# THE EFFECT OF CERTAIN LAUNDRY SOAPS ON SELECTED DRESS GINGHAMS

by

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# INTRODUCTION

## Statement of the Problem

This problem was a study of the deterioriation in three chambray and three peter pan ginghams, as shown by the fading, shrinkage, and change in tensile strength, resulting from treatment with white laundry soaps at different temperatures and concentrations.

## Reasons for the Study

Since little usable information concerning the effect of laundry soaps on dress ginghams is available this investigation was made. To establish, if possible, some comparisons between types of white laundry soaps at varying temperatures and concentrations three of the most important factors - change in tensile strength, fading, and shrinkage - were studied. Oftentimes one is requested to recommend a type of soap suitable for laundry purposes, therefore, it was desired to determine some basis for choice from these experiments.

## REVIEW OF LITERATURE RELATING TO SUBJECT

When man began to wear clothing made from textiles the problem of cleaning these materials immediately arose. During the Middle Age soap was not used as a cleaning agent but lye was frequently mentioned by early writers (Johnson 1927). Reference is made to soap in the Old Testament (Jeremiah 2:22) however, the general belief at the present time is that ashes of plants and other purifying agents were used instead of soap as it is now known. Soap as a medicinal and as a cleaning agent was known to Pliny and he speaks of soap as a "Gallic invention used for giving a bright hue to the hair" (Encyclopedia Britannica, 11th edition).

Although soap has been known for many centuries, the laundering industry is of comparatively recent date. According to Johnson the first record of laundries is during the nineteenth century. Their establishment was prompted by an outbreak of cholera in London. The filthiest sections suffered most from the disease and to relieve the danger of further spread, Parliament appropriated public funds for the establishment of public laundries.

From the historical summary laundering as an industry in the United States is due to an entirely different cause. The invention of the detachable collar for men ushered in laundering as a commercial project in 1827. However, laundries as they are known today were not started until 1851. The gold rush to California increased the demand for some means of caring for men's clothing. For many years commercial laundering was confined to hotel and restaurant linens and men's clothing. It has been within the last thirty years that family washings have been done outside the home.

Laundering is satisfactory only when the laundering agent is efficient. The best work is done when the fabric is restored to its original state without change in color, appearance, or feel, with the greatest saving in time and materials (Bureau of Standards - Technological Paper,#273). Soap is accepted as the best detergent and is therefore, perhaps the most widely known laundering agent.

The first soap was made from goat's tallow and beech ashes. During the 13th century the manufacture of soap from olive oil was established at Marseilles, France. Developments in chemistry in the 19th century revolutionized the process of soap-making. Inasmuch as this is an informational study primarily for those interested in Clothing and Textiles a brief survey of the chemistry and methods involved in soap-making will lead to a clearer understanding of the reactions taking place.

At present soap is defined (Bureau of Standards, Circular #62) as the metallic salts of fatty acids. Fat is a general term used to include oil which is liquid at room temperature and fat which is solid under the same conditions. In chemical terms it is defined as a mixture of glycerides which yield glycerol and fatty acids upon hydrolysis (Morris 1922). Animal and vegetable fats are mixed esters or glycerides of higher fatty acids. The splitting of these esters by water to give alcohols and fatty acids is known as saponification and takes place in the making of soap. The fatty acids in turn are acted upon by alkalies as in the following reactions which are typical of all fatty acids when so treated:

$$\underset{\text{Stearin}}{(C_{17}H_{35}COO)_3C_3H_5} + 3HOH \longrightarrow \underset{\text{stearic acid}}{3C_{17}H_{35}COOH} + \underset{\text{glycerol}}{C_3H_5(OH)_3}$$

$$\underset{\text{stearic acid}}{C_{17}H_{35}COOH} + NaOH \longrightarrow \underset{\text{sodium stearate}}{C_{17}H_{35}COONa} + H_2O$$

If caustic potash is used in place of sodium hydroxide the reactions are similar, potassium salts being formed instead of sodium salts (Perkins and Kipping, 1911).

The alkali salts of the fatty acids are the only soaps soluble in water and are, therefore, the only ones used as cleansers. In addition to the alkali salts of fatty acids, soaps contain some water, a small amount of impurities and by-products of manufacture. Certain substances known as "builders" frequently enter into the composition of commercial soap. These "builders" are to give hardness to the soap and to make it more detergent when used with hard water. Some of the "builders" commonly used are sodium compounds - as carbonates, silicates, borates, and phosphates. Ground pumice stone, clay, starch, sand and volcanic ash aid mechanically in the cleaning process. Glycerol is often used for emollient purposes. Alcohol, glycerol, and sugar are used for transparency in cake soaps and to prevent foaming or cloudiness in liquid soap. In addition to the uses already mentioned "builders" prevent waste and increase efficiency by acting as water-softening agents especially when used with fabrics containing grease or when badly soiled (Bureau of Standards, Circular #62).

As is shown in the foregoing statements alkali, fat, and water are the essential elements in soap (Harap, 1924). The alkalies most commonly used are caustic soda and caustic potash. When caustic soda is boiled with fat a hard soap results which is very slightly soluble in water. It does not lather freely if made from tallow alone and is not a desirable laundry soap (Norris 1922). Caustic potash is used more extensively in making laundry soap than is caustic soda and produces what is known as a soft soap.

There are two methods of soap-making practiced in commercial manufacture. One is known as the hot process in which the fat is boiled with the alkali until saponification is 90-95 per cent completed. Salt is added to the hot mixture causing the soap to go out of solution and float on top as a curdy mass. This product is called "curd" soap. The salt solution containing glycerol, excess alkali and other impurities settles and is drawn off. Water and caustic alkali are added to the curd. The impurities and soap are again separated by "graining out" with salt. This procedure is continued until saponification is complete. The soap is then thinned with water and boiled to a uniform consistency. After settling for several days the upper portion is pumped off, mixed with the "building" materials, put in frames to cool, cut into cakes, stamped, wrapped and packed for distribution. The hot process provides for complete saponification, separation of impurities from soap, and a lower water content (Bureau of Standards, Circular #62). If salt is not added the jelly-like mass cools containing all the impurities of manufacture and is known as "soft" soap (Perkin and Kipping, 1911).

The second process used in commercial manufacture of soaps is known as the cold process. An aqueous solution of alkali sufficient to saponify the fat is mixed thoroughly with the liquid fat. The mixture is heated somewhat to start the saponification, but when once started sufficient heat is generated by the reaction to carry it to completion. Several days are required to completely hydrolyze the fat and then the soap contains all the impurities originally in the ingredients. There may be free caustic alkali or free fatty matter in the soap and unless used immediately it may become rancid and turn yellow (Norris, 1922).

Since the establishment of commercial laundries much experimental research work has been done by the Laundry-owners National Association. Credit for the following standard information used in washroom practice is due this association. The fact that bundles of clothes vary in the amount of dirt they contain necessitates a careful sorting of garments before washing. If all bundles were put through the same number of suds baths some would come out clean while others would be only partially cleaned. For the laundryman to return the garments that are poorly laundered would mean dissatisfaction on the part of the customer and would be detrimental to growth in business.

In all laundry work the character of the water and detergents used is of prime importance. Because of the water softening plants in connection with commercial laundries the water used is essentially the same as distilled water. The detergents most universally used are soda ash and dry neutral soap powder. For water of "zero" grains of hardness two parts of soap powder are used to one of soda ash. For water of greater hardness the amount of soda ash is increased accordingly, up to three parts of soda ash to two parts of soap.

The temperature of the wash water is an item for consideration. As a rule the first bath is cooler than the subsequent ones. Some animal matter is coagulated at a temperature of 130°-140°F. Since many stains on household and personal linens are of an albuminous nature it is better to avoid too high a temperature at first and as warm water is more effective than cold in removal of soil the moderate temperature of 100°F has been chosen as the optimum for the first bath. The temperature of the second and third baths may be higher since the dirt has been loosened from the fabric in the first bath. The temperature for these baths and the first three rinses is 140°-160°F. The following rinses are increasingly cooler until the last one which is cold.

