THE EFFECT OF HOME AND COMMERCIAL LAUNDERING
UPON THE WEARING QUALITY OF GINGHAMS AND SIMILAR FABRICS
AND
THE RELIABILITY OF THE CONSUMERS' JUDGMENT
IN THE SELECTION OF THESE FABRICS.

by

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INTRODUCTION

The laundering of clothing and household articles is an ever present necessity of the homemaker. In the past, practically all of the laundry work was done in the home and generally by the housewife herself. The time came when this task was gradually transferred to a laundress or to a commercial laundry. Paralleling the trend toward commercial laundries, the invention of labor saving devices, such as power washers, irons, and mangles, has again made laundering an important home task.

¹
In 1917, Leeds made a survey of sixty families, finding that five families used commercial laundries, thirty families employed laundresses, and nine families did not use commercial laundries at all. Leeds also found that an average of four and one-half hours per week was devoted to washing and six hours per week to ironing.

In a 1919 survey of ten thousand rural families in ²thirty-three northern and western states, Ward estimated

1. Leeds, The Household Budget, p. 54.

2. Ward, The Farm Woman's Problem, U. S. Department of Agr. Cir. No. 148, p. 8-9.

that 96 per cent of these families did their own washing and that 57 per cent used washing machines.

"The washing and cleaning of clothing presents definite problems arising from the relation of the fabric to the chemical constituents of soap, to temperature, to fastness of dyes, and to mechanical action." ³ This complexity of the problem provokes inquiry as to the effect of laundering upon various fabrics from the standpoint of durability and appearance after a series of launderings.

Cotton fabrics have found wide use in the home over a long period of time. The homemaker of the past who produced fabrics knew that the intrinsic value of her product was dependent upon the raw materials used in it, as well as upon the method employed in making the product. Women are no longer responsible for production of textiles in the home but must depend entirely upon fabrics produced according to mill specifications. Modern life has demanded a revision of women's activities. Women's problems of consumption have increased largely through industrial advancements.

Economically considered, the selection of gingham must be based upon cost, satisfaction, attractiveness, and durability. It is the homemaker's responsibility to

3. Harap, Education of the Consumer, p. 283.

(3)

buy wisely, therefore her choice of fabrics must not be governed only by the appearance of the fabric, but by the durability when subjected to actual wear.

Studies have been made of the fastness of a group⁴ of colored cotton fabrics to light and laundering; of⁵ the durability of new white fabrics⁶ and new gingham⁸ as measured by laboratory tests; of the reliability of consumers' judgment in the selection of sheeting for quality⁷ in comparison with laboratory tests; on laundered sheets⁹ and overalls.

Ginghams are widely used staple fabrics available in a range of prices. Some are quite fast in color to¹⁰ light and laundering. Information in regard to the durability of gingham⁸ and of similar cotton fabrics as

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4. Kirkpatrick, A Study of Fastness of Cotton Fabrics Guaranteed to Laundry and Light, Thesis, Univ. of Missouri, 1927.
 5. Farnum, An Analytical Study of Some Varieties of White Goods, J. Home Economics, V.10, p. 33-35.
 6. MaTanish, A Study of Gingham, J. Home Economics, V. 10, p. 321-322.
 7. Cook, How Can Our Method of Buying Textiles Be Made Reliable? J. Home Economics, V.19, p. 33-36.
 8. What Laundry Tests Show About Sheetings, Mod. Hosp. V. 24, p. 390.
 9. Anonymous, Effect of Laundering Overalls, Textile World J., V. 71,² p. 2032-2033.
 10. Kirkpatrick, op. cit.

(4)

affected by laundering, is lacking. In view of this fact it was thought worthwhile to make such a study. It seemed advisable to include the commercial as well as the home method of laundering because the former method is coming into such general use. Since the judgment of the consumer in the selection of sheeting for quality was found inadequate,¹¹ there is a question as to the consumers' ability to judge other fabrics. With these considerations in mind, it was thought worthwhile to determine the effect of the home and commercial laundering methods on a group of gingham as well as to determine the reliability of consumers' judgment in the selection of these fabrics for wearing quality.

11. Cook, op. cit.

HISTORICAL

In 1914 investigations were made of the chemistry of¹ laundering by Faragher. He found that ten successive treatments of cotton threads with an alkaline soap solution increased the strength of the threads while both bleaching and acid solutions decreases the strength. Tests for wear on men's turn-over collars showed similar results. Some of the conclusions from this experiment were as follows: Bleaching and acid treatments of fabrics seem to be the most injurious part of the steam laundry processes; alkalies injure the strength and color of the fabrics when used excessively; and soft water is better than hard water for all laundering purposes.

²
Grün and Jungman found that hard soap, soda, sodium silicate, and perborate used with hard water in washing cotton and linen goods thirty times, left the fabric with greater strength than when soft water alone was used. Fabrics washed with soap had a much better appearance than fabrics washed with soda or silicate. These authors

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1. Faragher, An Investigation into the Chemistry of Laundering, J. Ind. and Eng. Chem., V. 6, p.640-649.
 2. Grün and Jungman, Action of Laundering Agents on Textiles, J. Soc. Chem. Ind., V. 37, p. 411A.

(6)

say, "The loss of tensile strength suffered by textiles in washing is not a simple measure of the changes which have taken place in the fibers. In estimating the loss of quality the external appearance of the fiber must be taken into account and particularly the splitting of the fibers as observed microscopically....."

3

The Textile Bureau of the Laundry-owners' National Association realizing the lack of knowledge as to how long textiles should last and realizing the importance of such information, experimented with men's collars. The wear of the collars in laundering was estimated to be approximately 50 to 57 per cent of the life of the collar.

4

This Bureau also studied the effect of the mechanical action of a power laundry washing machine and of detergents on cotton and linen fabrics. A handkerchief which had been put in the machine with a regulation load in cold water and had been washed continuously for twenty-five hours lost approximately 0.18 per cent in strength for each hour of treatment. Fabrics washed with a load in ten gallons of hot water and eight-tenths of a pound

3. Elledge, The Conservation of Garments in Laundering.
Proceedings of the Second Annual Textile Conference, U. S. Dept. of Commerce, Bureau of Standards
Misc. Pub. No. 19, p. 24.

4. Ibid, p.27.

(7)

of soda ash, in hot water alone, in water with six ounces of soap and eight-tenths of a pound of soda, and in water with six ounces of soap lost 0.48 per cent, 2.77 per cent, 0.22 per cent, and 0.5 per cent respectively, in strength per hour of treatment.

5

Ebner made tests to determine the effect of solutions of sodium perborate, soap and soda, and other washing agents upon fibers, in a series of fifty washings. In all cases the fibers lost in strength. The fibers washed in the sodium perborate solution showed the least and those washed in the solution containing an agent without available oxygen, showed the greatest loss in strength.

Since these experiments seemed to indicate that soap alkali solutions weakened cotton and linen fabrics and fibers, Turnbull and Supple⁶ experimented with neutral soap to determine its effect on fabrics under home laundering conditions. Cotton and linen fabrics were washed (1) in distilled water, (2) in solutions of two washing powders, (3) in a solution of a neutral soap. Records were kept of the tensile strength, the thread count, the

5. Ebner, The Injury of Fibers by Washing, Chem. Abstract, V. 17, p. 3258.

6. Turnbull and Supple, The Effect of Washing Agents on Linen and Cotton Fabrics, J. Home Econ., V. 17, p. 382-387.

(8)

shrinkage, and the general appearance before laundering and after 10, 25, 40, and 50 launderings on 60 by 63 inch samples. All of the washing agents weakened the linen fabric slightly at first, and more decidedly after the fortieth laundering. Cotton was strengthened by the soap washing powders and by the neutral soap from the first to the twenty-fifth laundering, and thereafter it decreased in strength considerably. The authors attribute the changes in the tensile strength to the action of the washing agents rather than to the increase in thread count or shrinkage. The soap washing powder was the only solution which did not cause discoloration at any time during the experiment.

A study of linen, and cotton, and union kitchen⁷ towelings was made at Iowa State College primarily to supplement the meager knowledge then available in regard to the actual durability of various types of towelings when laundered by home methods. At the end of the experiment, union towels ranked the highest in tensile strength; cotton towels, the more expensive and the cheaper linen towels ranked second, third, and fourth respectively. In all of the towelings tested, the tensile strength de-

7. Cranor and Dorsey, Wearing Tests of Kitchen Toweling, J. Home Econ., V. 17, p. 254-259.

creases in proportion to the time which they had been used.

Wearing tests made on cotton fabrics by Cady⁸ included five different gingham suitable for children's clothes. Garments made from these fabrics were worn one day per week for twenty weeks and subjected to home laundering twenty times. Inspection of the garments occurred after 8, 16, and 20 launderings. From the laboratory tests made on the fabrics the author concluded that tensile strength, length of fibers, and thread count are factors in determining quality.

Overalls and overall fabrics were laundered at various temperatures and in baths of different percentages of washing powder by home and commercial laundering methods to determine the effect on shrinkage and on tensile strength. Apparently the type of detergent used affected shrinkage very little and decreased the tensile strength but slightly. The various temperatures employed gave no considerable decrease in the tensile strength, and the two laundering methods used resulted in approximately the same shrinkage.⁹

8. Cady, Wearing and Fading Tests of Cotton Materials Used for Children's Clothing. Thesis, Iowa State College, 1923.

9. Anonymous, Effect of Laundering Overalls. Textile World, V. 71, p. 2032-2033.

To answer inquiries pertaining to the amount of shrinkage and to wearing qualities of gingham¹⁰s of different prices, McTavish at Iowa State College made a study of some gingham¹⁰s suitable for house dresses, children's dresses, and aprons. Tests were made for tensile strength, shrinkage, and thread count. The study showed that the thread count, both in the warp and the filling, increased with the price of the materials. The warp showed less shrinkage with an increase in price while the filling did not follow this same trend. The breaking strength did not increase with an increase in price. Wearing quality was not influenced by thread count as was shrinkage.

An analytical study to determine the value of a group of white fabrics showed that an increase in the price did not always indicate an increase in the breaking strength. An increase in the thread count generally indicated an increase in the price.¹¹

At Iowa State College,¹² five cotton sheetings were studied. An analysis of these sheetings was made when

10. McTavish, A Study of Gingham, J. Home Econ., V. 10, p. 321-322.

11. Farnum, An Analytical Study of Some Varieties of White Goods, J. Home Econ., V. 10, p. 33-38.

12. Griffith and Edgar, Deterioration of Five Wide Cotton Sheetings Due to Laundering, J. Home Econ., V. 20, p. 111-120.

(11)

they were new, and after 3, 50, 75, 100, and 200 launderings in the college laundry. The study showed that the deterioration was quite uniform for each kind of sheeting. Upon testing the sheetings after intervals of laundering, they showed less deviation from the average for tensile strength than the sheetings did when new.

Twenty-four sheets of different brands were washed 160 times with other fabrics in a commercial laundry as regular flat work. Tests were made for tensile strength at intervals of twenty launderings. The tests showed that the initial breaking strength is not indicative of the number of washings the sheetings will withstand and that it is essential to remove sizing from materials before making a test to determine the initial strength.

13

14
Noer continued "A Study of the Relation Between Certain Variable Factors and the Tensile Strength of a Group of Cotton Fabrics", made by Streed, and included some additional factors for comparison. Noer's study showed no pronounced relationship between price and any one of the factors studied. Noer's study showed that in

13. What Laundry Tests Show About Sheetings, Mod. Hosp. V. 24, p. 390.

14. Noer, Relation Among Some Variable Factors in Certain Cotton Fabrics, Thesis, Univ. of Missesota, 1925.

general, shrinkage decreased or was stationary with an increase in price, the most expensive fabric showing the least shrinkage and the cheapest fabric showing the greatest shrinkage. Sizing was found in the cheaper materials. The thread count tended to increase with price. The author states that "Thread count was found to vary more uniformly with price than did any other factor".¹⁵ Within groups of fabrics the tensile strength tended to increase with the price, but when groups were disregarded the tensile strength tended to decrease as the price increased.

