TIE-DYEING OF COTTON FABRIC USING NATURAL DYES

BY

SELVARANI. S.

A THESIS SUBMITTED TO

THE AVINASHILINGAM INSTITUTE FOR HOME SCIENCE AND HIGHER EDUCATION

FOR WOMEN (DEEMED UNIVERSITY) COIMBATORE-641 043

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE

DEGREE OF MASTER OF SCIENCE TEXTILES AND CLOTHING

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CERTIFIED AS BONAFIDE RESEARCH WORK

G. Krishna Bai 9/5/97 | Kamla 9/5/97

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Introduction

I. INTRODUCTION

Colour has been a method of adornment for mankind since prehistoric times. Colour improves appearance. Clothes and fabrics are made beautiful by the application of vivid colours through dyeing or printing. The knowledge and use of colours began with the dawn of civilization. Ancient records show that the art of extraction and use of colour was discovered and perfected in India. India had the distinction of being the colour box of ancient world.

Prior to the invention of synthetic dyes in 1856, all colouring matters were extracted from the naturally occuring materials like leaves, stems, animals and minerals. The processes involved were purely mechanical namely grinding, crushing or steeping in water. The most important colouring materials produced were Indigo for blue, Saffron for yellow, Manjit for red, and Cochineal for scarlet.

The decline in the use of natural dyes started with the introduction of synthetic dyes. Synthetic dyes replaced almost all natural dyes, owing to their mass production, good reproducability of shades and brilliance of shade. However, the production of synthetic dyes involves many reactions which are conducted at high temperature and pressure using primary chemicals isolated from petroleum and many carcinogenic chemicals. The toxic or environmentally unfriendly by-products formed, have to be discarded in the rivers, ponds or into the atmosphere.

Owing to the pollution problem, some of the synthetic dyes have been banned and the processors are left with limited number of dyes for colouration of textiles. Even the dyes which are not banned, poses problems in the form of effluent, as these dyes require a lot of acids, alkalies, salt and other auxillaries. These drawbacks of synthetic dyes have prompted environmentalists to look for eco friendly products and technologies. This opens way to the revival of natural dyes.

As Mashelkar and Ravindran (1995) state, natural dyes have several advantages over synthetic dyes from the point of view of health, safety and ecology. The operations involved are purely physical such as grinding, spraying or vaccum drying and water or solvent extraction.

Natural dyed materials have good resistance to moth invation. Some of their constituents are antiallergence and non toxic. Natural dyes are sought for their glow, rich colour, aromatic smell, soft light and shadow effect. They harmoniously blend to give beautiful shades which may not be possible with synthetic dyes. Commercial use of natural dyes shall minimise the environmental pollution. The waste in some cases becomes an ideal fertilizer. The use of natural dyes in the field of textiles would provide more employment through cultivation, extraction, application and waste land utilization for producing vegetable dyes.

India's pride in the world of textiles is cotton. There are references in ancient vedas and great epics like Ramayana and Mahabaratha to the finely woven and decorated cotton clothes. Cotton is described as naturally pure fibre in contrast to the synthetic fibres, which are made from chemicals. In India, cotton has been regarded as a symbol of whiteness, purity and simplicity. Cotton is the fabric for every home and is the most widely produced of textile fabrics, says Storey (1992). Cotton has many qualities like absorbency, strength, easy care and handle, which makes it ideal for any seasonal wear. Cotton can be dyed and printed easily.

Creating a pattern on cloth by tie-dyeing is one of the most basic textile arts. It is found in some form in almost all parts of the world. The technique of resist dyeing by binding individual areas of cloth to shield from dye is usually known in India as bandhani or bandhej, say Murphy and Crill (1991). The earliest evidence for the use of bandhani cloth in India is its depiction on the walls of Ajantha caves which date from VI to VII century A.D.

Tie and dye is the simplest method of resist printing which does not need advanced technical methods, machines and space. By varying the methods of tying, indefinite designs can be produced. In this study, the investigator has made an attempt to create design on cotton fabric by tie-dyeing process, using selected natural dyes and evaluate the fabric both subjectively and objectively.

The objectives of the study are to :

1. Extract dye from selected vegetable sources.
2. Apply the same on cotton fabric by adopting the technique of tie and dye.
3. Evaluate the dyed samples for selected qualities.

It is hoped that the study would enable the investigatior to introduce eco friendly textile through the use of natural dyes.

Review of Literature

II. REVIEW OF LITERATURE

The literature collected for the study are reviewed under the following headings :

2.1 Cotton and its properties.

2.2 Concept of Dyeing

2.3 Eco friendliness of Natural Dyes

2.4 Natural Dyes and their classifications

2.4.1 Definition of Natural Dyes

2.4.2 Antiquity of Natural Dyes

2.4.3 Classifications of Natural Dyes

2.5 Mordanting

2.6 History and Development of Tie and Dye

2.7 Techniques of Tie and Dye

2.1 Cotton and its properties :

Cotton is a gift of nature, it plays a vital role in our lives. Half of the clothing used by man is made of cotton, states Karkannavar (1995). Cotton fabrics may be said to be the pearl of Indian weaving, remarks Chattopadhyay (1985). Cotton has been given not only a royal status, but also been regarded as a symbol of whiteness, purity and simplicity states Gaur (1994).

Holland (1985) reports, that the cotton shrub, which is four to six feet in height needs a tropical climate and wet soil. One cotton boll contains four grams seed cotton which would yield approximately 1.5 grams fibre after ginning says Natarajan (1997). Each fibre has 20 to 30 layers of cellulose. The cotton fibre consists of about 89 percent cellulose with small amounts of gums and oils.

Hall (1980) remarks, that the cotton fibre is the shortest of all textile fibres. Its length varies from 1/2" to 2". The finer and longer the fibre, the more suitable it is for making high quality materials. Cotton fibres ranges in fibre diameter from about 11mm to 22mm, point out Gohl and Vilensky (1987). The density of fibre is 1.52 gm/cm which makes cotton a heavy fibre.

Joseph (1984) says that cotton has a tenacity of 3.0 to 5.0 grams per denier. This produces a fibre of moderate to above average strength. Gupta (1989) views that cotton is 10 to 20% stronger when wet than when dry.

Holland (1985) states that cotton is a good conductor of heat and is therefore cool to wear. Cotton is an absorbent fibre and is suitable to wear next to the skin.

Lyle (1982) reports that cotton withstands high temperature well. Cotton will start to scorch and turn brownish at 475 F. It distintegrates above this temperature. Although cellulosics are highly resistant to sunlight, heat and alkalies, it is deteriorated by the action of acids and oxidising agents such as hydrogen peroxide and chlorine bleaching compounds, remarks Hall (1980).

2.2 Concept of Dyeing :

Dyestuffs and dyeing are as old as textiles themselves says Wingate (1984). Dyeing is an art of colouring the textiles in such a manner that the colour may be fast or may not be ordinarily removed by such operations as washing, rubbing, sunlight and others, states Cowan (1980).

Dyeing may also be called as finishing process as it colours the fabrics and so adds to its beauty opines Deulkar (1988). Hall (1975) says that dyeing is distinguished from printing, in that it only allows one shade to be produced all over the fabric. Arora (1983) states that a dye is a colourant material which imparts a particular colour to the fibre by penetrating and appearing to become part of it.

2.3 Eco Friendliness of Natural Dyes :

The increasing environmental awareness has lead to emergence of eco standards for textiles. This has persuaded researchers and manufactures of textiles to reassess the feasibility of natural colourants, views Kannan (1996). The Union Minister of textiles, Shri Ram Niwas Mirdha (1989) observed that the use of natural dyes should be viewed in the context of growing concern for the health of people and the safety of the environment.

Achwal (1995) says that natural dyes which were pushed into background by synthetic dyes are recently becoming objects of consumer interest. The production of synthetic dyes involves many primary chemicals isolated from petroleum derivatives and carcinogenic chemicals. They are toxic or environmentally unfriendly. Due to these drawbacks, natural colourants have attracted the attention, owing to its non-hazarduous nature, state Verma and Gupta (1995)

According to Chattopadhyay (1985), vegetable colours are sought and used for their many intrinsic values. They are safe healthwise. They are gentle, soft, subtle and create a restful effect. Agarwal. et. al (1993) state that the more fascinating aspects of natural dyes are their glow and charming variability. They are considered to be good for their experimentation quality. They further add that natural dyes do not create any pollution problem. Rather the waste in the process becomes an ideal fertiliser.

According to Das (1992), natural dyes have the following advantages :

1) Natural dyes are non polluting.
2) They produce automatically harmonising colours.
3) They are more challenging due to elements of chance and rare colour ideas.
4) Natural dyes, besides being replaceable are bio-degradable unlike synthetic dyes which are irreplaceable.
5) The environment is regenerated through commercial cultivation of plants.

2.4 Natural Dyes and their classifications :

2.4.1 Definition of Natural dyes :

Dyes are organic chemical compounds which have the property of producing the phenomenon of colours by reacting light absorption, define Goel and Chauhan (1996).

The term dye includes:

1) Natural dyes

2) Synthetic dyes

3) Pigments and Whiteners.

Storey (1992) quotes the definition of natural dyes and pigments as given by the Society of Dyers and Colouritsts Colour Index as follows :

These dyes and pigments comprise all those that are obtained from animal and vegetable matter, with no or very little chemical processing. They are mainly mordant dyes, but include some vatdyes, few solvent dyes, some pigments, some direct and acid dyes. Only one natural basic dye is known, there is no natural sulphur, disperse, azoic or ingrain dye or oxidation base.

According to Kannan (1996), natural dyes are those that are derived from barks, flowers, seeds, leaves roots of the plants, lichens, secretion of insects and minerals. Natural dyes are pigments derived from mineral, animal or plant sources, views Needles (1981).

2.4.2 Antiquity of Natural Dyes :

The Encyclopedia of Textiles (1980) states that the knowledge and use of colour began with the dawn of civilization. In the beginning man utilised the colours he found in the earth and in the products of the earth.

The first fibre dyes used in prehistoric times comprised of fugitive stains says Das (1992).

Gahlot and Kaur (1996) remark that advanced dyeing and printing procedures were developed to produce colours with betterfastness. Shenai (1991)opines that the history of the use of natural dyesfor dyeing, printing and painting goes to prehistoric periods. The frescoes of Ajanta Cave I dated to I century A.D. were painted with natural dyes.

Tooley (1971) points out that as early as 3000 BC, the Egyptians and Chinese were dyeing fabrics as shown by pictures and other relics which have been discovered.

Trotman (1990) says that the earliest records of Indian religious and Social practises, belonging to 2500 B.C, contain references to coloured silk, which concludes that dyeing, was then already established.

Labarthe (1975) reports that an ancient Egyptian Papyrus, Papyrus Graccus Horkepsis, gives 70 recipes dealing with dyeing and mordanting of wool.

2.4.3 Classification of Natural Dyes :

Natural dyes can be classifed in various ways. The earliest classification was according to alphabetical order. Later, classifications were based on chemical structure. Besides these methods of classifications, natural dyes have been listed on the basis of their botanical names and common names, views Gulrajani (1993).

Anshumi, (1988), Duelkar (1988), Gupta. et. al (1989) and Chavan (1995) broadly divided natural dyes into three classes according to their sources as;

1. Vegetable dyes
2. Animal dyes
3. Mineral dyes

Wickens (1983) classifies natural dyestuffs into two groups:

1. Those which produce a fast colour just by boiling (substantive or non-mordant dyes).
2. Those which need an additional chemical to make the colour permanent (adjective or mordant dyes).

Agarwal (1981) gives the classification of natural dyes as follows :

1. Indigo and related compounds
2. Logwood
3. Natural dyestuffs producing shades of red
4. Natural dyestuffs producing shades of pale yellow to brown

Nalankilli (1997) views that natural dyes can be classified as monogenetic and polygenetic dyes. the monogenetic type of dyes produce only one colour irrespective of the mordant applied. The polygenetic dyes produce different colours, according to the mordant employed.

2.4.3.1 Vegetable dyes :

Deulkar (1988) states vegetables dyes are the ones extracted from various parts of vegetation like leaves, barks, flowers and fruits.

All India Handicrafts Board (1980) classified natural vegetable dyes as below :

a) Wood and bark dyes

b) Flower and fruit dyes

c) Leaf dyes

d) Root dyes

a) Wood and bark dyes :

According to Gahlot and Kaur (1996), the following are the different types of wood and bark dyes used in dyeing textiles.

1) Cutch : Acacia Catechu:

Bahl and Gupta (1988) say that catechu or cutch is an extract from the heart wood of acacia catechu. This is marketed, in the form of small cubes or blocks. The dye is extracted by boiling these cubes in water. The colour obtained is brown. It is also used to improve the rubbing fastness of the Indigo dyed materials.

2) Red Sandalwood : Pterocarpus santalinus :

Agarwal.et.al (1993) remark that Red Sandalwood is a small to medium sized deciduous tree, native to the warmer and moist part of India. The wood is heavily impregnated with reddish brown gum and contains 16% of a red colouring matter called santalin. It is used for dyeing silk, cotton and wool with various mordants, it produces different tones of pink, peach, brown and copper dust colours.

3) Jackwood : Atrocarpus Integrifolola:

The wood initially pale,turns to a reddish brown or mahagony colour later. It gives various shades of light yellow and brown colours with different mordants.

