

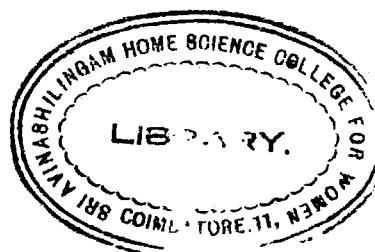
COMPARITIVE STUDY OF WAXES IN BATIK PRINTING ON VISCOSE RAYON

By

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I. INTRODUCTION

Colour plays an important role in making fabric attractive to consumers. Colour can be applied to textiles at different stages during the manufacturing processes the fibres, yarns or fabrics. Colour is applied to Textile materials in the form of dyestuffs which can be used in two basic forms of process; namely dyeing and printing.

Dyeing in its simplest form consists of the immersion of the textile material in a solution of the dyestuffs in hot water, when the temperature is raised sufficiently the dyestuff passes from the solution into the textile material and colours it uniformly. Jules Laberthe(1977) says that dyestuffs can be applied to Textiles by Chemical process to produce colour. Decorative applied designs may also be achieved by the applications of colours or Chemicals to the surface of the fabric after the fabric has been woven.

Printing is regarded as a specialised technique of dyeing instead of one uniform colour all over the piece, remarks

Kale (1960). One or more colours are printed in a particular form to produce a single or multi colour design effect. Printing is simply the controlled application of colour to selected areas or figures on the cloth.

According to Potter (1945) the methods of decoration that produce colour designs are:-

Blotch printing

Roller Printing

Discharge or Extract Printing

Resist Printing

Stencil Printing

Screen Printing

Warp Printing

Batik Dyeing

Tie Dyeing

Composition or Paste Designs

Spray Painting

New developments, discoveries and changes can be quickly applied through printing to create new designs and colours in the fabrics. Lyle (1976) points out that printing of fabrics has existed from time immemorial such as the use of wood or metal blocks, and dye resist printing, these hand methods are still used in arts and crafts courses.

The ancient methods of dyeing employed one or another of the techniques associated with resist printing or dyeing, in which the protected areas of a fabric are kept from being exposed to a liquid dyebath certain portions of the cloth are covered with was plunged into the dyestuff.

Tortora (1978) expresses that today the best known was resist process is used for making of batik fabrics, the name batik originates in Indonesia where resist printing has become an important art form. An analysis of the batik method shows clearly the art of resist printing method. This is the reversal of dyed style. The parts of the cloth which are required to remain white or ground colour are printed with a substance capable of resisting the dye.

Clarke (1968) opines the Batik is an ancient Javeneese form of fabric pattern dyeing. The parts of fabric not to be coloured are protected by a coating of wax. Edward Miller (1968) says that in resist printing the fabric is printed with a compound which prevents the absorption of dye. After printing, the fabric is dyed and the treated part stays undyed and the ground takes the colour.

The resist or reserve style of printing obtains white figures on coloured ground by means of printing. The design is applied on the cloth with the substances that are impervious to the dye liquids when these substances are thoroughly dried the cloth is dyed, but all portions covered with the resist paste or substances remain white, remarks Joyce Storey (1974).

Resist materials are starch, clay and wax. Today wax is mostly used for making the batik fabrics. Cowan (1969) states that the most characteristic feature of batik is the crackle effect. The veining effect may be obtained by using

special waxes like paraffin and beeswax in certain composition. The delicate net work of thin line effect can be developed throughout the design, when the dye is allowed to seep into cracks in the waxed areas.

Russ (1964) suggests that Batik can be dyed in any of the cold dyes like naphthol dyes, vat dyes, procion dyes and indigo dyes. The dark background gives good appearance and beauty to the fabrics. Multicolour effects are possible by immersing the fabric in dyebaths of different colours. Batik print is traditionally done on cotton, silk and wool. Of synthetics, only viscose rayon can be dyed successfully.

The art of Batik dyeing is one of the simplest and useful methods when compared to other printing methods because it needs no machinery and electricity. Labour, knowledge and originality is more important in batik printing and it gives employment to the persons individually.

Hence, the investigator has made an attempt to find out the effectiveness of paraffin wax and beeswax on batik printing both individually as well as the combination of the same. She has tried out batik print on viscose rayon in three different dyes namely naphthol, vat and procion, It is hoped that this study would benefit the manufacturers of batik fabrics.

II. REVIEW OF LITERATURE

- A. The Art of Batik Printing
- B. Origin of Batik Printing
- C. Characteristics of Batik Printing
- D. Design in Batik Printing
- E. Application of Design on Material
- F. Materials used for Batik Printing
- G. Types of Waxes and Dyes Used
- H. Equipment Needed for Batik Printing
- I. Method of Dyeing
- J. Dewaxing
- K. Recent Trends in Batik

I. The Art of Batik Printing

The Art of Batik, Stuart and Patricia (1970) defines is a resist technique for producing designs on fabric. The resist substances may be wax or starch. Making coloured patterns on cloth by the known as batik is an Indonesian Art, views Norma Jameson (1970).

Monk (1969) says that it is a paste resist technique which enables one to have a light coloured or white motif on a coloured ground.

Corbman (1975) states that the resist dyeing process whereby designs are made with wax on a fabric which is subsequently immersed in a dye to absorb the colour on the unwaxed portions is known as batik dyeing.

Baker and Stran (—) point out that it is a method of drawing or painting with wax or clay upon a fabric, after which the material is dyed and the wax removed.

Batik printing, as Barbhaiya (1964) states is the wax printing which protects the portion of a material it covers from taking the dye, thus leaving a beautiful pattern or design on the material when it is removed after dyeing.

Hurst (1952) considers that it is a peculiar kind of resist work.

Marsh (1958) says that the resist or reserve style enables white or coloured patterns to be produced on dyed grounds; it relies on the printing on white fabrics of a resisting or reserving substance which prevents the production of colour during the subsequent dyeing operation, resists are not limited to dyeing, for it is possible to apply them to printed patterns and so create great variety of effects.

The art of Batik simply is fabric, wax and dye, shaped patterns and lines are drawn directly on to the fabric with molten wax, opines John Houston (1975).

The basic principles of batik (resist) printing is the protection of certain areas of the fabric by some means device to prevent colour or dye penetration says, Hess,(1969).

3. Origin of Batik Printings

Batik is an Indonesian word describing a form of resist printing which although known and practised as a native craft in South East India. Europe and parts of Africa, has

achieved an unrivalled degree of craftsmanship in the island of Java, Practical Manual for use in Laboratories (1967).

Batik work is found in South East Asia, India, Europe, and Africa, but it reached its highest development in Java. The word is possibly derived from root of tik which is thought to be an onomatopaeitic word meaning 'drop or dot.' Records of Sung dynasty we find that batiked cotton cloth from Java was very highly prized and made presents for Princessly Joyce Storey (1974).

Chitrangada Krishna (1977) says that Batik is an ancient art, nearly 2,000 years old. The Egyptian and Persians used to wear batiked garments. In China it was there as early as the seventh century A.D. The Modern Textile and Apparel Dictionary (1978) states that this method of hand colouring fabrics originated in Netherlands and Indies. Corbman (1975) say that it has been done in the orient, notably India and to some extent in Japan for many centuries.

Houston (1975) says that Javenese batik is relatively modern first appearing in Dutch texts in the early seventeenth century. It derives from ambatik which refers to the whole range of activities of drawing, painting, tattooing and writing.

In 1835 Dutch firms began to imitate batiks and tried to sell them in Java. In England and Switzerland huge roller presser printed batik designs complete with design irregularities and imitation veining. In Holland wooden blocks produced a close imitation of a new technique introduced to Java in the middle of 19th century. This method used to tjap, a block set with a raised upper pattern used to print the wax resist on the front and back of fabrics, explains Houston (1975).

'Batik' - This ancient Asiatic word one of the oldest crafts of the orient. In India, Java and Japan the highest made a great art of costuming. Each caste, religion and festival required its special garment by Wright (1949).

C. Characteristics of Batik Printings

Batik decoration is free from limitations that restrict mechanical print. It is a characteristic of the Java batik that the resist is obtained by applying wax to both sides of the fabric. Dyeing is then carried out in the cold to avoid melting the wax thus confirming the colouration to the unwaxed area. Selective further waxing and redyeing allows variety of colourings of increasing depth to be built up additively, says Baker. (—)

Its main character is that the application of colour should be from lightest to darkest, because each colour will affect, the most colour dyed over it. It is a joy of discovery, states Cockett (1955).

Wingate (1976) points out that the most characteristic feature of batik is the crackle, the delicate net work of pair thin lines which develop throughout the design when dye is allowed to seep into cracks in the waxed areas. This effect has the seductive charm of a happy accident. Yet it

is possible to control and vary this subtle, veining by the use of special wax or by applying dye with a brush rather than immersing fabric in the dye.

James Fother Gill (1952) expresses that the characteristic feature of typical batiks is the appearance of fine veins of colour running irregularly across the reserved parts of the pattern.

This can give vertical folds or horizontal folds or crush softly all over the material. It can be achieved symmetrically if the weaver has the patience to do it. Before giving folds it would be best to dip the cloth in a little cold water so that the wax hardens a bit, this makes it easier to get the crackles, reveals Jarjory (1966).

D. Designs in Batik Printing.

It is considered more as a practical skill than as a decorative art. The Javanese batik has developed and unequalled delicacy and precision, making finely detailed silhouettes of birds, flowers and animals into densely packed geometric frames expresses John Houston (1975).

Cockett (1955) points out that shaded or ombre effects may be obtained in batik by spraying or allowing portions of a fabric to be immersed in a dye bath.

Birrell (1959) views that the best batik designs are small ornate all over patterns in which minute dots plays an important part. Every conceivable type of design scenic, floral or abstract can also be executed in batik.

Harries (1974) expresses that the designs and quality remained unchanged, being practised only by the Javanese women and girls of the upper classes and the nobility.

According to a guide to printing techniques (1978), the patterns are generally in geometric, floral, bird or animal motifs, but the artists imagination may introduce other fanciful designs. The motif is drawn on fabric by melted wax.

E. Materials Used for Batik Printing:

Hersk (1975) recommended that cotton, cotton broad cloth silk, organdy and linen are preferred for best printing

of batik. Viscose rayon is good for making scarves, sarees, because of its sheen. Most synthetic fibres do not 'take' chemical dyes. He further expresses that the finish and weave of the material will greatly effect the batik. Smooth, closely woven material will absorb wax and dye evenly, before waxing, desizing, washing and ironing are required. This is essential step because the dye will not 'take' evenly if any sizing remains in the fabric.

Chitragada Krishna (1977) says that cotton, lawn, calico, silk, voils are suitable for batik work. Materials of synthetic finish, non-iron, non-crease resistant are not suitable as the dye does not work well on them. But in synthetics, rayon is the best one to absorb dyes well to all parts of the fabric.

F. Application of Design on Material.

The wax can be applied by tjanting, blocks, by drybrush cutout paper shape method and freehand method. For producing groups of spots, double lines and rosettes, number

number of spouts are used. To facilitate the waxing process the cloth is stretched over a bamboo frame and the wax kept on a small charcoal stove.

Barbhaya (1964) says that it is interesting to do a multicolour batik painting. The usual painting done on paper by different colours can be done on the cloth.

In Java, the traditional designs and standard patterns drawn on papers are available to be purchased. The paper designs can be perforated to make stencils which can then be used on the cloth to transfer the design with charcoal pouncing. It is also possible to fix such papers on the cloth by pins and outline the design holding it against light. Experienced works simply hang the design before them and work it on the cloth. Freehand wooden stamps are put to use in the case of repetitive designs, reveals Clarke. (1958).

Sirrell (1959) says that the variations of batik are outlined and tinted batik. Crackle batik, Crayon batik, white

line silhouette Batik and Pin point batik.

Chitrangada Krishna (1977) suggests that the dry brushing technique of applying wax on the cloth one can get some lovely textures. Further he expresses that there are two different ways of dry brushing namely the dab method and the cutout paper shape method.

G. Types of Waxes and Dyes Used.

Hersk (1975) indicates that there are four types of waxes used for batik.

Paraffin wax:

Paraffin wax is brittle and is used to achieve more crackling effect.

Bees wax:

For bolder and big designs this wax is used. It is more flexible than paraffin and melts at a higher temperature.

It can be mixed with paraffin to minimize crackling effect.

Sticky wax:

Sticky wax is a petroleum product. It is an inexpensive substitute for beeswax having a nature very close to that of beeswax. Like beeswax melted sticky wax saturates into the material and creates or complete resist. It can be combined with paraffin, 50% paraffin to 50% sticky wax depending on the amount of crackle that is desired.

Batik wax:

Batik wax is a combination of paraffin and beeswax. This combination can easily be made by melting $\frac{2}{3}$ beeswax to $\frac{1}{3}$ paraffin, adding more or less paraffin depending on the amount of crackle desired. It is especially good to be used in tjanting.

Most commonly paraffin and beeswax is used for batik work. A suitable mixture is one of four parts of resin with one part of paraffin wax or three parts of resin with one part of paraffin wax should the resin be a high melting variety.

The higher the properties of the paraffin wax in the mixture the more brittle becomes the print and more pronounced the "cracking."

In Java, banana leaves previously soaked in dilute caustic soda are used as the wax will neither adhere to these nor penetrate into them. The wax is applied by a special form of printed block. Cassava starch paste is used as the resist in Java.

Kathleen Monk (1969) says that either decorators paste or flour paste and starch resist can be used for the resist.

Dyestuffs suitable for this work must be capable of being applied from a cold dye bath, since a heated dyebath would remove the wax resist, a practical Manual for use in laboratories (1967). The following classes of dyes are of interest:

1. Indigo and other cold dyestuffs
2. Vat dyestuffs
3. Anzoic (Brenthol for naphthol) dyestuffs
4. Procion dyestuffs
5. Soledon dyestuffs.

