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Interaction Between Phthalate Plasticizers and Calcium Oxalate: Impacts on Precipitation Behavior

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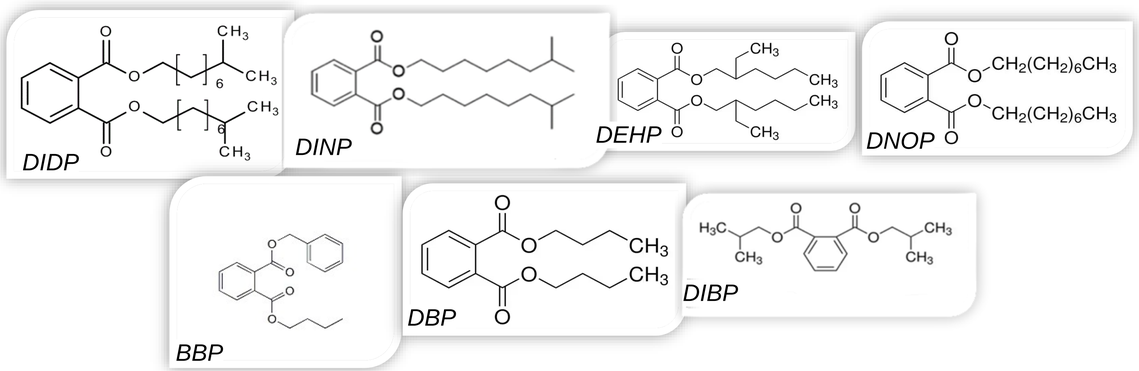
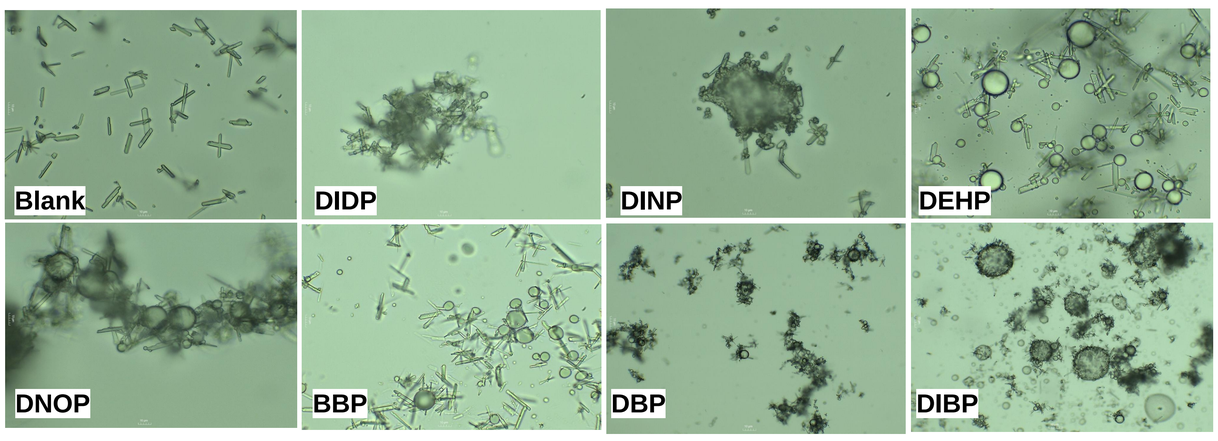
INTRODUCTION & AIM