4) Patang: Ceasalpinia Sappon Lin :

Gulrajani (1993) says that the commercially valuable parts of the tree, are the wood and pods. The dye is so rich, that a small quantity is enough for several parts of cotton fabrics. It gives different tones of red and brown.

Odiyamaram and Red Creeper are the two bark dyes used in dyeing textiles according to All India Handicrafts Board (1980).

1) Odiyamaram : Lannea Grandis :

This is a tree with stout, soft, branches. The bark contains tannins and ash which contain considerable quantity of potassium carbonate. This gives different tones of light brown and light grey on cotton, wool and silk.

2) Red Creeper : Ventilago Madrespanta :

This is seen in Western Peninsula and throughout the plains of India. The bark gives a chocolate colour. The root and bark give a valuable red dye which is used for dyeing cotton and tassar silk.

Gupta and Verma (1994) are of the view that Eucalyptus bark powder can also be used for dyeing wool. Various mordants give various tones of colours.

b) Flower and Fruit Dyes :

According to Gahlot and Kaur (1996) the following are the main flowers and fruit dyes used in dyeing textiles.

1) Tessu : Butea monosperma

This is a flower dye. Gulrajani.et.al (1992) suggest that the dye is extracted from the flowers by boiling with dilute hydrochloric acid. It produces shades of yellow, rust, orange and leaf green colours.

2) Balsam : Impatiens Balsamina

The flowers of this species give shades of yellow, brown, blackish brown and orange when boiled with water and used.

3) Parijataka : Nyctanthes arbortristis

The coloured flower stalk, when dried and used, produces shades of lemon yellow, yellow green, yellow ochre and yellow orange with good fastness properties.

The Readers Digest Association (1990) says :

1) Hibiscus : Hibiscus esculentus

Hibiscus is also a source of black dye, for varying purposes from blackening shoes to tinting women's hair and eye brows.

2) Safflower : Carthamus Tinctorious :

The flowers of safflower or kusumba yields a golden yellow dye. The florets contain two principal pigments namely carthamin and safflower yellow.

3. Saffron : Crocus Sativus

The blossoms produce a yellow dye which gives different colour with different mordants. The fruit dyes that are listed are:

1) Kamela : (Kapila) Mallotus Phillipensis

One of the best known fruit dye is obtained from red glands on the surface of the kamala seed. The colouring matter is rottlerin and isorottlerin. Dye is obtained from powedered fruits and flowers state Gulrajani et.al (1992).

2) Promegranate : Punica granatum

Agarwal et.al (1993) state that pomegranate is a tree bearing large reddish brown fruits. The thick skin of this fruit is used for dyeing in the form of powder. The extract which is yellow in colour, produces different tones of yellow, khaki, black and dark golden brown, with different mordants.

3) Myrobalan : Terminalia Chebula

All the parts of this tree are used for dyeing says Gupta (1990). Fruits give a valuable yellow dye, bark gives a dark brown and the wood gives brownish grey colour. It contains tannins which are very useful as mordants with iron salts, the yellow colour extract produce a black dye. Turnsole (croton tinctorium) give a blue colour. Persian berries (Rhamnus infectorius) gives an orange yellow dye. Robinson (1982) reports that Walnuts provide a good brown dye from shells and roots without a mordant.

C. Leaf Dyes :

1. Indigo : Indigofera Tinctoria

Indigo has been one of the most important and popular dyes from ancient and medieval times until today state Paul. et.al (1996). Mathur and Agarwal (1981) say that colouring matter is obtained form the leaves. When plants are cut, they are immediately brought to the processing centre and processed immediately till the fermentation sets in. The main colouring matter in the indigo plant is indigotin.

2. Woad : Isalis Tinctoria

This is the other type of indigo species found in Europe.The dye is mainly extracted form the green leaves.The fleshy leaves of the plant were fermented and after a lengthy processing gave rich blue dye.Storey(1992) says that a fresh dye bath gives black,next blue and finally when the bath is more exhausted,it would yield a green colour.

3. Henna : Lawsonia Inermis

The dye Henna is obtained from the leaves of this plants. Dantyagi (1983) suggests that dye solution is obtained from henna by soaking crushed henna leaves in water and filtering it through a piece of cloth. It is mixed with a small quantity of dilute acetic acid and boiled. Shades of mustard, yellow, dark brown and beige colour could be obtained.

4. Teak : Tectona Grandis

Gahlot and Kaur (1996) remark that the dry leaves of teak yield a purplish and pink shade when bolied, and filtered and used.

d. Root Dyes :

1. Turmeric : Cucurma longa

According to the Dictionary of Dyes and Dyeing (1980), Turmeric is a root dye known as Indian Saffron, because of its origin. The dye comes from the rhizome of the plant. Cucurmin is the natural colouring pigment seen in this group. It gives a yellow colour to wool when dyed directly, When mordanted with different mordants, its yields yellow, brown, orange, red and brownish black colours.

2. Madder

The Africans discovered that the roots of madder stained the mouth and lips with a brilliant red when eaten and the dye was difficult to remove. The well grown roots are scrubbed and dried in the sunlight. These dried roots are taken in a muslin bag and water is added and boiled. The red colour dye comes out. The dye produces different shades of red and brown with different mordants.

3. Onion : Allium Cepa :

Onions belongs to the liliaceae family. The rhizomes are used for dyeing. The dried skins are taken and boiled in water for 45 minutes. Then it is filtered and the extract is used for dyeing. It dyes wool and silk in a range of colours from golden yellow to copper red with different mordants.

4. Barberry : Barberis Vulgais :

Barberry was principally used for silk dyeing the simple process of simmering finely cut roots in soft water, for about an hour and extracting the dye.

There is a group of lichens, says Storey (1992), particularly Rocella Tinctoria, which yield a vivid violet under the influence of ammonia and atmospheric oxygen.

2.4.3.2. Animal Dyes:

As per Deulkar (1988) animal dyes are extracted in the form of juices from the body of insect.

1. Cochineal :

Shenai (1991) states that the colouring matter, cochineal is extracted from dried bodies of the female insects which feeds on cactus, Nopales Cochinellifera. Cochineal is an important red element used as a source for natural dye. It is the brightest of all available natural red dyes. The main colouring component of this dye is carminic acid. Cochineal produces beautiful crimsons, scarlets, and pink on wool.

2. Lac : Cocus Lacca :

Lac is a scarlet dye obtained form the insects which are found in South, East Asia and India. It also yields shellac says Robinson (1969). The dye also exhibits good fastnes properties especially to light and washing.

3. Kermes :

Kermes is a brillant scarlet dye used since ancient times. It is obtained from the dried bodies of pregnant of females of kermes, a shield louse (Coccusilicis) principally found on the ilex oak says Storey (1992). The main colouring component in kermes is the kermesic acid.

4. Molluscs :

Tyrian purple is a very expensive dye obtained from several species shellfish of the two genera, Murex and Purpura. About 8000 shellfishes are needed to obtain one gram of dye. The dye is a pale yellow. But changes gradually to purple by the photochemical action of sun's rays, observes Tooley (1971).

2.4.3.3. Mineral Dyes :

According to Goodwin (1982) mineral colourants derive their name form the natural sources, which was at one time used to produce these colourants. Later they were produced form purified inorganic components. Some of the important colourants were chrome yellow, iron buff, namkin yellow, prussian blue and managenese brown. Deulkar (1988) says that iron buff was first made by placing scraps of iron in a barrel covering them with vinegar and water and allowing the mixture and then in solution of wood ash, after which it was exposed to air, when it developed the yellowish brown shade called the "Iron buff".

2.5 Mordanting:

Wickens (1983) suggests that majority of natural dyes need a chemical in the form of a metal salt, to create affinity between the fibres and the pigment. These chemicals are known as mordants.

According to Gulrajani (1993), a mordant is regarded as a chemical that can fix itself and also be fixed on the fibre. It also combines whih the dyestuff. A link is therefore formed between dyestuff and fibre which allows certain dyes with no affinity for the fibre to be fixed.

There are three types of mordants say Paul.et.al. (1996). They are:

1) Metallic mordants

2) Tannins and Tannic acid

3) Oil Mordants.

1. Metallic Mordants :

Originally only naturally occuring metal salts were used as mordants. Now-a-days metal salts of aluminium, chromium, iron, copper and tin are used. The following four mordants are in general use:

1. Alum : Pottassium Aluminium Sulphate is obtainable in the form of white crystals. This is a popular and safe mordant for use, as it is least toxic among metals.

2. Chrome : Potassium Dichromate is available in the form of orange crystals. It is sensitive to light. This is the most modern mordant and is widely used reports, Das (1992).

3. Iron : Ferrous Sulphate, copperas green vitriol can be obtained as soft green crystals.

4. Tin : Stannous Chloride is available as white crystals. This mordant must be used carefully and sparingly says Wickens (1983).

2. Tannins and Tannic Acid :

Tannins are primarily used in the preservation of leather. Vegetable tannins are bitter and astringent substances in plants, often occuring as secretions in the bark and other parts. Chemically vegetable dyes are similar to basic dyes says Gupta (1990). It is well known that cellulosic fibres have no affinity for basic dyes. The tannins impart affinity for basic dyes. They also act as a primary mordant for metalic salts.

For instance, a cotton cloth is first treated with tannin or tannin containing vegetable matter (eg., harda) and subsequently mordanted with metallic mordant. The metallic mordants form complex with the carboxylic groups of tannin, suggests Nalankilli (1997).

Among the tannins myrobalans and sumach are the most important ones according to Paul et. al (1996).

Myrobalans : Terminalia Chebula :

Terminalia Chebula is a large tree found in sub himalayan tract of West Bengal and Assam. The dried fruits are collected during January-April and then dried in shade and marketed say Gulrajani. et. al (1992).

They further add that the dried flesh sorrounding the seed is rich in tannin (av.30-32%). For dyeing, the myrobalans are soaked overnight after removing their stones and then boiled.

3. Oil Mordants :

Gulrajani (1993) says oil mordants are used mainly in the dyeing of Turkey Red colour from madder. The main function of the oil mordant is to form a complex with alum used as the main mordant. Since alum is soluble in water and does not have affinity for cotton, it is easily washed out from the treated fabric. The naturally occuring oils contain fatty acids. The - COOH groups of fatty acids react ith metal salts, and get converted into - COOM, where M denotes the metal.

2.6 History and Development of Tie and Dye :

It is impossible to say when bandhani clothes were first made in India, or indeed any-where in the world state Murphy and Crill (1991). The earliest known examples of tie dyed textiles, apart from those in the peruvian paracus culture (I-II Century BC) were excavated from a tomb at astana in Chinese Turkestan dating from the fourth century A.D and it is possible that the technique was brought to the far east from India report Anushumi. et. al (1997).

According to Clarke (1980) our earliest evidence for the use of bandhani cloth in India is the depiction on the walls of the Ajanta Caves. Joseph (1980) states that

Bandhani textiles have had a continuous history in India and is shown by their reoccurance in written and visual documents at an interval over the centuries.

Maile (1987) points out that the earliest records, from India and Japan, date back to the sixth and seventh centuries A.D. Traders travelling throughout Asia, India and the far east carried tie and dye clothes from one place to another as part of their merchandise.

Jain (1989) say that one of the earliest written reference to bandhani fabrics appears in Bana's Harshcharita or the life of king Harsha (606 - 648 A.D).

2.7 Techniques of Tie and Dye :

Hudson (1992) suggests that the basic techniques of tie and dye are relatively simple. Small seeds or shells can be fastened into the cloth. It can be pleated and then tied large areas of it can be gathered together forming great variegated 'sunbursts' of colour.

Knotting :

One of the easiest and quickest ways of producing a dyed texture is to tie a length of cloth into knots, says Stuart and Robinson (1982). The cloth is twisted into a roll and a knot is tied. The most interesting texture is obtained from more and smaller knots than from large clumsy ones.

Marbling :

This is an effective method of producing an all over texture. When the cloth is crumpled and bunched up closely and bound with thread or string, before being dyed, uneven dyeing and in some parts complete resistance to the dye is caused, says Maile (1987).

Binding :

This technique is sometimes known as clump tying. According to Hess (1978) in this method, a clump of fabric is picked and it is tied either tightly or it is tied leaving some space in between. Wingate (1985) is of the opinion that certain portion of the fabric is tied by inserting beads, cotton reels, pebbles, pulses and small pieces of wood. These will give a wide variety of spot shapes, accordingly.

Folding :

According to Dhamijee (1989) the fabric is crumpled, knotted and pleated into folds. Thus when dipped into the dye liquor, the solution cannot penetrate into the folds. Many striking patterns and effects, especially stripes are produced by the folding technique, combined with binding. Chatterjee (1991) says if the material is folded in a second direction after the first dyeing one gets a chequered design.

Pegging and Clipping :

The fabric is folded several times into a pad. The edges are clipped together with paper clips or bull dog clips remarks Robinson (1969).

Tritik or Sewing Technique :

In West Africa, sewing methods with fine straws of raffia as the sewing thread, are practised. The design is drawn on to the cloth and sewn along the lines. Longer and shorter stitches may be combined to vary the texture. Then the thread is pulled up at one end and fastened having a knot at the other suggest Jain and Aggarwala (1989).

Bandhani :

The most widely used element in Bandhani work is the simple dot bindi or bundi which is formed by pinching a small area of cloth and tightly wrapping cotton around the raised part reports Storey (1992).

Laheria :

This literally means wavy, refers to the wavy pattern of a fabric processed in the tie and dye technique. The material is rolled diagonally and certain portions resisted by tightly binding threads at a short distance from one another before the cloth is dyed describes Jain (1989).

