THE EFFECT OF CERTAIN FINISHES ON THE SERVICE QUALITIES OF A MERCERIZED COTTON FABRIC AND A SPUN VISCOSE RAYON FABRIC

by

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B. S., University of Nebraska, 1942

A THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Clothing and Textiles

KANSAS STATE COLLEGE
OF AGRICULTURE AND APPLIED SCIENCE

1948

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INTRODUCTION

The problems of the consumer increase with the complexity of the goods offered on the market. As with other commodities this is true with regard to fabrics and detergents. Wartime development and production of many new synthetic detergents now available constitute a new problem for the housewife in her choice of a washing agent. Not only does she need to know of its efficiency as a soil remover, but also she needs information about the effect produced on the fabric itself.

Soap has been known for many centuries as a cleaning agent but its general use was slow in developing. Its unavailability to the masses restricted its use to the upper classes. Morgan (16) reports that until the eighteenth century soap was the only cleanser known. Sulfonated vegetable oils were the first of the synthetic detergents to be produced and made their appearance during the nineteenth century. In the 1930's a group of synthetic organic detergents was produced which utilized petroleum rather than animal or vegetable fats as the basic source of raw materials. Widely used industrially at first, they were later adopted for household use. Their advantages which have made them so widely accepted are that they are quite stable and do not break down to form magnesium and calcium curds in hard water, they are readily soluble and cleanse rapidly at low temperatures and low concentrations.

The enormous number of cleaning materials on the market today and the phenomenal growth of the industry is reported by King (13). From an approximate 65 million pounds produced in 1939, the output has increased to an anticipated 700 million pounds in 1948.

The development of synthetic detergents was greatly accelerated by the war. Sunde (23) states that the possibility of a global war pushed investigation of possible synthetic detergents even before Pearl Harbor. These investigations showed advantages over the usual laundry cleaning agents for use in a variety of hardness and temperatures of water. The timeliness of these investigations was demonstrated by the sharp curtailment of cocoanut oil for soap making. Sunde states further that consumption by the American soap industry dropped from 480 million pounds of cocoanut oil in 1941 to 140 million pounds in 1942. The figures are even more impressive when it is considered that 100 million pounds were used during the first half of 1942 and only 40 million during the last half. Shortages of other oils at the same time forced the use of substitutes.

The stationing of army and navy personnel all over the world during the war brought the attention of the government to the problem of detergents for a variety of purposes and places. Harris (10) tells that the inability of the navy to obtain sufficient bids to cover requirements of a salt-water soap focused attention on synthetic detergents for salt-water usage. The soap required oils no longer available in the quantity necessary. Due to the relatively short washing cycle employed by service men a detergent had to be used that would not cause dermatitis if garments were not fully rinsed.

Committee D 12 (3) defines a detergent simply as "a composition that cleans", and a soap as "the product formed by the saponification or neutralization of fats, oils, waxes, rosins, or their acids with organic or inorganic bases." Synthetic detergents are designated as "a detergent produced by chemical synthesis and comprising an organic composition other than soap."

McCutcheon (15) elaborates on the above definition of a detergent and states that to be a good detergent, a compound must be soluble to some extent in water, it must lower the surface tension of water, allowing the latter to penetrate the capillaries of the fibers and to wet them; it must reduce the interfacial tension to a point where the solid dirt or oil particles are displaced by the solution and finally to emulsify such displaced dirt or oil and hold it in solution until it is washed free of the fabric. Detergents in general lather well, but such a property alone is not a measure of washing power.

According to Snell (20) "detergency is too broad a concept and detergents too varied in nature to permit description in simple chemical terms. They are best defined, rather, in terms of performance." Snell assigns to detergents three specific properties, wetting power or a lowering of the surface tension, emulsifying power which enables the detergent to remove oily matter and suspend it in the form of fine particles or globules within the detergent solution. These particles must be prevented from coalesing or coming together and from redepositing on the cleaned surface. The third property is that of dispersing power or the ability to keep solid particles in suspension in the detergent solution.

The limitless number of synthetic detergents can be classified into six main groups (15). These are the sulfated alcohols, the sulfonated amides or ester derivitives, alkyl aryl sulfonates, alkyl aryl ether sulfates, partial esters of poly alcohols, and quaternary ammonium salts.

The problem of laundry also includes that of rinsing, the purpose of which is to remove the suspension of soiling matter in the detergent without allowing it to redeposit its soiling matter on the fabric (18). During rinsing the concentration of detergent falls considerably as the suspension is diluted with rinsing water. It is known that rapid changes in concentration and in temperature can cause emulsions to break and to redeposit their soiling matter on the goods being washed. This is the cause of the gray appearance of many articles washed at home.

Another technical development contributing to the problem of wise consumption is that of manufactured fibers. Science and industry have joined forces to present familiar fabrics with different fiber content and to present entirely new materials. With the fiber scarcity of wartime years the development and production of spun rayon greatly increased. The high cost and unavailability of cotton caused frequent substitution of spun rayon in everyday garments formerly made exclusively of cotton.

In a study conducted by the Bureau of Human Nutrition and Home Economics (17) in five different sections of the country during the wartime years it was found that the supplies of civilian cottons were greatly reduced. The staple cotton fabrics available were coarse and sleazy and many of them did not warrant

the effort required to make them into garments. Rayon fabrics were generally found to be more plentiful and more comparable to prewar quality than were the cottons. When checked in the laboratory the types of materials or fiber content of fabrics were frequently found to have been misrepresented by the salespeople.

> The still current shortage of and low quality of many civilian textile materials together with a dearth of information concerning the performance that fabrics will give in use, is directly responsible for many of the sad experiences every consumer is chalking up against yard goods and ready-made articles now on the retail market. (7)

Certain names of staple fabrics have long been associated with a particular type of fabric and have indicated the fiber content of that fabric. This is no longer true. Appearing on the market are fabrics made from manufactured fibers that simulate cotton in appearance, if not in performance. Chambray, batiste, seersucker and broadcloth are examples of such fabrics. Due to faulty or inadequate labeling the consumer may unwittingly buy an all-rayon or part-rayon fabric in place of a cotton fabric and expect the same service.

Rayon continues to increase in production and replacement of cotton in consumer goods. Johnson, general manager of the American Institute of Laundering, reported shirt manufacturers were predicting that 35 to 50 per cent of men's daytime dress shirts will be made of rayon. Mill men urged collaboration between laundries and manufacturers to assure the most satisfactory results for the consumers. Improvements would include adequate permanent marking to guide the laundrymen in giving proper care and an adjustment of laundry methods to accommodate the new fibers. (14)

Slub-broadcloth was formerly a fabric made exclusively of cotton and was used in women's utility garments, sports clothing and other garments of this type. A spun rayon fabric of similar construction is now available and may easily be mistaken for all-cotton. Since the two fabrics appear so much the same they are likely to receive similar care in laundering. Therefore, the fabric should be tested under identical conditions for comparison.

Recent studies have shown that cellulose fibers tend to deteriorate when exposed to extreme ultraviolet rays; i.e. less than 3,000 A. U. and that the speed of deterioration is increased under humid conditions. The widespread practice of drying clothes in the sunlight may have a tendering effect on the fabrics. However, evaporation in sun-drying may be so rapid that the effect on speed of deterioration is negligible.

The purpose of this study was threefold: first, to compare the performance of a cotton and a spun viscose rayon of similar construction and color when subjected to the same treatment; second, to compare the effects of washing with soaps and with synthetic detergents upon these fabrics; and third, to compare the effect of Fade-Ometer drying with that of laboratory drying.

REVIEW OF LITERATURE

The study of the serviceability of spun rayon as compared with cotton has been inadequate and has not kept pace with the development of this fiber.

A study of Graydon, Lindsley, and Brodie (8) on five types of rayons, cellulose acetate satin, cellulose acetate taffeta, viscose spun slub crepe, viscose taffeta and cuprammonium crepe, showed no significantly greater tensile strength losses by any one of four different washing methods. The test procedures used were two hand washing methods with squeezing or wringing for water removal, and two machine methods, one including a presoak. The results indicated that present day rayons may withstand more vigorous washing than has been recommended. The most harsh method produced the greatest soil removal with no greater degradation.

Wash tests on cotton, linen, and viscose rayon (21) to determine effects of varying washing conditions showed an increase in the deposition of calcium and magnesium compounds when the fabrics were washed with hard water and soap. The loading increased rapidly during the first 50 launderings and then remained practically constant at eight per cent of the dry weight of the fabric. Synthetic detergents gave a lower rate of loading, but the rate remained the same up to 100 launderings when the loading exceeded ten per cent. With soap the deposit is lime soap, with synthetic detergents it is chalk.

A study conducted at Alabama (12) compared the serviceability of an all-cotton chambray with a chambray of cotton warp and viscose rayon filling. Similar blouses of these materials were made and were then worn by students for a period of seven months. Examination showed that the cotton-rayon fabric developed excessive fraying and yarn slippage and greater color change. Laboratory tests on breaking strength did not show any great decrease in fabric strength after seven months of wear.

