Home Laundering Dish Towels:

A Comparison of Soft Water and Soap, Hard Water and Synthetic Detergent

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Among the fabrics used in the home, none has a more specific function or receives more frequent laundering than dish towels. Although absorption of water is the main purpose of dish towels, texture, color, and design may influence the selection.

There is evidence that soil is removed more effectively by washing in conditioned (softened) water and soap than in hard water and synthetic detergent.[1] The washing procedures for commercial laundries recommend the use of soap and softened water.[2] Because of the effects which laundering may have not only on soil removal but also on absorption and durability, the service received from dish towels may be affected by the laundering.

To find whether washing in (1) soft water with soap and (2) hard water with synthetic detergent, resulted in differences in certain properties of dish towels, two types of white cotton dish toweling were washed by the two methods. Measurements were made over a period of 60 washings. Measurements were made of: rate of water absorption, amount of water absorption, yellowness of the white cloth, breaking strength, weight, and number of yarns per inch.

MATERIALS AND METHODS

The Fabrics Laundered

The two types of cotton toweling, cambric and crash, were quite different in appearance and in their various properties. (See Figure 1.) The cambric was made especially for sacking. It had more and finer yarns than the crash and contained a high percent of sizing. It was the type of cloth which might be purchased in stores as washed squares of cloth hemmed or unhemmed. The crash was a regular toweling fabric.

* Formerly a member of the Home Economics Research Staff.
[1] Florence Ehrankranz. "Radioactive Soil for Testing Laundering in Home Washers." Soap and Chem. Spec., 32 (March, 1956), 41-42
[2] American Institute of Laundering. "Washing Formulas, Special Report No. 231." Report prepared by Lee G. Johnston. (Joliet, Ill.)

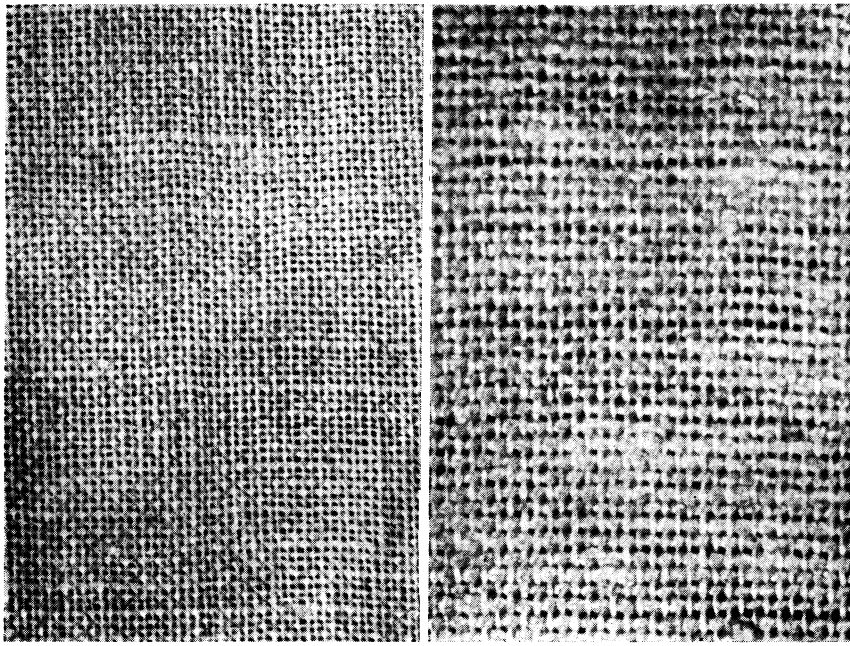

Figure 1. The two fabrics used in the expriment: cambric, left, and crash, right.

Although the two towelings were compared in the effects of the two methods of washing, they represent two different types of fabrics, both of which might be used for dish towels.

The Samples Used

For each method of laundering, 12 cambric and 12 crash swatches with dimensions 12″ x 16″ were used for measuements of fabric weight, yarns per inch and yellowness. Measurements were made on these same swatches throughout the experiment. Five swatches, also 12″ x 16″, of each fabric were used in both methods of washing to measure breaking strength each time this measurement was made.

Twelve round swatches of both fabrics for each method of washing were used to make the absorption measurements. These swatches, which were 3 3/4″ in diameter, were stitched with an overcast machine stitch to prevent fraying. The same samples were used for measurements throughout the experiment.