¹⁶

Furry made a study of 130 brands of cotton sheetings and a few additional fabrics. Determinations made on the sheetings and other materials included the following: thickness, weight, thread count, gloss, yarn number, diameter, twist, crimp, and length of fiber, shrinkage, breaking and bursting strengths when laundered and unlaundered and when wet and dry, mercerization, water extract, and the presence of inorganic materials. No conclusions were given for this study.

15. *Ibid.*, p. 43.

16. Furry and Edgar, An Analysis of Wide Cotton Sheetings, J. Home Econ., V. 20, p. 429-442.

In a report of the sub-committee of the Textile
 Section of the American Home Economics Association^{17,18}
 on the study of purchasing habits, it was found that only
 a few wool, silk, and cotton materials were of outstand-
 ing importance. For example, data showed that from the
 group of 22 cotton fabrics used for children's clothes
 four, namely gingham, percale, voile, and Devonshire cloth
 were used for almost three-fourths of the 205 garments
 reported. Gingham alone was used for nearly one-half of
 the total number of garments. The entire study showed
 that only thirty-two fabrics were reported frequently
 enough to be worthy of standardization.

¹⁹
 Rosamond C. Cook made a study entitled "The
 Scientific Determination of Reliability of the Consumer's
 Method of Buying". At the conclusion of the study it
 was evident that there was little correlation between
 laboratory tests for quality in sheeting and consumers'
 and salespersons ranking of these same sheetings.

17. Phelps, Study of Clothing Purchasing Habits, J. Home
 Econ., V. 12, p. 491-495.

18. Phelps, Further Data On Purchasing Habits, J. Home
 Econ., V. 13, p. 600-603.

19. Cook, The Scientific Determination of Reliability of
 the Consumer's Method of Buying, 1927.

METHOD

Selection of Fabrics.

A group of eighteen gingham and similar fabrics frequently used for aprons, dresses, rompers, blouses, and household purposes were selected for this experiment. Such a choice was made because gingham are widely used staple cotton fabrics obtainable in a range of prices. These fabrics were purchased in Kansas City and Columbia, Missouri during October 1927 and ranged in price from fifteen cents to \$1.25 a yard.

The group included branded, unbranded, guaranteed, imported, and domestic fabrics as follows: Five unbranded gingham, Peter Pan, Everfast, Edna May, Anderson's Imported, Wee Kiltie, Vacation, Dream Girl, Ivanhoe, and Amoskeag gingham, Chambray, Charma, English Supercloth, and Chamoisette. Some of the gingham chosen were identical with those used by Kirkpatrick¹ in the study made on fastness of color to light and laundering.

1. Kirkpatrick, op. cit.

Division of the Fabrics for Testing.

A ten yard piece of each fabric was used for the tests. Three and one-ninth yards of each fabric were reserved for the home laundering tests. This amount provided ample material for representative sampling for tensile strength strips, weight squares, and for shrinkage units. All samples were taken no less than three inches from the selvage. A like quantity of material was used for tests on fabrics laundered commercially, and the remainder of the material was reserved for tests on unlaundered fabrics and for samples used for consumers' judgment.

Laboratory Procedure1. Selection of Equipment.

An electric washing machine and an electric iron were used because such equipment is found in the home to a considerable extent. A dolly type machine equipped with a roller wringer, and an electric iron with an automatic heat control were selected for this experiment.

It has been estimated that about 2,500,000 washing machines, or approximately one to every nine homes, are being used.²

2. Crain, Market Data Book and Directory, p. 219.

A survey of clothing and laundering problems conducted by a sub-committee of the Education Section of the American Home Economics Association indicated that some type of washing machine was used in approximately 50 per cent of 1,031 rural homes and in approximately 55 per cent of 2,993 city homes. Electric washers were used in about 19 per cent of the rural homes and 35 per cent of the city homes. Electric irons were used in approximately 39 per cent and 62 per cent of the rural and city homes respectively. Ironers or mangles were used in approximately 1 per cent and 16 per cent of the rural and city homes respectively.

2. Methods of Laundering.

The gingham and similar fabrics were laundered forty-five times since this number of launderings was considered representative of the total launderings a gingham garment might undergo in the course of its use.

Home Method of Laundering.

Since textile authorities as Woolman,⁴ Nystrom,⁵ and

3. Hastie and Gorton, What Shall We Teach Regarding Clothing and Laundry Problems? J. Home Econ., V. 18, p. 132-133.

4. Woolman, Clothing, Choice, Care and Cost, p. 208 and 211

5. Nystrom, Textiles, p. 297.

members of the staff of the United States Department of Agriculture, ⁶ differ on the laundering formula and procedure for colored fabrics, and since explicit directions cannot be found because of the fugitive dyes frequently used in these fabrics, preliminary tests were made to determine the amount of fabric to the load, the proportion of soap to water, the amount of water to the load, and the temperature of the water. Ivory soap flakes were used because analyses indicate that they contain but 0.5 per cent free alkali. ^{7,8.} The convenient form also made the flakes desirable for this experiment.

A solution made up of seventy-five grams of Ivory soap flakes in fifteen and one-half gallons of soft water was used for a four and one-half pound load. Since it was necessary to run two loads, one-half of the fabrics were laundered first on one day. The other half were laundered first the next time, thereby subjecting all of the fabrics to uniform treatment. Each load was run for eight minutes in a suds at the temperature of 50° C., followed by three rinses in soft water. The first rinse was at

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6. Methods and Equipment for Home Laundering, U. S. Dept. Agr., Farmers Bul. No. 1497, p. 24-32.
 7. Kirkpatrick, op. cit.
 8. Sensintaffer, The Selection and Economic Use of Soap in the Home, Thesis, Univ. of Mo., 1924.

35 C. and the other two rinses were at the temperature of the water in the tank. The rinsing of the fabrics was done in the machine, each load being run five minutes. Only a single length of fabric was wrung at one time in order to avoid undue and irregular pressure. The fabrics were dried indoors on clothes racks, dampened, permitted to stand, then ironed in the warp direction.

Commercial Method of Laundering.

A set of eighteen gingham and similar fabrics was laundered at a commercial laundry affiliated with the National Layndryowners Association on the same day that a similar set was laundered at home.

3. Methods of Testing.

Tests were made on the unlaundered, home laundered, and commercially laundered fabrics.

Conditioning Fabrics.

Conditioning the fabrics^{9, 10} was necessary when determinations were made for tensile strength, weight, sizing, and yarn number. The fabrics were conditioned in an

9. Haven, The Moisture Factor in Textile Testing, p. 4-8.

10. A.S.T.M., Report of Committee D-13 on Textile Materials, p. 18.

electric drying oven until a constant weight was secured. The corrections for standard moisture regain which is 6.5 per cent of the original bone dry weight of the goods, were then made.

For tensile strength, a correction was made for the machine readings according to the following formula: corrected tensile strength = $\frac{\text{machine reading} \times [100 + (5.15 \times 6.5)]}{100 + (5.15 \times \text{actual regain})}$

This formula was given by Haven¹¹ as suitable for gingham weighing approximately three and one-half ounces per square yard.

Determinations on Unlaundered Fabrics.

Cost. The cost of each material was determined for both a linear yard and a unit of 1152 square inches, i. e. thirty-two by thirty-six inches.

¹²
Width. The average of three measurements across the entire width of the fabric was used.

¹³
Weight. The weight in ounces for a square yard was determined on the basis of the weight of three pieces of fabric each four by four inches.

-
11. Haven, Letter of Mar. 12, 1928, addressed to Adella I. Eppel, Univ. of Mo., from Geo. B. Haven in Charge of Textile Laboratory, Mass. Institute of Technology, Dept. of Mech. Eng., Cambridge, Mass.
 12. U. S. Government General Specifications for Textile Materials, U. S. Dept. of Commerce, Cir. of the Bureau of Standards, No. 293, p.8.
 13. A.S.T.M., Report of Committee D-13 on Textile Materials p. 19.

14

Thread Count. The average of five counts for both the warp and the filling threads was used. The count was made with a Lowinson apparatus.

15

Yarn Number. Based upon 840 yards to a hank, the weights of twelve yards of both the warp and the filling yarns were used to determine the yarn number.

16

Twist. The twist was removed from five inch lengths of twenty warp and twenty filling yarns, by a twist counter. Count was reported as the number of twists per inch. Because of the difficulty of removing twist in sized yarns, twist was recorded only for unsized yarns.

17,18.

Sizing. The percentage of sizing was based upon two samples of the fabric each six by six inches and of known dry weight. Each square was completely immersed in distilled water and was boiled for one hour, a constant water level being maintained throughout. This process was then repeated for each fabric, renewing the supply of distilled water. The per cent sizing was deter-

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14. Testing and Properties of Textile Materials, U. S. Dept. of Commerce, Cir. of the Bureau of Standards No. 41, -p. 16-17.
 15. Matthews, The Textile Fibers, p. 998-1002.
 16. Testing and Properties of Textile Materials, U. S. Dept. of Commerce, Cir. of the Bureau of Standards, No. 41, p. 12 and 13.
 17. Matthews, Application of Dyestuffs, p. 692-694.
 18. Berry, Chemistry Applied to Home and Community, p. 225.

mined for each fabric after the samples had been dried to constant weight. The liquid from the above process was tested for starch, dextrin, gum, gelatin, sugar, chlorides, zinc, calcium, and sulphates.

19

Tensile Strength. Six breaks in both warp and filling direction were made since preliminary tests consisting of ten breaks in both directions indicated that a constant average was obtained with six breaks. To prevent an interchange of warp and filling strips while testing, the former strips were cut eight inches in length and the latter strips were cut seven inches in length. The width of the strips was determined by the thread count of the respective fabrics. Each strip was ravelled to exactly one inch in width and the ends of the strips were ravelled one-eighth of an inch to prevent a loss of yarns while testing. The breaking tests were made on a motor driven Scott testing machine equipped with an automatic recorder, with jaws set three inches apart and geared to travel at the rate of twelve inches a minute.

Due to the variations in atmospheric conditions from day to day, the warp and the filling strips of like fabrics were broken and weighed on the same day. The six warp strips from a fabric were weighed and conditioned together.

The six filling strips were treated in the same way.

Tests on Laundered Fabrics.

Tests were made on the laundered fabrics after 5, 15, 30, and 45 launderings.

Shrinkage. To determine shrinkage, the fabrics were marked in two ways: (1) By drawing yarns for three, six-inch squares, (2) by three groups of two running threads placed six inches apart and at right angles to the selvage and across the entire width of the fabric. The latter sections alone were used to obtain the average shrinkage in length and width since the squares marked by drawn yarns were unsatisfactory after the fabrics were laundered.

20

Weight. Weight was determined after the forty-fifth laundering for a comparison with the unlaundered fabrics.

21

Thread Count . Thread count was taken after 5, 15, and 45 launderings. A few counts after the thirtieth laundering showed approximately the same values as those taken after the fifteenth laundering, therefore the counts after the thirtieth laundering were not recorded.

20. A.S.T.M., op. cit., p. 19.

21. Testing and Properties of Textile Materials, U. S. Dept. of Commerce, Cir. of the Bureau of Standards, No. 41, p. 12 and 13.

Tensile Strength. These tests were made the same as the tensile strength tests on the unlaundered fabrics were made.

Consumers' Judgment of Fabrics.

1. Selection of Consumers.

Approximately 200 consumers were chosen to judge the wearing quality of the eighteen fabrics that were used in the laboratory tests. The consumers were about equally divided into groups made up of homemakers with Home Economics training, homemakers without Home Economics training, college and University students with approximately six credit hours in textiles and clothing, Home Economics teachers, and salespersons.

2. Form of Questionnaire.

The questionnaire on the following page is a duplicate of those which were distributed to the consumers. Three by five inch samples of the eighteen fabrics were enclosed with the questionnaire. Approximately one-half of the consumers from each of the five groups were given the information concerning the width and the cost per yard of the fabrics to be judged.

(25)

- I. Rank the enclosed samples according to durability and record your ranking in the form at the left.

Rank order of
Samples-Durability

A	
B	
C	
D	
E	
F	
G	
H	
I	
J	
K	
L	
M	
N	
O	
P	
Q	
R	

Explanation of ranking.

