Mechanisms and Properties of Chitosan-Assisted Bamboo Dyeing

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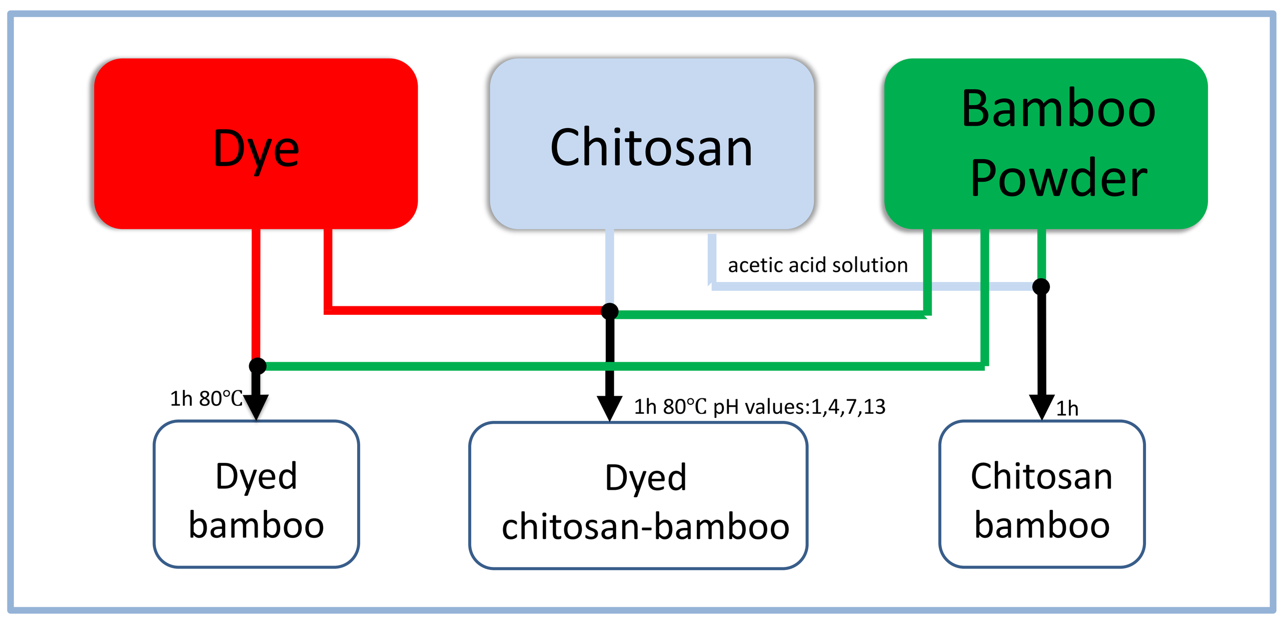
Abstract

- Acid dyes are often used to improve the decorative properties of bamboo products. However, the use of these dyes is problematic because they run easily. This study examined the use of chitosan as a fixing agent to address this issue, and investigated the interaction between dyed bamboo powder and dyed veneers pre-treated with chitosan.
- Powder was dyed at various pH values with acid scarlet GR and soaked in various solvents. Analyses were conducted using Fourier transform infrared spectroscopy, a zeta potential measurement analyzer, UV-visible spectroscopy, and a color measuring instrument. Pre-treated bamboo veneers were also dyed with acid scarlet GR and evaluated with the color measuring instrument, a scanning electron microscope, and an optical microscope.
- Chitosan functioned as a bridge and immobilized dye on the bamboo. This occurred through a chemical reaction and opposite charge attraction under acidic conditions.

