

THE EFFECTS OF INSTITUTIONAL AND COMMERCIAL LAUNDRY  
METHODS UPON COTTON AND LINEN FABRICS

by

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## INTRODUCTION

The introduction of scientific methods into routine household tasks has revolutionized the problem of washday. Formerly the sole concern of the laundress was an adequate supply of water, the quantity being of more importance than the quality. In course of time choice of soaps, bleaches, and still later of washing machines were added to her responsibilities. Now the housewife may send her wash to the commercial laundry, to whom she shifts the task of selecting efficient methods and equipment.

Soap, one of the indispensable detergents in the laundry at present, was considered a luxury up to the nineteenth century and was seldom, if ever, used for cleansing clothes. Records, however, show that herbs, barks, and roots of plants were employed very early as stain removers.

The process of bleaching was not unknown to the primitive peoples. They spread the cloth on the grass and left it exposed to the air and sunlight for several months, sprinkling it daily. Later the fabrics were steeped in potash lye and soaked in butter-milk for several days and spread on the grass to whiten.

The washing of clothes was, for centuries, exclusively a domestic operation. Commercial power laundries were

established in England by an act of Parliament as a sanitary measure during the cholera epidemic of the nineteenth century. Their rise in the United States dates from the Gold Rush days when California miners sought the service of the laundry for the washing of their linens.

The increasing density of the population of our modern cities, with the consequent crowding into hotels and apartment houses, has made more and more difficult the functioning of the traditional home laundry. The commercial laundry, which formerly had been patronized exclusively by hotels, restaurants, and by men customers, is now entrusted with the family bundle as well. Laundry service has been enabled to extend its services beyond the limits of the city through the medium of improved highways. Lack of water has caused suburban and even rural families to add their names to the commercial laundry's list of patrons. Institutions usually prefer to maintain their own laundry system. Even though they do not doubt the efficiency of the commercial plant, they find the institutional laundry more convenient and economical.

The institutional laundry is a combination of both the commercial and the home laundry. It partakes of the nature of the commercial laundry in that it uses similar equipment, and similar methods; of the nature of the home

laundry in so far as it serves a select group and its methods are adapted to meet the needs of that group.

The purpose of the commercial laundry is to offer a type of service satisfactory to its patrons, and at the same time to secure as wide a margin of profit as possible; the purpose of the institutional laundry is to insure, at the most economical rate possible, a type of service most highly conserving the appearance and longevity of the fabric.

#### REVIEW OF LITERATURE

Institutional laundries, their methods, effects upon fabrics, and costs of operation offer a field of study hitherto little explored by the research worker. Since institutional laundries have the nature of both home and commercial laundries, available studies of commercial laundries will help to solve the problems of the institutional plant.

The surveys made by the Wisconsin Laundrymen's Association as reported by Stephenson (1926) show that although much work of high quality was done by the commercial laundry, still lack of standard methods tended to discourage patronage of such plants, because of the unreliability of work of uniformly high character.

Since the move toward standardization of methods and

certification of laundries has got under way, confidence in the commercial laundries has proportionally increased. De Armond (1932) states that textile mills are now recommending the service of the commercial laundry to the users of their fabrics. According to him, the Wamsutta Mills advises its patrons to send the sheets and pillow cases made from Wamsutta Mills fabrics to commercial laundries certified by the Laundry Owners' National Association, and subscribing to its code of ethics.

This recommendation agrees with the findings of a study made by Howarth (1933) which shows that commercial laundry methods affect fabrics and color to no greater extent than does the average home plant.

The findings of a series of experiments made by Snyder and Winegar (1933) indicate that the tensile strength of fabrics suffers more depreciation from the treatment of the commercial laundry than from the domestic one. In this study two sets of pillow cases of three qualities and three prices were subjected to fifty washings by a commercial laundry and a home plant respectively, the latter using a machine of the cylinder type and a hand iron for the pressing. The greater decrease of strength on the part of the material washed by the commercial laundry was attributed

to the use of bleach.

The effect of bleach on the tensile strength of fabrics has been studied by MacMahon (1935), who gives a detailed account of the procedure adopted and a synopsis of its results. Bleaches of various concentrations were used in order to determine the most efficient strength for laundering. It was discovered that where bleaching conditions were accurately and carefully controlled the loss of tensile strength was negligible. The ideal chlorine concentration seemed to be that obtained by using two quarts of 1 per cent standardized bleach per hundred pounds of dry weight of washing.

The Laundry Age (1932) reports an investigation on the effect of commercial bleach on linens, made in a New York laundry. Two napkins, after having been washed and bleached five hundred times with the daily load, showed only a slight wear on the selvage. This treatment was considered equivalent to thirty-eight months of service, fourteen more months than the ordinary life of a table napkin in actual use.

