Colorfastness of Black-Colored Fabrics with Various Fibers

Yoon Young Yang, Hae-Woon Choi[1], Myung-Ja Park[2]*

Graduate Student, Dept. of Home Economics Education, Hanyang University, Korea
[1]Lecturer, Dept. of Clothing and Textiles, Hanyang University, Korea
[2]Associate Professor, Dept. of Clothing and Textiles, Hanyang University, Korea

Abstract : Black garments can lose color, image, and be the main cause of color staining when washed with other laundry that can cause color contamination from interaction with other garments. To know the fiber-based dye fastness for colored garments, 4-5 pieces of various fibers of different fabrics were selected; cotton, linen, wool, silk, rayon, acetate, polyester, and nylon. To determine the colorfastness to washing and crocking, the black fabrics were washed with alkali and neutral detergents under the Laund-O-Meter method under the Crockmeter method. In an alkali detergent laundering conditions, most colored samples did not undergo color or light fastness. However, most of the stained fabrics slightly changed in K/S values while other samples underwent severe changes. With neutral detergent laundering, sample fabrics underwent less shrinking, and had less naps. The stained fabrics also underwent less change in K/S values. With time-repeatedly-washing the original sample went through colorfastness to lose color. In crocking fastness, most samples produced good to excellent results under dry conditions but produced relatively low crocking fastness under wet conditions. Natural fibers especially showed lower crocking fastness than artificial fibers. In conclusion, garments of the same color should be laundered together. The black garments that are washed using neutral detergents can decrease the amount of damage from color change. While it is the responsibility of garment producers to provide appropriate quality indications they should also provide adequate instructions for consumers to understand and appropriately cope with the quality indications in order to contribute to establishing a correct laundering method.

Key Words : black, colorfastness, laundering, crocking, fibers

1. Introduction

Purchasers consider various factors such as color and fashion when buying clothes. Maintaining the original color of clothes is significant from the point of view of the customer. Based on the statistical results of *Customer Complaints and Cause of Disputes in Textile Products* surveyed by the Korea Consumer Agency (2005) 23, 242 cases in "Textile Products and Cleaning Service" have been mediated by the Korea Consumer Agency over the last 8 years (1997-2004). Among them, 79.2% (18,408 cases) concentrated on "functional quality problems", such as the changes on clothing surface after wearing or cleaning. In this period, fabric product disputes increased more than four times (458 cases in 1997, 3,182 cases in 2004); it sharply increased. Cleaning service disputes also increased more than three times (916 cases in 1997 to 3,182 cases in 2004). Customer complaints on textile products and cleaning services are constantly increasing.

One of the reasons that cleaning accidents increased is because of the increase of new materials, which are difficult to manage. Another reason is that the attitudes of customers changed and became open to criticizing and complaining about unsatisfied services with an increase in

*Corresponding Author: Myung-Ja Park, Ph. D., 17 Haedang-dong, Seongdong-gu, Seoul, 133-791, Korea
Tel : +82-2-2220-1192 Fax: +82-2-2297-1190 E-mail : mjapark@hanayng.ac.kr

expectations and demands. Manufacturing industries induce customers to purchase products by emphasizing the advantages, color, and designs. However, they neglect to indicate qualities that result in cleaning accidents that customers complain about. According to the complaint list, the most common accidents are cases of cleaning accidents because of the bad dyeing quality of polyurethane fabric, staining, accidents after cleaning, and bleaching accidents due to the shortage of binder treatment or following cleaning, customers lack information on how to efficiently maintain clothes (Lee et al, 2005).

Colorfastness is the characteristic of not changing or fading color of fabrics due to cleaning or exposure to light. These two characteristics are particularly critical when dyeing fabrics. Colorfastness means the resistance of the color of a dyed object. The changing and fading of the color of a fabric happens when it is exposed to sunlight, cleaning, friction, bleach, sweat, atmosphere gas, acid, and alkali solutions. The colorfastness of textiles is influenced by various collaborated factors. The main factors are the effects of remaining detergent in fabrics, the kinds of fibers, the kinds of dyes, and process method, whether dyeing or printing (Kim et al, 2000).