1. By durability is meant lasting quality, not fastness to light or laundering.
2. The samples are lettered A,B,C, etc., as is the form at the left.
3. Insert numbers in the durability column which correspond to the rank you have given each particular sample.
4. Let 1 represent the fabric of highest durability, 2, second highest, etc. If you should judge two or more samples to be equal in durability, give them the same number.

II. Fill in the questions below.

III. Return this sheet to the Department of Home Economics, Univ. of Missouri, Columbia, Missouri, on or before April 7, 1928.

1. What is your occupation?
2. What is your training in fabric selection?
 - a. Where taken?
 - b. List courses.
3. Check the types of materials listed which you have had experience in selecting.
 - a. cotton
 - b. linen
 - c. rayon
 - d. silk
 - e. wool
4. Check the garments and articles listed for which you use materials like the enclosed samples.

a. dresses	d. rompers	g. pillows
b. aprons	e. pajamas	h. children's dresses
c. smocks	f. curtains	i. trimming
j. list others used here--		

Ranking of Fabrics

The fabrics were ranked according to laboratory tests as well as according to consumers' judgment. For a comparative evaluation the fabrics were put in rank orders from 1 to 18 inclusive, 1 representing the highest and 18 the lowest value. In cases where two or more fabrics were shown to be equal, by either consumers' judgment or laboratory tests, a rank midway between their respective positions was given, for example, two materials, each of which ranked 7, would be given a rank 7.5.

1. According to Laboratory Tests.

Selection of Factors to be Used in Ranking.

The problem of ranking fabrics according to wearing quality is most difficult because (1) the terms "quality" and "wearing quality" or "durability" are taken to include a variety of factors, (2) there is insufficient proof as to what factors are pertinent in predicting durability of cotton fabrics and just how significant each factor is, (3) investigators indicate that durability is highly dependent upon tensile strength, (4) recent investigators indicate that strength tests on unlaundered fabrics may not be the best measure of predicting the strength of that fabric after laundering.

(27)

In a study of wearing and fading tests on cotton fabrics used for children's clothes, Cady²⁴ concluded that tensile strength, length of fiber, and thread count determine quality, but for tests on fabrics after laundering and wear she reported the tensile strength of the fabrics.²⁵ In an experiment on hospital sheetings by Millard, the tensile strength of the laundered fabrics as compared with the unlaundered fabrics was the basis for judging deterioration.²⁶ In a laundering experiment with overalls, the weakening due to washing with various laundering reagents²⁷ was measured by means of tensile strength. Cook, in a study of sheetings, based her laboratory ranking of quality on tensile strength, thread count, and weight. These are the qualities used by the United States Bureau of Standards in establishing specifications for sheetings for government purchase.

Government specifications for gingham have not been found, but those specifications for percale, a similar fabric, include tensile strength, thread count, and weight.

24. Cady, op. cit.

25. What Laundry Tests Show About Sheetings, Mod. Hosp., V. 24, p. 390.

26. Anonymous, Effect of Laundering Overalls, Textile World J., V. 71, p. 2032-2033.

27. Cook, The Scientific Determination of Reliability of the Consumer's Method of Buying, p.2.

28

Haven in referring to fabrics used for mechanical purposes says "While the tensile strength of a fabric is rarely, if ever, used as a direct quantity in the design of any machine or appliance using such fabrics, it nevertheless constitutes at the present time the best property on which to base the excellence or inferiority of a given textile."

29

Cook in referring to quality in bed linens says, "Durability is determined by three factors: tensile strength, thread count, and weight; and of these tensile strength is probably twice as important as the two others!"

30

Matthews says, "It has generally been the practice to test fabrics by obtaining the tensile strength of warp and filling but this method does not accurately measure the actual durability or wearing quality of the cloth".

Since wearing quality means lasting property, it would seem more significant that this property be measured by tensile strength tests on laundered fabrics rather than by either tensile strength tests on unlaundered fabrics or a combination of tests on unlaundered fabrics.

28. Haven, The Moisture Factor in Textile Testing, p.2

29. Cook, When the Bride Selects Bed Linens, Ladies H. J., p. 118, Jan. 1928.

30. Matthews, The Textile Fibers, p. 994.

The rank according to tensile strength after forty-five launderings was used because (1) the composite rank appears to include measures of quality rather than just wearing quality, (2) the tensile strength of a fabric may depend somewhat upon its thread count, and this may result in an overlapping in the evaluation of the durability of a fabric according to the composite rank of thread count, tensile strength, and weight, (3) this study and one on sheetings³¹ show that tensile strength tests made after the removal of sizing, are more significant than those made on the sized fabrics.

The author therefore used this method of ranking gingham for durability according to laboratory tests because she feels that it is the best of the present methods from which to choose. However she believes that the best method of predicting durability cannot be determined until gingham as well as other fabrics are experimented with until actual wear is shown and the tests on the worn fabrics are compared with the tests on the unlaundered fabrics.

31. What Laundry Tests Show About Sheetings, Mod. Hosp., V. 24, p. 390.

Determinations of Tensile Strength and Thread Count Values.

For purposes of comparison, tensile strength values and thread count values for both warp and filling are sometimes found averaged together. This method seems unsatisfactory since it does not take into consideration the balance obtained by the strengths or counts in both directions. With strain equally applied on both the warp and the filling of a cloth, it would only be reasonable to expect that the fabric which has strength values, more nearly equal for the warp and the filling, would give the best wear. In the report "Tensile Testing of Textiles", by W. F. Edwards,³² Cox criticizes the method of classifying fabrics for strength, using the average of the warp and the filling, and suggests the method of using minimum strength of the fabric in either direction, in preference to average strength.

In this study the tensile strength values of the fabrics after forty-five launderings by both home and commercial methods, were averaged. The warp and filling values were averaged separately. In this way only one warp and one filling value were obtained for each fabric.

The fabrics were then ranked according to tensile

32. Edwards, Tensile Testing of Textiles, Mech, Engineering V. 49, p. 246.

strength by taking that combination of warp and filling strips in which the lowest tensile strength value for either one, ranked higher than the successive combination with the next lowest tensile strength values of warp or filling, for example: A fabric with warp and filling values of 35.8 and 33.5 pounds respectively ranks higher than a fabric with warp and filling values of 49.35 and 32.95 pounds respectively because the lowest value, i. e. 33.5, of the first fabric is higher than the lowest value i. e. 32.95 of the next highest combination.

The fabrics were ranked according to thread count in a similar manner.

The author again wishes to state that this method of obtaining tensile strength and thread count values was used because it appears to be better than the method of obtaining values by averaging. She also believes that the accuracy of the method can only be determined through further experiments in which values obtained by both methods are compared.

2. According to Consumers' Judgment.

Ranking by various groups of consumers.

The total rank value of the materials for each group of judges was recorded in order to determine what relation, if any, existed between the judgment of trained and un-

trained homemakers, teachers, students, and salespersons.

Ranking of Fabrics With and Without Cost.

Separate records were kept of the ranks of fabrics reported by consumers who had information, and by consumers who did not have information in regard to prices and trade names of the fabrics. This was done in order to determine what effect a knowledge of price would have upon the judgment of the consumers.

3. Laboratory Tests Compared With Consumers' Judgment.

A comparative study was made of rankings based upon laboratory tests with the rankings given by the consumers, to determine what correlation, if any, existed between the two methods for judging wearing quality.

EXPERIMENTAL DATA

Unlaundered Fabrics. (Table 1)

1. Cost.

The gingham and similar fabrics ranged in price from fifteen cents to \$1.25 per linear yard and from seventeen cents to \$1.25 per unit of 1152 square inches, i. e. thirty-two by thirty-six inches.

2. Width.

The fabrics ranged in width from twenty-seven to thirty-six inches. Fourteen of the fabrics were thirty-two inches wide, three were thirty-six inches wide, and one was twenty-seven inches wide.

3. Weight.

The fabrics ranged in weight from 2.191 to 3.716 ounces per square yard. The three fabrics lowest in weight were of the Soiesette type of fabric.

4. Thread Count.

In the fifteen gingham the count for warp yarns was higher than for filling yarns. The other three fabrics which were of a Soiesette type had a lower count in the warp than in the filling. The lowest and the highest counts for the warp were 54 and 133 respectively and the lowest and the highest counts for the filling were 48 and

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INATIONS ON EIGHTEEN UNLAUNDERED GINGHAMS AND FABRICS

Wing	Twist of Yarns						Sizing		Tensile Strength	
	Warp			Filling			Percent	Kind	Pounds Per	
	Twists Per Inch	Direction	Ply	Twists Per Inch	Direction	Ply			Inch Strip	Warp Filling
1.9							3.39	Starch	50.7	33.2
2.8							4.62	Starch	44.0	41.0
2.9								Dextrin	44.0	41.0
2.3							2.27	Sugar	36.3	30.0
2.8							4.87	Starch	48.4	23.9
3.0							5.97	Starch	53.5	30.6
1.2							0.91	Starch	45.4	26.6
3.6							2.91	Starch	40.3	16.7
4.4							4.60	Starch	49.1	27.5
4.6							0.56		25.8	45.7
0.5	25.1	Left	Single	15.3	Left	Single	1.49		26.4	35.6
3.1	20.3	Left	Single	15.1	Left	Single	1.90	Starch	38.3	26.7
2.5							1.16		36.8	30.5
3.6	22.9	Left	Single	15.2	Right	Single	0.89		41.8	30.7
7.1	23.1	Left	Single	23.7	Left	Single	1.10	Starch	35.7	24.8
8.8				17.5	Right	Single	0.58		40.5	33.1
1.2	26.1	Left	Single	16.4	Left	Single	0.35		31.6	32.1
2.6	22.9	Left	Single	14.5	Left	Single	0.36		36.8	32.1
4.7	20.1	Left	Single	24.0	Left	Single	0.31		49.4	31.3
4.7	16.7	Left	Single	17.3	Left	Single				

147 respectively.

5. Yarn Number.

In 11 cases the fabric had a lower yarn number for the warp than for the filling. In 7 cases the yarn number for the warp was higher than for the filling yarns. The highest yarn numbers recorded for the warp and filling were 90 and 104.7 respectively, and the lowest yarn numbers recorded were 19.9 and 20.9 respectively. Two of the ginghams had a corded portion which showed lower yarn numbers, i. e., 9.7 and 9.8 for the warp and filling respectively, than any of the fabrics.

6. Twist.

The twist in the unsized fabrics was greater for the warp than for the filling yarns, in 5 of the 8 cases.

7. Sizing.

Ten fabrics contained sizing. The smallest and the greatest amounts of sizing recorded for the materials were 0.91 per cent and 5.97 per cent respectively. All of the sized fabrics gave a positive test for starch and one of them also gave a test for dextrin and sugar. The range in price per unit of 1152 square inches for the sized fabrics was from seventeen to fifty cents inclusive. The eight fabrics without sizing ranged from thirty-nine cents to \$1.25 for 1152 square inches.

8. Tensile Strength.

In the fifteen gingham the warp yarns were stronger than the filling yarns. The opposite was true of the other three fabrics. The lowest and the highest tensile strength records for the warp were 25.8 pounds and 53.5 pounds respectively; for the filling, 16.7 pounds and 45.7 pounds respectively. Some of the fabrics showed a close balance in the tensile strength values for the warp and the filling yarns. Others showed a considerable difference in the tensile strength values for the warp and the filling.

Laundered Fabrics.

1. Shrinkage. (Table 2.)

Home Method of Laundering.

After forty-five launderings the range in shrinkage was from 0 to 9.39 per cent in length and from 1.05 to 10.42 per cent in width. In all cases the greatest amount of shrinkage occurred between the first and fifth launderings. In 13 cases the total shrinkage was greater in width than in length.

Tests after the fifth laundering showed shrinkage in all cases in both length and width. Eleven fabrics had reached their limit of shrinkage in length; six materials had reached their limit of shrinkage in width.