Further studies relative to the effects of laundering were made by Griffith and Edgar (1928). Five types of wide cotton sheetings were carefully analyzed and subjected to

two hundred washings, this number of trips to the laundry was taken to represent the life-term of an average sheet.

Amount of shrinkage, as well as loss of tensile strength, is a factor to be reckoned with in the laundering of the finished fabric. Yoder and Willard (1935) attacked the problem of shrinkage in a series of experiments, the purpose of which was to study the effects of those factors which they thought produced shrinkage. Their findings agree with those of Johnson (1927); both found that time and temperature have little effect on the shrinkage of unbleached muslin, but that it is governed largely by the properties of the material itself.

MacGowan, Smither, and Schoffstal (1924) consider as ideal laundry practice that treatment which restores the fabric to its original condition of color and texture with the least possible damage to the material and with the greatest saving of time.

Studies relating to the effect of commercial laundries on the tensile strength of fabrics lack full practical value when they fail to take into consideration the depreciation of the fabric from the wear and tear of service as well as from the treatment of the laundry. Haley (1935) met this difficulty by conducting a series of experiments in which the fabrics not only went through a series of



laundry operations but also had intermediate intervals of actual use. Ten cotton sheets were used for a week, then laundered. He found that after eight weeks' wear sheets lost 25 per cent in weight, and that after fifty weeks of service they were definitely worn out. This finding furnished a contrast to the experiments in which materials were laundered from two hundred fifty to three hundred sixty-four times before being worn out, the difference in durability being due to the deleterious results of service.

METHOD OF PROCEDURE

The fabrics chosen for this study were those most commonly handled by laundries of all types--bed and table linens. To insure uniformity of quality, the materials were purchased by the yard and made into sheets and tablecloths.

The sheets were made of a plain woven bleached cotton fabric of medium weight, purchased for thirty-five cents a yard. They were used as lower sheets on single beds for three nights each week and laundered weekly. Since the areas of wear are conditioned by the height and weight of the individual, each sheet was used by the same person throughout the experiment. The hospital method of bed making was employed, bringing the portion subject to the greatest amount of wear in approximately the same place.

each time.

The table linen, bought for \$2.50 a yard, was a bleached single damask consisting of a combination sateen and satin weave. The all-over pattern, a small leaf design an inch in diameter, was located at intervals of two and one-half to three inches on a satin background. The border contained a similar but larger motif. The longest floats used in forming the designs passed over seven threads. These tablecloths were used three days a week on tables accommodating six persons. The same sets of table and bed linens were sent to the same laundry throughout the test.

Two institutional and two commercial laundries, located in a city of approximately twelve thousand inhabitants, were selected to carry out the experiment. The methods used in each plant are recorded in table 1.

A piece of the original material was analyzed for thickness, thread count, breaking strength, elongation, weight per square yard, and sizing. These measurements were made as recommended by Committee D-13 (1933) for the American Society for Testing Materials.

The number of warp and filling yarns per inch were counted with the Lowinson thread counter. An average of ten countings, taken from the different portions of the

Table 1. METHODS USED BY THE LAUNDRIES SELECTED FOR THIS STUDY.

	Commercial A	Commercial B	Institutional C	Institutional D
Source of water supply	City water	City water	City water	City water and rain water
Softener used	Synthetic sand	Wayne softener	Webb-Zeolite	None
Soaking	Not reported	Cold water-5 minutes	Cold water-5 minutes	Cold water 10-15 minutes
Nets used	None	None	None	None
Soap:				
Kind	Builds to own pH	ArmourFlint Shreds	Soda and flake soap	White Pearl Soap Chips
Amount	Not reported	Not reported	1 quart liquid to 30 gallons water	1/5 pound per gallon
Suds:				
Number	Multiple suds	Three	Two	One or two
Time	according to standards	15 minutes each	10 minutes	10 minutes
Temperature		Varies with clothes washed.	145° F.	To boil
Bleach:				
Kind	None	Kind not reported	Chlorinated lime and soda	Chlorinated lime and soda
Amount		Not reported		Not reported.
Sour	Fluoride	Acetic acid	None	None
Rinses:				
Number	Five to six	Four to five	Three	Three to four
Time of each		Five minutes	Ten minutes	Ten to fifteen minutes
Temperature	Temperature of last suds to cold	Temperature of suds gradually to cold	Cold, tepid, cold	First, near boiling rest cold
Bluing	Not reported	Zanzibar	Sunshine	Aniline blue
Tumbler used?	Yes	Yes	No	Yes
Time	Not reported	45 minutes-1 hour		5 to 10 minutes
Approximate temperature of rolls	Steam at 100 pounds pressure	Steam at 80 pounds pressure	327° F.	Steam at 90 to 100 pounds pressure

fabric, exclusive of ten inches from the selvage, was considered as the average number of threads per inch.