Experimental Procedure

III. EXPERIMENTAL PROCEDURE

The procedure adopted for the study consisted of the following steps.

3.1 Selection of fabric

3.2 Preparation of fabric

3.3 Tying of the fabric

3.4 Nomenclature of the samples

3.5 Dyeing

3.5.1 Selection of Dye sources

3.5.2 Preparation of Dye powders

3.5.3 Tannin treatment of the fabric

3.5.4 Extraction of Dyes

3.5.5 Actual Dyeing

3.5.6 Mordanting

3.5.7 After treatment of the fabric

3.6 Evaluation

3.6.1 Visual Evaluation

3.6.2 Laboratory tests

3.6.2.1 Fabric Weight

3.6.2.2 Fabric Strength

3.6.2.3 Stiffness

3.6.2.4 Abrasion resistance

3.6.2.5 Drapability

3.6.2.6 Crease recovery

3.6.2.7 Statistical Analaysis

3.6.2.8 Colour fastness tests

3.1 Selection of fabric :

Cotton is a gift of nature, it plays a vital role in the wardrobe of every body. Half of the clothing used by man is made of cotton, says Karkannavar (1995). Cotton has many qualities which makes it an ideal fibre states Storey (1992).

Hollen. et.al (1988) remark that cotton has a combination of properties like absorbency, comfort, handle and wicking that makes it ideal for clothing. Wingate (1984) says cotton fabrics feel good against the skin, regardless of the temperature and humidity.

Hence cotton was chosen for the study. Of the indefinite varieties of cotton, poplin was selected for its varied use. The details of the selected fabric are given in Appendix I.

3.2 Preparation of the fabric :

Stuart and Robinson (1982) suggest that except for fabrics supplied ready for dyeing or printing, it is essential that fabrics are well washed before dyeing or printing, to remove all dressings, impurities, dirt or stains. In the case of new material, the starch or sizing applied during the manufacturing process should be first removed thoroughly, state Gupta. et.al (1989). As a preparatory step for dyeing, the cloth was boiled for one hour in soapless detergent water. Then the fabric was rinsed thoroughly in soft water several times and dried.

3.3 Tying of the fabirc :

Before finalising the method of tying for the actual study, a pilot study was conducted wherein the following few techniques were tried.(Plates I,II,III and IV).

Knotting :

According to Maile (1987), one of the easiest and quickest ways of producing a dyed texture is to tie a length of cloth into knots. The cloth was picked up, twisted, curled and knotted. Each of the corners were also knotted.

Clump Tying :

Stuart and Robinson (1982) say that clump tying is sometimes known as binding in. It is one of the most important process in tie and dye work. Certain parts of the fabric are bound very tightly with thread before being dyed, so that they would resist dye absorption partially or completely.

The sample was held in left hand with the thumb adjoining the area that requires binding. The beginning of the binding thread was placed between the thumb and the cloth. The rest of the thread was wrapped round the sample several times and pulled as tightly as possible and fastened off.

Folding :

Many striking patterns and effects especially stripes, are produced by the folding technique combined with binding remarks Maile (1987).

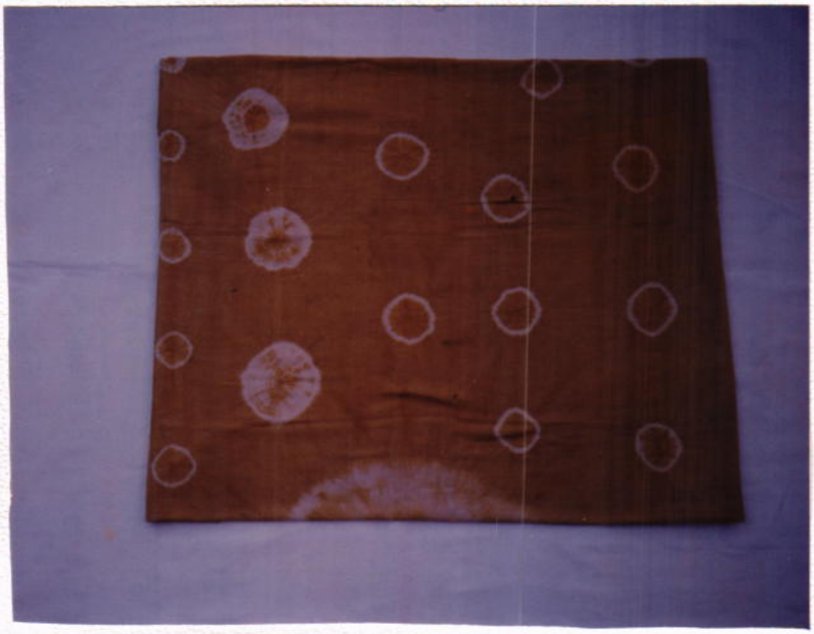


PLATE III

CLUMP TYING

PLATE IV

FOLDING

The striped effect was produced by folding the cloth together very accurately like accordian pleats. Bindings were made to form resist stripes. It was made at right angles to the folded edge of the cloth.

This samples tied in the above three methods were dyed with the natural dyes selected for the study and the final effect was shown to a panel of 15 judges. Based on their suggestions clump tying method was selected for the study.

3.4 Nomenclature of the samples :

The fabric was cut into five equal pieces, each measuring one metre in length. One piece was retained as original and named as sample "O". The rest were tied using clump tying technique and named as 'A', 'B', 'C' and 'D', each one to be dyed in one particular dye, as indicated in the table below :

TABLE I

NOMENCLATURE OF THE SAMPLES

S.No.	Sample	Source of dye used
1.	O*	
2.	A	Onion skin
3.	B	French Marigold
4.	C	Red sandalwood
5.	D	Pomegranate skin

* - Original

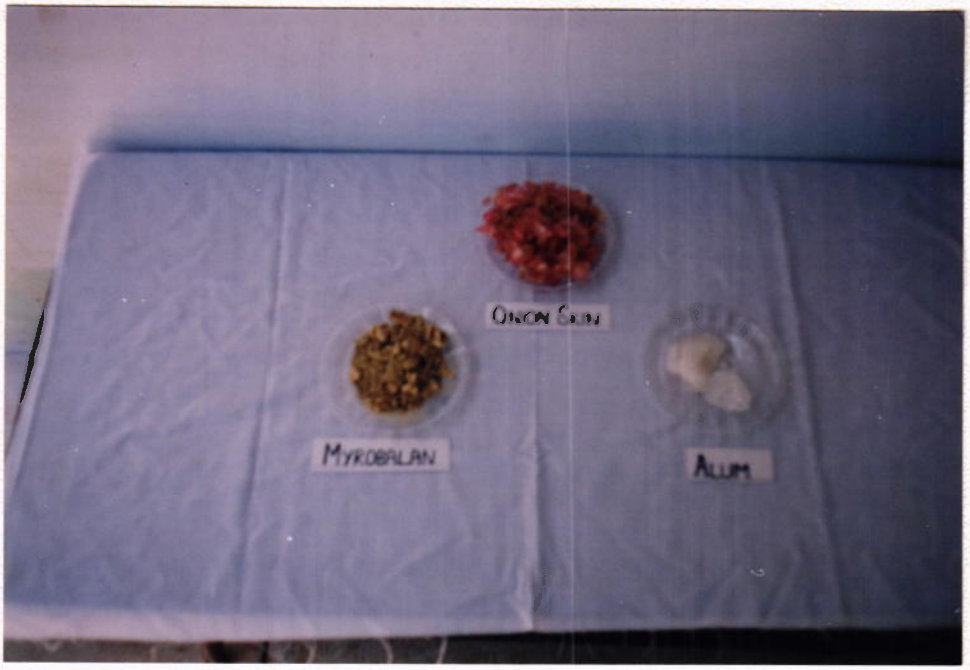


PLATE V

REQUIREMENTS FOR ONION DYE

PLATE VI

REQUIREMENTS FOR FRENCH MARIGOLD DYE

3.5 Dyeing

3.5.1 Selection of dye sources :

Based on a pilot study, four sources of dyes were chosen from the following Table :

TABLE II
LIST OF SOURCES

S. NO.	Common Name	Botanical Name	Parts used
1.	Balsam	Impatiens balsamina	flowers
2.	Henna	Lawsonia Inermis	fresh leaves
3.	Teak	Tectona Grandis	leaves
4.	French Marigold	Tagetes Species	flowers
5.	Pomegranate	Punica Granatum	fruit rind
6.	kamala	Mallotus Philippensis	fruits
7.	Onion	Allium Cepa	skins
8.	Cutch	Acacia Catechu	wood powder
9.	Red Sandalwood	Pterocarpus Santalinus	wood
10.	Walnut	Juglans Regia	bark

The following table and plates (V,VI,VII, and VIII) gives the sources of dyes selected for the study. These sources were selected owing to their easy availability.

PLATE VII

REQUIREMENTS FOR RED SANDALWOOD DYE

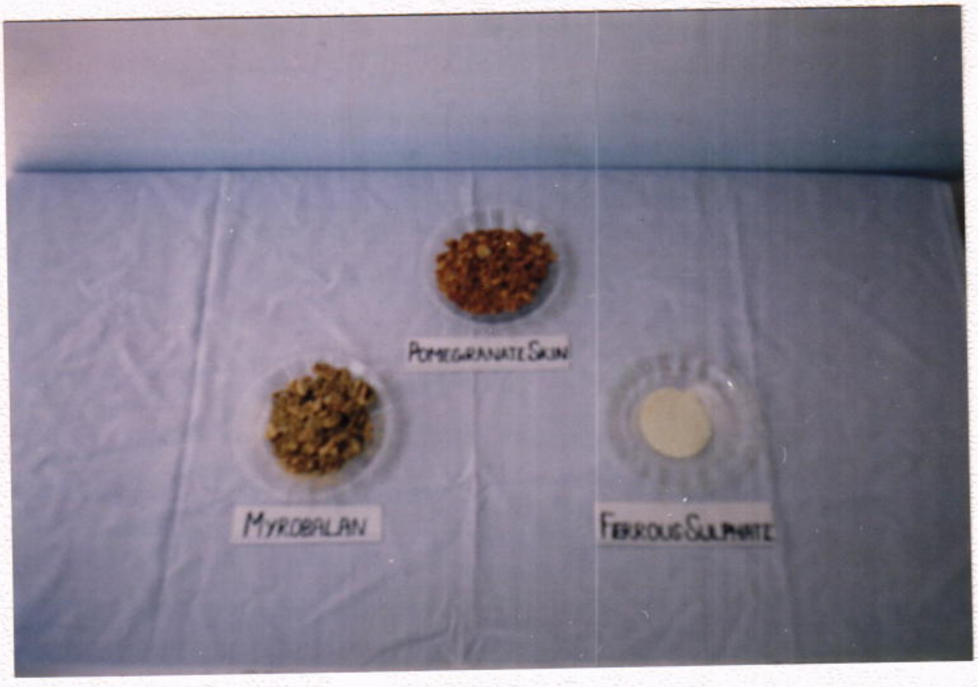


PLATE VIII

REQUIREMENTS FOR POMEGRANATE DYE

TABLE III

SOURCES SELECTED FOR NATURAL DYES

S. NO.	Common Name	Botanical Name	Parts used
1.	Onion	Allium cepa	skins
2.	French Marigold	Tagetes species	flowers
3.	Red sandalwood	Pterocarpus santalinus	wood
4.	Pomegranate	Punica granatum	fruits rind

3.5.2 : Preparation of Dye Powders :

From the selected sources, the respective dye powders were prepared as follows :

1. Onion Skin : The fresh skins of onions were dried in the shade.

2. French Marigold : The florets were separated and dried throughly and powdered.

3. Red Sandalwood : The wood pieces were first made into very small chips and then powdered.

4. Pomegranate Skin : The fresh skins of pomegranate fruits were dried and powered finely.

3.5.3 Tannin treatment of the fabric :

Tannin has been the most widely used mordant ever since the colouration of textiles started, states Nalankilli (1997). He further adds that cotton fabric is first treated with tannin or tannin containing vegetable matter (harda) and subsequently mordanted with metallic mordants. The role of tannin is that it holds the metal and the metal forms the complex with dye. Gupta (1990) points out that the importance of harda by a proverb, Harra lage Na Fitkar, Rang Chokho Aaye, meaning that without using harda, colours cannot be achieved at all.

Paul. et.al (1996) state that among the tannins, myrobalan and sumach are most important. Myrobalan (Kadukkai) was chosen for the study owing to its easy availability. Dried myrobalans were bought and pound to break open the seed pod and separate the seeds.

The quantity of myrobalans taken was ten percent of the fabric weight as suggested by Gayathri (1996).

Weight of the fabric = 500 gms.

Weight of myrobalan required = 500 x 10 / 100 = 50 gms

As myrobalans were hard, they were soaked overnight in 100 ml of water. It was boiled on the next day for 45 minutes with the material, liquor ratio, as 1:20. The extraction was filtered. The fabric was dipped into this solution. (Plate IX). Care was taken to see that the fabric absorbed the myrobalan extract, evenly. It was taken out and dried under shade.

PLATE IX

TANNIN TREATMENT

PLATE X

EXTRACTION OF DYE

3.5.4 Extraction of Dye :

To extract the dyes from its sources the following steps were followed as suggested by Gayathri (1997).

The amount of dye powder taken was twice the weight of the fabric sample.