Stephan Russ (1964) says that batik can be dyed in any of cold dyes and as it is light on dark style, the darker the background, the better multicolour effects are possible by immersing the fabric in a succession of dye-bathes of different colours.

H. Equipment Needed for Batik Printing.

According to Neel Dyrenforth (1975) the standard materials for working in batik are as follows:

1. An electric heater or stove
2. Enamel bowl or saucepan to heat wax
3. Desized viscose rayon material
4. Wide and narrow bristle brushes
5. Adjustable frame
6. Paraffin wax
7. Bees wax
8. Detergent
9. Rubber gloves
10. Washing soda
11. Plastic container cleaning fluid
12. A sheet of asbestos to keep under the stove for safety measures.

13. Tools like brushes and blocks to
to the printing and painting .

14. Sand with wooden table.

Jameson (1970) states that different coloured tissue papers are useful when testing one colour against another. Transparent coloured cellophane can also be used. Colour in batik can be imaginative and unique. Indigo is a profession in Java.

I. Method of Dyeing:

Dyeing implies some affinity between the fibre and the dye.

Welford (1969) suggests that cold water dyes such as the Dylon cold dyes or the procion M range of reactive dyestuffs can be used for dyeing. Mordant colours are easily resisted.

Johnson (1948) opines that all dyeing for batik must be done in cold water dye bath as any heat for fixing the dye

would melt the waxed design and render it useless. Also he expresses that one should be careful not to squeeze the waxed material as the wax may crack and penetrate with the fibre and give a path effect.

Jameson Watson (1970) views that by the use of resist methods of printing it is obviously possible to produce the ~~multicoloured~~ patterns on coloured grounds.

4. Removal:

Stephan Russ (1964) points out that the resist paste is removed from the fabric either by heat boiling water or by the use of solvent.

Stuart and Patricia Robinson (1970) recommends 4 ways to remove the wax by boiling off by ironing out, by the use of solvents (Gonlene ICI benzene or petrol) and by dry cleaning.

Øihari (1964) tells that the cloth is pressed with an iron between newspaper or blotting paper sheets. Thus the melted wax is absorbed by the paper.

Linton (1978) recommends that the wax however will crack and allow fine vein lines of cloth to appear as the dye steeps through and penetrates into the material. After the full coloured areas and the vein line areas are completed, the fabric is then removed from the bath, rinsed with hot water or solvent to remove wax from the fabrics.

K. Recent Trends in Batik:

Storey (1974) states that in recent years, however instruction in the skills of batik designing and waxing has been started in training establishments set up by the Government in an effort to preserve all that is best in these traditional fabrics.

Stuart and Patricia Robinson (1970) express that although most of the batik product was for home consumption a lively export trade developed in the Seventeenth Century and this grew with the founding of various trading companies until Javenese Batiks were found all over the civilized world.

Joseph (1966) says that more recent resist methods include screen printing which is frequently considered the newest technique used for decorating process.

Originally the cotton material used in Java went from India but since 1815 this had been replaced by European materials. Not cotton and silk are used. The cloth should be firmly woven closely so as to allow the brush or pen to move freely. Silk and art silk develop beautiful cracks and these materials are preferable for bold and elaborate designs. This will look shiny.

Jameson (1970) expresses that the art of batik is becoming widely known and recognised as an investive medium. Western artists are using batik techniques to translate their own ideas not only into patterns designed for useful materials, but as an art form to produce to - dimensional decorative hangings.

III. EXPERIMENTAL PROCEDURE

The Experimental Procedure adopted for this study comprised the following steps:

- A. Selection of the Material
- B. Selection of the Method for Waxing
- C. Selection of Design
- D. Setting up of the Table
- E. Selection of Waxes and its Combinations
- F. Preparation of the Material
- G. Method of Waxing
- H. Selection of the Dyes
- I. Equipment used for Dyeing
- J. Methods of Dyeing
- K. Dewaxing
- L. After Treatment
- M. Evaluation

A. Selection of the Material.

Hersk (1975) says that viscose rayon is good for making batik in sarees and scarves because of its sheen. Closely woven material absorbs wax and dye evenly. Viscose Rayon is mostly used by all because its inexpensiveness. The combination of high heat conductivity and absorbancy of rayon makes it suitable for every season especially for summer. Hence the investigator selected viscose rayon for the study. The sample of the selected material is shown in Appendix I.

B. Selection of the Method for Waxing:

Birrell (1959) states that a tjap is a block provided with ridges made out of thin brass strips or nails arranged to conform to the outline of the design. Tjap is used for applying wax on the material. Therefore the investigator selected block method for applying wax to maintain the uniformity and accuracy in design.

C. Selection of the Design:

A single wooden block made of wood with iron pins arranged in the form of floral design which is suitable to



SELECTED DESIGN

apply one colour was selected. The size of the block was 10 cms x 10 cms and is shown in plate I.

D. Setting up of the Table:

Barbhuiya (1964) suggests that a rectangular wooden frame or wooden frame with sand is more suitable for waxing the material. A wooden table of rectangular shape was used for waxing the material. The size of the table was (70 cms x 100 cms). Fine sand was spread on the surface of the table to obtain the uniform surface. It also helped in the even disposition of wax on the other side of the material.

E. Selection of Wax and Its Combinations:

Noel Dyenforth (1975) expresses that pure Beeswax is more pliable and is therefore excellent for drawing lines and fine details or for work requiring minimum crackle. Paraffin wax is more brittle and cracks easily. A combination of beeswax and paraffin wax yields varying results. Hence both paraffin and beeswax were selected for the study, since the investigator wanted to find out the effect of the paraffin and

beeswax both individually and in combination with each other. She tried with different proportion of wax as given below:

100%	-	Beeswax
100%	-	Paraffin Wax
50%	-	Beeswax and 50% Paraffin wax
75%	-	Beeswax and 25% Paraffin wax
75%	-	Paraffin wax and 25% Beeswax.

F. Preparation of the Material for Waxing:

Marjory Joseph (1972) strongly stresses that the material should be thoroughly washed to remove starch or sizing before dyeing or printing. The desized material absorbs dye evenly. As suggested by him, the material was soaked in 5% soap solution (boiled water) for half an hour. After that the material was washed in cold water thoroughly, dried and ironed.

The delized material were cut into 16 pieces. One piece was kept aside as original and the other 15 pieces were to be used as test samples. They were divided into three groups. Each one having five samples. The first group, second group and third group samples were named as N₁, N₂, N₃, N₄ and N₅. V₁, V₂, V₃, V₄ and V₅. P₁, P₂, P₃, P₄ and P₅ which were to be treated with naphthol, vat and procion dyes respectively. Sample N₁, V₁ and P₁ were spread on the table for waxing, since these samples were to be waxed with 100% beeswax, 0.5 kg. of beeswax was melted in an enamel bowl and the same was applied on each sample by using the selected block. The temperature of the melting point of wax 55°C (120°F) was maintained. For waxing N₂, V₂ and P₂, 0.5kgk of paraffin wax was melted in a separate container and applied on each sample using the same block. Samples N₃, V₃ and P₃ were waxed by melting a combination of 0.25 kg of beeswax and 0.25 kg. of paraffin wax. Samples N₄, V₄ and P₄ were waxed by melting a combination of 0.375 kg of beeswax and 0.125 kg of paraffin wax.

6. Method of Waxing

For samples N₅, V₅ and P₅, 0.375 kg of paraffin wax and 0.125 kg of beeswax were melted together and applied. The waxed samples are shown in Appendix II.

II. Selection of the Dyes:

Edmund and Fothergill (1952) consider that the dyestuffs suitable for batik work must be capable of being applied from a cold dye bath since a heated dyebath would remove the wax resist.

Erode, being is the famous place for batik printing, the investigator visited a number of batik printing centres in Erode and found that naphthol, vat and procion dyes were commonly used in almost all the centres for getting brilliant colours and shades. Hence these three dyes were selected for the study, since the emphasis was laid only on different proportion of wax, the shades in these dyes were chosen.

Naphthol	-	Brown
Vat	-	Green
Procion	-	Pink

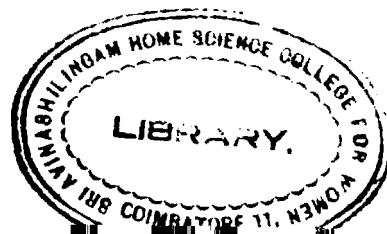
Equipment Used for Dyeing

As Chitrangada Krishna (1977) suggested the following equipment were used for dyeing.

1. Dyes and Chemicals
2. Enamel Bowls and Buckets for dyebaths
3. Glass measures
4. Rubber Gloves
5. Plastic sheet to keep the samples separately
6. Plastic spoons
7. Newspaper to cover working surface
8. Stove
9. Small Bowls to mix dyes
10. Physical balance for Measuring
11. Wooden stirrer.

Methods of Dyeing:

Clarke (1978) points out that Anzoic or Naphthol dyes are cold waterdyes suitable for batik printing, mainly



for cellulosic fibres. The characteristic feature of these dyes is that they are formed within the fibre by the reaction of two components that is the component and the coupling component. The preparation of naphthol dyebaths are given in Appendix II.

Samples N₁, N₂, N₃, N₄ and N₅ dyed with Naphthol dyes. After dyeing the samples were washed well to remove mechanically held colour pigments and to respond good rubbing fastness.

Samples V₁, V₂, V₃, V₄ and V₅ were dyed with vat dyes. The preparation of vat dyebath is given in Appendix III. while doing this dye, care was taken not to expose the material outside and contact with air. After half an hour, each of the sample was taken out and exposed to atmosphere. The exposure developed the colour on the material. Samples P₁, P₂, P₃, P₄ and P₅ were dyed with procion dyes. The procedure used for procion dyeing method is given in Appendix IV.

K. Dewaxing:

Stuart and Patricia (1970) point out that the wax can be removed by three ways:

1. By boiling method
2. By using Benzene or Petrol
3. By ironing method.

The investigator chosen boiling method to remove the wax from the material. The dyed samples were put in hot water to melt the wax. Boiling was continued for about ten minutes and the samples were stirred continuously. After de-waxing, the samples were taken away and rinsed in cold water.

L. After Treatment:

Since soaping develops true shade in the dyed materials the same was given to the samples. The samples were washed thoroughly, dried and ironed. The batik printed samples are shown in Appendix

The ~~evaluation~~ for the study included:

1. Visual Inspection
2. ~~Preparation~~ of Test Samples
3. Laboratory Test
 - a. Breaking Strength Test
 - b. Abrasion ~~Resistance~~ Test
 - c. Fabric Thickness Test
 - d. Colour ~~Fastness~~ Test

1. Visual Inspection

Twenty judged from Post Graduate Textiles and Clothing, Sri ~~Arumaha~~ Home Science College, ~~Guntur~~ were selected to evaluate the batik printed samples, since they had enough knowledge on the same. In order to evaluate the ~~effectiveness~~ of the batik printed samples, a rating scale was prepared by the ~~investigator~~ and is given in Appendix V . The samples were displayed for easy ~~evaluation~~. The rating scale was given

to the selected judges and the same was collected after evaluation. The results were consolidated and is presented in Results And Discussion.

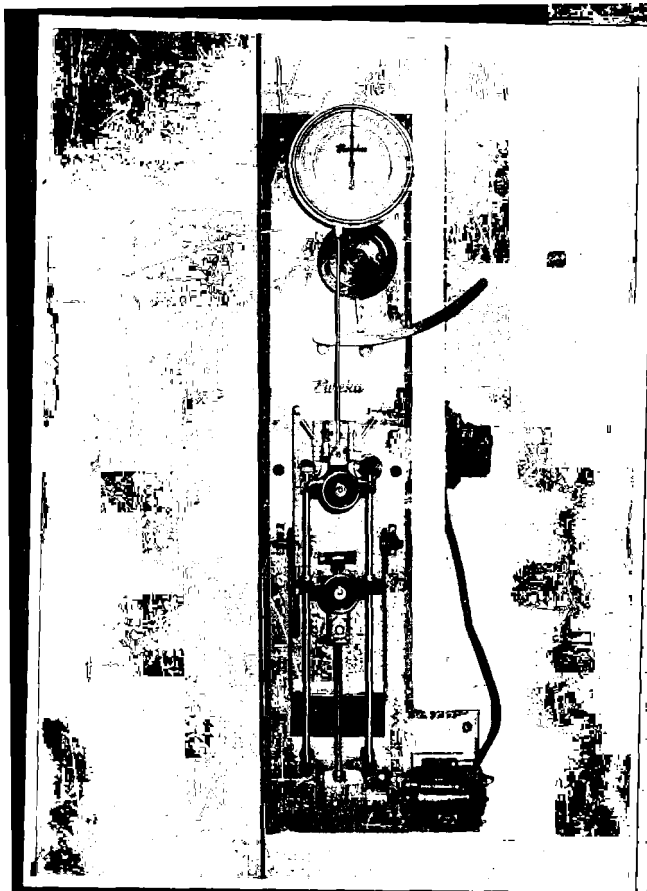
2. Preparation of Test Samples:

The original and batik printed samples were tested by taking the sample pieces from different parts of the material for each test.

3. Laboratory Test:

1. Breaking Strength Test:

Grover and Hamby (1969) define that the breaking strength is a measure of the resistance of the fabric to a tensile load or stress in either the warp or filling direction. Further they explained that Elongation is a measure of the extent of deformation along to the axis of a material under a tensile stress and is expressed as present change in length based on the original length of the test sample.

