

Biomining trees turn CO₂ into CaCO₃? Identifying novel oxalate-carbonate pathways associated with East African Fig trees in Samburu County, Kenya.

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The oxalate-carbonate pathway (OCP) is a connected plant-soil-microbe system that sequesters atmospheric CO₂ as inorganic C (CaCO₃) adjacent to calcium oxalate (CaOx) producing plant species (Verrecchia et al., 2006). The process begins when certain plants produce CaOx crystals, which are then subsequently released into the surrounding ecosystem, and catabolised by oxalotrophic microorganisms. Oxalotrophy drives a localised alkalisation that eventually precipitates CaCO₃ in non-calcareous soils. Yet, the OCP has rarely been studied in connection to tree species with significant agroforestry potential, (Rowley et al., 2017), limiting its application in agro-ecosystems.

This study investigates novel oxalate-carbonate pathways associated with three food-producing East African fig tree species (*Ficus wakefieldii* *n* = 5, *Ficus natalensis* *n* = 3, and *Ficus glumosa* *n* = 5) in the degraded basaltic soils of Samburu County, Kenya. We employ a range of bulk techniques to characterise the C and Ca biogeochemical cycles associated with the fig trees. We also used μ -X-ray fluorescence coupled to μ -X-ray absorption near edge structure spectroscopy at the Ca k-edge (beam line 14-3b) to investigate changes in the Ca speciation of aboveground biomass.

All the studied fig trees in Samburu County were associated with CaCO₃ precipitation. *Ficus wakefieldii* was associated with larger quantities of CaCO₃ and had a stronger effect on local soil biogeochemistry. We mapped the Ca speciation of *F. wakefieldii* aboveground biomass, showing that precipitation of CaCO₃ seemed to occur both on the exterior and interior of the tree. This study highlights that the aboveground precipitation of CaCO₃ associated with the OCP species seems to occur through two separate mechanisms, which will be explored in this

presentation. It also highlights the potential for Fig-based OCP-agroforestry to sequester significant quantities of atmospheric CO₂ as CaCO₃, while contributing to local food security.

References

Rowley, M. C., et al., 2017. Moving carbon between spheres, the potential oxalate-carbonate pathway of *Brosimum alicastrum*. <https://doi.org/10.1007/s11104-016-3135-3>.

Verrecchia, E. P., et al., 2006. The oxalate-carbonate pathway in soil carbon storage. <https://doi.org/10.1017/CBO9780511550522.013>.

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$\text{CaCO}_3 + 2 \text{HCl} \rightarrow \text{CaCl}_2 + \text{H}_2\text{O} + \text{CO}_2$