Weight of the sample = 100 gms.

Weight of the dye powder required = 100x2 = 200 gms.

The dye powder was boiled in water,(Plate X) with material liquor ratio as 1:20 for one hour. After that it was filtered to get the dye solution.

3.5.5 Actual Dyeing :

The tied fabric was first wetted out and spread out to avoid creases.Then it was immersed into the dye extract and boiled for one hour (Plate XI). This was followed for all the four samples. Later it was taken out and dried under shade.

3.5.6 Mordanting :

According to Paul et al (1996) majority of natural dyes need a chemical in the form of metal salt to create an affinity between the fibre and the pigment. These chemicals are known as the mordants.

Aluminium sulphate is suitable for dyeing most natural dyes, as alum is least toxic among metals, says Achwal(1995). Hence alum was used as a mordant for all the samples except pomegranate (Plate XII).

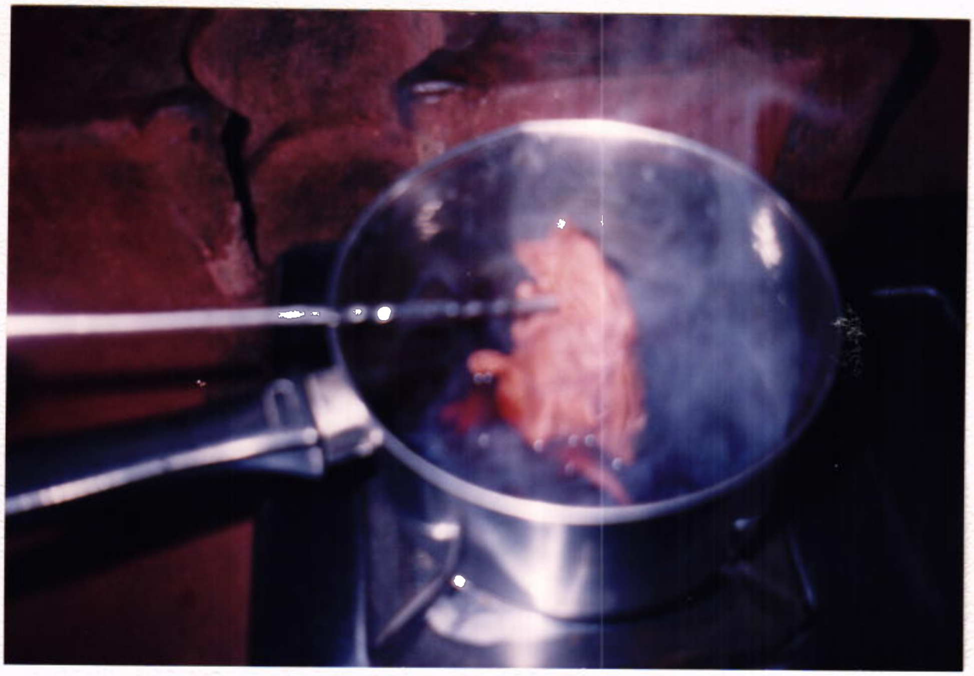


PLATE XI

DYEING

PLATE XII

METALIC MORDANTING - ALUM

Tannins combine with ferrous salts to form complexes which give a range of grey-brown shades says Naik (1996). Ferrous sulphate was used as a mordant on the tannin rich pomegranate skin to produce greenish grey colour.

Alum crystals were powdered well and dissolved in water with material liquor ratio as 1:20. The alum used was 10 per cent of the weight of the fabric. The fabric was immersed in the mordant for 30 minutes.

For ferrous sulphate, three per cent solution was prepared with the material liquor ratio as 1:30 and the fabric was immersed in this for 30 minutes.

3.5.7. After treatment of the fabric :

After immersing in the mordant, the fabric as taken out and rinsed in soft water for several times and dried in the shade. The dyed samples are presented in appendix II.

3.6. Evaluation

The samples dyed with natural dyes were evaluated as follows:

3.6.1 Visual Inspection

A Panel of 25 post graduate students specialising in the field of Textiles and clothing were selected as judges for rating the samples using proforma given in Appendix III. The main aspects taken into consideration for visual inspection were general appearence, texture, lustre and evenness of dyeing.

3.6.2. Laboratory Tests

3.6.2.1. Fabric Weight

Booth (1972) and Skinkle (1972) state that the weight of a fabric can be described in two ways, either as the "weight per unit area" or as the "weight per unit length". Eureka brand cloth Quadrant balance (Plate XIII) was used to determine the weitht of the samples. It had a copper quadrant scale graduated in ounces per square yard. Five samples were cut at random from each of the samples using a template. Each sample was suspended from the hook and the reading was recorded. Five readings were noted for the five samples and the mean weight was calculated. This was expressed in ounces per square yard.

3.6.2.2. Fabric Strength

Osayande (1990) says the breaking strength or tear strength is measure of resistance the fabric to a tensile load or stress warp or weft direction. Pizzuto (1985) views breaking strength as the force required to break a fabric when it is under tension. Breaking elongation is the increrase in length that has occured when the fabric breaks.

Grover and Hamby (1969) define breaking strength as a measure of the resistance of the fabric to a tensile load or stress in either the warp of filling direction. Elongation measures the extent of deformation along the axis of a material under a tensile stress.

PLATE XIII

QUADRANT BALANCE

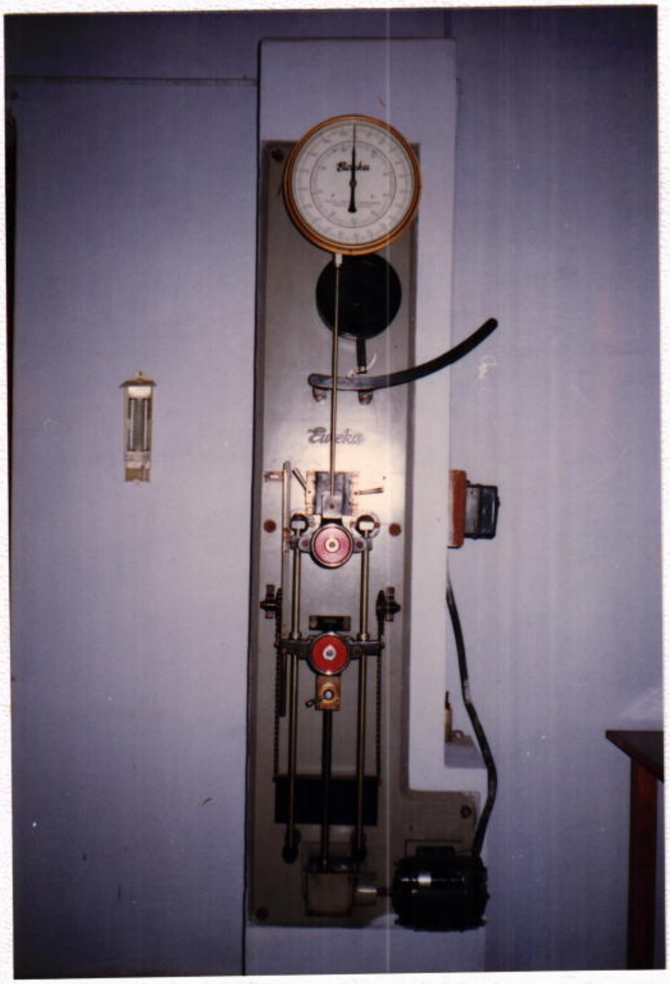


PLATE XIV

TENSILE STRENGTH TESTER

Eureka brand tensile strength tester (Plate XIV) was used for the study. Five samples each were cut from the warp and weft directions. Each sample was 35 cms in length and 13.75 cm in width. Lengthwise yarns form the sides of the strip were ravelled out upto quarter inch from each strip so that 2.5 cms width as maintained. Each sample was then clamped between the jaws. Care was taken to see that the sample was perpendicular to the load. The load was applied. The reading was recorded in kilograms for strength and in inches for elongation as soon as the sample was broken. Ten such readings were taken and the mean strength and elongation were found out.

3.6.2.3. Stiffness :

According to the Textile Committee (1993) stiffness is the resistance to bending. Shirley's stiffness tester (Plate XV) was used to determine stiffness as bending length, using a scale of six inches length and one inch width which formed the template. Samples were cut both in warp and weft directions. Each samples along with the scale were mounted on the platforms which was horizontal. The scale was moved along with the fabric slowly until the fabric fell to the edge of the platform and the tip of the fabric coincided with the index line which was viewed in the mirror. The bending length was read from the scale mark opposite to the zero line on the side of the platform. Five readings were taken and the mean was calculated.

PLATE XV

STIFFNESS TESTER

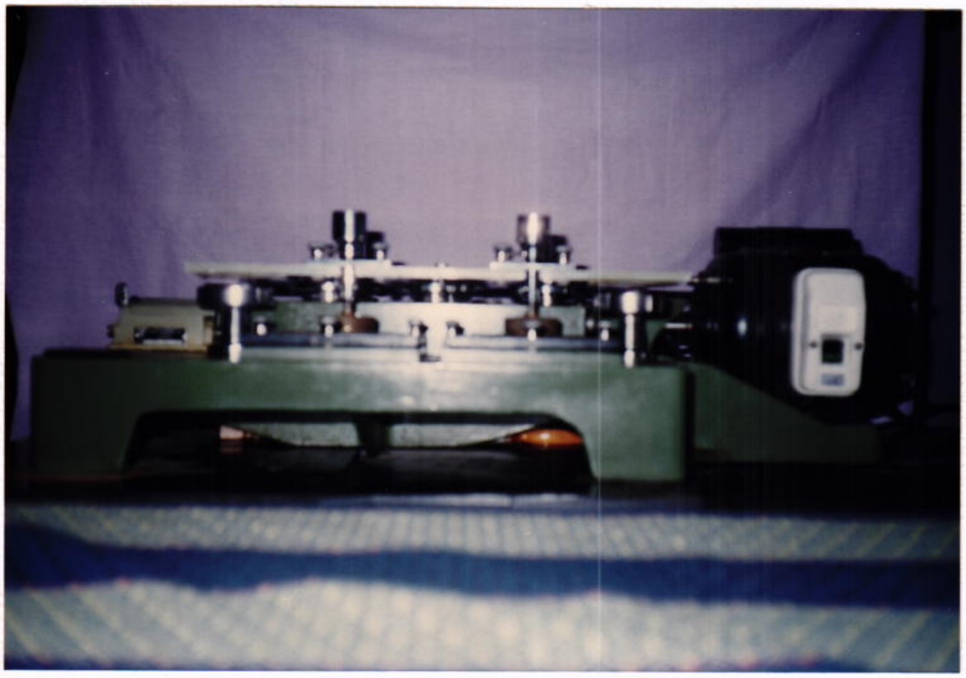


PLATE XVI

ABRASION RESISTANCE TESTER

3.6.2.4. Abrasion Resistance :

Booth (1982) considers wear to be a net result of a number of causes which reduce the serviceability of textile materials. He further says that abrasion is just one aspect of wear and is caused by rubbing away of the compound fibres and yarns of the fabric. According to ASTM Standards (1983) abrasion is the wearing away of any part of a material by rubbing against another surface.

Eureka Martindale abrasion resistence tester (Plate XVI) was used to determine the abrasion resistance of the samples. Universal carborundum extra fine (K2L98LC) was used as an abradant. Five samples were cut from different places of each material at random using the template. The initial weight of each sample was found out, then the sample was mounted on a sample holder, which carried a weight of 200 gms.

The number of rubs required to cause a hole in the sample due to abrasion was standardised. Each of sample was made to rub against the abrasive surface for the standardised 4 number. After that, the sample was removed and the final weight of the sample was found out. Weight loss due to abrasion was calculated. The test was repeated for five samples and the mean weight loss was calculated.

