Production of Natural Green Dye from Bamboo Leaves

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1. INTRODUCTION

Bamboo exhibits attractive greenish color due to the abundant chlorophyll in culms as well as in leaves. But the green color on the bamboo culms fades away because of chlorophyll degradation by light, oxygen and enzymes [1]. The green color protection of bamboo had been widely studied to increase the economic value of bamboo products using green culms. Abundant bamboo leaves have not been utilized, except that young leaves made into bamboo tea recently in Korea. We thought the bamboo leaves have a high potentiality for useful resource of natural green dye. In previous studies, several inorganic salts including chromates, nickel salts, and copper salts were used as protectors of green color of bamboo culms [2, 3]. In addition to inorganic salts treatments, alkali pretreatment was necessary process for the protection of bamboo green color [4]. Paying attention on this point, the objective of this study was to find an appropriate method and process for protecting the green color in bamboo leaves and subsequent extraction of the green colorants. Various inorganic salts including cupric sulfate, ferric sulfate, and zinc chloride were employed as green color protectors. Accordingly, the effects of metal salts and treatment conditions on color protection were investigated to find appropriate protector and conditions. And also, the efficacy of bamboo colorants as a natural green dye was evaluated through dyeing and colorfastness tests.

2. EXPERIMENTAL

Materials

Bamboo leaves of Phyllostachs nigra(Lodd) Munro var. *henonis* (Bean) Stapf in Damyang areas were collected, dried in the shade and kept in a refrigerator. Reagents used were of first grades. For dyeing test, wool and microfiber nylon fabrics were obtained commercially.

Methods

Bamboo leaves (50g) were boiled for 60min to remove yellow colorants and subsequently treated with inorganic salts solution to protect green color of chlorophyll. The pretreated bamboo leaves were used to extract colorants in alkali solution and this extraction process was repeated twice. Using colorant extracts, dyeing was carried out 100°C for 60min at a liquor ratio of 1:100 using an infra-red automatic dyeing machine (Ahiba Nuance, Data Color International, USA), and rinsed for further evaluation. Dye uptake was assessed by measuring K/S value at the maximum adsorption wavelength (λmax; 400nm) using a Macbeth Coloreye 3100 spectrophotometer. CIELab coordinates (Illuminant D_{65}/10°Observer) was measured with a Macbeth Coloreye 3100 spectrophotometer at 640 nm. H V/C values were obtained from $L^*a^*b^*$ data using CIE Munsell conversion program. Absorbance of colorants extraction was measured using a UV-Vis spectrophotometer (Agilant 845, Agilant Technologies, Waldbronm, Germany).

Fastness to washing of the dyed samples was evaluated by AATCC method 61-1989. Light fastness was assessed in terms of color difference (ΔE*) and color change against the appropriate Gray scale according to AATCC method 16-1998 with a Xenon Test Chamber(Q-Sun Xe-1-B, USA). Color differences after irradiating for 5, 10, 20, and 40 hours was measured to get fading curve. Dry and wet rubbing fastness also evaluated by AATCC method 8-2005.

Antimicrobial activity of dyed fabrics was measured by shake flask method in terms of bacterial reduction rate. *Staphylococcus aureus* (ATCC 6538) was the bacteria used.

3. RESULTS AND DISCUSSION

Fig. 1 shows absorption spectra of colorant extracts at different metal pretreatment. Two peaks are observed at 400-420 nm and 630-660 nm, indicating yellow-green and green colors, respectively. Depending on metal type, peaks were varied slightly in similar color ranges. Light stability of the extracts was evaluated in terms of absorbance retention (colorant concentration) for 12 days under the artificial daylight (6500K), including UV, conditions (Fig. 2). Among inorganic metals, copper salt was the most stable, 80% of colorants were remained after 12 days of light exposure. Other metals resulted to retain 10-30% of colorants at 630-660 nm.