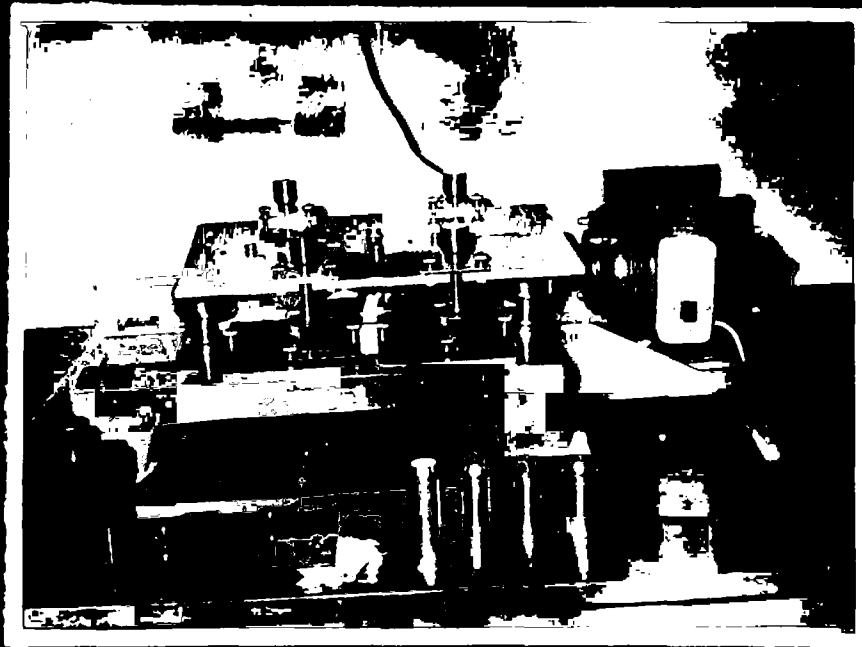


BR_LAKING STRENGTH TESTER

Eureka Tensile strength Tester was used. This is most common type of tester. The rate of traverse and the capacity of the machine were 18 inches per minutes and 200 pounds respectively. The guage length was kept as 9". The dial of the machine was calibrated in pounds and mm. The test samples were cut out 1½ inches wide and 13 inches long and ravelled to 1 inch width and 12 inches long by drawing the yarns from four sides. Ten samples were taken from both of the warp and weft direction of each test specimen. The samples were clamped in between the two jaws. Care was taken to see that the samples were perpendicular to load. The load was applied and the reading was recorded in kg for load, and in inches for elongation as soon as the sample was broken. The mean value of ten readings were taken and recorded for each specimen.

Abrasion Resistance:

According to Lonax (1979) Abrasion defined the friction between cloth and other material. Eureka Martindale Abrasion tester was used. The severity of the abrasion varies with



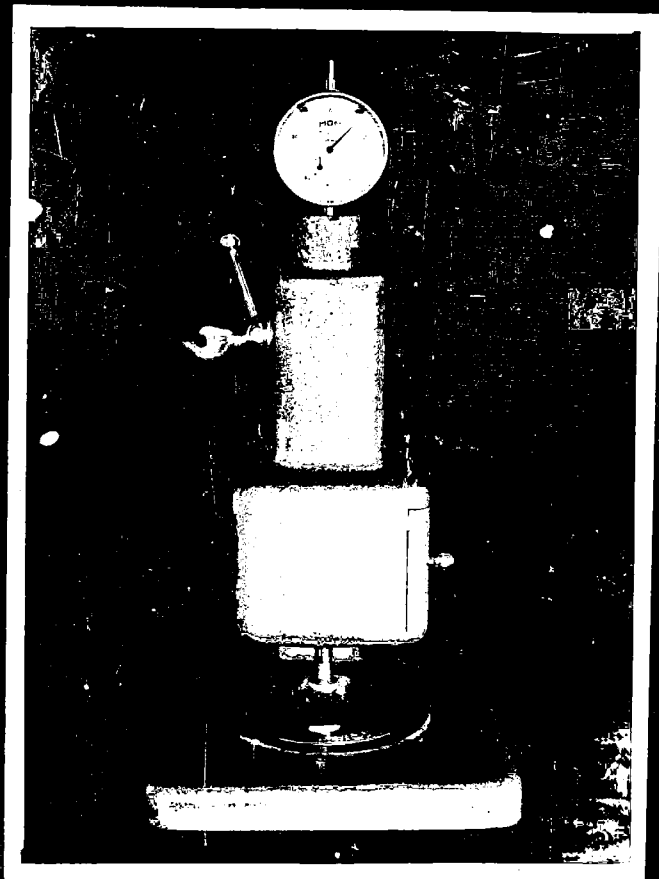
A BRASION STRENGTH TESTER

the nature of the abrader. Silicon carbide No. C-400 was used as an abradent. The samples were cut from different parts of the original and the test specimens by using the template. The initial weight of each sample was taken. First a few samples were tested to standardise the number of rubs, 5 rubs were found to be sufficient. Every time a fresh abradent was used. Final weight of the samples were taken after abrasion. The loss in weight was noted for each sample. The mean value of ten readings were taken and recorded for each sample.

6. Fabric Thickness Test.

According to Skinkle (1964), fabric thickness test is used to find its density in connection with such property of air permeability, water permeability and thermal conductivity.

Hagenian Thickness Tester was used. It had a broad anvil upon which a presser foot was pressed by a spring. The sample was placed on the anvil without tension and the presser foot was lowered upon the sample gradually by releasing the lever and allowed to rest upon it for 2 seconds at 4 kilograms pressure.



FABRIC THICKNESS TEST OR

The dial indicated the thickness of the material, thousands of an inch. Each division on the dial read 0.01 mm. The readings were taken from different places of the original and tested samples. The mean value of ten readings were taken and recorded.

d. Colour Fastness Test.

- i. Colour fastness to sunlight
- ii. Colour fastness to washing
- iii. Colour fastness to wet and dry pressing
- iv. Colour fastness to wet and dry procking

i. Colour Fastness to Sunlight.

The original printed sample 4" x 2" were taken half of the samples were covered with a thick black paper to protect it from the atmospheric conditions. The samples were exposed to direct sunlight for a period of 10 A.M. to 4 P.M. for one week. The tested samples were then evaluated.

ii. Colour Fastness to Washing.

A 5 per cent soap solution as suggested by Dasu(1964) was used for washing. Staining on white material was carefully observed fastness to crocking.

iii. Colour Fastness to Wet and Dry Pressing.

As suggested by Wright (1975) the samples were kept inbetween the white material and then pressed with a heavy iron for twenty seconds. Keeping the temperature at 200°C in both dry and wet conditions.

iv. Colour Fastness to Crocking.

As explained by Lyle (1976) the sample materials were rub briskly against a white cloth in dry as well as in wet conditions. The colour transference on the white material was noted.

IV. RESULTS AND DISCUSSION

The results of the study are discussed under the following headings:

A. Visual Inspection

B. Laboratory Tests

C. Colour Fastness Test

1. Fastness to Sunlight

2. Fastness to Washing

3. Fastness to Wet and Dry Pressing

4. Fastness to Wet and Dry Crocking

A. Visual Inspection:

The details of panel ratings regarding the brilliancy of colours, clarity of design, general appearance and evenness of design are given in table I.

From Table I, it is evident that the brilliancy of colour, N₁ ranked first as it was considered to be very good by 95 per cent of the judges, N₂ and N₅ were considered to be very good by 90 per cent of judges. Samples P₅, P₃, V₃ and N₃ were rated as good by 66, 50, 45 and 40 per cent of judges respectively.

As regards in clarity of design, samples N₂ and N₅ were considered as very good by 75 per cent of judges. Samples P₅, N₄, V₂ and V₃ were rated as good by 65, 55 and 45 per cent of judges.

In Evenness of design, samples N₅ and N₂ were first ranked as very good by the 55 and 50 per cent of judges respectively. Samples N₄, V₂ and P₁ were considered as good by 60, 60 and 50 per cent of the judges respectively.

Regarding general appearance, sample N₂ was ranked very good by 55 per cent of judges. Samples N₄, V₅, V₁, V₂ and P₅ were considered as good by 65, 65, 60, 60 and 55 per cent of judges respectively.

Hence, it is clear that samples N₂ and N₅ waxed with 100 per cent paraffin wax and 75 per cent paraffin + 25 per cent beeswax respectively, were appreciated by majority of the judges.

B. Laboratory Tests

1. Breaking Strength
2. Abrasion Resistance
3. Fabric Thickness

1. Breaking Strength.

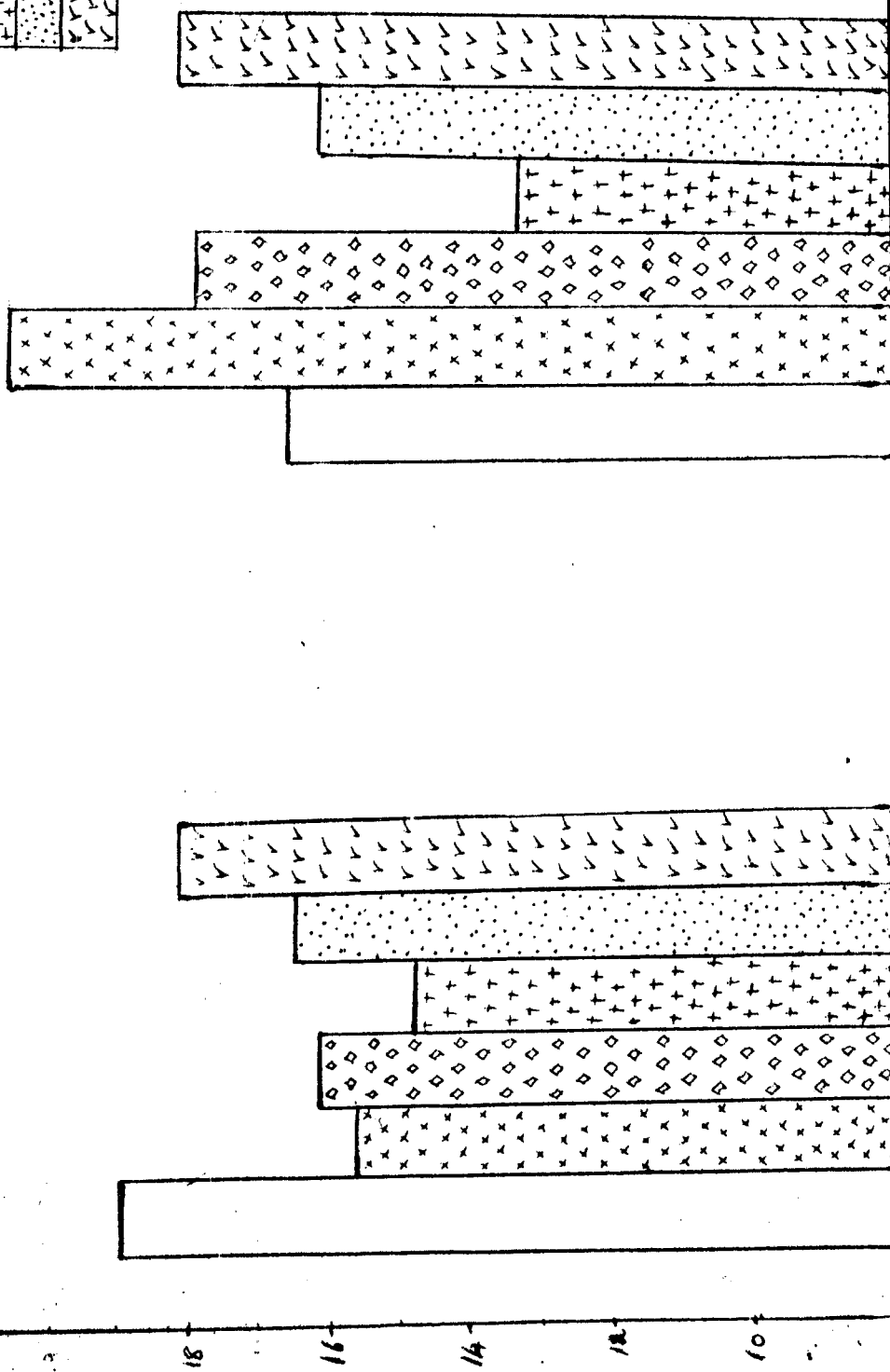
The breaking strength of the original and tested samples are given in Table II, Figure 1, 2 and 3.

SCALE: 1cm - 2K.G.

KEY:-

ORIGINAL
100% BEES WAX
100% PARAFFIN WAX
50% BEES + 50% PARAFFIN
75% BEES + 25% PARAFFIN WAX
75% PARAFFIN + 25% BEES WAX

BREAKING STRENGTH



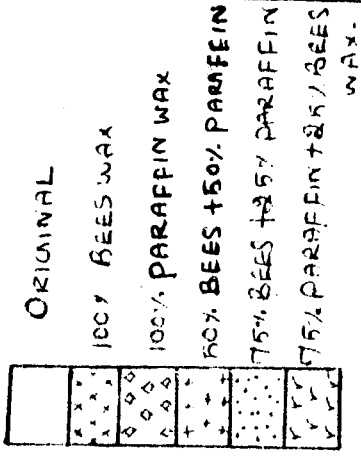
WEFT.

WARP.

