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Dyeability and Antibacterial Activities of Persimmon Tree Leaves Extracts

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Ⅰ. Introduction

It has been known that persimmon leaves (*Diospyros kaki* L. folium) contain polaroid glucoside, tannin, phenol family, resin, polysaccharide, essence, and chlorophyll, and tannin is a major secondary product. Newly flushed persimmon leaves are used for making teas, and the tea was reported to reduce blood pressure. We wanted to evaluate the possibility of using persimmon leaves as dye and antibiotic, because persimmon leaves have been wasted after persimmon harvesting.

Ⅱ. Methods and Materials

1. Materials

Raw silk fabric was used for testing color fastness as defined in KS K 0905. The characteristics of test fabric are shown in 〈Table 1〉.

2 Dye

We collected naturally grown persimmon leaves around Naju area for the test. We extracted

〈Table 1〉 The characteristics of test fabric

Fabric	Weave structure	Yarn Number		Fabric counts (thread/5cm)		Weight (g/m)
		Warp	Weft	Warp	Weft	
Silk	Plain	21D (2.3tex)	21D/2 (2.3tex × 2)	276〈	192〈	25.1~27.2

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pigments from the persimmon leaves by boiling them in water. We filtered the extract using G5 glass filter to freeze-dry(Ilshinlab, Korea) and powder it.

3 Mordant

We used Iron Sulfate($(FeSO_4 \cdot 7H_2O)$, Shinyo Pure Chemicals Co., LTD, Japan), Cupric Acetate Monohydrate($((CH_3COO)_2 \cdot Cu \cdot H_2O)$, Junsei Chemical Co., Ltd, Japan), Alum ($(Al_2(SO_4)_3)$, Sungdong Chemicals Co., Ltd., Korea), Acetic acetate((CH_3COOH), Chunggungwon Co. Ltd., Korea) as a mordant.

4 Antibiosis test

We performed antibiosis test on yellow staphylococcus (*Staphylococcus aureus* ATCC 6538) and pneumobacillus (*Klebsiella pneumoniae* ATCC 4352) as regulated in KS K 0693. Reduction rate of bacteria (%) was calculated by dividing the difference in the number of auxotrophy between treatment and control with the number of auxotrophy in control multiplying with 100.

Ⅲ. Results and Discussion

〈Table 2〉 Munsell's HV/C by concentration of extracts from persimmon leaves

Cocentration(%)	L	a	b	ΔE	ΔL	Δa	Δb	H	V	C
RefrenceValue	97.88	0.28	-0.28					0.00	9.69	0.00
10	92.30	0.27	2.97	6.46	-5.58	-0.01	3.25	0.01Y	9.12	0.01
20	90.66	0.35	6.06	9.61	-7.22	0.07	6.34	0.61Y	8.96	0.82
30	88.44	2.25	9.11	13.47	-9.44	1.98	9.40	7.85YR	8.73	1.47
40	86.63	1.51	10.52	15.64	-11.25	1.23	10.80	9.42YR	8.54	1.56
50	85.43	1.96	11.87	17.48	-12.45	1.68	12.16	9.14YR	8.42	1.81

〈Table 3〉 Munsell's HV/C by a mordant type with pre-mordant

Mordant	L	a	b	ΔE	ΔL	Δa	Δb	H	V	C
RefrenceValue	97.88	0.28	-0.28					0.00	9.69	0.00
$FeSO_4 \cdot 7H_2O$	75.16	0.35	5.12	23.35	-22.72	0.07	5.40	1.15Y	7.36	0.73
$(CH_3COO)_2Cu \cdot H_2O$	81.99	0.50	16.42	23.05	-15.89	0.22	16.70	1.61Y	8.07	2.30
$Al_2(SO_4)_3$	86.07	1.99	11.38	16.69	-11.81	1.71	11.67	8.97YR	8.49	1.74
CH_3COOH	85.41	2.59	11.91	17.59	-12.47	2.31	12.19	8.38YR	8.42	1.90

〈Table 4〉 Munsell's HV/C by a mordant type with post-mordant

Mordant	L	a	b	ΔE	ΔL	Δa	Δb	H	V	C
Refrence Value	97.88	0.28	−0 28					0.00	9.69	0.00
$FeSO_4 \cdot 7H_2O$	73.17	−0 07	7.14	25.81	−24.71	−0.35	7.42	2.50Y	7.16	0.97
$(CH_3COO)_2Cu \cdot H_2O$	79.43	−0.71	19.28	26.91	−18.45	−0.98	19.56	3.11Y	7.80	2.64
$Al_2(SO_4)_3$	85 72	0.99	13.90	18.70	−12.16	0.72	14.18	0.59Y	8 45	1.95
CH_3COOH	87.02	2.01	11.33	15.99	−10.86	1.73	11.62	8.89YR	8.58	1.73

