

## Key factors determining surface charge and colloidal stability in phosphorylated cellulose nanocrystals via metaphosphoric acid–urea functionalization

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Área temática: A. Síntesis de nanomateriales

Phosphorylated cellulose nanocrystals (P-CNCs) have emerged as an alternative to sulfuric acid-derived conventional CNC due to their enhanced colloidal stability. In this study, P-CNCs were synthesized from bleached hardwood kraft pulp (BEKP) via a controlled hydrolysis route involving  $H_3PO_3$  pretreatment followed by reaction with metaphosphoric acid ( $HPO_3$ ) and urea. A full factorial design was applied to evaluate the effects of reaction time (60–90 min) and  $HPO_3$  concentration (3–4 M) on surface charge and zeta potential. Surface charge densities ranged from 757 to 1993 mmol/kg, while zeta potential values ranged from –30.17 to –67.40 mV, confirming high colloidal stability. Statistical analysis revealed that reaction time had a significant main effect on surface charge ( $p = 0.0022$ ), and the only factor significantly affecting zeta potential ( $p = 0.0488$ ), whereas  $HPO_3$  concentration showed a secondary but significant effect on surface charge ( $p = 0.0203$ ). A significant interaction between the two factors ( $p = 0.0097$ ) indicates that their effects are not independent. These results demonstrate that surface functionalization and colloidal behavior of P-CNCs can be effectively tuned through controlled processing conditions, with reaction time playing a central role. These findings contribute to a better understanding of the surface modification and stability of P-CNCs and support the sustainable production of functional nanocellulose materials.

### REFERENCIAS

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