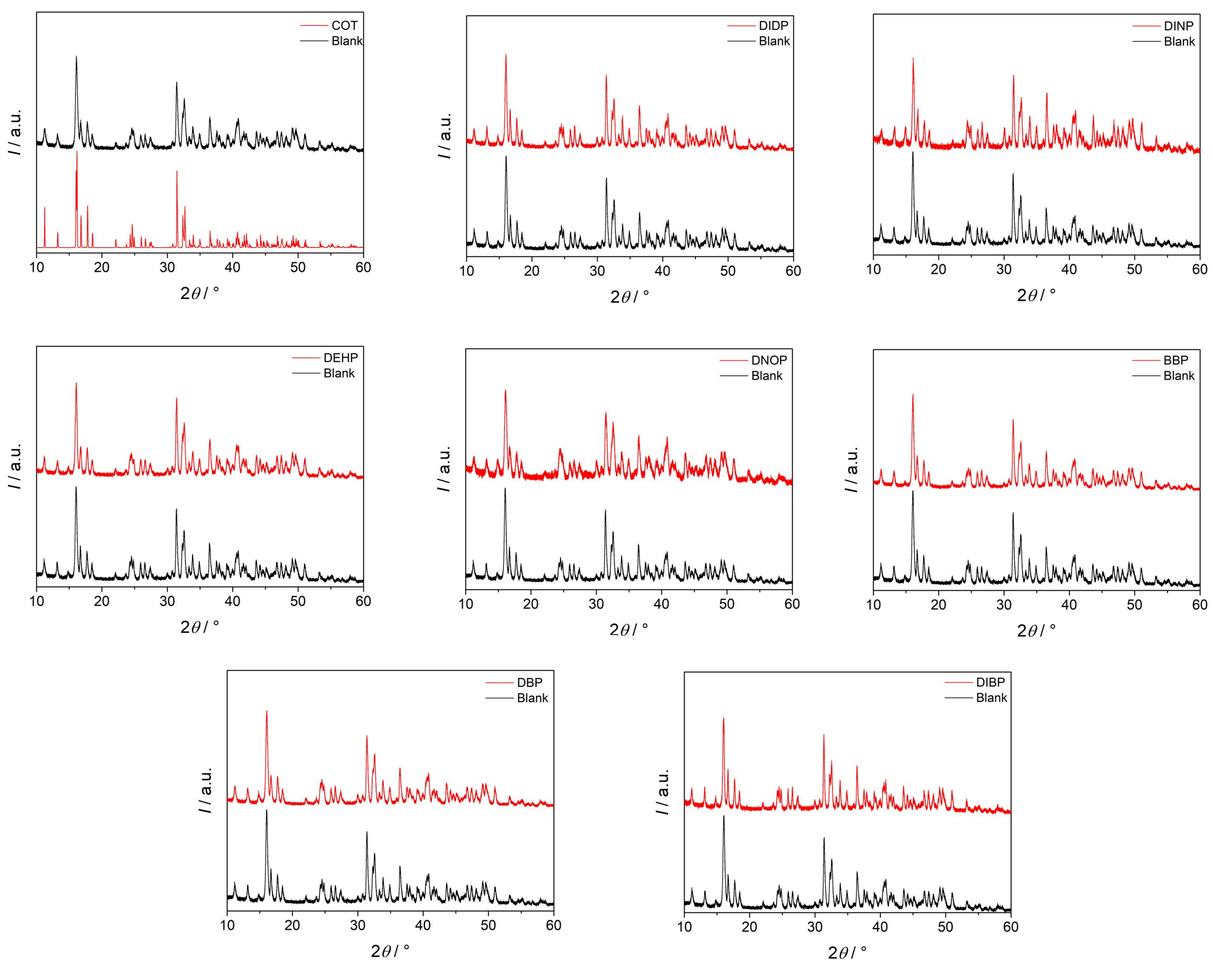
Calcium oxalate (CaOx) is the major constituent of most kidney stones. Since crystal nucleation, growth, and phase selection are key processes in stone formation, identifying factors that influence CaOx crystallization is of considerable clinical interest. Phthalate esters, widely used environmental plasticizers, are ubiquitous contaminants with potential biological effects. Here, the impact of seven structurally distinct phthalates (DIDP, DINP, DEHP, DNOP, BBP, DBP, and DIBP) on CaOx crystallization under physiologically relevant conditions was examined.