For the purpose of removing sizing the enzyme method which is recommended in the A.S.T.M. was used. A sample six inches square, cut on the diagonal of the material, was brought to constant weight by drying it at a temperature of 221° to 230° F. (105° to 110° C.) in an Emerson Conditioning oven. The specimen was then extracted for two hours with carbon tetrachloride in a Soxhlet or similar extractor. The specimens were dried in the air and washed, alternately squeezing and immersing in hot distilled water. The specimens were then put in a starch enzyme solution at 122° F. (50° C.) and squeezed while immersed, removed and squeezed again, repeating this procedure three times. The enzyme solution was then heated to 158° F. (70° C.) and the specimens kept in it for a period of fifteen minutes, the temperature being maintained at 158° F. 12° F. (70° C. ± 1.1°C.). The specimens were rinsed twelve times in fresh portions of hot distilled water, squeezing after each rinse, and dried at 221° to 230° F. (105° to 110° C.) to constant weight. The total percentage of sizing was calculated as follows:

$$\frac{\text{weight of dry specimens} - \text{weight of treated specimens}}{\text{weight of dry specimens}} \times 100$$

The average thickness of the fabrics was determined by ten measurements, taken at different parts of the fabrics, within six inches of the selvage, by means of a Randal Stickney thickness gauge, which exerted constant pressure on a circle of fabric three-eighths inch in diameter.

The strip method was used to determine the breaking strength. Strips one and one-fourth inches wide were raveled to exactly one inch; the Lowinson Thread Counter being used to check the width. The breaking strength tests were made on a vertical type Scott Tester with capacities of 0-50 pounds and 0-250 pounds and having an automatic recording device both for strength and elongation. Two inch jaws were set three inches apart; the rate of speed of the machine was twelve inches per minute. An average of ten strips was taken for both the warp and filling yarns. The difference in tensile strength after the first and after twenty launderings was used to determine the percentage loss in strength.

Similar tests were made after one, and again after twenty launderings. Ten samples of warp and filling from the areas of maximum and minimum wear respectively, were tested in accordance with the procedure detailed above. Those for maximum wear, in the case of the table cloths, were taken from points six inches from the selvage; for

Table 2. ANALYSIS OF ORIGINAL FABRICS.

	Sheets		Linens	
	Warp	Filling	Warp	Filling
Threads per inch	70.2	60.0	77.0	92.0
Breaking strength in pounds	55.9	40.6	83.7	90.2
Elongation in inches	.2309	.5782	.1128	.1886
Weight per square yard in ounces	4.059		5.194	
Percent of finish	Two per cent			
Thickness in inches	.00106		.00091	

Table 3. ANALYSES OF FABRICS AFTER LAUNDERING.

	Commercial								Institutional									
	A				B				C				D					
	Sheets		Linens		Sheets		Linens		Sheets		Linens		Sheets		Linens			
	Warp	Fill-	Warp	Fill-	Warp	Fill-	Warp	Fill-	Warp	Fill-	Warp	Fill-	Warp	Fill-	Warp	Fill-		
Threads per inch	: ing	: ing	: ing	: ing	: ing	: ing	: ing	: ing	: ing	: ing	: ing	: ing	: ing	: ing	: ing	: ing		
One laundering	:	:	:	:	:	:	:	:	:	:	:	:	:	:	70.6	63.0	79.0	93.0
Twenty launderings	68.9	64.0	79.3	97.3	68.1	64.0	79.9	97.8	71.0	64.1	79.0	96.0	72.0	64.0	79.1	96.3		
Breaking strengths	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	
One laundering	:	:	:	:	:	:	:	:	:	:	:	:	:	:	43.8	38.6	89.0	93.7
Twenty launderings	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	
Maximum	41.9	36.4	56.1	54.2	37.0	32.4	51.5	46.6	42.4	36.5	61.0	60.8	39.1	35.9	53.5	48.6		
Minimum	40.1	35.7	54.4	50.8	35.7	35.4	50.3	50.6	43.4	32.4	61.1	54.4	40.3	33.3	56.2	49.9		
Elongation	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	
One laundering	:	:	:	:	:	:	:	:	:	:	:	:	:	:	.3045	.5700	.1053	.2108
Twenty launderings	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	
Maximum	.2941	.4128	.1539	.2200	.2760	.3883	.1432	.2108	.2460	.4270	.1410	.1980	.2450	.4460	.1330	.1920		
Minimum	.2848	.4191	.1253	.2368	.3925	.4318	.1644	.2611	.2600	.4351	.1221	.1930	.2389	.4364	.1147	.1830		
Thickness	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	
One laundering	:	:	:	:	:	:	:	:	:	:	:	:	:	:	.00131		.00134	
Twenty launderings	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	
Maximum	.00135		.00174		.00139		.00187		.00135		.00170		.00134		.00164			
Minimum	.00139		.00178		.00143		.00202		.00138		.00181		.00138		.00171			

minimum wear from the center; for the sheets the portions for maximum wear were taken from the center, for minimum wear at points six inches from the selvage.

