May 7, 1973

To the Graduate Council:

I am submitting herewith a thesis written by Karen Jean Braun entitled "An Investigation of Paste Resist Mixtures and the Effect of Nonfat Milk on Dyes." I recommend that it be accepted for nine quarter hours of credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Related Arts, Crafts, and Interior Design.

Major Professor

We have read this thesis
and recommend its acceptance:

Accepted for the Council:

Vice Chancellor for
Graduate Studies and Research

AN INVESTIGATION OF PASTE RESIST MIXTURES AND THE EFFECT OF NONFAT MILK ON DYES

A Thesis

Presented to

the Graduate Council of

The University of Tennessee

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

by

Karen Jean Braun

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ABSTRACT

This study was an investigation of the effectiveness of selected paste resist mixtures and the performance of nonfat milk as related to the effect of selected dyes on cotton fabric using the paste resist technique of fabric dyeing. A compilation of the limited information recorded concerning the historical and contemporary uses of the technique is made in the review of literature.

The ability of the resist agents to penetrate fabric and to resist the dye was studied with regard to the viscosity and ingredients of selected mixtures. The experimentation involved three paste recipes and three viscosities of those recipes. Each of the mixtures was silk screened on two samples and painted on two samples. For each of the mixtures, one of the silk screened and one of the painted on samples were immersed in dye and the remaining samples had the dye painted on. In analyzing the experimental results, it was evident that the recipe calling for flour, alum and water was most effective as a dye resist. The most viscous mixtures of the three recipes were the most effective in resisting dye. Also painting rather than silk screen printing on the mixtures, applied a resist coating that was more effective. The samples dyed by immersion were most effective in bringing out the contrast in dyed and non-dyed areas.

The performance of the nonfat milk was examined by comparing the wash fastness and light fastness of three dyes in the three primary colors on both nonfat milk treated cotton and untreated cotton. For the fastness tests, one set of dyed samples (meaning one milk coated and

one plain fabric sample for each color and kind of dye) was used for each of the two tests, with a set saved for comparison as a control group. To test for wash fastness, separate loads of each dye and color were washed in an automatic washer for one complete cycle. Light fastness was tested by exposing the dyed samples to fluorescent lighting twenty-four hours a day for eight weeks. The experimental results showed that the nonfat milk coating was effective in intensifying the color of the dyed fabric in all of the colors and kinds of dyes. Additionally, the milk coated fabric samples remained as color fast as the uncoated samples in the tests.

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CHAPTER I

INTRODUCTION

In the field of fabric decoration there are a number of dyeing techniques used to carry out the design possibilities. These methods are basically direct application, where the dye is applied directly to the fabric, and resist application, where part of the fabric is coated to resist the dye. The Javanese word "batik," although typically associated with resist dyeing, refers only to wax as the resist agent. Many other substances which will not melt or dissolve when dye is applied to fabric can be used. Clay, mud, lard, and pastes of starch and flour are used, with pastes being the most prevalent.

A subtle crackle effect in the dyed fabric is characteristic of resist dyeing, due to the brittle nature of the hardened resist agent. In normal handling of the resist-coated piece of cloth, the resist tends to crack, and when immersed in the dye-bath, dye seeps into the cracked areas producing fine lines.

Modern research has led to new resist materials, dyes, and fabrics. These improvements will naturally lead to new techniques of resist dyeing. The possibilities of this age-old method are far from being exhausted; there are many opportunities for innovation.

An investigation of the effectiveness of selected paste resist mixtures and the performance of nonfat milk as related to the effect of selected dyes on cotton fabric was made in this study. The ability of the resist agents to penetrate fabric and to resist the dye was studied

with regard to the viscosity and ingredients of selected mixtures. The performance of the nonfat milk was examined by comparing the wash fastness and light fastness of three dyes on both nonfat milk treated cotton and untreated cotton. A critical analysis was made of the effects that were visually observed.

I. Statement of the Problem

The purposes of this study, using the technique of resist dyeing, were two fold: to investigate the effectiveness of selected paste resist mixtures and to examine the performance of nonfat milk as related to the effect of selected commercial dyes on cotton fabric.

II. Reasoning for Experimentation

Due to the lack of concrete knowledge in the area of paste resist dyeing, many assumptions are made as to techniques. An explanation of the assumptions held in this study will more easily define the reasoning for experimentation.

A variety of paste resist mixtures was suggested in various references indicating the importance of the ingredients. It was believed that the ingredients used in formulating the resist pastes affect the brittleness and adhesiveness. However, it was felt these properties are not the most important of the resist. Rather, it is probably the paste's ability to penetrate the fabric and prevent dye solution from reaching it. It is possible that the most important property may be the paste's viscosity during application. A very viscuous paste cannot penetrate deeply into the fabric and consequently cannot protect the entire

thickness of the fabric when being dyed by immersion. A less viscous paste, on the other hand, is assumed to penetrate more deeply through the fabric and would resist dye when the fabric is immersed in dye.

The use of nonfat milk as a coating before dyeing was suggested in one reference to aid the fabric in holding the dye.[1] It was questionable as to whether the dye was actually reacting with the milk or with the fabric. It was assumed the former was the case, and the dye would tend to wash out with the milk when the fabric was machine washed due to the solubility of the milk. The light fastness should not be affected by the coating of milk.

III. Method of Procedure

The investigation of the effectiveness of selected paste resist mixtures and the performance of nonfat milk as related to the effect of selected dyes on cotton fabric were conducted separately. The ability of the resist agents to penetrate fabric and resist the dye was studied with regard to the viscosity and ingredients of the selected mixtures. A critical analysis was made of the effects that were visually observed. The performance of the nonfat milk was examined by comparing the wash fastness and light fastness of the three primary colors of commercial direct, household, and fiber reactive dyes on both nonfat milk treated cotton and untreated cotton. Wash fastness was tested by visual comparison of samples washed in the regular cycle of an automatic washer

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[1]Morely B. Smith, "Exciting Crafts with Dye," Better Homes and Gardens, XLVIII (September, 1970), 66.

with laundry detergent, while light fastness was examined by visual comparison of samples exposed to fluorescent lighting for a designated length of time.

IV. Delimitations

1. The fabric used in this study was limited to scoured, unbleached cotton muslin.
2. The scouring process was limited to washing the muslin in a machine washer twice using regular laundry detergent.
3. The dyes used were limited to fiber reactive, commercial direct, and two brands of household dye.
4. The brands of household and fiber reactives dyes were limited to those easily available to the consumer, while the commercial direct dye was a sample obtained from a dye company.
5. The colors of dyes used were limited to the three primary colors.
6. All dyes were applied cold.
7. The method of dyeing in the nonfat milk experiments was limited to brush application, while the paste resist experiments used both brush application and immersion.
8. The milk used in this study was limited to powdered nonfat dry milk mixed according to the processor's recommended proportions.
9. The paste resist mixtures were chosen for their ease of preparation, availability of ingredients, and variety.

10. Application of the paste mixtures was limited to brush and silk screen.
11. The viscosities were not measured and are given only in comparative terms.
12. The test for wash fastness was limited to automatic machine washing using cold water and cold water laundry detergent in proportions recommended by the manufacturer.
13. The test of light fastness was limited to exposure of the dyed samples to fluorescent lighting for eight weeks, twenty-four hours per day.