Laundering Procedures

The two methods of washing the fabrics were alike except for the cleansing agent and type of water. The washings were done in an agitator-type automatic washer. The quantity of soap used was that found to give a good suds in softened water with the wash load. The quantity (about ½c.) of synthetic detergent was that recommended for a wash load. For both cleansing agents, the amount was determined by weight, and the same amount was used for each washing.

Since the test samples constituted only a small quantity of fabric for the washer, previously laundered pieces of bleached cotton cloth were added to make a full wash load.

The temperature of the water for washing was 150°-155° F., and the wash cycle was ten minutes. The temperature for the rinses and the cycle for rinsing and spinning were the normal ones for the washer. No bleach or bluing was added in washing.

The cloth was dried in an electric dryer at a medium temperature for 35 minutes. Only the 12″ x 16″ samples were ironed. These were ironed following only the last laundering before tests were made. The ironing was done on a rotary ironer.

The Soap and Synthetic Detergent

A heavy-duty, all-purpose soap and a heavy-duty, low-sudsing synthetic detergent were used for the washing. Both were "built" compounds. Terminology for synthetic detergents has not been clearly defined. Several terms are used, one of which is syndet. Hereafter, in this report, the two cleansing agents will be referred to as soap and syndet.

Hardness of Water

Tap water was used for the washing in hard water and syndet. The hardness of this water ranged from 6 grains per gallon or 103 ppm (parts per million) to 9 grains or 154 ppm with the median 7.8 grains or 134 ppm. In using the classification that designates "hard" water as that with 6+ to 12 grains, the water used in this experiment was hard water, but at the lower limits of the range.[3]

3 All About Modern Laundering. Ruud Manufacturing Co. (1954.) p. 20.

The soft water was obtained by a water softening unit in which a high capacity resin removed the hardness by absorption. The hardness of this water varied from 0.0 to 1.3 grains with a median of 0.2 grains. The hardness was more than 0.4 grains only four of the 60 launderings.

How Measurements Were Made

All measurements were made on the two types of toweling before they were laundered and after each 15th laundering. In addition, measurements of absorption were made after 1, 3, 5, and 10 launderings.

Weight. The loss of weight was determined by weighing both the 12″ x 16″ swatches and the 3 3/4″ pieces of cloth. The two sizes of samples were used to find whether the same results in loss of weight would be found with large and small samples.

Yarns per Inch. The number of yarns per inch was counted in three places at approximately the same places on each sample at each test period of 15 washings. The change in count of yarns in washed compared with unwashed fabrics was an indication of shrinking or stretching of the fabrics.

Yellowness. Changes in the yellowness of the white were determined by measuring reflectance. Three measurements of reflectance were made on each sample and in the same position on the sample at each test period. The results are reported as yellowness of the white of the laundered fabrics as compared with the unlaundered fabrics.

Breaking Strength. Breaking strength, a measure of the number of pounds of force necessary to rupture a sample of cloth 1″ in width, was determined by the strip method. Five determinations of warp and filling strength were made on each of the five swatches, 12″ x 16″, of each toweling after each 15th laundering.

Absorption. Because the greatest increase in both rate and amount of water absorption may occur in the first few washings, measurements of absorption were made at 1, 3, 5, and 10 launderings and then at each 15th laundering.

The rate of absorption and the ultimate absorption as determined by the porous plate method were measured by apparatus and a procedure adapted from those developed at the Southern Regional Research Laboratory.[4] Absorption was also measured by the static immersion method.[5]

[4] E. N. Burais, Jr., C. F. Golthwait, and R. M. Kraemer. "Measurement and Theory of Absorbency of Cotton Fabrics." Textile Research Journal, XX. (April, 1950), 239-248.
[5] American Association of Textile Chemists and Colorists. Technical Manual and Yearbook of the AATCC. XXXII (1956), 128-129.

To measure the rate of water absorption, a sample of the toweling was placed in contact with the porous plate in the funnel of the apparatus shown in Figure 2. A fixed weight was placed on the sample to hold it in contact with the plate. The flow of water through the porous plate and thus into the fabric was measured. Measurements of the rate of absorption and ultimate absorption by the porous plate method were made at the same time.