Dyed objects easily change colors, staining, or fade colors, so appropriate cleaning methods based on the characteristics of products are necessary. When treated suitably, cleaning can improve appearance and damage to clothes can be prevented, so users can maintain the original form and color. Learning a professional and scientific knowledge of cleaning is required to understand: fabric composition, characteristics of textiles, appropriate cleaning water, detergent type, cleaning method, and cleaning evaluation system.

The same fabric materials can differ in colorfastness according to dyeing methods or management afterwards. The darker the fabric is the more difficult the fastness management can be. Black provides a powerfully intense image that is one of the most basic and important colors along with white; various kinds of black colors are used in clothes to satisfy the demands of customers. According to the "Survey of 2005 clothes consumption" investigated by the Korea Federation of Textile Industries (2005), the preferred colors of men were black, indigo, and white, 36% were achromatic colors and black showed a bigger percentage than in previous years. Women also showed the highest preference, 15.2 percent for black among 19 kinds of colors. Gallup Korea Co. Ltd. (2004) surveyed 1,728 men and women over 15 years old in Korea (except Jeju province) about "the 40 kinds of what Koreans like". The clothes color preference result showed that even though Koreans are known for the white-clad folk-style, the highest percentage (23%) of Koreans prefer black regardless of seasons. Among ages, black was preferred by men over 50 years old.

Comparing to the market use of black garments (Kim, 2005) and studies on the aesthetical characteristics, studies on management of black clothes after wearing are insufficient (Park, 2004; Kwak, 1995). Customer complaints on colorfastness are continuously increasing and various studies are required for appropriate maintenance methods.

To maintain the color of garments as when first bought (even after repetitive wearing and cleaning) this study will focus on purchasing a number of clothes in the market, then solving the problems of color change after cleaning (a leading complaint according to the statistical data of the Korea Consumer Agency) to prevent cleaning accidents. Based on customer needs for convenient products and the necessity of suitable cleaning methods, this study will first deal with colorfastness after washing in various cleaning conditions, such as different fabric types of black dyed textiles, cleaning time, and detergent types. In addition, this study will cover different kinds of black fabric colorfastness to crocking.

II. Experimental

1. Materials

The black fabrics for test fabrics used in this experiment were the most commonly used fibers in the market. 4-5 pieces of various fibers of different fabrics were selected

by random sampling. When 100% cotton was not sufficient, blended cotton was used; mostly, more than 50% blended cotton were selected. <Table 1> shows the weight and thickness of natural fibers (cotton, linen, silk, and wool), regenerated fibers (rayon and acetate), and synthetic fibers (polyester and nylon). Information on the dyes in the commercial fabrics was not known.

Two kinds of white fabrics were added with the black specimens. A fiber of one white fabric was same as the black specimen, and a fiber of the other white fabric was

<Table 1> Characteristics of the test fabrics

Fiber	Fiber Content	Sample Code	Weight (g/㎡)	Thickness (mm)
Cotton (C)	C 100%	C1	320	0.54
		C2	660	1.33
		C3	600	1.22
		C4	600	0.54
		C5	480	0.50
Linen (L)	L 50%, C 50%	L1	500	0.52
	L 78%, S 22%	L2	200	0.24
	L 64%, C 36%	L3	440	0.47
	L 80%, S 20%	L4	280	0.25
	L 100%	L5	380	0.42
Wool (W)	W 100%	W1	560	0.84
		W2	380	0.34
		W3	500	0.76
		W4	500	0.76
		W5	500	0.48
Silk (S)	S 70%, N 26%, PU 4%	S1	160	0.18
	S 100%	S2	120	0.12
	S 100%	S3	200	0.23
	S 100%	S4	380	0.40
Rayon (VI)	VI 80%, W 20%	R1	420	0.31
	VI 91%, N 9%	R2	220	0.20
	VI 70%, L 30%	R3	500	0.62
	VI 85%, S 15%	R4	540	0.47
	VI 55%, W 45%	R5	420	0.35
Acetate (AC)	AC 80%, VI 20%	A1	400	0.40
	AC 71%, N 26%, PU 3%	A2	520	0.33
	AC 72%, S 28%	A3	280	0.23
	AC 51%, C 45%, PU 4%	A4	420	0.49
	AC 50%, W 50%	A5	500	0.49
Polyester (P)	P 100%	P1	240	0.20
		P2	300	0.50
		P3	240	0.41
		P4	220	0.13
		P5	220	0.11
Nylon (N)	N 100%	N1	640	0.12
		N2	260	0.21
		N3	540	0.77
		N4	380	0.26
		N5	280	0.19

of a different kind. According to KS K ISO105-C01, the white fabrics made of cotton and linen fibers were used with wool and silk specimens, the white fabrics made of silk fiber for black linen and rayon specimens, white rayon for black acetate, and white cotton for black polyester and nylon specimens.