Richardson (19) conducted wear tests on cotton, cuprammonium rayon, viscose rayon, linen, silk and wool. Duplicate garments were soiled by wearing and were washed with either a soap or a synthetic detergent. The detergents showed similar ability in the cleaning of the silk and the all-wool fabrics. For the other materials, however, soap was superior in cleaning efficiency, though the effect on breaking strength was the same.

Sumner and Roseberry (22) tested the serviceability of linen, cotton with a permanent finish and rayon-cotton table napkins. After 32 launderings the linen was found to have deteriorated the most. The rayon-cotton blend gave very satisfactory service and was as attractive at the conclusion of the test as when new.

In a report by Hill (11) it is pointed out that fabric tendering by light occurred only when oxygen was present. At a constant oxygen pressure, increased moisture content decreased strength. Fabrics dyed with vat dyestuffs, particularly yellows of the anthrequinone class are the most prone to tendering. Some volatile agent, possible H_2O_2 was believed to be the cause of the weakening of such dyed fabrics.

In a study of the action of light on dyed and undyed cotton, Egerton (6) found that degradation and tendering occurred more readily in dyes of the yellow and orange shade ranges than in the green and blue shade ranges when subjected to the same conditions of light and moisture. This is attributed to the greater light sensitivity of the yellow and orange shades. Egerton found much greater loss of strength with increased relative humidity when the yarns studied were exposed to sunlight. Excessive fading was usually coupled with excessive tendering. Greater tendering after laundering was attributed to inadequate rinsing which left fabrics in an alkaline state and enhanced the degree of decomposition on subsequent exposure to light.

No study was found on the effect of sun or Fade-Ometer drying of fabrics.

METHOD OF PROCEDURE

Fabrics used for utility garments require rather rigorous cleaning and should be able to withstand many washings without being affected. A good detergent should clean effectively without materially shortening the life of the garment.

Fabrics

A cotton slub-broadcloth being used in another study was chosen for this work so that a comparison of the results of the two experiments might be obtained. A spun viscose rayon fabric of comparable construction and color was purchased in order to have

a fair judgment of the performance of cotton and spun viscose fibers. Samples of these fabrics are shown in Plate I. Both fabrics were yellow, the cotton vat-dyed, thread count of the cotton was 103 x 43 and of the rayon was 113 x 47. Weight of the cotton was 3.6 ounces per square yard and of the rayon was 5.6 ounces per square yard. Tests were conducted on the original fabrics to determine sizing, breaking strength (raveled-strip method), elongation, thread count, weight per square yard and color-fastness to light.

Sampling of the cotton and rayon fabrics were slightly different due to differences in the width of the fabric. Committee D-13 (4) states that no testing should be done of samples taken nearer the selvage than one-tenth the width of the fabric. It was necessary to cut the cotton with only a one and one-half inch allowance beyond the abrasion strips, but the tested portion was still within the allowance required. To provide eight replicates for each of the four detergents it was necessary to cut 16 sets of cotton and 16 sets of rayon as shown in Plate II. Each of these pieces was divided into two groups as shown by A, B, C and D. When cut there were a total of 32 sets of cotton specimens and 32 sets of rayon specimens to be washed. Each set was composed of warp and filling abrasion strips, a piece 7 x 13 inches for Fade-Ometer drying, and a similar one for laboratory drying, and a piece approximately 11 x 18 inches for weight per square yard and sizing samples. The abrasion strips were cut at this time but will be washed and tested in a subsequent study. In addition to these pieces eight cotton and eight rayon squares

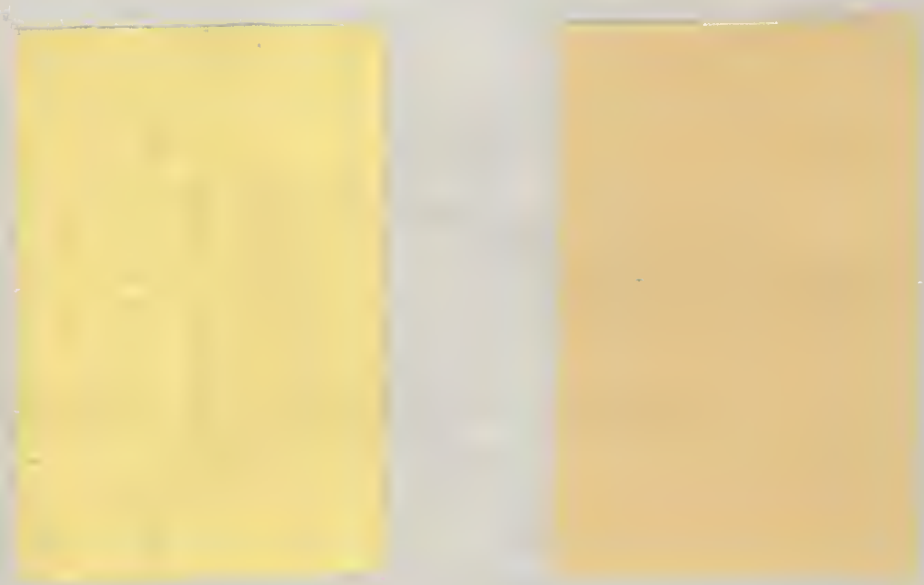
EXPLANATION OF PLATE I

Samples of Fabrics Used

A. Cotton Slub Broadcloth

B. Spun Viscose Rayon Slub Broadcloth

PLATE I



A B

EXPLANATION OF PLATE II

Cutting Chart for Fabrics

A. Set of cotton test specimens

B. Duplicate set of cotton test specimens

C. Set of rayon test specimens

D. Duplicate set of rayon test specimens

1. Warp abrasion

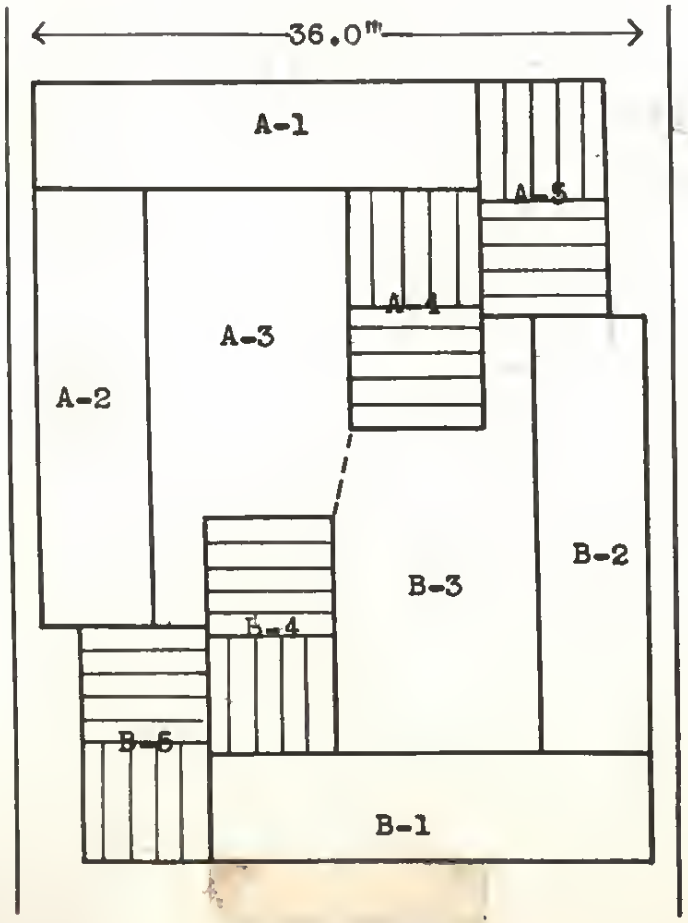
2. Filling abrasion

3. Weight per square yard and sizing

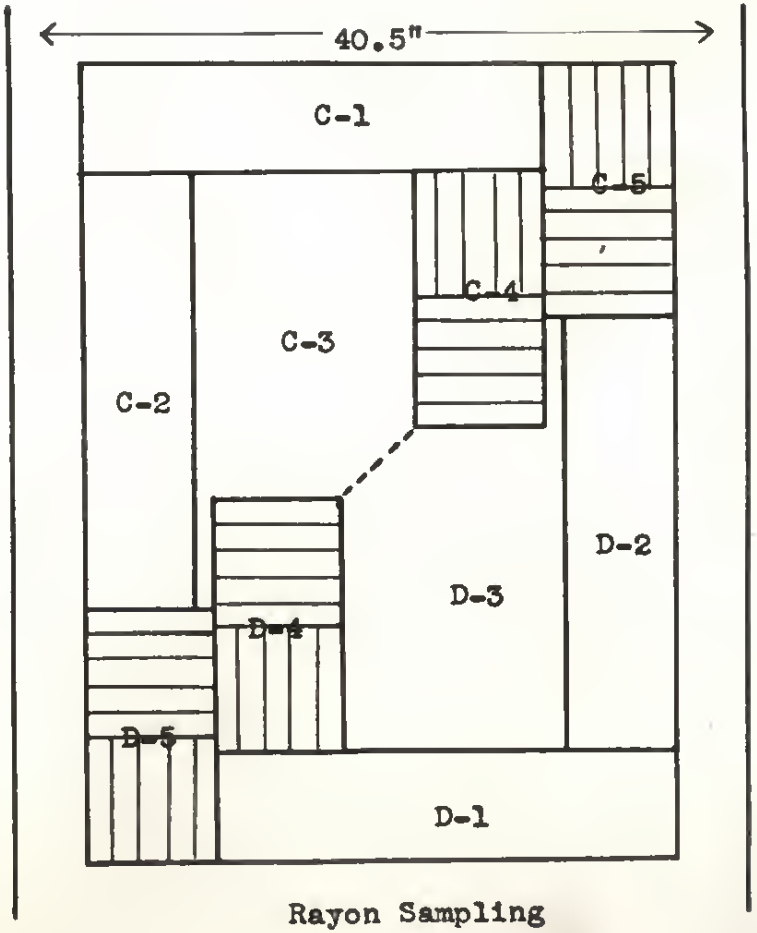
4. Fade-Ometer dried breaking strength

5. Laboratory dried breaking strength

PLATE II



Sampling



Rayon Sampling

25 x 25 inches were cut for testing of dimensional restorability. A total of approximately 25 yards of each fabric was required for testing.