In the static immersion absorption method, the same samples were used as in the porous plate method. A sample was weighed, then immersed in distilled water for 20 minutes. It was removed from the water, placed between two pieces of blotting paper[6] and passed through a

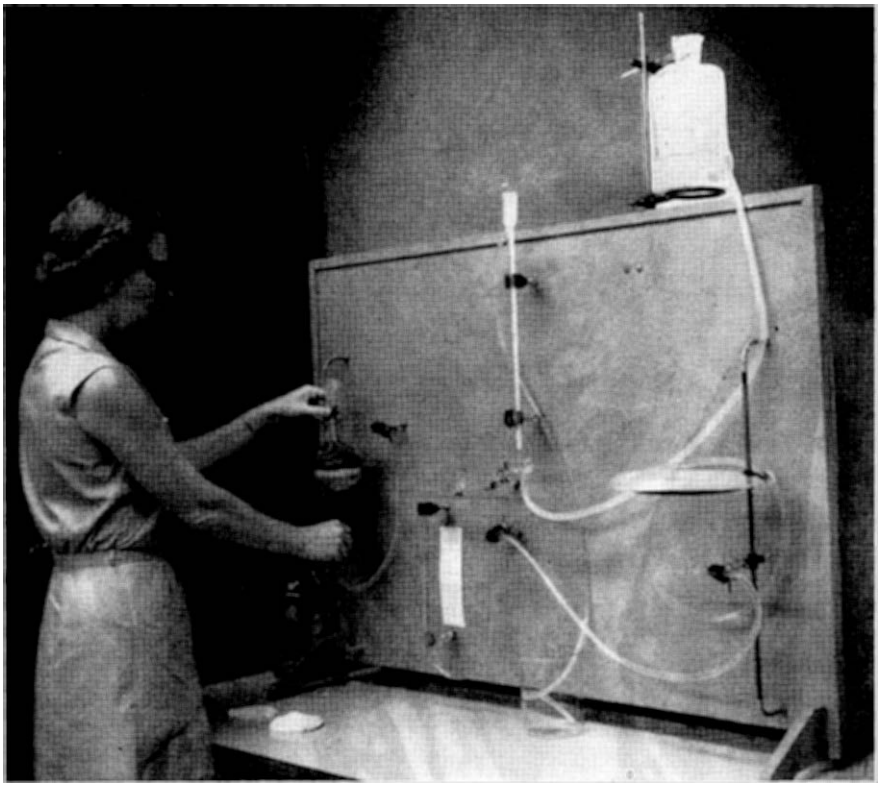

Figure 2. Apparatus used in the porous plate method of measuring the rate and amount of absorption.

[6] A special white textile blotting paper.

Figure 3. Apparatus used in measuring absorption by the static immersion method.

wringer. The sample was immediately reweighed. The increase in weight represented the amount of water absorbed and retained by the fabric in the immersion and squeezing processes. (Figure 3.)

RESULTS AND DISCUSSION

The first five launderings caused considerable change in the appearance of the cambric because of the removal of sizing. (Figure 4.) Both fabrics had some change in dimension as shown by difference in number of yarns per inch. Laundering produced greater changes in the fabrics between 0 and 30 washings than between 30 and 60 washings, as shown by the data in Table 1. Absorption of water, both in rate and amount, changed less after 30 washings (see Figures 5, 6, 7, and 8) than in the first launderings.

Weight

The cambric was a much lighter weight fabric than the crash and contained much more sizing. The difference between the two fabrics increased with laundering because of the removal of sizing. Between 20 and 25 percent of the weight of the cambric was lost in laundering.

No difference was found in loss of weight due to method of washing with either the small or large samples.

Yarns per Inch

Washing produced a change in the number of warp and filling yarns per inch in both fabrics and this change was the same for both methods of washing. However, the change was not the same in both fabrics. The number of yarns per inch in the filling was increased in both fabrics due to shrinkage in washing. The number of yarns per inch in the warp increased in the cambric, but the number decreased in the crash, indicating the fabric stretched crosswise when it was laundered.