For the washing test, the standard powder laundry detergent based on KS K ISO105-C01 and a commercial neutral detergent were used. Laund-O-Meter (Laboxtex Co. LTD) was used for the experimental washing machines (which functions similar to drum-type washer) and the axis of rotation was operated by twelve 450ml washing bottles.

2. Methods

1) Test Methods of Colorfastness to Washing and Crocking

The Laund-O-Meter (KS KISO105-C01) method was used to run laundering tests according to the fiber types for the experiment of the laundering fastness. Laund-O-Meter (Labotex Co. LTD) was used for the experimental washing machine (which functions similar to drum-type washer) and the axis of rotation was operated by twelve 450ml washing bottles. For 1-2 pieces of fiber samples with high K/S values, different amounts of time-repeatedly-washing and detergent types were applied to measure the extent of color fastness and K/S values after laundering. The crocking fastness of different fibers was measured through experiments under the Crockmeter method (KS K 0650) under dry and wet conditions.

2) Evaluation methods of Colorfastness to Washing and Crocking

For evaluation of color changes and staining of the black specimens and the white fabrics, Spectroscopy (Macbeth Color-Eye 3000) was used to measure reflectance of the fabrics after and before the laundering. They were measured by the three-time measured average at the maximum absorption wavelength, in 580 nm wavelength extent and then dye absorption was expressed in terms of K/S values. After washing, Color-eye was used to measure the color and color difference(ΔE). In 10 degree observer under D_{65} light source, color coordinates of L* (lightness), a*(+a*: redness, -a*: greenness), b*(+b*: yellowness, -b*: blueness) in CIELab color space before and after laundering were measured. A Gray Scale was used to compare the color changes and color difference before and after the experiment and graded 1 to 5.

III. Results and Discussion

1. Colorfastness of the Black Fabrics with Different Fibers by Laundering Conditions

1) Colorfastness under Alkali Detergent

All-purpose laundry detergents in the market (granule or powder type) are mostly alkali, so colorfastness evaluation under alkali detergents is useful for consumers. <Table 2> shows the results after washing according to standard washing method, in order to observe the degrees of changed and faded colors, staining of the attached white fabrics while washing under alkali detergents. K/S value is proportioned to dye absorption so a higher degree means a darker color.

(1) Color Change of the Black Fabrics

Based on the results, most of the degrees of fabric changed and faded colors by one laundry were the rating 5 among the gray scale. Only few fabrics were higher than the rating 4. However, wool or silk fabrics showed a little change in form, such as fluffing or curling up.

(2) Staining of the White Fabrics

Black fabrics did not show big color changes. However, as shown on the <Table 2> the white fabrics were stained by the dyes of black fabrics. Most fabrics except polyester fabrics were stained (each fabrics showed various ratings from 1 to 5). When washing black clothes with white or light color clothes a serious laundry accident can happen. Especially, in every specimen, silk and acetate fabrics

