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Stimuli responsive cellulose–*p*-coumaric acid system for functional supplement design

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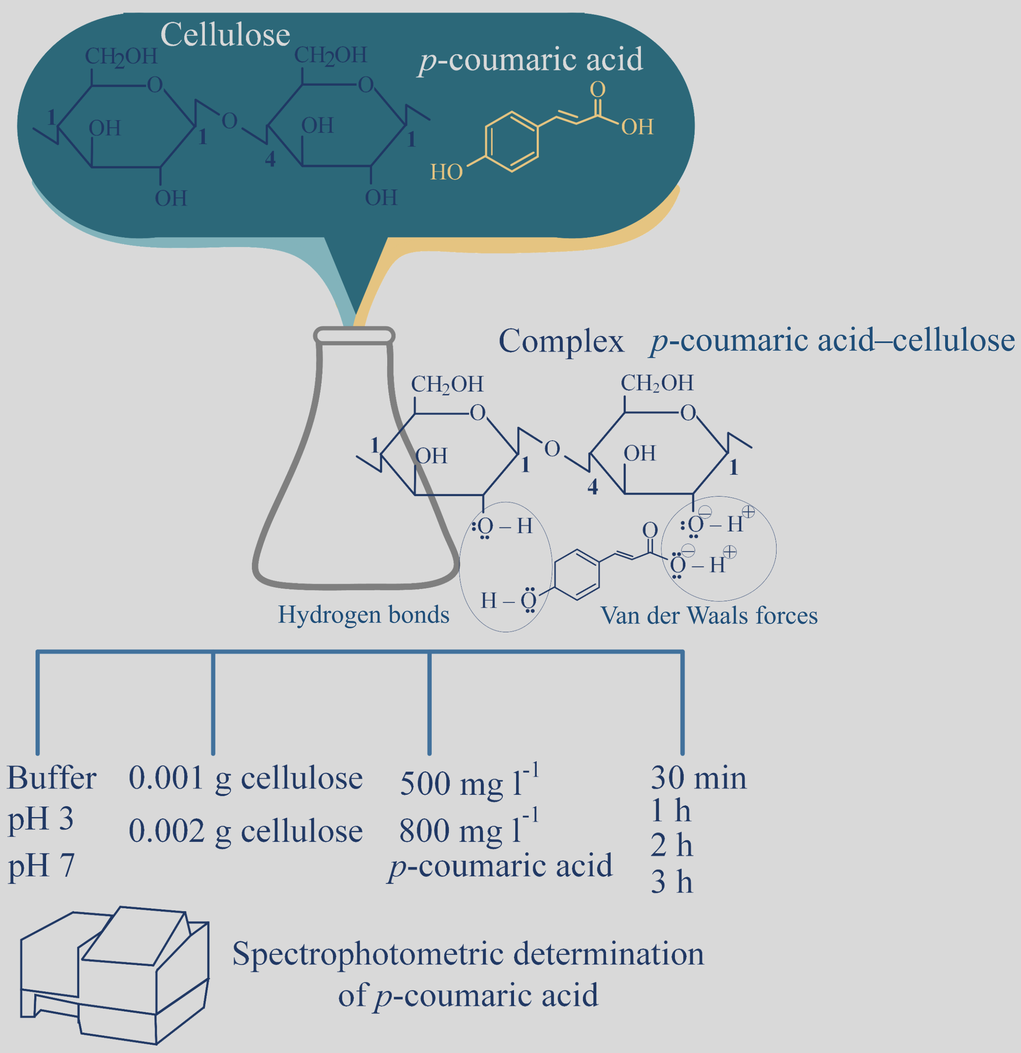
INTRODUCTION

- Polymers are widely used in the design and development of drug delivery systems.
- Cellulose - one of the most abundant naturally occurring insoluble biopolymer.
- Cellulose finds applications in various biomedical fields, including the design of polyphenol-based supplements.
- Polyphenols like *p*-coumaric acid, exhibit numerous health-promoting bioactivities and gained significant attention for pharmaceutical applications.
- Interactions depends on pH values.
- The aim was to investigate pH-dependent adsorption between varying concentrations of cellulose and *p*-coumaric acid over time, assessing how pH influences adsorption capacity and binding stability.

MATERIALS AND METHODS



CONCLUSIONS

- *p*-coumaric acid can be found in various fruits and vegetables and exhibit numerous health-promoting bioactivities and gained significant attention for pharmaceutical applications
- Different factors can influence the interactions between *p*-coumaric acid and cellulose like pH values and concentration.
- Adsorption was the highest for 0.001 g cellulose and 800 mg l^{-1} p-coumaric acid at both pH 3 and 7 values.

➡ Interactions between *p*-coumaric acid and cellulose was pH values and concentration depended process.

➡ These findings contribute to the development of dietary supplements by enabling stimuli-responsive, controlled release of bioactive compounds.

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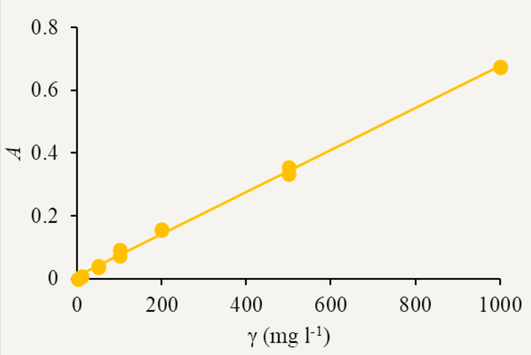
RESULTS

VALIDATION OF FOLIN-CIOCALTEU METHOD:

Calibration curve of *p*-coumaric acid in methanol and validation parameters.