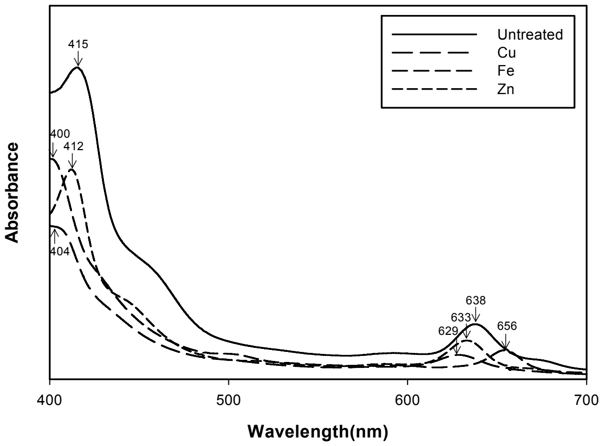

Fig. 1. Visible absorption spectra of bamboo leaves extracts.

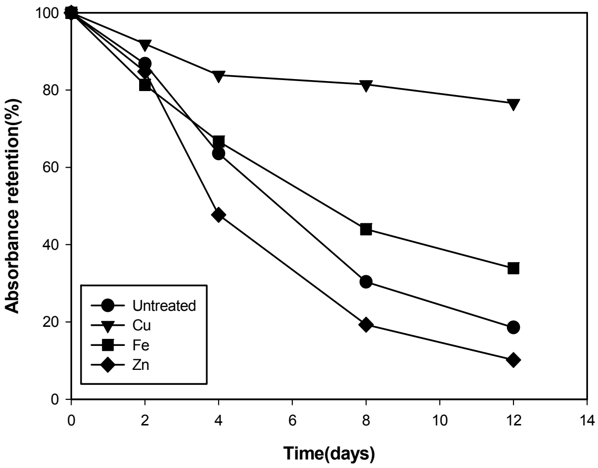

Fig. 2. Light stability of bamboo leaves extracts pretreated with different metal salts.

Table 1 shows dyeing results using colorants extracts with different metal treatments respectively. Without pretreatment, the colors of dyed wool and nylon fabrics were 0.6GY and 10.0Y, indicating yellow color rather than green color. The results confirmed that green color can be protected by metal salts pretreatment and Cu salt among metal salts gave more greenish color to the dyed fabrics.

On the basis of experimental results for stabilizing bamboo leaves colorants, it was confirmed that Cu was the most appropriate metal type considering dye uptake, photostability, and light fastness, and its optimum concentration was 0.025% (Fig. 3). After the stabilization, NaOH aqueous solution of 1% was efficient extraction condition.

Table 1. Color and colorfastness of dyed fabrics with colorants extracts after different metal pretreatment

Fabric	Metal	H V/C	L^*	a^*	b^*	ΔE^*	Light fastness
Wool	Control	0.6GY 3.9/3.1	39.96	-4.33	21.41	46.01	1
	Cu	3.4GY 5.3/3.1	53.93	-7.76	20.80	32.97	2/3
	Fe	9.9Y 4.5/3.1	46.04	-3.91	22.71	40.47	1
	Zn	1.7GY 4.3/3.5	44.39	-6.48	23.87	42.64	1
Microfiber nylon	Control	10.0Y 5.3/3.4	54.10	-4.12	24.96	47.92	1
	Cu	7.5GY 6.2/3.5	63.24	-13.87	19.33	39.45	2/3
	Fe	9.8Y 5.8/3.3	59.47	-4.12	24.29	43.08	1
	Zn	0.8GY 5.0/3.5	51.32	-5.60	24.59	50.25	1

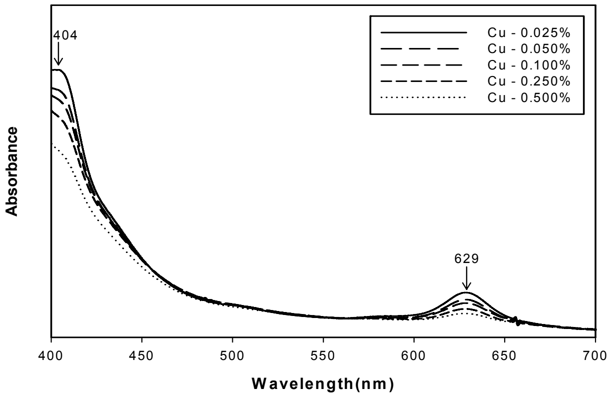

Fig. 3. Visible absorption spectra of bamboo leaves extracts.

4. ACKNOWLEDGEMENTS

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