<Table 2> Evaluation of color change & staining to laundering

Sample	Color change	Staining		K/S value		
		Stained fabric 1	Stained fabric 2		Stained fabric 1	Stained fabric 2
C1	5	3	3	25.372	1.095	0.171
C2	4	4-5	4	32.490	0.213	0.145
C3	5	5	5	39.113	0.122	0.147
C4	5	5	5	21.982	0.123	0.147
C5	5	5	5	23.282	0.119	0.148
L1	5	4-5	5	20.228	0.122	0.156
L2	5	3	5	20.719	0.290	0.197
L3	3	5	4-5	13.957	0.141	0.257
L4	5	5	5	21.201	0.123	0.152
L5	5	5	5	28.191	0.120	0.149
W1	5	2-3	3	46.324	0.316	0.294
W2	5	5	5	29.296	0.152	0.122
W3	5	3	5	41.863	0.253	0.155
W4	5	3	3-4	39.437	0.201	0.180
W5	5	3	4	31.128	0.292	0.168
S1	5	2-3	2	22.267	0.835	0.360
S2	4-5	3	5	17.717	0.654	0.134
S3	5	2-3	1-2	21.333	1.305	0.621
S4	5	4	2-3	27.257	1.176	0.236
R1	4-5	5	5	16.276	0.282	0.143
R2	4	1	5	15.888	1.173	0.181
R3	5	5	5	31.475	0.277	0.150
R4	5	3	5	24.348	0.401	0.178
R5	5	4	3	25.605	0.320	0.240
A1	5	2	2	32.267	0.476	0.497
A2	5	2	2-3	22.159	0.739	0.422
A3	5	5	2-3	27.257	0.283	0.337
A4	5	1-2	2-3	23.968	1.307	0.543
A5	5	1-2	2	30.991	1.206	0.507
P1	5	5	5	21.947	0.304	0.116
P2	5	5	5	22.670	0.343	0.131
P3	5	5	5	27.744	0.348	0.124
P4	5	5	4	15.682	0.315	0.124
P5	5	5	5	15.926	0.303	0.119
N1	5	4	3-4	32.193	0.529	0.124
N2	5	5	5	19.962	0.496	0.113
N3	4	2	1-2	19.120	1.230	0.277
N4	5	5	4-5	19.228	0.512	0.115
N5	5	4-5	5	17.218	0.511	0.120

* Grade Scale - 5: excellent, 4: good, 3: fair, 2: poor, 1: very poor
- Conc.: 5%, Time: 30min. Temp.: 40°C, Instrument: Laund-O-meter, Detergent: alkali

showed low colorfastness, lower than the rating 3; they should be carefully washed under special conditions of, detergents, temperature, or friction. This often happens in dark colored fabrics, so it is important to remember that when not washing enough after dyeing, color fading can happen in the first laundry. The table shows that the first

white fabric was the same fabrics to each code, and the second white fabric was different from that of the black specimen.

In <Table 2>, K/S values of the stained fabrics are presented, measured to compare the dye absorption, among colorfastness between natural and artificial fibers. Unlike reflectance, K/S value is proportioned according to the dye amount in fabrics, so the exact amount of dyes in fabrics can be compared. The staining of the first and second white fabric of natural fabrics: cotton, linen, wool, and silk fabrics showed different results. K/S values of the first stained fabric from black silk fabrics were 1.305 in S3, and S4, S1, S3 also showed high dye absorption: 1.176, 0.835, and 0.654. Staining of the second white fabric with silk fiber showed a lower degree, but the average of four specimens was 0.338. The degree is high enough to recognize color differences. Cotton fabrics that are often washed by water had generally a low K/S value. Except the five materials suggested in the chart, 15 kinds of cotton fabrics were used in the experiment in reserve, but no stain was observed by naked eyes. This shows the differences of dyeing methods. The dyes for direct dyeing methods are soluble and friendly to fabrics so they are often used for dyeing cellulose fabrics. However, when washing with water it can easily fade color, so recently cellulose is dyed by reactive dyes or vat dyes, which have low stains in order to raise colorfastness. C3, C4, and C5 showed low staining. Only C1 showed a high degree, 1.095. L2 was 0.290, which is the highest among linen fabrics, but most of the other materials showed slight differences of color, probably because careful changes of dyes or management afterwards when dyeing cellulose fabrics like cotton. Wool fabrics showed higher staining than cotton or linen. W1 was 0.316, and W4 was 0.292. Like silk fabrics, the first white fabric was a higher staining, and the second white fabric was a comparatively lower staining. However, the black dyes caused fluffing, shrinking, or rolling when washed with water and this should be avoided when possible.

In addition, the black fabrics with artificial fibers showed higher degrees than natural fabrics. The color density (K/S) of the first and second stained artificial white fabrics of rayon, acetate, polyester, and nylon fabrics showed a higher staining degree than natural fabrics. The degree was high for rayon, acetate, and nylon. Polyester were rarely stained in naked eyes, presumably because of the high dye fixation with disperse dyes that raise the hydrophobic fiber of the colorfastness of polyester.

