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Phosphate mineral weathering by carboxylic acids is driven by functional group composition and orientation

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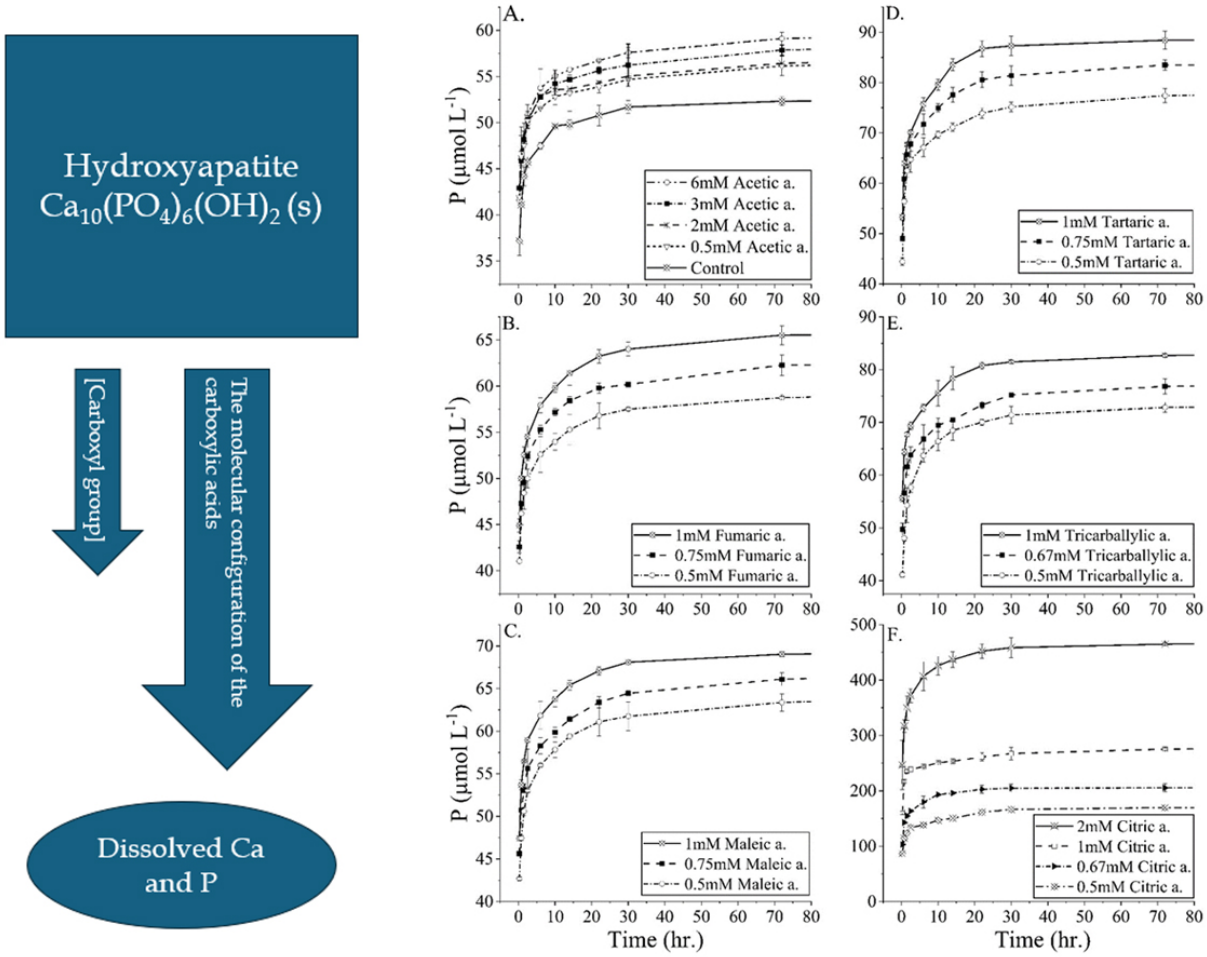

Cumulative release of phosphate (P) during dissolution of hydroxyapatite with and without the addition of acetic acid (A), fumaric acid (B), maleic acid (C), tartaric acid (D), tricarballylic acid (E), and citric acid (F). The dissolution occurred at pH 8.01. Blue arrows indicate that the arrangement ("molecular configuration") of carboxylic acid functional groups is more important to the weathering process than their concentration (brackets). Adapted figure courtesy of Yaniv Fraiberg and Yuji Arai.

Phosphorus is an essential nutrient for crops, but it is not readily available to plants in alkaline soils because it forms insoluble calcium phosphate minerals.

Organic acids released from soil microorganisms and found in soil humus and organic amendments are known to induce the weathering of these minerals. However, mineral weathering by specific chemical functional groups (i.e., active part of organic acids that determine how they behave in chemical reactions) remains poorly understood.

In this study, six different organic acids, each containing distinct numbers and arrangements of important functional groups, were tested in mineral weathering experiments. It was found that the arrangement of carboxyl- and/or hydroxyl-functional groups was more important in weathering calcium phosphate minerals than their concentration.

These findings enhance our understanding of how organic acids in soils can improve phosphorus plant availability in alkaline soils.

Dig deeper

Freiberg, Y., & Arai, Y. (2026). Hydroxyapatite dissolution kinetics: The effects of molecular configurations of six carboxylic acids. *Soil Science Society of America Journal*, *90*, e70212. https://doi.org/10.1002/saj2.7021

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