V. Organization of the Study

The first chapter of this research introduces the study, the reasoning for experimentation, the methods of procedure in carrying out the experiments, and delimitations made before the testing was begun. Chapter II is a resume of related literature, summarizing the history and current uses of the paste resist technique. A detailed description of procedures for the experimentation is presented in Chapter III with conclusions of the study and suggestions for further research presented in Chapter IV. The Appendixes include a glossary of terms, paste recipes tested, paste recipes of varying viscosities, dye recipes, and miscellaneous paste recipes.

CHAPTER II

RELATED LITERATURE

The paste resist technique of fabric dyeing is so old a craft that the true origin has never been determined. Unfortunately, no one group of people can be named as the originators of this craft, nor can the lines along which the technique may have spread from one location to another be followed. Additionally, there is no satisfying evidence that this particular technique originated in only one area, or at one time. Even data concerning the practice of the craft today are limited; a compilation of the information is not available.

As stated earlier, the origin of batik has never been determined, but it is estimated to be at least 2,000 years old. Archaeological findings prove that batiked garments were worn by the people of Egypt, Persia, India, China, Japan, and most countries in the East.[2] The origin of batik cannot be determined, nor can the spread of the technique to so many countries be traced, due to individuality of the craft in each country. It has been determined that rice starch was used as a resist before wax.[3] After the introduction of wax resist, however, paste resists were less significant, and record of their use was not made until much later.

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[2] I. Keller, Batik: The Art and Craft (Rutland, Vermont: Charles E. Tuttle Co., 1967), p. 13.

[3] Ibid.

A breakdown into regions and countries is made in reviewing more recent history and characteristic practices. Distinctions in each area make this organization imperative.

The Chinese paste resist technique is perhaps the most influential, for its effects are evident in the work of other cultures. The in-fa-pu method in the twelfth century was the first method recorded, but there is evidence of earlier work with paste resists. The in-fa-pu technique used a mixture of glutinous rice and rice bran which was boiled, mashed, and kneaded together to make the resist paste. It was then applied to the fabric by squeeze tube, stencil, and pouring.[4]

It is recorded that in the nineteenth century, Chinese country women wove the eighteen inch wide cotton to be used for dyeing. They printed or stenciled a resist paste of ashes or flour mixed with gum of glue on the fabric, then dyed the pieces indigo blue or black. The fabric was taken to the market with the paste still on for the buyer to remove.[5]

Dou fu, another technique used by the peasant women, is still practiced today. It consists of a soya bean cheese used as the resist substance. It was applied by stencil, dried, then dyed in an indigo vat. The elasticity of the dou fu substance prevents breakage and the resulting crackle effect.[6]

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[4]"Japanese Resist-dyeing Techniques," Ciba Review, IV (1967), 24.

[5]Florence H. Pettit, America's Printed and Painted Fabrics 1600-1900 (New York: Hastings House, 1970), pp. 52-53.

[6]A. Steinman, "Batik Work, It's Origin and Spread," Ciba Review, LVIII (July, 1947), 2108.

The resist dyeing practices of the Japanese were greatly influenced by the Chinese. Of particular note is the in-fa-pu methods from which some of the Japanese techniques evolved.[7]

The recipe for a Japanese paste resist combines rice and bran flour with small amounts of powdered zinc sulfate and salt. The mixture was cooked until it was transparent and of creamy consistency, then stirred until cooled.[8]

Bingata textiles, produced by the yuzen process combines several textile decoration techniques. A silk screen design was first applied to establish the motif, then resist paste was added for additional decoration. The resulting designs were famed for their bright colors, sharp lines, gradation of color, and great detail.[9]

An unusual technique, fukuje, is said to have originated in Holland, where it may have been copied from the ancient Chinese. This process utilizes the blowing of color through a brass funnel onto the parts of the cloth not covered with resist.[10]

The oriental fabrics decorated with the paste resist techniques were made with a great variety and combination of colors. Other regions use this paste technique for monochromatic color schemes, with indigo blue as the most common dye.

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[7]"Japanese Resist-dyeing Techniques," Loc. cit.

[8]Ibid.

[9]Stuart Robinson, A History of Dyed Textiles (Cambridge, Mass.: M.I.T. Press, 1969), p. 74.

[10]Ibid.

Evidence shows that paste resist dyeing may have been done in Peru during the pre-Columbian period. Their techniques were rather rudimentary and never as highly developed as in other areas.[11]

In Java, a large island of Indonesia, wax batik was so important that only in isolated districts were rice flour pastes used. Small bamboo spoons, palm leaf bag, bamboo quills of various sizes, and fingers were used to apply the resist design on one or both sides of the fabric. The turkey red dye was generally applied with a circle brush, but in a few regions was steeped in a dye bath.[12]

In Batavia, a city in Java, the process known as katung was used. The paste used there was composed of well crushed ground-nuts, lime, and water. A stencil made of lacquered paper was used to apply the resist to both sides of the fabric.[13]

Unlike the intricate designs used in Javanese wax resist decoration, the paste resist used simple forms of magic symbols such as animal figures, sun, etc.[14] The pattern was always executed in a monochromatic color scheme with indigo as the common dye.

Paste resist in India, although also monochromatic in color scheme, was of a completely different nature. The mixture of sticky

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[11]Raoul D'Harcourt, Textiles of Ancient Peru and Their Techniques (Seattle: University of Washington Press, 1962), p. 69.

[12]Steinman, op. cit., p. 2094.

[13]Ibid., p. 2096.

[14]Laurens Langewis and Frits Wagner, Decorative Art in Indonesian Textiles (Amsterdam: N. V. Boekhandel en Vitgeverij C. P. J. van der Peet, 1964), p. 25.

clay, gum, crude sugar, and water was applied to the fabric with printing blocks. The nature of the mixture produced a veining effect, similar to that of wax batik when the fabric was immersed in an indigo bath.[15]

Paste resist techniques are commonly associated with fabric decoration in Africa as well as those regions previously mentioned. Nigeria was the center for such work, with the Yoruba people excelling in the craft. They used a hot cassava paste which was applied freehand by brush or stencil. The coated fabric was dried until hard, then immersed in an indigo bath.[16] A piece of wood was used as the squeegee to scrape the paste through the stencil made of zinc foil, tin foil, or leather on to the fabric.[17]

In Senegal, a tough rice resist was used. The Soninka people in the country covered the cloth entirely with the resist, then furrowed it with the teeth of a comb. An indigo dye bath was used.[18]

Resist dyeing, not commonly thought to be used in Europe, was, in some areas, quite highly developed. The first evidence is in the grave of a sixth century saint, but it is not certain whether it was locally designed or imported from China.[19]

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[15]Robinson, loc. cit.

[16]Stephen Russ, Fabric Printing by Hand (New York: Watson-Guptill Pub., 1967), p. 100.

[17]Steinman, op. cit., p. 2109.

[18]Robinson, loc. cit.

[19]Ibid.

By 1200 A.D. resist printing was highly developed in monasteries along the Rhine river. The monks adapted and imitated woven patterns such as brocades and damasks using the resist printing technique.[20]

In 1690, exotic indigo fabrics imported from Siam became so popular, that the same resist dyeing was done in France, England, and other parts of Europe to keep up with the fashion. Due to importation rivalries, the countries were compelled to issue decrees to protect their own trade.[21]

In Germany, a recipe of 1780 mentions pipe clay and turpentine as the main ingredients of the resist substance used in the blaudruck technique. Pearwood blocks were used to print the resist on the fabric. Sand was sprinkled on the sticky resist, then the fabric was allowed to dry before immersing in an indigo bath.[22] Paste recipes from a book of 1771 are listed in Appendix E, along with a contemporary craftsman's interpretation of one of the recipes.