NAPHTHOL
FIGURE - 1

SCALE:- 1cm = 3K.G

KEY:-



BREAKING STRENGTH

20

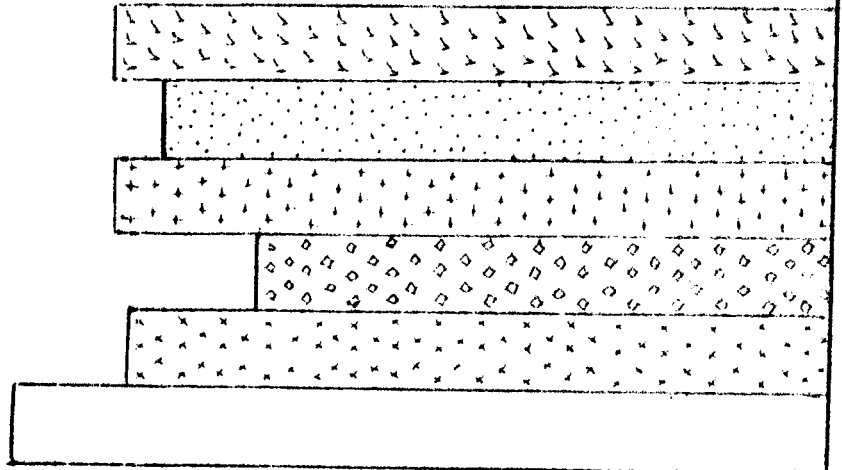
18

16

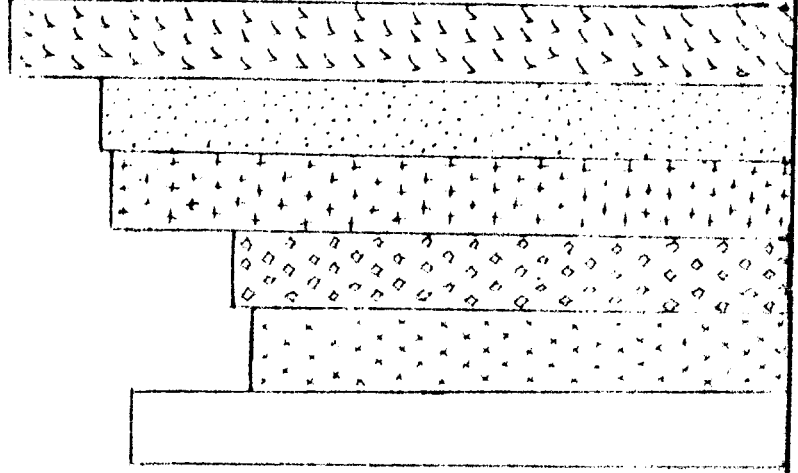
14

12

10



WARD

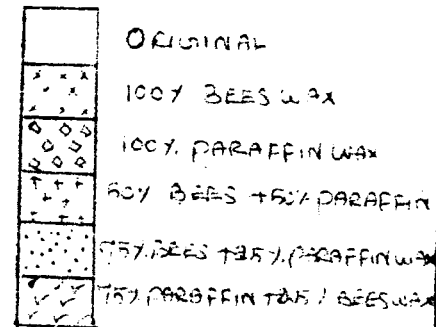


NEFT

VAT DYE
FIGURE - 2

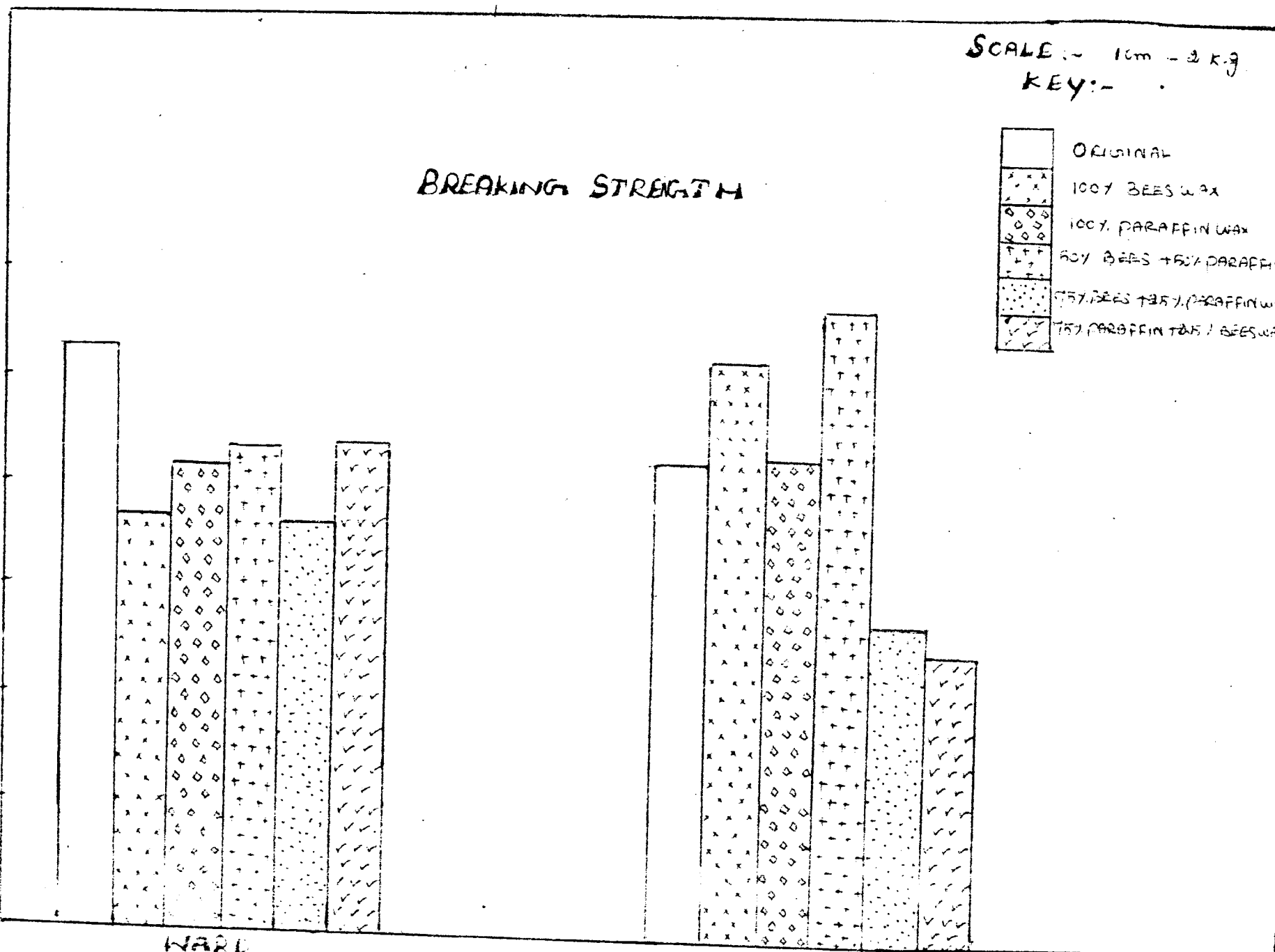
SCALE :- 1cm = 2 K.g

KEY :-



BREAKING STRENGTH

20
18
16
14
12
10



WARP

WEFT

PROCION DYE
FIGURE - 3

Comparing the original and tested samples in warp direction, the breaking strength of N_5 , V_3 and P_5 were found to be the highest. The percentage loss over original were found to be the highest in N_3 , V_5 and P_4 and the lowest in N_5 , V_3 and P_5 .

In the weft direction, the breaking strength of N_1 , V_5 and P_3 were found to be the highest. The percentage gain over original was found to be highest in N_3 , V_5 and P_3 and the lowest in N_2 , V_3 and P_2 .

On analysing statistically, it was learnt that the difference between the original and tested samples N_1 , N_2 , N_3 , N_4 , V_1 , V_2 , P_2 , P_4 and P_5 were significant at 5 per cent level in the warp direction. In the weft direction, it was found that the samples N_1 , N_2 , N_3 , N_5 , V_5 , P_1 , P_4 and P_5 were significant at 5 per cent level.

Hence it could be concluded that 100 per cent paraffin waxed samples showed greater strength when compared with the other samples.

Breaking Strength Elongation:

The Elongation of the Original and Tested samples is given in Table III.

Comparing the original and tested samples in warp direction, the elongation of N_4 , V_2 , V_4 , P_2 and P_4 were found to be the highest. The percentage gain over original was found to be the lowest in N_1 , V_1 and P_1 and highest in N_4 , V_2 , V_4 , P_2 and P_4 .

In the weft direction, the elongation of N_1 , V_2 and P_1 were found to be the highest. The percentage gain over original was found to be the highest in N_1 , V_2 and P_1 and the lowest in N_3 , V_1 , P_4 and P_5 .

On analysing statistically, it was found that the difference between the original and tested samples, except N_1 , N_2 , V_2 , P_1 , P_2 and P_4 were found to be significant at 5% level in the warp direction. In the weft direction, all the tested samples except N_1 and N_2 were found to be significant at 5 per cent level.

It could be concluded that the elongation of all the samples were more in both warp and weft direction when compared with the original.

Abrasion Resistance:

The Abrasion Resistance of the original and tested samples is given in Table IV.

TABLE IV
ABRASION RESISTANCE

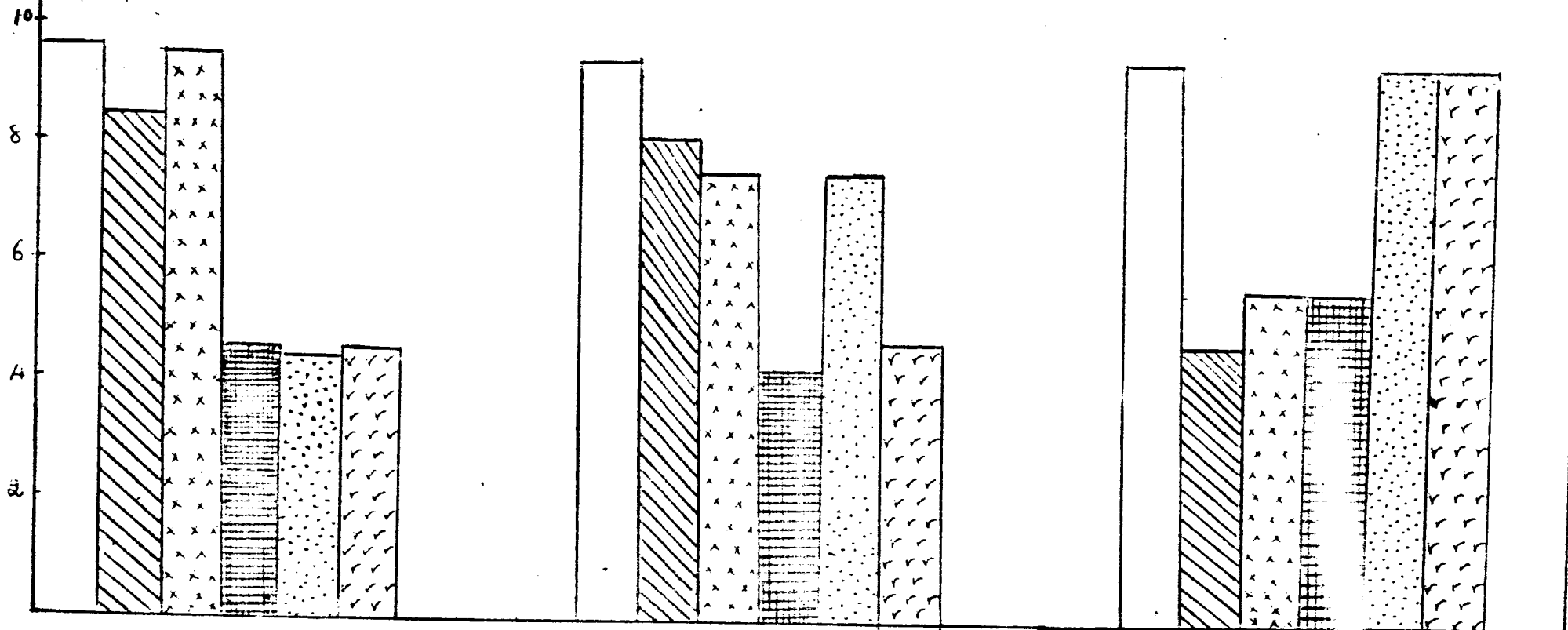
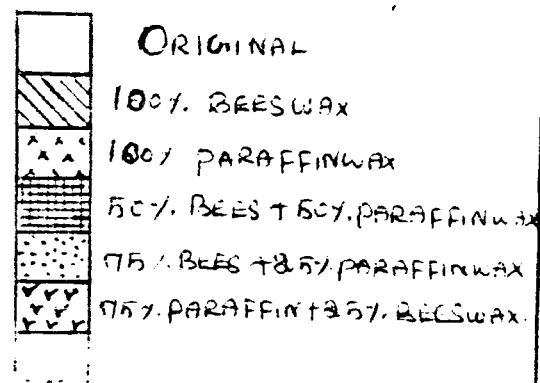
S.No.	Loss in wt. (in mg)	% Loss over Original	t - value
Original	9.62		
N ₁	8.44	12.27	0.6129
N ₂	9.5	1.24	1.394
N ₃	4.46	53.35	1.712
N ₄	4.38	54.18	1.772
N ₅	4.5	52.9	1.964
V ₁	8.1	15.7	0.2167
V ₂	7.76	19.3	1.039
V ₃	4.1	19.2	2.513*
V ₄	7.86	18.20	0.952
V ₅	4.4	53.97	2.28
P ₁	4.4	53.97	2.28
P ₂	5.88	38.67	1.615
P ₃	5.98	37.73	0.799
P ₄	9.54	0.828	0.2469
P ₅	9.5	1.241	0.9020

* Significant at 5 per cent level.

ABRASION STRENGTH

SCALE:- 1cm - 3mg.