TABLE 2. SHOWING THE EFFECT OF HOME AND COMMERCIAL LAUNDRING ON GINGHAMS AND

Number of Fabric	Percent Shrinkage After 5 Launderings				Increase in Percent Shrinkage Between the 6th and 16th Launderings				Increase Shrinkage Be and 31st L	
	Home Method		Commercial Method		Home Method		Commercial Method		Home Method	
	Length	Width	Length	Width	Length	Width	Length	Width	Length	Width
1	7.29	9.42	6.25	12.48	2.10	0	0	0.38	0	1.1
2	6.25	10.20	5.21	12.30	1.04	0	0	+1.10	0	0.4
3	8.33	6.85	5.21	8.77	+1.04	0.39	1.04	0	1.04	0.7
4	7.29	5.97	5.21	6.74	0	0.19	0	0.96	0	0.3
5	6.25	6.37	4.17	7.54	1.04	0.58	0	+0.39	0	0.9
6	5.21	6.48	3.13	7.21	0	0.59	2.08	0.78	0	0.3
7	3.13	3.33	1.04	5.07	+1.04	0.39	2.08	1.17	1.04	0.5
8	3.13	6.27	3.13	8.59	2.08	0.78	+1.04	+0.78	1.04	0.3
9	5.21	4.82	2.08	5.20	+3.13	0	0	+0.20	0	+0.4
10	2.08	3.59	2.08	4.36	1.04	+1.19	2.08	+0.79	0	0.6
11	5.21	5.61	2.08	7.72	+1.04	0.77	1.04	0.19	0	0.5
12	3.13	2.93	2.08	5.27	0	+0.59	0	+1.37	1.04	0.2
13	5.21	5.66	2.08	7.03	0	0.59	2.08	0.59	0	0.7
14	5.21	1.00	3.13	3.21	0	0.40	1.04	+0.20	0	0.2
15	3.13	6.28	2.08	7.88	0	+0.90	0	+1.25	0	0
16	1.04	4.84	0	5.89	0	+0.36	0	0.18	0	0.3
17	1.04	2.63	0	3.16	0	+1.23	1.04	+1.05	1.04	+0.5
18	3.13	3.76	0	5.35	0	0	0	+0.40	1.04	0.4

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COMMERCIAL LAUNDERING ON THE SHRINKAGE OF EIGHTEEN AND SIMILAR FABRICS.

Increase in Percent Shrinkage Between the 16th and 46th Launderings			Total Percent Shrinkage for 45 Launderings			
Commercial Method			Home Method		Commercial Method	
Length	Width		Length	Width	Length	Width
.15	1.04	+2.30	0	+0.96	1.04	2.11
.45	1.04	0.68	0	+0.23	0	0
.78	+1.04	0	1.04	+0.58	0	+0.97
.38	0	0	0	0	0	+0.58
.97	1.04	0.19	0	+0.77	0	+0.19
.39	+1.04	0.39	1.04	0	0	+0.39
.59	0	+0.20	0	0	0	+0.20
.39	0	0.98	0	0	1.04	+0.58
.40	0	0.40	0	+0.60	0	+1.20
.60	+3.10	0	0	+0.60	1.04	+0.99
.58	0	0	0	0.19	+1.04	+0.19
.20	0	0	0	+0.59	1.04	+0.98
.78	+1.04	0.39	0	0.20	0	+0.20
.20	+1.04	+0.60	0	+0.20	1.04	+0.40
0	+1.04	0.18	0	+0.36	0	+0.18
.36	0	+0.18	0	0	0	+0.54
.53	+2.08	0	0	0.18	0	+0.18
.40	+1.04	0.20	0	0	0	0.20

(38)

Tests after the fifteenth laundering showed no additional shrinkage in length, in 9 cases, increased shrinkage in 5 cases and stretch in 4 cases. Tests showed no additional shrinkage in width, in 4 cases, increased shrinkage in 9 cases and stretch in 5 cases. Three additional fabrics had reached their limit of shrinkage in length; one additional fabric had reached the limit of shrinkage in width.

Tests after the thirtieth laundering showed no additional shrinkage in length in 12 cases, increased shrinkage in 4 cases, and stretch in 2 cases. Tests showed no additional shrinkage in width in 1 case, increased shrinkage in 15 cases and stretch in 2 cases. Three additional fabrics had reached their limit of shrinkage in length; nine additional fabrics had reached their limit of shrinkage in width.

Tests after the forty-fifth laundering showed no additional shrinkage in length in 16 cases, increased shrinkage in 1 case, and stretch in 1 case. Tests showed no additional shrinkage in width in 6 cases, increased shrinkage in 3 cases and stretch in 8 cases. One additional fabric had reached its limit of shrinkage in length; two additional fabrics had reached their limit of shrinkage in width.

Commercial Method of Laundering.

After forty-five launderings the range in shrinkage was from 0 to 8.33 per cent in length and from 1.99 to 12.67 per cent in width. In all cases but three, the greatest amount of shrinkage occurred between the first and fifth launderings. Of these three materials, one showed no shrinkage in length in forty-five launderings, one showed no shrinkage in length until after the fifteenth laundering, and after the thirtieth laundering it stretched more than it had previously shrunk; the third material showed no shrinkage in length until after the fifteenth laundering. In 16 cases the total shrinkage was greater in width than length; in the other 2 cases the total shrinkage was greater in length than in width.

Tests after the fifth laundering showed shrinkage in length in 15 cases; in width, in all cases. Six fabrics had reached their limit of shrinkage in length; thirteen fabrics had reached their limit of shrinkage in width.

Tests after the fifteenth laundering showed no additional shrinkage in length in 9 cases, increased shrinkage in 8 cases and stretch in 1 case. Tests showed additional shrinkage in width in 1 case, increased shrinkage in 8 cases and stretch in 9 cases. Four additional fabrics had reached their limit of shrinkage in length, four additional fabrics had reached their limit of shrinkage in

width.

Tests after the thirtieth laundering showed no additional shrinkage in length in 7 cases, increased shrinkage in 5 cases, and stretch in 6 cases. Tests showed no additional shrinkage in width in 6 cases, increased shrinkage in 8 cases, and stretch in 4 cases. Two additional fabrics had reached their limit of shrinkage in length; one additional fabric had reached its limit of shrinkage in width.

Tests after the forty-fifth laundering showed no additional shrinkage in length in 12 cases, increased shrinkage in 5 cases, and stretch in 1 case. Tests showed no additional shrinkage in width in 1 case, increased shrinkage in 1 case, and stretch in 16 cases. Three additional fabrics reached their limit of shrinkage in length; no additional fabrics reached their limit of shrinkage in width.

Groups of two or more fabrics of the same or almost the same prices tended to have approximately the same percentage of total shrinkage in the warp.

2. Weight. (Table 3.)

Home Method of Laundering.

In all cases the weight of the fabric was greater after the forty-fifth laundering than it was when new. The increase in weight ranged from 0.32 to 21.32 per cent.

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TABLE 3. SHOWING THE EFFECT OF HOME AND COMMERCIAL LAUNDERING
ON THE WEIGHT OF EIGHTEEN GINGHAMS AND SIMILAR FABRICS.

Number of Fabric	Weight Per Square Yard of Unlaundered Mat- erial (ounces).	Weight After 45 Launderings		Percent Increase in After 45 Launderings	
		Home Method (ounces)	Commercial method (ounces)	Home Method	Commercial Method
1	3.682	4.367	4.489	21.32	21.9
2	3.432	4.111	3.944	19.49	14.9
3	3.716	4.336	4.323	16.68	16.3
4	2.924	3.261	3.226	11.53	10.3
5	3.423	3.585	3.455	4.73	0.9
6	2.887	3.344	3.329	15.83	15.3
7	2.540	2.660	2.727	4.72	7.3
8	2.577	3.305	3.125	28.25	21.2
9	2.201	2.482	2.458	12.77	11.6
10	2.231	2.395	2.355	7.35	5.5
11	3.211	3.656	3.519	13.86	9.5
12	2.846	3.011	2.982	5.80	4.7
13	2.721	3.099	2.996	13.89	10.1
14	2.577	2.753	2.691	6.83	4.4
15	2.325	2.600	2.626	11.83	12.9
16	2.648	2.866	2.785	8.23	5.1
17	2.191	2.198	2.177	0.32	-0.6
18	2.747	2.916	2.874	6.15	4.6

Fifteen fabrics laundered by this method were heavier than the same kind of fabrics laundered by the commercial method.

Commercial Method of Laundering.

In 17 cases the weight of the fabric was greater after the forty-fifth laundering than it was when new. In 1 case the fabric weighed less after forty-five laundering than when it was new. The increase in weight for the 17 fabrics ranged from 0.93 to 21.92 per cent. The decrease in weight of the one fabric was 0.64 per cent.

3. Thread Count (Table 4.)

Home Method of Laundering

The total increase in thread count ranged from 1.16 to 11.00 per cent in the warp and from 1.36 to 14.75 per cent in the filling direction, after forty-five laundering. In 10 cases there was a greater increase in filling threads than warp threads per inch.

Tests after the fifth laundering showed an increase in warp threads in 17 cases, and a decrease in 1 case. Tests showed an increase in filling threads in all cases. Six fabrics showed no change in count in the warp, and three showed no change in the filling after the fifth laundering.

Tests after the fifteenth laundering showed no increase in warp threads in 10 cases, an increase in 5 cases.

TABLE 4. SHOWING

THE EFFECT OF HO

Number of Fabric	Threads Per Inch Unlaundered Fabric		Threads Per Inch After 5 Launderings				Threads Per After 15 Lau	
			Home Method		Commercial Method		Home Method	
	Warp	Filling	Warp	Filling	Warp	Filling	Warp	Filling
1	64	55	66	58	66	56	67	58
2	54	48	60	54	61	54	60	55
3	61	52	65	55	64	55	65	57
4	65	55	68	59	68	58	67	58
5	65	56	69	60	69	58	69	60
6	74	67	79	70	79	70	79	70
7	80	65	83	69	83	69	84	69
8	69	55	74	59	74	59	74	60
9	68	99	78	104	78	106	79	103
10	75	93	80	97	79	97	79	97
11	76	64	80	68	80	66	80	67
12	86	79	87	82	88	82	87	83
13	91	82	96	86	96	84	96	87
14	100	78	98	81	98	80	99	81
15	97	88	106	90	106	90	106	90
16	97	88	104	90	104	89	104	91
17	133	147	143	149	142	149	142	149
18	94	88	96	92	97	90	97	92

(43)

HOME AND COMMERCIAL LAUNDERING ON THE THREAD COUNT OF EIGHTEEN GINGHAMS AND SIMILAR FABRICS.

Per Inch Launderings		Threads Per Inch After 45 Launderings				Increase in Threads After 45 Launderings			
Commercial Method		Home Method		Commercial Method		Home Method		Commercial Method	
Warp	Filling	Warp	Filling	Warp	Filling	Warp	Filling	Warp	Filling
66	58	68	57	69	60	4	2	5	5
60	54	60	55	61	53	6	7	7	5
64	55	65	56	66	56	4	4	5	4
69	58	69	59	69	59	4	4	4	4
69	59	70	61	70	60	5	5	5	4
79	71	80	73	79	70	6	6	5	3
84	69	83	70	83	69	3	5	3	4
74	60	74	60	74	58	5	5	5	3
78	104	79	103	79	102	11	4	11	3
81	97	79	97	80	95	4	4	5	2
81	68	81	67	82	66	5	3	6	2
90	83	87	83	87	82	1	4	1	3
97	86	97	87	97	85	6	5	6	3
100	82	99	82	100	82	-1	4	0	4
105	90	106	92	105	90	9	4	8	2
103	90	104	92	105	90	7	4	8	2
141	150	142	149	142	152	9	2	9	5
98	91	97	92	98	90	3	4	4	2

THE THREAD COUNT OF EIGHTEEN

Warp Filling	Commercial Method	Increase in Threads After 45 Launderings				Percent Increase in Threads After 45 Launderings			
		Home Method		Commercial Method		Home Method		Commercial Method	
		Warp	Filling	Warp	Filling	Warp	Filling	Warp	Filling
60		4	2	5	5	6.25	3.64	7.81	9.09
53		6	7	7	5	11.00	14.75	12.96	10.40
56		4	4	5	4	6.56	7.50	8.33	7.50
59		4	4	4	4	6.11	7.27	6.11	7.27
60		5	5	5	4	7.69	8.75	7.69	7.15
70		6	6	5	3	8.11	8.96	6.76	4.48
69		3	5	3	4	3.75	7.69	3.75	6.12
58		5	5	5	3	7.25	9.09	7.25	5.45
102		11	4	11	3	16.18	4.04	16.18	3.03
95		4	4	5	2	5.33	4.30	6.66	2.15
66		5	3	6	2	6.58	4.69	7.89	3.13
82		1	4	1	3	1.16	5.06	1.16	3.79
85		6	5	6	3	6.59	6.10	6.59	3.65
82		-1	4	0	4	-1.00	5.13	0	5.13
90		9	4	8	2	9.28	4.52	8.25	2.27
90		7	4	8	2	7.22	4.52	8.25	2.27
152		9	2	9	5	6.77	1.36	6.77	3.40
90		3	4	4	2	3.19	4.55	4.26	2.28

and a decrease in 3 cases. Tests showed no increase in filling threads in 9 cases, an increase in 6 cases, and a decrease in 3 cases. Five additional fabrics showed no change in count in the warp and six showed no change in the filling after the fifteenth laundering.