Pap was the paste resist used in Slovakia for their folk art prints of white figures on a blue ground. Block printing method was used in applying the pap (recipe in Appendix E) to the fabric. After it had dried, the fabric was dyed in an indigo bath.[23]

In Europe, the resist dyeing technique was employed for a while but never became as important as in the Orient. The United States also

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[20]Pettit, op. cit., p. 50.

[21]Robinson, loc. cit.

[22]Ibid., p. 75.

[23]Pettit, op. cit., p. 113.

used a paste resist technique known as China blue which became popular in the eighteenth century. The process involved was not only mechanical but also a chemical block of the indigo dye. The copper in the solution of sulphate, acetate, nitrate or other soluble salts of copper, prevented the indigo from being permanently fixed in those areas.[24] Information of the process used in applying the paste was not recorded, but it was felt a block printing method was employed.

The paste resist technique of fabric dyeing is still prevalent in parts of the world. It exists, however, as a craft rather than the necessary method of fabric decoration due to large scale printing and dyeing plants. Commercially, the resist printing is used to produce volumes of printed fabric.

Contemporary craftsmen have various resist mixtures which they resort to, according to their needs and the availability of the ingredients. Additionally, several commercial resist agents are supplied whose properties enable craftsmen to immerse the fabric in a hot dye bath. It was with the various mixtures of resist pastes, and techniques of dyeing that this study was concerned.

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[24]Florence M. Montgomery, Printed Textiles English and American Cottons and Linens 1700-1850 (New York: Viking Press, 1970), p. 200.

CHAPTER III

EXPERIMENTAL PROCEDURES

The investigation of the effectiveness of selected paste resist mixtures and the performance of nonfat milk as related to the effect of selected dyes on cotton fabric were conducted separately but simultaneously. While the lengthy tests of fastness were performed on the dyed fabric samples, the investigation of effective paste resist mixtures was also carried out. Description of all of the experimental procedures used in this study are dealt with in this chapter, with the paste resist research reported first.

I. Paste Resist Experimentation

The following procedures were carried out:

1. Fabric Preparation.
   - A. Muslin scoured.
   - B. Muslin cut into 36 8 x 16 inch samples.
   - C. Samples coded for easy identification.
   - D. Samples coated with nonfat milk.[25]
     1. Immerse in nonfat milk.
     2. Wring out samples.
     3. Dry.

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[25]For further information refer to Morely B. Smith, loc. cit.

II. Paste Recipes (Appendix B).

A. Three paste recipes chosen for:

1. Ease of preparation.

2. Availability of ingredients.

3. Variety.

B. Varying viscosities (Appendix C).

1. Proportion of water varied in recipes to vary the viscosities of the mixtures.

2. Flour and alum recipe selected as control for mixtures.

a. Mixtures of varying viscosities of other recipes mixed to compare in viscosity with control mixtures.

b. Comparisons strictly visual judgements of similarity made by pouring a control mixture and another mixture.

3. Description of viscosities of paste mixtures.

a. Thin paste similar to chocolate milk.

b. Medium paste similar to polymer medium.

c. Thick paste similar to cake batter.

III. Application of Paste and Dye Medium.

A. Apply paste.

1. Silk screen with lacquer stencil in scale design on two fabric samples for every paste mixture.

2. Paint paste mixture on two fabric samples for every paste mixture in vertical and horizontal stripes.

3. Allow all samples to dry completely.

B. Dye.

1. Samples separated into two groups with each group having one sample of each mixture applied to fabric by silk screen and by brush.

a. One group of samples dyed by immersion in cold dye bath.

b. Other group of samples had dye painted on side to which paste was applied.

c. Table on page three illustrates samples used in this part of study.

2. Samples dried.

3. Samples steamed in canner for 45 minutes.[26]

4. Samples soaked to soften paste.

5. Softened paste removed by scrubbing with brush.

6. Samples rinsed and dried.

IV. Results of Experimentation Analyzed in Chapter IV.

(See Figure 1.)

II. Dyeing Experimentation

The following procedures were carried out:

1. Fabric preparation.

A. Muslin scoured.

B. Muslin cut into 96 8 x 16 inch samples.

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[26]For further information refer to Meda Parker Johnston and Glen Kaufman, Design on Fabrics (New York: Van Nostrand Reinhold Co., 1967), pp. 67-70.

Method of Dyeing		Dyed by Immersion		Dye Painted On	
Paste Application		Silk Screen	Painted	Silk Screen	Painted
Paste #1 Flour and Water	Thin				
	Medium				
	Thick				
Paste #2 Starch, Ground Rice, Flour and Water	Thin				
	Medium				
	Thick				
Paste #3 Alum, Flour and Water	Thin				
	Medium				
	Thick				

Figure 1. Example of individuality of paste resist samples.

C. Samples coded for easy identification.

D. Fifty percent of the samples coated with nonfat milk.

1. Immerse in milk.

2. Wring out.

3. Dry.

II. Dyes.

A. Dye selection based on those easily obtainable.

1. Fiber reactive (Procion from I.C.I. America).

2. Commercial direct (sample of Intralite from Intracolor Corp.).

3. Household (Rit from CPC International, Inc.).

4. Household (Putnam from Putnam Dyes, Inc.).

B. Three primary colors used for each dye.

C. Dye solutions mixed to a concentration of dye for 1 pound of fabric in 2 quarts of water (see Appendix D).

III. Application of dye.

A. Four samples of milk coated and four samples of plain fabric dyed for each kind and color of dye.

B. Dye applied cold by painting on one side.

C. Samples dried.

D. Samples steamed for 45 minutes in canner.[27]

E. Samples rinsed and dried.

IV. Fastness tests.

A. Sets assembled for tests.

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[27]For further information refer to Meda Parker Johnston and Glen Kaufman, loc. cit.

1. One milk coated and one plain fabric sample for each color and kind of dye make a set.
2. One set of samples used for each of the two tests.
3. Two sets of samples used as a control group for comparisons.
4. Table on page six illustrates samples used in this part of the study.

B. Wash fastness test.

1. One set of dyed fabric samples used.
2. Separate loads of wash for each dye and color.
3. Washed in automatic washer for one cycle using cold water and cold water laundry detergent.
4. Comparisons of washed samples and control group analyzed in Chapter IV.

C. Light fastness test.

1. One set of dyed fabric samples used.
2. Exposed set to fluorescent lighting.
   a. Exposed 24 hours per day for eight weeks.
   b. Equivalent to lighting in office during regular working days for one-half year.
   c. Results of test analyzed in Chapter IV.

(See Figure 2.)

Set Use		Wash Test		Control		Light Test		Control	
Fabric Coating		Milk	Plain	Milk	Plain	Milk	Plain	Milk	Plain
Procion Dye	Yellow								
	Red								
	Blue								
Intralite Dye	Yellow								
	Red								
	Blue								
Rit Dye	Yellow								
	Red								
	Blue								
Putnam Dye	Yellow								
	Red								
	Blue								

Figure 2. Example of individuality of dye samples.

CHAPTER IV

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

In analyzing the results of the experimentation, the studies will be examined separately. The analysis of the experimentation involving the paste resist mixtures precede that of the tests related to the use of nonfat milk in dyeing fabric. Recommendations for further studies are made following the conclusion of the experimental studies.