Until rather recently two suds formulas were recommended, largely because of common practice; however, it is now considered better to use three suds instead of two for unusually soiled bundles and four if the clothes are extremely soiled. It requires very little more soap and soda ash for the three suds than it does for two and the results are far better. In addition to using an extra suds for extremely soiled bundles the temperature of the water for the second and third bath is raised to 190°-200°F.

Laundry practice varies according to the form of soap used - some make up a solution of soap using sixteen pounds of soap powder and eight pounds of soda ash to one hundred gallons of water. This practice provides a solution ready for use but necessitating large amount of storage space. Another difficulty is that it is next to impossible to close a faucet through which a hot soap solution runs tightly enough to prevent leaking. The addition of the dry mixture to the wash wheel has the distinct advantage of being less bulky and it can be stored near the wheels thus encouraging the operator to use small quantities as needed. Regardless of the form in which the soap mixture is stored a sufficient quantity should be used to produce a good "running" suds. This is understood to mean a suds that will form a cushion of about six inches on top of the goods, immediately after stopping the machine. By adding small amounts of the detergent mixture to the third and fourth baths the soap concentration may be kept sufficiently high to hold the dirt in suspension.

Since satisfactory rinsing is possible only when the dirt is held very loosely in the fabric it is readily understood that the addition of proper amounts of soap is important. Frequently rinsing is considered of minor importance in the process of washing clothes; however, this is a mistake as the whole laundry procedure is a series of rinsings. The soap and soda ash act as carriers for the dirt as it is loosened from the fabric; consequently if an insufficient amount of these ingredients is used some dirt remains in the cloth and satisfactory rinsing is impossible causing the laundered fabric to have a gray appearance.

One argument advanced against power laundries is that their output cannot be sanitary since bundles from all environments are sorted, mixed, and washed together. However, the danger of contamination in power laundries is far less than in private hand laundries. The conditions maintained in a power laundry are not favorable to bacterial growth. Experiments have proved that the thermal death point of most pathogenic non-spore-bearing bacteria lies between 130°-140°F when maintained for five to twenty minutes. The temperature and running time for the wash wheels exceed that necessary to kill these bacteria. Soap solutions have a germicidal effect upon bacteria at a temperature of 104°-120°F. In addition to the bactericidal value of the soap and water, Javel water is used as the bleaching liquor. This solution contains the same oxidizing agent (sodium hypochlorite) as the Carrol-Dakin antiseptic which was used so extensively and effectively in treating wounds during the War. Moreover, the temperatures of the drying rooms and ironers are sufficiently high to kill any remaining organisms. The above statements backed by scientific investigation should be sufficient to substantiate the conclusion that power laundries afford more sanitary protection to the customer than the home laundress who takes in washings (Manual of Standard Practice for the Power-Laundry Washroom, 1927).

In the so called "wet wash" the laundry procedure is the same as when clothes are dried at the laundry, except that they are not subjected to the high temperatures of drying. As a result all the bacteria may not have been killed by the suds baths and rinsings. The garments are returned in a condition favorable to bacterial growth and thus the customer has less protection than when the articles go through the drying rooms and ironers.

Methods for commercial laundries can be formulated only as a result of detailed experiment. Many factors have great importance when laundering is done on a large scale that are of minor consideration in home manipulation. The housewife has only the personal and household linens of her family with which to deal; she is able to sort the clothes according to color and amount of soil; and furthermore, she knows the type of stains and can treat them before washing. For home practice, experience tells the laundress how much soap and water to use and these ingredients can be varied easily to meet any situation. Smaller quantities of clothing are washed at one time which enables more careful supervision. Then too, there is a personal interest in the articles laundered at home which makes for more careful manipulation whereas, in the power laundry one article is the same as any other to the operator.

In the average home laundry the neutral soap powder and soda ash are replaced by soaps of one kind or another. Definite requirements for laundry soap are set up by the United States Government. The general specifications for ordinary laundry soap state that the soap must be made of soda and fats, with no excessive amount of rosin and only a moderate amount of matter insoluble in alcohol, furthermore, it must be free from objectionable odor or substances to add weight and must be suitable for use in moderately hard water (U. S. Bureau of Standards, Circular #129). It is readily seen that by using a cake soap measuring up to these standards, the housewife has essentially the same compounds in her detergent that the power laundry has to have regulated very carefully by a formula.

## INVESTIGATION

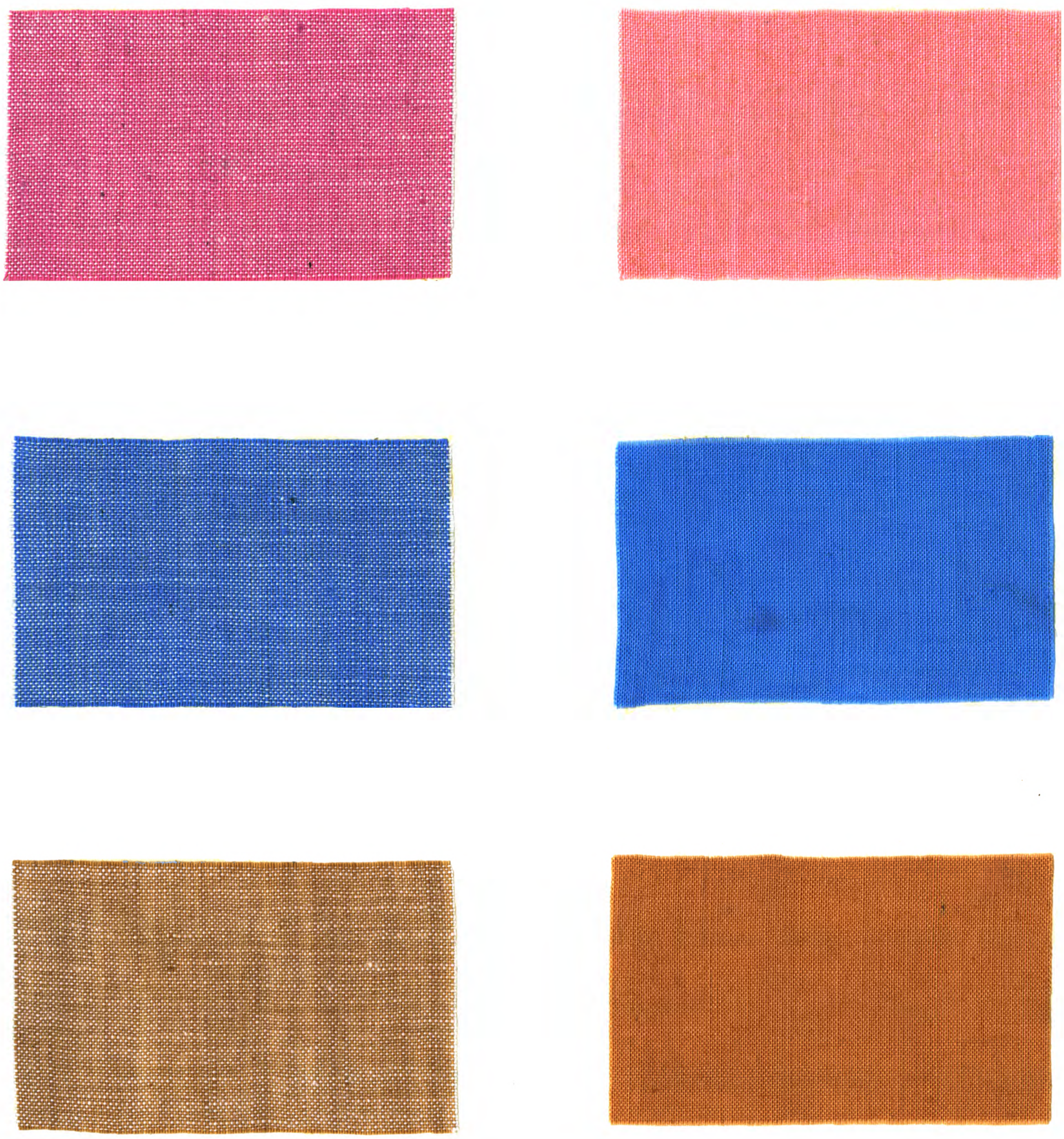
### Selection of Materials

The two most important materials to be considered in this piece of work were the soaps and the fabrics. Because of the great number of tests to be made, before making definite statements or drawing conclusions, it was necessary to limit the number and kind of fabrics to be studied. Those chosen were two types of materials suitable for house dresses and children's play clothes, Table I. Color and quality were factors used as a basis for the selection of the fabrics. Since pink, blue, and tan seemed to be the colors most nearly of the same intensity in each case, those were used. In every instance the chambray appeared to be a lighter hue; however, if the dyed yarns in the two classes of fabrics were matched very little differ-

Table I. Fabrics Used in this Study.