Tests after the thirtieth laundering were not completed as the counts for a few fabrics showed no variation with the counts after the fifteenth laundering.

Tests after the forty-fifth laundering showed no increase in warp threads in 11 cases, an increase in 6 cases, and a decrease in 1 case. Tests showed no increase in filling threads in 9 cases, an increase in 7 cases, and a decrease in 2 cases. Seven additional fabrics showed no change in count in the warp and nine showed no change in the filling after the forty-fifth laundering.

Commercial Method of Laundering.

The total increase in thread count ranged from 0 to 16.18 per cent in the warp and from 2.15 to 10.40 per cent in the filling direction after the forty-fifth laundering. In 13 cases the increase in count was greater in the warp than in the filling threads after forty-five launderings.

In all cases but one, the count in warp threads increased after the fifth laundering. This one fabric showed a decrease in number of threads per inch. In all cases in the filling the count increased. Two fabrics showed

no change in warp or filling after the fifth laundering.

Tests after the fifteenth laundering showed no increase in warp threads in 6 cases, an increase in 8 cases, and a decrease in 4 cases. Tests showed no increase in count of filling threads in 6 cases, an increase in 11 cases, and a decrease in 1 case. Five additional fabrics showed no change in count in the warp, and two showed no change in the filling after the fifteenth laundering.

Tests after the forty-fifth laundering showed no additional decrease in count of warp threads in 7 cases, an increase in 8 cases, and a decrease in 3 cases. The tests showed no increase in filling threads in 4 cases, an increase in 5 cases, and a decrease in 9 cases. Eleven additional fabrics showed no change in count in the warp and fourteen showed no change in the filling after the forty-fifth laundering.

4. Tensile Strength (Tables 5 and 6.)

Home Method of Laundering.

After forty-five launderings the tensile strength ranged from 22.6 pounds to 49.2 pounds for the warp and from 14.8 pounds to 46.3 pounds for the filling. In 15 cases the warp showed greater tensile strength than the filling, and in 3 cases the filling showed the greatest strength. The decrease in tensile strength after forty-five launderings ranged from 0.40 to 28.40 per cent in the warp;

(46)

TABLE 5. SHOWING THE EFFECT OF HOME AND COMMERCIAL LAUNDRY
OF EIGHTEEN GINGHAMS AND S

Number of Fabric	Unlaundered Fabric		After 5 Launderings				After 15. Launderings			
			Home Method		Commercial Method		Home Method		Commercial Method	
	Pounds Per Inch Strip		Pounds Per Inch Strip		Pounds Per Inch Strip		Pounds Per Inch Strip		Pounds Per Inch Strip	
	Warp	Filling	Warp	Filling	Warp	Filling	Warp	Filling	Warp	Filling
1	50.7	33.2	37.7	29.1	40.9	29.1	36.2	26.0	38.6	25.4
2	44.0	41.0	33.4	33.9	36.4	36.5	33.9	37.3	30.4	33.6
3	36.3	30.0	29.1	26.8	29.3	28.3	31.1	27.6	30.1	28.3
4	48.4	23.9	38.6	21.5	40.4	23.5	37.9	22.4	39.4	21.3
5	53.5	30.6	43.1	27.5	45.9	27.0	43.4	29.4	42.2	24.8
6	45.4	26.6	39.0	29.0	41.5	28.2	43.5	28.2	42.7	27.1
7	40.3	16.7	32.6	14.9	34.7	18.9	33.5	18.4	31.8	17.9
8	49.1	27.5	41.9	25.9	41.2	24.8	42.7	27.9	41.2	25.9
9	25.8	45.7	22.5	40.1	23.9	44.3	24.4	48.6	24.2	40.8
10	26.4	35.6	23.6	36.5	25.8	35.4	24.6	39.5	24.9	33.9
11	38.3	26.7	35.9	27.4	34.7	27.4	33.5	27.0	33.4	25.5
12	36.8	30.5	38.1	31.6	39.4	31.1	39.5	36.0	36.9	31.3
13	41.8	30.7	41.4	31.4	39.9	31.7	39.9	30.8	38.6	31.5
14	35.7	24.8	29.9	26.7	32.4	25.5	30.7	26.8	30.4	27.3
15	40.5	33.1	36.5	32.4	41.3	29.4	38.6	35.1	36.0	30.9
16	31.6	32.1	34.5	32.0	34.0	34.5	35.7	34.2	32.7	31.1
17	36.8	32.1	39.5	32.8	35.8	33.5	41.1	34.6	37.2	30.7
18	49.4	31.3	49.8	33.4	49.3	31.7	51.4	33.7	50.2	30.6

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AND COMMERCIAL LAUNDERING ON THE TENSILE STRENGTH SEEN GINGHAMS AND SIMILAR FABRICS.

15. Launderings			After 30 Launderings				After 45 Launderings			
Per rip line	Commercial Method		Home Method		Commercial Method		Home Method		Commercial Method	
	Pounds Per Inch Strip	Warp Filling	Pounds Per Inch Strip	Warp Filling	Pounds Per Inch Strip	Warp Filling	Pounds Per Inch Strip	Warp Filling	Pounds Per Inch Strip	Warp Filling
26.0	38.6	25.4	37.0	24.1	33.1	25.7	36.3	24.6	32.1	26.7
37.3	30.4	33.6	33.0	38.1	32.0	33.5	32.5	36.1	32.5	32.6
27.6	30.1	28.3	29.7	28.7	29.3	27.9	28.6	27.9	31.9	31.5
22.4	39.4	21.3	35.1	21.3	36.0	21.6	34.3	22.6	38.2	22.9
29.4	42.2	24.8	41.1	28.0	41.8	26.9	39.3	25.5	44.2	26.7
28.2	42.7	27.1	39.2	26.9	40.0	25.9	36.2	24.6	38.1	28.5
18.4	31.8	17.9	31.7	16.1	30.6	15.6	29.5	14.8	32.1	17.0
27.9	41.2	25.9	37.6	25.3	39.2	22.7	37.2	24.7	38.0	24.4
48.6	24.2	40.8	21.9	47.3	23.4	44.9	23.5	46.3	23.2	46.2
39.5	24.9	33.9	23.4	33.1	23.8	33.7	22.6	35.1	24.8	36.8
27.0	33.4	25.5	33.0	27.5	31.4	28.2	32.0	28.2	36.1	31.6
36.0	36.9	31.3	34.6	33.6	37.5	34.9	35.1	33.8	36.2	34.0
30.8	38.6	31.5	39.2	30.5	39.3	32.3	34.7	28.6	38.3	28.7
26.8	30.4	27.3	30.1	27.2	30.4	24.7	28.7	23.1	27.4	23.5
35.1	36.0	30.9	37.4	34.0	37.0	31.1	35.5	31.6	37.0	32.2
34.2	32.7	31.1	33.3	31.8	33.5	30.5	35.9	35.7	35.7	31.6
34.6	37.2	30.7	39.2	34.3	41.2	31.8	36.9	32.9	40.3	30.5
33.7	50.2	30.6	51.1	34.4	50.4	32.9	49.2	32.8	49.5	33.1

TABLE 6. SHOWING THE EFFECT OF HOME AND COMMERCIAL LAUNDERING ON COUNT AND TENSILE STRENGTH OF EIGHTEEN GINGHAMS AND SIM

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Number of Fabric	Shrinkage (Percent) (Stretch)				Weight Percent Increase		Thread Cou Percent Inc	
	Home Method		Commercial Method		Home Method	Commercial Method	Home Method	
	Length	Width	Length	Width			Warp	Filling
1	9.39	9.61	8.33	12.67	21.32	21.92	6.25	3.64
2	7.29	10.42	6.25	11.88	19.49	14.91	11.10	14.75
3	7.29	7.43	4.17	7.80	16.68	16.33	6.25	7.50
4	7.29	6.54	5.21	7.13	11.53	10.33	6.11	7.27
5.	7.29	7.16	5.21	7.16	4.73	0.93	7.69	8.75
6	6.25	7.47	4.17	8.01	15.83	15.31	8.11	8.96
7	3.13	4.31	3.12	5.87	4.72	7.37	3.75	7.69
8	6.25	7.44	3.12	8.20	28.25	21.27	7.25	9.09
9	2.08	3.82	2.08	4.22	12.77	11.68	16.18	4.04
10	3.12	2.40	2.08	3.59	7.35	5.55	5.33	4.30
11	4.17	7.14	2.08	7.72	13.86	9.59	6.58	4.69
12	4.17	1.96	3.12	2.92	5.80	4.78	1.16	5.06
13	5.21	7.23	3.12	7.81	13.89	10.11	6.59	6.10
14	5.21	1.41	4.17	2.01	6.83	4.42	1.00	5.13
15	3.13	5.02	1.04	6.63	11.83	12.95	9.28	4.53
16	1.04	4.84	0	5.35	8.23	5.17	7.22	4.53
17	0	1.05	+1.04	1.99	0.32	-0.64	6.77	1.36
18	2.09	4.16	+1.04	4.95	6.15	4.62	3.19	4.55

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HOME AND COMMERCIAL LAUNDRING ON SHRINKAGE, WEIGHT, THREAD LENGTH OF EIGHTEEN GINGHAMS AND SIMILAR FABRICS.

Weight Percent Increase Home Commercial Method Method		Thread Count Percent Increase				Tensile Strength Percent Increase or Decrease			
		Home Method		Commercial Method		Home Method		Commercial Method	
		Warp	Filling	Warp	Filling	Warp	Filling	Warp	Filling
.32	21.92	6.25	3.64	7.81	9.09	-28.40	-25.90	-36.69	-19.5
.49	14.91	11.10	14.75	12.96	10.40	-26.14	-11.95	-26.14	-20.4
.68	16.33	6.25	7.50	8.20	7.50	-21.21	-7.00	-12.12	+5.0
.53	10.33	6.11	7.27	6.11	7.27	-29.13	-5.44	-21.07	-4.1
.73	0.93	7.69	8.75	7.69	7.15	-26.54	-16.67	-17.38	-12.7
.83	15.31	8.11	8.96	6.76	4.48	-20.26	-7.52	-16.08	+7.1
.72	7.37	3.75	7.69	3.75	6.12	-26.80	-11.38	-20.09	+1.8
.25	21.27	7.25	9.09	7.25	5.45	-24.24	-10.18	-22.61	-11.2
.77	11.68	16.18	4.04	16.18	3.03	-8.91	+1.31	-10.08	+1.0
.35	5.55	5.33	4.30	6.66	2.15	-14.39	-14.04	-9.09	+3.3
.86	9.59	6.58	4.69	7.89	3.13	-16.45	+5.61	-5.74	+18.3
.80	4.78	1.16	5.06	1.16	3.79	-4.62	+10.82	-1.60	+11.4
.89	10.11	6.59	6.10	6.59	3.65	-16.99	-6.84	-8.37	-6.5
.83	4.42	1.00	5.13	0	5.13	-19.61	-6.89	-23.25	-5.2
.83	12.95	9.28	4.53	8.25	2.27	-12.35	-4.53	-8.64	-2.7
.23	5.17	7.22	4.53	8.25	2.27	+13.61	+11.21	+12.97	-1.5
.32	-0.64	6.77	1.36	6.77	3.40	+0.27	+2.49	+9.51	-4.9
.15	4.62	3.19	4.55	4.26	2.28	-0.40	+4.79	+0.20	+5.9

the increase in strength ranged from 0.27 to 13.61 per cent. The filling showed a decrease in strength ranging from 4.53 to 25.90 per cent and an increase from 1.31 to 11.21 per cent.