Rayon R2 had a remarkably high K/S value 1.173, a big color difference. The second stained white fabric of acetate fabric (A4) was 0.543 and the first stained white fabric (A5) was 1.206, an enormous color difference. Most of the white fabric of A1-6 acetate showed higher degrees than other fabrics. Nylon N1-5 also showed high degrees. Especially N3 was 1.230. The structures of rayon and acetate are similar, so it is presumed that washing with water will be fine. However, mechanical characteristics are weaker, so when washing with other colored fabrics, damage such as bleaching and shrinking constantly appear; that is the reason for the higher staining than cotton and linen fabrics. Nylon also has higher staining than other synthetic fiber because the high absorption of dyes when dyeing, so colorfastness was low because when washing with water dyes are washed off.

2) Colorfastness to Washing under Neutral Detergent

Neutral detergent is a kind of liquid-type synthetic detergent. It dissolves in water easily and fabrics composed of protein fibers are not damaged. Dirt is also washed off even in hard water or an acid solution. <Table 3> is a stain comparison by K/S values of the severely stained fabrics with neutral and alkali detergents, selected based on the results in <Table 2>. Cotton fabrics used C1 and C2 for linen fabrics used L2; silk used S1 and S3; wool fabrics used W1 and W4; rayon fabrics used R2 and R4; acetate used A2 and A4; and nylon used N2 and N3. Black specimens changed or faded color grade was good in alkali and neutral detergent, so they are not indicated on the table. However, when comparing stained fabrics, there were differences of dye absorption by detergents.

K/S values of the stained fabrics of artificial fibers (rayon, acetate and nylon) in neutral detergent solution in

<Table 3> K/S values of the stained fabrics in detergent solution

Code BL-WT \ Detergent	Alkali	Neutral
C1-1	1.095	0.240
C1-2	0.171	0.279
C2-1	0.213	0.168
C2-2	0.145	0.171
L2-1	0.290	0.199
L2-2	0.197	0.159
S1-1	0.835	0.580
S1-2	0.360	0.231
S3-1	1.035	0.710
S3-2	0.621	0.444
W1-1	0.316	0.184
W1-2	0.294	0.212
W4-1	0.201	0.151
W4-2	0.180	0.153
R2-1	1.173	0.223
R2-2	0.547	0.181
R4-1	0.401	0.202
R4-2	0.533	0.178
A2-1	0.739	0.450
A2-2	0.422	0.238
A4-1	1.307	0.511
A4-2	0.543	0.255
N1-1	0.529	0.125
N1-2	0.124	0.100
N3-1	1.230	0.395
N3-2	0.277	0.299

- Sample: severely stained fabrics from Table 2
- Detergent: alkali, neutral
- Conc.: 5%, Time: 30min. Temp.: 40°C
- Instrument: Laund-O-meter

<Table 2> show that the degree after washing with neutral detergent was lower for all fabrics. Especially C1 rapidly diminished from high dye absorption 1.095 to 0.240. The first white fabric of C2 was lowered from 0.213 to 0.240, but the second white fabric did not show a big difference between the two specimens, C1 and C2. The first white fabric of L2 lowered from 0.29 to 0.199, and the second white fabric changed from 0.197 to 0.159. K/S degrees of both of the white fabrics were lowered after washed by neutral detergents; low staining.

Comparing to cotton and linen fabrics (except C1) the K/S values of silk and wool were raised in both alkali and neutral detergents. Because of the inner structure, silk, and linen fabrics readily shrank or lost the smoothness when washing with water, so water laundering was not preferred. However, when using neutral detergents, staining decreased from 0.835 to 0.58 in S1, 1.035 to 0.71 in S3, and 0.316 to 0.184 in W1. Due to the low dye absorption, protein fibers like wool or silk easily fade in alkali detergents, so water laundry is not a good choice for dirty clothes, light course of laundry using neutral detergent is helpful to maintain the black color of clothes. Cotton and linen fabrics also showed a lowered staining when washing with neutral detergent. In order to extend the lifespan like luxurious cotton and linen fabrics, appropriate choices of detergents are required. Washing with neutral detergent prevents damages of delicate fabrics and clothes more than alkali detergent. In addition, linen summer clothes, bedclothes, knitted clothes, and silk underwear are recommended to wash with neutral detergent to avoid damage to the texture and to maintain freshness.

