STAINING CHARACTERISTICS OF SELECTED SYNTHETIC FABRICS FOR "MINIMUM CARE" GARMENTS

by

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INTRODUCTION

Wash and Wear is defined as: "A term used to describe garments—also fabrics from which they are made--that will satisfactorily retain their original neat appearance after repeated wear and laundering with occasional or no ironing."[1] In 1957, in well over three-fourths of the households in the nation one or more members owned wash and wear garments.[2]

Good fabric performance depends on two things—the inherent characteristics of the fiber and the characteristics imparted by chemical and mechanical finishing of the fabric. The hydrophobic characteristic of the synthetic fibers, as opposed to the hydrophilic characteristic of the natural fibers, has caused the synthetic fibers to be used extensively in minimum care fabrics and garments. Most textile technologists agree that the hydrophilic or hydrophobic nature of the fiber is the outstanding characteristic of a textile fiber.[3]

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[1] J. J. Press, Man-Made Textile Encyclopedia (New York: Textile Book Publishing Company, 1959), p. 901.

[2] D. F. Holmes, "Man-Made Fibers," Wash and Wear--Fact or Fantasy! (11th National Home Laundry Conference. Chicago: American Home Laundry Manufacturers' Association, 1957), pp. 10-11.

[3] B. C. M. Dorset, "Fiber Surfaces and Their Influence on the Properties of Cotton Textile Materials," The Textile Manufacturer, 83:460, September, 1957.

> It can be said as never before, that the man-made fibers have come into their own in the American Textile industry. And, even more importantly, they have come into their own in every aspect of American Life. They are not only warmly accepted by consumers; they are relied upon to give service in apparel and home furnishings and industrial uses far beyond that given by natural fibers.[4]

The wash and wear idea was built upon the polyfibers, Dacron polyester fiber, Orlon acrylic fiber, and nylon.[5]

Since the synthetic fibers are being used singly or in blends with the natural fibers in minimum care or wash and wear garments, it is necessary to understand the staining characteristics of the synthetic or man-made fibers. This study was undertaken to gain some understanding of the staining characteristics of selected synthetic fabrics for minimum care or wash and wear garments.

This study was designed to parallel a study in progress on the staining characteristics of cotton fabrics treated for wash and wear characteristics.[6]

The purposes of this study were: to compare the staining characteristics of selected synthetic blends and combination fabrics

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[4] A. H. McCollough, "A Bright Future for Man-Made Fibers," Modern Textiles Magazine, 40:31, September, 1959.

[5] James S. Ramsey, "How to Handle Dacron-Cotton Blends," Modern Textiles Magazine, 36:70, July, 1955.

[6] Alice J. Willingham, "Staining Characteristics of Cotton Wash-Wear Fabrics," (unpublished Grant-in-Aid, No. 91, The Research Council, The Woman's College of the University of North Carolina, Greensboro, 1961).

used for "minimum care" garments, to evaluate the effectiveness of stain removal at differing periods of time and by different treatments, and to compare the results with those of a similar study using cotton fabrics treated for wash and wear characteristics.

The characteristics of the fibers in the fabrics used in this study, the characteristics of minimum care garments, the basic methods for stain removal, and the stains with their ingredients and the specific methods for their removal are included in Chapter II.

Chapter III includes the selection of fabrics, the selection of stains, the preparation of the fabrics, the application of stains, the methods for removal of spots and stains, the methods for evaluation of stain repellency, and the methods for evaluation of stain removal.

Chapter IV includes the compilation and evaluation of the data from all laboratory tests, and Chapter V includes the summary of the study and the recommendations for further study.

CHAPTER II

REVIEW OF LITERATURE

Technical studies related to stain removal are few, and none were found similar to the needs of this study. The studies which have been done are of a promotional nature concerning laundering and detergents. A brief summary of the characteristics of the fibers used in this study, the characteristics of minimum care garments, the basic methods for stain removal, and the stains with their ingredients and the specific methods for their removal are included in this chapter.

I. CHARACTERISTICS OF THE FIBERS USED IN STUDY

The cellulose fibers are highly hydrophilic or hydroscopic in that they absorb and retain large quantities of moisture. The cellulose fibers have low resiliency which causes them to wrinkle badly unless finished for recovery.

A synthetic fiber is a man-made material produced by synthesis from chemical elements or compounds.[1] The synthetic fibers are hydrophobic in nature. This causes them to have low moisture absorption and spot resistance. They are easily washed with stains being easily removed, and they are quick drying. The resiliency, elasticity, and elongation of the synthetic fibers are good, causing them to resist

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[1] J. J. Press, Man-Made Textile Encyclopedia (New York: Textile Book Publishers', Incorporated, 1959), p. 900.

wrinkles and to recover from wrinkles. With the exception of acetate, their wet strength is comparable to their dry strength. All of the synthetic fibers are heat sensitive.

In a study of stain removal methods on cotton and cotton blended fabrics, it was found that stains penetrated the blended fabrics more slowly than the pure cotton fabrics.[2]

Cotton. "Cotton is very absorbent because of the many available hydroxyl groups."[3] "The cotton fiber is highly hygroscopic. It absorbs and releases large quantities of water."[4] Cotton is the most washable fiber since it is 25 per cent stronger when wet, may be boiled for sterilization, washed in strong soaps, bleached to remove soil and stains, and ironed with a hot iron to remove wrinkles. Although cotton is not greatly harmed by alkalies nor organic acids, it is harmed by the mineral acids. "Fruit stains should be removed immediately from a garment to prevent setting."[5]

Rayon. "Rayon is a manufactured fiber composed of regenerated cellulose, as well as manufactured fibers composed of regenerated

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[2] Margaret Elizabeth Davis, "A Study of the Effectiveness of Stain Removal Methods on Cotton and Cotton Blended Fabrics," (unpublished Master's thesis, The University of Tennessee, Knoxville, 1956), p. 11.

[3] Norma Hollen and Jane Saddler, Textiles (New York: The Macmillan Company, 1955), p. 21.

[4] Zelma Bendure and Gladys Pheiffer, American Fabrics (New York: The Macmillan Company, 1947), p. 74.

[5] Hollen and Saddler, op. cit., p. 17.

cellulose in which substitutes have replaced not more than 15% of the hydrogens of the hydroxyl groups."[6] Rayon is an absorbent fiber, for like cotton, it is a hygroscopic fiber. Rayon is weaker when wet and low in resiliency. Like cotton, rayon is harmed by acids, but it is fairly resistant to alkalies. Rayon can be laundered, and it can be bleached with chlorine type bleaches.[7]

Acetate. "Acetate is a manufactured fiber in which the fiber-forming substance is cellulose acetate."[8] Unlike the other synthetic fibers, acetate is a weak fiber and loses much of its strength when wet. Acetate is resistant to shrinking, more resistant to spotting and staining than cotton or rayon, and rather quick drying. Acetate is more absorbent than the other synthetic fibers.[9]

> Strong alkalies should not be used on acetate since they cause a chemical change in the fiber. Cellulose Acetate is more resistant to acids than is pure cellulose... If bleaching is necessary, a mild hydrogen peroxide or a very weak chlorine bleach should be used.[10]

> Arnel. "Arnel" is a fibre spun from cellulose Triacetate made by Celanese Corporation of America. In this fibre, the hydroxyl groups of the cellulose

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6 Textile Handbook (Washington: American Home Economics Association, 1960), p. 16.

7 Hollen and Saddler, op. cit., pp. 17, 28-34.

8 Textile Handbook, op. cit., p. 7.

9 Hollen Saddler, op. cit., p. 55.

10 Ibid., p. 58.

> molecules have been replaced more completely by acetyl groups than in the normal acetate fibre. "Arnel" is thus a step farther away from the cellulose of viscose or cuprammonium rayons. It is a fibre in which the non-cellulose characteristics are more pronounced than in the normal acetate fibre.[11]

"Laboratory tests indicate that it is machine washable at any temperature, resistant to glazing, needs little or no ironing, and has other properties similar to acetate."[12] Arnels are not subject to chlorine damage. They retain their whiteness and have good resistance to scorching. They dry rapidly due to a lower moisture regain. Another ease of care property of Arnel is the ease with which soil is removed.[13]

Dacron. Dacron is a polyester fiber. "Polyester is a manufactured fiber in which the fiber-forming substance is any long chain synthetic polymer composed of at least 85 per cent by weight of an ester of a dihydric alcohol and terephthalic acid (p-HOOC-C_6H_4-COOH)."[14] Dacron is very stable to conditions of humidity and washing. It is naturally quite white, and when used in blends with other fibers, any bleach suitable to the other fiber may be used as Dacron has excellent

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[11] J. Gordon Cook, Handbook of Textile Fibres (Watford Herts : Merrow Publishing Company, 1960), p. 216.

[12] Hollen and Saddler, op. cit., p. 60.

[13] Claude S. Clutz, Howard F. Elsom, and Robert D. Williams, "Arnel 60, A New Stronger Triacetate Fiber," Modern Textiles Magazine, 41:71-75, November, 1960.

[14] Textile Handbook, op. cit., p. 15.

resistance to oxidizing agents. A Dacron and cotton blend fabric does not soil as easily as an all-cotton fabric.[15] "Dacron has wicking tendencies."[16] Wicking is the capillary action of a fiber in drawing up a liquid.

Nylon. "Nylon is a manufactured fiber in which the fiber forming substance is any long chain synthetic polyamide having recurring amide groups (-C-NH-) as an integral part of the polymer chain."[17] Nylon may be laundered, wet cleaned, or dry cleaned. It should be bleached with hydrogen peroxide or sodium perborate bleaches. Nylon has a low moisture absorption, resists non-oily stains, washes easily, and dries quickly.[18]

II. CHARACTERISTICS OF MINIMUM CARE GARMENTS

> Wash-and-Wear: A term used to describe garments--also fabrics from which they are made--that will satisfactorily retain their original neat appearance after repeated wear and laundering with occasional or no ironing. Note: "Retain their original neat appearance" means that after laundering the garments will (1) retain desirable pressed-in creases or pleats, if any, and (2) be essentially free from undesirable wrinkles both during wear and after laundering. It is also assummed the fabrics

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15 Jerome Campbell, "Dacron and Cotton Form Happy Union," Modern Textiles Magazine, 35:31, February, 1954.