I. Paste Resist Experimentation

In the preliminary research, a variety of paste recipes were suggested in various references, indicating the importance of the ingredients. It was believed the ingredients effected the brittleness and adhesiveness of the paste, but not the paste's ability to penetrate the fabric and prevent the dye solution from reaching it. The paste's viscosity was believed to be the most important property in dye resistance. It was in this research then, that the ability of resist agents to penetrate fabric and resist dye was studied with regard to the viscosity and ingredients of the selected mixtures. The experimentation involved three paste recipes (Appendix B) and three viscosities of these recipes (Appendix C). Each of the mixtures was silk screen printed on two samples and painted on two samples. For each of the mixtures, one of the silk screen printed and one of the painted on samples were immersed in the dye and the remaining samples had the dye painted on them. All samples were steamed to set the dye, scrubbed to remove the paste,

rinsed, and dried. It was noted that the samples were stiffer than the original fabric even after the paste was removed.

In drawing conclusions as to the effectiveness of the paste mixtures to resist the dye, it was evident that the following were the most successful: (1) the alum, flour, and water recipe, (2) the most viscous mixtures, (3) the painted on mixtures. The samples dyed by immersion were most effective in bringing out the contrast in dyed and non-dyed areas.

The individual recipes did differ in their application and resist qualities due to the ingredients. As shown in Figure 3, the use of the flour and water mixture resulted in a smooth resist coating, that did not very effectively resist the dye. The rice flour, starch, and flour recipe (Figure 4) painted on the samples, produced a grainy texture and crackle effect when dyed. The silk screen samples did not have the texture of the painted samples, but rather, a smooth texture. With the exception of the most viscous mixture painted on, the paste did not very effectively resist the dye. The flour and alum recipe (Figure 5) generally was much more effective as a resist than the first two. In this recipe, the painted on resist, dyed by brush application, produced a crackle effect, and provided the most contrast between dyed and resisted areas of all of the samples. It is noted also, that the flour and alum paste was easier to remove after dyeing and steaming than the other pastes.

Unlike the assumptions made, the viscosity of the paste did not effect the paste's penetration through the fabric. The paste did not penetrate completely through the fabric in any of the samples. The

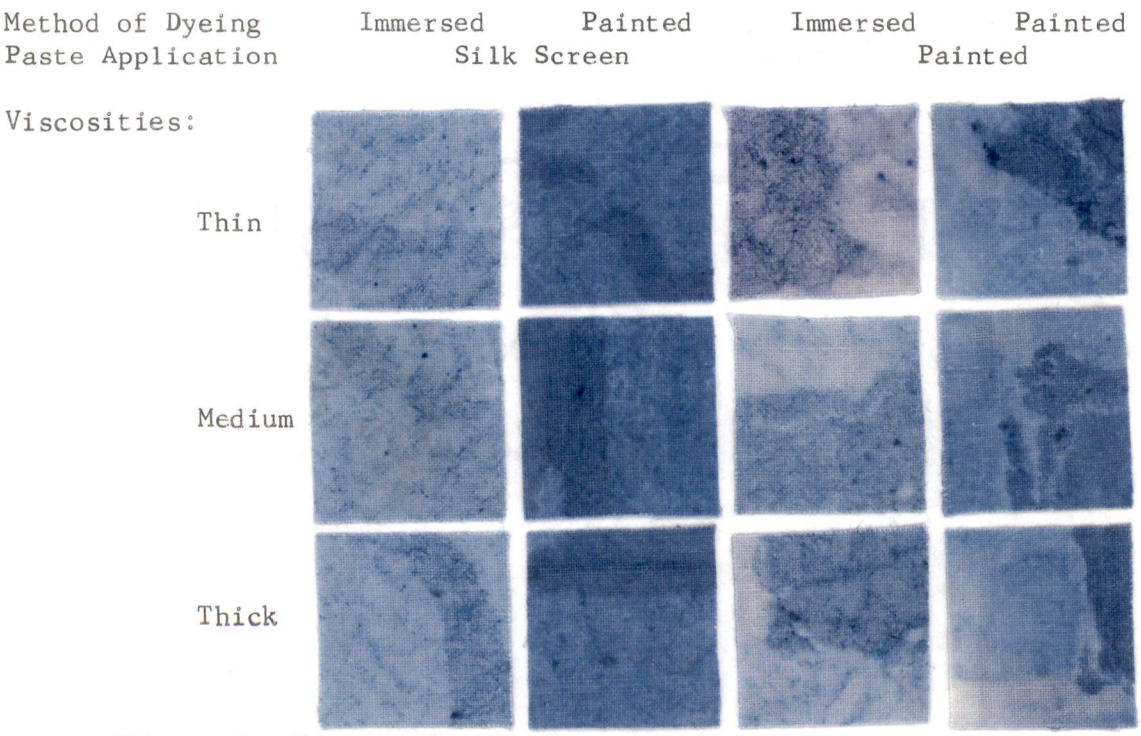


Figure 3. Flour and water paste recipe.

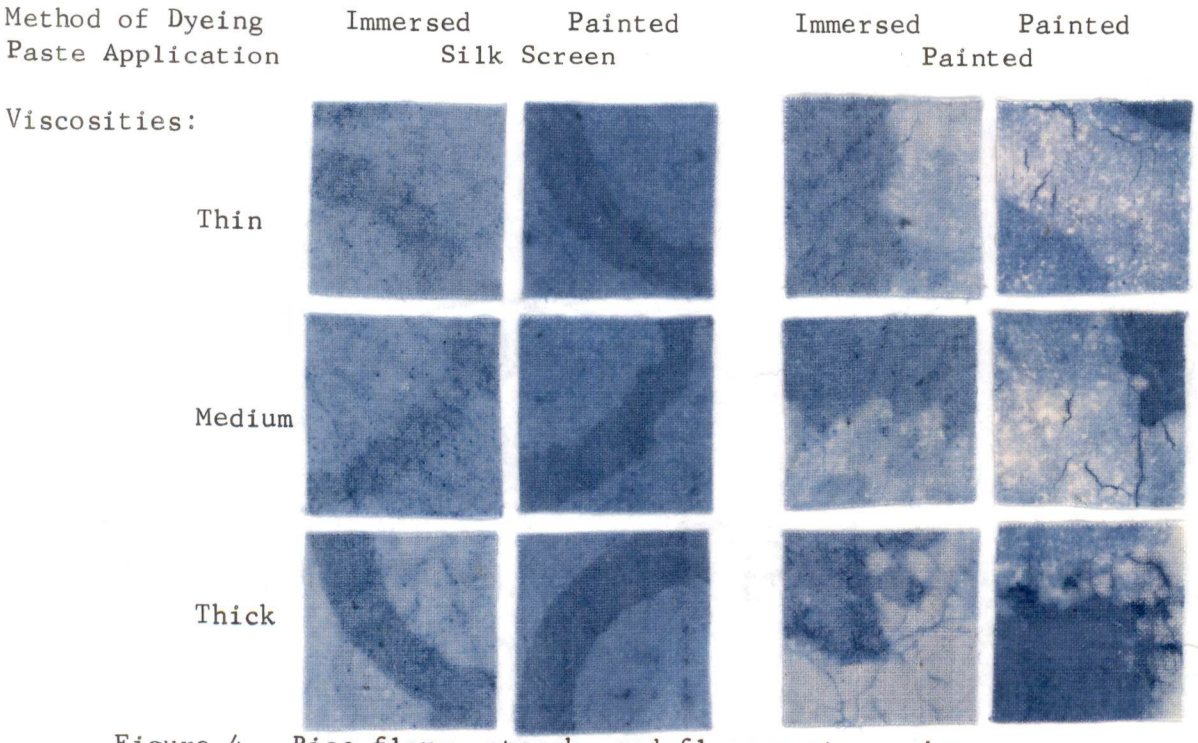


Figure 4. Rice flour, starch, and flour paste recipe.