KEY:-



NAPHTHOL

VAT DYE

PROCION DYE

FIGURE - 4

The loss in weight of the sample due to abrasion as shown in Table IV, ~~determines~~ the abrasion ~~resistance~~ of the sample. The greater the loss in weight, the lesser will be the ~~resistance~~ to friction.

More ~~resistance~~ was found in N_4 , V_3 and P_1 when compared to the original.

On ~~fr~~ analysing ~~statistically~~, the sample V_3 was found to be ~~significant~~ at 5 per cent level. On the whole it is clear that more ~~resistance~~ was found in all the Batik printed samples when compared with the original

3. Fabric Thickness

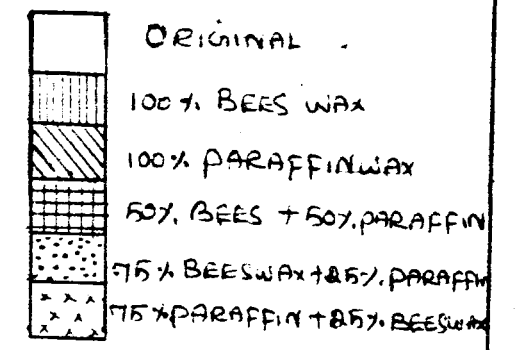
The fabric thickness of the original and tested samples is presented in Table V, Figure 5.

TABLE V
FABRIC THICKNESS

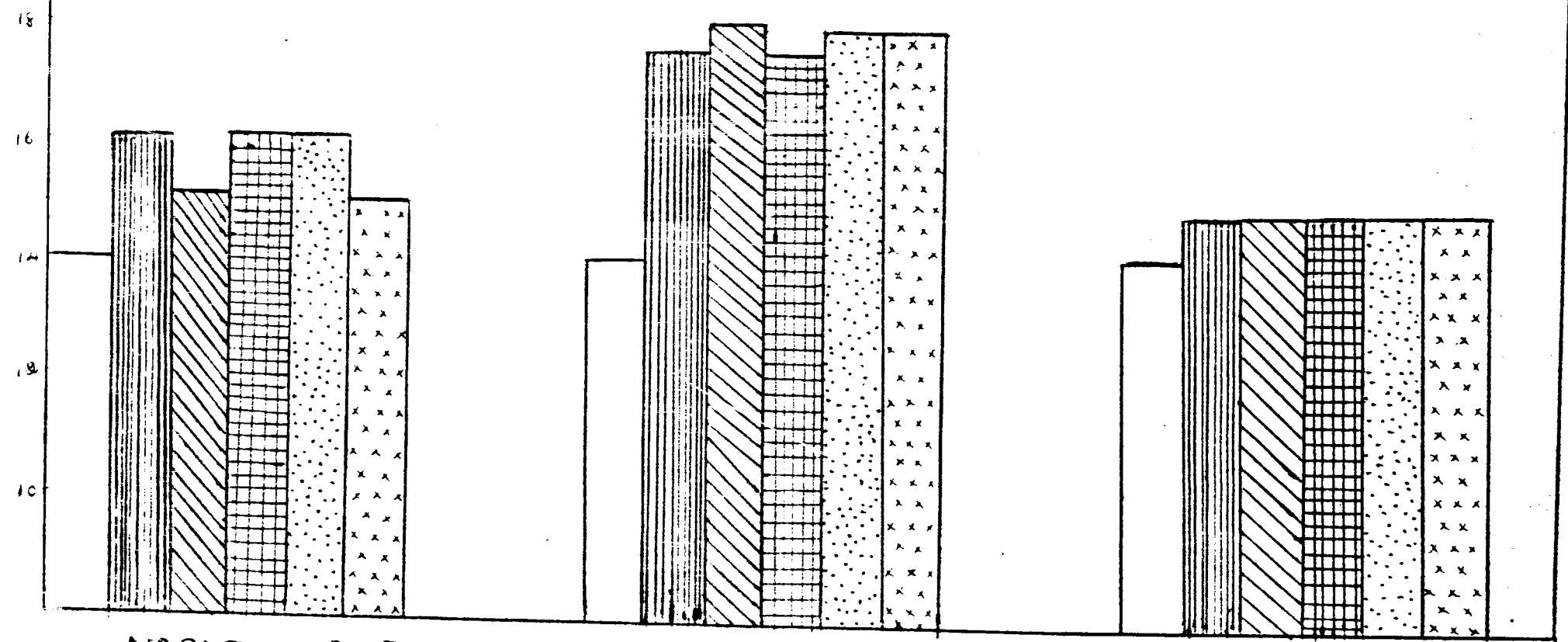
Sample No.	Mean Fabric Thickness (in millimetres)	% gain over original
Original	14.0	
N ₁	16.0	14.29
N ₂	15.2	8.57
N ₃	16.0	14.29
N ₄	16.0	14.29
N ₅	15.0	7.413
V ₁	17.8	27.14
V ₂	18.0	28.57
V ₃	17.7	21.43
V ₄	17.9	27.86
V ₅	17.9	27.86
P ₁	15.0	7.413
P ₂	15.0	7.413
P ₃	15.0	7.413
P ₄	15.0	7.413
P ₅	15.0	7.413

SCALE:- 1cm - 2mm.

KEY:-



FABRIC THICKNESS TEST



NAPHTHOL DYE

VAT DYE

PROCION DYE

FIGURE - 5

From Table V a noticeable difference was found to exist in the thickness of the original and the Batik printed samples. There was a considerable increase in thickness in all the samples dyed with vat dye, followed by Naphthol and procion. The thickness of the samples V₂ was found to be greater than the other samples.

C. Colour Fastness Tests

1. Fastness to Sunlight

The samples when tested for colour fastness to light after a weeks exposure to sunlight, it was found that all the samples dyed in Naphthol (N₁, N₂, N₃, N₄ and N₅) and vat (V₁, V₂, V₃, V₄ and V₅) were as bright as it they were earlier. The samples treated in procion dye (P₁, P₂, P₃, P₄, P₅) showed light dullness in their colour.

2. Fastness to Washing

Irrespective of the wax combinations, all the samples showed good colour fastness to washing.

3. Fastness to Wet and Dry Pressing

The white material at the back of all the samples remained white when it was given pressing in both dry and

wet conditions. From this, it was found that the colour of all samples were fast to pressing in both dry and wet conditions.

4. Fastness to Wet and Dry Crocking.

The samples treated with procbn and vat dyes were highly colour fast to crocking in both wet and dry conditions. This was learnt from the fact that the white material at the back of the samples remained white even after crocking in both wet and dry conditions. Naphthol dyed samples showed colour fast to dry crocking and moderate fast to wet crocking.

V. SUMMARY AND CONCLUSION

This study was undertaken to find out the effectiveness of bees and paraffin wax on Batik work, both individually and in combinations. The following proportions were randomly chosen:

- | | | | |
|----|------|---|--------------------------------|
| A. | 100% | : | Bees Wax |
| B. | 100% | : | Paraffin Wax |
| C. | 50% | : | Paraffin Wax and 50% Bees Wax |
| D. | 75% | : | Bees Wax and 25% Paraffin Wax |
| E. | 75% | : | Paraffin Wax and 25% Bees Wax. |

To determine the possible error of one, particular dyes reaction to different wax combination, the investigator selected three different dyes namely naphthol, vat and procion.

Fifteen samples from Viscose Rayon were taken and one metre was kept aside as original for the study. They were equally grouped into three parts each one having five samples for five different wax combination. The samples were named as N₁, N₂, N₃, N₄, N₅, V₁, V₂, V₃, V₄, V₅, P₁, P₂, P₃, P₄ and P₅.

The samples N₁, V₁ and P₁ were waxed with first combination, N₂, V₂ and P₂ with second combination N₃, P₃ and P₃ with third combination, N₄, V₄ and P₄ with fourth combination and N₅, V₅ and P₅ with fifth combination.

The waxed samples of first group treated with Naphthol, second group with Vat and third group with Procion dyes. The dyed samples were dewaxed by using hot water method and evaluated by:

- A. Visual Inspection.
- B. Laboratory Tests
- C. Colour Fastness Tests.

Findings:

A. Visual Inspection.

1. In Visual Inspection 100 per cent paraffin waxed, Naphthol dyed samples were rated as very good in all the aspects.
2. Samples waxed with 75 per cent paraffin wax and 25 per cent Beeswax were rated as very good in Brilliancy of colour clarity of Design, and Evenness of design.

B. Laboratory Tests:

1. On analysing statistically, breaking strength revealed that the difference between the original and tested samples $N_2, N_3, N_4, V_1, V_2, P_2, P_4$ and P_5 were significant at 5 per cent level in the warp direction.

2. In the weft direction it was found that the samples, $N_1, N_2, N_3, N_5, N_5, P_1, P_4$ and P_5 were significant at 5 per cent level.

In breaking strength, 100 per cent paraffin waxed samples showed greater strength when compared with other samples.

3. Comparing the original and tested samples in warp direction the Elongation of N_4, V_2, V_2, P_2 and P_4 were found to be the highest. The percentage gain over original were found to be the highest in N_1, V_1 and P_1 and lowest in N_4, V_2, V_4, P_2 and P_4 .

4. In the weft direction, the Elongation of N_1, V_2 and P_1 were found to be the highest. The percentage gain over original



was found to be the highest in N_1 , V_2 and P_1 and the lowest in N_3 , V_1 and P_4 and P_5 .

It could be concluded that the elongation of all the samples were more in both warp and weft direction when compared with the original

5. The loss of weight due to abrasion was high in samples N_2 , V_1 and P_4 . More resistance was found in N_4 and V_3 and P_1 when compared to the original.

6. There was a considerable increase in thickness in all the samples dyed with vat dye followed by Naphthol and Procion. The thickness of the samples V_2 was found to be greater than the other samples.

C. Colour Fastness Test.

1. The colour fastness of all the samples dyed in Naphthol and vat were as bright as it they were earlier.

2. Irrespective of the wax combinations, all the samples showed good colour fastness to washing, wet and dry pressing and dry crocking and moderate fast to wet crocking.

Hence, it could be concluded that 100 per cent paraffin wax is the best one to do batik printing on viscose rayon. The combination of 75 per cent of paraffin wax and 25 per cent bees wax comes next. All the three dyes namely Naphtho, Vat and Procion and good colour fastness to sunlight washing, pressing and crocking.



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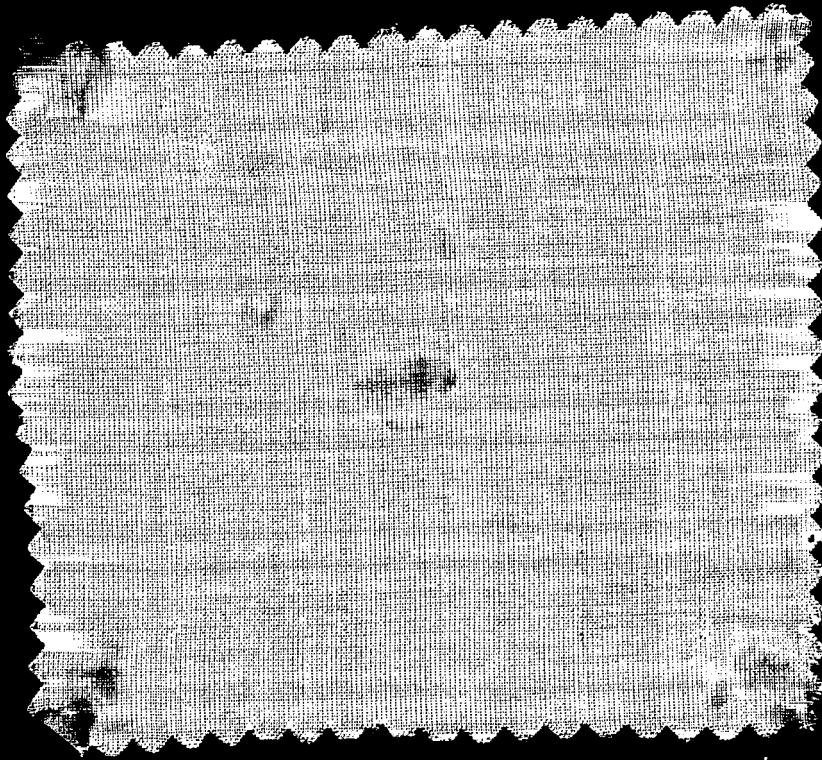
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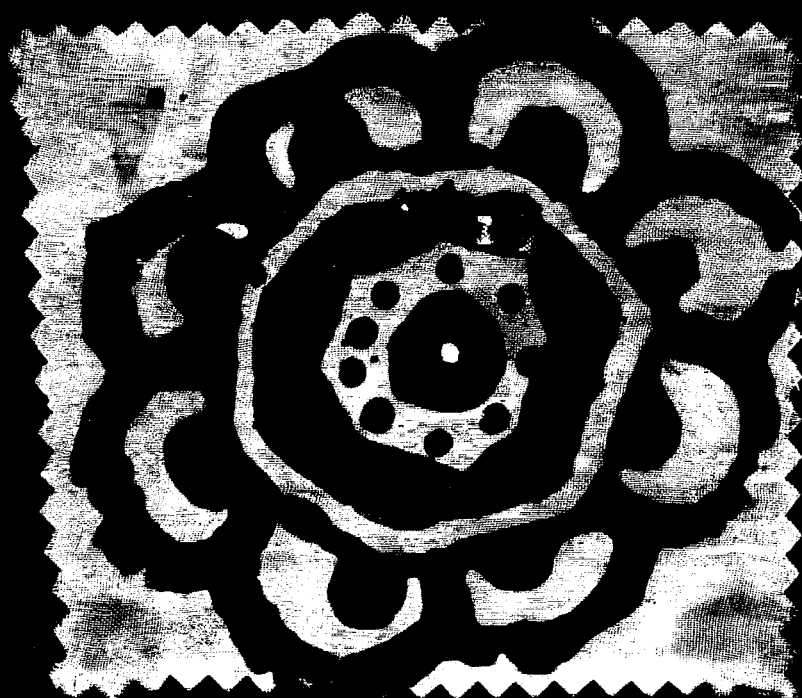