3.6.2.5. Drapability :

According to ISI Hand Book (1982) Drape is one of the subjective performance characteristics of fabric that

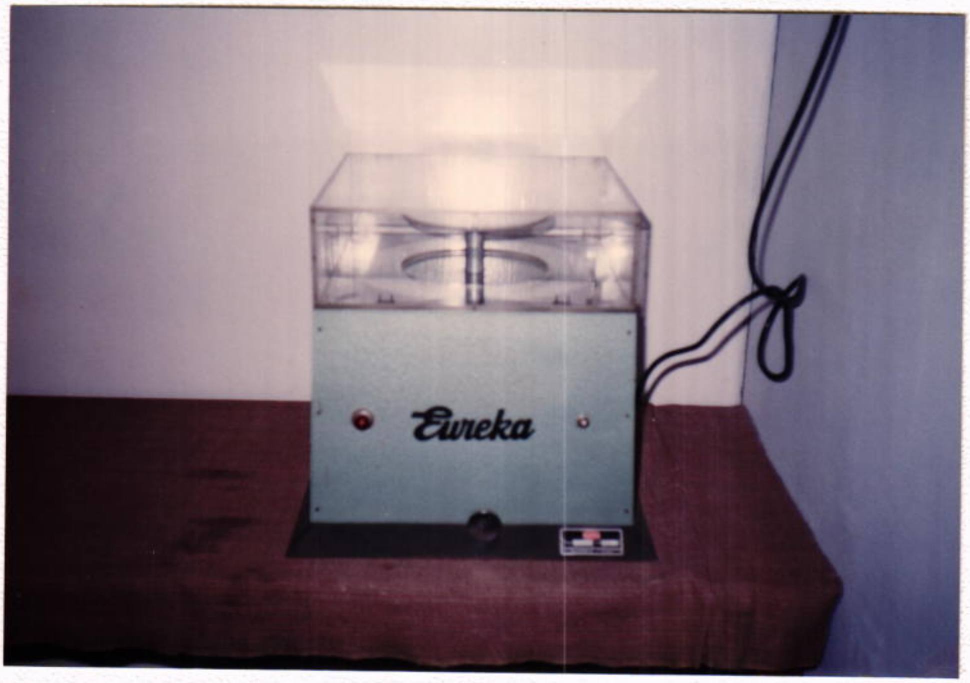


PLATE XVII

DRAPEMETER

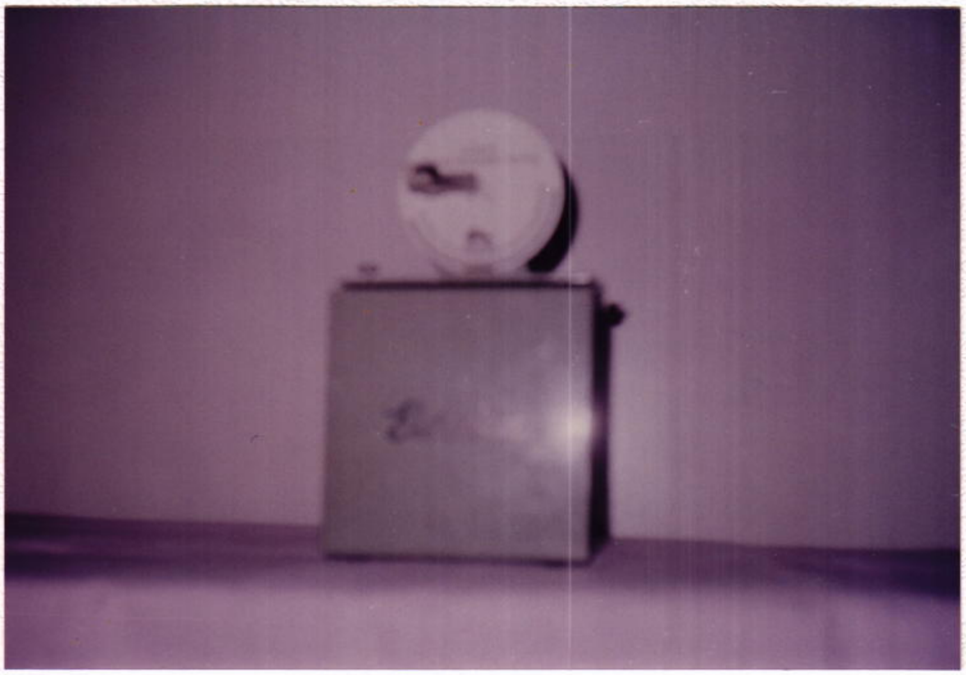


PLATE XVIII

CREASE RECOVERY TESTER

contributes to aesthetic appeal. Fabric drape is the extent to which a fabric will deform when it is allowed to hang under its own weight.

Booth (1982) says drape is the ability of fabric to assume a graceful appearance in use.

The Eureka Drapemeter (Plate XVII) was used for the study. A circular sample of 12" diameter was cut using a template and was draped over a disc which was subsequently smaller in diameter than the sample. A light source and lens located below the disc projected an image of the draped sample on the brown paper that was palced over the glass cover which was also 12" in diameter. The weight of the brown paper was first taken and then the outline of the shaded area was traced out, cut and the weight was noted.

The drape co-efficient was calculated using the formula :

Drape Coefficient = (PS-PQ)/PS X 100

PS : Actual weight of the circualr brown paper.

PQ : Weight of the projected area, cut from the circular brown paper.

3.6.2.6. Crease Recovery :

Inderjit (1989) remarks that the recovery from creasing is one of the most important mechanical property of apparel fabrics. Crease recovery is usually expressed in terms of degrees.

The crease recovery of a fabric is measured by gripping one arm of previously creased specimen, so that the other arm hangs vertically and the angle of crease is observed.

Eureka crease recovery tester (Plate XVIII) was used to determine the crease recovery angle of the samples. Samples of 2" length and 1" width were cut both in the warp and weft directions using a template. The specimen was carefully creased by folding in half and this was inserted into the metal specimen holder using a tweezer. After two minutes the dial of the instrument was rotated to keep the free edge of the specimen in line with the knife edge. The crease recovery angle in degrees was read directly from the engraved scale. The reading for the five samples, both in the warp and weft directions were taken separately and the mean value was calculated.

3.6.2.7. Statistical Analysis :

The results obtained in laboratory tests like fabric weight, abrasion resistance, strength and drape were analysed statistically, using analysis of variance procedure. A model of the same is given in appendix V.

3.6.2.8. Colour Fastness Tests :

Trotman (1990) states that the outstanding property of the dyed material is the fastness of its shade.

According to Agarwal. et.al (1993) a fabric that retains its colour during care and use is said to be colour fast.

The following colour fastness tests were conducted to determine the colour fastness of the dyed samples.

(i) Colour fastness to sunlight.

(ii) Colour fastness to wet and dry crocking.

(iii) Colour fastness to wet and dry pressing.

(iv) Colour fastness to washing.

(v) Colour fastness to perspiration.

(i) Colour fastness to Sunlight :

Majority of colour become light in hue when exposed to light and some become dark says Lyle (1982). A sample of 8"x2" was cut from the material. The eight inches portion was divided exactly into eight divisions of one inch width. The strip was covered with black chart paper. On the first day, the first division was cut and exposed to sunlight from 9 A.M. to 4.30 P.M. Consecutively, second division was cut on the second day and so on. Finally the first division after exposing it for seven days was assessed for colour change using grey scale given in appendix IV.

(ii) Colour fastness to crocking :

Crocking is the transference of colour by rubbing from one coloured textile material to another. A wet fabric will crock more readily than the dry one, because the moisture present assists in removing dye, says Pizzuto(1985).

Sasmira Crockmeter (Plate XIX) was used for the test. Each of the samples was cut to a size of 10"x8" and mounted on a flat base. A white material was mounted on to the rubber finger with a ring. Each sample was given twenty

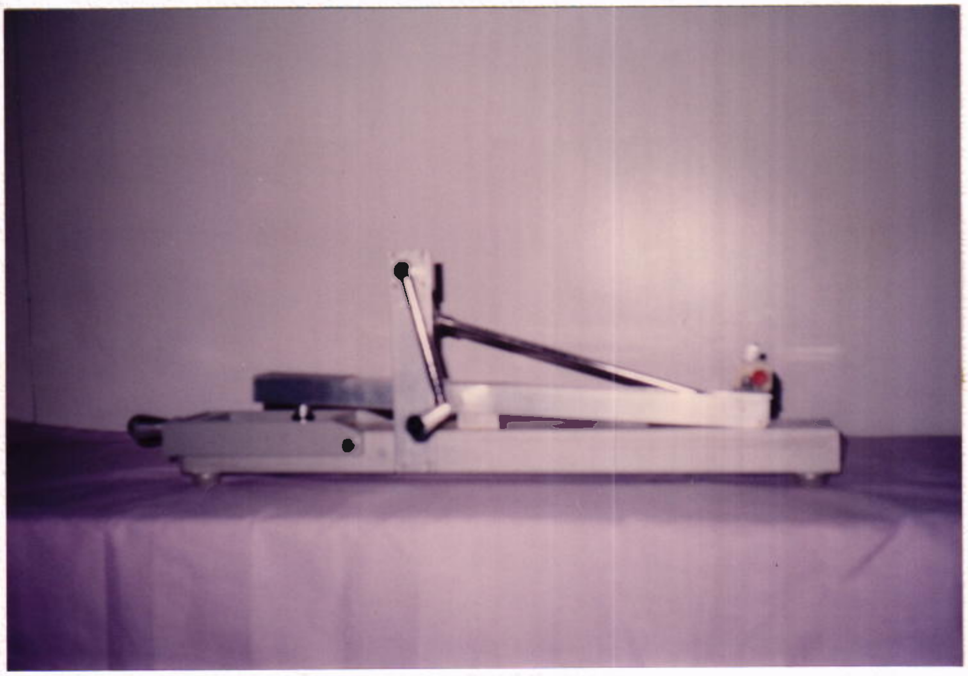


PLATE XIX

CROCKMETER

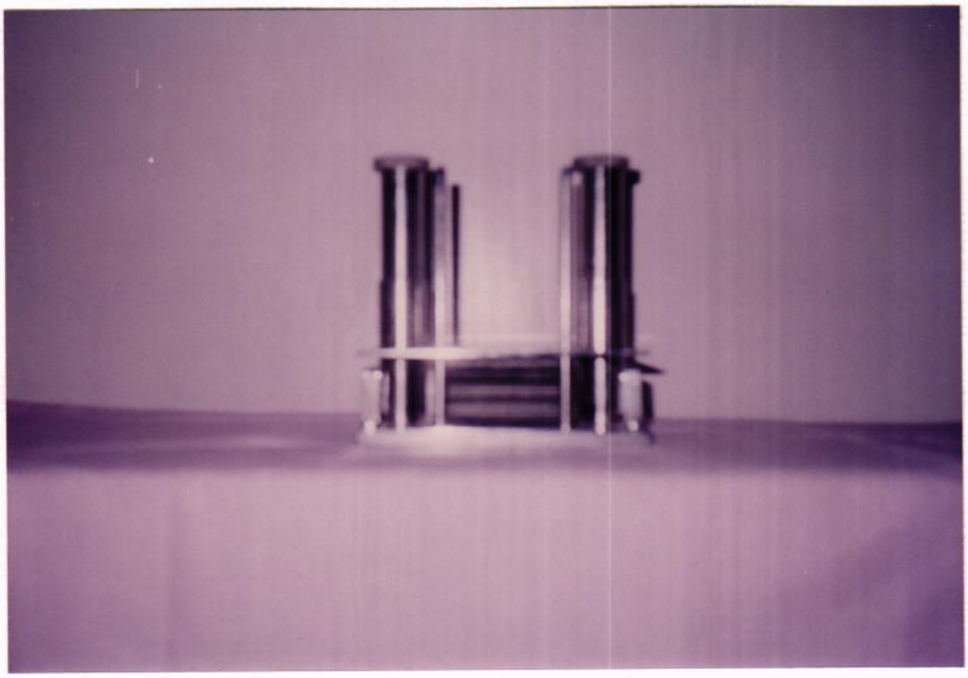


PLATE XX

PERSPIROMETER

rubs based on standardisation. The colour transfer from the dyed sample to the white material was assessed using grey scale.

A damp white material was used for wet crocking. The procedure adopted was the same as that of dry crocking.

(iii) Colour fastness to pressing :

Colour fastness to pressing was carried out as per the instructions of Wingate (1984). Samples each of 4"x4" size were used. One sample was covered with a wet piece of white, desized cloth. The sample was ironed for 10 seconds at 350 F. The other test sample was ironed dry for 5 seconds at 425 F. The samples under dry and wet conditions were assessed for colour change and staining using grey scale.

(iv) Colour fastness to washing :

The test samples of 2"x4" size were cut from each of the dyed material. Each sample was sandwiched between the undyed, desized sample. Soap solution of about 5 grms/litre was prepared. Each of the test samples were soaked in the soap solution separately for about half an hour. After that, the test samples were removed, rinsed in cold water thoroughly, squeezed well and dried.

The colour change and staining of the samples were assessed in comparison with grey scale.

(v) Colour fastness to perspiration :

Hall(1980) remarks that the action of perspiration is an excellent nutrient medium for all kinds of bacteria and attack the textile fibres in both acid and alkaline medium.

Sasmira perspirometer (Plate XX) was used for the study. As suggested by Sundaram (1979), two test samples of 5 cm x 4 cm size each were cut from all the samples and placed between to pieces of undyed cotton cloth, each having a size of 5 cm x 5 cm. The two common 5 cm sides were sewm to form a composite specimen.

The acidic test liquor was prepared by dissolving 2.65 gms of sodium chloride and 0.75 gm of urea in one litre of water. The pH was adjusted to 5.6 by the addition of acetic acid. The alkaline test liquor, consisted of a solution of three gms sodium chloride in one litre of water. The pH was adjusted to 7.2 by the addition of sodium bicarbonate as suggested by Sundaram (1979).

The sample was immersed in the acidic liquor and allowed to remain in the same for 30 minutes at room temperature. After that the liquor was poured off and the specimen was placed between two glass plates under a load of 10 kgs. The apparatus was placed in an air oven for four hours at 37 + 2 C.

At the end of the period, the specimens were removed, the samples were separated from the two pieces of undyed cloth and dried out apart in air at room temperature. Similarly all the samples were treated in alkaline liquor. The test samples were evaluated using a grey scale.

Results and Discussion

IV. RESULTS AND DISCUSSION

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

4.1 Visual evaluation

4.2 Laboratory tests

4.2.1 Fabric weight

4.2.2 Breaking strength

4.2.3 Elongation

4.2.4 Fabric stiffness

4.2.5 Abrasion resistance

4.2.6 Drape

4.2.7 Crease recovery

4.3 Colour fastness tests

4.3.1 Colour fastness to pressing

4.3.2 Colour fastness to dry crocking

4.3.3 Colour fastness to wet crocking

4.3.4 Colour fastness to perspiration

4.3.5 Colour fastness to washing

4.3.6 Colour fastness to sunlight

4.1 Visual evaluation

The ratings given by the judges regarding the general appearence, brightness of colour, evenness of dyeing, texture and lustre are given in the following Table and Figures I, II and III.