16 Hollen and Saddler, op. cit., p. 66.

17 Textile Handbook, op. cit., p. 13.

18 Ibid.

will meet normal consumer's demands for such properties as durability, color fastness, and shrinkage.[19]

There are three requirements for automatic wash and wear performance. The fabric must contain a major percentage of high-performance fibers. The garment must be fabricated from stable components in order to withstand the mechanical action of the machine. Automatic wash and wear must be tumble dried at a controlled temperature around 150° F., and it must be cooled while tumbling.[20]

In establishing tests for evaluating wash and wear, 140° F. was used for the fabrics which were washed in a machine.[21] The quick drying time required by the synthetic fibers has encouraged them to be used in wash and wear fabrics.[22] The wash and wear fabric, Dacron and Cotton, has been found to be more difficult to soil.[23]

III. BASIC METHODS FOR STAIN REMOVAL

Of the sources and authorities reviewed on stain removal, one

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19 Press, op. cit., p. 901.

20 D. F. Holmes, "Man-Made Fibers," Wash and Wear--Fact or Fantasy! (11th National Home Laundry Conference. Chicago: American Home Laundry Manufacturers' Association, 1957), p. 11.

21 Graham H. Richardson, "Research Developments Committee on Wash and Wear," American Dyestuff Reporter, 48:20-21, January 12, 1959.

22 Richard Steele, "Factors Affecting the Drying of Apparel Fabrics," Textile Research Journal, 28:136-147, February, 1958.

23 Jerome Campbell, "Dacron and Cotton Form Happy Union," Modern Textiles Magazine, 35:31, February, 1954.

reference was a compilation of all the information and presented all the phases of stain removal. This source was used for the review of literature.

There are five basic methods of spot removal. Sometimes one method is sufficient, but sometimes it is necessary to use a combination of methods or all five methods of removal.[24]

Mechanical Method. Many stains which are on the surface can be entirely removed, or sufficiently broken up to permit the solvents used to act more freely, by brushing or rubbing with a brush or spatula. Food, mud, soil, and some blood stains are more likely to respond to mechanical action.[25]

Chemical Action. Some stains must be treated with an agent which will form a new and soluble substance with the stain. This soluble substance can then be washed out. To prevent too high a concentration of the chemical which is being used, the stain area should be wet out. The chemical and stain should be prevented from spreading as much as possible.[26]

Solvent Action. The solvent action is the most frequently used method of stain removal. When the nature of the stain is known, a suitable solvent can be selected for its removal.[27]

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[24] Ibert Mellan and Eleanor Mellan, Removing Spots and Stains (New York: Chemical Publishing Company, 1959), p. 33.

[25] Ibid.

[26] Ibid.

[27] Ibid., p. 34.

Softening Action or Lubrication. Stains caused by insoluble or inert substances can best be removed by applying a softening agent. The particles of the stain are made smooth and slippery and are dislodged so they can be washed away.[28]

> Digestive or Enzymic Action. When digestants are used on stains that require them, they convert them into substances soluble in water which are then removed by flushing out with water. There are certain digestants for carbohydrates, such as sugars and starches, and others for protein materials such as milk, albumin, and blood. It is best to use these enzymes in a neutral solution. Cleaners used before, such as soaps, acids, or ammonia, should be washed out before applying a digestant. Allow sufficient time for the digestant to complete its reaction.[29]

IV. STAINS USED IN THIS STUDY AND THE METHODS FOR THEIR REMOVAL

Since the fabrics used in this study were those used for minimum care or wash and wear garments, the methods for stain removal were the ones recommended for washable fabrics. However, since the synthetic fibers are heat sensitive, methods which called for the use of boiling water were not used. In those cases, the methods recommended for sensitive fabrics were reviewed and employed in this study.

As in the basic methods for stain removal, the source, which was a compilation of the other sources reviewed, was used for the principle

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[28] Ibid.

[29] Ibid.

part of this review. This is also the source used by the parallel study.[30] The ingredients of each stain with the method of removal are given here.

> Catsup. Contents: Tomatoes, salt, garlic, condiments, vinegar, tannin, and coloring matter, such as cochineal, water, and sugar.
>
> Method: Moisten the stain with warm water. Apply warm glycerin (120° F.). Work the stain with a brush. Flush out with water. Apply a paste of protein digestant and leave it on for 30 minutes. Moisten frequently with warm water. Flush out with water. Feather out and dry.
>
> If a trace of stain is visible, bleach out with hydrogen peroxide-sodium perborate solution.[31]
>
> Chocolate Sauce. Contents: Coloring matter, cocoa butter, oil, flavoring, essential oil, starch, mucilaginous matter, and sugar.
>
> Method: Wash in warm, soapy water. To remove a persistant stain, sponge with a hydrogen peroxide solution or with a hydrogen peroxide-sodium perborate solution, if the fabric permits. Rinse out thoroughly with water.[32]
>
> Coffee with Cream and Sugar. Contents: Fat, coloring matter, protein, organic acids, dextrins, etc. These belong to the tannin stains.
>
> Method: Sponge with lukewarm water. Apply warm glycerin (120° F.) and leave it on for 30 minutes. Flush out with water. Feather out and dry. To remove persistant stains, moisten them with water.

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30 Alice J. Willingham, "Staining Characteristics of Cotton Wash-Wear Fabrics," (unpublished Grant-in-Aid, No. 91, The Research Council, The Woman's College of the University of North Carolina, Greensboro, 1961).

31 Mellan, op. cit., p. 49.

32 Ibid., pp. 50-51.

Apply a paste of protein digestant and leave it on for 30 minutes. Moisten frequently with warm water. Flush out with water. Feather out and dry.[33]

Cola Drink. Contents: Coloring matter, sugar, flavoring, tannin, organic extracts, water, etc.

Method: Saturate the stain with warm glycerin (120° F.). Loosen the stain with a brush. Flush out with water. Feather out and dry.[34]

French Dressing. Contents: It may contain egg, cream, lemon juice or vinegar, or catsup, and oils.

Method: Apply a paste of cornstarch and V. M. & P. naphtha. Brush off when dry. Repeat this procedure until the stain disappears.[35]

Grape Juice. Contents: Coloring matter, acids, and tannin.

Method: Apply warm glycerin (120° F.) to the stain. Add a soapless shampoo. Loosen with a brush. Flush out with water. Feather out and dry. To remove a remaining stain, apply a few drops of 10% acetic acid solution. Flush out with water. Apply 3% hydrogen peroxide solution, if the fabric permits. Flush out with water. Feather out and dry.[36]

Gravy. Contents: Blood, oil, grease, flour, and albumin.

Method: Soak in warm, soapy water. Avoid using hot water which will set the stain.[37]

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33 Ibid., pp. 52-53.

34 Ibid., p. 52.

35 Ibid., p. 85.

36 Ibid., pp. 60-61.

37 Ibid., p. 63.

Margarine. Contents: Oils and coloring matter.

Method: Saturate the stain with V. M. & P. naphtha. Loosen the stain with a brush. Flush out with V. M. & P. naphtha. Feather out and dry.[38]

Mustard. Contents: Ground mustard seed, salt, spices, coloring matter, turmeric, vinegar, and water.

Method: Moisten the stain. Rub glycerin into the stain. Soak in warm, soapy water. Rinse well. If the stain persists, apply a bleach, such as hydrogen peroxide-sodium perborate solution. Rinse out well.[39]

Tea with Sugar. Contents: Coloring matter, tannin, albumin, etc.

Method: Flush out the stain with water. Apply warm glycerin (120° F.) and work it into the stain with a brush. Flush out with water. Apply a few drops of 10% acetic acid solution. Flush out with water. If a stain persists, bleach with 3% hydrogen peroxide solution, if the fabric permits. Flush out with water. Feather out and dry.[40]

From a study conducted at Ohio State University, it was found that soil was removed more effectively from synthetic and synthetic blends if the fabrics were washed in hot water.[41]

In a study conducted with Arnel blouses, it was found that regular home or automatic machine washing was sufficient to remove most stains. However, in this study, it was found that grease-borne stains

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[38] Ibid., p. 53.

[39] Ibid., p. 77.

[40] Ibid., p. 90.

[41] Elaine Knowles Weaver and Maurice Miller Welch, "Wash Water--Should It Be Hot or Cold?" Wash and Wear--Fact or Fantasy! (11th National Home Laundry Conference. Chicago: American Home Laundry Manufacturers' Association, 1957), pp. 49-51.

required treatment with extra detergent or a soapless shampoo. The length of time in which a stain was allowed to remain had little or no effect on the degree of stain removal.[42]

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[42] Margaret E. Gebhardt and Evelyn E. Stout, "Performance and Acceptance of Twelve Spun-Yarn and Filament Arnel Blouses," Journal of Home Economics, 52:269-271, April, 1960.

CHAPTER III

METHOD OF PROCEDURE

The four treatments used in determining the staining characteristics of synthetic fabrics for minimum care garments were the same as those used in the study of the staining characteristics of cotton fabrics treated for wash and wear properties.[1]

The coding for the methods of removal is as follows:

1	Method I	Stain applied and immediately laundered.
2	Method II	Stain applied and laundered after aging for one week.
1a	Method III	Stain applied and treated by a procedure recommended by Mellan immediately.
2a	Method IV	Stain applied and treated by a procedure recommended by Mellan after aging for one week.[2]

The design of the study is shown in Figure 1.

I. SELECTION OF FABRICS

Six synthetic and synthetic blend fabrics were selected from those available to consumers as yard goods in department stores and fabric shops. They were selected for their similarity and identity to

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[1] Alice J. Willingham, "Staining Characteristics of Cotton Wash-Wear Fabrics," (unpublished Grant-in-Aid, No. 91, The Research Council, The Woman's College of the University of North Carolina, Greensboro, 1961).

[2] Ibert Mellan and Eleanor Mellan, Removing Spots and Stains (New York: Chemical Publishing Company, 1959).