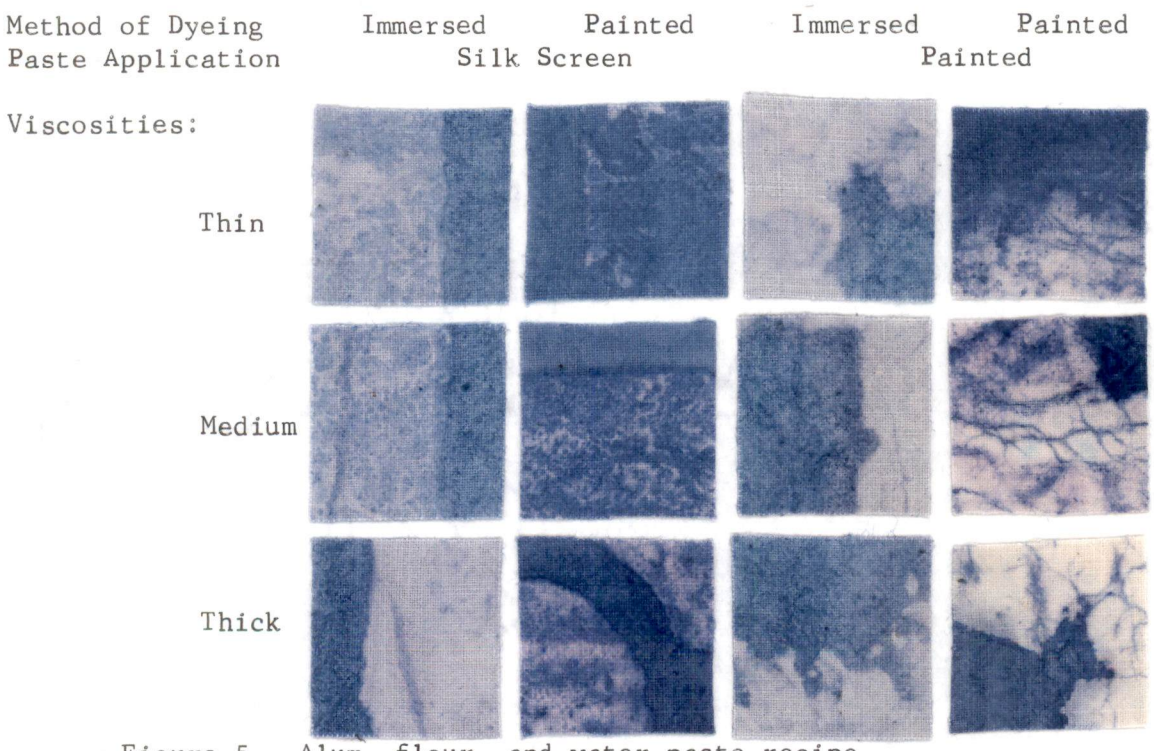


Figure 5. Alum, flour, and water paste recipe.

viscosity did, however, effect the resistance to dye in that the most viscous mixtures produced a thicker coating of paste on the fabric, and therefore, resisted the dye most effectively.

The paste mixtures painted on the fabric resisted the dye more satisfactorily than silk screen application. Due to the nature of brush application, a thicker layer of paste was applied. On the other hand, the silk screen method of paste application, although applying a less effective dye resist, was still a valuable tool. The method was faster, can produce more precise designs, and was good for design repetition.

In comparing the dyeing of the fabric by immersion and by brush application, the contrast in intensity of color in resist coated and uncoated dyed areas, was greater in a majority of the samples when dyed by immersion. Additionally, the design on the samples where the paste was applied by silk screen, showed up far batter in the immersion dyeing. These results, although significant, do not confirm the assumptions held in Chapter I.

II. Dyeing Experimentation

The use of nonfat milk as a coating before dyeing effectively intensifies the color of the dyed fabric. This study examined the effect of milk on three kinds of dyes and examined the wash fastness and light fastness of the dyes.

For the fastness tests, one set of dyed samples (meaning one milk coated and one plain fabric sample for each color and kind of dye) were used for each of the two tests, with two sets saved for comparison as

a control group. To test for wash fastness, separate loads of each dye and color were washed in an automatic washer for one complete cycle. Light fastness was tested by exposing the dyed samples to fluorescent lighting for twenty-four hours a day for eight weeks.

In preparing samples using the fiber reactive dye, it was noted that the dyed samples were considerably less brilliant than expected (Figure 6). The prepared dyes were stored overnight before use, and therefore, had already reacted chemically before dyeing the fabric. Another set of samples was prepared by dyeing them immediately after the dyes were mixed. These samples proved as brilliant as originally expected. The samples were steamed as before, but all the samples turned brown (Figure 7). With no explanation of this phenomenon available, it was decided to eliminate the fiber reactive dye from the rest of the study.

In analyzing the experimental results, the effectiveness of the nonfat milk coating to assist in intensifying the color of dyed fabric and be as colorfast as the uncoated fabric samples is significant. The experimental samples are displayed in Figures 8, 9, and 10.

The milk coating did significantly intensify the dye color on the fabric in all of the kinds and colors of dye. Due to the light color, the contrasts in the yellows in this study, were not as apparent as the other colors but differences still existed.

In the wash fastness test, all of the washed samples faded slightly as compared to the unwashed control group. The assumption that the milk coated samples would fade more than the same dye and color in the uncoated samples, proved to be incorrect. The samples faded approximately equally. The stiffness of the milk coated samples remained after washing.

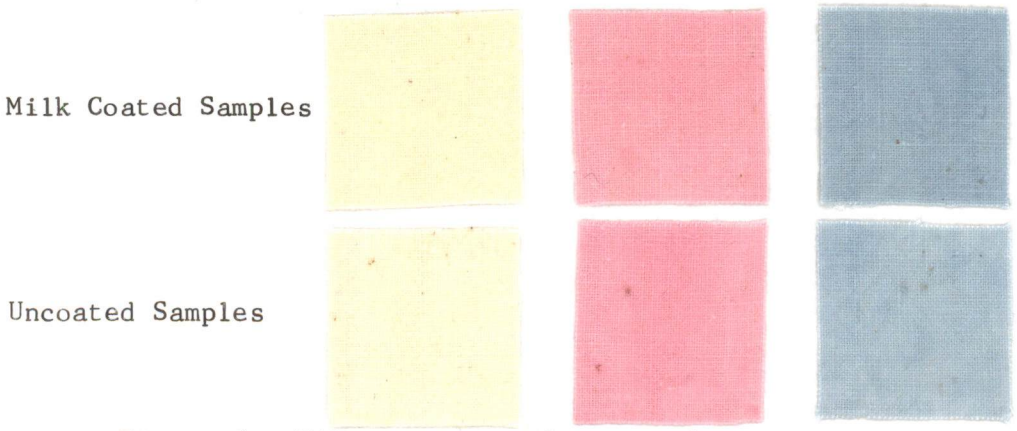


Figure 6. Fiber reactive dye stored.