Chambray Ginghams

Peter Pan Ginghams



ence in color was noticeable. In addition to matching the colors in the two types of ginghams it was desirable to have the number of picks and ends per inch comparable in the three pieces of each type. The selection of the fabrics purchased was based on the above requirements. For their analysis the methods of Posselt and Herzfeld were followed (See Tables II - III).

The soaps used in this study were the three white laundry soaps having the largest sale (based on the rapidity of turnover) in five grocery stores in various sections of Manhattan, Kansas. Upon investigation these proved to be representative of three types of cake soaps - a pure soap, a naphtha soap, and a filled soap. Partial analysis of the soaps including tests for moisture and volatile matter, total alkali, combined alkali, free caustic alkali, free sodium carbonate, total fatty matter, chlorides, and silicates was made (Griffin, 1921).

From the analysis it was seen that the free sodium carbonate content in the three soaps varied from 0.56% to 10.32%. In the naphtha soap the moisture and volatile matter was much higher than in the other soaps. This might be attributed to the fact that naphtha is volatile and also to the sodium silicate which has a great affinity for water.

| Tests | Pink Chambray Picks | Pink Chambray Ends | Blue Chambray Picks | Blue Chambray Ends | Tan Chambray Picks | Tan Chambray Ends |
|---|---|---|---|---|---|---|
| Yarns per inch | 62 | 79 | 65 | 78 | 64 | 77 |
| Yarn size | 1/34S | 1/28S | 1/36S | 1/28S | 1/34S | 1/28S |
| Twists per inch | 25.6 | 28.1 | 27.8 | 26.6 | 26.6 | 24.6 |
| Tensile strength of yarns | 24.33 | 50.5 | 23.57 | 43.48 | 25.89 | 41.23 |
| Tensile strength of fabrics | 28.4 | 51.66 | 27.63 | 50.2 | 29.84 | 45.77 |
| Width and cost per yd. | 30 inch @ 25¢ | | 30 inch @ 35¢ | | 30 inch @ 35¢ | |
| Wt. in grams per sq. yd. 65% humidity at 70°F. | 101.5934 | | 90.3936 | | 99.4819 | |
| Per cent of sizing | 3.67 | | 2.92 | | 4.27 | |

Table II. Fabric Analysis of Chambray Ginghams.

| Tests | Pink Peter Pan | | Blue Peter Pan | | Tan Peter Pan | |
|---|---|---|---|---|---|---|
| | Picks | Ends | Picks | Ends | Picks | Ends |
| Yarns per inch | 76 | 85 | 88 | 98 | 87 | 98 |
| Yarn size | 1/40S | 1/38S | 1/56S | 1/62S | 1/56S | 1/56S |
| Twists per inch | 15.6 | 30.1 | 19.8 | 33.1 | 17 | 28.6 |
| Tensile strength of yarns in pounds | 18.48 | 39.27 | 19.76 | 30.64 | 17.05 | 33.53 |
| Tensile strength of fabrics in pounds | 32.18 | 43.89 | 35.47 | 38.66 | 26.63 | 38.56 |
| Width and cost per yd. | 31 inch @ 50¢ | | 35 inch @ 58¢ | | 35 inch @ 58¢ | |
| Wt. in grams per sq. yd. 65% humidity at 70°F. | 87.5188 | | 69.2732 | | 71.8891 | |
| Per cent of sizing | .31 | | .22 | | 1.66 | |

Table III. Fabric Analysis of Peter Pan Ginghams.

# PROCEDURE

After the materials had been selected and analyzed a definite procedure for the experimental work had to be established. It was somewhat difficult to set an arbitrary concentration and temperature for the soap solutions. Johnson (1927) in his experimental laundry work in colored fabrics used temperatures ranging from 30°- 100°C. In common practice one does not boil colored articles, consequently the temperatures of 30°C and 70°C were decided upon. "Average soap concentration in power laundries usually fall within the limit of 0.12% to 0.15%. The American Association of Textile Chemists and Colorists recommends a concentration of .5%" (Personal communication from Johnson). With these two facts in mind the logical concentrations of soap to use for comparison were either the two higher ones - 0.15% and 1% - or the two lower ones - 0.12% and 0.5%. Considering the laboratory facilities at hand, the two lower concentrations were chosen and used throughout this study. A treatment of thirty minutes at these temperatures and concentrations seemed to be a satisfactory time and all tests were made accordingly.

In the preparation of the soap solution the cake of soap was shaved into very thin strips and thoroughly mixed. Portions were weighed from this mixture and made up to the desired concentration with distilled water.

The fabrics to be tested were cut into strips fourteen by seven inches. After treatment with the soaps, specimens were prepared by the strip method for the testing of the tensile strength.

The washing was done by bringing 600 cc. of the soap solution to the desired temperature and immersing the piece of fabric in it. The temperature was maintained for thirty minutes. During the last five minutes the fabric was swished vigorously, then squeezed out, and rinsed through three clear waters of the same temperature. Each piece was squeezed out of each water before putting into another. After the last rinsing the strip was spread out and allowed to become sufficiently dry for ironing. The pieces were pressed parallel to the warp threads with a moderately hot iron. This method of ironing was employed so as to maintain a uniform method and to keep the stretch in pressing as nearly the same for all pieces as possible.

To determine whether any fading had resulted the method used by Johnson was modified to some extent. A piece of white cloth was washed in the suds bath with the colored material. In practically all cases the fading was so slight that the white cloth was not discolored although it was evident some color had been lost because of the discoloration in the water. Another method for testing color was devised. The washing waters were saved in clear glass bottles and matched with a bottle containing a similar soap solution through which no fabric had been washed.

The laundered samples fourteen by seven inches in size were cut into narrow strips in such a manner as to give five pieces with the warp threads running lengthwise and five pieces with the filling running lengthwise. To test the same number of yarns before and after treatment the specimens were ravelled to the exact number contained in the original fabric per inch. From the change in the number of yarns per inch it was possible to determine the shrinkage resulting from the various treatments (See Tables IV - V). To show whether the soap was entirely responsible for the total shrinkage, pieces of the fabric were treated with distilled water of the same temperatures and for the same length of time as used for the suds baths. From these results it was decided that the soap treatments were not solely responsible for the shrinkage.