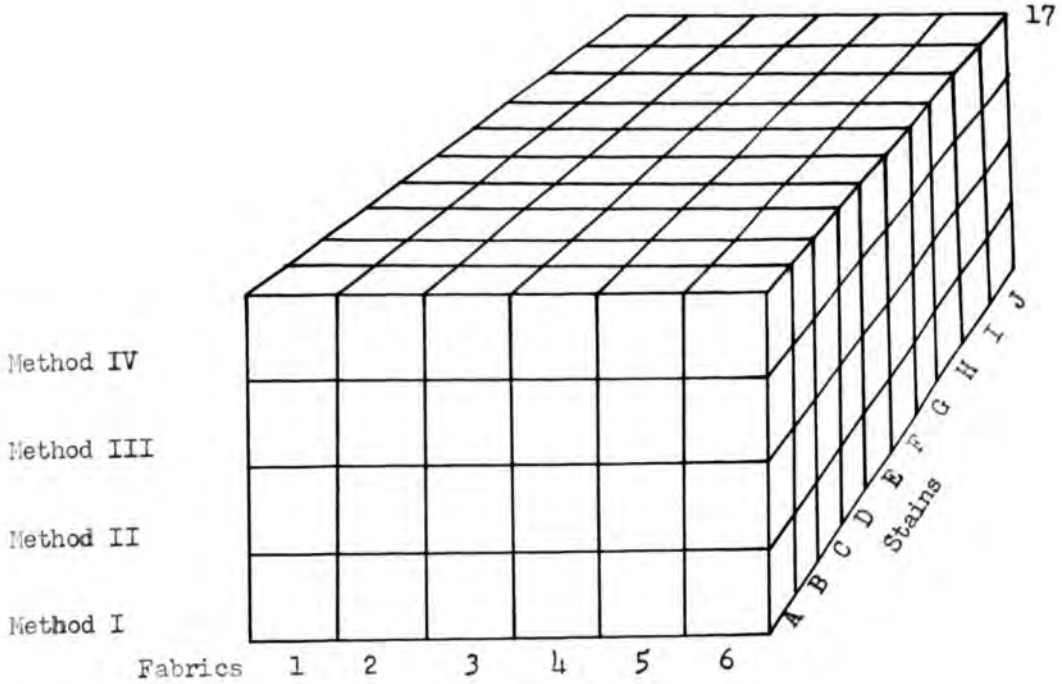

FIGURE 1

DESIGN OF THE STUDY

Fabrics

1--Dacron
2--Dacron and Cotton
3--Arnel and Cotton
4--Arnel and Rayon
5--Arnel and Nylon
6--Acetate and Nylon

Stains

A--Catsup
B--Chocolate Sauce
C--Coffee with Cream and Sugar
D--Cola Drink
E--French Dressing
F--Grape Juice
G--Gravy
H--Margarine
I--Mustard
J--Tea with Sugar

Methods

Method I Stain applied and immediately laundered.
Method II Stain applied and laundered after aging for one week.
Method III Stain applied and treated by a procedure recommended by Mellan immediately.
Method IV Stain applied and treated by a procedure recommended by Mellan after aging for one week.

the fabrics used in ready to wear garments. They consisted of fabrics possessing characteristics for wash and wear or minimum care which were or could be used in blouses and shirts. Samples of the fabrics are included in Figure 2. Fiber content and code numbers used in presenting the data are: 1--Dacron, 2--Dacron and Cotton, 3--Arnel and Cotton, 4--Arnel and Rayon, 5--Arnel and Nylon, and 6--Acetate and Nylon.

II. SELECTION OF STAINS

The stains selected were the same as those used in the parallel study using cotton fabrics treated for wash and wear characteristics.[3] The ten food stains were selected for their differences in staining characteristics, variety of ingredients in make-up, and for their frequency in being a problem to the consumer in that, "Food has been estimated to cause about 90% of the stains."[4] The stains with their code are as follows: A--Catsup, B--Chocolate Sauce, C--Coffee with Cream and Sugar, D--Cola Drink, E--French Dressing, F--Grape Juice, G--Gravy, H--Margarine, I--Mustard (Prepared), and J--Tea with Sugar.

III. PREPARATION OF FABRICS

Verification of the composition and structure of the fabrics was made through laboratory analysis of the fiber content, weave, width, thickness, weight, thread count, yarn number or denier, staple length

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[3] Willingham, op. cit.

[4] Mellon, op. cit., p. 33.

1--Dacron

2--Dacron and Cotton

3--Arnel and Cotton

4--Arnel and Rayon

5--Arnel and Nylon

6--Acetate and Nylon

FIGURE 2

SAMPLES OF THE FABRICS

or filament count, and twist count. The procedures followed in performing these tests were those recommended by the American Society for Testing Materials.[5]

All fabrics were desized before the stains were applied. This laundering procedure was carried out in a small commercial wash wheel with a reversing action. They were laundered for seven minutes in a mild soap solution at 120° F. and given two 5-minute rinses at the same temperature.

The fabrics were then cut into three-inch squares to allow for raveling, handling, and sufficient background for judging.

IV. APPLICATION OF STAINS

The samples were placed on a blotter. The stain was applied by a dropper with one drop of stain used on each sample. After five minutes, any staining agent which was not absorbed was removed by blotting with a tissue.

Each stain was applied to specimens from each fabric for use as a control in judging of the apparent stain removal. Each stain was applied to three samples of each fabric to be used for Method I. The same number were treated in the same manner for Method II. Each necessary stain was applied to three samples of the necessary fabrics for Method III and Method IV. The samples to be used in Method I and Method II were machine stitched one-fourth inch from the edge to prevent further raveling.

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[5] ASTM Committee D-13, ASTM Standards on Textile Materials (Philadelphia: American Society for Testing Materials, 1960).

V. REMOVAL OF SPOTS AND STAINS

There is no standard method established for the testing of stain removal. The research committee, Evaluation of Finishes for Resistance to Staining and Soiling, of the American Association of Textile Chemists and Colorists is presently working on a method.[6]

One of the instruments which is used in textile testing is the Launder-Ometer. This instrument is used alone for certain tests, and it is frequently used in conjunction with other instruments as one phase of the testing.

> The Launder-Ometer is an approved laboratory device that provides greatly accelerated scientific foreknowledge of the effects of commercial laundering and or soaps and detergents on textiles and other materials applicable for many other services where the simultaneous agitation of a number of samples at controlled temperature is required.[7]

> One of the features of the Launder-Ometer is the controlled mechanical action, which furnishes agitation of the textile material that is being treated or tested. The jars revolve at a uniform speed which is sufficiently rapid to give a complete mixing and uniform agitation of the material.[8]

The Launder-Ometer was the device used for removing the stains by laundering. The procedure used was adapted from the standard procedures recommended by the American Association of Textile Chemists

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[6] William D. Appel, 1960 Technical Manual of the American Association of Textile Chemists and Colorists Volume XXXVI (New York: Howes Publishing Company, 1960), p. 11.

[7] Atlas Launder-Ometers, A Booklet of Instructions published by the Atlas Electric Devices Company, Chicago, Illinois, p. 2.

[8] Ibid., p. 5.

and Colorists.[9]

The methods used in further treatment were those recommended for washable fabrics in Removing Spots and Stains.[10]

Method I. The Launder-Ometer was used to wash the fabrics as soon as the stain was applied in Method I. Each test (a specific stain on a specific fabric) was performed individually in a pint jar which contained 100 cc. of a five per cent soap solution. The fabrics were washed for twenty minutes at 140^{0} F. This time and temperature was chosen because it represented the average home automatic washer time cycle and water temperature and because it was the time and temperature used in the parallel study.[11]

Each set of tests was rinsed by dipping up and down for fifty times in 200 cc. of water. Each set was rinsed two times. The samples were then placed on a towel on a flat surface and allowed to dry. If necessary, they were then pressed on the wrong side to obtain a smooth surface.

Method II. The Launder-Ometer was used to wash the fabrics after the stain had aged for one week. The procedure of washing, rinsing, and drying was the same as in Method I.

Method III and Method IV. Those stains not completely removed in Method I and Method II were subjected to a further study in Method III

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9 Ibid., pp. 2-14.

10 Mellan, op. cit., pp. 49-90.

11 Willingham, op. cit.

and Method IV. Method III was the investigation of the removal of the stain immediately after application. Method IV paralleled Method II in removing the stain after aging for one week. The stain removal methods used for each of the stains were adapted from the following methods:

Catsup: Moisten the stain with warm water. Apply warm glycerin (120° F.). Work the stain with a brush. Flush out with water. Apply a paste of protein digestant and leave it on for 30 minutes. Moisten frequently with warm water. Flush out with water. Feather out and dry.

Chocolate Sauce: Wash in warm, soapy water. To remove a persistant stain, sponge with a hydrogen peroxide solution or with a hydrogen peroxide-sodium perborate solution, if the fabric permits. Rinse out thoroughly with water.

Coffee with Cream and Sugar: Sponge with lukewarm water. Apply warm glycerin (120° F.) and leave it on for 30 minutes. Flush out with water. Feather out and dry. To remove persistant stains, moisten them with water. Apply a paste of protein digestant and leave it on for 30 minutes. Moisten frequently with warm water. Flush out with water. Feather out and dry.

Cola Drink: Saturate the stain with warm glycerin (120° F.). Loosen the stain with a brush. Flush out with water. Feather out and dry.

French Dressing: Apply a paste of cornstarch and V. M. & P. naphtha. Brush off when dry. Repeat this procedure until the stain disappears.

Grape Juice: Apply warm glycerin (120° F.) to the stain. Add a soapless shampoo. Loosen with a brush. Flush out with water. Feather out and dry. To remove a remaining stain, apply a few drops of 10% acetic acid solution. Flush out with water. Apply 3% hydrogen peroxide solution, if the fabric permits. Flush out with water. Feather out and dry.

Gravy: Soak in warm, soapy water.

Margarine: Saturate the stain with V. M. & P. naphtha. Loosen the stain with a brush. Flush out with V. M. & P. naphtha. Feather out and dry.

Mustard: Moisten the stain. Rub glycerin into the stain. Soak in warm, soapy water. Rinse well. If the stain persists, apply a bleach, such as hydrogen peroxide-sodium perborate solution. Rinse out well.

Tea with Sugar: Flush out the stain with water. Apply warm glycerin (120° F.) and work it into the stain with a brush. Flush out with water. Apply a few drops of 10% acetic acid solution. Flush out with water. If a stain persists, bleach with 3% hydrogen peroxide solution, if the fabric permits. Flush out with water. Feather out and dry.[12]

Since acetic acid is harmful to Arnel and acetate, that step was omitted from the procedures for removing the grape juice and tea with sugar stains.

VI. EVALUATION OF STAIN REPELLENCY

There was no standard procedure available for the evaluation of the stain repellency of the fabrics. Subjective analysis can be used as a method for measuring visual effects of fabrics. The scores can then be analyzed statistically.

Subjective Analysis. Each stain was applied to a sample of each fabric which was placed on a white blotter on a flat surface under a daylight fluorescent light. During the five minutes which the stain was allowed to remain on the sample, each of the samples was rated for its repellency for stains by one person. Each test was repeated two times.

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[12] Mellan, op. cit.