Tests after the fifth laundering showed a decrease in tensile strength in the warp in 14 cases and an increase in 4 cases. These four fabrics continued to increase in strength and showed no decrease until after the thirtieth laundering. The tests showed a decrease in tensile strength in the filling, in 10 cases and an increase in 8 cases.

Tests after the fifteenth laundering showed a decrease in strength both for the warp and filling in 4 cases and an increase in 4 cases.

Tests after the thirtieth laundering showed a decrease in tensile strength of the warp in 17 cases, and an increase in 1 case. Tests showed a decrease in the filling in 13 cases and an increase in 5 cases.

Tests after the forty-fifth laundering showed a decrease in strength in the warp in 15 cases and an increase in 3 cases. Tests showed a decrease in the filling in 12 cases and an increase in 6 cases.

Commercial Method of Laundering.

After forty-five launderings the tensile strength

ranged from 23.2 to 49.5 pounds for the warp and from 17.0 to 46.2 pounds for the filling. In 15 cases the warp showed greater tensile strength than the filling and in 3 cases the filling showed the greatest strength. The decrease in tensile strength after forty-five launderings ranged from 1.60 to 36.69 per cent in the warp, the increase in strength ranged from 0.20 to 12.97 per cent. The filling showed a decrease in strength which ranged from 1.56 to 20.49 per cent and an increase which ranged from 1.09 to 18.35 per cent.

Tests after the fifth laundering showed a decrease in tensile strength of the warp in 15 cases and an increase in 3 cases. The tests showed a decrease in the filling in 9 cases and an increase in 9 cases.

Tests after the fifteenth laundering showed no change in tensile strength in 1 case in the warp, a decrease in 12 cases, and an increase in 5 cases. Tests showed no change in the filling in one case, a decrease in 13 cases and an increase in 4 cases.

Tests after the thirtieth laundering showed no change in tensile strength in 1 case in the warp, a decrease in 10 cases, and an increase in 7 cases. Tests showed a decrease in the filling in 8 cases and an increase in 10 cases.

Tests after the forty-fifth laundering showed no

change in the warp in 1 case, a decrease in 9 cases, and an increase in 8 cases. Tests showed a decrease in the filling in 6 cases and an increase in 12 cases.

In 11 cases the warp showed a greater decrease in strength after home laundering than by commercial laundering. In 1 case the warp of a fabric laundered by the home method decreased in strength and the warp of a like fabric laundered by the commercial method increased in strength. In 1 case the decrease in strength was the same for both methods of laundering. In 1 case a home laundered fabric showed a greater increase in strength than the warp of the fabric laundered by the commercial method.

In 6 cases the home laundered fabrics showed greater decreases in strength in the filling than the fabrics laundered by the commercial method; in 1 case the home laundered fabric showed a greater increase than when laundered by the other method; in 6 cases the fabrics laundered by the home method decreased and the others increased in strength in the filling direction.

5. A Comparison of Thread Count, Tensile Strength, Weight, and Shrinkage After Forty-five Launderings.

Home Method of Laundering.

Table 6 shows the following: after forty-five launderings all fabrics increased in thread count in both the warp and the filling; all increased in weight; all shrunk

in both length and width with one exception in which an expensive fabric showed no shrinkage in the warp. In 12 cases the tensile strength decreased in both the warp and the filling; in 4 cases the strength decreased, and in 2 cases, increased in the warp. In 6 cases the strength increased in the filling.

Commercial Method of Laundering.

After forty-five launderings all fabrics increased in thread count in both warp and filling with one exception; seventeen fabrics increased in weight, and sixteen fabrics shrunk. One fabric increased and eight fabrics decreased in strength in both warp and filling directions. Of the other nine fabrics, the strength decreased in seven cases and increased in two cases in the warp direction; the strength decreased in two cases and increased in seven cases in the filling direction.

Ranking of the Fabrics.

1. Laboratory Rankings Based on Tensile Strength (Table 7)

Two fabrics costing fifty cents and fifty-three cents per unit of 1152 square inches, ranked first in tensile strength. A fabric costing thirty-five cents ranked 18. The fabric which cost the most ranked third in strength. The fabric which was second highest in price ranked fifth. The five cheapest fabrics ranging in price from seventeen to twenty cents per unit of 1152 square inches ranked 12, 4, 8, 15, 5, and 11 respectively.

2. Laboratory Rankings Based on Tensile Strength, Weight, and Thread Count. (Table 7)

In only 3 cases were the rank values based on tensile strength, weight, and thread count identical to the rank values of the same fabrics when based only upon tensile strength. The expensive fabrics tended to rank a little higher and the cheap fabrics tended to rank a little lower when based on the three factors than when based on tensile strength alone.

3. Rankings by Consumers. (Table 8)

The composite ranking of the fabrics by the consumers tended to show a direct relation to the price of the fabric only with the cheapest and most expensive fabrics.

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TABLE 7. SHOWING THE RANK OF FABRICS ACCORDING TO WEIGHT, THREAD COUNT AND TENSILE STRENGTH.

Number of Fabric	Rank According to weight	Rank According to Thread Count	Rank According to Tensile Strength	Average of Three Ranks	Ranks of Average of Three Ranks
1	1	15.5	12	9.5	10
2	3	18	4	8.3	8
3	2	17	8	10.3	12
4	7	15.5	15.5	12.7	15.5
5	5	13	11	9.7	11
6	6	10	10	8.7	9
7	13	11	18	14	18
8	8	14	13	11.7	13.5
9	15	9	14	12.7	15.5
10	17	8	15.5	13.5	17
11	4	12	7	7.7	5
12	10	7	1.5	6.2	2
13	9	5	9	7.7	5
14	12	6	17	11.7	13.5
15	14	2	6	7.3	3
16	11	3	1.5	5.2	1
17	18	1	5	8	7
18	16	4	3	7.7	5

(53a)

TABLE 8. SHOWING THE RANKS BY CONSUMERS OF THE
GINGHAMS AND SIM

Number of Fabric	Composite Rank	Homemakers With- out Home Econom- ics Training		Homemakers With Home Economics Training		Ho
		Rank	Deviation From Com- posite Ranks	Rank	Deviation From Com- posite Ranks	
1	18	17	-1	18	0	1
2	15	16	+1	15	0	1
3	16	14	-2	16	0	1
4	17	18	+1	17	0	1
5	13	12	-1	12	-1	1
6	8	9	1	6	-2	
7	10	10	0	10	0	1
8	14	15	+1	14	0	1
9	12	11	-1	13	+1	1
10	11	8	-3	11	0	1
11	9	13	+4	9	0	
12	6	4	+2	5	-1	
13	2	3	+1	1	-1	
14	3	2	-1	3	0	
15	7	7	0	7	0	
16	5	6	+1	8	+3	
17	4	5	+1	4	0	
18	1	1	0	2	+1	
Total Deviations			+13 -9		+5 -5	

(53a)

KS BY CONSUMERS OF THE WEARING QUALITY OF EIGHTEEN
GINGHAMS AND SIMILAR FABRICS.

Homemakers With Home Economics Training		Home Economics Students		Home Economics Teachers		Salespersons		Deviation Within 5 Groups for each Fabric
Rank	Deviation From Com- posite Ranks	Rank	Deviation From Composite Rank	Rank	Deviation From Composite Rank	Rank	Deviation From Composite Rank	
18	0	18	0	18	0	18	0	1
15	0	12	3	11	-4	14	-1	9
16	0	16	0	16	0	15	-1	3
17	0	17	0	17	0	17	0	1
12	-1	10	-3	10	-3	16	+3	11
6	-2	7	-1	7	-1	7	-1	6
10	0	11	+1	12	+2	12	+2	5
14	0	14	0	14	0	13	-1	2
13	+1	13	+1	15	+3	9	-3	9
11	0	15	+4	13	+2	10	-1	10
9	0	9	0	9	0	11	+2	6
5	-1	6	0	6	0	4	-2	5
1	-1	2	0	3	+1	3	+1	4
3	0	3	0	2	-1	2	-1	3
7	0	8	+1	8	+1	8	+1	3
8	+3	4	-1	5	0	5	0	5
4	0	5	+1	4	0	6	+2	4
2	+1	1	0	1	0	1	0	0
	+5 -5		+8 -8		+9 -9		+11 -9	

Consumers judged these to have the least and the greatest wearing qualities respectively. Intermediate ranks showed no definite relationship between price and the judgment of consumers as to wearing quality.

The scores given by consumers judging the fabrics with and without cost differed by less than 0.5 per cent.

The rank of the eighteen fabrics given by homemakers without Home Economics training showed a deviation which was higher in 13 cases and lower in 9 cases than the composite rank of all the consumers. The deviation of the rank given by the trained homemakers was both higher and lower in 5 cases; the deviation of the rank given by Home Economics students was both higher and lower in 8 cases; the deviation of the rank given by Home Economics teachers was both higher and lower in 9 cases; the deviation of the rank given by salespersons was higher in 11 cases and lower in 9 cases than the composite rank of the consumers.

The trained homemakers ranked the fabrics nearer to the composite rank than did any other group of consumers. The untrained homemakers ranked the fabrics farther from the composite rank than did any other group of consumers.

There was less variation in the way the five groups of consumers judged both the least and the most expensive fabrics than in the way they judged those of intermediate prices. The greatest variation in judgment was shown for

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fabrics costing eighteen and twenty cents and for two
fabrics costing thirty-nine cents.

ANALYSIS AND DISCUSSION

The data of this experiment are analyzed as follows:

(1) The relationship between price, width, weight, thread count, yarn number, twist, sizing, and tensile strength of the unlaundered fabrics; (2) a comparison of the effect of home and commercial methods of laundering upon the wearing quality of the gingham and similar fabrics; (3) a comparison of consumers' judgment of wearing quality with laboratory tests for gingham and similar fabrics.

1. The Relationship Between Price, Width, Weight, Thread Count, Yarn Number, Twist, Sizing, and Tensile Strength of the Unlaundered Fabrics. (Table 1)

Width and Cost.

Fourteen of the fabrics were thirty-two inches wide but had varying costs, which showed that width was a comparatively distinct factor for gingham, irrespective of price.

Weight.

Although the four cheapest fabrics weighed the most, there seemed to be no constant correlation between weight and price in the other fourteen fabrics. The most expensive fabric ranked ninth in weight. Griffith's and

and Edgar's¹ study, as well as Craner's and Dorsey's² study also showed this lack of correlation between price and weight.

Although the four fabrics which had the greatest weight contained the highest percentage of sizing, no proportionate relationship was shown between weight and sizing. This indicates that weight was not dependent upon sizing.

In comparing weight with yarn number, there seemed to be a higher correlation than between weight and sizing, since the two fabrics of the lowest weights had the highest average yarn number and the four fabrics of the greatest weights had the lowest average yarn number.

Weight seems to be somewhat dependent upon thread count in that the fabric of least weight had the highest count and the three of highest weight had the lowest thread counts.

Thread Count.

The tendency was for thread count to increase with price, although not proportionally.

Yarn Number.

There seemed to be no consistent relationship be-

1. Griffith and Edgar, op. cit., p. 112.
2. Craner and Dorsey, op. cit., p. 255.

tween yarn number and price, although the three fabrics with the smallest yarn number cost the least. The fabric with the highest yarn number was not the most expensive.

Although the yarn numbers for the warp yarns in 11 cases were lower than for the filling yarns, the exceptions to this were found in the most expensive gingham and in the fabrics of Soiesette type. A lower yarn number in the warp than in the filling is also reported by Cranor³ and Dorsey⁴ in only one of the four towelings, by Griffith and Edgar⁵ in three of the five sheetings, and by Furry⁶ and Edgar⁶ in most of the sheetings. Noer reported Streed's study as showing a lower yarn number in the warp than in the filling in all but one case for underwear fabrics.