APPENDICES

APPENDIX-I

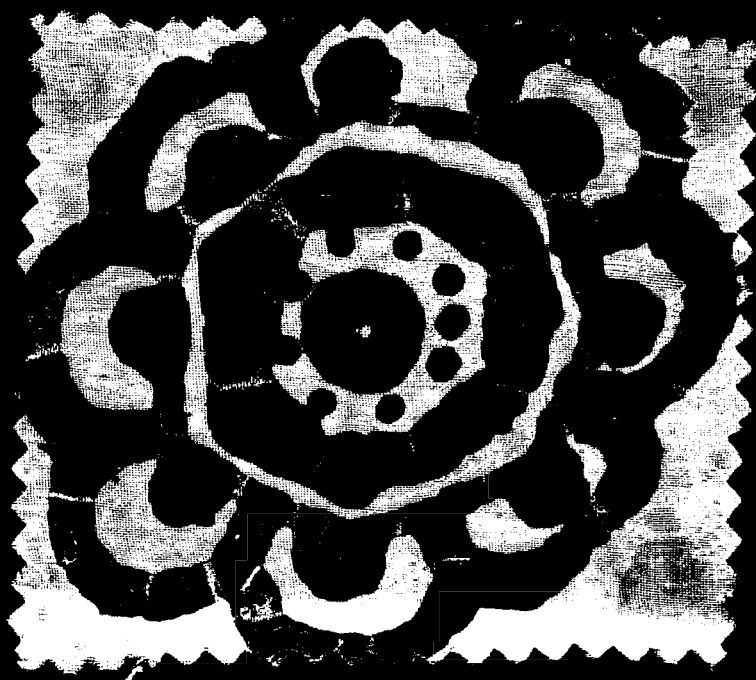


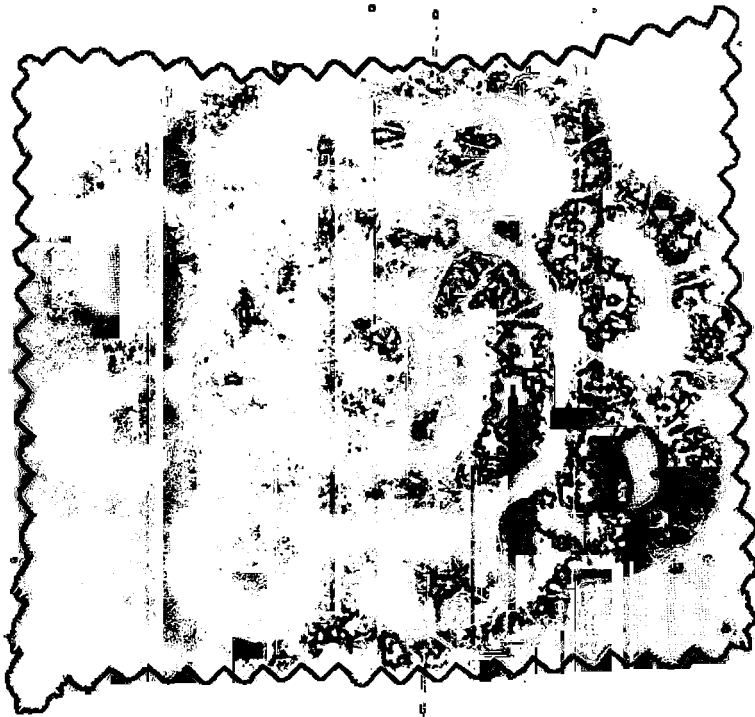
ORIGINAL SAMPLE



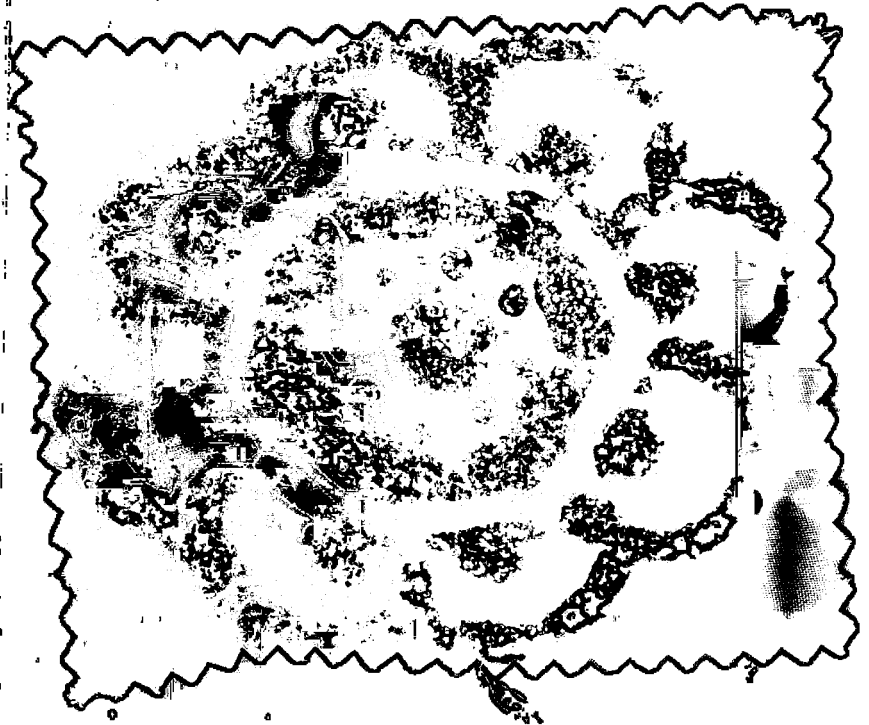
100% BEESWAX

100% PARAFFIN
WAX





50% BEES WAX +
50% PARAFFIN WAX



75% BEES WAX
+ 25% PARAFFIN
WAX



7-11-1944 WASH DC BELLEVUE

APPENDIX II

NAPHTHOL DYEING:

Dye Powder	-	15 gms
Sodium Hydroxide	-	10 gms
Monopal Soap	-	
Temperature	-	100°F

Preparation of Naphthol Solution:

The dye powder was made into paste with monopal soap and to this paste hot water was added and was dissolved completely. Lumps formed were broken. As praying () says monopal soap is commonly used for pasting Naphthols by the hot dissolving method to wet and disperse the dry powder to enable sodium hydroxide to react with it.

10gms of sodium hydroxide was dissolved in the water and then this was added to the solution stirred well and kept aside. Naphthol solution should be cold always.

Preparation of Base Solution

Base	-	15 gms
Conc. HCl	-	10 ml
Aluminium Sulphate		120 gms
Sodium Nitrate		15 gms

To the dye powder 10 ml of HCl was added followed by little water so that the base dissolved without any lumps. Required amount of cold water was added to make the solution more clear. To this, sodium nitrate was added and stirred well till the brownish fumes exhausted and the bath was allowed to settle for 10 minutes. Complete elimination of the brownish fumes was the indication about the completion of diazotisation.

To the diazotised solution, sodium acetate was added to remove the excess of the HCl from the bath. Then to this aluminium sulphate was added and the entire solution was stirred well.

APPENDIX III

VAT DYEING:

Dye	-	10 gms
Monopal Soap	-	
Caustic Soda	-	25 gms
Sodium Hydrosulphate.	-	20 gms
Temperature.		

Procedure.

Dye powder was first mixed with monopal soap and made into a paste and is dissolved in hot water. To this, caustic soda and sodium hydrosulphate were added. The solution was stirred continuously and kept aside to turn completely cold. After cooling, the samples were immersed, in the dyebath for 10 minutes and then exposed to air.

APPENDIX IV

PROCION DYEING:

Dye : 10 gms

Caustic Soda :
(or) Soda ash

Sodium Chloride : 20 gms

Water.

Procedure.

The dye powder was mixed with a little amount of water and made into a paste and then dissolved in water. To this, sodium chloride was added to exhaust the dyebath and the material was dipped into the solution for 45 minutes. Then the material was lifted and caustic soda was added into the dyesolution and the material was again dipped in this solution for half an hour to fix the colour on to the material.

APPENDIX V
RATING SCALE USED TO EVALUATE THE BATAK PRINTED
SAMPLES

Samples	Brilliance of colour	Clarity of Design	Evenness in Design	General Appearance
N	V.Good Good Fair Poor	V.Good Good Fair Poor	V.Good Good Fair Poor	V.Good Good Fair Poor
N ₁				
N ₂				
N ₃				
N ₄				
N ₅				
V ₁				
V ₂				
V ₃				
V ₄				
V ₅				
P ₁				
P ₂				
P ₃				
P ₄				
P ₅				
P				

APPENDIX VI

STATISTICAL ANALYSIS OF DATA USED FOR THE STUDY:

$$t = \frac{\bar{X}_1 - \bar{X}_2}{s} \sqrt{\frac{n_1 n_2}{n_1 + n_2}}$$

Where $s = \frac{(x_1 - \bar{X}_1)^2 + (x_2 - \bar{X}_2)^2}{n_1 + n_2 - 2}$

\bar{X}_1 = Mean of the original samples

\bar{X}_2 = Mean of the tested sample

n_1 = The size of the original

n_2 = The size of the tested sample.

The 't' value of N_2 was compared with that of original sample after breaking strength in warp direction.