Materials and methods

1 Preparation of Dyed Chitosan-bamboo



2 Analytic Methods to Determine Immobilization Mechanisms

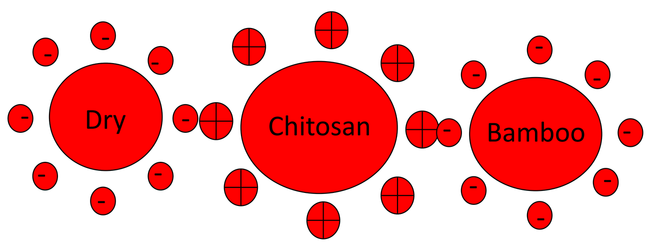
a) Zeta Potential Analysis
b) FTIR Analysis
c) SEM Analysis
d) Effects of Chitosan on Bamboo Dye Uptake
e) Stability of Dyed Chitosan-Bamboo under Various Conditions

Results

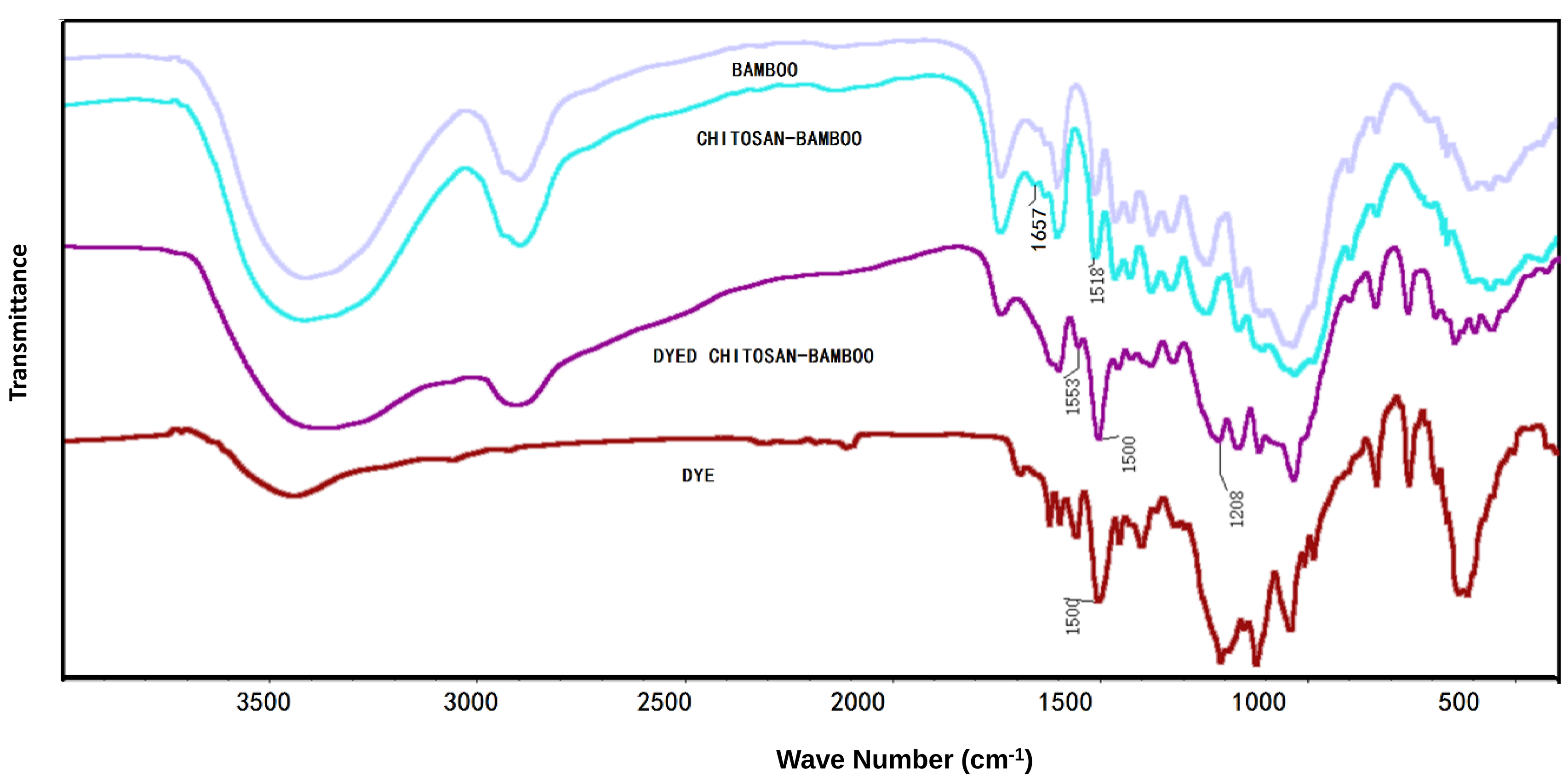
a) Zeta Potentials of Bamboo, Chitosan, and Dye at Different pH Values