Calculations for the weight in ounces per square yard were based on the average weight of two conditioned samples six inches square.

The elongation of the fabric was obtained at the same time that the breaking strength was determined by an automatic recording device on the Scott Tester. An average of the results of ten specimens was taken as the amount of stretch.

The relative economic merits of the institutional laundries were investigated by means of a questionnaire sent to each plant selected for this study.

#### FINDINGS

The thickness of the fabrics after one and after twenty launderings exceeded the original; this finds its explanation in the fact that the materials during the process of manufacture had been sized and subjected to unusual pressure which compressed and flattened the threads to a high degree. In every case the commercial laundries had the higher thickness rating. This was in accord with the full, linty appearance of the fabric from the commercial laundry.



Both the sheets and table linens showed a noticeable decrease in thickness in those areas which were subjected to maximum wear.

After the first laundering there was a slight increase in thread count both warp and filling-wise of the sheets and table linens. In every case the thread count of the linens after twenty launderings was higher than after one laundering; those from the commercial plants were slightly higher than those from the institutional laundries. The sheets from the commercial laundries revealed a slight decrease in the warp thread count after twenty launderings, whereas, the institutional fabrics showed an increase in warp thread count after the same number of launderings. This variation was caused by the method of pressing the fabric.

There was an increase in breaking strength of the linen both in the warp and the filling threads after one laundering. This was to be expected since, on account of shrinkage, the thread count of the one inch strip had increased slightly. After twenty launderings the breaking strength had decreased approximately 35 to 45 per cent, using the breaking strength after the first laundering as a basis for the calculations. The minimum loss was in the fabric from institutional laundry C. Commercial laundry

A, which used the four suds formula and no bleach, was second in order with a loss of 6 per cent below that of institutional laundry C. Commercial laundry B showed a maximum loss of breaking strength--45 per cent.

In the case of the sheets there was a loss in tensile strength in both the warp and the filling threads after the first laundering. Here also, the minimum loss of tensile strength was found in those sheets sent to institutional laundry C; with commercial laundry A again ranked second. The percentage breaking strengths of linens and sheets were as follows:

	Linen	Sheets
Institutional laundry C	35 per cent	6.1 per cent
Commercial laundry A	41 per cent	6.5 per cent
Institutional laundry D	43 per cent	9.0 per cent
Commercial laundry B	45 per cent	14.0 per cent

The general appearance of the fabrics which had been handled in the institutional laundries was superior to that of the articles sent to commercial laundries. Ordinary inspection of the color showed that the sheets and table linens from the institutional laundries had less of the gray or yellow tinge, though slight traces of bluing were noticeable in one instance. The linen shrank excessively, about one-fourth inch from the selvage, and caused it to ruffle along the edge. At the commercial laundries no effort was made to straighten the edges; the edges of those from the institutional laundries had been straightened

and ironed flat. The lustre or gloss of the materials from the institutional laundries was superior to that from the commercial laundries indicating that those from the institutional laundries had been subjected to greater pressure. The commercial laundry product had collected a large amount of lint and the yarns had a round appearance.

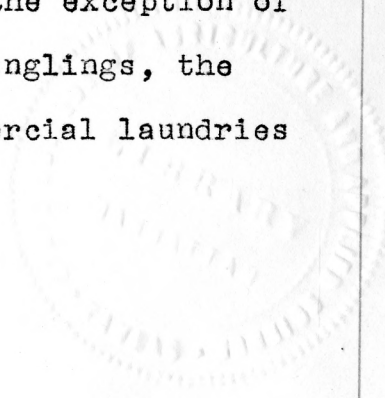
Institutions find that it is more expensive to send their laundry to the commercial plant than to maintain their own laundry. In order to compare costs, it was necessary to consider the amount invested, interest on the investment, cost of maintenance and labor. These amounted to less per month than the charge made by the commercial laundry.

#### CONCLUSIONS

The findings of this study show that:

- 1) The tensile strength of the fabrics treated by the institutional laundry, and by the commercial laundry using the standardized formula show little variation.
- 2) The color of the fabrics from the institutional and from the commercial laundry are of practically the same quality.
- 3) The finish of the work of the institutional laundry uniformly outranked that of the commercial.

Hence it may be concluded that with the exception of a superior finish, produced by repeated manglings, the work of the institutional and of the commercial laundries is of nearly uniform quality.



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