The samples were rated as follows:

5 Forms a ball on the fabric
4 Forms a ball on the fabric, then is absorbed
3 Is not absorbed readily; nor built-up on the fabric
2 Is absorbed readily in a small area
1 Is absorbed readily in a wide area

Statistical Analysis. An analysis of variance for a 2-factor factorial in a randomized complete block design was used to compare the scores from the subjective analysis.[13]

The following hypotheses were tested:

1. There are no differences among the six selected synthetic and synthetic blend fabrics in the absorption of the ten selected food stains.

2. There are no differences among the ten selected food stains in the manner of absorption by the six selected synthetic and synthetic blend fabrics.

3. There is no interaction between the six selected synthetic and synthetic blend fabrics and the ten selected food stains.

VII. EVALUATION OF STAIN REMOVAL

There was no standard procedure available for the evaluation of the stain removal from the fabrics. Method I and Method II were evaluated by subjective analysis and statistical analysis.

Due to the procedures used in removing the stains in Method III and Method IV, the samples could not be rated subjectively in the same manner as Method I and Method II. The investigator, the investigator of the parallel study, and a student assistant determined whether the

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[13] Bernard Ostle, Statistics In Research. (Ames: The Iowa State College Press, 1954), pp. 339-356.

stain was completely removed before another technique for removal was employed. Neither Method III nor Method IV permitted statistical analysis because of the many variables which could not be controlled.

Subjective Analysis. From the samples used for each test of Method I and Method II, and one which best represented the three samples was chosen to be judged. Each sample to be rated was mounted with dry mount paper on a white 4 x 6-inch card. The samples were placed on a white blotter and viewed from a forty-five degree angle.

Each sample was judged by comparison with the original fabric and with the control. The tests were judged individually in a random order of fabrics and stains by three persons. The tests were judged under a daylight fluorescent light. The samples were rated as follows:

5 No evidence of stain
4 Some evidence of stain
3 Moderate evidence of stain
2 Some evidence of removal
1 No evidence of removal

Number 5 would be comparable to Number 5 of the AATCC Geometric Staining Scale, however, the scale did not lend itself to this study.

Statistical Analysis. An analysis of variance for a 3-factor factorial in a randomized complete block design was used to compare the scores from the subjective analysis.[14]

The following hypotheses were tested:

1. There are no differences in the immediate versus the delayed launderings in removing the ten selected food stains from the six selected synthetic and

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[14] Ibid.

synthetic blend fabrics.

2. There are no differences among the six selected synthetic and synthetic blend fabrics in the removal of the ten selected food stains when laundered.

3. There are no differences in the removal of the ten selected food stains from the six selected synthetic and synthetic blend fabrics when laundered.

4. There is no interaction between the time of the launderings and the ten selected food stains.

5. There is no interaction between the time of the launderings and the six selected synthetic and synthetic blend fabrics.

6. There is no interaction between the six selected synthetic and synthetic blend fabrics and the ten selected food stains.

7. There is no interaction between the time of the launderings, the stains, and the fabrics.

CHAPTER IV

PRESENTATION OF DATA

I. FABRICS USED IN STUDY

The fabrics used in this study were selected from those available to consumers as yard goods in department stores and fabric shops. They were selected for their identity and similarity to the fabrics which are used in ready-to-wear garments. The selected fabrics possessed wash and wear or minimum care characteristics and were of the type used in blouses and shirts. The six selected fabrics were a Dacron Piqué, a Dacron and Cotton Batiste, a Dacron and Cotton Novelty Weave, an Arnel and Rayon Honeycomb Weave, an Arnel and Nylon Surah, and an Acetate and Nylon Crepe.

The fabric specifications as given by the manufacturer or supplier are given in Table I.

II. LABORATORY ANALYSIS OF FABRIC CONSTRUCTION

The detailed features of the fabric construction as shown by laboratory analysis are given in Table II.

Fiber Content. The fiber content of the piqué, fabric 1, was 100 per cent Dacron. The fiber content of the batiste, fabric 2, was 68.7 per cent Dacron and 31.3 per cent cotton. The fiber content of the novelty weave, fabric 3, was 51.1 per cent Arnel and 48.9 per cent cotton. The honeycomb weave, fabric 4, was 51.4 per cent Arnel and 48.6 per cent rayon. The surah, fabric 5, was 76.5 per cent Arnel and 23.5 per cent

TABLE I

FABRIC SPECIFICATIONS GIVEN BY MANUFACTURER OR SUPPLIER

Type of Fabric	Fabric Number	Fiber Content (Per Cent)	Cost Per Yard	Manufacturing Firm	Supplier	Miscellaneous Information
Piqué	1	100 Dacron	$1.29	"A Crooke Fabric"	Becky Hinkle's Fabric Shop	
Batiste	2	65 Dacron 35 Cotton				
Novelty Weave	3	51 Arnel 49 Cotton	.98	Erlenger Mill, Incorporated	Mill Fabrics, Incorporated	
Honeycomb	4	50 Arnel 50 Rayon	.98	Rosewood Fabrics, Incorporated	Textile Sales Company	Minimum of Ironing Permanent Crease Resistant Pleatable
Surah	5	Arnel Nylon	.89		Mill Fabrics, Incorporated	Drip-Dry
Crepe	6	Acetate Nylon	.89		Textile Sales Company	

TABLE II

LABORATORY ANALYSIS OF FABRIC CONSTRUCTION

Type of Fabric	Fabric Number	Fiber Content (Per cent)	Weave	Width (Inches)	Thickness (Inches)	Weight (Oz.sq.yd)	Thread Count		Yarn Number		Denier		Staple Length		Filament Count		Twist Count	
							Warp	Filling	Warp	Filling	Warp	Filling	Warp	Filling	Warp	Filling	Warp	Filling
Piqué	1	100 Dacron	Piqué (Dobby)	45.25	.005	1.89	104	79			76	82			30	32	10.1z	3z
Batiste	2	68.7 Dacron 31.3 Cotton	Plain	45.60	.008	2.90	103	98	46.0	60.0			1.6	1.6			26.0z	33z
Novelty	3	51.1 Arnel 48.6 Rayon	Novelty (Dobby)	45.25	.009	2.84	149	60		26.6	76			1.4	20		2.0z	18.6z
Honey-comb	4	51.4 Arnel 48.6 Rayon	Honeycomb (Dobby)	45.00	.015	3.37	90	62	36.5			210	0.75			46	27.8z	2.4z
Surah	5	76.5 Arnel 23.5 Nylon	Twill	46.5	.009	2.55	101	73			104	114			30	27	20.0z	20.0z
Crepe	6	86.0 Acetate	Plain	44.60	.008	3.13	153	74			70	180			48	50	1.1z	30.7z

nylon. The fiber content of the crepe, fabric 6, was 86 per cent acetate and 14 per cent nylon.

Weave. Fabric 2, Dacron and cotton, and fabric 6, acetate and nylon, were both of a plain weave construction. Fabric 5, Arnel and nylon, was a twill weave. Fabric 1, Dacron; fabric 3, Arnel and cotton; and fabric 4, Arnel and rayon; were of a dobby weave construction. Fabric 1, Dacron, was a piqué; fabric 3, Arnel and cotton, was a novelty weave; and fabric 4, Arnel and rayon, was a honeycomb weave.

Width. The fabrics ranged in width from 44.6 inches for fabric 6, acetate and nylon, to 46.5 inches for fabric 5, Arnel and nylon. Fabric 4, Arnel and rayon, was 45.0 inches wide. Fabric 1, Dacron, and fabric 3, Arnel and cotton, were 45.3 inches wide each. Fabric 2, Dacron and cotton, was 45.6 inches wide.

Thickness. The fabrics ranged in thickness from 0.005 inches for fabric 1, Dacron, to 0.015 inches for fabric 4, Arnel and rayon. Fabric 2, Dacron and cotton, and fabric 6, acetate and nylon, were each 0.008 inches thick. Fabric 3, Arnel and cotton, and fabric 5, Arnel and nylon, were each 0.009 inches thick.

Weight. The fabrics ranged in weight from 1.89 ounces per square yard for fabric 1, Dacron, to 3.37 ounces per square yard for fabric 4, Arnel and rayon. Fabric 5, Arnel and nylon, weighed 2.55 ounces per square yard. Fabric 3, Arnel and cotton, weighed 2.84 ounces per square yard. Fabric 2, Dacron and cotton, weighed 2.90 ounces per square yard, and fabric 6, acetate and nylon, weighed 3.13 ounces per square yard.

Thread Count. Fabric 1, Dacron, had a warp thread count of 104

and a filling count of 79. Fabric 2, Dacron and cotton, had a warp count of 103 and a filling count of 98. Fabric 3, Arnel and cotton, had a warp count of 149 and a filling count of 60. Fabric 4, Arnel and rayon, had a warp count of 90 and a filling count of 62. Fabric 5, Arnel and nylon, had a warp count of 101 and a filling count of 73. Fabric 6, acetate and nylon, had a warp count of 153 and a filling count of 74.

Yarn Number. The yarn number is a standard measure of the fineness of yarn made from staple fibers.

The yarn number of fabric 2, Dacron and cotton, was 46 for the warp and 60 for the filling. The yarn number for the filling of fabric 3, Arnel and cotton, was 26.6. Fabric 4, Arnel and rayon, had a yarn number of 36.5 for the warp yarn.

Denier. The denier is a standard measure of the fineness of yarn made of filament fibers.

The denier of fabric 1, Dacron, was 76 for the warp and 82 for the filling. The denier of the warp of fabric 3, Arnel and cotton, was 76, and the denier of the filling of fabric 4, Arnel and rayon, was 210. Fabric 5, Arnel and nylon, had a denier of 104 for the warp and 114 for the filling. Fabric 6, acetate and nylon, had a denier of 70 for the warp and 180 for the filling.

Staple Length. The average length for the staple fibers of fabric 2, Dacron and cotton, was 1.6 inches for the warp and filling. The staple length of the filling of fabric 3, Arnel and cotton, was 1.4 inches. The staple length of the warp of fabric 4, Arnel and rayon, was 0.75 inches.

Filament Count. The filament count is the number of filaments in a yarn.

Fabric 1, Dacron, had a filament count of 30 for the warp and 32 for the filling. Fabric 3, Arnel and cotton, had a filament count of 20 for the warp yarn. There were 46 filaments in the filling yarn of fabric 4, Arnel and rayon. The filament count of fabric 5, Arnel and nylon, was 30 for the warp and 27 for the filling. Fabric 6, acetate and nylon, had a filament count of 48 for the warp and 50 for the filling.