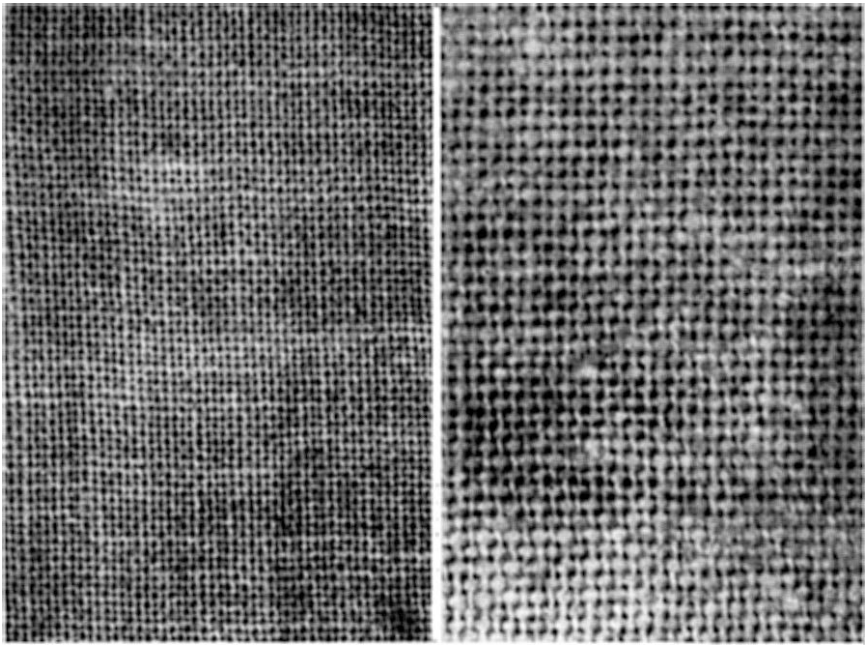

Figure 4. Cambric, left, and crash, right, after five launderings.

Table I. The Average Weight, Number of Yarns per Inch, Breaking Strength, and Yellowness of Two Dish Towelings, Cambric and Crash, Before and After Washings in Soft Water with Soap and Hard Water with Synthetic Detergent, or Syndet.

	Wt. (grams)	Wt. Loss (percent)	Yarns per inch (warp)	(filling)	Br. Str. in lbs. (warp)	(filling)	Yellowness
Cambric							
Soft water-soap							
Before washing	17.69	0.00	57.4	56.9	48.5	42.3	1.94
After 15 washings	13.85	21.71	63.0	60.8	46.6	38.1	4.21
" 30 "	13.79	22.04	63.4	61.2	45.2	37.9	3.28
" 45 "	13.71	22.47	63.8	61.3	44.2	37.8	3.42
" 60 "	13.52	23.55	62.7	61.0	45.0	39.5	3.46
Hard water-syndet							
Before washing	17.62	0.00	57.2	56.7	48.5	42.3	1.90
After 15 washings	13.82	21.46	63.0	60.5	50.4	41.3	4.32
" 30 "	13.66	22.49	62.6	60.4	47.2	42.1	4.15
" 45 "	13.59	22.89	62.3	60.4	47.4	42.4	4.01
" 60 "	13.47	23.57	62.5	60.5	46.0	39.1	4.01
Crash							
Soft water-soap							
Before washing	26.76	0.00	40.9	32.8	75.6	76.6	1.82
After 15 washings	26.54	.83	38.4	35.3	62.5	77.2	2.83
" 30 "	26.49	1.02	38.6	35.7	60.4	81.1	2.55
" 45 "	26.31	1.71	38.7	36.1	59.9	79.5	3.09
" 60 "	26.15	2.77	38.3	36.0	57.0	77.0	2.96
Hard water-syndet							
Before washing	26.78	0.00	40.7	32.1	75.6	76.6	2.07
After 15 washings	26.86	+ .29	38.4	35.4	65.2	81.1	3.61
" 30 "	26.48	1.10	38.2	35.2	62.4	82.2	3.39
" 45 "	26.39	1.46	38.1	35.3	62.2	81.6	3.48
" 60 "	26.25	1.99	38.1	35.5	59.4	78.9	3.43

Yellowness

The laundered fabrics were a more yeliowed white than the unlaundered ones. Both cambric and crash yellowed less when washed in soft water with soap than when washed in hard water with syndet. During the 60 washings the crash changed less from its original whiteness than the cambric.

The yellowness was considerably higher in fabrics laundered fifteen times than in the unlaundered fabrics. Some difference in the first washings may have been due to removal of bluing added in finishing the cloth rather than to any real yellowing of the cloth. A higher numerical value for yellowness indicates a greater amount of yellowness in the white. (Table I).

Breaking Strength

The strength of the crash toweling was much higher than that of the cambric in both warp and filling. Both fabrics had a good balance of strength between the lengthwise and crosswise yarns. In the laundered fabrics, the strength was affected to some extent by the change in number of yarns per inch due to shrinkage. Although laundering caused an increase in the number of yarns per inch in both warp and filling in cambric, the strength was lower in both directions in the laundered than in the new fabric. (Table I). In crash, the strength was lower warpwise and higher fillingwise in the laundered than in the unlaundered fabric. However, the change in strength was not proportional to the change in number of yarns per inch.

Although the fabrics washed in hard water and syndet had somewhat higher average strength in the warp or filling or both directions, as shown in Table I, the difference was not significant. Because of the wide variation in breaking strength of samples within and between some swatches, especially in the cambric, more measurements of breaking strength would have been desirable for conclusive results.