$\bar{X}_1 = 1.64$

$\bar{X}_2 = 1.8$

$s = \frac{.0120 + .23}{n_1 + n_2 - 2}$

$\frac{.0120 + .23}{8} = \frac{.2420}{8}$

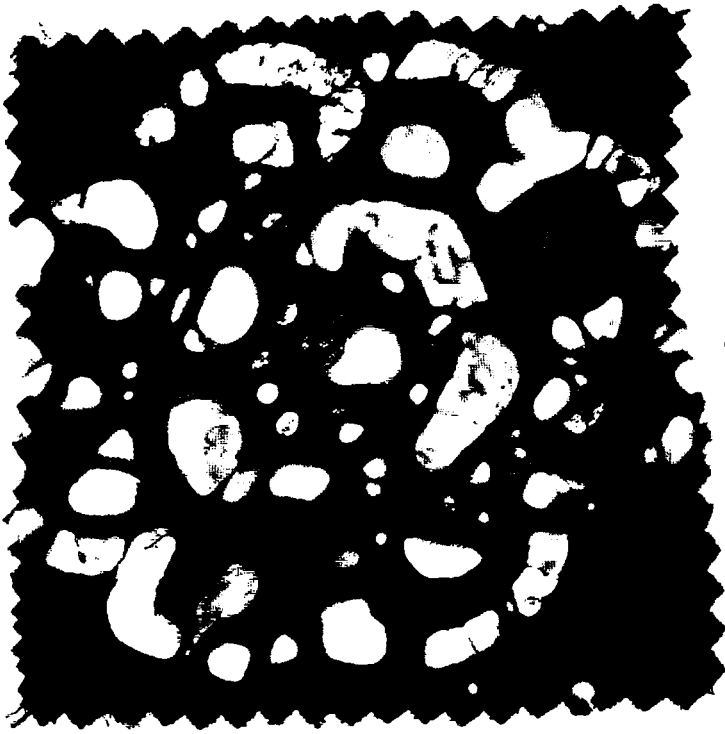
$s = .302 = .5495$

$s = .5495$

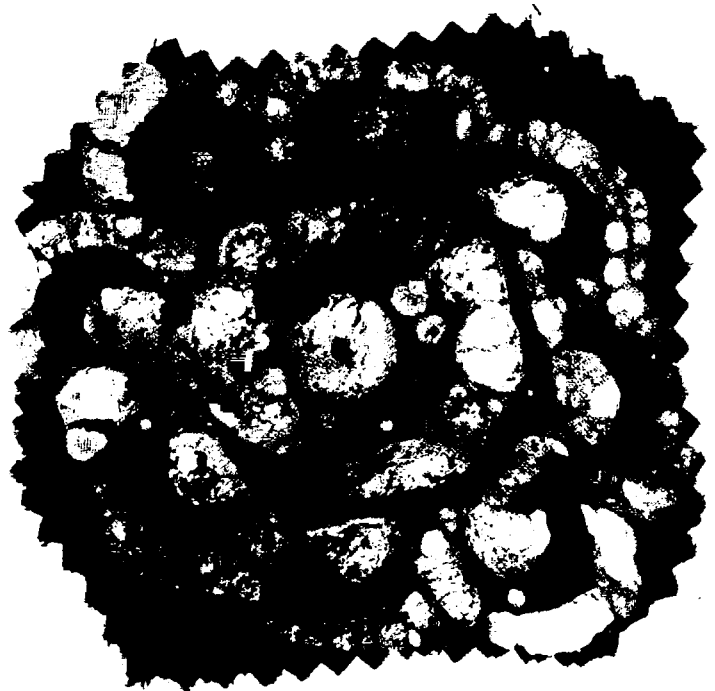
$t = \frac{.16}{.5495} \times 1.58$

$= .7512$

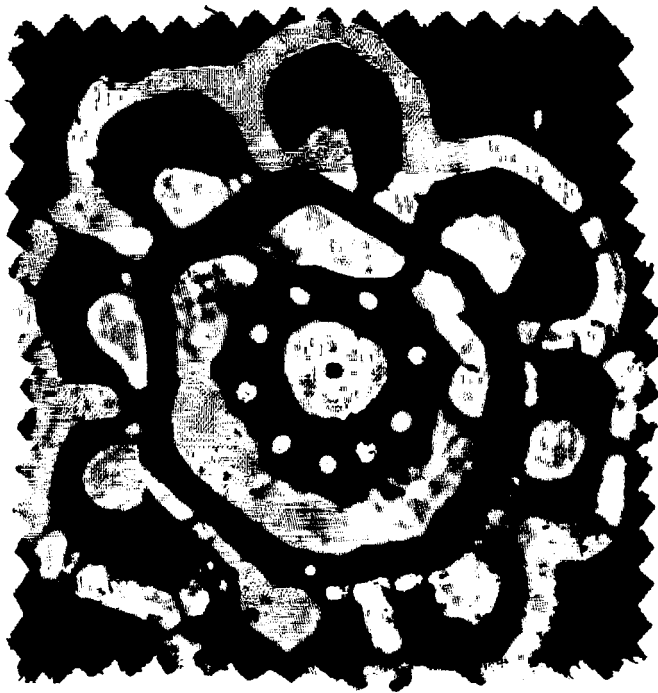
$t = .7512$



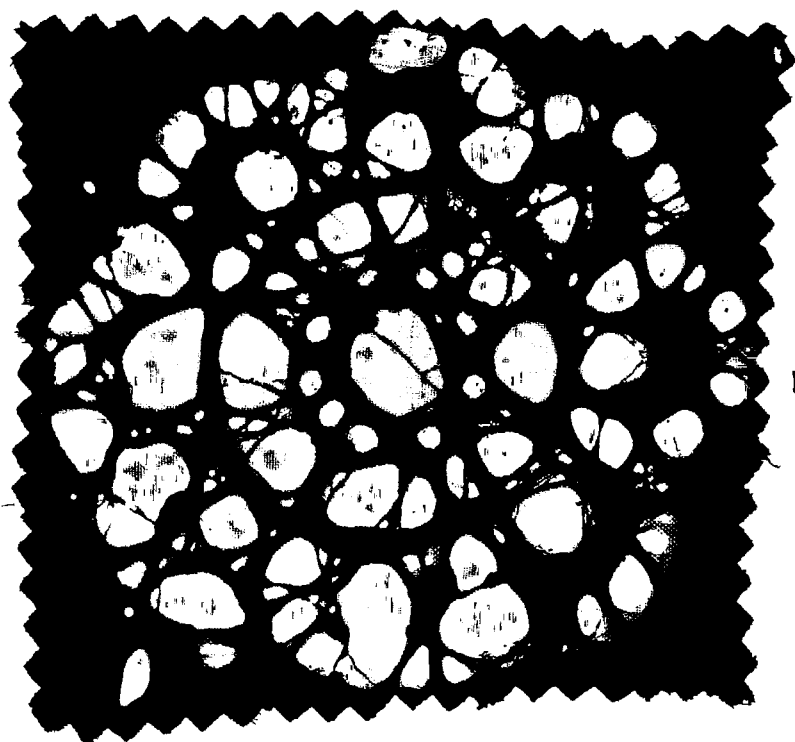
100% BEESWAX - NAPHTHOL DYE



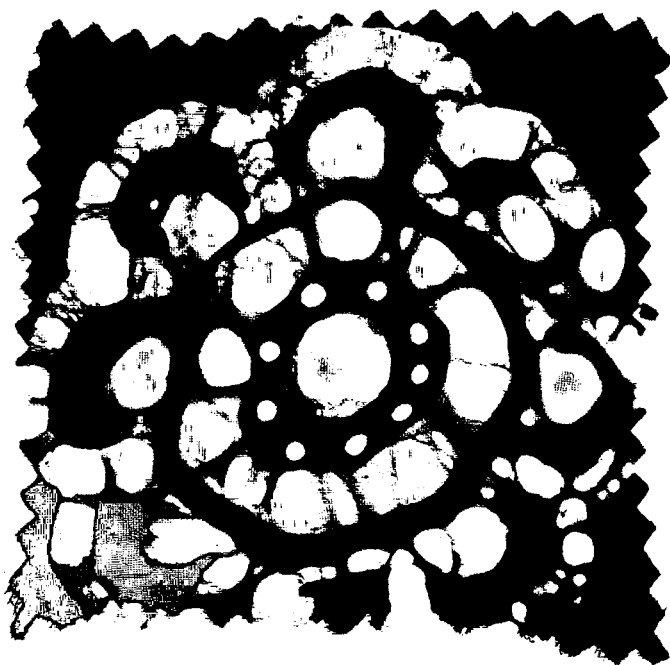
100% BEESWAX - VAT DYE



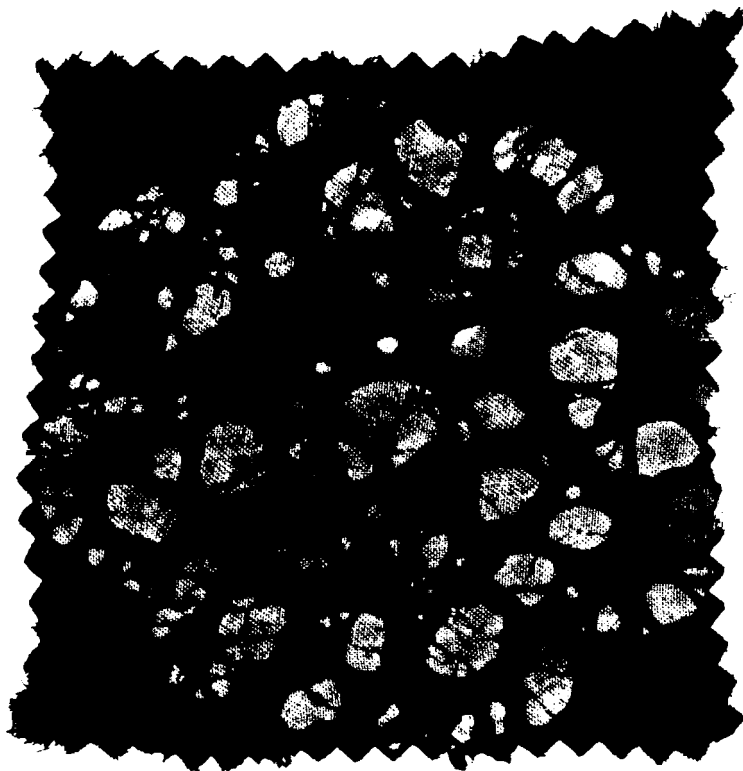
1007. BEESWAX - PROUON DYE.



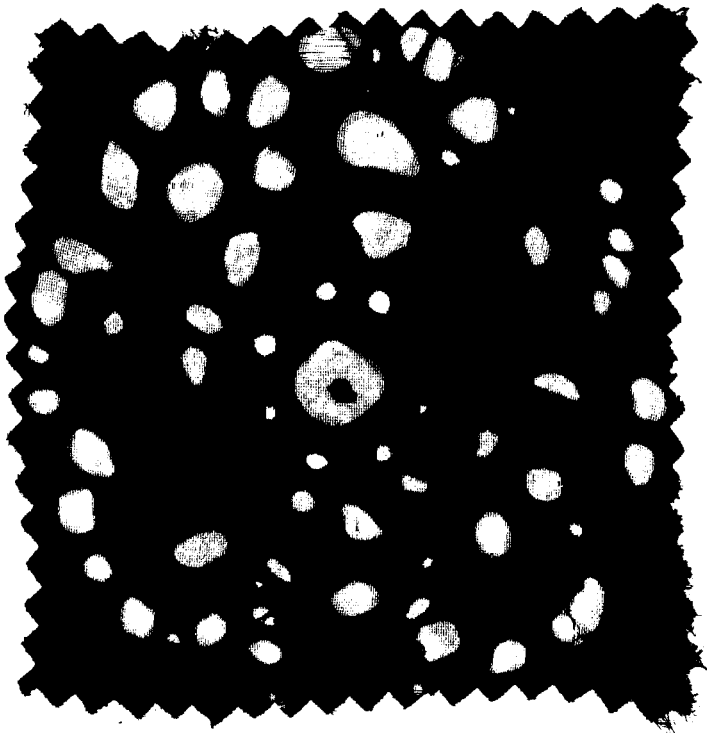
100% PARAFFIN WAX - NAPHTHOL DYE



100% PARAFFIN WAX - VAT DYE

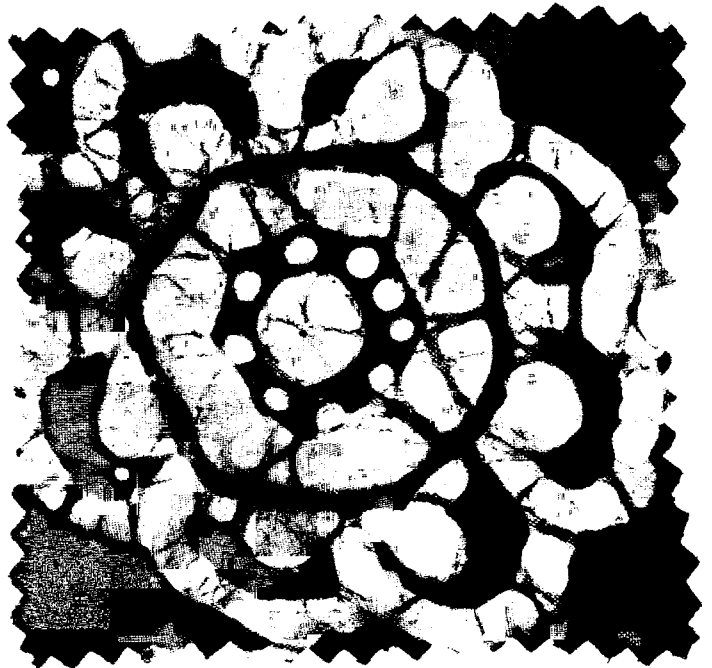


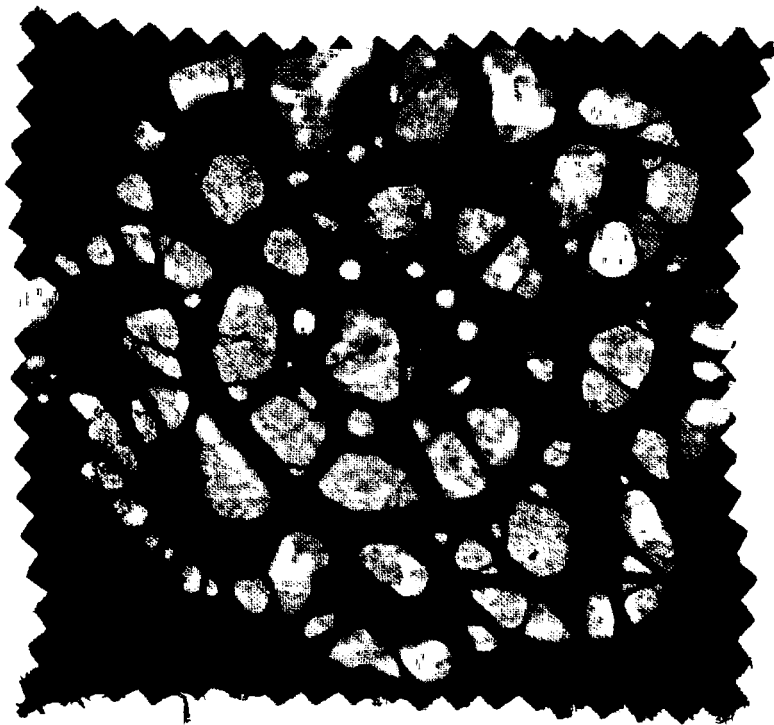
100y. PARAFFINWAX - PROCLON Dye



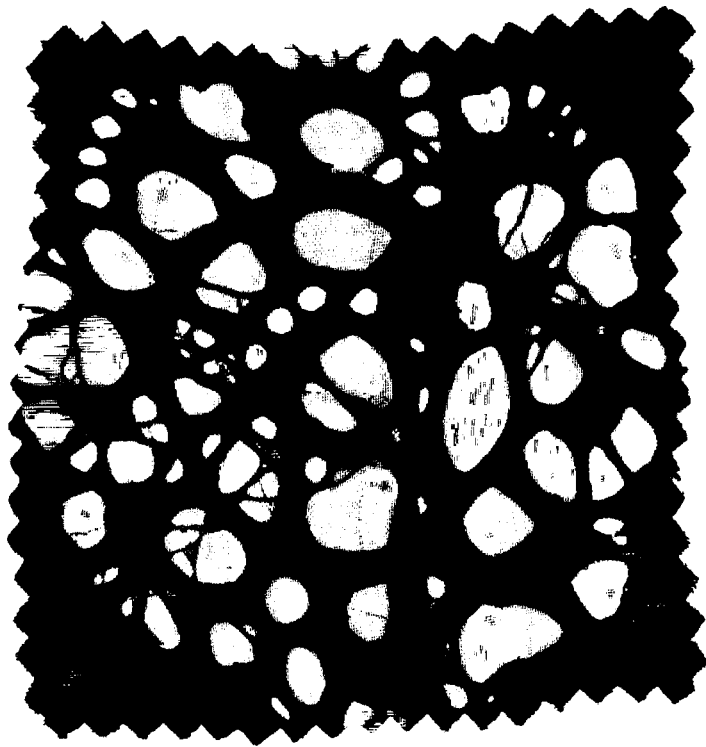
50%. BEESWAX + 50%. PARAFFINWAX
- NAPHTHOL DYE.

50%. BEESWAX + 50%. PARAFFIN
WAX - YAT DYE.