METHOD

CaOx crystallization was performed in aqueous solutions with and without phthalates (DIDP, DINP, DEHP, DNOP, BBP, DBP, and DIBP) at controlled pH, ionic strength, and temperature (pH = 6.5, I_c = 0.05 M, and 37 °C). Crystal morphology was analyzed by light microscopy, and phase composition was characterized by XRD and FTIR spectroscopy.



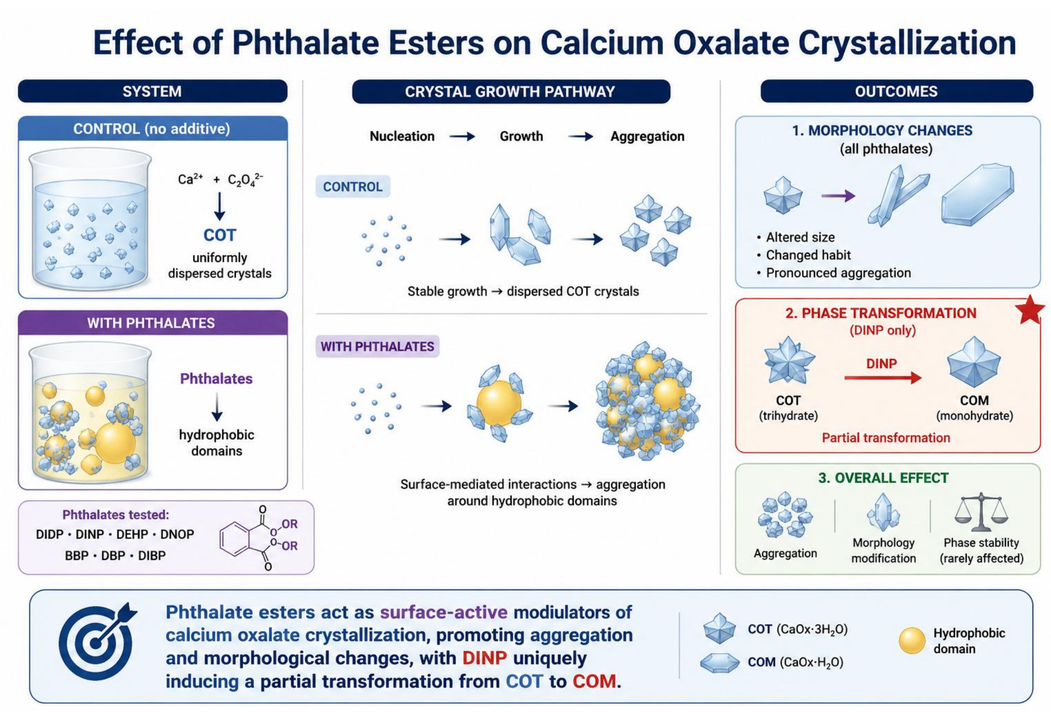


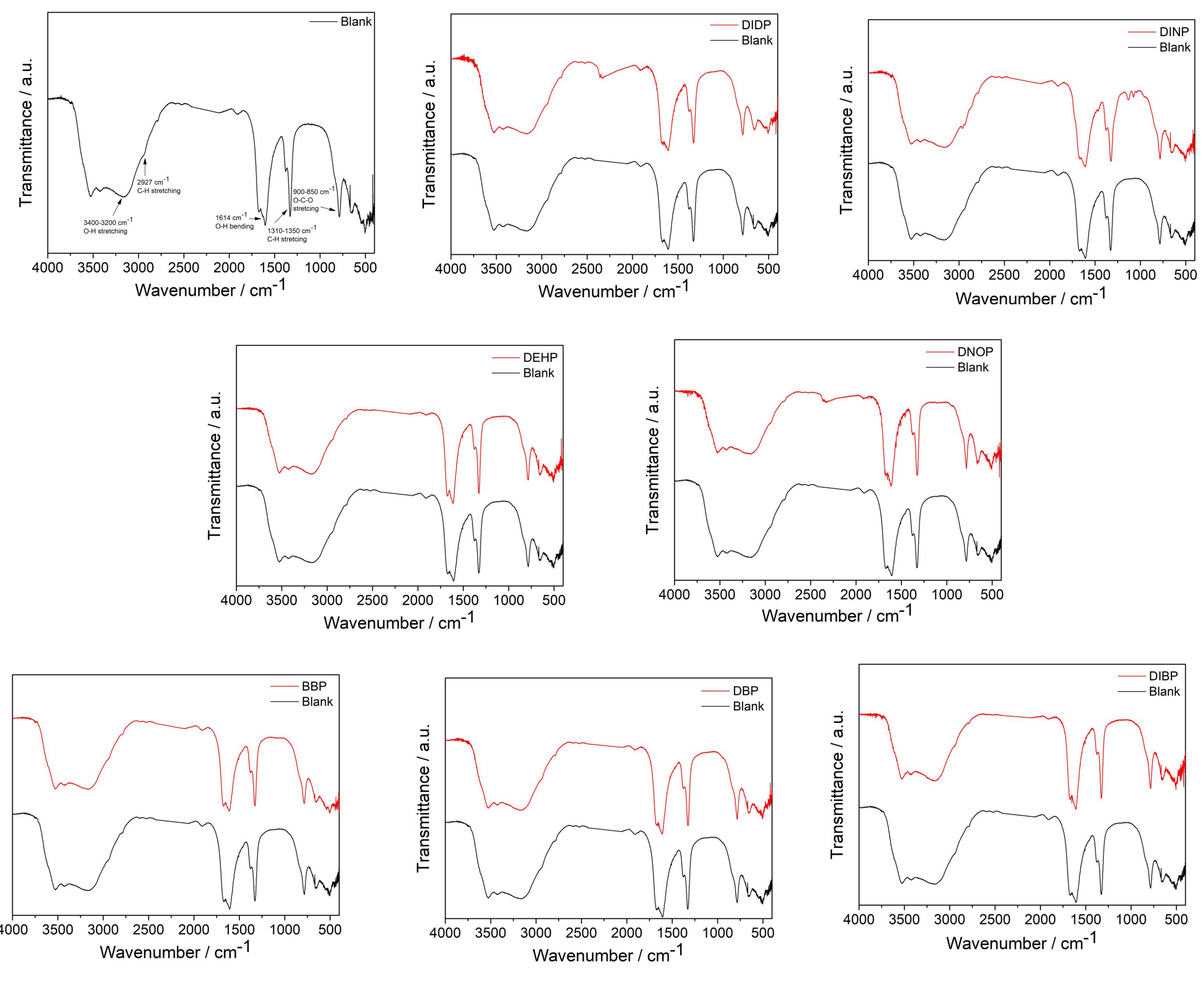


RESULTS & DISCUSSION

In the additive-free system, calcium oxalate crystallized exclusively as calcium oxalate trihydrate (COT), forming uniformly dispersed crystals without aggregation. All tested phthalates (DIDP, DINP, DEHP, DNOP, BBP, DBP, and DIBP) significantly affected crystallization behavior, inducing pronounced crystal aggregation around hydrophobic domains. This suggests strong crystal–additive interactions likely driven by hydrophobic effects. Phthalate exposure also led to consistent changes in crystal morphology, including variations in crystal size, width, and length, indicating an influence on crystal growth dynamics [1].

Notably, DINP uniquely induced a partial phase transformation from COT to the more stable calcium oxalate monohydrate (COM), highlighting a distinct effect on CaOx phase stability compared to the other tested compounds.





CONCLUSIONS

Phthalate esters consistently promoted calcium oxalate (CaOx) crystal aggregation, indicating surface-mediated interactions with growing crystals. While overall phase composition was largely unaffected, all compounds induced noticeable morphological changes, suggesting that molecular structure (hydrophobicity, chain length, and branching) governs crystal growth behavior. Only DINP induced a partial transformation from calcium oxalate trihydrate (COT) to the more stable monohydrate (COM), highlighting a unique effect on CaOx phase stability among the tested phthalates.

FUNDINGS/REFERENCES

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