Absorption

Rate. The rate of absorption was higher for crash than for cambric. (See Figure 5.) Also, the rate of absorption was higher for both cambric and crash washed in hard water and syndet than in soft water and soap. Repeated washing (from 0 to 60) resulted in a greater increase in rate of absorption for cambric than for crash. For both fabrics and both methods of washing, the rise in rate of water absorption showed a definite decline from 30 to 60 washings, but more than 60 washings would have been

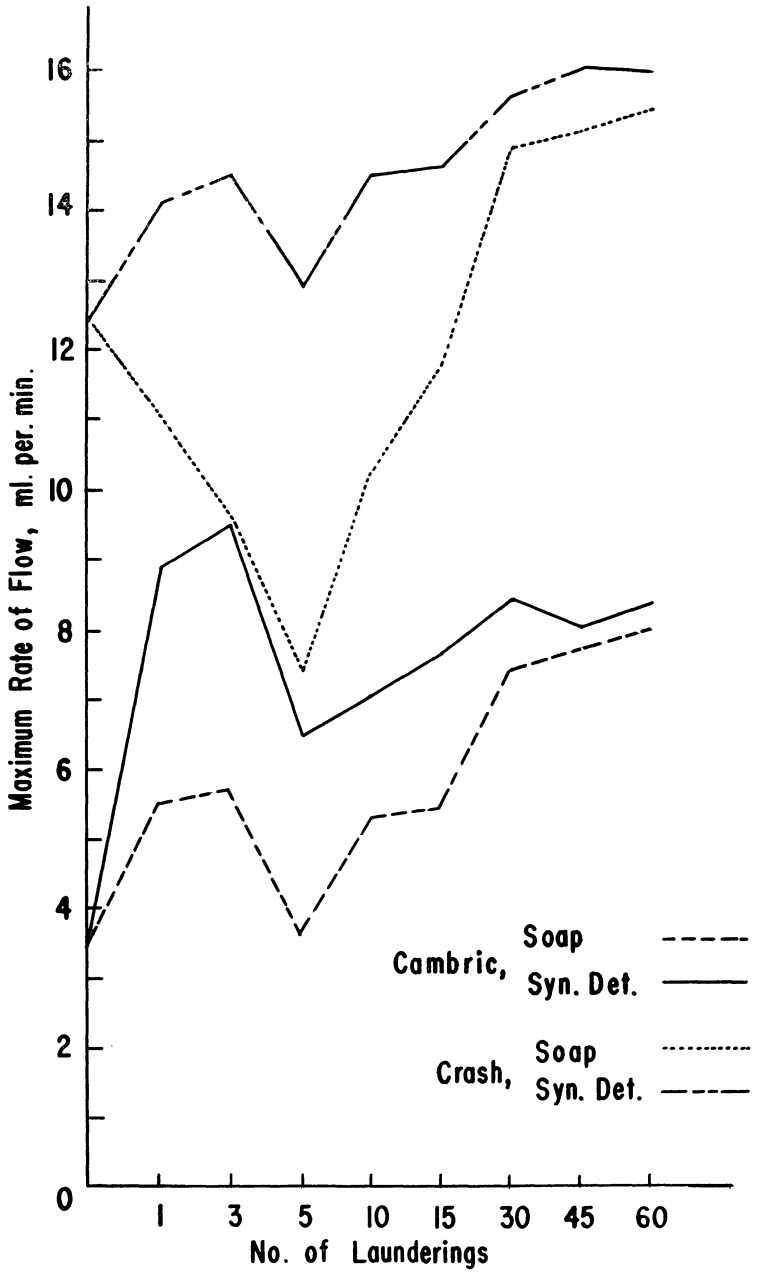

Figure 5. Maximum Rate of Absorption, Porous Plate Method. Avg. of 12 measurements.

needed to find whether the maximum rate of absorption had been reached. The difference in rate of absorption due to method of washing was greatly reduced at 30 washings and thereafter. Again, to find whether the difference might have disappeared entirely, more than 60 washings would have been needed.

The big drop in rate of absorption for crash washed in soft water with soap in the first launderings, the extreme rise in rate of absorption for cambric washed in hard water with syndet, and the drop in all readings at five washings, were not normal occurrences. (See Figure 5.) In a repeat of the experiment through 30 launderings and measurements of rate of absorption at the same intervals as before, normal curves were obtained except for crash washed in soft water and soap. Again, the rate of absorption dropped low in the first few washings. At 30 washings, however, the two sets of data corresponded closely.