In comparison of degrees between before and after washing stained fabrics of rayon, acetate, and nylon, washed by alkali detergent, stained polyester was grade 4 only in P4, and other specimens were grade 5. The staining was not that serious so they were excluded in this experiment. Disperse dyes colored in polyester used in this experiment needs thermosol dyeing, so if discolored during washing, it would not dye under 80°C. Like natural fibers, synthetic fibers showed lowered staining of white fabric when washing with neutral detergent than alkali detergent.

Rayon or acetate fibers are weak in alkali solution and water. When washing with water, the appropriate detergent choice and light washing by hands are preferred. K/S values of natural fibers were higher when washing with alkali detergent. After changing the detergent to neutral, the degree of the first white fabric of R2 decreased from 1.173 to 0.223, and the first white fabric of A4 decreased from 1.307 to 0.511. Results show that when washing with alkali detergent or neutral detergent it is possible to lessen the staining phenomenon of fabrics after washing.

The first nylon white fabric of N3 were sharply lowered from 1.230 to 0.395; high dye absorption with alkali detergent lessened when using a neutral detergent. Comparing to other synthetic fibers, nylon is water friendly and the dye absorption is high. Staining possibility is high, so when washing nylon (100% or blended product) it is important to choose a detergent and wash with caution.

3) Colorfastness by Number of Washing Cycles

Clothes after wearing need washing to remove stains. However, due to the development of the big washer, the number of washing times increased. Although excessive use of detergent, repetitive laundry and strong friction can elevate detergency, the lifespan of clothes will decline, because the shape or color of clothes changes. The result of washing the same fabric repetitively is shown below.

(1) Color Change of the Black Fabrics

In repetitive washing experiment, as the number of washing increased, staining of the white fabric decreased. However, as shown in <Table 4>, the color changed and faded, which led to lower grade. This experiment was five times repeated. In daily life, frequent clothes wearing and washing will cause more changes of color. The original color flow out in the beginning, staining other clothes, and gradually lose color. In order to prevent change of colors, one should avoid frequent washing, and separated laundry management is necessary.

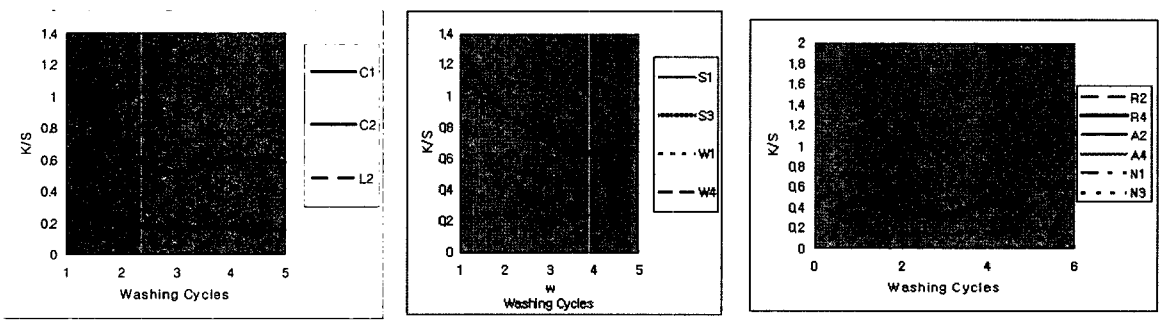
(2) Staining of the White Fabrics

Unlike black specimens, white fabrics showed less dye absorption as laundry progressed. Staining was the most serious in the first laundry, and gradually dye absorption declined. <Figure 1> is a graph of K/S density degree by frequencies, after washing in the same condition for five times; (a) is the result of cellulose fabric, (b) protein fabric, and (c) synthetic fabric. As washing frequencies increased, the degree of staining to the white fabric gradually lessened. Sharply lessened cases are C1 in (a), S1 and S3 in (b), and R2 and N3 in (c). C1, S1, W1, R2, A2, and N3 irregularly lessened and rose; probably because adhesive dyes flow out when washing, due to friction or penetration by the detergents, and the timing varies with dyes and fabrics.

<Table 4> Evaluation of color fastness to repeated laundering of color change of the black fabrics

Samples	C1	C2	L2	S1	S3	W1	W4	R2	R4	A2	A4	N1	N3
Grade	3	4-5	3-4	5	4-5	4-5	4-5	4	3-4	5	5	5	4

*Grade Scale - 5: excellent, 4: good, 3: fair, 2: poor, 1: very poor
**The result after 5 laundry cycles.



