

A Study on the Dyeability and Antimicrobial Activity of Turmeric

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I. Introduction

Natural dyeing is very popular because of the naturalness of color and environment -friendly. Turmeric is an aromatic, perennial herb, up to 1 m high and distributed in East Asia. Parts used of it Rhizomes and is known to be used a medicinal stuff yellow dye stuff from past to nowadays in the Oriental region. This study tried to compare to the dyeability of Turmeric according to pH, temperature, mordants, and the antimicrobial properties of it between fabrics dyed with turmeric and without it.

II . Materials and experimental

1. Colorant : The coloring material, *Curcuma longa* L, extracted from Turmeric

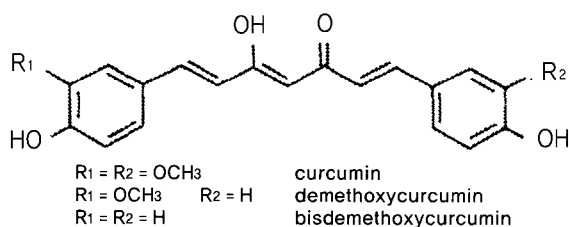


Fig. 1. The structure of *Curcuma longa* L

2. Fiber : White wool is guaranteed by FITI Korea(product ID : KS K 0905).

3. Mordants : The mordants used in this experiment were Al(OH)(CH₃COO)₂., FeCl₂H₂O, Cu(CH₃COO)₂H₂O and are abbreviated as Al, Fe and Cu respectively.

4. Antimicrobial activity test

- Test Bacteria : *Staphylococcus aureus* (ATCC 6538) o medium : Nutrient medium,
- solution for dilution of bacteria : 0.85% NaCl(Saline)
- material : ① 1st and 2nd extract of Turmeric
② undyed, dyed one time and twice with Turmeric extract

5. Dyeing and mordanting : The silk fabrics were dyed with 10% o.w.f. of the gel extracted from Turmeric at various temperature(40-100°C) for 6 hours with the liquid ratio of 1:100, and then washed. Mordanting processes were carried out at 50°C for 40 minutes after dyeing.

6. Dyeing rate : The reflectance of dyed fabric was measured at 462nm using UV2100 Spectrophotometer(Shimadzu Japan) and K/S value was obtained from reflectance by Kubelka-Munk equation. The dye in residual bath was analyzed quantitatively from the calibration curve(λ_{max} 446nm, gram absorptivity : 4.7).

$K/S = (1-R)^2 / 2R$ K : light absorbing factor, S : light scattering factor, R : reflectance

7. Measuring of color : The $L^*a^*b^*$ were measured using computer color matching system(Datacolor)

8. Fastness of dyed fabric : The light fastness was tested using Fade-O-meter(Atlas Electric Device Co.) by the Korean standard method, KS K0700 and the washing fastness was tested using Launder-O-meter(AATCC Standard Instrometer) by the KS K0644.

9. Test of Antibacterial Effect

- ① On a solid medium : Freshly cultivated Staphylococcus aureus ATCC 6538 was spreaded on a nutrient agar medium. The paper disks soaked in staining-solution, extracted from Korean Plant, and stained clothes were put on the medium and incubated at 37°C overnight and the bacterial growth inhibition-zones were observed.
- ② In a liquid medium : The 0.2 g of stained and none-stained clothes were submerged into the diluted solution of Staphylococcus aureus ATCC 6538 (108-107 cell/ml) with saline and incubated at 37°C for 12 hrs. After being diluted adequately with saline, the incubated bacteria were spread on the nutrient agar medium and incubated at 37°C overnight, the number of colonies were then calculated.

III. Results

1. Dyeability of concentration and temperature

Fig. 2 shows the dyeing rates at 100°C, pH 5, according to various dye concentration(dilution times 5, 10, 20, 30, 50) on wool fiber in 60 minutes and the dyeing rates are decreased according as dilution times are increased..

Fig. 3 shows the dyeing rates according various temperature(40, 60, 80 100°C) on wool fiber in 60 minutes and the dyeing rates are increased according to high temperature.

