants has been shown to be a potential alternative N-source for plants and therefore gained rising scientific interest during the last years. Currently the uptake of intact amino acids is calculated via bulk 13C and 15N measurements of plants grown in soil that has received dual labeled amino acids (13C, 15N). However due to methodological considerations some authors assume that this method includes the risk of overestimating the amount of amino acid uptake and suggest the use of compound specific isotope (CSI) measurements of single amino acids. Despite the considerable number of publications in the field of amino acid uptake differences between both methods have never been quantified and hence it remains unclear if it is worthwhile to replace the common bulk measurements by the more time- and money consuming CSI measurements. We therefore conducted a field experiment in which four dual labeled (15N, 13C) amino acids (glycine, valine, tyrosine and lysine) were applied to soil of a Plantago lanceolata monoculture. Isotopic enrichment of plant tissues 24 h after labeling was measured parallel via bulk or CSI measurements. We found a significant correlation between 13C and 15N enrichment for bulk plant material suggesting that uptake of intact amino acids occurred. However, the measured 13C enrichment in the plant tissues showed that uptake rates for all plant compartments were higher in the case of bulk measurements compared to CSI measurements. Consequently bulk measurements led to a 10, 6, 3 and 7 fold higher amino acid uptake than did CSI measurements. We ascribe this finding to the plants' uptake of tracer derived C-skeletons or bicarbonate originating from the microbial breakdown of tracer amino acids in soil. As bulk measurements can not differentiate between the uptake of 13C in the form of amino acids and in the form of C-fragments originated from tracer decay with bulk measurements, this directly leads to an overestimation of amino acid uptake when bulk measurements are used. We therefore highly recommend the future use of the compound specific isotope technique when investigating the uptake of intact amino acids by plants.