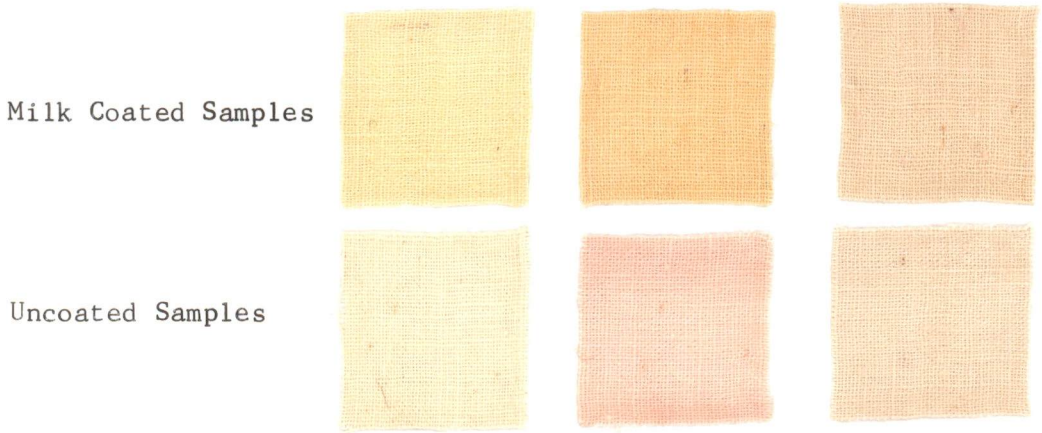


Figure 7. Fiber reactive dye steamed.

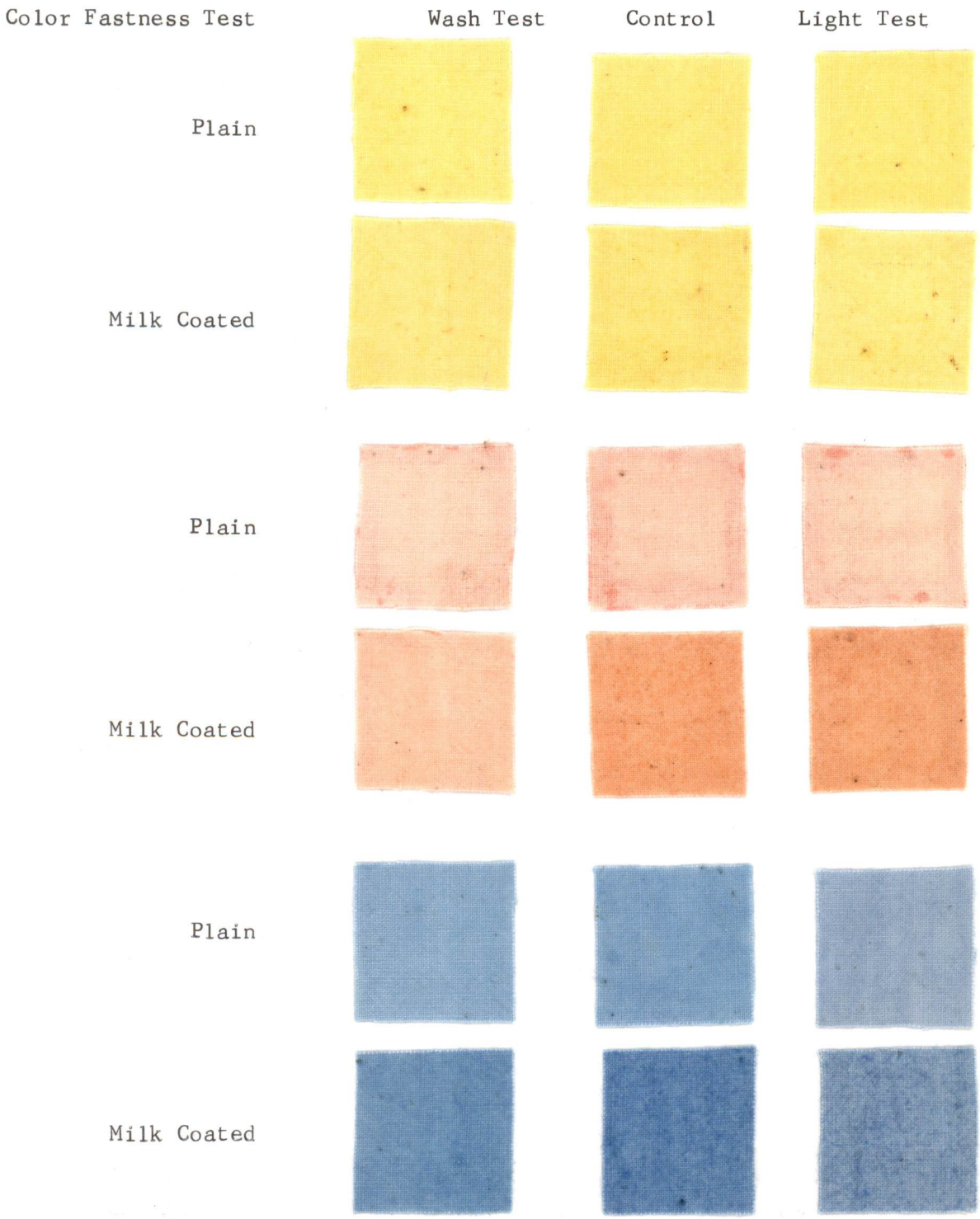


Figure 8. Household dye (Putnam).