Twist Count. The warp and filling yarns of all of the fabrics had a Z twist with the exception of the warp yarn of fabric 6, acetate and nylon, which had an S twist.

The amount of twist in fabric 1, Dacron, ranged from 10.1 turns per inch in the warp to 3 turns per inch in the filling. In fabric 2, Dacron and cotton, the amount of twist ranged from 26 turns per inch in the warp to 33 turns per inch in the filling.

The amount of twist in fabric 3, Arnel and cotton, ranged from 2.0 turns per inch in the warp to 18.6 turns per inch in the filling. Fabric 4, Arnel and rayon, had a twist count of 27.8 for the warp and 2.4 for the filling.

In fabric 5, Arnel and nylon, the amount of twist was 20 turns per inch in both the warp and filling. The amount of twist in fabric 6, acetate and nylon, ranged from 1.1 turns per inch in the warp to 30.75 turns per inch in the filling.

III. STAIN REPELLENCY

One of the objectives of this study was to determine whether certain synthetic and synthetic blend fabrics used for minimum care garments would repel certain food stains. The average rating for each sample is given in Table III. The samples were rated from 5, forms a ball on the fabric; to 1, is absorbed readily in a wide area. The analysis of variance for affinity of fabrics for stains is given in Table IV. In all of the statistical analyses, F values were considered significant only if they exceeded the one per cent level of significance.

TABLE III

AVERAGE RATINGS FOR STAIN REPELLENCY

Fabrics	Stains										Average
	A	B	C	D	E	F	G	H	I	J	
1	4.00	5.00	4.33	1.00	5.00	4.33	4.00	5.00	4.00	4.66	4.13
2	3.66	5.00	1.66	4.00	3.66	1.00	4.00	3.33	4.00	3.66	3.40
3	4.33	5.00	3.66	5.00	5.00	4.00	4.66	4.00	5.00	5.00	4.57
4	5.00	5.00	2.66	4.33	5.00	4.00	5.00	4.66	5.00	5.00	4.57
5	4.00	5.00	1.00	2.00	4.33	1.00	4.00	2.66	4.00	1.00	2.90
6	3.66	5.00	2.00	2.00	4.00	1.33	4.00	2.00	4.00	2.66	3.07
Average	4.10	5.00	2.55	3.05	4.50	2.61	4.27	3.61	4.33	3.66	

Fabrics

1 Dacron
2 Dacron and Cotton
3 Arnel and Cotton
4 Arnel and Rayon
5 Arnel and Nylon
6 Acetate and Nylon

Stains

A Catsup
B Chocolate Sauce
C Coffee with Cream and Sugar
D Cola Drink
E French Dressing
F Grape Juice
G Gravy
H Margarine
I Mustard
J Tea with Sugar

Rating

5 Forms a ball on the fabric
4 Forms a ball on the fabric, then is absorbed
3 Is not absorbed readily, nor built up on the fabric
2 Is absorbed readily in a small area
1 Is absorbed readily in a wide area

TABLE IV

ANALYSIS OF VARIANCE FOR STAIN REPELLENCY

FOR A 2-FACTOR FACTORIAL

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square	F	F 0.01
Replicates	2	0.01	0.005	0.04	4.78
Treatments					
A-Stains	9	124.90	13.880	115.67*	2.56
B-Fabrics	5	98.76	19.750	164.58*	3.17
AB-Stains x Fabrics	45	78.40	1.740	0.15	1.75
Experimental Error	118	14.66	0.120		
Total	179	316.73			

*Significant

Replicates. The analysis of variance indicated that the difference between the replicates was not statistically significant.

Stains. The analysis of variance indicated a statistically significant difference in the extent to which the stains were absorbed by the fabrics. The average rating for each stain is given in Table III. The range was from 5.00 for the chocolate sauce to 2.55 for the coffee with cream and sugar. The difference in the ratings appeared to be caused by the nature of the stain, since the more liquid stains had lower ratings.

Fabrics. The analysis of variance indicated a statistically significant difference in the degree of absorption of the stains by the fabrics. The average rating for the absorption of each fabric is given in Table III.

Fabric 3 and Fabric 4 had the same score, 4.57, indicating that these fabrics repelled the stains to a greater degree. Fabric 5 had a score of 2.90, indicating that it absorbed the stains more than the other fabrics.

Interaction of Stains and Fabrics. The analysis of variance indicated there was no statistically significant interaction between the fabrics and the stains.

IV. STAIN REMOVAL USING THE LAUNDER-OMETER (METHOD I AND METHOD II)

Another objective of this study was to determine whether ten selected food stains could be removed from six selected synthetic and synthetic blend fabrics by laundering conditions simulating that of the home washer. Method I was washing immediately after staining. Method II was washing after the stain had been aged for one week. The average rating for each of the samples is given in Table V. The samples were rated from 5, no evidence of stain, to 1, no evidence of removal. The analysis of variance for stain removal is given in Table VI.

Replicates. The analysis of variance showed a statistically significant difference in the replicates. This indicated that the three judges were not in agreement. The totals of the scores of the individual judges were 530, 548, and 548. The total of 530 indicated that this judge was more critical than the other judges.

Launderings. The analysis of variance showed no statistically significant difference between the immediate and delayed launderings.

TABLE V

AVERAGE RATINGS FOR STAIN REMOVAL

(Method I and Method II)

Fabric	Method	Stains										Average
		A	B	C	D	E	F	G	H	I	J	
1	I	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
	II	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
	Average	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
2	I	5.00	4.00	5.00	5.00	5.00	4.33	5.00	5.00	5.00	4.66	4.79
	II	5.00	3.33	5.00	5.00	4.66	4.00	5.00	5.00	4.66	3.66	4.53
	Average	5.00	3.66	5.00	5.00	4.83	4.16	5.00	5.00	4.83	4.16	4.66
3	I	5.00	4.66	5.00	5.00	5.00	4.33	5.00	5.00	3.66	4.33	4.69
	II	4.66	5.00	5.00	5.00	5.00	4.33	5.00	5.00	4.00	4.66	4.77
	Average	4.83	4.83	5.00	5.00	5.00	4.33	5.00	5.00	3.83	4.49	4.73
4	I	3.66	2.66	2.33	5.00	4.33	2.00	4.00	5.00	3.66	2.66	3.53
	II	4.00	2.66	2.66	4.00	4.66	2.00	4.00	4.66	3.66	2.33	3.46
	Average	3.83	2.66	2.49	4.50	4.49	2.00	4.00	4.83	3.66	2.49	3.49
5	I	5.00	5.00	5.00	5.00	5.00	4.00	5.00	4.66	3.00	5.00	4.67
	II	4.66	4.33	5.00	5.00	5.00	3.33	5.00	5.00	4.00	4.33	4.57
	Average	4.83	4.66	5.00	5.00	5.00	3.66	5.00	4.83	3.50	4.66	4.62
6	I	5.00	4.00	5.00	5.00	4.66	4.66	5.00	5.00	2.66	4.66	4.56
	II	5.00	3.00	5.00	5.00	5.00	4.33	5.00	5.00	3.66	5.00	4.60
	Average	5.00	3.50	5.00	5.00	4.83	4.49	5.00	5.00	3.16	4.83	4.58
Average	I	4.77	4.26	4.55	5.00	4.83	4.05	4.83	4.94	3.83	4.38	
	II	4.72	3.88	4.61	4.83	4.88	3.83	4.83	4.94	4.16	4.13	
	I and II	4.74	4.07	4.58	4.91	4.85	3.94	4.83	4.94	3.99	4.25	

C O D E

Fabrics	Stains	Rating	Methods
1 Dacron	A Catsup	5 No evidence of stain	I Stain applied and immediately laundered
2 Dacron and cotton	B Chocolate sauce	4 Some evidence of stain	II Stain applied and laundered after aging for one week
3 Arnel and cotton	C Coffee with cream and sugar	3 Moderate evidence of stain	
4 Arnel and rayon	D Cola drink	2 Some evidence of removal	
5 Arnel and Nylon	E French dressing	1 No evidence of removal	
6 Acetate and Nylon	F Grape juice		
	G Gravy		
	H Margarine		
	I Mustard		
	J Tea with sugar		

TABLE VI

ANALYSIS OF VARIANCE

FOR STAIN REMOVAL FOR A 3-FACTOR FACTORIAL

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square	F	F .01
Replicates	2	1.80	0.90	20.00*	4.71
Treatments					
A-Launderings	1	0.27	0.27	6.00	6.76
B-Stains	9	53.45	5.94	132.00*	2.50
C-Fabrics	5	81.06	16.21	360.20*	3.11
AB-Launderings x Stains	9	2.95	0.33	7.40*	2.50
AC-Launderings x Fabrics	5	1.10	0.22	4.90*	3.11
BC-Stains x Fabrics	45	64.39	1.43	31.80*	1.69
ABC-Launderings x Stains x Fabrics	45	24.68	0.55	12.20*	1.69
Experimental Error	238	10.70	0.045		
Total	359	240.40			

* Significant

The average rating for the immediate laundering was 4.54, and the average rating for the delayed laundering was 4.49.

Stains. The analysis of variance indicated a statistically significant difference between the stains in the extent to which they were removed from the fabrics. The average rating for each stain is given in Table V. The range of ratings was from 4.94 for the margarine to 3.94 for the grape juice. The differences between the ratings appeared to be caused by the coloring matter contained in the stains.

Fabrics. The analysis of variance indicated a statistically significant difference between the fabrics in the extent that the stains were removed from the fabrics. The average rating for each fabric is given in Table V. The range of the ratings was from 5.00 for Fabric 1 to 3.49 for Fabric 4. The greatest difference between the fabrics appeared to be with Fabric 4, Arnel and rayon. This difference may have been caused by the combination of Arnel and rayon fibers, the staple length (0.75 inches) of the rayon fiber, or the weave (honeycomb) of the fabric.

Interactions

Launderings and Stains. The analysis of variance indicated a statistically significant interaction between the launderings and the stains. The average ratings for the launderings and stains are given in Table V. Differences between the ratings of immediate and delayed launderings ranged from 0.00 to 0.38. There appeared to be interactions between the launderings and stains for the chocolate sauce, cola drink, grape juice, mustard, and tea with sugar.

Launderings and Fabrics. The analysis of variance indicated a statistically significant interaction between the launderings and the fabrics. The average ratings for the launderings and the fabrics are given in Table V. Differences between the ratings of the immediate and delayed launderings ranged from 0.00 to 0.26. Fabric 2 had a difference of 0.26, indicating that this fabric was most affected by delayed laundering.