The strips used in calculating the shrinkage were con-

| Treatments | Pink Chambray Warp | Pink Chambray Filling | Blue Chambray Warp | Blue Chambray Filling | Tan Chambray Warp | Tan Chambray Filling |
|---|---|---|---|---|---|---|
| Distilled Water at 30°C | 6.45 | 0 | 4.30 | 0.10 | 6.56 | 2.47 |
| Distilled Water at 70°C | 5.49 | 0 | 4.61 | 1.79 | 4.84 | 0.10 |
| 0.12% Soap Solution at 30°C | | | | | | |
| Soap Number 1 | 5.80 | -0.5 | 2.77 | 2.05 | 7.81 | 3.89 |
| Soap Number 2 | 4.83 | 1.26 | 4.61 | 3.84 | 6.26 | 3.89 |
| Soap Number 3 | 5.45 | 0.25 | 3.07 | 2.05 | 2.50 | 3.63 |
| 0.12% Soap Solution at 70°C | | | | | | |
| Soap Number 1 | 4.83 | 0.76 | 6.15 | 4.10 | 6.87 | 3.63 |
| Soap Number 2 | 8.71 | 0 | 4.00 | 2.56 | 5.62 | 4.26 |
| Soap Number 3 | 5.16 | 1.77 | 4.00 | 3.84 | 7.18 | 2.59 |
| 0.5% Soap Solution at 30°C | | | | | | |
| Soap Number 1 | 3.54 | 0.25 | 5.54 | 1.79 | 7.19 | 2.85 |
| Soap Number 2 | 4.19 | 0 | 3.38 | 1.79 | 5.31 | 1.55 |
| Soap Number 3 | 4.83 | 0.63 | 4.30 | 2.30 | 6.25 | 4.67 |
| 0.5% Soap Solution at 70°C | | | | | | |
| Soap Number 1 | 4.19 | 0.50 | 6.15 | 3.33 | 5.93 | 3.63 |
| Soap Number 2 | 7.41 | 0.25 | 7.15 | 4.10 | 10.31 | 3.37 |
| Soap Number 3 | 5.16 | 1.52 | 4.00 | 3.84 | 7.19 | 2.59 |

Table IV. Showing Percentage of Shrinkage in Chambray Ginghams, due to Various Treatments, based on Yarn Count per Inch.

| Treatments | Pink Peter Pan | | Blue Peter Pan | | Tan Peter Pan | |
|---|---|---|---|---|---|---|
| | Warp | Filling | Warp | Filling | Warp | Filling |
| Distilled Water at 30°C | 1.84 | 1.17 | 6.66 | 3.06 | -1.16 | 1.63 |
| Distilled Water at 70°C | 2.39 | 2.35 | 1.59 | 3.87 | 1.15 | 2.85 |
| 0.12% Soap Solution at 30°C: | | | | | | |
| Soap Number 1 | 2.37 | 3.53 | 7.04 | 9.57 | 1.38 | 4.69 |
| Soap Number 2 | 3.15 | 2.35 | 6.81 | 4.08 | -1.15 | 3.67 |
| Soap Number 3 | 0.78 | 4.00 | 5.00 | 5.10 | 0.45 | 2.85 |
| 0.12% Soap Solution at 70°C: | | | | | | |
| Soap Number 1 | 1.52 | 4.23 | 3.18 | 5.10 | 1.15 | 3.46 |
| Soap Number 2 | 0.26 | 3.53 | 7.27 | 5.61 | -0.45 | 4.28 |
| Soap Number 3 | 1.31 | 2.58 | 4.88 | 3.87 | 1.38 | 3.26 |
| 0.5% Soap Solution at 30°C: | | | | | | |
| Soap Number 1 | 3.94 | 2.35 | 4.09 | 5.10 | 1.15 | 1.42 |
| Soap Number 2 | 1.31 | 3.40 | 7.95 | 5.86 | 1.72 | 3.73 |
| Soap Number 3 | 1.58 | 1.76 | 3.41 | 4.28 | 0.22 | 3.67 |
| 0.5% Soap Solution at 70°C: | | | | | | |
| Soap Number 1 | 3.94 | 4.70 | 5.68 | 4.08 | 1.84 | 4.49 |
| Soap Number 2 | 2.63 | 3.40 | 6.81 | 4.08 | 1.15 | 4.08 |
| Soap Number 3 | 1.31 | 2.35 | 4.09 | 3.46 | 0.68 | 1.83 |

Table V. Showing Percentage of Shrinkage in Peter Pan Ginghams, due to Various Treatments, based on Yarn Count per Inch.

ditioned in moving air for two hours and then broken on the Scott Tester. The percentage of moisture regained by the fabrics in room air was obtained by weighing them air dry and then after drying to constant weight. With the percentage of regain determined all the breaking strengths were corrected to standard conditions of 65% humidity at $70^{o}F$, according to American Society Testing Materials (1925). Thus corrected, the breaking strengths were all comparable and definite comparisons between the original fabrics as to the effects of distilled water, and the soaps could be observed. Tables VI - XI show the comparison of the treatments on the fabrics.

Table VI. Showing the Effect of Laundry Soaps at Different Temperatures and Concentrations on the Tensile Strength of Pink Chambray Gingham.

| | Breaking Strength in Pounds Warp | Breaking Strength in Pounds Filling |
|---|---|---|
| Original Fabric | 51.66 | 28.40 |
| Distilled Water at 30°C | 59.24 | 39.08 |
| Distilled Water at 70°C | 58.23 | 38.82 |
| 0.12% Soap Solution at 30°C | | |
| Soap Number 1 | 38.44 | 28.90 |
| Soap Number 2 | 43.10 | 24.13 |
| Soap Number 3 | 41.92 | 25.13 |
| 0.12% Soap Solution at 70°C | | |
| Soap Number 1 | 48.33 | 27.55 |
| Soap Number 2 | 40.83 | 27.01 |
| Soap Number 3 | 41.90 | 24.14 |
| 0.5% Soap Solution at 30°C | | |
| Soap Number 1 | 36.00 | 22.44 |
| Soap Number 2 | 41.58 | 27.41 |
| Soap Number 3 | 43.06 | 32.36 |
| 0.5% Soap Solution at 70°C | | |
| Soap Number 1 | 41.87 | 22.82 |
| Soap Number 2 | 47.02 | 30.50 |
| Soap Number 3 | 44.59 | 26.91 |