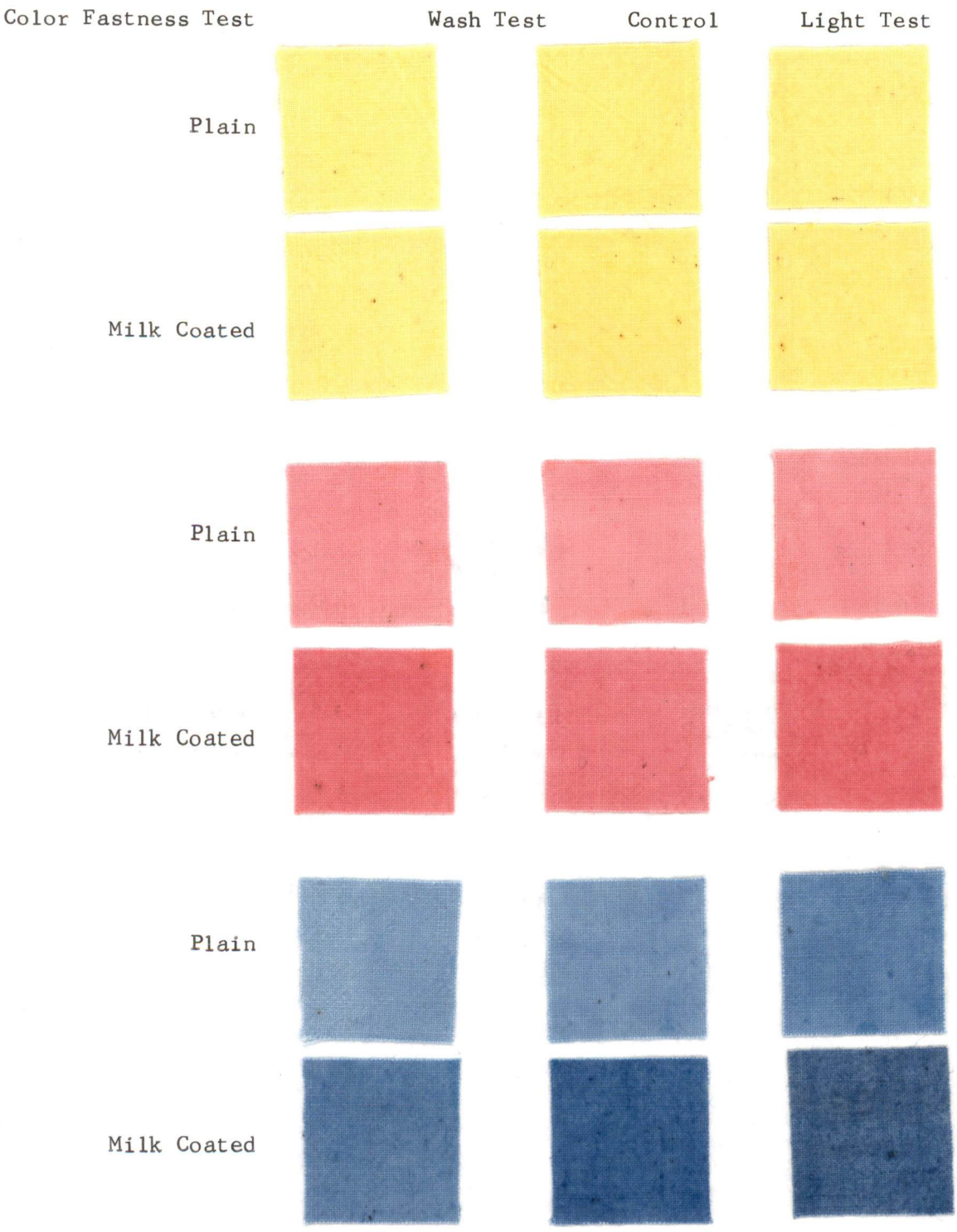


Figure 9. Direct dye (Intralite).

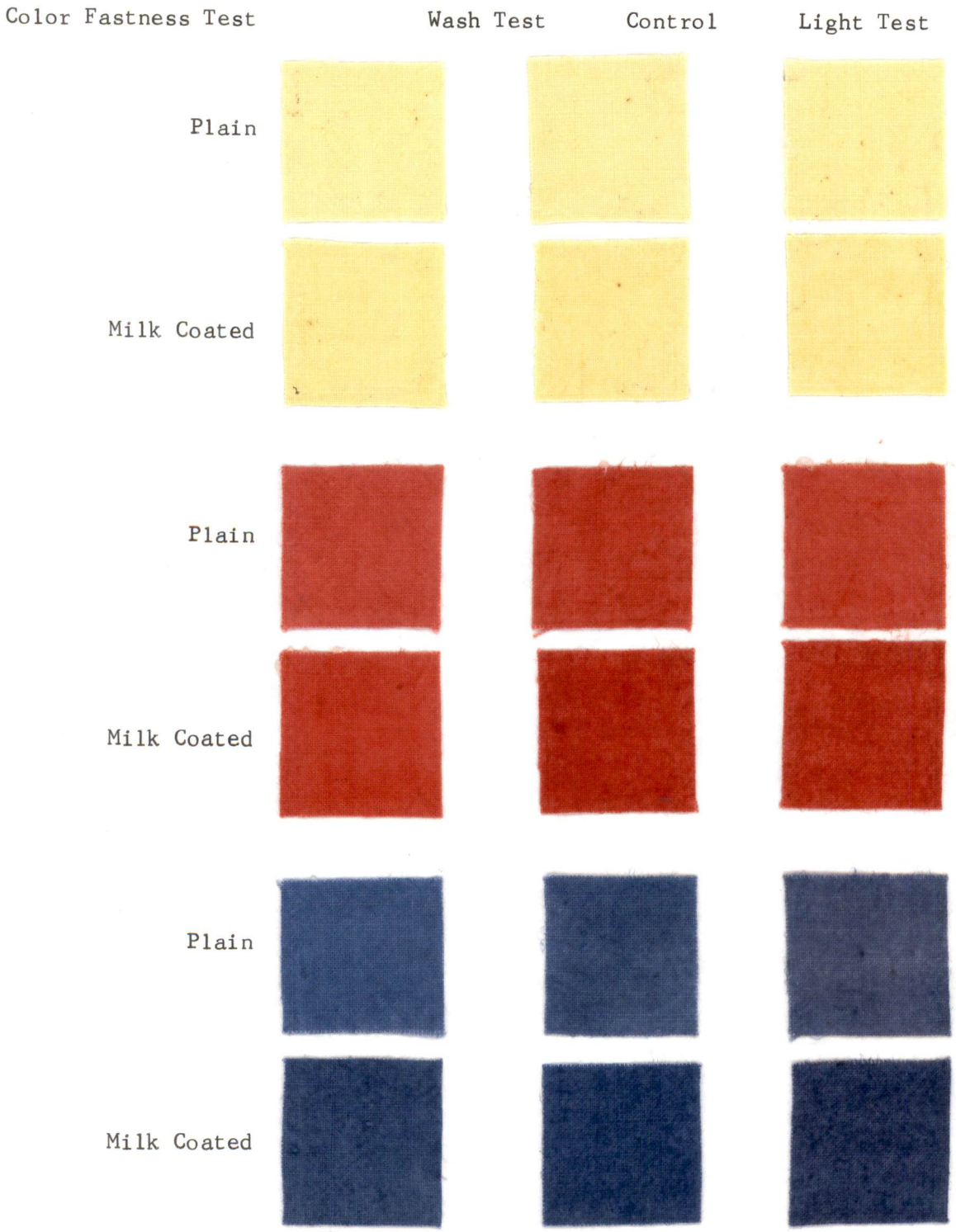


Figure 10. Household dye (Rit).

No significant difference in any of the samples was noted between the control group and the group exposed to fluorescent lighting for eight weeks. It is possible that the exposure time was not long enough to cause fading. No difference was noted in the fading of the milk coated fabric samples as compared to the uncoated fabric samples.

The use of paste resist and milk as a fabric coating in the resist technique of fabric decoration has many possibilities. It was hoped that the experimental results of this study will be of benefit to the craftsman interested in this little used technique.

III. Recommendations for Further Study

Needs for research in other areas of this technique became apparent as this study progressed. The following studies would be of value:

1. An examination of the paste resist technique on various weights and kinds of fabric.
2. A study of the bleaching of fabric, reserving areas of cloth with a paste resist.
3. A study of resist agents that chemically, rather than physically resist dye.
4. An investigation of fabric coatings other than milk which will intensify the color of the dyed cloth.
5. An examination of the color fastness of milk coated and uncoated fabric samples using all of the standard color fastness tests.

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APPENDIXES

APPENDIX A

GLOSSARY OF TERMS

The following definitions were alphabetically presented to clarify terms used in this study:

1. Batik - a Javanese term which describes a form of resist dyeing obtained when hot wax, an effective dye resist, is applied to the fabric.
2. Cellulose - the natural material which is the main component of cotton, flax, and other vegetable products. The basic unit for the cellulose molecule is the glucose unit.
3. Color Fastness - the ability of a color to resist color destroying agents, such as sunlight, washing, drycleaning and rubbing.
4. Common Salt - sodium chloride, used in dyeing to exhaust the dye bath.
5. Direct Dyes - a dye which has an attraction but not a chemical affinity for cellulose. The swelling of the fiber in hot water enables the dye particles to be absorbed by the cellulose through osmotic action into the interior of the fiber where the dye remains. These dyes, commonly used with protein and cellulose fibers, lack brilliance and general fastness.
6. Fiber Reactive Dyes - a dye which contains as part of the molecule, a reactive group which combines with the hydroxyl groups in cellulose fibers. The reaction results in a new chemical compound, making it color fast. These are brilliant dyes used on cellulosic fibers.
7. Household Dyes - a direct dye easily obtained and used by the consumer.

8. Muslin - a plain weave balanced fabric of cotton.

9. Penetration - degree to which a paste has progressed from the surface to the interior of a fabric.

10. Resist - refers to a method of fabric decoration where certain parts of the cloth are protected from the dye by covering them.