TABLE IV

VISUAL EVALUATION OF DYED SAMPLES

S.No	Samples	Dyes used	General appearance			Brightness of colour			Evenness of Dyeing			Texture				Lustre		
			Percentage of judges rating as															
			Good	FAIR	POOR	BRIGHT	MEDIUM	DULL	EVEN	FAIRLY EVEN	UNEVEN	NOCHANGE	FINE	EVEN	UN-EVEN	GOOD	FAIR	POOR
1.	A	ONION SKIN	-	26	74	-	-	100	82	-	-	100	-	-	-	-	-	100
2.	B	FRENCH MARIGOLD	86	14	-	53	47	--	88	12	-	100	-	-	-	-	100	-
3.	C	RED SANDAL WOOD	92	8	-	-	100	-	72	28	-	100	-	-	-	-	100	-
4.	D	POME - GRANATE SKIN	100	-	-	-	100	-	86	14	-	100	-	-	-	-	100	-

Figure I
GENERAL APPEARANCE

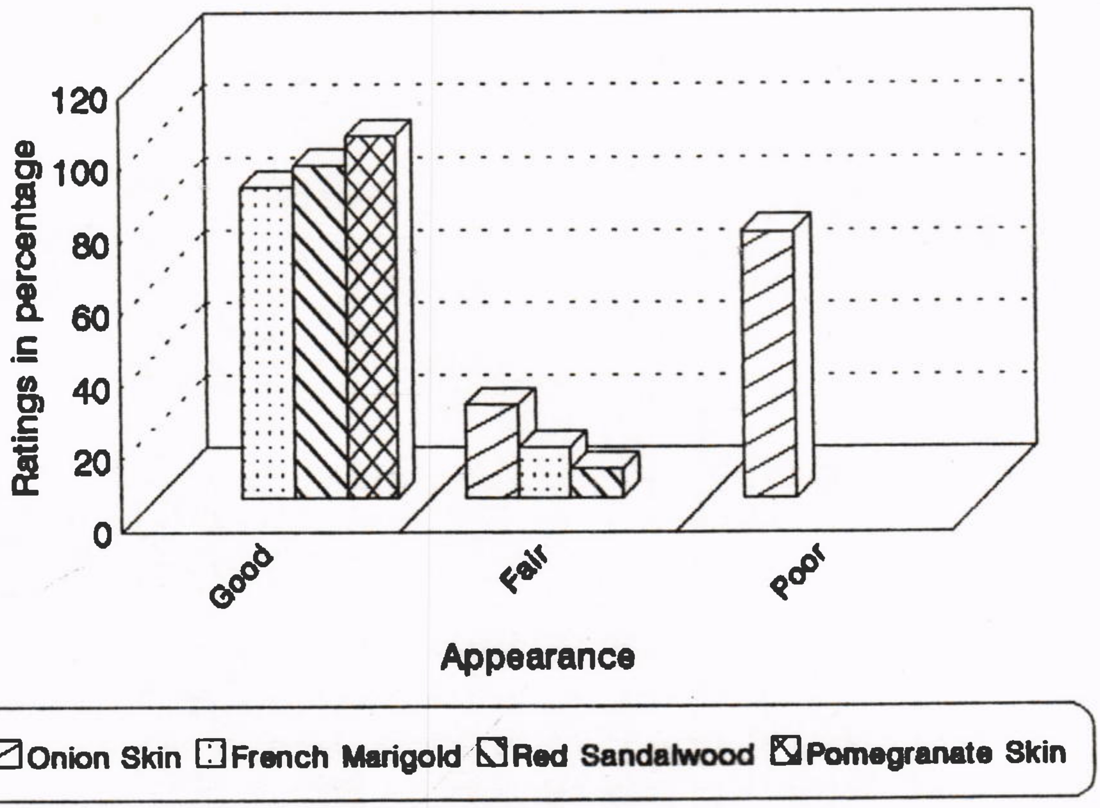


Figure II
BRIGHTNESS OF COLOUR

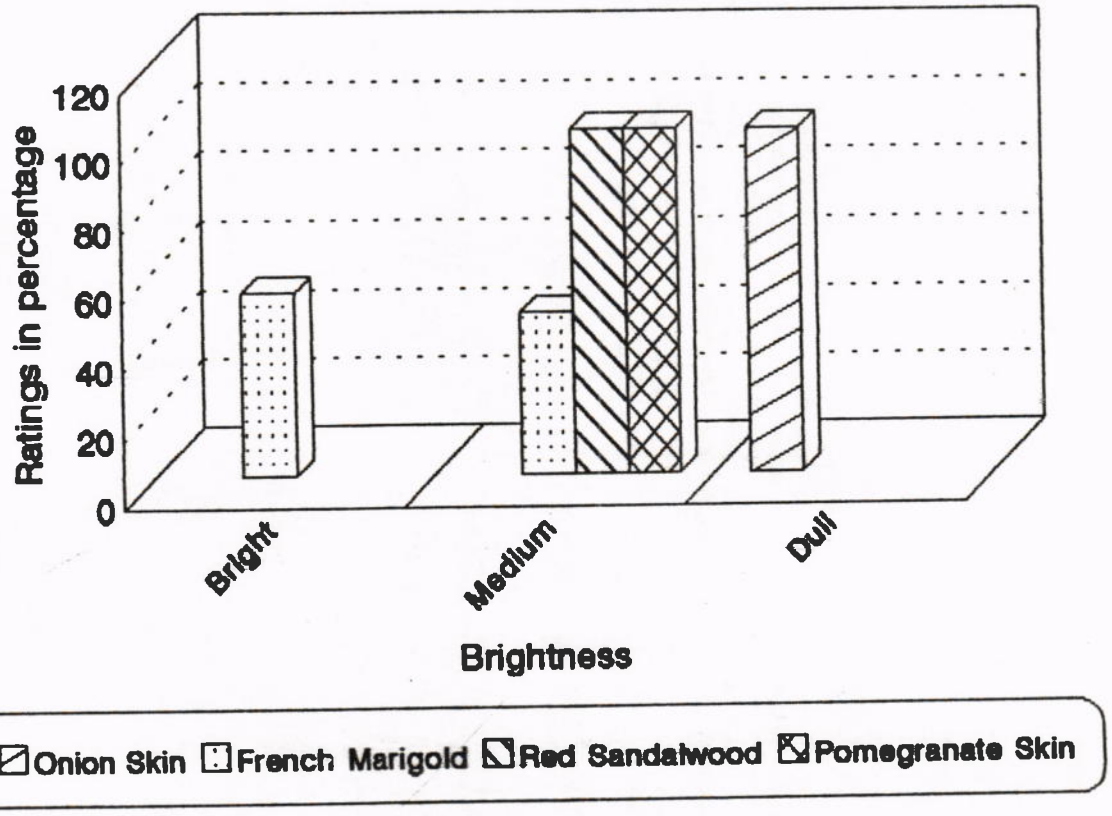
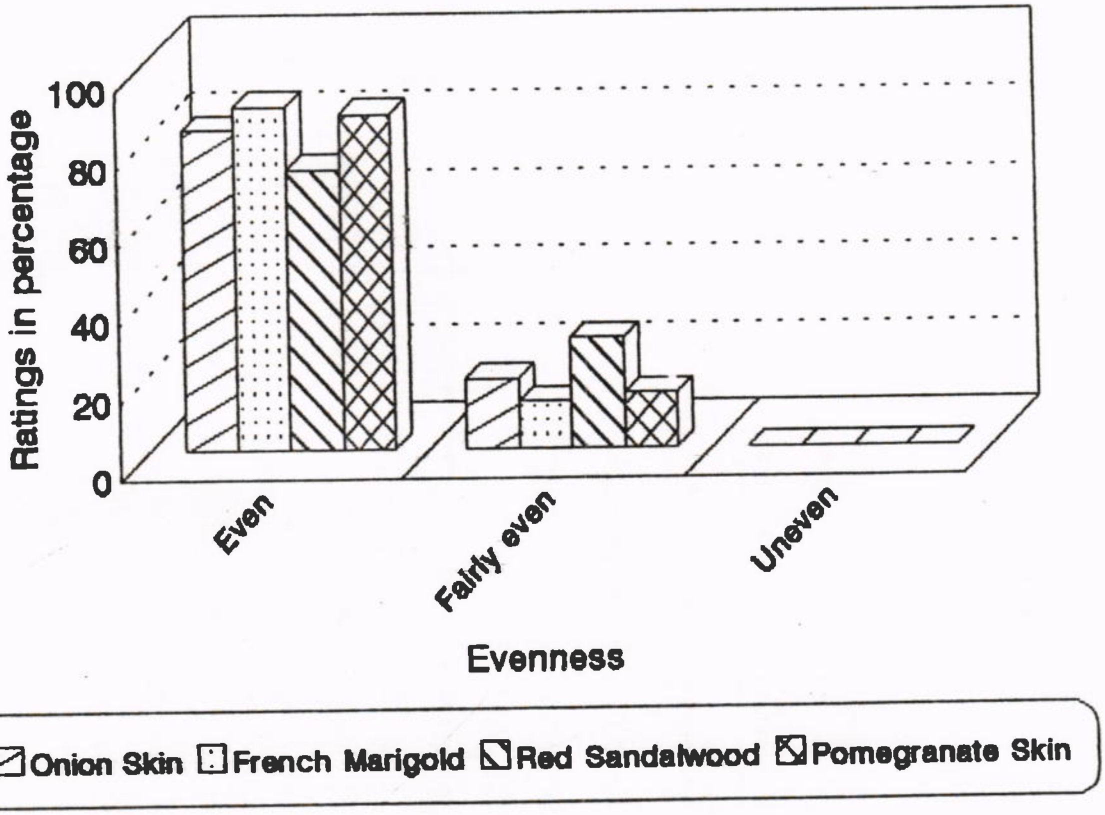


Figure III
EVENNESS OF DYEING



From Table I, it is evident that sample D ranked first in general appearance, as it was rated as good by cent percent of the judges. Samples C and B ranked second and third as accepted by 92 and 86 percent of the judges. The general appearance of sample A was rated as poor by 74 per cent of the judges.

As regards brightness of colour, only sample B was rated as bright by 53 per cent of the judges. Samples C and D were rated as medium in brightness by almost all judges. Sample A was rated as dull by all the judges.

With reference to evenness of dyeing, almost all samples were rated as evenly dyed by more than 70 per cent of the judges.

With regard to texture, cent percent of the judges accepted that none of the natural dyes had caused a change in texture. In otherwords, the texture was maintained same as that of the original.

In the case of lustre, the general rating was that sample A was poor while the rest were fair. The lustre of none of the samples was rated as good.

4.2 Laboratory tests

4.2.1 Fabric weight

The weight of the original and dyed samples are given in the following Table and also in Figure IV.

Figure IV
FABRIC WEIGHT

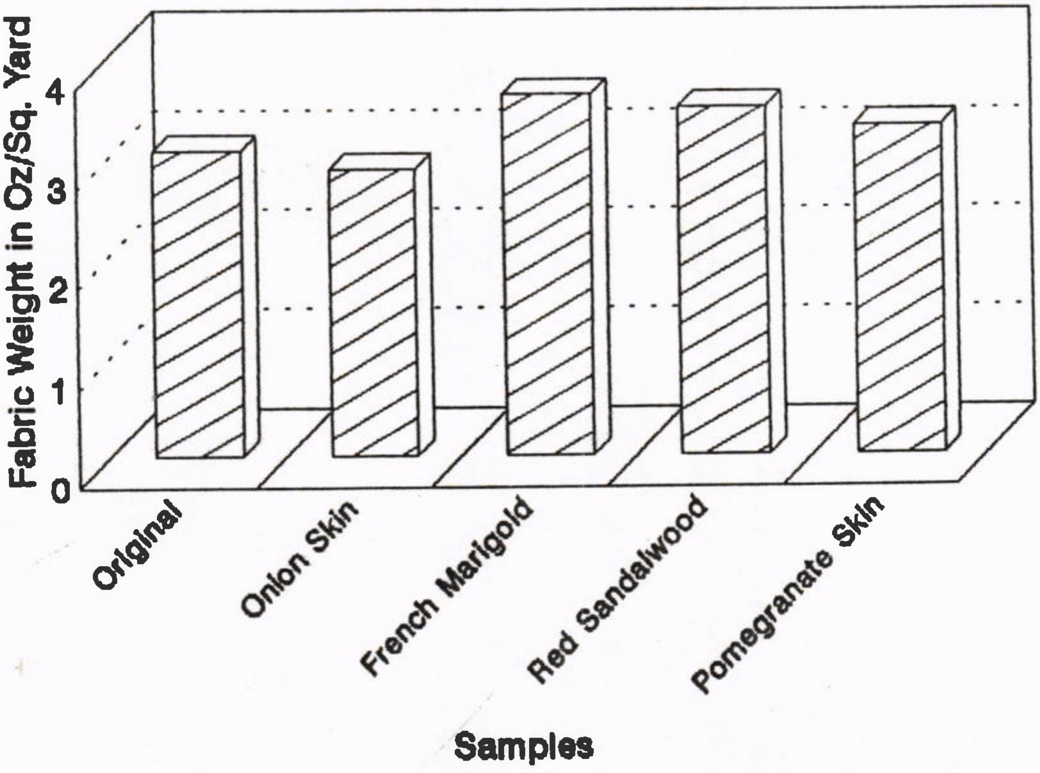


TABLE V

FABRIC WEIGHT

S.NO.	Samples	Mean Fabric Weight /(ounces/ Square Yard)	Gain or loss over original	% gain or loss over original	statistical analysis S.V	F
1	O	3.25	----	----		
2	A	3.0	- 0.25	- 7.69	Between	6.94
3.	B	3.75	+0.5	+15.38	samples	NS
4.	C	3.5	+0.25	+ 7.69		
5.	D	3.25	----	----		

NS = Not Significant
CV = 7.1 %

From Table V, it is evident that sample D maintained the fabric weight same as that of the original, while the others showed a variation. Samples B and C showed a gain of 15 and eight per cent respectively, where as sample A reduced in fabric eight by eight percent.