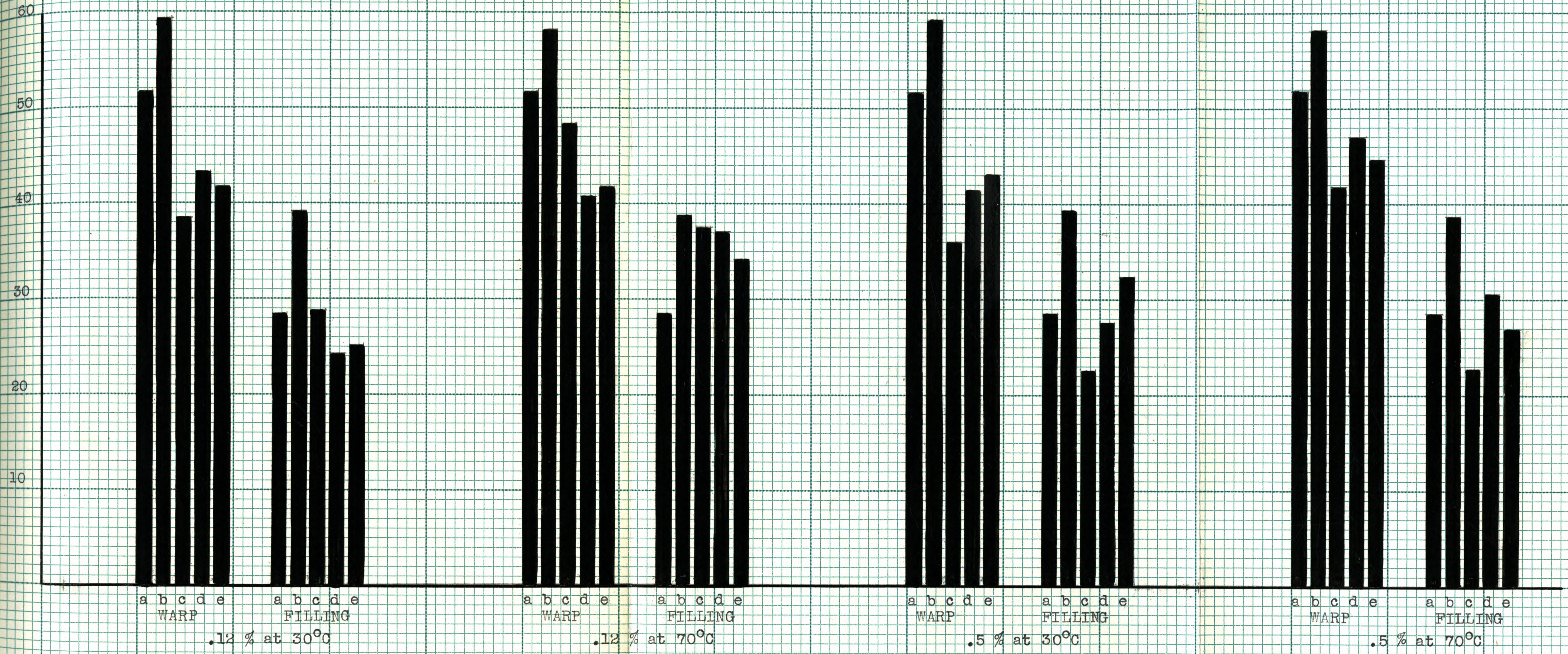



FIGURE 1. SHOWING THE EFFECT OF LAUNDRY SOAPS AT DIFFERENT TEMPERATURES AND CONCENTRATIONS ON THE TENSILE STRENGTH OF PINK CHAMBRAY GINGHAM

a. Original Fabric b. Distilled water c. Soap Number 1 d. Soap Number 2 e. Soap Number 3

Table VII. Showing the Effect of Laundry Soaps at Different Temperatures and Concentrations on the Tensile Strength of Blue Chambray Gingham.

| | Breaking Strength in Pounds Warp | Filling |
|---|---|---|
| Original Fabric | 50.20 | 27.63 |
| Distilled Water at 30°C | 54.32 | 34.11 |
| Distilled Water at 70°C | 51.49 | 34.89 |
| 0.12% Soap Solution at 30°C | | |
| Soap Number 1 | 37.95 | 26.63 |
| Soap Number 2 | 37.22 | 26.03 |
| Soap Number 3 | 34.86 | 24.38 |
| 0.12% Soap Solution at 70°C | | |
| Soap Number 1 | 39.48 | 26.99 |
| Soap Number 2 | 41.08 | 28.00 |
| Soap Number 3 | 40.11 | 24.56 |
| 0.5% Soap Solution at 30°C | | |
| Soap Number 1 | 31.94 | 23.71 |
| Soap Number 2 | 37.90 | 27.16 |
| Soap Number 3 | 36.48 | 24.15 |
| 0.5% Soap Solution at 70°C | | |
| Soap Number 1 | 40.61 | 25.92 |
| Soap Number 2 | 41.08 | 30.03 |
| Soap Number 3 | 36.78 | 28.20 |

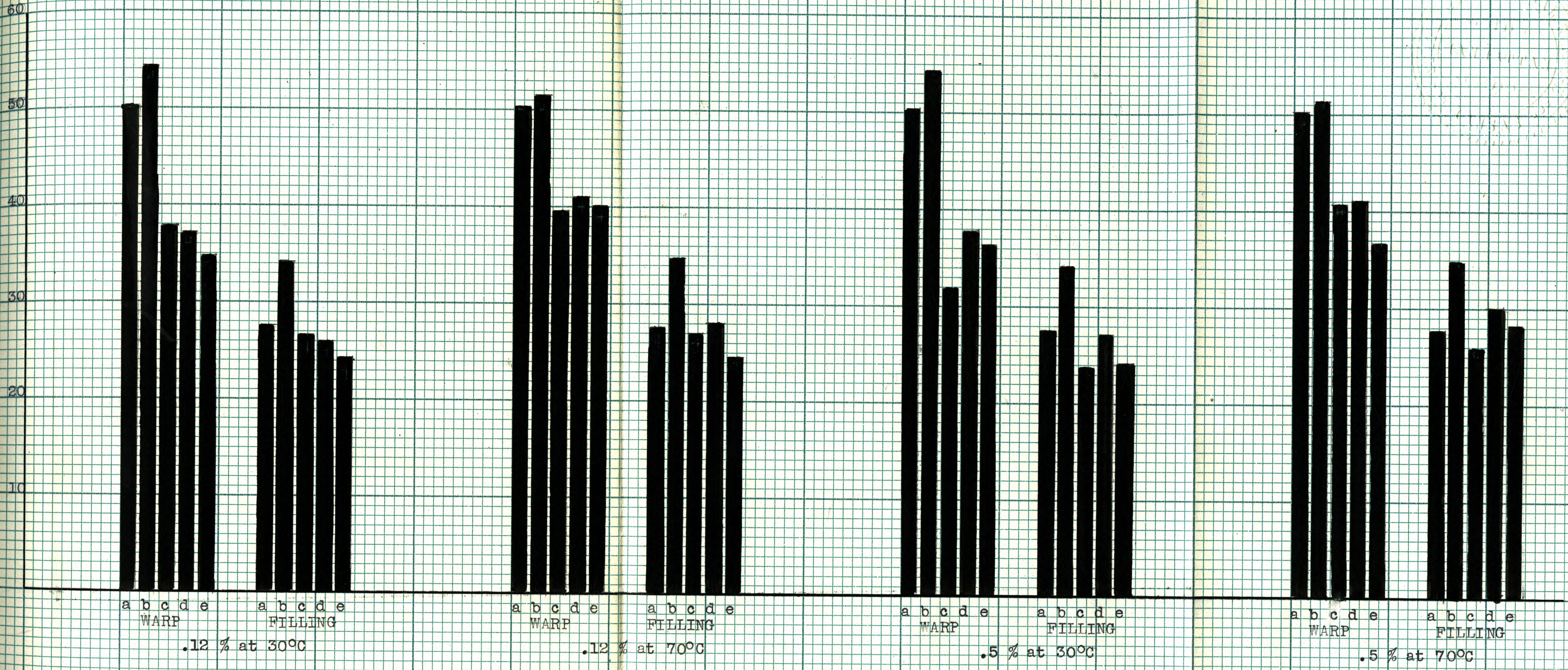



FIGURE 2. SHOWING THE EFFECT OF LAUNDRY SOAPS AT DIFFERENT TEMPERATURES AND CONCENTRATIONS ON THE TENSILE STRENGTH OF BLUE CHAMBRAH GINGHAM

a. Original Fabric b. Distilled water c. Soap Number 1 d. Soap Number 2 e. Soap Number 3

Table VIII. Showing the Effect of Laundry Soaps at Different Temperatures and Concentrations on the Tensile Strength of Tan Chambray Gingham.

| | Breaking Strength in Pounds | |
|---|---|---|
| | Warp | Filling |
| Original Fabric | 45.77 | 29.84 |
| Distilled Water at 30°C | 49.59 | 28.64 |
| Distilled Water at 70°C | 49.22 | 36.39 |
| 0.12% Soap Solution at 30°C | | |
| Soap Number 1 | 28.97 | 22.84 |
| Soap Number 2 | 33.41 | 27.10 |
| Soap Number 3 | 30.68 | 25.68 |
| 0.12% Soap Solution at 70°C | | |
| Soap Number 1 | 36.17 | 28.12 |
| Soap Number 2 | 35.99 | 27.39 |
| Soap Number 3 | 32.00 | 25.65 |
| 0.5% Soap Solution at 30°C | | |
| Soap Number 1 | 30.58 | 25.93 |
| Soap Number 2 | 31.34 | 24.04 |
| Soap Number 3 | 32.41 | 25.46 |
| 0.5% Soap Solution at 70°C | | |
| Soap Number 1 | 33.80 | 27.05 |
| Soap Number 2 | 39.57 | 29.21 |
| Soap Number 3 | 36.92 | 27.17 |