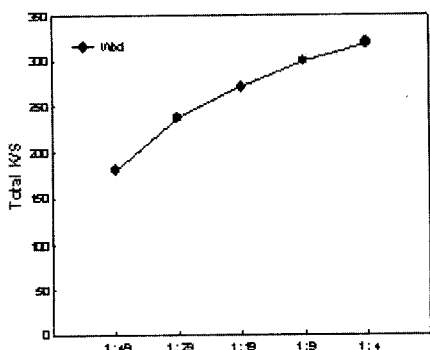


Fig. 2 The dyeing rate according to dye concentration

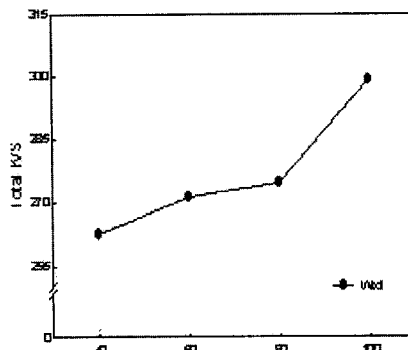


Fig. 3 The dyeing rate according to temperature

Fig. 2 The dyeing rate according to dye concentration Fig. 3 The dyeing rate according to temperature

2. Color difference of pH and the mordanted fabrics

The color differences of the fabrics according to pH and the mordants were shown in Fig.4 and Fig 5. The color of pH 3-7 is yellow green, over pH 9 is turned to orange yellow. The color of the non-mordant sample is yellow but it changed to bright yellow by Al, to orange yellow by Cu mordant, and to brown yellow by Fe mordant.

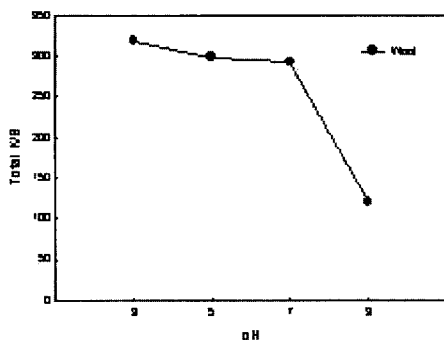


Fig. 4 The color difference according to pH

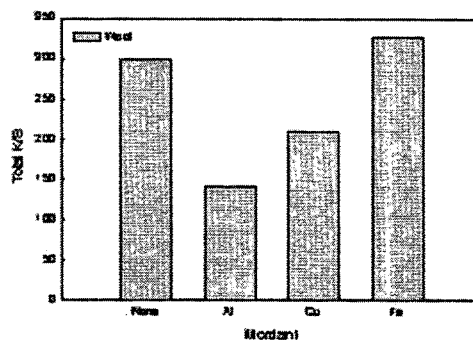


Fig.5 The color difference according to mordants

3. Fastness of dyed fabric

The launder and dry-cleaning fastness of the dyed wool fabrics were shown in Table 3. The launder fastness is not good. The dry-cleaning fastness of the samples by Fe are 3-4 grade and Some of the samples of Al and Cu are very low, 1~2 grade.

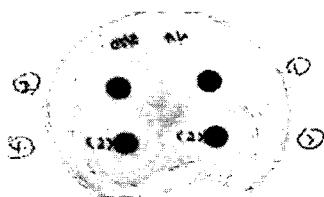
Table 3. Launder and light fastness of silk dyed with Turmeric extract

Test item		Color change	Acetate	Cotton	Nylon	PET	Acryle	Wool/Viscose
Washing fastness	None	2-3	3-4	1-2	1-2	4-5	4-5	4
	Al	2-3	3-4	1	1-2	3-4	3-4	2-3
	Fe	4	4	2	2-3	4-5	4-5	4
	Cu	3-4	4-5	2	2-3	4-5	4-5	4-5
Dry-cleaning Fastness	None	4-5	4-5	4-5	4-5	4-5	4-5	4
	Al	4-5	3-4	3	2	3-4	3-4	2-3
	Fe	4-5	4-5	4	4	4-5	4-5	3-4
	Cu	4-5	4	3-4	2-3	4	3-4	1-2

4. Antibacterial property of Turmeric extract

Antibacterial property of solutions which were obtained from the first and the second extraction of Turmeric were tested under the conditions of heat treatment. The results (Fig.4) show that antibacterial activity was observed in both the first extract and the second extract. The first extract had higher activity than the second extract. The heat treated extracts and non

treated extracts showed no difference. Taken together, the used solution extracted from Turmeric in this experiment has the strong antibacterial agent which was thermostable.