pH value	Zeta potential		
	Bamboo	Chitosan[a]	Dye
1	-1.1±0.76	14.8±2.88	-13.0±5.59
4	-12.2±1.81	57.9±5.32	-19.7±2.33
7	-11.8±1.25	-	-24.8±1.62
13	-13.6±1.37	-	-28.4±7.13

[a] Chitosan was dissolved with acetic acid solution, so the zeta potentials at 7 and 13 were not tested.

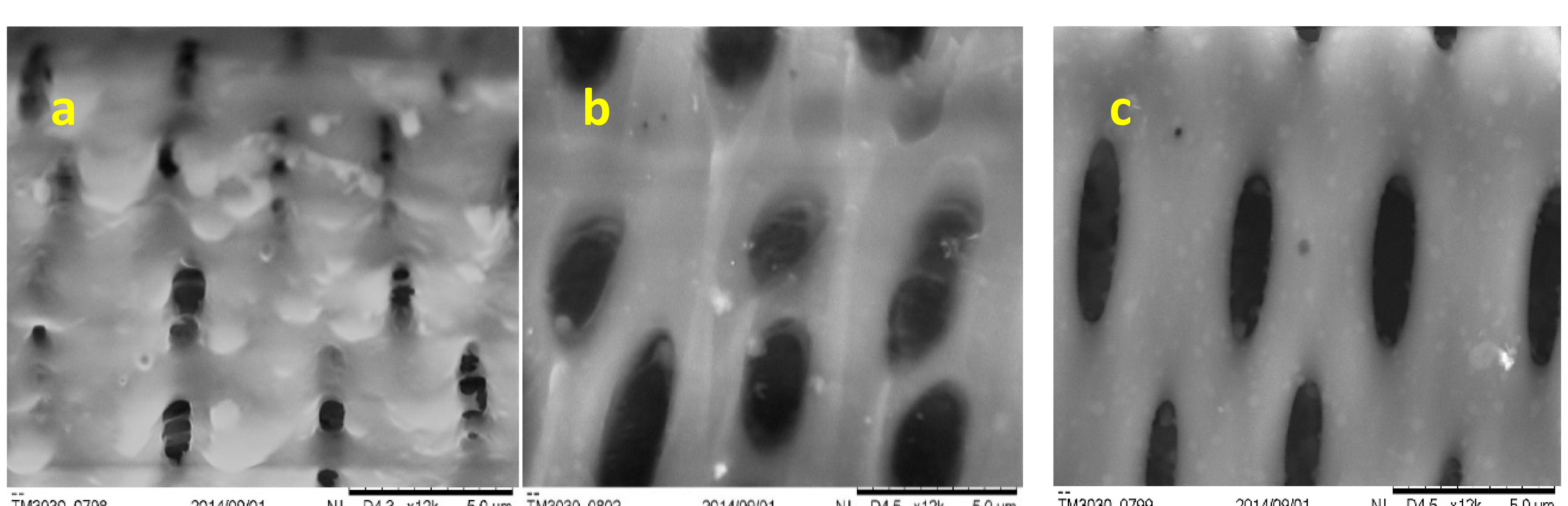


b) FTIR spectra of bamboo, chitosan-bamboo, dye, and dyed chitosan-bamboo



$$CTS-NH_2+HSO_3-GR\rightarrow CTS-NH_3^{+-}SO_3-GR \qquad GR-SO_3Na+H^+\rightarrow GR-SO_3H+Na^+$$