Stains and Fabrics. The analysis of variance indicated a statistically significant interaction between the stains and the fabrics. The average ratings for the stains and fabrics are given in Table V. From the ratings, there appeared to be interactions between:

Fabric 4 and mustard
Fabric 5 and grape juice
Fabric 5 and mustard
Fabric 6 and chocolate sauce
Fabric 6 and mustard

Launderings, Stains, and Fabrics. The analysis of variance indicated a statistically significant interaction between the launderings, stains, and fabrics. The average ratings for the launderings, stains, and fabrics are given in Table V. Significant interactions appeared to be between the launderings and the following fabrics and stains:

Fabric 2 and tea with sugar
Fabric 5 and chocolate sauce
Fabric 5 and grape juice
Fabric 5 and mustard
Fabric 5 and tea with sugar
Fabric 6 and chocolate sauce
Fabric 6 and mustard

V. STAIN REMOVAL BY RECOMMENDED TREATMENTS (METHOD III AND METHOD IV)

The stains which were not given a rating of 5 by each of the three judges were treated by methods recommended by Mellan.[1] In Method III, the treatment was applied immediately after staining. In Method IV, the treatment was applied after the stain had aged for one week. New samples were cut and stained for both Methods III and IV.

Due to the procedures used in removing the stains in Methods III and IV, the samples could not be rated subjectively in the same manner as Methods I and II. Neither Method III nor Method IV permitted statistical analysis due to variables which could not be controlled. The rating of the samples to be treated by Method III and Method IV are shown in Table VII.

During the testing, the investigator, the investigator of the parallel study, and a student assistant determined whether the stain was completely removed before another technique for removal was employed. This was necessary since some of the treatments were in steps and various additional steps were taken depending on the reaction of the previous ones.

Stains

Some of the stains were removed by the recommended treatments by

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[1] Ibert Mellan and Eleanor Mellan, Removing Spots and Stains (New York: Chemical Publishing Company, 1959), pp. 49-90.

TABLE VII

AVERAGE RATINGS FOR STAINS TO BE TREATED BY METHODS III AND IV

Fabric	Method	Stains									
		A	B	C	D	E	F	G	H	I	J
1	I										
	II										
2	I		4.00				4.33				4.66
	II		3.33			4.66	4.00			4.66	3.66
3	I		4.66				4.33			3.66	4.33
	II	4.66					4.33			4.00	4.66
4	I	3.66	2.66	2.33		4.33	2.00	4.00		3.66	2.66
	II	4.00	2.66	2.66	4.00	4.66	2.00	4.00	4.66	3.66	2.33
5	I						4.00		4.66	3.00	
	II	4.66	4.33				3.33			4.00	4.33
6	I		4.00			4.66	4.66			2.66	4.66
	II		3.00				4.33			3.66	

C O D E

Fabrics

1 Dacron
2 Dacron and cotton
3 Arnel and cotton
4 Arnel and rayon
5 Arnel and Nylon
6 Acetate and Nylon

Stains

A Catsup
B Chocolate sauce
C Coffee with cream and sugar
D Cola drink
E French dressing
F Grape juice
G Gravy
H Margarine
I Mustard
J Tea with sugar

Methods

I Stain applied and immediately laundered
II Stain applied and laundered after aging for one week
III Stain applied and treated by a procedure recommended by Mellan immediately
IV Stain applied and treated by a procedure recommended by Mellan after aging for one week

Rating

5 No evidence of stain
4 Some evidence of stain
3 Moderate evidence of stain
2 Some evidence of removal
1 No evidence of removal

Mellan.[2] Other stains required additional bleaching or a different treatment. When bleaching was necessary a 3% hydrogen peroxide or a hydrogen peroxide-sodium perborate bleach was used.

Catsup. The catsup was not removed from Fabric 4 with immediate laundering (Method I). With delayed laundering (Method II), it was not removed from Fabrics 3, 4, and 5. The stain was moistened with warm water, loosened with warm glycerin, and flushed out with water. A paste of protein digestant was applied to the stain. The paste and stain was moistened frequently with warm water, and at the end of thirty minutes, the stain was flushed out with warm water. Then the stain was feathered out. Since this treatment did not completely remove the stain, it was bleached. This removed the stain from Fabrics 3 (Arnel and cotton) and 5 (Arnel and nylon). The remaining stain in Fabric 4 (Arnel and rayon) was removed by further bleaching.

Chocolate Sauce. The chocolate sauce was not removed from Fabrics 2, 3, 4, and 6 with immediate laundering (Method I). With delayed laundering (Method II), the stain was not removed from Fabrics 2, 4, 5, and 6. The stained fabrics were washed by hand in warm, soapy water. This removed the stain from all of the fabrics with the exception of Fabric 4 (Arnel and rayon). This fabric was then bleached and washed in warm, soapy water. A trace of the stain continued to remain in this fabric.

Coffee with Cream and Sugar. This stain was removed from all of

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[2] Ibid.

the fabrics with the exception of Fabric 4 (Arnel and rayon) with immediate and delayed launderings (Methods I and II). The stain was sponged with lukewarm water and loosened by warm glycerin. After thirty minutes, the stain was feathered out, and the fabric was dried. A paste of protein digestant was applied to the remaining stain and left on the stain for thirty minutes. The stain was moistened frequently with warm water, and then it was flushed out with water. A trace of the stain remained, so the samples were bleached and washed with warm, soapy water. A trace of the stain continued to remain in this fabric.

Cola Drink. The cola drink was not removed from Fabric 4 (Arnel and rayon) with the delayed laundering (Method II). This stain was saturated with warm glycerin, loosened with a brush, flushed out with water, and feathered out. This treatment removed the stain.

French Dressing. The French dressing was not removed from Fabrics 4 and 6 with immediate laundering (Method I). It was not removed from Fabrics 2 and 4 with delayed laundering (Method II). A paste of cornstarch and naphtha was applied and brushed off when dry. This procedure was repeated. Since the stain was not completely removed, the samples were washed by hand in warm, soapy water. This treatment removed the stain.

Grape Juice. The grape juice was not removed from Fabrics 2, 3, 4, 5, and 6 by immediate nor delayed laundering (Methods I and II). The stain was loosened with warm glycerin. Then the samples were soaked in a solution of hydrogen peroxide and soap with a pH of 8 at 120° F. for two hours. This solution was recommended by the American Institute of

Laundering.[3] This treatment removed the stain with the exception of that in Fabric 4 (Arnel and rayon).

Gravy. This gravy was not removed from Fabric 4 (Arnel and rayon) with immediate nor delayed laundering (Methods I and II). The stained samples were soaked and then washed by hand in warm, soapy water. Final traces of the stain were removed by bleaching.

Margarine. The margarine was not removed from Fabric 5 by immediate laundering (Method I) nor from Fabric 4 by delayed laundering (Method II). The stain was saturated with naphtha, loosened with a brush, flushed out with naphtha, and feathered out. This treatment removed the stain.

Mustard. The mustard stain was not removed from Fabrics 3, 4, 5, and 6 with immediate laundering (Method I). It was not removed from Fabrics 2, 3, 4, 5, and 6 with delayed laundering (Method II). The stain was moistened with warm water, and warm glycerin was rubbed into the stain. The samples were soaked in warm, soapy water, rinsed, and bleached. This procedure did not remove the stain.

Various treatments in addition to the above recommended treatment by Mellan were used.[4]

New samples were prepared, and warm glycerin was rubbed into the stain. The samples were washed in the Launder-Ometer in the same manner as Methods I and II. This procedure did not remove the stain.

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[3] How to Remove Stains, Special Report No. 134 (Joliet: American Institute of Laundering), p. 18.

[4] Mellan, op. cit., p. 77.

New samples were prepared and washed in an acid shampoo solution in the Launder-Ometer in the same manner as Methods I and II. This process did not remove the stain.

None of the above treatments were as effective as Methods I and II. Therefore, new samples were washed in the Launder-Ometer with a five per cent soap solution in the same manner as Methods I and II. The samples were then bleached by direct sunlight for four and one-half hours. This removed the stain.

Tea with Sugar. The tea with sugar was not removed from Fabrics 2, 3, 4, and 6 by immediate laundering (Method I). The stains were not removed from Fabrics 2, 3, 4, and 5 by delayed laundering (Method II). The stain was flushed out with water, loosened with warm glycerin, and washed by hand in warm, soapy water. This removed the stain with the exception of that on Fabric 4 (Arnel and rayon). These samples were bleached and washed by hand in warm, soapy water. Traces of the stain remained in this fabric.

Fabrics

All of the fabrics were treated in the same manner. Since the fabrics were partially or completely composed of man-made fibers, none of the stains were treated with boiling water. Since some of the fabrics contained Arnel or acetate, none of the stains were treated with acetic acid, even though acetic acid was recommended for removing difficult grape juice and tea stains.

Dacron. All of the stains were removed from this fabric by immediate and delayed laundering (Methods I and II).

Dacron and Cotton. The stains on this fabric which were not removed by Methods I and II were removed by washing in warm, soapy water or by treatments with glycerin, naphtha, or bleaches.

Arnel and Cotton. The stains on this fabric which were not removed by Methods I and II were removed by washing in warm, soapy water or by treatments with glycerin or bleaches.

Arnel and Rayon. This fabric required more bleaching than the other fabrics in treating the catsup, chocolate sauce, grape juice, and tea with sugar stains. It was the only fabric which had to be treated by Methods III and IV to remove the coffee with cream and sugar, cola drink, and gravy stains, and it was the only fabric in which all of the stains were not removed. The chocolate sauce, coffee with cream and sugar, grape juice, and tea with sugar stains were not removed from this fabric by treatment in either Method III or Method IV.

Arnel and Nylon. The stains on this fabric, which were not removed by immediate and delayed laundering, were removed by washing in warm, soapy water or by treatments with glycerin, protein digestant, naphtha, or bleaches.

Acetate and Nylon. The stains on this fabric, which were not removed by immediate and delayed laundering, were removed by washing in warm, soapy water or by treatments with glycerin, naphtha, or bleaches.

VI. COMPARISON OF STAIN REPELLENCY OF SYNTHETIC AND SYNTHETIC BLEND FABRICS WITH COTTON WASH-WEAR FABRICS

It was also an objective of this study to compare the stain resisting characteristics of the synthetic and synthetic blend fabrics used

in this study with the cotton wash-wear fabrics used in the parallel study.[5] The selected food stains were the same for both studies.

