EXTRACT FROM IXORA FLOWERS AS A SOURCE OF DYE FOR COTTON AND WOOL

BY

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1999

CERTIFICATE

Ms. R. SAI KIRAN MAI has satisfactorily prosecuted the course of research and that the thesis entitled **EXTRACT FROM IXORA FLOWERS AS A SOURCE OF DYE FOR COTTON AND WOOL** submitted is the result of original research work and is of high standard to warrant its presentation to the examination. I also certify that the thesis has not been previously submitted by her for a degree of any university.

15/11/99

Date: 15. 11. 99.

Dr. (Mrs.) Mary Jacob
Major Advisor

CERTIFICATE

This is to certify that the thesis entitled **EXTRACT FROM IXORA FLOWERS AS A SOURCE OF DYE FOR COTTON AND WOOL** submitted in partial fulfilment of the requirements for the degree of **MASTER OF SCIENCE IN HOME SCIENCE** for Acharya N.G.Ranga University, Hyderabad is a record of the bonafide research work carried out by **R. SAI KIRAN MAI** under my guidance and supervision. The subject of the thesis has been approved by the Student's Advisory Committee.

No part of the thesis has been submitted by the student for any other degree or diploma. The published part has been fully acknowledged. All assistance and help received during the course of the investigations have been fully acknowledged by the author of the thesis.

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DECLARATION

I, **R. SAI KIRAN MAI** hereby declare that the thesis entitled **EXTRACT FROM IXORA FLOWERS AS A SOURCE OF DYE FOR COTTON AND WOOL** submitted to Acharya N.G. Ranga Agricultural University for the degree of **MASTER OF SCIENCE IN HOME SCIENCE** is a result of original research work done by me. It is further declared that the thesis or any other part thereof has not been published earlier in any manner.

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R. Sai Kiran Mai

R.Sai Kiran Mai

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LIST OF ABBREVATIONS

Alum	:	Aluminium potassium sulphate
%	:	Per cent
Gm	:	Grams
°C	:	Degree centigrade
Mins	:	Minutes
Hrs	:	Hours
Gm/litre	:	Grams per litre
H_2O_2	:	Hydrogen peroxide
HCl	:	Hydrochloric acid
ml	:	Millilitre
M:L	:	Material Liquor ratio
Fig	:	Figure

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ABSTRACT

Natural vegetable dyes have become a part of human life since time immemorial. Until the beginning of the 19^{th} century, all dyes were obtained from natural sources. With the introduction of synthetic dyes in the middle of the 19^{th} century, the decline in the use of natural dyes started. Worldwide emphasis is given today for production of fabrics using products and application techniques with minimum damage to ecology. Therefore, efforts are being made to revive the use of natural dye with revised techniques and scientific methodology. The available literature indicates that, no study has been done on extraction of dye from Ixora. Hence, the present study was taken up to dye cotton and wool yarns with dye extracted from Ixora flowers.

Ixora flowers were collected from various places in Hyderabad. Cotton and wool yarns were selected for the study. Alkaline method of extraction was found to be best suited for cotton, whereas acidic method of extraction was suited for wool. Alum and myrobolan were tried as mordants as both were non-toxic and eco-friendly. Cotton and

wool yarns were pretreated with alum and myrobolan as pre mordanting was found to be suitable for cotton and wool yarns. Different shades of colour were obtained on cotton and wool. The dyed cotton and wool samples were subjected to colour fastness tests.

The results of colour fastness test on cotton samples exhibited good to very good fastness to washing, good to very good fastness to sunlight, excellent to very good fastness for both dry and wet rubbing and excellent to very good fastness to acidic and alkaline perspiration. The findings of colour fastness test on wool samples showed good to very good fastness to washing, excellent fastness to sunlight, excellent to very good fastness to rubbing and perspiration.

The results of subjective evaluation revealed that Ixora dye was suitable for dyeing cotton and wool. It was also found that the colour was good on both cotton and wool. The cost of dyeing process on cotton and wool indicated that myrobolan treated samples incurred higher cost when compared to samples mordanted with alum. For dyeing unmordanted samples, the cost involved was nil as no chemical was used.

Introduction

INTRODUCTION

In every civilization from the stone age to the silicon chip age, colour has played a very important role in human life. Colour not only gives a pleasant look to the substrate, but also expresses emotions and ideas. With the invention of first synthetic dyestuff in1856, 'Perkin Mauve', the chemistry of dyes and the technology of dyeing has progressed very rapidly. The invention of synthetic dyes almost limited the use of vegetable dyes to specific textiles such as Kalamkari, hand printed textiles, etc. Natural vegetable dyes have become a part of human life, It is believed that the art of dyeing had its origin in India.

In earlier times, the principal dyestuff were from plant sources, a number of natural dyes, however, known are black, yellow, dark blue, green, scarlet and madder. Natural dyes obtained from natural sources exhibit better biodegradability and generally have a better compatibility with the environment. These natural dyes are non pollutant and non allergic. They also possess lower toxicity and allergic reactions than synthetic dyes. In recent years, people are realising the need of using environmentally safe products for their day-to-day life. With the environmental concerns growing, there is a spurt in the demand of plant based dye products for processing textile goods.

Today, the world is for synthetic dyes, but due to the problems posed by the synthetic dyes, people are once again going back to the past where the roots of natural dyeing existed. Though vegetable dyes cannot replace synthetic dyes they have several advantages over synthetic dyes from the point of view of health, safety and ecology. There is however, no denying, that the need is paramount today to give an earnest thought for reviving natural dyes.