50% BEESWAX + 50% PARAFFINWAX — PROLINDYE

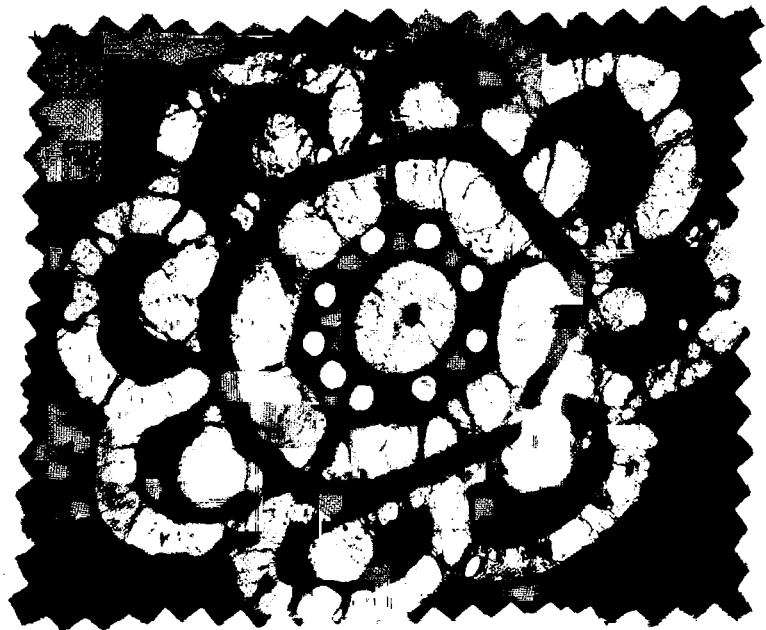


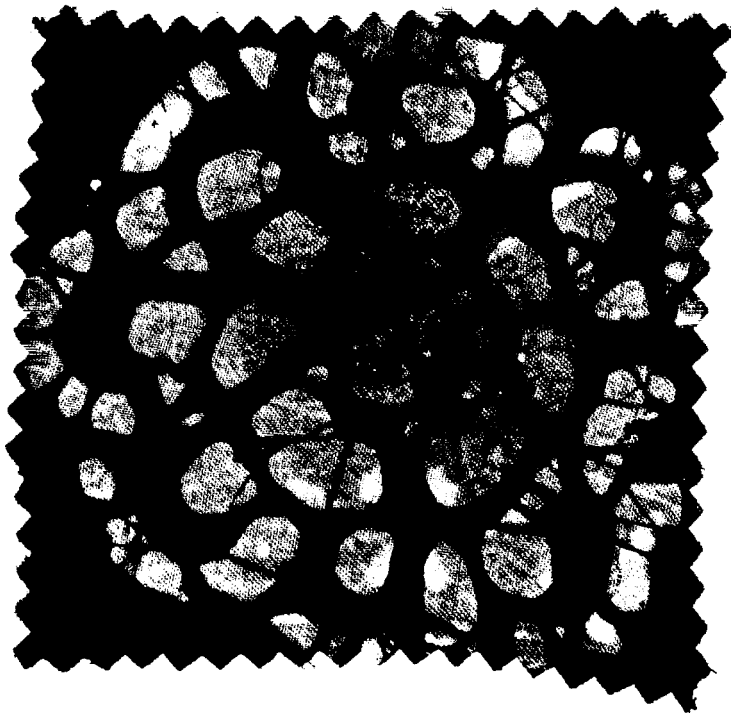
75% BEES WAX + 25% PARAFFIN WAX

- NAPHTHOL DYE

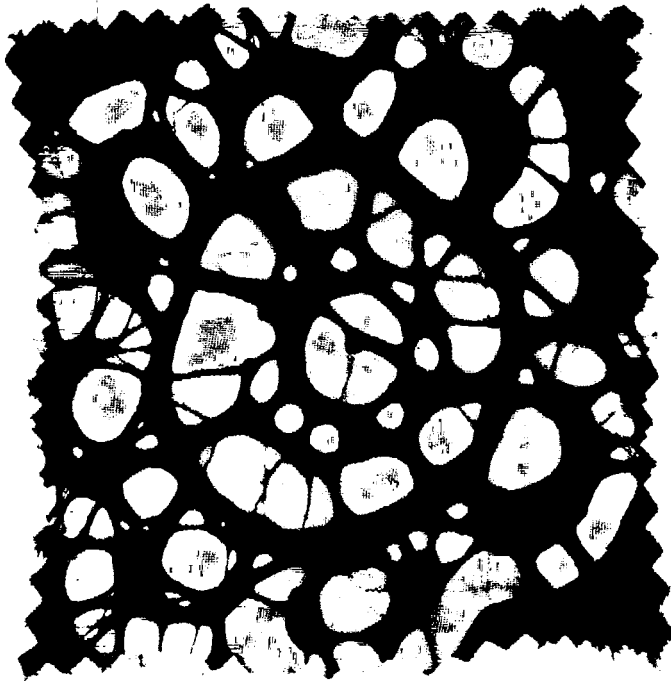
75% BEES WAX +
25% PARAFFIN WAX -

YAT DYE.



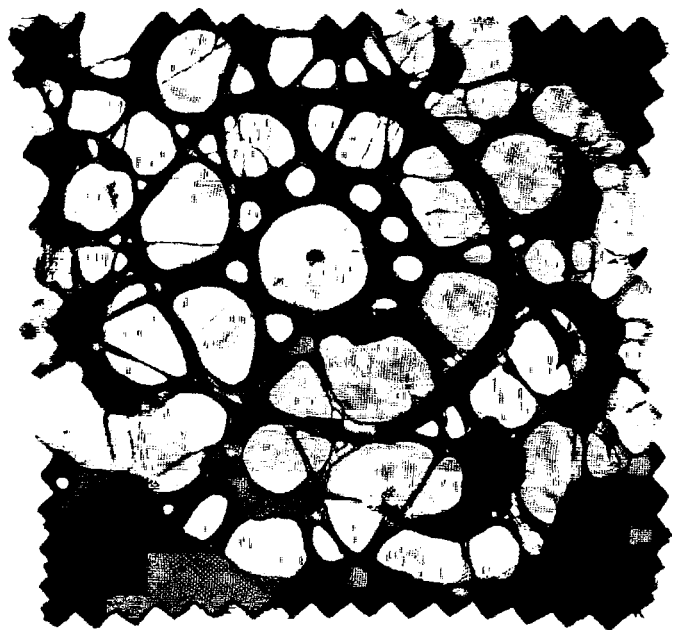


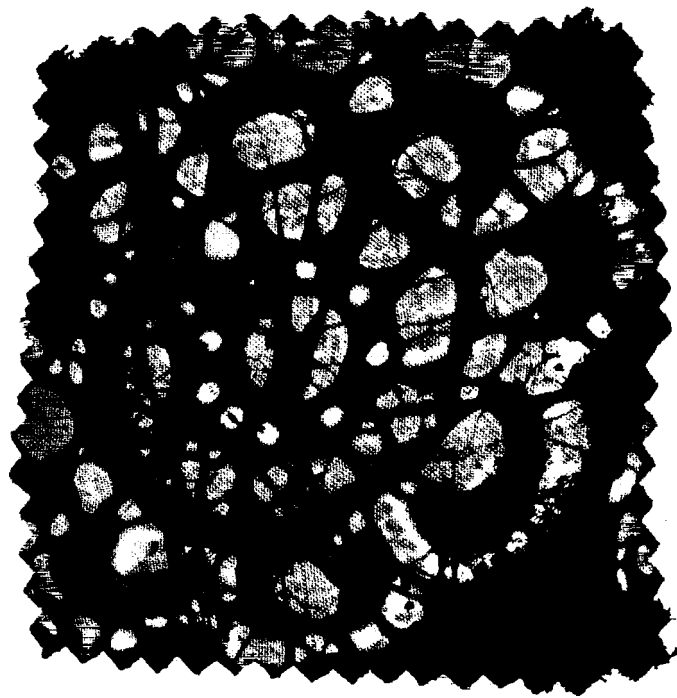
75% BEESWAX + 25% PARAFFINWAX - PROCIONDYE.



75% PARAFFIN WAX + 25%
BEES WAX - NAPHTHOL DYE

75% PARAFFIN WAX +
25% BEES WAX -
VAT DYE.





75% PARAFFINWAX + 25% BEESWAX - PROCLON DYE.

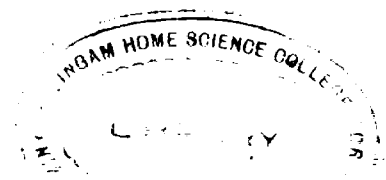


TABLE I

RATING SCALE USED TO EVALUATE THE BATIK PRINTED SAMPLES

Sample No.	Brilliance of colour (in percentage)				Clarity of Design (in percentage)				Evenness of Design (in percentage)				General Appearance (in percentage)			
	Very Good	Good	Fair	Poor	Very Good	Good	Fair	Poor	Very Good	Good	Fair	Poor	Very Good	Good	Fair	Poor
N ₁	95	5	-	-	-	15	55	30	15	45	30	10	5	45	35	15
N ₂	90	10	-	-	75	15	10	-	50	40	10	-	55	35	10	-
N ₃	45	40	15	-	-	25	35	40	10	30	25	30	10	10	45	35
N ₄	70	30	-	-	10	55	35	-	30	60	10	-	10	65	25	-
N ₅	90	10	-	-	10	35	40	-	55	40	5	-	35	40	20	5
V ₁	85	15	-	-	15	20	60	5	40	35	15	10	5	60	25	10
V ₂	80	20	-	-	50	45	5	-	35	60	5	-	5	60	20	5
V ₃	15	45	35	5	5	45	30	20	10	40	50	-	-	25	75	-
V ₄	35	15	25	25	5	25	35	35	-	15	85	-	15	25	35	25
V ₅	80	20	-	-	75	10	5	10	20	45	25	10	30	65	-	5
P ₁	50	35	15	-	25	30	40	5	35	55	10	-	15	25	50	10
P ₂	70	25	5	-	5	15	15	65	5	10	30	60	10	10	50	30
P ₃	30	50	15	5	5	15	10	70	-	20	65	15	5	-	65	30
P ₄	35	40	20	5	-	15	10	75	5	20	55	20	-	10	50	40
P ₅	45	55	-	-	-	65	30	5	-	45	40	15	10	55	30	5

TABLE II
BREAKING STRENGTH

WARP					EFT		
Sample No.	Mean Strength (kg / cm) ²	% Loss or Gain Over original	t - value	Samples Compared	Strength / cm) ²	% Loss or Gain over original.	t - value
Original	18.5						
N ₁	15.6	15.60	4.05*	Original vs N ₁	19.4	17.57	4.53*
N ₂	16.1	12.97	3.29*	Original vs N ₂	18.0	9.09	3.87*
N ₃	14.8	19.998	4.46*	Original vs N ₃	13.2	19.99	4.29*
N ₄	16.4	11.36	2.55*	Original vs N ₄	16.3	18.79	.302 *
N ₅	18.0	2.71	.74*	Original vs N ₅	18.2	10.30	5.67*
V ₁	17.2	7.03	2.41*	Original vs V ₁	15.0	9.09	2.02*
V ₂	15.3	17.31	3.74*	Original vs V ₂	15.4	6.67	1.54*
V ₃	17.4	5.95	1.79*	Original vs V ₃	17.1	3.37	1.076*
V ₄	16.9	8.66	2.29*	Original vs V ₄	17.2	4.24	.656*
V ₅	17.3	17.85	1.92*	Original vs V ₅	18.1	9.696	4.54*
P ₁	15.2	17.83	2.22*	Original vs P ₁	18.4	11.51	2.42*
P ₂	16.3	11.90	2.41*	Original vs P ₂	16.8	1.82	.478*
P ₃	16.5	10.82	2.23*	Original vs P ₃	19.5	18.18	1.84*
P ₄	15.2	17.85	4.31*	Original vs P ₄	17.8	16.36	4.024*
P ₅	16.7	9.74	2.96*	Original vs P ₅	15.0	9.09	3.002*

*significant at 5 per cent level

TABLE III
BREAKING STRENGTH - ELONGATION

Samples	WARP			Samples Compared	WEFT		
	Mean Value in inches	Percentage gain or loss over original	t - value		Mean Value in inches	Percentage Gain or loss over original	t - value
Original	1.64				1.5		
N ₁	1.74	6.098	0.948*	Original vs N ₁	2.26	50.66	0.378*
N ₂	1.8	1.76	.7512*	Original vs N ₂	12.16	44.00	0.1767*
N ₃	1.84	12.200	3.51*	Original vs N ₃	1.66	10.67	3.121*
N ₄	1.98	20.73	4.66*	Original vs N ₄	1.78	18.66	2.93*
N ₅	1.9	15.85	6.02*	Original vs N ₅	20.04	35.00	21.88*
V ₁	1.96	19.51	2.41*	Original vs V ₁	1.94	29.33	6.62*
V ₂	2.1	28.05	1.73*	Original vs V ₂	2.24	49.33	12.32*
V ₃	2.08	26.83	8.37*	Original vs V ₃	2.2	46.66	11.06*
V ₄	2.1	28.05	8.75*	Original vs V ₄	2	33.33	5.97*
V ₅	2.04	24.39	11.48*	Original vs V ₅	2.06	37.33	22.68*
P ₁	1.68	2.44	0.518*	Original vs P ₁	2.1	29.99	5.99*
P ₂	1.92	17.07	0.3065*	Original vs P ₂	1.92	27.99	2.46*
P ₃	1.9	15.85	2.52*	Original vs P ₃	1.94	29.33	21.87*
P ₄	1.92	17.07	1.79*	Original vs P ₄	1.6	6.67	11.29*
P ₅	1.84	12.20	2.55*	Original vs P ₅	1.6	6.67	11.29*

* significant at 5 per cent level.