The two cotton wash-wear fabrics were the same basic fabric: a desized, boiled and bleached 80 x 80 cotton print cloth which was commercially mercerized. One of the fabrics, Number 7 in Table VIII, was treated with dimethylol cyclic ethyleneurea (DMEU) and polyethylene additive softener. The other fabric, Number 8 in Table VIII, was treated with dimethylol ethyl traizone (DMET) and polyethylene additive softener. The average rating for each sample is given in Table VIII. The samples were rated from 5, forms a ball on the fabric; to 1, is absorbed readily in a wide area. The analysis of variance for comparison of stain repellency is given in Table IX.

Replicates. The analysis of variance indicated there was no statistically significant difference between the replicates.

Stains. The analysis of variance indicated a statistically significant difference in the extent to which the stains were repelled by the fabrics. The average rating for each stain is given in Table VIII. The range of the ratings for the stains was from 4.92 for the chocolate sauce to 2.96 for the coffee with cream and sugar. Since the more liquid stains were absorbed to a greater degree, the differences in the ratings may have been caused by the nature of the stain.

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[5] Alice J. Willingham, "Staining Characteristics of Cotton Wash-Wear Fabrics," (unpublished Grant-in-Aid, No. 91, The Research Council, The Woman's College of the University of North Carolina, Greensboro, 1961).

TABLE VIII

AVERAGE RATINGS FOR COMPARISON OF STAIN REPELLENCY

Fabrics	Stains										Average
	A	B	C	D	E	F	G	H	I	J	
1	4.00	5.00	4.33	1.00	5.00	4.33	4.00	5.00	4.00	4.66	4.13
2	3.66	5.00	1.66	4.00	3.66	1.00	4.00	3.33	4.00	3.66	3.40
3	4.33	5.00	3.66	5.00	5.00	4.00	4.66	4.00	5.00	5.00	4.57
4	5.00	5.00	2.66	4.33	5.00	4.00	5.00	4.66	5.00	5.00	4.57
5	4.00	5.00	1.00	2.00	4.33	1.00	4.00	2.66	4.00	1.00	2.90
6	3.66	5.00	2.00	2.00	4.00	1.33	4.00	2.00	4.00	2.66	3.07
7	4.66	5.00	4.33	5.00	4.00	5.00	4.00	2.00	4.00	4.33	4.23
8	4.00	4.33	4.00	5.00	4.00	4.66	4.00	1.66	4.00	4.66	4.03
Average	4.17	4.92	2.96	3.54	4.38	3.17	4.20	3.17	4.25	3.88	

Fabrics

1 Dacron
2 Dacron and Cotton
3 Arnel and Cotton
4 Arnel and Rayon
5 Arnel and Nylon
6 Acetate and Nylon
7 Wash-wear Cotton (DMEU)
8 Wash-wear Cotton (DMET)

Stains

A Catsup
B Chocolate Sauce
C Coffee with Cream and Sugar
D Cola Drink
E French Dressing
F Grape Juice
G Gravy
H Margarine
I Mustard
J Tea and Sugar

Rating

5 Forms a ball on the fabric
4 Forms a ball on the fabric, then is absorbed
3 Is not absorbed readily; nor built up on the fabric
2 Is absorbed readily in a small area
1 Is absorbed readily in a wide area

TABLE IX

ANALYSIS OF VARIANCE FOR COMPARISON OF STAIN REPELLENCY FOR A 2-FACTOR FACTORIAL

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	F	F 0.01
Replicates	2	0.29	0.15	1.00	4.75
Treatments					
A-Stains	9	87.00	9.67	64.46*	2.53
B-Fabrics	7	90.16	12.88	85.86*	2.76
AB-Stains x Fabrics	63	201.30	3.20	21.33*	1.56
Experimental Error	158	24.38	0.15		
Total	239	403.13			

* Significant

Fabrics. The analysis of variance indicated a statistically significant difference in the extent to which the fabrics absorbed the stains. The average rating for each fabric is given in Table VIII. The range of the ratings for the fabrics was from 4.57 for Fabric 3 (Arnel and cotton) and for Fabric 4 (Arnel and rayon) to 2.90 for Fabric 5 (Arnel and nylon). The cotton wash-wear fabrics were within this range. Fabric 7 (DMEU) had a rating of 4.23, and Fabric 8 (DMET) had a rating of 4.03.

Interaction of Stains and Fabrics. The analysis of variance indicated a statistically significant interaction between the fabrics

and stains. The average ratings for the stains and fabrics are given in Table VIII. From the ratings, the interactions appeared to be between Fabric 1 and the cola drink, Fabric 7 and the margarine, and Fabric 8 and the margarine.

VII. COMPARISON OF STAIN REMOVAL FROM SYNTHETIC AND SYNTHETIC BLEND FABRICS WITH COTTON WASH-WEAR FABRICS (METHOD I AND METHOD II)

One of the objectives of this study was to compare the stain removal of selected food stains from selected synthetic and synthetic blend fabrics with the stain removal of the same food stains from cotton wash-wear fabrics. The cotton wash-wear fabrics were those used in the parallel study.[6]

The average rating for each sample is given in Table X. The samples were rated from 5, no evidence of stain; to 1, no evidence of removal. The analysis of variance for comparison of stain removal is given in Table XI.

Replicates. The analysis of variance showed a statistically significant difference in the replicates. This indicated that the three judges were not in agreement. The totals of the ratings of the individual judges were 701, 715, and 722.

Launderings. The analysis of variance indicated a statistically

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[6] Ibid.

TABLE X

AVERAGE RATINGS FOR COMPARISON OF STAIN REMOVAL

(Method I and Method II)

Fabric	Method	Stains										Average
		A	B	C	D	E	F	G	H	I	J	
1	I	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
	II	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
	Average	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
2	I	5.00	4.00	5.00	5.00	5.00	4.33	5.00	5.00	5.00	4.66	4.79
	II	5.00	3.33	5.00	5.00	4.66	4.00	5.00	5.00	4.66	3.66	4.53
	Average	5.00	3.66	5.00	5.00	4.83	4.16	5.00	5.00	4.83	4.16	4.66
3	I	5.00	4.66	5.00	5.00	5.00	4.33	5.00	5.00	3.66	4.33	4.69
	II	4.66	5.00	5.00	5.00	5.00	4.33	5.00	5.00	4.00	4.66	4.77
	Average	4.83	4.83	5.00	5.00	5.00	4.33	5.00	5.00	3.83	4.49	4.73
4	I	3.66	2.66	2.33	5.00	4.33	2.00	4.00	5.00	3.66	2.66	3.53
	II	4.00	2.66	2.66	4.00	4.66	2.00	4.00	4.66	3.66	2.33	3.46
	Average	3.83	2.66	2.49	4.50	4.49	2.00	4.00	4.83	3.66	2.49	3.49
5	I	5.00	5.00	5.00	5.00	5.00	4.00	5.00	4.66	3.00	5.00	4.67
	II	4.66	4.33	5.00	5.00	5.00	3.33	5.00	5.00	4.00	4.33	4.57
	Average	4.83	4.66	5.00	5.00	5.00	3.66	5.00	4.83	3.50	4.66	4.62
6	I	5.00	4.00	5.00	5.00	4.66	4.66	5.00	5.00	2.66	4.66	4.56
	II	5.00	3.00	5.00	5.00	5.00	4.33	5.00	5.00	3.66	5.00	4.60
	Average	5.00	3.50	5.00	5.00	4.83	4.49	5.00	5.00	3.16	4.83	4.58

7	I	4.66	4.00	4.33	5.00	5.00	4.00	4.66	4.66	4.00	4.66	4.50
	II	5.00	4.00	4.00	5.00	5.00	2.66	5.00	4.66	2.66	3.66	4.16
	Average	4.83	4.00	4.16	5.00	5.00	3.33	4.83	4.66	3.33	4.16	4.33
8	I	5.00	4.33	4.00	5.00	4.00	4.00	5.00	3.66	4.00	4.66	4.37
	II	5.00	5.00	3.66	5.00	4.00	3.00	5.00	3.00	3.00	3.66	4.03
	Average	5.00	4.66	3.83	5.00	4.00	3.50	5.00	3.33	3.66	4.16	4.20
Averages	I	4.80	4.20	4.36	5.00	4.67	4.03	4.83	4.55	3.91	4.52	
	II	4.86	4.04	4.22	4.91	4.69	3.33	4.91	4.39	3.49	3.89	
	I and II	4.83	4.12	4.29	4.96	4.68	3.68	4.87	4.47	3.70	4.20	

C O D E

Fabrics

1 Dacron
2 Dacron and cotton
3 Arnel and cotton
4 Arnel and Rayon
5 Arnel and Nylon
6 Acetate and Nylon
7 Wash-wear cotton (DMEU)
8 Wash-wear cotton (DMET)

Stains

A Catsup
B Chocolate sauce
C Coffee with cream and sugar
D Cola drink
E French dressing
F Grape juice
G Gravy
H Margarine
I Mustard
J Tea with sugar

Methods

I Stain applied and immediately laundered
II Stain applied and laundered after aging for one week.

Rating

5 No evidence of stain
4 Some evidence of stain
3 Moderate evidence of stain
2 Some evidence of removal
1 No evidence of removal

TABLE XI

ANALYSIS OF VARIANCE

FOR COMPARISON OF STAIN REMOVAL FOR A 3-FACTOR FACTORIAL

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square	F	F 0.01
Replicates	2	1.44	0.72	6.50*	4.66
Treatments					
A-Launderings	1	1.88	1.88	17.09*	6.70
B-Stains	9	66.85	7.42	67.45*	2.46
C-Fabrics	7	87.23	12.46	113.27*	2.69
AB-Launderings x Stains	9	13.10	1.45	13.18*	2.46
AC-Launderings x Fabrics	7	2.82	0.40	3.63*	2.69
BC-Stains x Fabrics	63	103.92	1.64	14.90*	1.47
ABC-Launderings x Stains x Fabrics	63	1.87	0.03	0.27	1.47
Experimental Error	318	35.89	0.11		
Total	479	315.00			

* Significant

significant difference between the immediate and delayed launderings. The average ratings for the launderings are given in Table X. There was a difference of 0.12 between the immediate and delayed launderings, indicating that the stains were more difficult to remove after aging for one week.