11. Scouring - washing fabric to remove sizing and dirt before dyeing.

12. Setting the Dye - the process by which the dye is permanently fixed in or attached to the fiber. All setting processes are basically treatments with heat.

13. Silk Screen - a printing method based on the use of a stencil which is supported on a screen mesh. The printing medium is forced through the stencil and into the fabric by means of a squeegee.

14. Steaming - a method of setting the dye.

15. Viscosity - a molecular attraction resisting a tendency to flow. A less viscous liquid tends to flow more freely than a more viscous liquid.

APPENDIX B

PASTE RECIPES TESTED

1. 3 tablespoons flour

   1 cup cold water

   Cook in double boiler, stiring constantly, until semi-transparent. Apply hot.[1]

2. 1/2 ounce laundry starch

   1 ounce ground rice

   1 ounce plain white flour

   10 ounces hot water

   Mix ingredients to stiff paste with a little cold water. Add hot water to make smooth cream then boil on double boiler for thirty minutes. Apply hot.[2]

3. 1 teaspoon alum

   3-1/2 teaspoons all-purpose flour

   1/4 cup water

   Mix alum and water in small bowl. Add flour gradually, stirring constantly until smooth.[3]

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[1]Stephen Russ, Fabric Printing By Hand (New York: Watson-Guptill Pub., 1967), p. 101.

[2]Meda Parker Johnson and Glen Kaufman, Design on Fabrics (New York: Van Nostrand Reinhold Co., 1967), p. 114.

[3]Morely B. Smith, "Exciting Crafts with Dye," Better Homes and Gardens, XLVIII (September, 1970), 66.

APPENDIX C

PASTE RECIPES OF VARYING VISCOSITIES

1. Flour and Water

   I. 38 percent more water

   II. 25 percent more water

   III. Regular recipe

2. Rice Flour and Starch

   I. 75 percent more water

   II. 50 percent more water

   III. Regular recipe

3. Alum and Flour

   I. 25 percent more water

   II. Regular recipe

   III. 38 percent less water

APPENDIX D

DYE RECIPES

1. Putnam (Household) Putnam Dyes, Inc.

   #8 yellow
   #9 scarlet
   #2 sky blue

   2 packets in 1 gallon water

2. Intralite (Direct) Intracolor Corp.

   #4GL blue
   #5BRL red
   #5G11 yellow

   1 teaspoon dye
   12 tablespoons common salt
   1 gallon water

3. Procion (Fiber Reactive) I.C.I. America, Inc.

   #MX5B red
   #MX8G yellow
   #MX2G blue

   1 teaspoon dye
   12 tablespoons common salt
   6 tablespoons washing soda
   1 gallon water

4. Rit (Household) CPC International

   #29 royal blue
   #5 scarlet
   #1 yellow

   1 packet dye
   1/2 gallon water

Instructions of the package were followed in mixing the household dyes. The fiber reactive and direct dyes were prepared following the directions of I.C.I. America, Inc., and Design on Fabric by Meda Parker Johnston and Glen Kaufman.

APPENDIX E

MISCELLANEOUS PASTE RECIPES

Japanese

rice flour

bran flour

powdered zinc sulfate

salt

Solution cooked until it is a transparent cream then stirred until cool.[4]

Slovakian Resist - Pap

white painter clay

gum arabic

acetate of lead

lead sulfate

blue stone (chalk?)

salve (tallow?)

alum

Applied to fabric with block.[5]

Germany - Three Recipes from a Book of 1771

1. white tobacco - pipe clay
   vitriol
   starch
   turpentine
   alum
   six egg whites
   wax

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[4]Nik Krevitsky, Batik Art and Craft (New York: Reinhold Pub. Corp., 1964), p. 8.

[5]Florence H. Pettit, America's Printed and Painted Fabrics 1600-1900 (New York: Hastings House, 1970), p. 115.

2.	cologne glue	gum arabic
	starch	pipe clay
	alum	vitriol
	wax	tallow
	turpentine	
3.	water	gum arabic
	isinglass	brandy
	starch-flour	tallow
	calf gall	pipe clay

A Contemporary Craftsman's Interpretation of One of the Recipes:

1 pound Kaolin (white ceramic ball or pipe clay)

6 ounces alum (probably a thickener)

3 ounces vitriol (copperas or ferrous sulphate)

6 egg whites

handful corn starch

10-12 ounces melted beeswax stirred in 6 ounces turpentine[6]

Contemporary Adaptation of Adire Eleko (Nigeria)

1/2 cup tapioca paste solution

2 tablespoons yucca (cassava) starch

1 tablespoon corn starch

1 tablespoon rice flour

1 tablespoon gluten flour

1/2 teaspoon alum

1/8 teaspoon copper sulfate

water

Tapioca paste solution - 3/4 cup pearl tapioca and 3 cups water, grind in blender for 1 minute. Let rest for 24 hours then blend again for 3 minutes. Store in refrigerator and use as needed. Paste resist - Dissolve dry flours and starches in 1/2 cup cold water. Add tapioca solution to flours and add enough water to make total volume of 2 cups. (continued)

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[6]Pettit, op. cit., p. 112.

Blend until smooth in blender. Cook uncovered in double boiler for 5 minutes after mixture is thick and clear. Mix in alum and copper sulfate and beat occasionally as it cools. Refrigerate covered when not in use.[7]

Contemporary Recipe

1 tablespoon corn starch
1 tablespoon white flour
1 tablespoon rice flour
1 tablespoon laundry starch (powdered)
1/2 teaspoon alum

Dissolve starches in one cup water and heat in double boiler, stirring constantly until clear. If necessary add water until it is the consistency of honey. Add alum. Apply hot.[8]

Polymer Emulsion

Apply polymer emulsion to fabric and allow to set. When placed in a hot dye bath (nearly boiling), resist turns opaque. To remove resist after dyeing, rinse in warm water then immerse in cold water. The resist will dissolve and wash away.[9]

Ceramic Wax

This substance, sold in liquid form, dries in a thin wax coating that can easily be washed off with hot water. Serves as a good resist and does not give the same appearance as batik.[10]

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[7]Lois Brooks, "Workshop: Adire Eleko," Craft Horizons, XXXI, No. 4 (August, 1971), 12-13.

[8]Nancy Belfer, Designing in Batik and Tie Dye (Worcester, Mass.: Davis Publications, Inc., 1971), p. 69.

[9]Ibid., p. 70.

[10]Beryl Ash and Anthony Dyson, Introducing Dyeing and Printing (New York: Watson-Guptill Pub., 1970), p. 84.

VITA

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She entered the Graduate School of The University of Tennessee in September, 1971, and for the summer of 1972, accepted an Assistantship at Arrowmont School of Crafts. She received a Master of Science degree with a major in Crafts in June, 1973. For the summer of 1973 she received an appointment at Arrowmont School of Crafts as an assistant to demonstrate in the Great Smokey Mountain National Park.

She is a member of the American Crafts Council and Peters Valley Craftsmen. Her work has been exhibited at The University of Tennessee Student Show, University Center, at the Dogwood Arts Festival, McClung Museum, The University of Tennessee, at the Tennessee Artist-Craftsman Association Workshop, Gatlinburg, Tennessee, at the Art in Home Economics Workshop, Gatlinburg, Tennessee, at the Southern Highland Handicraft Guild Fair, Asheville, N. C., and Gatlinburg, Tennessee, at the Tennessee Artist-Craftsman Association Fair, Nashville, Tennessee, at Arrowmont School of Crafts, Gatlinburg, Tennessee, and at the Central Pennsylvania Arts Festival, State College, Pennsylvania.