Statistical analysis reveals that the fabric weight of samples very significantly based on the difference in the type of dye used.

4.2.2 Breaking Strength

The following Table and Figure V show the breaking strenth of the original and dyed samples.

TABLE - VI

BREAKING STRENGTH

		WARP					WEFT				
S.No	Sample	Mean Strength in Kgs	Loss or Gain over. original	% Loss or Gain over ori ginal	Statistical Analysis S.V	F	Mean Strength in Kgs	Loss or Gain over original	% Loss or Gain over ori ginal	Statistical Analysis S.V	F
1.	O	21.5	---	---	Between Samples	9.39 **	3	---	---	Between Samples	2.42 ns
2.	A	19	-2.5	-11.62			2.5	-0.5	-16.66		
3.	B	20	-1.5	-6.9			2.8	-0.2	-6.66		
4.	C	19.5	-2	-9.3			2.6	-0.4	-13.33		
5.	D	21.5	---	---			2.5	-0.5	-16.66		

C V = 3.9%
** = Significant at 1%

C V = 10.4%
ns = Not Significant

Figure V.
BREAKING STRENGTH

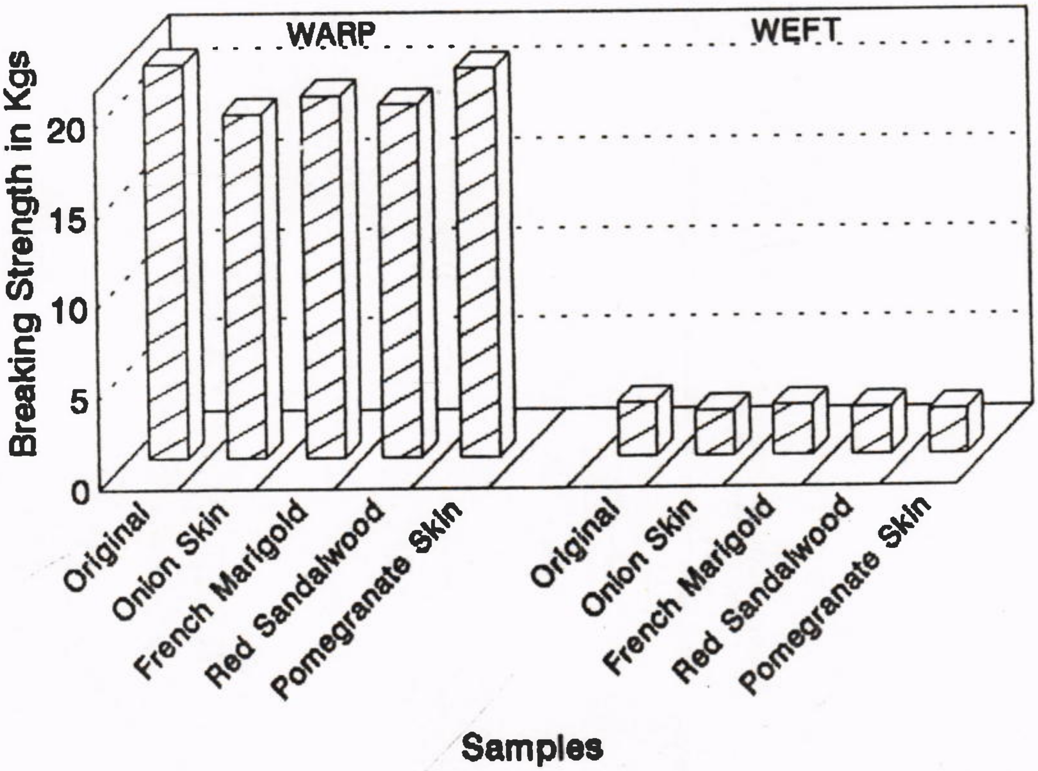


Table VI reveals that sample D alone maintained the breaking strength same as that of the original in the warp direction, while the others reduced. Minimum reduction of seven percent was observed in the case of sample B, followed by sample C with nine per cent reduction. Sample A had the maximum loss of twelve per cent.

As regards weft direction, almost all samples showed reduction in strength, minimum being in the case of sample B where, the percentage of reduction was seven. Sample C reduced by 13 per cent while A and D suffered a loss of 17 per cent.

Statistical analysis indicate that the variation in between the samples affect breaking strength significantly in warp direction. But their influence in weft direction is insignificant.

4.2.3 Elongation

The elongation of original and dyed samples are depicted in the Table below.

TABLE VII

ELONGATION

S.No.	Sample	WARP Mean strenth in Kg	WARP Loss or gain over original	WARP Percentage loss or gain over original	WEFT Mean strength in Kg	WEFT Loss or gain over original	WEFT Percentage loss or gain over original
1.	O	1.2	--	--	1.5	--	--
2.	A	1	- 0.2	- 16.66	1	- 0.5	- 33.33
3.	B	1.3	- 0.1	+ 8.33	1.2	- 0.3	- 20.0
4.	C	1.1	- 0.1	- 8.33	1.4	- 0.1	- 6.66
5.	D	1.2	--	--	1.3	- 0.2	- 13.33

The table on elongation indicates that sample D maintained elongation same as that of the original in the wrap direction. The percentage of elongation increased by eight per cent in the case of sample B while the same reduced in the case of samples A and C, by 16 and eight per cent respectively.

As regards weft direction, almost all samples reduced in their rate of elongation. Sample C had a minimum loss of seven per cent, followed by sample D with B per cent. Samples A and B had an obvious reduction of 33 and 20 per cent respectively.

4.2.4 Fabric Stiffness

The stiffness of samples is shown in Table VIII

TABLE VIII

FABRIC STIFFNESS

		WARP			WEFT		
S.No.	Sample	Mean str-enth in Kg	Loss or gain over original	Percentage loss or gain over original	Mean str-ength in Kg	Loss or gain over ori-ginal	Percentage loss or gain over original
1.	O	2.67	--	--	1.9	--	--
2.	A	2.53	- 0.14	+ 5.24	1.6	- 0.3	- 15.78
3.	B	2.47	- 0.20	- 7.49	1.5	- 0.4	- 21.05
4.	C	2.36	- 0.31	-11.61	1.7	- 0.2	- 10.52
5.	D	2.55	- 0.12	- 4.49	1.6	- 0.3	- 15.78

Natural dyes in general have reduced the stiffness of all samples. Sample D and A reduced by five percent in the warp direction. Samples B and C had a reduction percentage of seven and 12 respectively.

As regards weft, sample C had a minimum loss of 11 per cent while A and D has a loss of 16 per cent. Sample B had the maximum loss of 21 per cent.

4.2.5 Abration resistance

The following Table and Figure VI depicts the abrasion resistance of the samples.

TABLE IX

ABRASION RESISTANCE

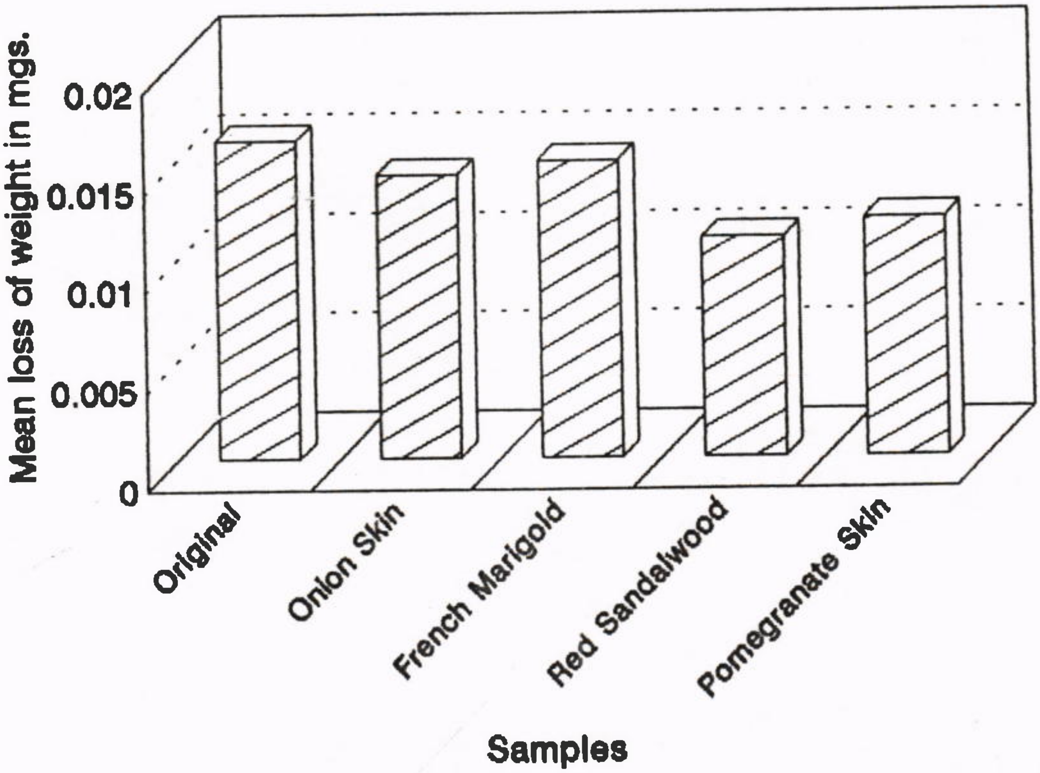
S.No.	Samples	Mean loss of Weight in mgs	Gain or over original in Kgs.	% gain or loss over original	statistical analysis S.V	F
1.	O	0.016	---	---		
2.	A	0.014	- 0.002	- 12.5		
3.	B	0.015	- 0.001	- 6.25	Between	1.43
4.	C	0.011	- 0.005	- 31.25	samples	NS
5.	D	0.012	- 0.004	- 25		

CV = 25.6%
NS =Not Significant

Natural dyes have increased the abrasion resistance of almost all samples. This is evident form the fact that the weight loss shown by almost all samples is less when compared to that of the original. Sample C showed a maximum loss of 31 percent when compared to the original and indicated that it is more resistant to abrasion than the other. It was followed by samples D, A and B as they had,13 and six present loss.

Statistical analysis indicate that the abrasion resistance of samples do not vary significantly based on the difference in the type of dye used.

Figure VI.
ABRASION RESISTANCE



4.2.6. Drape

The drape co - efficeient of the samples are shown in Table X and Figure VII.

TABLE X

DRAPE

S.No.	Samples	Mean drape co-effi--cient in %	Gain or over ori-ginal in Kgs.	% gain or loss over original	statistical analysis S.V	F
1	0	14.53	---	---		
2	A	14.34	- 0.19	- 1.31	Between	< 1
3	B	15.69	+ 1.1	+ 7.98	samples	NS
4	C	17.31	+ 2.78	+ 19.13		
5	D	17.55	+ 3.02	+ 20.78		

CV = 20.3%
NS = Not significant.

From Table X it is clear that sample A alone had a meagre reduction of one percent while the rest increased. Sample D had the maximum gain of 21 percent followed by samples C and B with a gain of 19 and eight percent respectively.

From the statistical analysis it is evident that drape co-efficient of samples do not vary significantly based on the difference in the nature of dye used for the samples.

4.2.7 Crease recovery

The crease recovery angle of the original and dyed samples are given in the following table.