〈Table 5〉 Munsell's HV/C by the pH of persimmon leaves

pH	L	a	b	ΔE	ΔL	Δa	Δb	H	V	C
Refrence Value	97.88	0 28	−0.28					0.00	9.69	0 00
pH 4	77.62	4.64	21.32	29.94	−20.26	4 36	21.61	9.03YR	7.62	3.44
pH 6	87.03	1.74	11.52	16.10	−10.85	1.46	11.81	9.26YR	8.58	1 72
pH 8	90 56	0.44	7.85	10.95	−7.32	0 16	8.14	0 67Y	8.95	1.06
pH 10	91.71	0.64	5.72	8.62	−6.17	0.36	6 00	0.00??	9.06	0 00

〈Table 6〉 Munsell's HV/C by treatment time

Time(min.)	L	a	b	ΔE	ΔL	Δa	Δb	H	V	C
Refrence Value	97.88	0.278	−0.284					0.00	9.689	0
10	88.30	1.19	9.45	13.69	−9.58	0.91	9.73	9.61YR	8.71	1.37
20	85.75	1.52	11.04	16.64	−12.13	1.25	11.32	9 53YR	8.45	1.63
30	85.43	1.96	11 87	17.48	−12.45	1.68	12.16	9.14YR	8.42	1.81
40	85.12	1.86	11.99	17.78	−12.76	1.58	12.27	9.30YR	8.39	1.81
50	85 34	2 09	11.63	17.39	−12.54	1.81	11.91	8.93YR	8.41	1.79

〈Table 7〉 Munsell's HV/C by dyeing temperature

Temperature(℃)	L	a	b	ΔE	ΔL	Δa	Δb	H	V	C
Refrence Value	97.88	0.28	−0.28					0.00	9 69	0.00
30	89 57	0.36	7.76	11.57	−8.31	0 08	8.05	0.88Y	8.84	1.05
50	89.44	0 86	8.15	11.95	−8.44	0.59	8 44	9.86YR	8.83	1.15
70	88.36	0.94	9.15	13.42	−9 52	0.66	9.43	9.96YR	8 72	1.30
90	85.43	1 96	11.87	17.48	−12.45	1.68	12.16	9.14YR	8.42	1.81

〈Table 8〉 Munsell's HV/C by the chitosan treatment

Mordant	L	a	b	ΔE	ΔL	Δa	Δb	H	V	C
Refrence Value	97 21	−0 03	0.15					0.00	9 62	0 00
non	80.73	4.54	22 59	28 21	−16 47	4.57	22 44	9.13YR	7.94	3 62
Fe	72.12	2.45	17.82	30 78	−25.08	2.48	17.67	0.48Y	7.05	2.69
Cu	73.57	1.66	27.96	36.54	−23.64	1.70	27.81	2.08Y	7 20	4.07
Al	79.75	2.94	24.58	30.17	−17.46	2.97	24.42	0.52Y	7.84	3.73
Acetic acid	79.08	3.91	24.01	30 22	−18.12	3.94	23 85	9.82YR	7.77	3.74

〈Table 9〉 Effect of extracts from persimmon on the reduction rate of bacteria

Strains	Reduction rate of bacteria(%)
Staphylococcus aureus	31.4
Klebsiella pneumoniae	56.2

Ⅳ. Conclusions

We compared the color change in fibroin using extracts from persimmon leave by bonding strength to fibroin and a mordant. We tested the effect of chitosan on coloring upon the report that chitosan improved bonding strength between dye and fabric. We also tested the antibiosis of persimmon leaves by reduction rate of bacteria using KS K 0693.

We found the changes in bonding strength between dye and fiber according to the dye concentration. When we differentiate the dye concentration (10, 20, 30, 40, and 50%) at 90C, difference in color (△E) was the largest at 50% dye concentration, where △E and hue was 17.48 and 9.14YR, respectively. We evaluated the effect of different mordant types and mordant methods (pre- and post-mordant) on the △E and hue. Cupric Acetate Monohydrate showed the largest effect; △E and hue were 26.91 and 3.11Y, respectively.

When the dye time was modified from 10 to 50 minutes (10, 20, 30, 40, and 50 minutes), 40 minutes condition generated the largest difference in E (17.78) and hue (9.30YR). △E and hue changed the most at 90℃ among the different temperature conditions (30, 40, 50, 60, 70, 80, and 90℃). △E and hue changed 17.48 and 9.14YR, respectively, at 90C. △E and hue changed 29.94 and 9.03YR under pH4, which is the largest difference among seven pH conditions (4, 5, 6, 7, 8, 9, and 10). When 0.4% (w/v) chitosan in 0.1% (v/v) acetic acid was applied in dyeing process using, Cupric Acetate Monohydrate showed the highest △E (36.54) and hue (2.08Y). Reduction rate in bacteria were 31.4 and 56.2% for yellow staphylococcus and pneumobacillus, respectively, using the KS K 0693 method.

We evaluated the possibility of using persimmon leaves as antibiosis and found the best

dyeing condition to use persimmon leaves as dye. We believe that our results will be useful for studying natural dye. Extracts from persimmon leaves showed the best dyeing result under 50%, 90℃, pH 4, and Cupric Acetate Monohydrate post-mordant. Chitosan treatment was the most effective on dyeing with Cupric Acetate Monohydrate. Reduction rate in bacteria were 31.4 and 56.2% for yellow staphylococcus and pneumobacillus, respectively.

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