Poster to 'Die 24. Mikrokalorimetrie Tage, Braunschweig, 26.-28. Mai 2021':

Using Isothermal microcalorimetry to measure cadmium-tolerant activity in soil microbial populations of cacao-growing farms in Colombia

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The presence of cadmium (Cd) in farmlands is one of the biggest concerns in the value chains such as chocolate production. In Colombia, cacao is the second largest crop in importance due to its economic and social inclusion to vulnerable populations. However, among other, the presence of cadmium in the cacao-growing soils has become one of the biggest challenges to sustain both production and quality. Therefore, several approaches have converged into mitigation strategies to diagnostic cadmium in soils and prevent its fluxes until its accumulation in the cacao beans. Interestingly, the flux regulation of cadmium in cacao soils, is in part mediated, by the microbial diversity related to this system able to deal with the heavy metal, where the activity of cadmium tolerant bacteria (CdtB) (Bravo and Braissant 2021), is from a major interest due to its metabolic pathways to interact with Cd (i.e., due to its bioweathering capacity). This study proposes the use of the tool of isothermal microcalorimetry, measuring the heat released during cadmium exposition, to assess the immobilization potential of CdtB active populations. In this study, the region selected was the northeastern zone of Antioquia district, in Colombia, where 3 cacao farms were studied taking soil samples and comparing the Cd distribution with cadmium tolerant bacteria diversity and function. As positive controls autochthonous CdtB populations from an enriched region in Santander district were used. The calorimetric thermograms shown higher metabolic activities between first 10h and then at 80 hours, indicating and increase on cadmium metabolization mediated by both fast and slow-growing populations. The metabolic fluxes and the maximum heat-flow produced were small overall, and reflect the metabolic activity associated with bacteria or archaea (to be confirmed by Illumina MiSeq Platform), where the average heat-flow does not exceed 500 mW and of 60.8 Joules of heat. Therefore, the metabolic activity of filamentous fungi with large population density is ruled out. In this study, the samples that showed the maximum heat-flow rates were S01, S05, S16 and S34, where S01 and S05 belong to the Farm 1 and samples S16 and S34 belong to farm 3. Interestingly, the soils samples S01 and S05 were found close to the trunks related to the cacao varieties of ICS95 and EET8 respectively. These varieties have been suggested as hyperaccumulators (Gil et al. 2021) For soil samples S16 and S34, both close to the trunk of the cocoa variety TSH565, allowing to generate a discussion based on the accumulation of Cd in tissues for certain specific cocoa varieties according to its biotranslocation/bioaccumulation factors. The IMC method to understand the role of CdtB active populations in cacao-growing soils is an important step to follow up bioremediation strategies where the selection of CdtB populations at specific soil conditions might contribute to reduce the labile fraction of cadmium going into the flux within the plant to a final deposition in cacao beans.

References.

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