Porous Plate Method. The crash absorbed more water than the cambric. This would be expected since the crash was about twice as heavy as the cambric with sizing removed. The absorption was higher in both fabrics when they were washed in hard water and syndet. This difference remained fairly constant at each wash period. (See Figure 6.) The greatest increase in ultimate absorption due to laundering occurred in the first 10 washings for both kinds of toweling. The absorption remained quite uniform from 30 through 60 washings. The drop in absorption at 15 launderings in both fabrics and for both soft water with soap and hard water with syndet was no doubt due to the measurement rather than to any such change in the fabrics.

Immersion Method. The crash absorbed more water by weight and in percent than the cambric. (See Figures 7 and 8.) Laundering increased the percent of water absorbed by cambric more than crash. In weight, the wet cambric was the same after 60 washings as when it was new. However, absorption had increased, or the fabric would have weighed much less due to loss of sizing. The drop in absorption of water, by weight, in cambric at one and three washings indicated loss of weight due to removal of most of the sizing. Results of absorption by weight and by percent gave similar curves for crash. The difference between results by weight and by percent for cambric was due to the loss of sizing.

Neither method of washing was found to be better than the other in effect on absorption as measured by immersion. Although the absorption for fabrics washed in hard water with syndet was higher at most wash periods, the difference was not significant. At 60 washings results were the same.

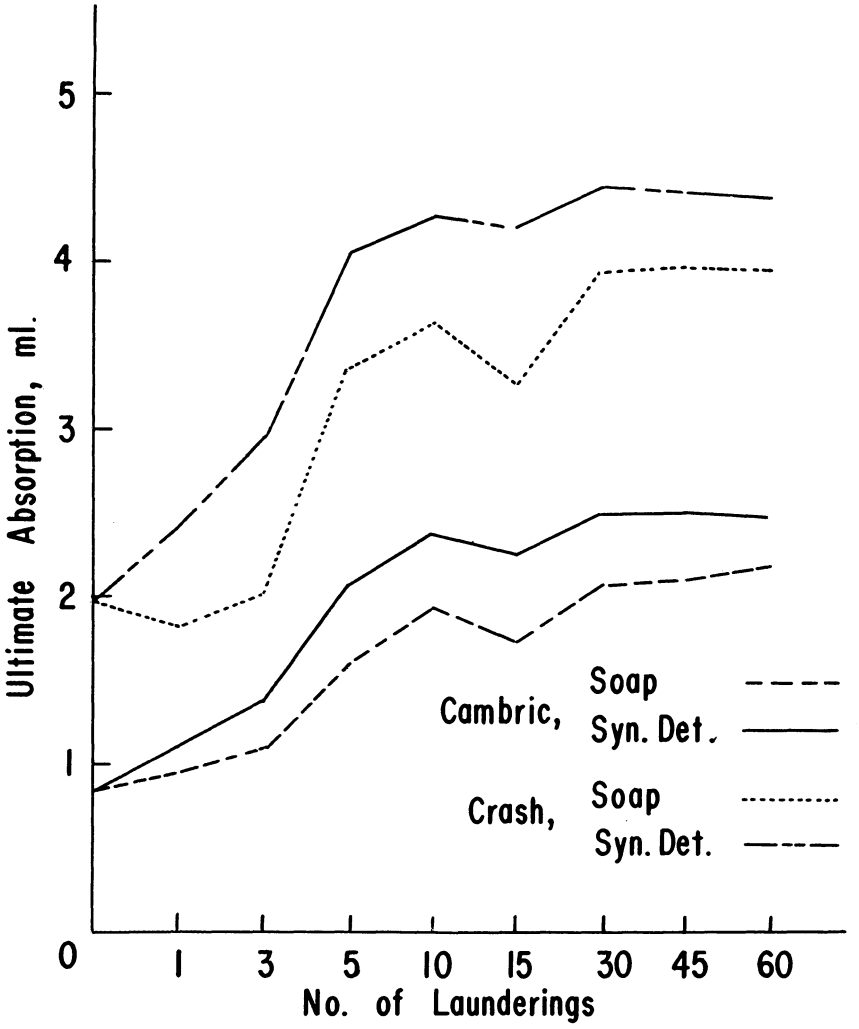

Figure 6. Ultimate Absorption, Porous Plate Method. Avg. of 12 measurements.