Detergents

Four detergents were used for washing the fabrics. Two synthetic detergents and two soaps, one flake and one bead were chosen. The soap bead, Rinso, and one synthetic detergent, Vel, were those being used in another study. The choice of the other synthetic detergent, Tide, was based upon a survey of local grocery stores at the time of the beginning of the study and was the one most frequently purchased at that time. In a survey of brands of soap used in home laundering in Kansas (9) the soap flake Ivory used in this study was the one most frequently named as being on hand in the home.

Laundry Procedure

Specimens of each fabric were washed 48 times with each of the detergents in special apparatus made for this study. Galvanized metal cans 22 inches in height and six inches in diameter with a capacity of 20 liters of water were constructed. Plate III shows the cans in the Launder-Ometer. These cans, made watertight with a rubber gasket and a heavy metal lid held in place by screws and thumb nuts, were laid lengthwise in a Launder-Ometer. Metal bands clamped over the cans to hold them in place. The cans were rotated at a rate of 40 revolutions per minute.

EXPLANATION OF PLATE III

Galvanized metal cans clamped in the Launder-Ometer

PLATE III

A ten-minute wash period with a 0.5 per cent detergent solution at 140° F. (60° C.) was used. The temperature was that recommended by the manufacturer of an automatic washer (1) for washing colored cottons. This temperature is also being used in a similar study and comparison of results will be made. Suggested practices of laundering of the American Hotel Association (2) also recommend 140° F. as the washing temperature for fast color fabrics. Forty grams of detergent were dissolved in a liter of hot water and sufficient water added to make 20 liters of solution. Three two-minute rinses at the same temperature and removal of moisture by hydro-extracting in a Laundromat completed the washing. The specimens were divided into two groups for drying. One group was dried in circulating air in north light in the laboratory. The other group was dried by placing in the Fade-Ometer for 50 minutes. At the end of 48 washings the specimens had a total of 40 hours exposure in the Fade-Ometer. Commercial Standards CS59-44 (24) states that dress fabrics should withstand 40 hours exposure for satisfactory service. After being washed and dried all specimens were sprinkled, allowed to stand for five minutes and pressed with a flat bed press.

Tests Conducted

At the end of the 6th, 12th, 18th, 24th, 30th, 36th, 42nd, and 48th washings specimens were withdrawn. The following tests to determine service qualities were made: sizing, breaking strength (raveled-strip method), elongation, thread count and

weight per square yard. Each was done according to the method outlined by Committee D-13 (4). The color change due to washing and light as compared with the original fabrics was determined visually by ten people and rated as satisfactory or unsatisfactory when compared with L5 Standard of Committee D-13.

An additional service quality, dimensional restorability was determined. Eight samples of each fabric were prepared according to the directions for use of the tension presser developed by the United States Testing Company (25). Duplicate samples were washed with each of the detergents in the regular washing, pressed, and measured. This procedure was repeated until stability was reached.

FINDINGS AND DISCUSSION

Results of the tests conducted on the original cotton and the spun viscose rayon fabrics are presented in Table 1. The materials were found to be quite comparable in thread count. The cotton fabric had the lower count with 103 warp yarns and 43 filling yarns per inch, the rayon fabric 113 warp and 47 filling yarns per inch. The weight of the rayon was nearly 60 per cent greater than that of the cotton, being 5.64 ounces per square yard and 3.59 ounces per square yard, respectively. Sizing in both fabrics was low, being 1.28 per cent of the weight of the cotton and 2.43 per cent of the weight of the rayon. Both fabrics had a much higher breaking strength warpwise than fillingwise. The ratio between warp and filling was about the same, the cotton warp being 50 per cent stronger than the filling and the rayon warp 80 per cent stronger

Table 1. Thread count, weight per square yard, sizing, breaking strength, elongation and width of the original cotton and spun viscose rayon fabrics.

Fabric	Thread count: W*	Thread count: F*	Oz. per sq. yd.	Sizing	Breaking strength: lbs. W	Breaking strength: lbs. F	Elongation: % W	Elongation: % F	Width in.
Cotton	103	43	3.59	1.28	39	21	10.0	13.3	36.0
Rayon	113	47	5.64	2.43	59	38	33.3	23.3	40.5

*W-warp; F-filling

than the filling yarns. However, the strength of the rayon filling was nearly as great as that of the cotton warp. An extreme difference was noted between the percentage elongation in the two fabrics. Elongation of the cotton warp was found to be 10.0 per cent and the filling 13.3 whereas the rayon warp was 33.3 per cent and the rayon filling 23.3. The rayon was the wider of the two fabrics, being 40.5 inches and the cotton 36.0 inches.

Thread Count

The warp thread count of the cotton increased slightly after the first washing but then remained quite constant, 104 plus or minus one as shown in Table 2. The filling thread count showed the same tendency, changing from 43 yarns per inch to a range of 43 to 46. The rayon fabrics showed a decided change after washing. The warp count decreased from 113 on the control sample to 108 or 109 after washing. The reverse was shown in the filling which increased from 47 to a count of 55 to 57. The thread count showed the same effect as that seen in the dimensional restorability. The tension on the warp yarns was released which permitted them to spread apart and the filling yarns to contract.

Breaking Strength

The breaking strength test is one of the most standardized of the textile tests and gives valuable information for comparison of fabrics. It has been used as being quite indicative of expected behavior of the fabric under normal conditions of use. In this study the results have been used to give a comparison of the effect

Table 2. Thread count of the cotton and rayon specimens after 6, 12, 18, 24, 30, 36, 42, and 48 washings with each of the four detergents.

Washings	Cotton								Rayon							
	Ivory		Rinso		Tide		Vel		Ivory		Rinso		Tide		Vel	
	W*	F*	W	F	W	F	W	F	W	F	W	F	W	F	W	F
6	104	44	104	43	104	43	103	44	109	55	109	56	109	55	109	55
12	104	45	104	44	104	43	103	44	109	55	108	56	108	55	107	56
18	104	44	104	44	104	43	103	44	109	56	108	55	109	55	10[illegible]	55
24	104	46	104	45	104	44	104	45	108	56	108	55	109	55	10[illegible]	55
30	104	45	105	43	104	44	104	45	109	56	1[illegible]	55	109	55	1[illegible]9	56
36	104	45	104	44	105	45	104	45	108	56	108	54	109	56	108	55
42	104	46	103	45	105	44	104	44	109	56	108	56	109	55	108	55
48	104	46	104	44	103	44	104	45	109	56	108	56	108	55	109	55

*W-warp; F-filling

of detergents, to compare cotton with rayon and to compare drying by exposure in the Fade-Ometer with drying in the laboratory. Since it was difficult to visualize and compare the data obtained in tabular form, graphs (Figs. 1 to 8) were prepared to show the trends in breaking strength.

Tables 3 and 4 give the breaking strength of the cotton and rayon samples, respectively. The percentage change of the warp breaking strength of the laboratory dried samples is shown in Fig. 1. All replicates follow the same general tendency. The cotton fabric washed with Vel showed the greatest strength throughout the washings. No detergent differed greatly from another in its effect on the rayon. In Fig. 2, Vel did not show the same effect on the cotton filling that it had on the warp. There was no great deviation from the average in either the cotton or the rayon filling. Nearly all the specimens showed a loss in strength at the 24th washing which was recovered at least partially with the 30th washing. With the exception of the Vel washed filling, both cotton and rayon, all samples were reduced in strength between the 40th and 48th washings. Throughout the 48 washings the cotton warp showed the greatest variance in strength, from 12 per cent loss to 67 per cent gain and the rayon filling the least, with a variation of 5 to 24 per cent gain.