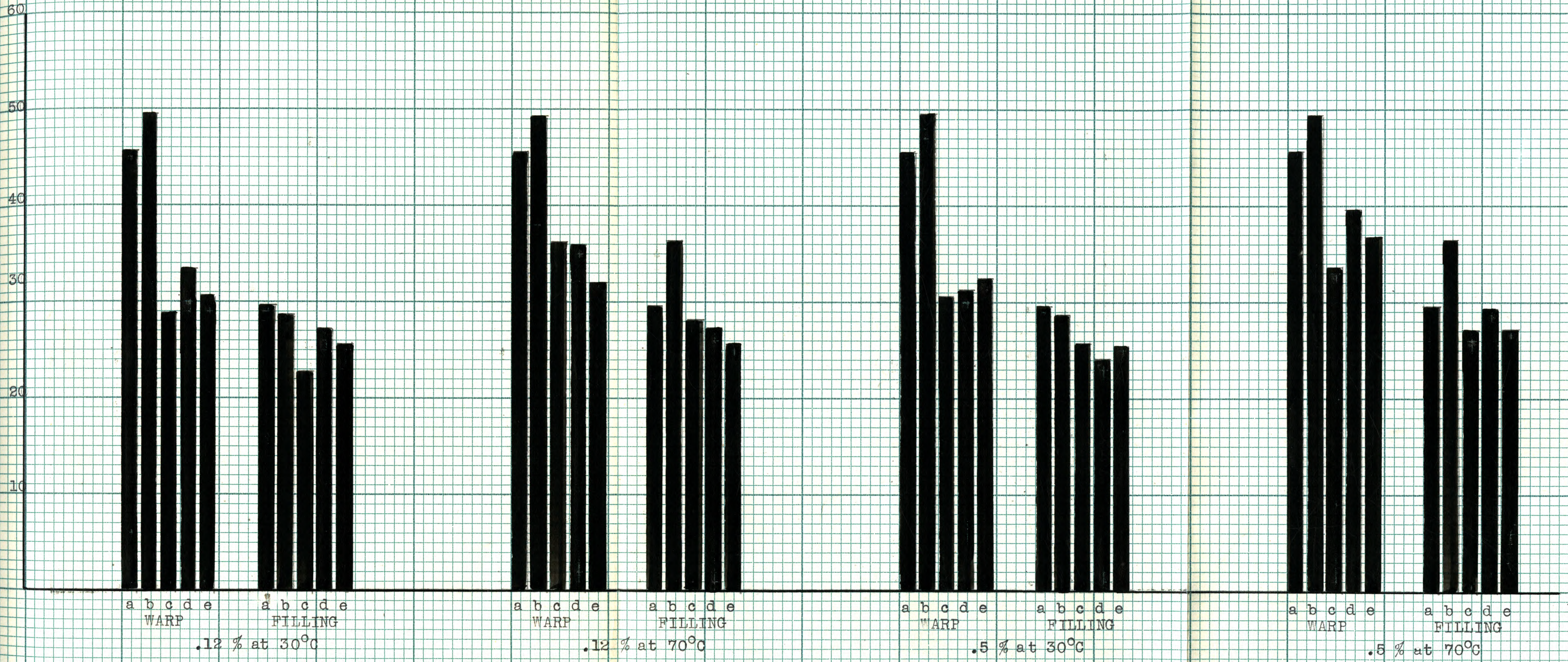



FIGURE 3. SHOWING THE EFFECT OF LAUNDRY SOAPS AT DIFFERENT TEMPERATURESAND CONCENTRATIONS ON THE TENSILE STRENGTH OF TAN CHAMBRAY GINGHAM

a. Original Fabric  b. Distilled Water  c. Soap Number 1  d. Soap Number 2  e. Soap Number 3

Table IX. Showing the Effect of Laundry Soaps at Different Temperatures and Concentrations on the Tensile Strength of Pink Peter Pan Gingham.

| | Breaking Strength in Pounds Warp | Filling |
|---|---|---|
| Original Fabric | 43.89 | 32.18 |
| Distilled Water at 30°C | 53.81 | 37.12 |
| Distilled Water at 70°C | 52.36 | 38.46 |
| 0.12% Soap Solution at 30°C | | |
| Soap Number 1 | 44.84 | 36.10 |
| Soap Number 2 | 42.02 | 33.83 |
| Soap Number 3 | 41.27 | 31.77 |
| 0.12% Soap Solution at 70°C | | |
| Soap Number 1 | 43.55 | 29.16 |
| Soap Number 2 | 37.30 | 32.66 |
| Soap Number 3 | 42.78 | 32.79 |
| 0.5% Soap Solution at 30°C | | |
| Soap Number 1 | 43.83 | 36.25 |
| Soap Number 2 | 39.20 | 31.60 |
| Soap Number 3 | 42.90 | 30.63 |
| 0.5% Soap Solution at 70°C | | |
| Soap Number 1 | 44.63 | 35.27 |
| Soap Number 2 | 44.31 | 36.80 |
| Soap Number 3 | 44.86 | 34.80 |

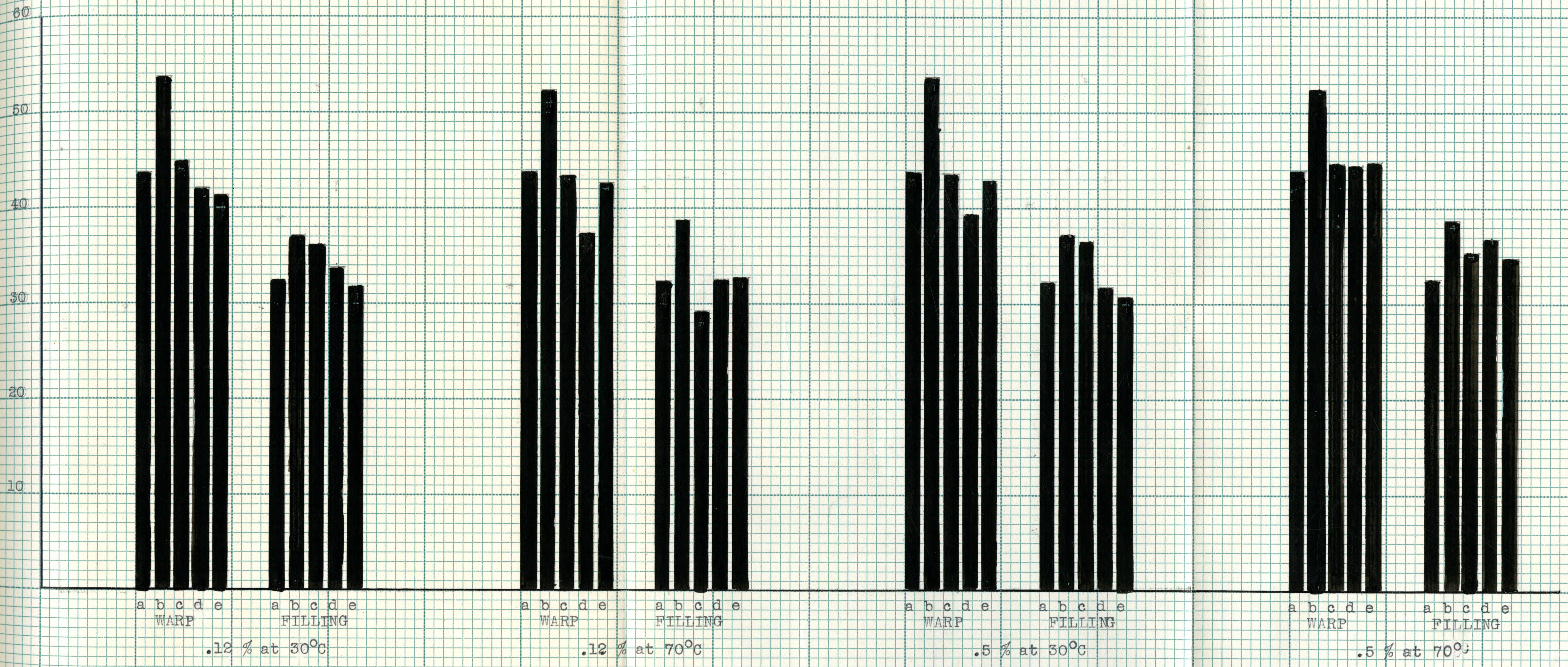



FIGURE 4. SHOWING THE EFFECT OF LAUNDRY SOAPS AT DIFFERENT TEMPERATURES AND CONCENTRATIONS ON THE TENSILE STRENGTH OF PINK PETER PAN GINGHAM

a. Original Fabric b. Distilled water c. Soap Number 1 d. Soap Number 2 e. Soap Number 3