Validation parameter	
Calibration curve:	
Range /mg L^{-1}	1-1000
Calibration equation	y=0.0007+0.0086
R^2	0.9980
LOD /mg L^{-1}	2.33
LOQ /mg L^{-1}	7.07
Accuracy :	
Slope	1.044
95 % confidence interval	1.01−1.07
Intercept	-0.5043
95 % confidence interval	-11.63−12.57

➡ linear calibration curves (R^2 is 0.9980), with reasonably low LOD (2.33 mg l^{-1}) and LOQ (7.07 mg l^{-1})

➡ the accuracy of the method is confirmed by the absence of systematic error, as indicated by the confidence interval for the slope (which contains 1) and the intercept (which contains 0)

➡ calibration curve was used in the experiment of the adsorption of *p*-coumaric acid onto the dietary fibers

CHARACTERISATION OF CELLULOSE:

Water holding capacity (WD, g g^{-1}), water swelling capacity (WSC, g g^{-1}) and water solubility (WS, g g^{-1}) for cellulose. Data represent mean ± SD (n=2).

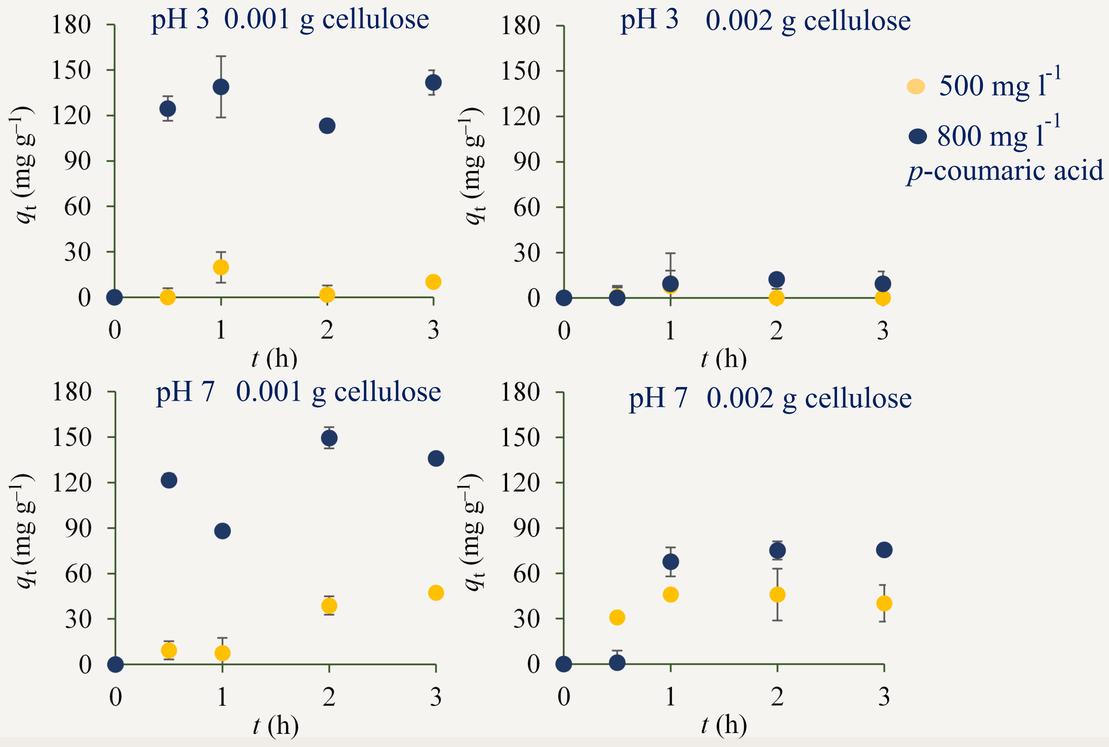
WD (g water g^{-1} fiber)	WSC (g water g^{-1} fiber)	WS (g water g^{-1} fiber)
6.44±0.38	8.03±1.55	0.024±0.0017

➡ water holding capacity depends on dietary fiber's structure, and range from 2.01 to 25.03 g g^{-1}

➡ the ability of celullose to retain water suggests that they may facilitate the uptake and incorporation of *p*-coumaric acid into the fiber

ADSORPTION CAPACITY OF *p*-COUMARIC ACID ONTO CELLULOSE

Adsorption capacity q_t in different time *t* for concentration of 500 and 800 mg l^{-1} *p*-coumaric acid and 0.001 g cellulose and 0.002 g at pH 3 and pH 7.



➡ pH value influenced the adsorption capacity, adsorption capacity differ at different pH value

➡ the amount od *p*-coumaric acid and cellulose influenced the adsorption capacity

➡ the adsorption capacity was simmilar at pH 7 (131 mg g^{-1}) and pH 3 (141 mg g^{-1}) for 0.001 g cellulose and 800 mg l^{-1} *p*-coumaric acid

Kinetic parameters of pseudo-first and pseudo-second order models describing the adsorption of *p*-coumaric acid onto cellulose and half-reaction time for pseudo-first and pseudo-second order models.

	Pseudo-first order				Pseudo-second order			
	k_1 (h^{-1})	q_e (mg g^{-1})	*SE*	$t_{1/2}$ (h)	k_2 (g mg^{-1} h^{-1})	q_e (mg g^{-1})	*SE*	$t_{1/2}$ (h)
pH 7								
0.001 g cellulose								
800 mg l^{-1} *p*-coumaric acid	3.0	140	21	0.23	0.08	129	18	0.09
pH 3								
0.001 g cellulose								
800 mg l^{-1} *p*-coumaric acid	5	145	14	0.14	3	120	9	0.002

➡ to understand the interactions during the time, kinetic study was performed

➡ experimentally obtained adsorption capacities obtained by pseudo-first orde are in accordance with adsorption capacities obtained by model