Since warp yarns generally must withstand more strain than filling yarns in weaving, this may explain the fact that five of the eight fabrics in which twist was removed had more twists in the warp than in the filling. The two most expensive fabrics and a fifty cent fabric had more twists in the filling than in the warp. All of the yarns were single ply and all but two of the yarns had a left twist.

3. Cranor and Dorsey, op. cit., p. 255.

4. Griffith and Edgar, op. cit., p. 112.

5. Furry and Edgar, op. cit., p. 434.

6. Noer, op. cit.

Cranor and Dorsey found twist to be about the same in the more expensive linen, the cotton, and the union towelings, and less in the cheapest toweling than in the other towelings. Practically all yarns were single ply and had a left twist.

Five fabrics showed a direct relationship between twist and yarn number for both warp and filling. Twist apparently had no relationship to price, nor to tensile strength.

Sizing.

Since the eight cheapest fabrics and two fabrics of medium price gave tests for sizing, it would seem that there is some relationship between sizing and price. This is in accordance with the findings of Noer⁸ for underwear fabrics. However, there was no consistent increase in sizing with an increase in price. Cranor's and Dorsey's⁹ findings with toweling indicated similar results.

The sized fabrics quite consistently show a lower thread count than the unsized fabrics. This may be explained by the fact that sizing is often added to fabrics to make them appear more closely woven.

7. Cranor and Dorsey, op. cit., p. 256.

8. Noer, op. cit.

9. Cranor and Dorsey, op. cit., p. 258.

Tensile Strength.

The lack of relationship between tensile strength¹⁰ and price is in accordance with the findings of Farnum,¹¹ and Cranor and Dorsey.¹² Noer found that strength in cotton underwear fabrics tended to increase with the price of like fabrics but that this relationship did not exist when different types of fabrics were compared.

Since warp threads were stronger than filling threads in the same ginghams and since the warp threads also had higher counts and coarser yarns than the filling threads, these factors so combined may aid in giving a higher breaking strength to the warp threads. Cranor's¹³ and Dorsey's study showed that all the towelings were¹⁴ stronger in the warp than in the filling. Cook's study showed that eight of the nine sheetings were stronger in the warp than in the filling. Although the yarn numbers of the warps tended to be lower than those for the fillings neither the warp nor the filling yarn numbers increased or decreased proportionally to tensile strength.

10. Farnum, op. cit., p. 38.

11. Cranor and Dorsey, op. cit., p. 258.

12. Noer, op. cit.

13. Cranor and Dorsey, op. cit., p. 257.

14. Cook, The Scientific Determination of Reliability of the Consumer's Method of Buying, p.2.

(61)

The strength of fabrics does not seem to be wholly dependent upon the presence of sizing, for some fabrics with sizing and some without sizing showed close tensile strength values.

No relationship exists between the weight of the fabrics and their respective tensile strength values.

Summary of the Relationship Between Price, Width, Weight, Thread Count, Yarn Number, Twist, Sizing, and Tensile Strength of the Unlaundered Fabrics.

- (1) Tensile strength and thread count appear to be indirectly related to yarn number.
- (2) There appears to be an indirect relationship between sizing and price, also between sizing and thread count.
- (3) There appears to be a direct relationship between thread count and price.
- (4) Yarn number and weight tend to have a direct relationship in the fabrics of the lowest and the highest weights.
- (5) There is a tendency for yarn number and twist to show a direct relationship in both the warp and filling.

2. A Comparison of Home and Commercial Methods of Laundering Upon the Wearing Quality of Gingham and Similar Fabrics.

Shrinkage. (Table 6)

The tendency was (1) for fabrics laundered by home and commercial methods to shrink more in width than in length, (2) for the fabrics laundered by the commercial method to shrink less uniformly in both warp and filling than the fabrics laundered by the home method. The fabrics were ironed with the warp in both home and commercial methods which may explain the greater shrinkage in width than in length.

The greater pressure of the mangle exerted in the warp direction may explain the less uniform shrinkage of the materials laundered by the commercial method.

¹⁵
Cranor and Dorsey reported shrinkage to be only in
¹⁶
length, and McTavish reported it to be considerable in
length but almost negligible in width.

In all cases most of the shrinkage due to laundering by both the home and commercial methods took place within
¹⁷
the first five launderings. In Griffith's and Edgar's

15. Cranor and Dorsey, op. cit., p. 256.

16. McTavish, op. cit., p. 321.

17. Griffith and Edgar, op. cit., p. 113.

experiment with sheetings, shrinkage was practically complete after three launderings. In experimenting with
¹⁸overalls it was found that ninety-one per cent of the total shrinkage of the overalls laundered twenty times,
¹⁹was in the first laundering. Turnbull found little additional shrinkage in cotton goods after the first ten launderings. She suggested stretch, differences in time of drying, weaving or finishing processes as possible reasons for the variation in the time required for complete shrinkage.

Ten of the fabrics laundered by the home method showed no further shrinkage in warp when tested after the fifth laundering; fourteen showed no shrinkage in the filling when tested after the thirtieth laundering; over one-half of the fabrics laundered by the commercial method showed no further shrinkage in either direction when tested after the fifteenth laundering. This again may be explained by the differences in the two ironing processes in that the steam mangle may exert a more uniform pressure throughout than the electric iron. Fabrics of

18. Anonymous, Effect of Laundering Overalls, Textile World J., V. 71, p. 2032-2033.

19. Turnbull, The Effect of Certain Washing Powders Upon the Tensile Strength and Appearance of Cotton and Linen Fabrics. Thesis, Univ. of Chicago. 1924.

the same or of similar price when laundered by both methods appeared to have some uniformity of shrinkage in the warp direction.

In an experiment to determine the causes of shrinkage on overall fabrics, it was determined that shrinkage was independent of temperature and detergent used but dependent upon the fabric itself.²⁰ Shrinkage of the gingham in neither warp nor filling with the home or commercial method of laundering showed a consistent relationship to price and only showed a tendency for the expensive fabrics to shrink the least.²¹ McTavish found that the warp but not the filling of the fabric shrunk less with an increase in price.²² Noer also agreed that shrinkage was not so great, or was stationary with an increase in price. As the total shrinkage for sized fabrics was in excess of the total shrinkage for unsized fabrics for both methods, this indicates that sizing influences the amount of shrinkage in a fabric.²³ Cady's study confirmed this relationship and also showed that in general, shrinkage increased with the amount of sizing in a fabric.

20. Anonymous, Effect of Laundering Overalls, Textile World J., V. 71, p. 2032-2033.

21. McTavish, op. cit., p. 321.

22. Noer, op. cit.

23. Cady, op. cit.

Since shrinkage in width was greater than in length, the coarseness of the yarns may serve in part as an explanation of this.

The stretch of the fabrics, especially in the filling of fabrics laundered by the commercial method, may possibly be explained by the method of ironing. Since more cases of stretch of the fabrics were shown in the last fifteen launderings than in the preceding launderings, the fact that shrinkage was practically complete at this time may explain the stretch of the fabric.

Weight. (Table 6)

Since all fabrics with the exception of one which was laundered by the commercial method increased in weight when tested after forty-five launderings, it would seem that shrinkage had a direct bearing upon weight; also that sized fabrics shrink considerably since they showed a decided gain in weight even though the weight of the sizing had been lost in the laundering process.

Home laundered fabrics showed a greater increase in weight and in thread count, as well as more shrinkage in both the warp and the filling combined, than the fabrics laundered by the commercial method.

Thread Count. (Table 6)

There was an increase in threads in both directions by both laundering methods but the fabrics laundered by

the home method showed the greater increase in filling threads; the fabrics laundered by the commercial method showed the greater increase in warp. By the latter method thread count became stationary for the majority of fabrics between the sixteenth and thirtieth launderings, and by the home method the count became constant for the majority of cases between the fifth and the sixteenth launderings. There were cases in which thread count showed a decrease of one or two threads within intervals of testing which might be explained by the unevenness in stretch of the fabric in the ironing process.

Since there were more cases in which the home laundered fabrics shrunk more in the filling than in the warp but showed about the same number of increases in thread count in the warp as in the filling direction, there was a lack of proportional increase between thread count and shrinkage. For fabrics laundered by the commercial method there were more cases of greater shrinkage and of increased thread count in the warp than in the filling.

The increase in thread count with laundering showed no proportionate relationship to the decrease in the per cent of sizing in a fabric.

Tensile Strength. (Table 6)

The tendency was for more of the fabrics laundered forty-five times to show lower, rather than higher tensile strength values as compared with the values of the unlaundered fabrics. The warp values were higher in strength than the filling values but the differences in strength were not as great as when new. Of those that increased by both methods of laundering, a greater increase in strength was shown for the filling yarns than for the warp yarns.

Fabrics laundered by the commercial method were stronger in both warp and filling than those laundered by the home method and showed fewer decreases in both warp and filling strength. The time of run for a load, the proportion of water and load in relation to the capacity of the machine, the strain from the roller type of wringer or the attendant irregularities in ironing by the home method may explain the differences in strength values for home laundered fabrics. Faragher found that cotton threads were strengthened after a few launderings in a soap-alkali solution. Ebner found that soap as a deter-

24. Faragher, op. cit., p. 643.

25. Ebner, op. cit., p.3258.

gent slightly decreased the strength of cotton fibers.

The figures 1 to 18 inclusive show a tendency for home laundered fabrics to increase in both warp and filling strength after fifteen launderings as compared with their respective strengths after five launderings. Turnbull and Supple²⁶ found that a decided increase in the strength of longcloth occurred after the first washings whether a soap washing powder or a neutral soap was used. The maximum increase was reached after ten or twenty-five launderings. In forty to fifty launderings, the tensile strength decreased to approximately the original value, with one exception, in which a fabric washed with a washing powder as a detergent fell below the original strength.

26. Turnbull and Supple, op. cit., p. 387.

(69)

Figure 1.- Showing the Effect of Home and Commercial Laundering on the Tensile Strength of Fabric No.1.

Figure 2.- Showing the Effect of Home and Commercial Laundering on the Tensile Strength of Fabric No. 2.

Figure 3.- Showing the Effect of Home and Commercial Laundering on the Tensile Strength of Fabric No. 3.

Figure 4.- Showing the Effect of Home and Commercial Laundering on the Tensile Strength of Fabric No. 4.

Figure 5.- Showing the Effect of Home And Commercial Laundering on the Tensile Strength of Fabric No. 5.

Figure 6.- Showing the Effect of Home and Commercial Laundering on the Tensile Strength of Fabric No. 6.

(75)

Figure 7.- Showing the Effect of Home and Commercial Laundering on the Tensile Strength of Fabric No. 7.

Figure 8.- Showing the Effect of Home and Commercial Laundering on the Tensile Strength of Fabric No. 8.

Figure 9.- Showing the Effect of Home and Commercial Laundering on the Tensile Strength of Fabric No. 9.

Figure 10.- Showing the Effect of Home and Commercial Laundering on the Tensile Strength of Fabric No. 10.

Figure 11.- Showing the Effect of Home and Commercial Laundering on the Tensile Strength of Fabric No. 11.

Figure 12.- Showing the Effect of Home and Commercial Laundering on the Tensile Strength of Fabric No. 12.

Figure 13,- Showing the Effect of Home and Commercial Laundering on the Tensile Strength of Fabric No. 13.

Figure 14.- Showing the Effect of Home and Commercial Laundering on the Tensile Strength of Fabric No. 14.

(83)

Figure 15.- Showing the Effect of Home and Commercial Laundering on the Tensile Strength of Fabric NO. 15.

Figure 16.- Showing the Effect of Home and Commercial Laundering on the Tensile Strength of Fabric No. 16.

Figure 17.- Showing the Effect of Home and Commercial Laundering on the Tensile Strength of Fabric No. 17.

Figure 18.- Showing the Effect of Home and Commercial Laundering on the Tensile Strength of Fabric No. 18.

In this experiment the home laundered fabrics, especially in the filling, tended to increase sufficiently in tensile strength after fifteen launderings to show greater strength than when new. The five cheapest fabrics did not show this increase when laundered by the home or the commercial method.