Table X. Showing the Effect of Laundry Soaps at Different Temperatures and Concentrations on the Tensile Strength of Blue Peter Pan Gingham.

| | Breaking Strength in Pounds Warp | Filling |
|---|---|---|
| Original Fabric | 38.66 | 35.47 |
| Distilled Water at 30°C | 41.80 | 37.80 |
| Distilled Water at 70°C | 45.24 | 35.59 |
| 0.12% Soap Solution at 30°C | | |
| Soap Number 1 | 36.90 | 34.60 |
| Soap Number 2 | 36.47 | 34.12 |
| Soap Number 3 | 36.50 | 25.64 |
| 0.12% Soap Solution at 70°C | | |
| Soap Number 1 | 36.00 | 32.84 |
| Soap Number 2 | 33.70 | 33.00 |
| Soap Number 3 | 35.34 | 32.55 |
| 0.5% Soap Solution at 30°C | | |
| Soap Number 1 | 34.36 | 27.17 |
| Soap Number 2 | 34.76 | 24.80 |
| Soap Number 3 | 36.90 | 31.90 |
| 0.5% Soap Solution at 70°C | | |
| Soap Number 1 | 44.67 | 30.58 |
| Soap Number 2 | 36.00 | 35.65 |
| Soap Number 3 | 38.96 | 36.44 |

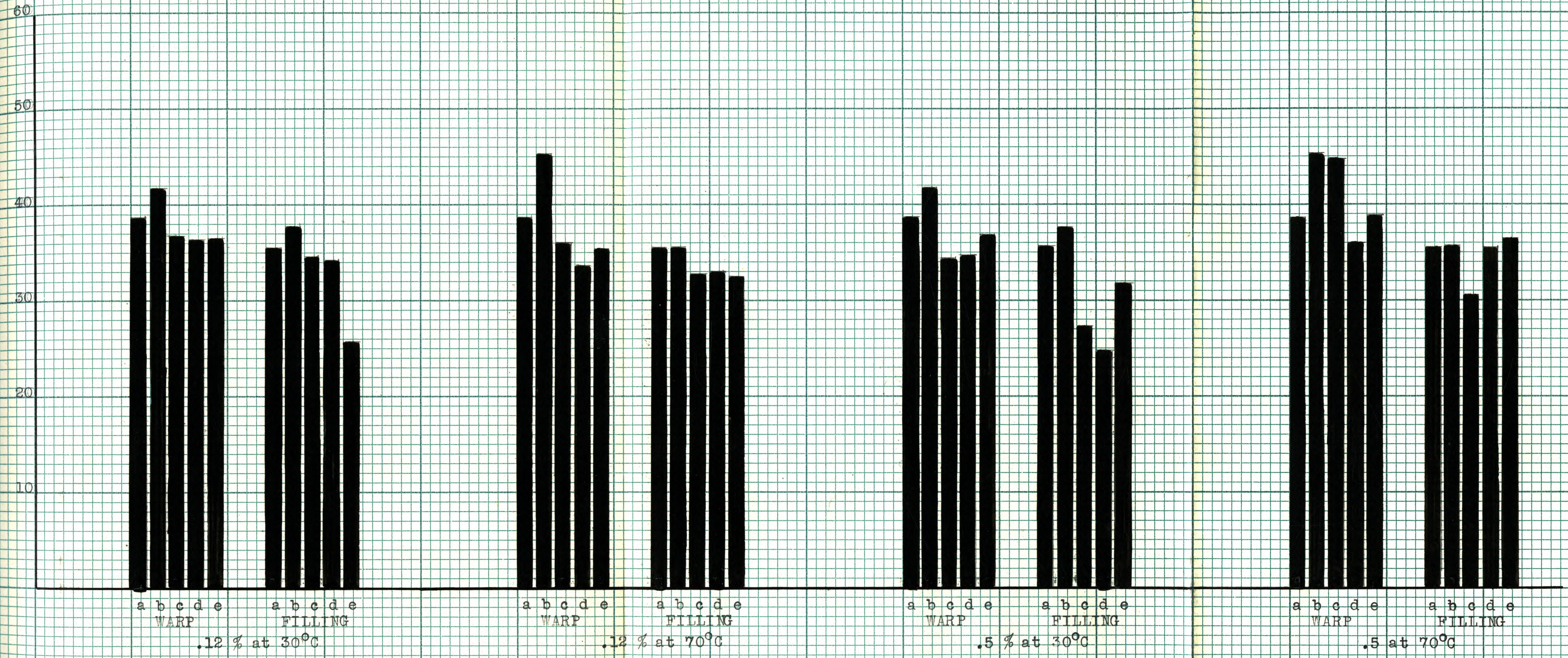



FIGURE 5. SHOWING THE EFFECT OF LAUNDRY SOAPS AT DIFFERENT TEMPERATURES AND CONCENTRATIONS ON THE TENSILE STRENGTH OF BLUE PETER PAN GINGHAM

a. Original Fabric b. Distilled water c. Soap Number 1 d. Soap Number 2 e. Soap Number 3

Table XI. Showing the Effect of Laundry Soaps at Different Temperatures and Concentrations on the Tensile Strength of Tan Peter Pan Gingham.

| | Breaking Strength in Pounds | |
|---|---|---|
| | Warp | Filling |
| Original Fabric | 38.56 | 26.63 |
| Distilled Water at 30°C | 46.45 | 34.41 |
| Distilled Water at 70°C | 44.68 | 32.32 |
| 0.12% Soap Solution at 30°C | | |
| Soap Number 1 | 41.14 | 27.83 |
| Soap Number 2 | 36.74 | 27.45 |
| Soap Number 3 | 37.69 | 27.71 |
| 0.12% Soap Solution at 70°C | | |
| Soap Number 1 | 38.59 | 25.25 |
| Soap Number 2 | 38.80 | 24.30 |
| Soap Number 3 | 37.60 | 28.39 |
| 0.5% Soap Solution at 30°C | | |
| Soap Number 1 | 41.04 | 28.08 |
| Soap Number 2 | 35.60 | 24.60 |
| Soap Number 3 | 37.30 | 26.10 |
| 0.5% Soap Solution at 70°C | | |
| Soap Number 1 | 37.59 | 27.12 |
| Soap Number 2 | 35.70 | 26.80 |
| Soap Number 3 | 37.40 | 29.87 |