Figures 3 and 4 show that, except for the rayon warp, all fabrics showed a gain in strength at the 6th or 12th washings with subsequent fluctuations always falling below this point. The cotton filling specimens were much the weakest throughout the testing,

Table 3. Breaking strength of cotton specimens washed with the four detergents, dried in the laboratory and in the Fade-Ometer, given in pounds and in percentage of original breaking strength.*

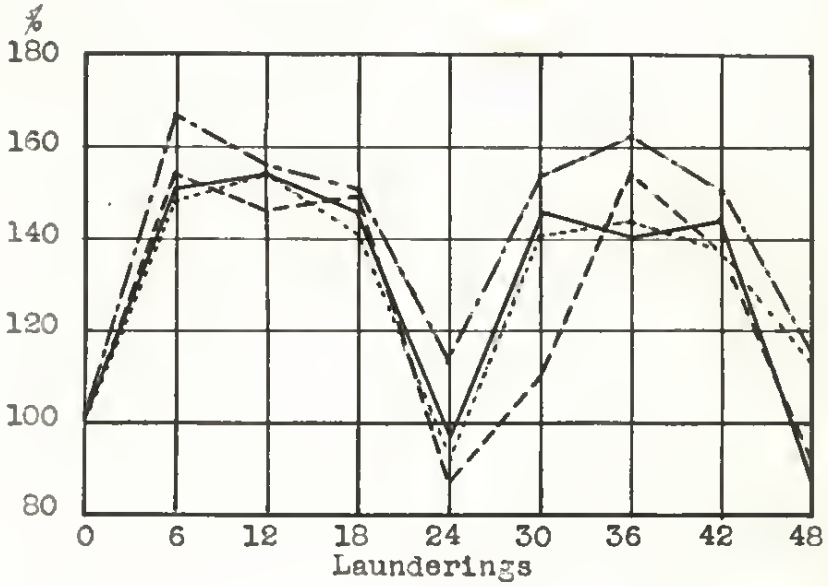
Washings	Ivory				Rinso				Tide				Vel			
	Warp		Filling		Warp		Filling		Warp		Filling		Warp		Filling	
	lbs.	%	lbs.	%	lbs.	%	lbs.	%	lbs.	%	lbs.	%	lbs.	%	lbs.	%
Laboratory dried																
6	59	151.3	25	119.0	61	156.4	26	123.8	58	148.7	24	114.3	65	166.7	24	114.3
12	60	153.8	20	95.2	57	146.2	27	128.6	60	153.8	23	109.5	61	156.4	24	114.3
18	57	146.2	22	104.8	58	148.7	23	109.5	55	141.0	27	128.6	59	151.3	23	109.5
24	38	97.4	19	90.5	34	87.2	20	95.2	36	92.3	24	114.3	44	112.8	22	104.8
30	57	146.2	21	100.0	43	110.2	21	100.0	55	141.0	23	109.5	60	153.8	24	114.3
36	55	141.0	24	114.3	60	153.8	21	100.0	56	143.6	23	109.5	63	161.5	24	114.3
42	56	143.6	21	100.0	54	138.5	22	104.8	54	138.5	23	109.5	59	151.3	21	100.0
48	34	87.2	21	100.0	36	92.3	20	95.2	44	112.8	22	104.8	45	115.4	22	104.8
Fade-Ometer dried																
6	59	151.3	25	119.0	54	138.5	24	114.3	59	151.3	24	114.3	64	164.1	23	109.5
12	57	146.2	21	100.0	55	141.0	25	119.0	55	141.0	22	104.8	61	156.4	22	104.8
18	56	143.6	21	100.0	50	128.2	21	100.0	57	146.2	22	104.8	57	146.2	20	95.2
24	52	133.3	19	90.5	39	100.0	18	85.7	33	84.6	20	95.2	41	105.1	20	95.2
30	52	133.3	19	90.5	37	94.9	20	95.2	51	130.8	19	90.5	58	148.7	22	104.8
36	49	125.6	22	104.8	49	125.6	20	95.2	52	133.3	19	90.5	58	148.7	22	104.8
42	53	135.9	19	90.5	47	120.5	19	90.5	52	133.3	20	95.2	56	143.6	19	90.5
48	36	92.3	16	76.2	36	92.3	17	81.0	35	89.7	19	90.5	38	97.4	20	95.2

*Warp 39 pounds; filling 21 pounds

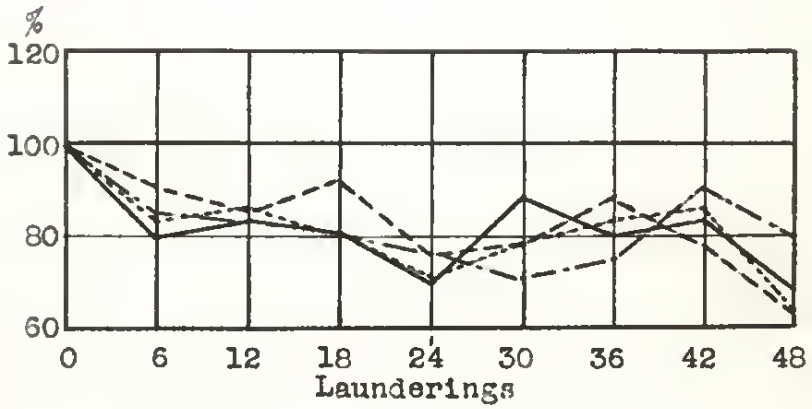
Table 4. Breaking strength of rayon specimens washed with the four detergents, dried in the laboratory and in the Fade-Ometer, given in pounds and in percentage of original breaking strength.*

Washings	Ivory				Rinso				Fide				Vel			
	Warp		Filling		Warp		Filling		Warp		Filling		Warp		Filling	
	lbs.	%	lbs.	%	lbs.	%	lbs.	%	lbs.	%	lbs.	%	lbs.	%	lbs.	%
Laboratory dried																
6	47	79.7	47	123.7	53	89.8	46	121.0	49	83.0	45	118.4	50	84.7	46	121.0
12	49	83.0	43	113.2	50	84.7	44	115.8	51	86.4	46	121.0	49	83.0	42	110.5
18	48	81.4	44	115.8	54	91.5	46	121.0	47	79.7	43	113.2	47	79.7	40	105.3
24	41	69.5	44	115.8	45	76.3	47	123.7	42	71.2	40	105.3	45	76.3	46	121.0
30	52	88.1	46	121.0	46	78.0	46	121.0	46	78.0	46	121.0	42	71.2	44	115.8
36	47	79.7	45	118.4	52	88.1	45	118.4	49	83.0	46	121.0	44	74.6	44	115.8
42	49	83.0	44	115.8	46	78.0	45	118.4	51	86.4	46	121.0	53	89.8	45	118.4
48	40	67.8	43	113.2	37	62.7	41	107.9	38	64.4	41	107.9	47	79.7	46	121.0
Fade-Ometer dried																
6	42	71.2	43	113.2	52	88.1	45	118.4	52	88.1	44	115.8	54	91.5	47	123.7
12	46	78.0	42	110.5	47	79.7	43	113.2	49	83.0	45	118.4	48	81.4	43	113.2
18	50	84.7	42	110.5	50	84.7	44	115.8	49	83.0	41	107.9	49	83.0	43	113.2
24	44	74.6	43	113.2	43	71.4	38	100.0	37	62.7	36	94.7	45	76.3	44	115.8
30	37	62.7	37	97.4	46	78.0	45	118.4	49	83.0	44	115.8	43	72.9	44	115.8
36	49	83.0	47	123.7	51	86.4	45	118.4	48	81.4	46	121.0	46	78.0	44	115.8
42	46	78.0	44	115.8	47	79.7	42	110.5	48	81.4	44	115.8	47	79.7	44	115.8
48	33	55.9	38	100.0	38	64.4	41	107.9	45	76.3	40	105.3	50	84.7	46	121.0

*Warp 59 pounds; filling 38 pounds



Cotton

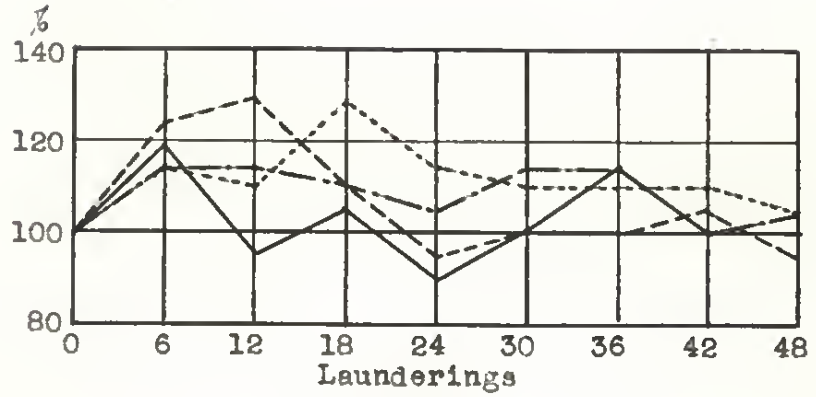


Rayon

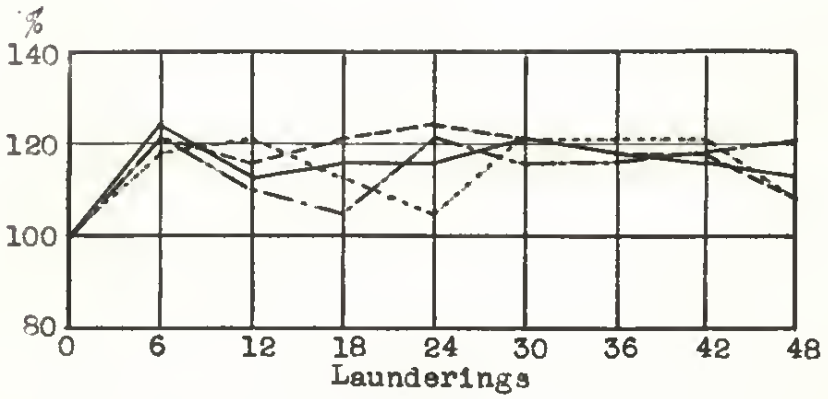
——— Ivory ····· Tide

----- Rinso —·—· Vel

Fig. 1. Warp breaking strength in per cent of control for laboratory dried cotton and rayon fabrics after 6, 12, 18, 24, 30, 36, 42 and 48 launderings with each detergent.