Porous plate vs. immersion methods. The water absorption by the porous plate method was much higher than by the immersion method, as would be expected. In the immersion method, the surface water, that

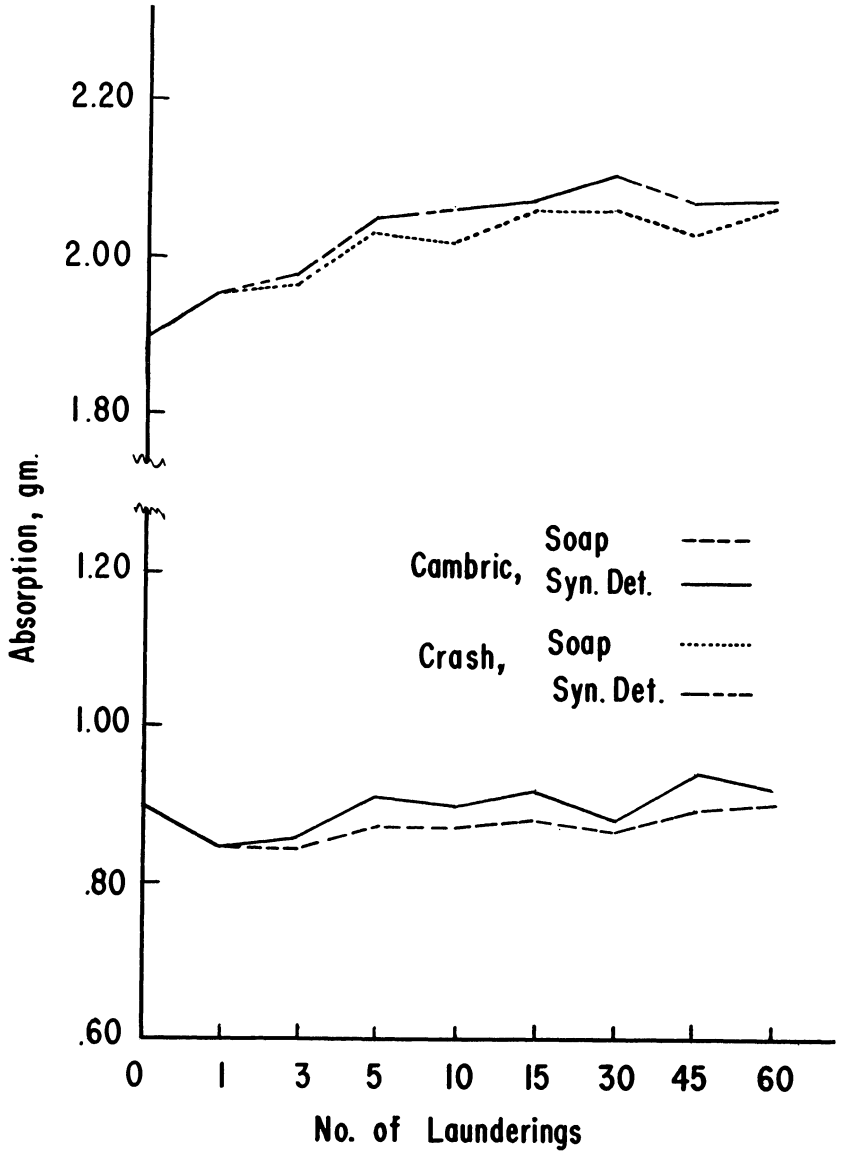

Figure 7. Absorption (by weight), Static Immersion Method. Avg. of 12 measurements.

water which adheres to the surface of the fabric between fibers and yarns, is removed by the squeezing process. The internal absorption or resistance to wetting is measured. In the porous plate method, the absorption is measured as all of the water that is held by the fabric.

SUMMARY

The purpose of the experiment was to determine the effects of washing two different dish towel fabrics, cambric and crash, in soft wa-