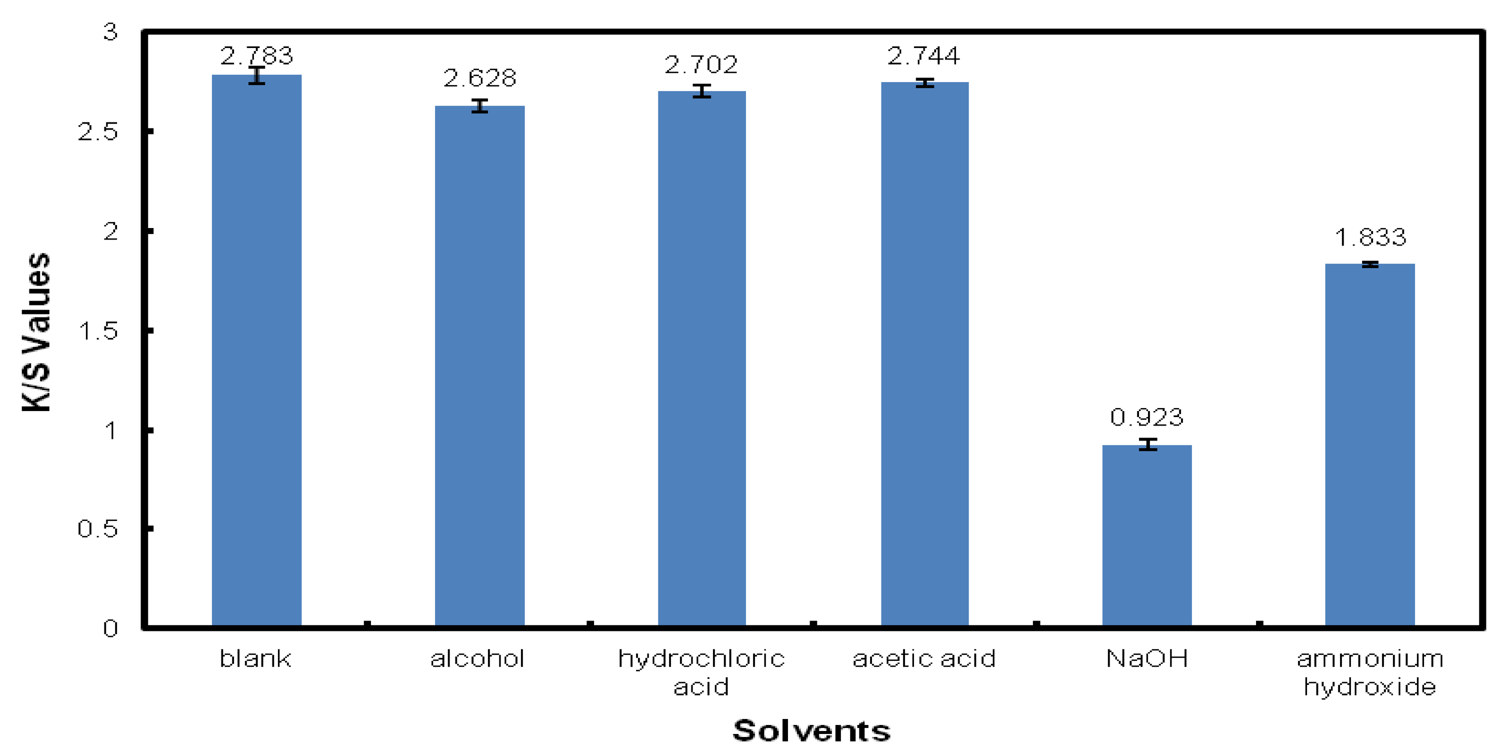
c) SEM micrographs of (a) dyed chitosan-bamboo, (b) chitosan-bamboo, (c) dyed bamboo