27

Elledge reported an experiment in which a handkerchief was found to lose 0.18 per cent in strength per hour in ten gallons of cold water in a run of twenty-five hours.

28

In another experiment, the strength of fabrics laundered by the power laundry and the strength of fabrics laundered by a washerwoman showed little difference in the weakening of the fabrics by the methods used.

29

In a paper by Elledge, the following conclusion was given, "It should be understood that every process of laundering a fabric wherever or by whom it is done affects the life of the fabric to some extent. We have also shown that the process properly conducted in the power laundry conserves the life of the fabric equally as well as does the process employed by a good laundress."

Thread count in general had no effect upon tensile

27. Elledge, op. cit., p. 26-27.

28. Ibid. p. 27-28.

29. Elledge, Conservation of Textile Products, Textile World J., v. 52, p. 3403.

strength since all counts increased and many tensile strength values decreased or increased for like fabrics,³⁰

In an experiment with hospital sheetings Millard brought out the facts that the initial breaking strength of a sheeting is not an indication of its ability to withstand a series of launderings. For example, the strongest new sheeting gave a breaking strength of twenty pounds after 160 launderings while two sheetings of a lower initial strength broke at twenty-seven and twenty-five pounds respectively after a like number of launderings. The report also contained the following statement: "In this connection it is well to remember that the sizing should be washed from goods before making a test to determine initial strength." The experiment with gingham brought out such facts as Millard's experiment showed. The cheapest gingham which was heavily sized showed an initial breaking strength of forty-two pounds and after forty-five launderings, a strength of 29.4 pounds in contrast to the most expensive ginghams which had an initial breaking strength of 31.9 pounds and a strength of 33.7 pounds after forty-five launderings. The greatest decrease in tensile strength of the ginghams tended to be in the warp rather

30. What Laundry Tests Show About Sheetings, Mod. Hosp. V. 24, No. 4, p. 390.

than in the filling direction and the fabrics which were cheap or of medium price tended to show a greater decrease than the expensive ones. Therefore, this experiment appears to show that price is neither an indication of initial breaking strength nor of wearing quality, and that wearing quality of gingham and similar fabrics should not be predicted by the breaking strength of the unlaundered fabrics.

Summary of the Results of Home and Commercial Methods of Laundering on the Wearing Quality of Gingham and Similar Fabrics.

- (1) There seemed to be a direct relationship between shrinkage, thread count, and weight for fabrics laundered by both methods.
- (2) The fabrics laundered by the commercial method showed somewhat higher tensile strength values in more cases than the fabrics laundered by the home method.
- (3) There seemed to be no definite relationship between breaking strength and price.
- (4) A loss in tensile strength during laundering seemed to be dependent upon the amount of sizing present in the fabrics.
- (5) The greatest shrinkage in the fabrics proved to

(90)

be in the direction of the fabrics in which there were less threads to the inch, and the coarsest yarns.

3. A Comparison of Consumers' Judgment of the Wearing Quality of Gingham and Similar Fabrics With Laboratory Tests.

Ranking According to Laboratory Tests.

The ranks of the fabrics by the laboratory tests for wearing quality based on tensile strength showed no relationship with price.

Since the ranks based upon tensile strength, thread count, and weight, tended to be a little lower for the cheap fabrics and a little higher for the expensive fabrics than when the ranks were based only on tensile strength, and since only three fabrics showed like ranks by both methods, it is evident that the two methods cannot be used interchangeably.

Ranking According to Consumers' Judgment.

Since the judgment of the trained homemakers showed the least deviation from the composite rank, and the untrained homemakers showed the greatest deviation, it might be concluded that the judgment of the three intermediate groups, i. e., salespersons, students, and teachers, is more closely related to one another than the other groups.

The rank of the fabrics seemed to be but slightly influenced by a knowledge of price. (Table 9). Although a knowledge of price showed a direct relationship with the cheapest and the four most expensive fabrics, in most

(91a)
TABLE 9. SHOWING THE AVERAGE RANKS OF EIGHTEEN
GINGHAMS AND SIMILAR FABRICS JUDGED BY CONSUM-
ERS WITH AND WITHOUT PRICE INFORMATION.

Number of Fabric	Cost Per Unit of 1152 Square Inches	Average Ranks		
		With Cost	Without Cost	
1	0.17	15.69	15.50	
2	0.18	12.26	12.55	
3	0.19	13.11	12.76	
4	0.20	14.74	15.78	
5	0.20	12.11	11.03	
6	0.29	8.23	7.58	
7	0.35	10.96	10.55	
8	0.35	12.13	12.35	
9	0.39	11.87	10.22	
10	0.39	11.67	10.32	
11	0.45	10.43	11.13	
12	0.50	6.63	6.59	
13	0.50	3.59	3.72	
14	0.50	3.94	3.41	
15	0.52	7.30	8.39	
16	0.53	6.27	6.94	
17	0.79	5.80	7.00	
18	1.25	3.13	3.40	
	Total	169.86	169.22	

cases there was only a slight variation between the ranks given by the consumers who knew price and those who had no price information. The total of the ranks given by the consumers who knew the price was less than 0.5 per cent higher than the total of the ranks given by consumers who did not have price information.

A Comparison of Laboratory Ranking Based Upon Tensile Strength, with Consumers' Ranking.

Ranks of like fabrics based on laboratory tests and consumers' judgment differed in all cases. A fifty and a fifty-three cent fabric which ranked 6 and 5 respectively according to the consumers' judgment ranked 1.5 by laboratory tests; a thirty-five cent fabric which ranked 10 by the consumers' judgment ranked 18 by laboratory tests; and a fifty cent fabric which ranked 3 by the consumers' judgment ranked 17 by laboratory tests.

Ranks by various groups of consumers when compared with ranks given by laboratory tests indicated little correlation. A thirty-five cent fabric which was ranked 13 by the salespeople also ranked 13 by laboratory tests; a thirty-nine cent fabric which was ranked 15.5 by the students ranked 18 by laboratory tests; a seventy-nine cent fabric which was ranked 5 by both the untrained homemakers and students ranked 5 by laboratory tests.

Cook's comparison of consumers' and salespersons' judgment with laboratory tests for quality of sheetings showed little correlation between their judgment and laboratory tests as well as little correlation within groups.

Summary of the Relationship Between Consumers' Judgment and Laboratory Tests.

- (1) There appeared to be no definite relationship between price and the ranks of fabrics based on tensile strength.
- (2) Ranks based on tensile strength alone differed from those based on tensile strength, thread count, and weight in all but three cases.
- (3) There appeared to be a slight relationship between price and the ranks based on tensile strength, thread count, and weight.
- (4) There appeared to be no correlation between consumers' judgment and laboratory tests for wearing quality based on tensile strength.
- (5) Of the five groups of consumers, the rankings by the groups of homemakers with and without Home Economics training showed the least and the greatest deviation, respectively, from the com-

(94)

posite ranking by the consumers.

- (6) A knowledge of price influenced the ranks of the fabrics by consumers but slightly and seemed to be most significant for the cheapest and the four most expensive fabrics.

CONCLUSIONS

1. The wear on gingham and similar fabrics, as measured by tensile strength, is but slightly affected by forty-five launderings.
2. The commercial method of laundering decreases the wear on gingham, as measured by tensile strength after forty-five launderings, slightly less than the home method decreases the wear.
3. The durability of fabrics cannot be accurately predicted by tests on the unlaundered fabrics.
4. The most significant tests for durability cannot be determined until more experimentation has been carried out with a wide variety of fabrics tested after they have shown wear and these tests have been compared with tests on the unlaundered fabrics.
5. Further experimentation is needed to determine the best method of obtaining a single value for the tensile strength of fabrics from the strength values in warp and filling direction. To do this, tensile strength values obtained by several methods must be compared and the testing must be done at intervals from the time the fabrics are new until completely worn.
6. Consumers need more reliable methods for judging wearing quality of gingham and similar fabrics.

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UNIVERSITY OF MISSOURI
COLUMBIA

DEPARTMENT OF CHEMISTRY

July 25, 1928

Dean Walter Miller
Graduate School
University of Missouri

Dear Dean Miller:

I have read with considerable interest the dissertation of Miss Cleora E. Johnson submitted in partial fulfillment for the degree of Master of Arts. I may say at the outset that I consider this thesis fully up to the general standard which has been established here in the University for the Master degree. This study of Miss Johnson's is quite comprehensive in character; it involves long and painstaking experimentation; the results of her work are written up in full, the style is clear, and the language--with a few exceptions--is quite precise.

In the following paragraphs I venture to make a few suggestions in an entirely friendly way, which I hope, may provoke some discussion and perhaps lead to a few additions and minor changes in the thesis. I may say right here that perhaps a closer study of the thesis would reveal that some of the suggestions in my own mind are sufficiently well covered in the thesis. For example: on the first hasty reading of the thesis, in coming to page forty, I was struck with the following statement: "in all cases the weight of the fabric was greater after the forty-fifth laundering than it was when new". On first thought this struck me as somewhat extraordinary, for surely in a process of laundering there must be some loss in weight. A closer reading of the text reveals the fact that in this statement the term "the fabric" is used as applied to the cloth as a whole and not to the specific sample of fabric used in the laundering process. In this sense the statement is perfectly correct--the increase in weight being doubtless due largely to shrinkage of the fabric during laundering.

The comments on some of the tables I found somewhat wearisome reading. Why not omit some of these remarks, since the tables will speak for themselves and besides, these details may divert attention from the general discussion.

It seems to me that the principal short-coming of this thesis is the failure of the author to utilize the extensive experimental data obtained in making a more detailed and exhaustive analysis of the problem. The tabulated results offer a splendid opportunity for statistical analysis. Let me illustrate: On page eighty-nine, in the summary we read: "There seemed to be a direct relationship between shrinkage, thread count, and weight" etc. How close is this correlation? Let us select samples number 1, 5, 7, and 11 (random selections). After deducting weight of sizing carried by original sample, and then computing the weight from data given on shrinkage, we may construct a table like this:

	No. 1	No. 5	No. 7	No. 11
Weight calculated	4.29 oz.	3.72 oz.	2.66 oz.	3.54 oz.
Weight found	4.37 "	3.59 "	2.67 "	3.66 "

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(In making these calculations I counted the four corner squares marked in red twice, instead of once as should be done.) Similarly can the experimental data be combined to compute the change in tensile strength per single thread in warp and per thread in filling, as a unit.

Miscellaneous Items:

Page 11, line eight - use of word "materials" is questioned.

Page 15, last paragraph, and on page 16, first paragraph - Are these not digressions?

Page 17 - Metric weight honored once!

Page 17 - Why this extreme impartiality in the order of laundering the two loads?

Page 19 - In formula used to get the values for corrected tensile strength does "actual regained" refer to the moisture regained at the time tests were made?

The past tense is adhered to throughout, but it seems to me that the past tense is somewhat awkward at times. - "cost was reported" e. g.

Page 31 - Ranking of fabric based upon lowest value for tensile strength, seems to me rather arbitrary. Is this ranking based upon the principle that the weakest link in the chain determines its strength? Does the weakest fiber in the character of a person determine his general moral strength?

The word "this" finds rather wide use.

Page 53 - last column, table seven --- How were these values obtained?

Page 56 - I fail to see why width and cost are compared. Does not the author wish to emphasize in this statement that the thirty-two inch width has practically become the standard width for gingham?

Page 61 - Would the word "inverse" in place of "indirect" be an improvement?

It seems to me that some of the curves are superfluous and there seems to be considerable repetition in the trend of these curves. Would it not be of interest to substitute curves showing other relationships.

Page 92 - Comment is made on Table 91A to the effect that total ranking given by consumers who knew prices was less than .5% higher than the total of the rankings by consumers who did not have price information. Theoretically both should be the same and both columns should total up to 171 instead of 169.5. Both columns

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would total up to 171 -- the sum of the numbers from one to eighteen.

Hoping to receive an early reply, I remain

Yours with good wishes,

Herman Schlundt

Herman Schlundt

HS/BB

Film
Neg.
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M.A. THESIS

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