Stains. The analysis of variance indicated a statistically significant difference between the stains in the extent to which they were

removed from the fabrics. The average rating for each stain is given in Table X. The range of ratings for the stains was from 4.96 for the cola drink to 3.68 for the grape juice. The difference appeared to be caused by the coloring matter in the stains.

Fabrics. The analysis of variance indicated a statistically significant difference between the fabrics in the extent to which the stains were removed from the fabrics. The average rating for each fabric is given in Table X. The range of the ratings for the fabrics was from 5.00 for Fabric 1 (Dacron) to 3.49 for Fabric 4 (Arnel and rayon). With the exception of Fabric 4, the cotton wash-wear fabrics ranked at least 0.25 below the synthetic and synthetic blend fabrics.

Interactions

Launderings and Stains. The analysis of variance indicated a statistically significant interaction between the launderings and the stains. The average ratings for the launderings and stains are given in Table X. The difference between the ratings for the immediate and delayed launderings ranged from 0.00 to 0.70. The interactions appeared to occur between the launderings and the grape juice, mustard, and tea with sugar stains.

Launderings and Fabrics. The analysis of variance indicated a statistically significant interaction between the launderings and fabrics. The average ratings for the launderings and fabrics are given in Table X. The differences between the ratings for the immediate and delayed launderings for the fabrics ranged from 0.00 to 0.34. There appeared to be interactions between the launderings and Fabrics 2, 7, and 8.

Stains and Fabrics. The analysis of variance indicated a statistically significant interaction between the stains and the fabrics. The average ratings for the stains and fabrics are given in Table X. From the ratings, there appeared to be interactions between:

Fabric 4 and mustard
Fabric 5 and grape juice
Fabric 5 and mustard
Fabric 6 and chocolate sauce
Fabric 6 and mustard
Fabric 7 and grape juice
Fabric 7 and mustard
Fabric 8 and french dressing
Fabric 8 and margarine

Launderings, Stains, and Fabrics. The analysis of variance indicated there was statistically no significant interaction between the launderings, stains, and fabrics.

VIII. COMPARISON OF SYNTHETIC AND SYNTHETIC BLEND FABRICS WITH COTTON WASH-WEAR FABRICS (STAIN REMOVAL BY RECOMMENDED TREATMENTS)

Another objective of this study was to compare the stain removal of certain food stains from selected synthetic and synthetic blend fabrics with the stain removal of the same food stains from cotton wash-wear fabrics. The cotton wash-wear fabrics were those used in the parallel study.[7]

The stains which were not given a rating of 5 by each of the three

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[7] Ibid.

judges were treated by methods recommended by Mellan.[8] Method III was the treatment immediately after staining. Method IV was the treatment after the stain had aged for one week. The samples which had to be treated by Methods III and IV are shown in Table XII. This table shows the stains which were removed by recommended treatments, the stains which had to be bleached for removal, and the stains which were not removed by recommended treatments.

The most effective treatments for the cotton wash-wear fabrics were the same as the treatments for the synthetic and synthetic blend fabrics.

The stains were removed from all the synthetic and synthetic blend fabrics with the exception of the Arnel and rayon fabric. Traces of the chocolate sauce, coffee with cream and sugar, grape juice, and tea with sugar stains remained in this fabric.

All of the stains were removed from the cotton wash-wear fabrics with the exception of the grape juice by Method IV in fabric 7 (DMEU) and the mustard with both methods in fabric 7 (DMEU) and fabric 8 (DMET).

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[8] Mellan, op. cit.

TABLE XII

COMPARISON OF SYNTHETIC AND SYNTHETIC BLEND FABRICS WITH COTTON WASH-WEAR FABRICS

(STAIN REMOVAL BY RECOMMENDED TREATMENTS)

Fabric	Method	Stain									
		A	B	C	D	E	F	G	H	I	J
1	III										
	IV										
2	III		X				XB				X
	IV		X			X	XB			XB	X
3	III		X				XB			XB	X
	IV	XB					XB			XB	X
4	III	XB	OB	OB		X	OB	XB		XB	OB
	IV	XB	OB	OB	X	X	OB	XB	X	XB	OB
5	III						XB		X	XB	
	IV	XB	X				XB			XB	X
6	III		X			X	XB			XB	
	IV		X				XB			XB	X
7	III	X	X	XB			XB	X	X	OB	XB
	IV		X	XB			OB		X	OB	XB
8	III		X	XB		X	XB		X	OB	XB
	IV			XB		X	XB		X	OB	XB

C O D E

Fabrics

1 Dacron
2 Dacron and cotton
3 Arnel and cotton
4 Arnel and rayon
5 Arnel and Nylon
6 Acetate and Nylon
7 Wash-wear cotton (DMEU)
8 Wash-wear cotton (DMET)

Stains

A Catsup
B Chocolate sauce
C Coffee with cream and sugar
D Cola drink
E French dressing
F Grape juice
G Gravy
H Margarine
I Mustard
J Tea with sugar

Methods

III Stain applied and treated by a recommended procedure immediately

IV Stain applied and treated by a recommended procedure after aging for one week

Ratings

X Removed when treated by recommended method, not bleached

XB Removed when treated by recommended method and bleached

OB Treated by recommended method, bleached, but not removed

CHAPTER V

SUMMARY AND CONCLUSIONS

The synthetic fibers have been accepted by the textile industry and by consumers for their vital role in "minimum care" garments. The synthetic fibers are being used singly, in blends and combinations with the natural fibers, and in blends and combinations with other synthetic fibers.

Removal of food stains has long been a problem to the consumer. This problem has been solved to some extent in relation to fabrics made of natural fibers. The hydrophobic and thermoplastic characteristics of the synthetic fibers would be likely to influence the staining characteristics of fabrics made from them. It is also likely that these characteristics of the synthetic fibers would create problems for the consumer in the effective treatment of stains.

The purposes of this study were:

1. To compare the stain repellency of selected synthetic blends and combination fabrics used for "minimum care" garments.

2. To evaluate the effectiveness of stain removal at differing periods of time and by different treatments.

    a. Stain applied and immediately laundered
    b. Stain applied and laundered after aging for one week.
    c. Stain applied and treated by a recommended procedure immediately.
    d. Stain applied and treated by a recommended procedure after aging for one week.

3. To compare results with those of a similar study using cotton fabrics treated for wash and wear characteristics.[1]

Six synthetic and synthetic blend fabrics were selected for their similarity and identity to the fabrics used in ready-to-wear garments. They consisted of fabrics possessing characteristics for wash and wear or minimum care, which were of the type used for blouses and shirts. The fabrics were a Dacron, a Dacron and cotton blend, an Arnel and cotton combination, an Arnel and nylon blend, and an acetate and nylon blend.

The ten food stains were selected for their differences in staining characteristics, variety of ingredients in make-up, and for their frequency in being a problem to the consumer. The stains were the same as those used in the parallel study using cotton fabrics treated for wash and wear characteristics. The stains were catsup, chocolate sauce, coffee with cream and sugar, cola drink, French dressing, grape juice, gravy, margarine, mustard, and tea with sugar.

Samples of the fabric were placed on a blotter. One drop of stain was used on each sample. After five minutes, any staining agent which was not absorbed was removed by blotting with a tissue.

Four methods were used for removing the stains. In Method I, the samples were washed immediately after staining in a five per cent soap solution for twenty minutes at 140° F. The samples were then rinsed two times and placed on a towel to dry.

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[1] Alice J. Willingham, "Staining Characteristics of Cotton Wash-Wear Fabrics," (unpublished Grant-in-Aid, No. 91, The Research Council, The Woman's College of the University of North Carolina, Greensboro, 1961).

In Method II, the stained samples were allowed to age for one week before laundering. The procedure of washing, rinsing, and drying was the same as in Method I.

Those stains not completely removed in Methods I and II were subjected to further study in Methods III and IV. In these methods techniques adapted from procedures recommended by Mellan were applied to each of the stained samples.[2] Method III was the treatment of the stain immediately after application. Method IV was the treatment of the stain which had aged for one week.

As a result of this study, the following conclusions can be drawn:

1. The synthetic and synthetic blend fabrics repelled the stains of a thicker consistency. The cotton wash-wear fabrics repelled the stains of a more liquid nature.
2. The Arnel and cotton and the Arnel and rayon fabrics repelled the stains to the greatest extent. The Arnel and nylon fabric was the least repellent. The cotton wash-wear fabrics were within the range of the synthetic and synthetic blend fabrics for repellency.
3. The most effective method of stain removal was

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[2] Ibert Mellan and Eleanor Mellan, Removing Spots and Stains (New York: Chemical Publishing Company, 1959), pp. 49-90.

laundering in a five per cent soap solution for twenty minutes at 140° F.

a. 71.4% of the stains on the synthetic and synthetic blend fabrics were removed by this treatment.
b. 67.5% of the stains on the cotton wash-wear fabrics were removed by this treatment.
c. All of the stains were removed from the Dacron fabric by this treatment.
d. Only 10% of the stains on the Arnel and rayon fabric were removed by this treatment.
e. With the exception of the Arnel and rayon fabric, the synthetic and synthetic blend fabrics ranked higher than the cotton wash-wear fabrics for the removal of stains by this treatment.

4. The stains on the synthetic and synthetic blend fabrics which were aged for one week were removed with approximetely the same ease as those which were laundered or treated immediately after staining. The stains on the cotton wash-wear fabrics which were aged for one week were more difficult to remove.

5. The chocolate sauce, coffee with cream and sugar, grape juice, and tea with sugar stains were more difficult to remove from the synthetic and synthetic blend fabrics, while the mustard was the most difficult to remove from the cotton wash-wear fabrics.

6. Lukewarm, soapy water was effective in removing the chocolate sauce and gravy stains which were not removed by the soapy water at 140° F.

7. The stains were removed from the synthetic and synthetic blend fabrics with the exception of the Arnel and rayon fabric. The chocolate sauce, coffee with cream and sugar, grape juice, and tea with sugar stains remained in this fabric. This fabric also required more bleaching than the other synthetic and synthetic blend fabrics.

From these findings, it can be concluded that most food stains can be removed from synthetic and synthetic blend fabrics by laundering or by simple treatments.

Recommendations for further study are:

1. To investigate the extent of stain removal through using the ultraviolet light.
2. To investigate the staining characteristics of synthetic and synthetic blend fabrics of the same fabric construction.
3. To investigate the staining characteristics of synthetic and synthetic blend fabrics after laundering at 2, 5, and 10 laundering intervals.
4. To investigate the staining characteristics of synthetic and synthetic blend fabrics using other stains.

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