Cotton

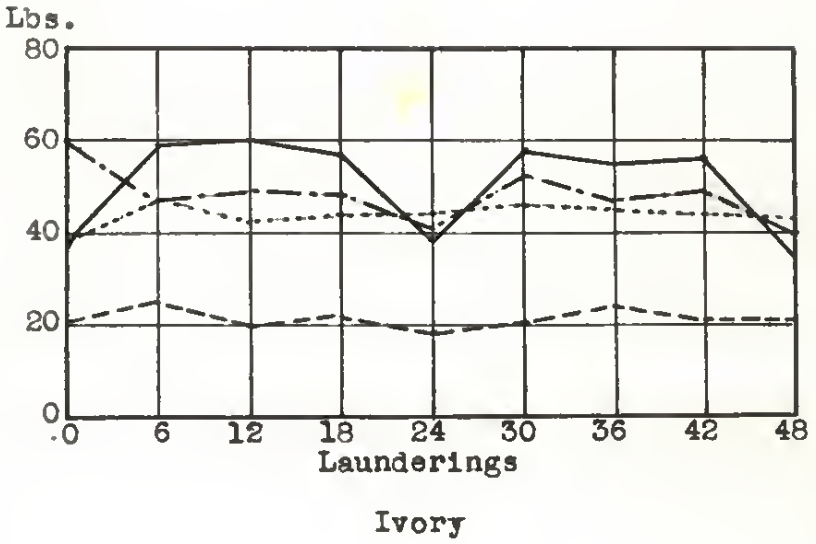


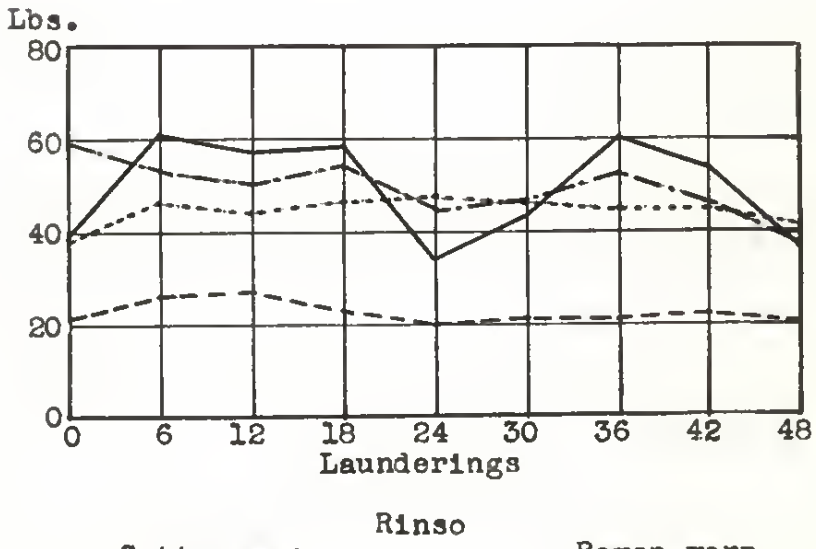
Rayon

——— Ivory -------Tide

-----Rinso —·—Vel

Fig. 2. Filling breaking strength in per cent of control for laboratory dried cotton and rayon fabrics after 6, 12, 18, 24, 30, 36, 42 and 48 launderings with each detergent.

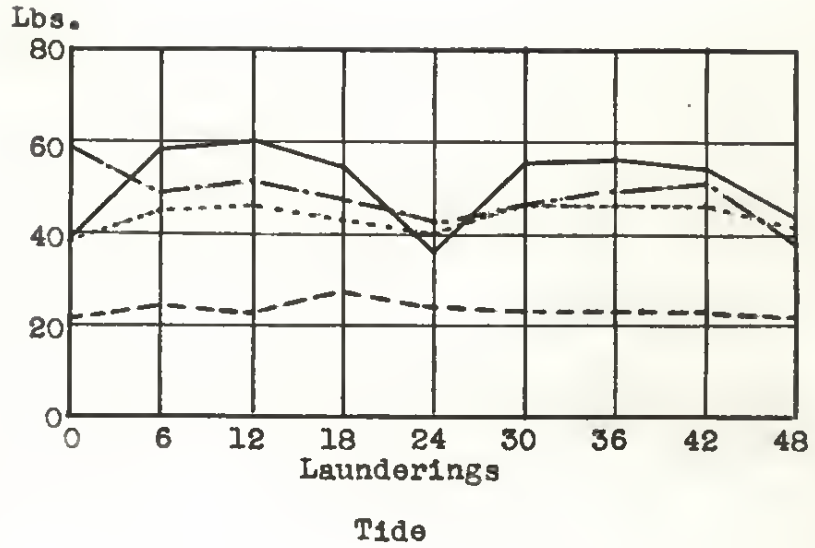




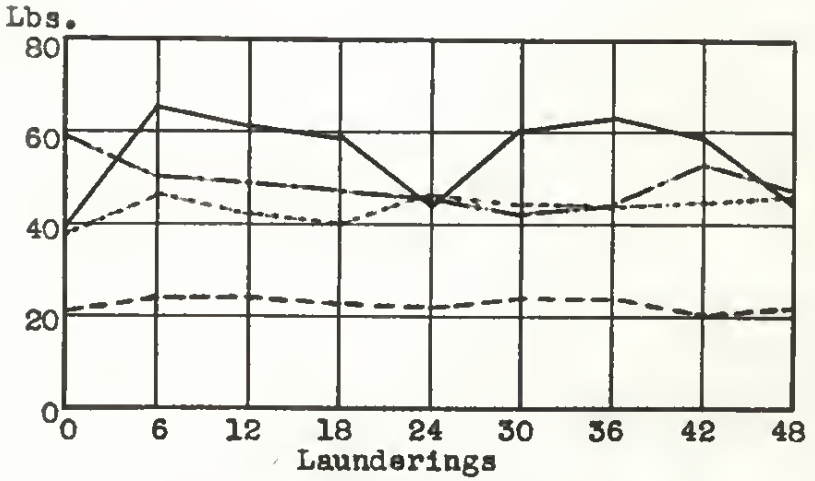
_____ Cotton warp _._._. Rayon warp

– – – – Cotton filling ····· Rayon filling

Fig. 3. Breaking strength in pounds of laboratory dried cotton and rayon warp and filling after 6, 12, 18, 24, 30, 36, 42 and 48 launderings with soaps Ivory and Rinso.



Tide



Vel

——— Cotton warp —·—·—Rayon warp
– – – – Cotton filling ·····Rayon filling

Fig. 4. Breaking strength in pounds of laboratory dried cotton and rayon warp and filling after 6, 12, 18, 24, 30, 36, 42 and 48 launderings with synthetic detergents Tide and Vel.

but showed the least variation in strength. The rayon warp and filling were quite comparable in strength to each other and to the cotton warp. The rayon was less affected by the washing both warpwise and fillingwise than the cotton warp and variation between tests was quite small.