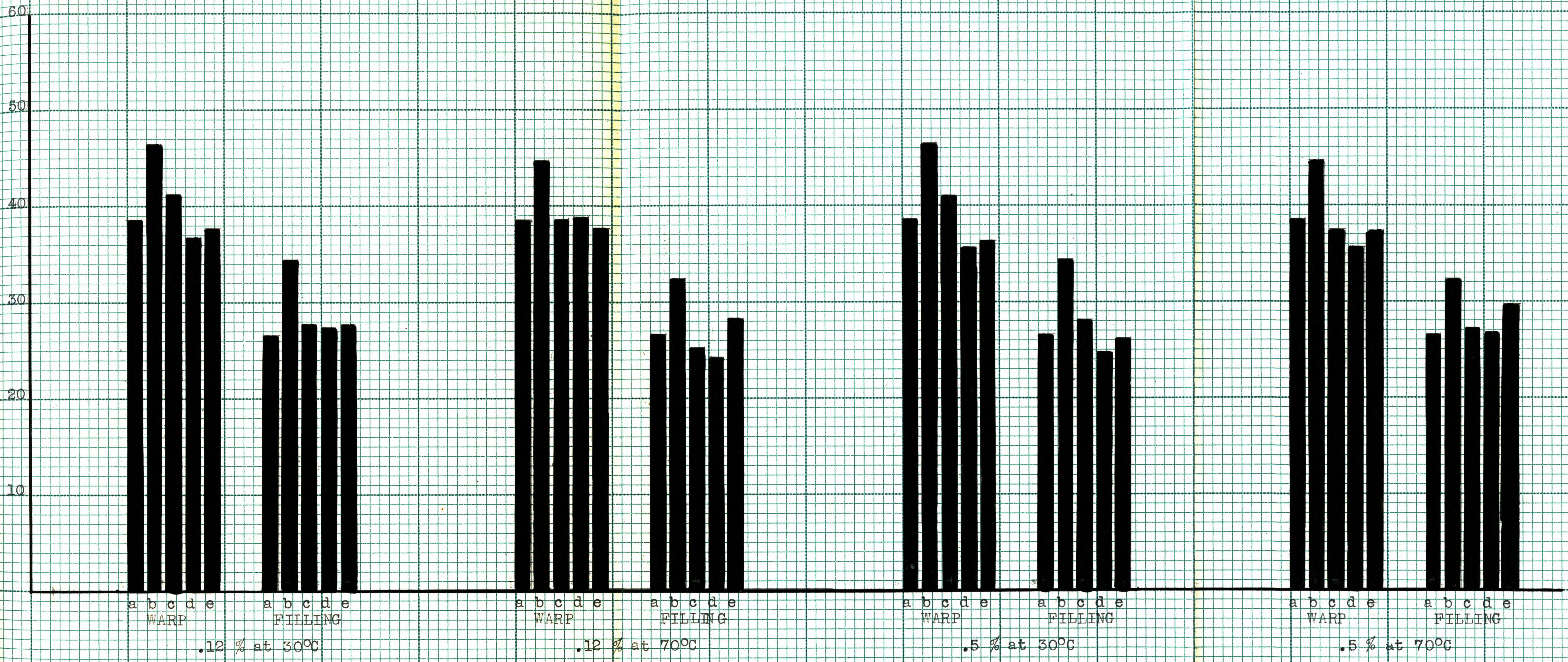



FIGURE 6. SHOWING THE EFFECT OF LAUNDRY SOAPS AT DIFFERENT TEMPERATURES AND CONCENTRATIONS ON THE TENSILE STRENGTH OF TAN PETER PAN GINGHAM

a. Original Fabric b. Distilled water c. Soap Number 1 d. Soap Number 2 e. Soap Number 3

## Discussion of Equipment

The equipment used for this experiment was that found in the laboratory - liter beakers, centigrade thermometers, bunsen burners, an analytical balance, conditioning oven, Scott Tester, and a microscope thread counter.

Several difficulties were encountered in carrying out this investigation. The temperature was very hard to control when using the direct flame. When the solutions were raised to the desired temperature and the flame withdrawn the temperature continued to rise because of the heated beaker and ring-stand. An electric hot plate with an automatic control would be a decided improvement as the desired temperature could be maintained for the required length of time.

With the laboratory facilities at hand it was impossible to employ a uniform method of agitating the fabrics while in the soap suds. This one factor may have caused the variation in results as shown by graphs (Figures 1-6). If it were possible to devise some systematic and uniform means of moving the cloth through the suds baths laundry conditions would be more nearly approximated and the results would be more accurate.

The method for measuring fading was unsatisfactory. If color was present in the suds it could be readily detected but the comparative amount of color could not be measured. Furthermore, it was impossible to decide whether the color in the soap solutions was due to actual loss of color from the fabric or to surplus dye removed in washing. If it were possible to measure the color by means of the degree of light reflection before and after washing, the loss of color might be accurately estimated. Perhaps the color in the fabric could be given a definite notation (Munsell system). Under these conditions a standard measurement of color change could be established and would mean the same thing whenever it was used.

## Summary of Results

Distilled water increased the tensile strength of the fabric over that of the original piece in both the warp-wise and filling-wise strips.

As a whole the soap treatments had less effect on the filling strips than on the warp strips; however, optimum conditions for laundering could not be determined because of variation in results.

In the chambray ginghams Soap Number 2 caused less deterioriation in the tensile strength (in more than half of the tests) than the other two soaps. In the peter pan ginghams Soap Number 1 caused less deterioriation in the tensile strength (in fourteen out of twenty four tests) than the other soaps; in a few instances, the tensile strength after treatment was greater than that of the original fabric.

The percentage of shrinkage was greater in the warp yarns in the chambray ginghams in the majority of calculations made but greater in the filling yarns for the peter pan ginghams.

## CONCLUSIONS

From this investigation the following conclusions can be drawn. The tensile strength of chambray and peter pan gingham is less affected by clear distilled water than by a soap solution.

A sufficient number of washings was not made to justify any positive statement regarding the optimum temperature and concentration of soap solution to use when laundering colored fabrics.

From the results of these experiments it would seem that soaps affect the color of the fabric much less than the tensile strength and shrinkage.

The apparent increase in tensile strength in many cases was due, perhaps, to the hydrolysis of the free sodium carbonate, in the soaps, to give caustic alkali which had a similar effect upon the cloth in laundering as in mercerization.

Although results were not obtained that could be used as a sound basis for the recommendation of laundry soaps, a definite method of procedure was established, and a beginning toward solution of the problem made.

Some of the difficulties encountered have already been mentioned and might form the foundation of further scientific study along this line, or in related fields.

## ACKNOWLEDGMENT

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## BIBLIOGRAPHY

Buanbull, Elizabeth and Supple, Mary
1925. The Effect of Washing Agents on Linen and Cotton Fabrics. Jr. Home Economics, 17:582-587.

Committee D-13 on Textile Materials
1925. A. S. T. M. Specifications and Methods of Test for Textile Materials. American Society for Testing Materials, Philadelphia.

1910-11 Encyclopedia Britannica (11th Edition). Univ. Press, Cambridge, Eng.

Griffin, R. C.
1921. Technical Methods of Testing. McGraw-Hill Book Co., N.Y.

Grim, A. and Jungman, J.
1918. Action of Laundry Agents on Textiles. Jr. of Society of Chemical Industry, 37:411.

Herzfeld, Dr. J.
1920. The Technical Testing of Yarns and Textile Fabrics. Scott, Greenwood and Son, London.

Johnson, G. H.
1927. Textile Fabrics. Harper and Bros., N.Y.

Norris, J. F.
1927. Organic Chemistry. McGraw-Hill Book Co., N.Y.

Perkins, W. H. and Kipping, F. Stanley
1911. Organic Chemistry. J. B. Lippincott Co.,Phil.

Posselt, E. A.
Third Printing. Textile Calculations. Bragdon, Lord and Nagle Co., N.Y.

Simm, D. M.
1926. Measurement of the Emulsifying Power of Soap Solutions by Means of the Drop Number. Society of Dyers and Colourists, 42:212.

St. James Version
1611. The Holy Bible.

United States Department of Commerce.
1924. Performance Tests of a Liquid Laundry Soap Used with Textile Materials. Bu. of Standards Technological Paper, No. 273, Gov. Print. Office, Wash., D. C.

1922. Specifications for Ordinary Laundry Soap. Bu. of Standards, Cir. No. 129, Gov. Print. Office, Wash. D.C.

1923. Soap. Bu. of Standards, Cir. No. 62 (3rd edition) Gov. Print. Office, Wash., D.C.