- ① : First extract - none sterilized
- ② : First extract - sterilized
- ③ : Second extract - none sterilized
- ④ : Second extract - sterilized

Fig. 4. Antibacterial effect of Turmeric extracts.

5. Antibacterial activity of dyed wool fabric with Turmeric extract

Once dyed and twice dyed wool fabrics with Turmeric were sliced into smaller than 0.5 cm x 1cm sizes. The sliced fabrics were submerged into *Staphylococcus aureus* ATCC 6538 (108-107 cell/ml) solution and incubated at 37°C for 12 hrs and the number of survival bacteria was measured. The bacteria were not killed by treating with un dyed fabric but dyed fabrics with Turmeric killed bacteria that are shown in Table 4. Washing of dyed fabrics with tap water did not affect antibacterial activity of the dyeing agent obtained from Turmeric.

Table 4. Bactericidal activity of dyed silk fabrics with Sappan Wood

	None Dyed	Dyed	
		Dyed One times	Dyed Two times
No. of <i>Staphylococcus aureus</i> (cell/ml)	4.3×10^7	< 100	< 100

IV. Conclusions

The extracted dye from Turmeric has affinity to wool. The dyeing rates are decreased according to diluting times and the dyeing rates are increased according to high temperature. The color of pH 3-7 is yellow green, over pH 9 is turned to orange yellow. The color of the non-mordant sample is yellow but it changed to bright yellow by Al, to orange yellow by Cu mordant, and to brown yellow by Fe mordant. The launder fastness are not good, 1~5 grade, but the dry-cleaning fastness are generally good, 3-5 grade. The fabrics dyed with Turmeric extract as well as extract itself showed antibacterial property and the antibacterial effect was remained fairly after washing.

Reference

1. Research Institute of Dyeing and Finishing, Kyungpook University(2000), Report of the development in Stabilization and Reappearance of natural dyes, 15-16,
2. Lenore Cheek(1990), Dyeing and Colorfastness Characteristics of Direct-Dyed Ramie in

- Comparison to Flax and Cotton, Clothing and Textiles Research Journal, 8(2). 38-41
3. Dae-Kwan Iim, Ung Choi and Dong-hwa Shin, (1996), Antioxidative Activity of Some Solvent Extract from *Caesalpinia sappan* L., J. Korean. FOOD SCI THECHNOL., 28(1).77-82
 4. Shin-HoLee, Won-Suk Moon and Kyung-Nam Park, (2000), Antimicrobial Activity of *Caesalpinia sappan* L. Extracts and its Effect on Preservation of Ground Meats, J. Korean. FOOD SCI THECHNOL., 29J. Korean. FOOD SCI THECHNOL., 28(1).77-82 (5).888-892.
 5. Eun-Kyung Kim and Jee-Hye Chang, (2000), Dyeing Properties of Sappan Wood Dyes by Screen Printing, J. Korean Home Economics, 38(9), 120-130.
 6. J.H. Hofenk, De Graff and W.G. Th. Roelofs. (1972), On the Occurrence Of Red Dyestuffs from 1450-1600, Proceeding of the ICOM.
 7. Byung Hee, Kim · Wha Soon, Song (2001). The dyeability and antimicrobial activity of methanol extracted in *artemisia princeps*. Journal of the Korean Society for Clothing Industry, 3(4), 113-117.
 8. Ok Sun, Cha · So Hyun, Kim (1999). A study on the dyeability and physical properties of mordanted and natural dyed fabrics. Journal of the Korean Society for clothing and Textiles, 23(6), 788-799.
 9. Young Joo, Chu (1998). A study on the physical properties of sappan wood dyeing fabrics treated by rice straw ash solution. Journal of the Korean society for clothing and Textiles, 22(6), 699-705.