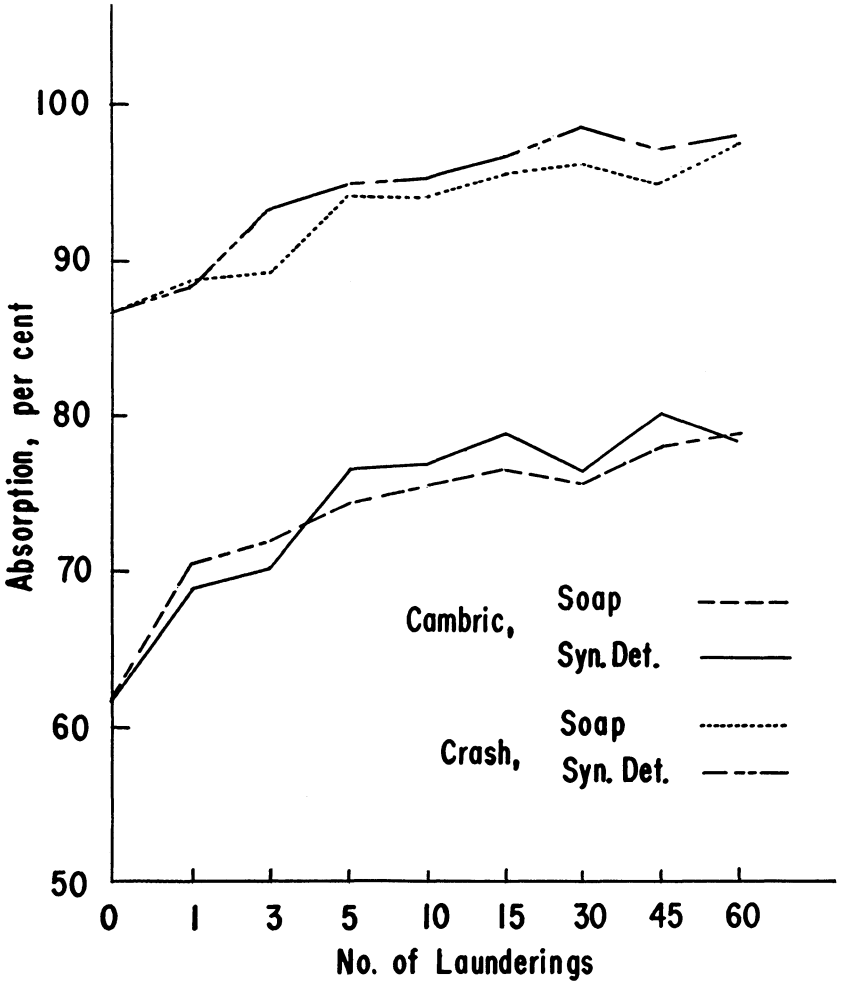

Figure 8. Absorption (in percent), Static Immersion Method. Avg. of measurements.

ter with soap and hard water with synthetic detergent, or syndet. Samples were laundered 60 times in an automatic agitator-type washer. At intervals of 15 launderings, determinations were made of rate and amount of absorption, weight, yarns per inch, breaking strength, and yellowness. In addition, measurements of absorption were made after 1, 3, 5, and 10 launderings.

The method of washing had no effect on loss of weight. The crash, a heavier fabric than the cambric, lost little weight in the launderings. The cambric, a heavily sized fabric, lost much weight when it was washed. The same results on change in weight were obtained with the two sizes of samples used for this measurement.

Both fabrics changed in number of yarns per inch when laundered, and changed the same for both methods of washing. The yarns per inch increased in both warp and filling in the cambric. In the crash, the yarns per inch increased in the filling but decreased in the warp direction.

The fabrics washed in soft water and soap became less yellowed, or in other words, the white was more like that of the new fabrics than those washed in hard water with syndet. The white of the laundered crash changed less from the unlaundered fabric than the cambric.

The crash was a much stronger fabric than the cambric. Laundering produced relatively small losses in strength. Some change in strength between the unlaundered and laundered fabrics was due to effect of shrinkage on number of yarns per inch. Although the fabrics washed in hard water with syndet were somewhat stronger than the others, the difference in strength was not an important one. Because of wide variation in strength within and between some swatches on which measurements were made, more measurements of strength would have been desirable.

The crash had a higher rate of water absorption than the cambric. Both fabrics had a higher rate of water absorption when they were washed in hard water and syndet than when washed in soft water and soap. The difference in rate of absorption due to method of washing was much less at 30 washings and thereafter than at earlier test periods. The rate of absorption increased more in cambric as a result of laundering than in crash.

The ultimate absorption by the porous plate method was greater for crash than for cambric and greater for both fabrics washed in hard water and syndet. The ultimate absorption increased more in the crash from 0 to 60 washings than in the cambric from 0 to 60 washings.

In absorption by immersion, the method of washing did not produce significant differences in amount of absorption. The crash had higher absorption than the cambric. The absorption of water by the cambric gave lower results on a weight basis than on a percent basis because of loss of weight due to removal of sizing. However, on a percent basis, laundered fabrics had increased water absorption, and the increase was greater for cambric than for crash.

Results of the two methods of measuring amount of water absorption cannot be compared since the methods do not measure the same properties.