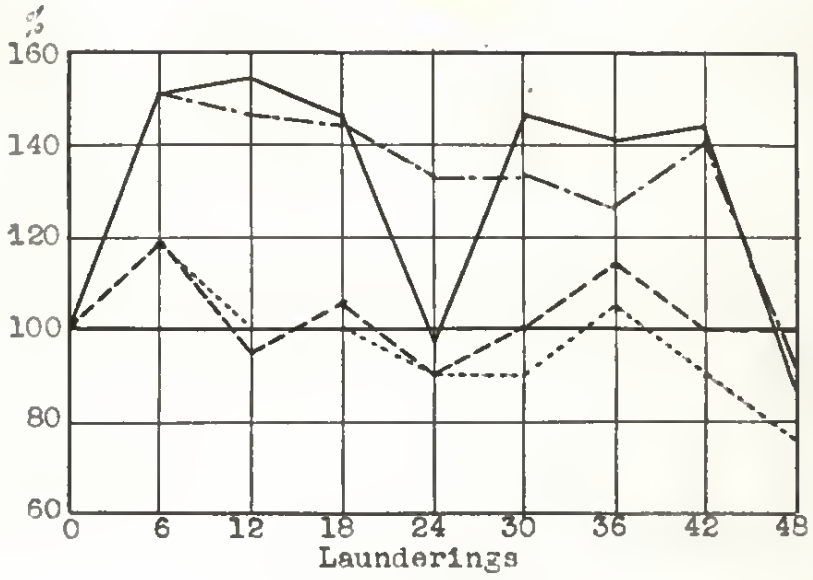
Figures 5, 6, 7, and 8 show breaking strength for the fabrics dried in the Fade-Ometer slightly lower than that for laboratory dried samples. The difference was small, but was quite consistent. The cotton showed a greater effect by Fade-Ometer drying, both warp and filling, whereas the rayon warp seemed to be the least affected.

Elongation

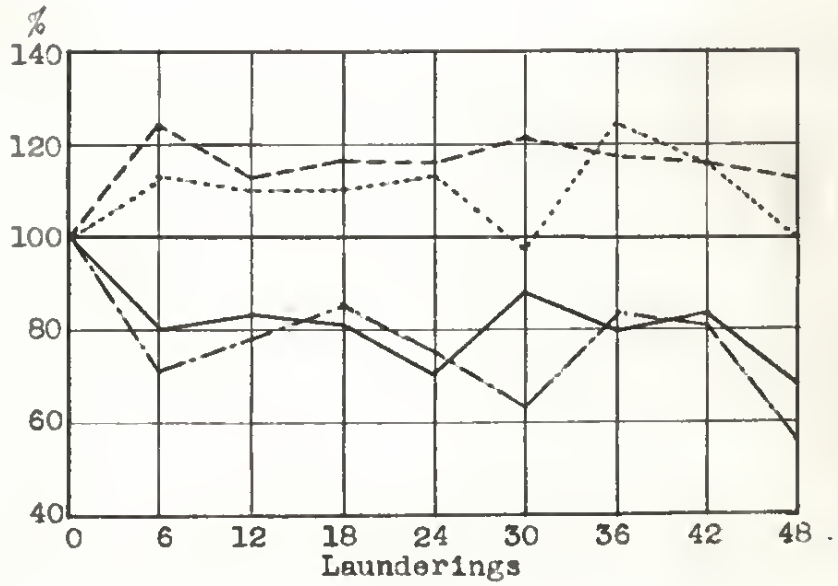
Elongation of the cotton fabrics, both warp and filling was less than that of the rayon and varied less, Table 5. Cotton elongation ranged from 10.0 per cent to 16.7 per cent warpwise and from 6.7 to 13.3 fillingwise. The rayon samples varied more in the warp and the elongation was much greater. Variation in the rayon warp was from 23.3 per cent to 40.0 and in the filling from 13.3 to 20.0 per cent.

Weight per Square Yard

Changes in weight per square yard are shown in Table 6 and in Fig. 9. The initial marked increase in weight from zero washings to six washings may be attributed, at least in part, to the shrinkage which increased the number of yarns per inch. The original rayon fabric was approximately 70 per cent heavier than the cotton and there was more variation with washing in the rayon than in the



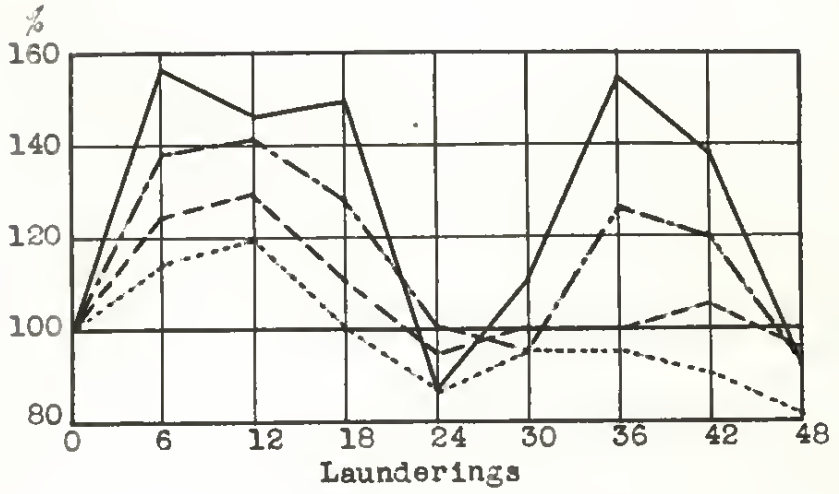
Cotton



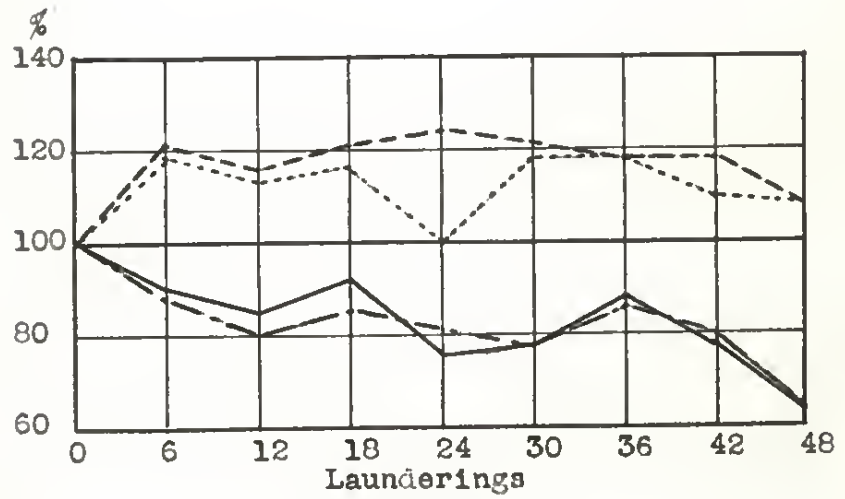
Rayon

——— Laboratory dried warp
– – – – Laboratory dried filling
—·—·— Fade-Ometer dried warp
····· Fade-Ometer dried filling

Fig. 5. Warp and filling breaking strength in percentage of control for laboratory dried and Fade-Ometer dried cotton and rayon fabrics after 6, 12, 18, 24, 30, 36, 42 and 48 launderings with Ivory.



Cotton

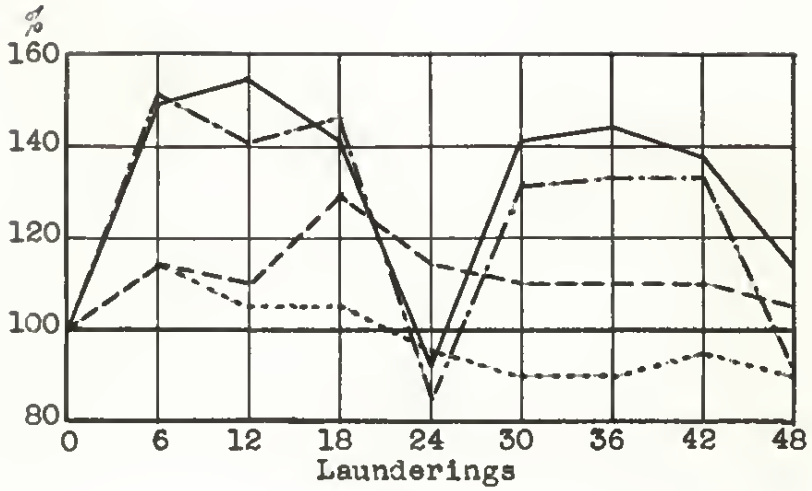


Rayon

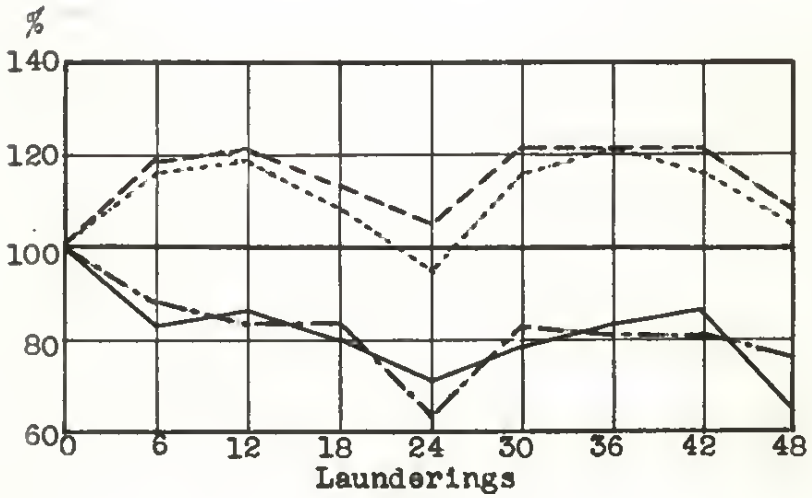
——— Laboratory dried warp —.—.— Fade-Ometer dried warp

– – – – Laboratory dried filling ····· Fade-Ometer dried filling

Fig. 6. Warp and filling breaking strength in percentage of control for laboratory dried and Fade-Ometer dried cotton and rayon fabrics after 6, 12, 18, 24, 30, 36, 42 and 48 launderings with Rinso.