(a) cellulose fibers (b) protein fibers (c) artificial fibers

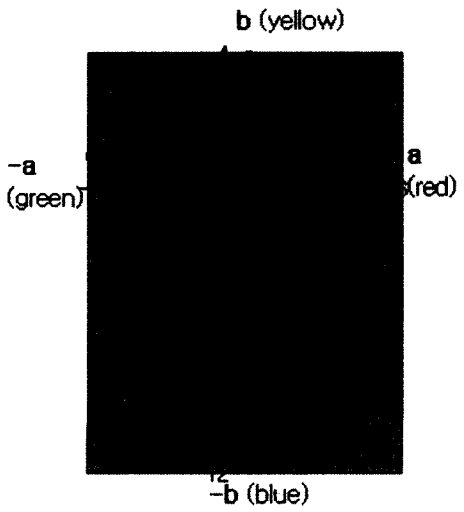
<Figure 1> K/S values of the stained fabrics to washing cycles.
Conc.: 5%, Time: 30 min. Temp.: 40°C, Instrument: Laund-O-meter, Detergent: alkali

4) Colors of the Stained White Fabrics

The color differences of the stained white fabrics after washing black fabrics were measured by a spectroscopy according to CIELab, then L*, a*, and b* were measured. <Figure 2> shows a big degree of difference between 'a' and 'b', and they are mainly blue. Black is a compound color of various colors, so when washing, specific colors especially flow out. Most of the staining was blue, and under the different black fabrics, some stained into green or light red. When washing, colored clothes are recommended to be cleaned among similar colors, but it is not easy to separate every color in reality. Preliminary washing with small amount of detergent and water will help recognize the flowing color. One can prevent staining damage by separating clothes based on similar flowing out of colors. The stained-fabric colors are mostly blue. It is important to find out how to separate similar colors. This can help save energy.

2. Colorfastness of the Black Fabrics with Different Fibers by Crocking Conditions

Colorfastness to crocking is decided by stained degrees to other fabrics. Clothes are slightly stained in daily life due to friction such as when wearing clothes, carrying a bag, or using a carpet or chair. The clothes of low colorfastness usually do not adhere to the inner side of fibers. Recently, for aesthetic effects dyes have been artificially let to adhere on the surface.



<Figure 2> CIE Lab Color Coordinate.

1) Crocking Colorfastness in Dry Condition

<Table 5> is the result of stain evaluation of the colorfastness of various fabrics in dry and wet conditions. The grades of the dry stained fabrics were generally better than that of the wet stained fabrics. Especially, silk fabrics showed grade 5 on all four specimens, and grades of nylon were generally good as well. Cotton, linen, rayon, and acetate fabrics also had good colorfastness in dry conditions, except on a specific fabric.

2) Crocking Colorfastness in Wet Conditions

The colorfastness under wet conditions showed that all fabrics in moist conditions were worse than in dry conditions. Stain evaluation of natural fabrics, cotton and

<Table 5> Colorfastness to crocking of the black-dyed fabrics

Abrasive samples	White test cloth		Abrasive samples	White test cloth	
	dry	wet		dry	wet
C1	2	1-2	R1	5	2-3
C2	3-4	2	R2	4-5	1-2
C3	4-5	4	R3	4-5	2-3
C4	3-4	1-2	R4	2-3	1-2
C5	3-4	1	R5	4-5	2-3
L1	4-5	1-2	A1	4-5	2-3
L2	4-5	2-3	A2	4-5	4
L3	4-5	2-3	A3	4-5	4-5
L4	4-5	3	A4	5	1-2
L5	2	1	A5	2	2-3
W1	3-4	1	P1	4-5	4-5
W2	4-5	2-3	P2	4-5	4-5
W3	4	2	P3	4-5	4
W4	4-5	3	P4	4-5	4-5
W5	5	2-3	P5	2-3	4-5
S1	5	4	N1	4-5	3-4
S2	5	4-5	N2	5	4
S3	5	2	N3	4-5	4
S4	5	4-5	N4	4-5	4
			N5	4-5	4

*Grade Scale- 5: excellent, 4: good, 3: fair, 2: poor, 1: very poor

linen were mostly low. Especially in moist conditions, C5 and L5 were grade 1, the lowest grade. W1 was also grade 1, and W3 and S3 were grade 2. Rayon and acetate had a higher evaluation than natural fabrics, but in the moist conditions experiment, the grades were generally low; 1-2 and 2-3 grades. However, grades of synthetic fabric polyester and nylon in both dry and moist conditions were both higher than grade 4. Colorfastness of synthetic fabrics are higher than natural fabrics, possibly because synthetic fabrics use various process and dye methods to let dyes penetrate deep inside fibers.