Figure VII.
DRAPE

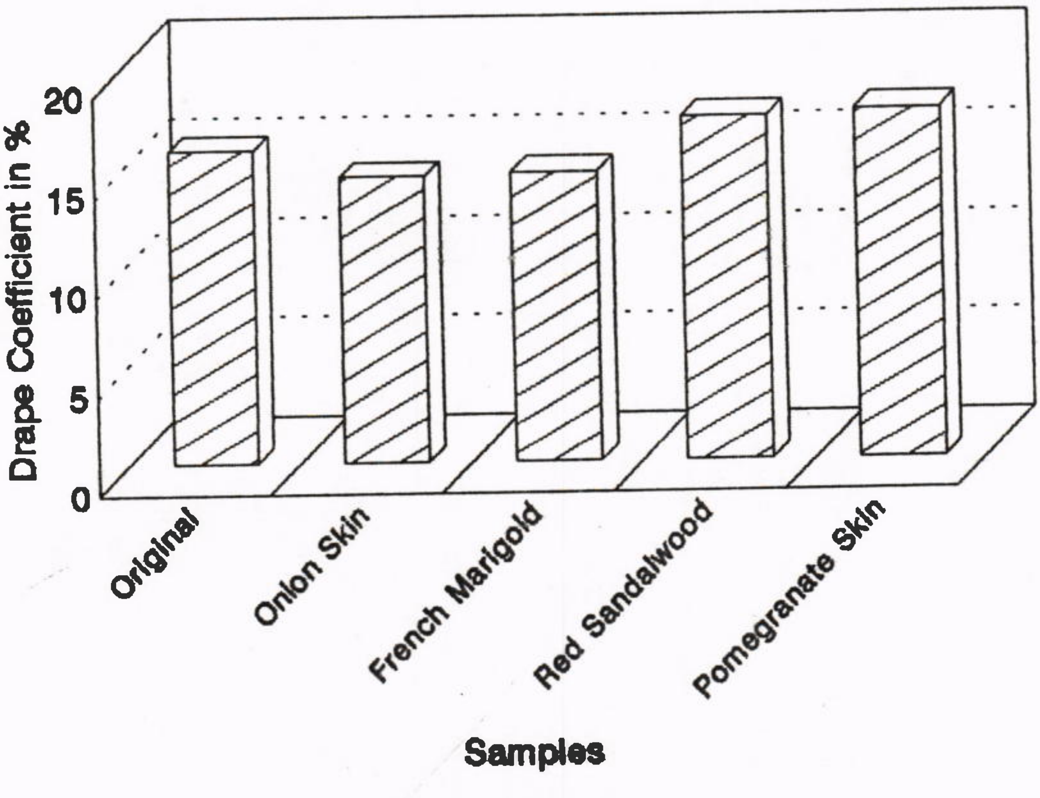


TABLE XI

CREASE RECOVERY

S. No	Sample	WARP Mean Value in degrees	Loss or gain over original in degrees	Percentange loss or gain over original	WEFT Mean value in degress	Loss or gain over original in degrees	Percentage loss or gain over original
1	O	88	--	--	75	--	--
2	A	83	- 5	- 5.68	72	- 3	- 4
3	B	86	- 2	- 2.27	74	- 1	- 1.3
4	C	79	-9	-10.22	75	--	--
5	D	82	-6	- 6.81	73	- 2	- 2.6

The above table indicates that use of natural dyes had caused a reduction in the crease recovery angle of almost all samples in the warp direction. Minimum loss of two percent was observed in the case of sample B followed by sample A with a loss of six percent, maximum reduction of ten percent observed in the case of smaple C.

In the weft direction also, all samples except C showed a reduction in crease recovery angle. Minimum reduction of one percent was observed in the case of sample B and maximum of four percent in the case of sample A.

4.3. Colour fastness tests

4.3.1. Colour fastness to pressing

With regard to colour fastness of the samples to both dry and wet pressing, cent percent of the judges stated that there was no change in colour in any of the samples, When compared to their respective originals. In staining tests also, none of the samples showed any colour transference on the white cloth attached to it. In other words, almost all samples were rated as colour fast to pressing by cent percent of the judges.

4.3.2. Colour fastness to dry crocking

Regarding dry crocking, almost all samples were rated as showing no change in colour by cent percent of the judges. Owing to the same reason, no colour transference was reported on the white cloth attached for the staining test.

4.3.3 Colour fastness to wet crocking :

The results of colour fastness to wet crocking are shown in Table XII.

TABLE XII

COLOUR FASTNESS TO WET CROCKING

S. No.	Sample	Percentage of Judges rating as: No Change	Faded Slightly	Faded moderately	Faded appreciably	Faded completely
1	A	14	86	---	---	---
2	B	26	74	---	---	---
3	C	27	73	---	---	---
4	D	10	90	---	---	---

The result of wet crocking test reveals that almost all samples were rated to have faded slightly in colour by more than 70 percent of the judges. Less than 30 percent of the judges rated samples B and C as maintaining the colour same as that of original. Similar rating was done by less than 15 percent of judges in the case of samples A and D. Slight transfer of colour on the white material was reported by more than 75 percent of the judges in the staining test. This was true in the case of all samples.

Hence it may be concluded that the dyed samples are colour fast to dry crocking than wet crocking.

4.3.4 Colour fastness to perspiration

The following Table shows the results of colour fastness test to perspiration.

TABLE XIII

COLOUR FASTNESS TO PERSPIRATION

S.No.	Sample	Percentage of Judges rating as									
		No Change		Faded Slightly		Faded moderately		Faded appreciably		Faded completely	
		Ad*	Al*	Ad.	Al.	Ad.	Al.	Ad.	Al.	Ad.	Al.
1	A	-	-	36	26	64	74	-	-	-	-
2	B	-	-	20	42	80	58	-	-	-	-
3	C	23	2	77	98	--	--	-	-	-	-
4	D	-	-	8		92	100	-	-	-	-

* Ad = Acid
* Al = Alkali

From the results of prespiration tests, it is obvious that sample C ranks first, as it was rated as faded slightly in colour by 77 and 98 percent of the judges in the acid and alkali perspiration respectively. The rest of the samples were rated to have faded moderately by more than 60 percent of judges in the case of acid perspiration test and by more than 55 percent of the judges in the case of alkali perspiration test.

4.3.5 Colour fastness to washing

The results of colour fastness to washing test are shown in the Table XIV.

TABLE XIV

COLOUR FASTNESS TO WASHING

		Percentage of Judges rating as				
S. No.	Sample	No Change	Faded Slightly	Faded moderately	Faded appreciably	Faded completely
1	A	100	---	---	---	---
2	B	98	2	---	---	---
3	C	92	8	---	---	---
4	D	4	10	86	---	---

As indicated in the above table, all samples except D were rated as showing no change in colour in the ashing test by more than 90 percent of the judges. Moderate fading in colour was indicated in the case of sample D by 86 percent of the judges.

4.3.6 Colour fastness to Sunlight

Table XV gives the results of colour fastness to sunlight.

TABLE XV

COLOUR FASTNESS TO SUNLIGHT

S. No.	Sample	Percentage of Judges rating as				
		No Change	Faded Slightly	Faded moderately	Faded appreciably	Faded completely
1	A	14	86	---	---	---
2	B	5	19	76	---	---
3	C	---	15	85	---	---
4	D		5	12	83	---

Only slight fading in colour due to exposure to sunlight was reported in the case of sample A, by 86 percent of the judges. The colour of samples B and C was rated to have faded moderately by 76 and 85 percent of the judges respectively. Sample D was reported as showing appreciable colour change by 83 percent of the judges.

Summary and Conclusion

V. SUMMARY AND CONCLUSION

From ancient times India has been popular for its variety of cotton clothes. Textiles are appreciated mainly for its intricacy of construction and beauty expressed throught its colour combination.

Until the later half of the nineteenth century all dyes were of vegetable, animal or mineral origin. In other words, the dyes were obtained from natural sources. Later due to advancement in science and technology, synthetic dyes have come into use. But the effluent from these dye industries have caused pollution to such an extent that people all over the world would like to go back to natural dyes. Hence today the focus is laid on the revival of natural dyes. These dyes are safe from the point of view of health and ecology. The most fascinating aspects of natural colourants are their glow and chances of variability. The do not create any pollution and are more labour oriented.

Creating a pattern on cloth by tie-dyeing is one of the most basic of textile arts. Tie-dyeing is the simplest method of resist printing which does not need advanced technical methods, machines and space. The technique of tie and dye is to bind induvidual areas of cloth to shield from dye.

In this study, an attempt has been made to

(1) Extract dye from selected vegetable sources.

(2) Apply the same on cotton fabric by adopting the technique of tie and dye.

(3) Evaluate the dyed samples for selected qualities.

The methodology adopted for the study consisted of :

(1) Extraction of dye form onion (Allium cepa), French marigold (Tagetes Species), Red Sandalwood (Pterocarpus Santalinus) and pomegranate (Punica granatum) which were easily available.

(2) Tie - dyeing of cotton material using the extracted dyes.

(3) Subjecting the dyed samples to visual evaluation and also laboratory tests like fabric weight, breaking strength, stiffness, abrasion resistance, crease recovery and colourfastness tests.

The findings of the study are as follows :

(1) All sample except the one dyed with onion skin was rated as good in general appearance.

(2) Only the sample dyed with french marigold was rated as bright in colour.

(3) Almost all samples were rated to be even in colour.

(4) Natural dyes caused no change in texture of any of the samples.

(5) The lustre of all samples were rated to be poor.

(6) Sample dyed with pomegranate alone maintained the fabric weight same as that of the original while the rest either

reduced or increased in fabric weight.

(7) Sample dyed with pomegranate alone maintained the strength same as that of original in warp direction while the others reduced.

(8) All samples showed a reduction in weft strength due to the effect of dyeing. Sample dyed with french marigold had minimal loss.

(9) Sample dyed with french marigold alone increased in elogation in the warp direction while the other decreased.

(10) All samples reduced in elogation in the weft direction, minimum loss was noticed in the case of sample dyed with red sandalwood.

(11) The abrasion resistance of all samples increased on dyeing, the minimum loss was displayed by sample dyed with french marigold, when compared to the others.

(12) The drape coefficient of sample dyed with onion skin decreased when compared to the original while the rest increased.

(13) The crease recovery angle of all samples reduced in the warp direction, the minimal loss was noticed in the case of sample dyed with french marigold.

(14) Sample dyed with red sandalwood maintained the crease recovery angle same as that of original in the weft direction while the others decreased.

(15) All samples were colourfast to both dry and wet pressing.

(16) Colour fastness to wet crocking revealed slight fading of colour in the case of all samples.

(17) The colour of sample dyed with red sandalwood alone was rated as slightly faded, while the others were rated moderately faded to both acid and alkali perspiration.

(18) All samples except the sample dyed with pomegranate were colourfast to washing.

(19) The colour of the sample dyed with onion skin was rated as slightly faded on exposure to sunlight. Sample dyed with pomegranate was rated to have faded appraciably in colour.

Hence it may be concluded, that the dye extracted from pomegranate is superior to others as it maintains the physical characteries of the sample more or less same as that of the original. The dye extracted form red sandalwood excels the others by porducing a fabric of very good appearence but it affects the physical characteristics of fabric appreciably.

Recommendations :

(1) The effectiveness of other sources of natural dyes for cotton can be studied.

(2) Suitability of natural dyes for fabrics others than cotton is worth trying.

(3) Different methods of printing can be tried using natural dyes.

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Appendices

APPENDIX - II

TIE - DYED SAMPLES

ONION SKIN

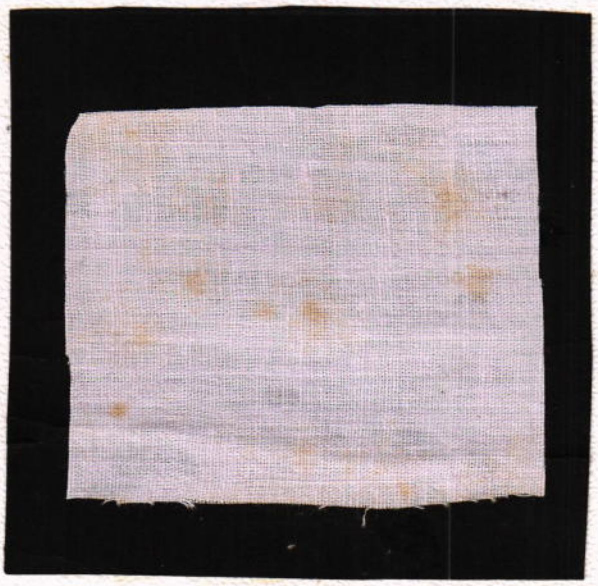
FRENCH MARIGOLD

RED SANDALWOOD

POMEGRANATE SKIN

APPENDIX - I

DETAILS OF THE FABRIC



Name of the fabric	:	Cotton
Variety	:	Poplin
Weave	:	Plain
Width	:	89 cms.
Label Information	:	100% Cotton, Mercerized
Manufacturers	:	Premier mills, Hosur
Price per metre	:	Rs.20/-

APPENDIX III

PROFORMA FOR VISUAL EVALUATION OF DYED SAMPLES

S.No	Samples	Dyes used	General appearance			Brightness of colour			Evenness of Dyeing			Texture				Lustre		
			Good	FAIR	POOR	BRIGHT	MEDIUM	DULL	EVEN	FAIRLY EVEN	UNEVEN	NO CH -ANGE	FINE	EVEN	UN-EVEN	GOOD	FAIR	POOR
1.	A	ONION SKIN																
2.	B	FRENCH MARIGOLD																
3.	C	RED SANDAL WOOD																
4.	D	POME - GRANATE SKIN																

APPENDIX IV

DETAILS OF GREY SCALE RATING

The dyed samples were rated using the AATCC Grey scale to measure the extent of colour change and staining.

Scores for rating.	Inference regarding colour change
5	No change
4	Slightly changed
3	Noticeably changed
2	Considerably changed
1	Much changed

	Inference regarding staining
5	No staining
4	Slightly stained
3	Noticeably stained
2	Considerably stained
1	Much stained

APPENDIX V

STATISTICAL ANALYSIS - MODEL

ANALYSIS OF VARIANCE FOR ABRASION RESISTANCE

SV	DF	SS	MS	F
Replication (R)	3	0.0000	0.0000	< 1
Samples (S)	4	0.0001	0.0000	1.43ns
Error	12	0.0002	0.000	
Total	19	0.0002		

CV = 25.6%
ns = not significant

Table of samples (S) Means for Abrasion Resistance

Samples	Ranks	Means
0	1	0.0160a
A	3	0.0143a
B	2	0.0150a
C	5	0.0110a
D	4	0.0120a
Mean		0.0137

Means followed by a common letter are not significantly different at 5% level by DMRT.