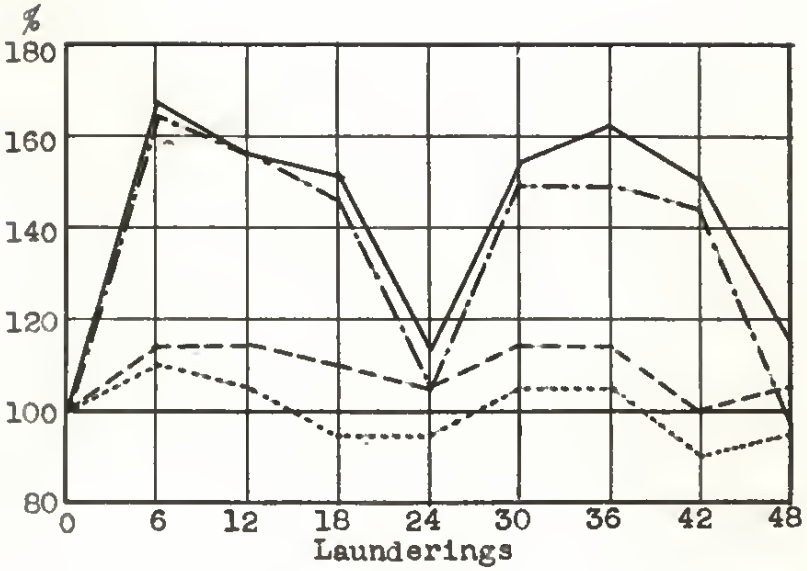
Cotton



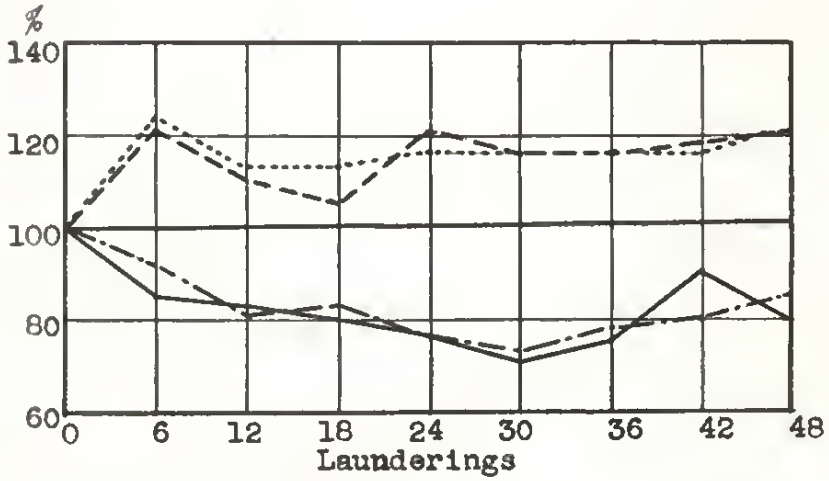
Rayon

——Laboratory dried warp
- - - -Laboratory dried filling
—·—· Fade-Ometer dried warp
..... Fade-Ometer dried filling

Fig. 7. Warp and filling breaking strength in percentage of control of laboratory dried and Fade-Ometer dried cotton and rayon fabrics after 6, 12, 18, 24, 30, 36, 42 and 48 launderings with Tide.



Cotton



Rayon

——— Laboratory dried warp

– – – Laboratory dried filling

—·—· Fade-Ometer dried warp

····· Fade-Ometer dried filling

Fig. 8. Warp and filling breaking strength in percentage of control for laboratory dried and Fade-Ometer dried cotton and rayon fabrics after 6, 12, 18, 24, 30, 36, 42 and 48 launderings with Vel.

Table 5. Percentage elongation of cotton and rayon fabrics, washed with each of the four detergents, laboratory dried and Fade-Ometer dried after each 6, 12, 18, 24, 30, 36, 42, and 48 launderings.

Washings	Cotton								Rayon							
	Ivory		Rinso		Tide		Vel		Ivory		Rinso		Tide		Vel	
	W*	F*	W	F	W	F	W	F	W	F	W	F	W	F	W	F
Laboratory dried																
6	13.3	13.3	13.3	13.3	13.3	10.0	13.3	13.3	33.3	20.0	33.3	16.7	33.3	16.7	36.7	16.7
12	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3	36.7	20.0	36.7	16.7	36.7	20.0	33.3	20.0
18	16.7	13.3	13.3	13.3	13.3	13.3	13.3	10.0	33.3	20.0	40.0	20.0	36.7	20.0	33.3	20.0
24	10.0	10.0	13.3	10.0	13.3	13.3	10.0	10.0	26.7	16.7	23.3	13.3	33.3	20.0	[illegible]	16.7
30	13.3	10.0	10.0	10.0	13.3	10.0	13.3	13.3	36.7	20.0	23.7	16.7	33.3	20.0	33.3	20.0
36	13.3	10.0	13.3	10.0	13.3	13.3	13.3	13.3	36.7	20.0	36.7	16.7	33.7	23.3	36.7	20.0
42	16.7	13.3	13.3	13.3	13.3	13.3	13.3	10.0	36.7	20.0	36.7	20.0	36.7	20.0	36.7	16.7
48	13.3	10.0	13.3	10.0	13.3	10.0	13.3	13.3	33.3	20.0	30.0	20.0	30.0	20.0	36.7	20.0
Fade-Ometer dried																
6	13.3	13.3	10.0	13.3	10.0	13.3	13.3	13.3	30.0	20.0	33.7	16.7	36.7	16.7	36.7	16.7
12	13.3	13.3	13.3	13.3	13.3	13.3	13.3	10.0	36.7	20.0	36.7	23.3	33.3	20.0	40.0	23.3
18	13.3	13.3	13.3	13.3	13.3	13.3	13.3	10.0	36.7	20.0	36.7	20.0	33.3	20.0	33.3	20.0
24	13.3	10.0	13.3	10.0	13.3	10.0	10.0	10.0	26.7	16.7	33.3	20.0	33.3	20.0	26.7	16.7
30	13.3	10.0	10.0	6.7	13.3	10.0	13.3	10.0	30.0	23.3	26.7	16.7	36.7	16.7	30.0	20.0
36	13.3	10.0	13.3	10.0	13.3	13.3	13.3	13.3	40.0	20.0	36.7	16.7	40.0	20.0	33.3	20.0
42	13.3	13.3	13.3	13.3	13.3	13.3	13.3	10.0	36.7	20.0	36.7	20.0	33.3	20.0	33.3	16.7
48	13.3	10.0	13.3	10.0	13.3	10.0	13.3	10.0	30.0	23.3	30.0	20.0	33.3	20.0	40.0	20.0

*W-warp; F-filling

Table 6. Weight per square yard of cotton and rayon fabrics after 6, 12, 18, 24, 30, 36, 42, and 48 washings with the four detergents and the percentage of each of the original fabric.*

Washings	Ivory		Rinso		Tide		Oxy	
	oz. per sq. yd.	%	oz. per sq. yd.	%	oz. per sq. yd.	%	oz. per sq. yd.	%
				Cotton				
6	4.01	111.7	3.86	107.5	3.68	102.5	3.63	101.1
12	3.93	109.5	4.01	111.7	3.63	101.1	3.62	100.9
18	3.90	108.6	3.74	104.2	3.86	107.5	3.58	99.7
24	3.94	109.7	3.75	104.4	3.86	107.5	3.66	101.9
30	3.93	109.5	3.75	104.4	3.60	100.3	3.64	101.4
36	3.99	111.1	3.79	105.6	3.59	100.0	3.72	103.6
42	3.98	110.9	3.92	109.2	3.60	100.3	3.66	101.9
48	4.12	114.8	3.98	110.9	3.68	102.5	3.68	102.5
				Rayon				
6	5.85	113.6	5.72	111.1	5.72	111.1	5.53	107.4
12	5.78	112.2	5.76	111.8	6.07	117.9	5.58	108.3
18	5.92	115.0	5.79	112.4	5.71	110.9	5.51	107.0
24	6.00	116.5	5.87	114.0	5.60	108.7	5.72	111.1
30	5.96	115.7	5.66	109.9	5.61	108.9	5.77	112.0
36	6.01	116.7	5.77	112.0	5.72	111.1	5.63	109.3
42	6.34	123.1	5.62	109.1	5.87	114.0	5.56	108.0
48	6.23	121.0	5.95	115.5	5.71	110.9	5.64	109.5

*Cotton, 3.59 oz. per sq. yd.; rayon, 5.15 oz. per sq. yd.