Except synthetic fibers, natural fibers and regenerated fibers showed higher colorfastness in dry conditions than moist conditions. Accordingly, when drying colored textiles after laundering, clothes should be in a broad space so they will not rub against each other. Particularly in moist weather (such as the rainy season) special care should taken when wearing colored clothes.

IV. Conclusion

Results and summary of washing and crocking color-fastness of the black fabrics with different fibers by laundering conditions are as follow.

After laundering once in an alkali detergent solution, most samples did not undergo color or light fastness. However, the most of the stained fabrics underwent a slight change in K/S values while other samples underwent severe changes. When black textiles are laundered for the first time, they can cause changes in K/S values to other garments by exerting dyes due to low laundering fastness or bad treatment. Therefore, only garments of the same color should be laundered together.

In the case of laundering fastness of all fabrics under neutral detergent solution, sample fabrics underwent less shrinking and had less naps. The stained fabrics also underwent less change in K/S values. When laundering luxury garments and textiles that are rarely washed in water, using neutral detergents can decrease the amount of damage from fabric damage and color or light fastness, as well as changes in K/S values.

In the case of laundering fastness, the change in K/S values was seen to significantly decrease according to the time-repeatedly-washing. This can be explained by the fact that the dye that has not sufficiently treated after dyeing is exerted from the fabric to change the K/S value of other fibers at first but decrease over the laundering process. However, with time-repeatedly-washing the original sample went through color fastness to lose color. The garment producer should develop good dyes and perform excellent treatment when dyeing the textile.

The fabrics that experienced changes in K/S values during laundering had a bluish color. It is considered that taking care and being aware whether garments with similar colors can be laundered together might be a method of conserving energy.

Crocking fastness of various black colored textiles with different fibers showed that most commercial fabrics produced good or excellent results under dry conditions but produced relatively low rubbing fastness under wet conditions. Natural fibers especially showed lower rubbing fastness than artificial fibers. Garment producers need to develop various process methods to increase rubbing fastness while consumers should take care when wearing colored garments during the summer when conditions are wet due to the monsoon or perspiration.

In conclusion from the results, it is necessary for consumers at home to master and exercise laundering methods according to the fabric characteristics to minimize damage to garments, while garment producers should take responsibility to provide appropriate quality indications. The producers should also provide adequate training for the consumers to understand and appropriately cope with the quality indications in order to contribute in establishing a correct laundering culture.

■ References

Gallup Korea (2004). *The 40 kinds of what Koreans like.*
Kim, E., Park, M., Shin, H. & Oh, K., (2000). *Com-*

prehension and evaluation of clothing materials- Textile testing. Seoul: Kyomoonsa Press.

Kim, J. (2004). *Washing and Dyeing*. Seoul: Hehamedia Press.

Kim, J. (2005). Color marketing of textile and fashion products, *Fiber Technology and Industry, 9(4)*, 399-414.

Korea Consumer Agency (2005). *Consumer complaints and cause of dispute in textile products: 1997-2004*.

Korea Federation of Textile Industries (2005). *Survey of 2005 Clothes Consumption*

Kwak, T., Yang J., & Kim, S. D. (1995). A study on colorfastness to washing of red disperse dyes. *Journal of Korean Fiber Society, 32(9)*, 888-894.

Lee, J., An, C., Song, K., Yu, H., Lee, H., & Kim, J. (2005). *Textile care & management*. Seoul: Hyungsul Press.

Park, Y. (2004). A study on the change of dyeability and colorfastness of lotus leaf extract with mordanting treatment). *Journal of Korean Home Economics, 42(12)*, 69-76.

Yoon, J. & Kim, Y. (2005). The images of fashion design transmitted by achromatic colors. *Korean Costume. 55(3)*, 122-135.

Received December 20, 2007
Revised April 29, 2008
Accepted April 30, 2008