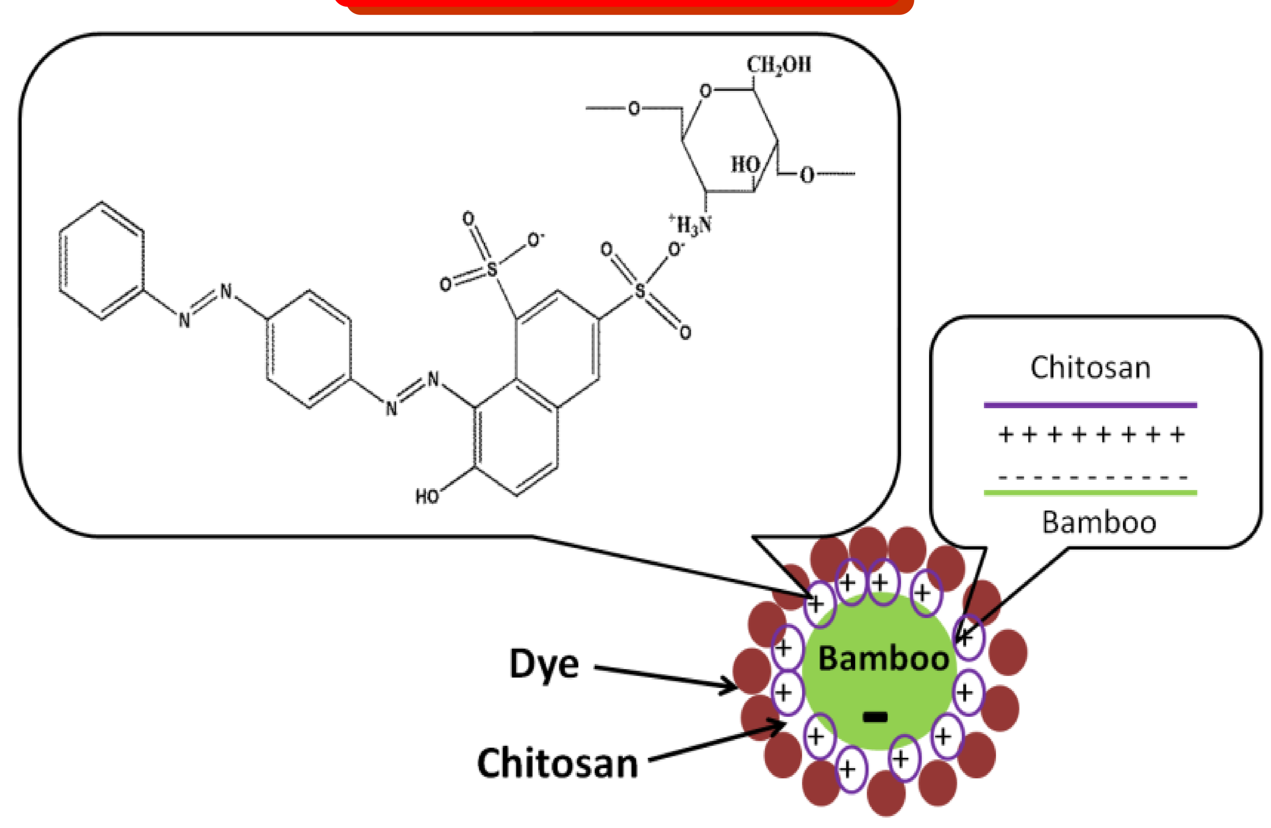
d) Dyeing Rate (%) of Bamboo and Chitosan-Bamboo at Different pH Values

pH value	Dyeing Rate (%)	
	Bamboo	Chitosan-bamboo
1	38.40 ± 2.57	59.71 ± 2.60 ⬆
4	37.97 ± 1.40	54.56 ± 6.25 ⬆
7	35.32 ± 0.70	52.43 ± 3.64 ⬆
13	19.82 ± 6.11	13.72 ± 1.09 ⬆

e) Stability of Dyed Chitosan-Bamboo under Various Conditions



Conclusions



1. Chitosan is a promising fixing agent for bamboo dyeing, except in alkaline conditions.
2. Chitosan functions as a bridge that links acid dyestuff and bamboo through chemical reactions and electrical attraction.
3. Chitosan modification improved the dyeing rate.