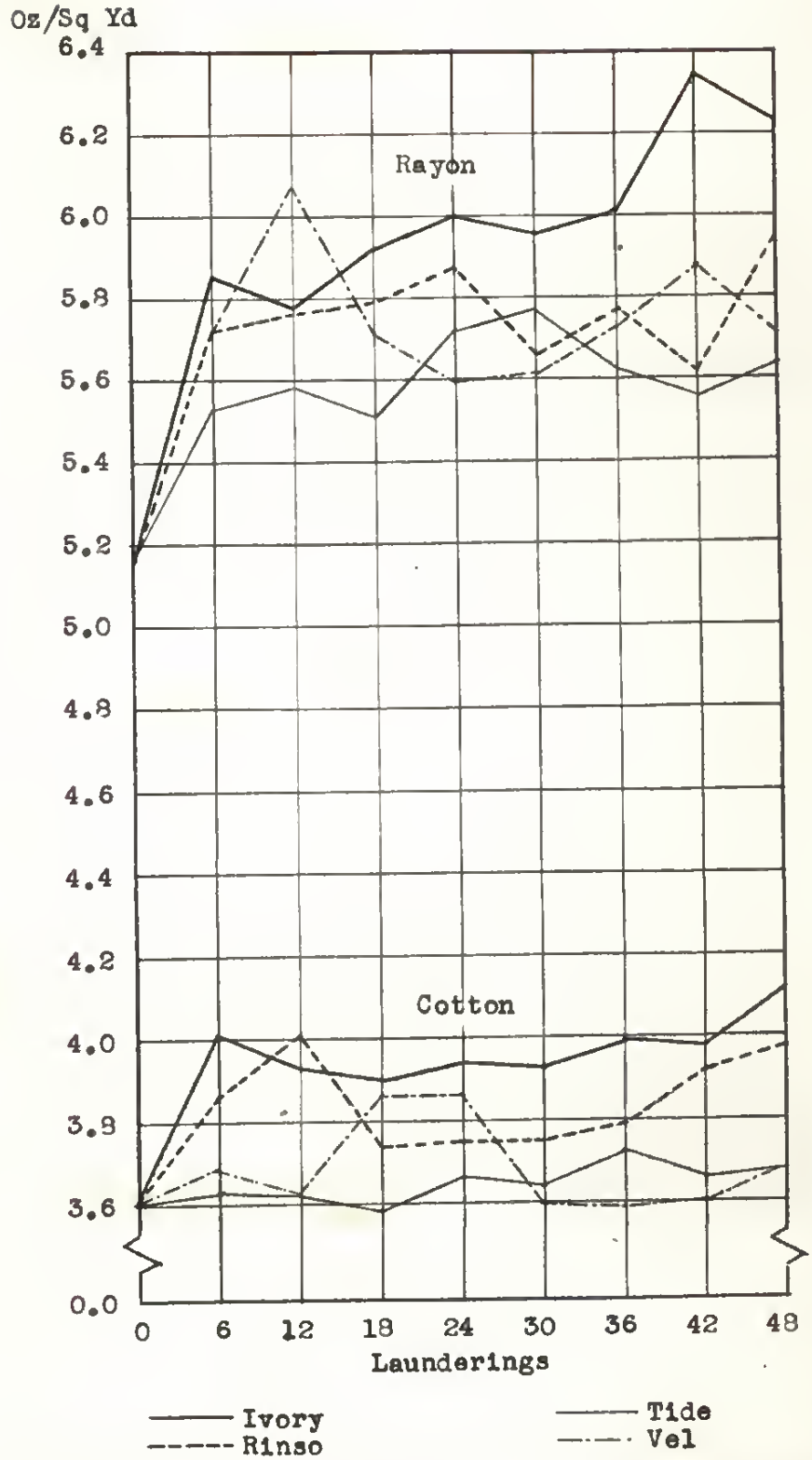


Fig. 9. Weight of cotton and rayon fabrics at the end of 6, 12, 18, 24, 30, 36, 42 and 48 launderings.

cotton. With both fabrics a gradual increase in weight was noted in samples washed with soaps Ivory and Rinso, with Ivory-washed specimens increasing the most. The specimens laundered with the synthetic detergents Vel and Tide showed less increase and at the 4th washing varied little from the weight found at the 6th.

Nonfibrous Content

Table 7 shows the same effect as Table 6, namely, that there was a greater increase in weight of fabrics washed with soaps than with synthetic detergents. The rayon fabric had a larger percentage of nonfibrous material in the control sample and in each of the washed samples than did the cotton.

Table 7. Percentage of nonfibrous material in original fabric and in samples washed six times with each of the four detergents.

Fabric	Control	Ivory	Rinso	Tide	Vel
	%	%	%	%	%
Cotton	1.28	2.20	1.56	.98	.70
Rayon	2.44	3.23	1.76	1.22	1.02

Dimensional Restorability

Dimensional restorability was little affected by the choice of detergent. After one washing cotton fabrics washed with Ivory and Tide fell into Group 3 of the classification set up by the United States Testing Company. After two washings cotton fabrics washed with Rinso and Vel also were classified in Group 3. According to directions of U.S.T.C. fabrics in Group 3 require a weight of three

pounds to restore the measurement within two per cent. "Such fabrics will be satisfactory when ironed with moderate tension applied in hand pressing in the direction of the greatest change." (25) After the initial shrinking the cotton fabric stabilized quickly. With pre-shrinking this fabric would give satisfactory service because the total shrinkage of the subsequent five washings did not total two per cent and the fabric had ceased to change dimensions by that time.

The rayon fabric behaved quite unsatisfactorily. After the first washing all samples were classified in Group 5. "Fabrics so reported will not be satisfactory for dimensional restorability because the tension necessary to restore the fabric to within two per cent plus or minus is impractical to apply in hand pressing." (25) The extreme shrinkage in the warp, 5.2 to 7.2 per cent, coupled with the stretch of 3.5 to 4.0 per cent in the filling, would render a garment unwearable. Repeated tests showed the same tendency of the fabric to shrink during washing and stretch during pressing.

Color Change

Exposure of the original cotton fabric to the Fade-Ometer for 20 hours caused no more fading than the L5 standard of Committee D 13 (4) and was judged to be satisfactory. Forty hours exposure caused greater change than the standard and was judged to be unsatisfactory. The original rayon fabric was judged unsatisfactory after 20 hours exposure because the color change was greater than the standard.

After 48 washings the cotton laboratory dried samples still showed no change in color, but those dried in the Fade-Ometer had changed greatly. Nearly all of the color had been bleached from them. All the rayon specimens showed great color change after 48 washings, though there was very little difference between the amount of color lost in the laboratory dried specimens and the Fade-Ometer dried specimens.

Choice of detergent seemed to make no difference in the speed of color loss in the cotton. Cotton fabrics washed with soap and those washed with synthetic detergents and dried by exposure in the Fade-Ometer showed unsatisfactory color change after the 12th washing.

Although after the 48th laundering there was little difference in the samples dried in the two ways, change took place more quickly in the Fade-Ometer dried samples which were judged to be unsatisfactory after six washings. The laboratory dried samples retained their color until after the 12th washing, at which time they, too, were unsatisfactory due to color change.

Fraying

Fraying of the rayon fabric was much more marked than that of the cotton. At the end of the 48th washing the samples had frayed to a depth of one-half inch. In a garment with average seams this would render the garment unwearable. Fraying of the cotton was less than one-fourth inch and would not affect the wear of a garment with average seam allowances. Plate IV shows the appearance of fraying of the two fabrics after 48 launderings.

EXPLANATION OF PLATE IV

A. Photograph showing fraying of cotton after 4[illegible] launderings.

B. Photograph showing fraying of rayon after 4[illegible] launderings.

PLATE IV

A B

SUMMARY AND CONCLUSIONS

From the data collected in this study it may be assumed that the choice of a detergent has little effect upon the breaking strength, elongation, thread count, shrinkage or color-fastness of the fabric after a series of launderings. There seemed to be no appreciable difference between the effect of the soaps and the synthetic detergents on these service qualities.

The increase in weight was found to be greater in the soap-laundered fabrics than in those washed with the synthetic detergents. This was attributed to the deposit of lime soap which accompanies the use of soap in hard water.

The cotton fabric stabilized dimensionally sufficiently after one washing to give satisfactory service. However, the rayon fabric did not cease to stretch and shrink so that satisfactory wash and ironing of a garment made from it would be most difficult, if not impossible. Also the rayon fabric frayed to such an extent in the washing that in a garment, sufficient seam finish to prevent excessive fraying would be difficult to obtain. Although the rayon fabric might be mistaken for the cotton in appearance, performance would not be comparable.

Fade-Ometer drying had very slight effect on the breaking strength of the fabrics, but it had a marked effect on the color-fastness of the cotton material. Color change in the cotton was caused by the Fade-Ometer, whereas in the rayon it was caused by washing. From the effect of the Fade-Ometer on the cotton fabric

it may be assumed that drying wet materials in direct sun-light will greatly accelerate fading, and colored materials should be protected by hanging them in the shade.

ACKNOWLEDGMENT

Appreciation is expressed to Miss Esther Cormany, Associate Professor of Clothing and Textiles, for her time and effort in directing this study.

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