1.1 HISTORICAL BACKGROUND OF NATURAL DYES

The history of natural dyes is more than 4000 years old. Human beings have always admired the beautiful natural colours of plants and minerals. In the beginning, men utilized the colours, which were available in nature, like blossoms, leaves, stems etc, and sometimes from the animal origin. As time passed natural dyes were used for cosmetics. (Mashelkar 1995)

The earliest authentic records are those of Chinese dated 2600 B.C in which reference has been made to silk dyeing with natural colours. Calico printing was also practiced in India from very ancient times. There are undoubted proof that the art of dyeing and printing was considerably advanced in India as found in the caves of Ajanta and Bagh which are supposed to be as old as 6^{th} century A.D. (Chavan 1995). During the Moghul period, when the architecture and printing were highly patronised and cultivated, the art of dyeing and printing also received proportionate encouragement. In the 17^{th} century, India had a virtual monopoly in the production of dyed, painted and printed textiles with natural colours. (Chavan1995).

Fabrics dating from 3500 B.C have been found in Thebes, Egypt that still possess the remains of blue indigo dye. Other fabrics discovered in ancient tombs of Egypt were yellow coloured. During the excavations of Harappan culture evidence of the use of vegetable dyes and mineral dyes were found. The evidence of the use of natural dyes during the premuslim and muslim period of Indian history is much better preserved in the form of dresses, manuscripts and printings. Today in the world of environmental consciousness, natural colouring substances have attracted the attention of the whole world.

1.2 ECOLOGICAL AWARENESS

Worldwide emphasis is given today for production of fabrics using products and application techniques with minimum damage to ecology. These ecological considerations led to the German resolutions of July 1994,which sought to ban fabrics dyed with azo dyes or other dyes that have carcinogenic effect. In India too, the government has banned the use of azo group dyes. These banned dyes mostly cover direct dyes, acid dyes, azo dyes, disperse dyes and some basic dyes. It is, therefore, imperative to think of substitute dyes, which can give good shades, fastness etc.

1.3 COMMON NATURAL DYESTUFF

The term natural dye covers all the dyes derived from plants, insects and minerals i.e., derived from natural resources. The basic colours known are blue, red and yellow which are easily available from natural resources like flowers, plants, barks, roots etc. Indigo blue from natural resources was widely accepted throughout the world. Red from manjista, ala root, lac etc and yellow dyes from jackfruit, basant flower, etc were extracted in early days by the handloom weavers. (Patra 1998).

"Kermes", the first of red dye consisted of the dried bodies of insects, found principally on the southern European oak. It is a pea-sized parasite of a prickly evergreen Mediterranean oak. It is a source of scarlet colour and the colouring matter is Kermic acid.

"Cochineal", a native of Mexico, Guatemala is a red colouring matter obtained from dried body of the female insects. The colouring matter is identified as carminic acid.

"Madder", became the most common red dyestuff and was extensively used because of its beautiful red rose colour, its great fastness and its availability. The important chemicals in madder are alizarin and purpurin.

"Log wood", also known as campeachy wood is actually classed among the red wood. The colouring principle is haematoxylin. It gives black and purple colours.

"Indigo" is the most famous of all dyes. The leaves of Indigo plant contains Indigotin, the actual dyestuff, which is insoluble in water and yields blue colour.

"Fustic", a species of sumac tree, growing principally in West Indies and Southern Europe. It contains a large amount of tannin material and three colouring matters, yellow, brown and red.

1.4 IXORA AS A SOURCE OF DYE

The name *Ixora* is derived from a sanskrit word "ikvana" which is the name of a malayan deity. The scientific name of Ixora is *Ixora singaporensis*. It belongs to the family Rubiaceae. There are many species and varieties of *Ixora*. They grow as shrubs with rough, grey branches and glossy dark red stems. A native of tropical Asia and Africa, the *Ixora* is now common in all eastern countries, both in its wild state and as a cultivated garden shrub. It flowers best during rainy season(Plate 1). As the flowers remain fresh for a long time after plucking, they are well suited for indoor decoration.(Cowen1983)

1.5 NEED FOR THE STUDY

Natural dyes have several advantages over synthetic dyes from the point of view of health, safety and ecology. They have been known and used for thousands of years without any reports showing that they are harmful. The production of synthetic dyes involves many reactions, which are conducted at high temperature and pressure using primary chemicals isolated from petroleum. During the

Plate 1

IXORA SINGAPORENSIS PLANT.

manufacturing process, many carcinogenic chemicals are required. The by-products formed have to be discharged in the rivers, ponds or in the atmosphere. These drawbacks of synthetic dyes have prompted environmentalists to look for eco-friendly dyes and technologies. It is interesting to note that India is one of the few countries to perfect the art of fixing natural dyes to the cloth. Indian textiles are greatly valued and sought after for their colours and enduring qualities. Due to the increased advantages of the natural dyes over synthetic dyes, India is concentrating on commercial manufacture of natural dyes. Many research and development programmes have been taken up by different organisations to develop the natural dyes. The available literature indicates that no study has been done using *Ixora* flowers, therefore the present study was taken to extract and develop dye from *Ixora* flowers.

1.6 OBJECTIVES OF THE INVESTIGATION

GENERAL OBJECTIVE

To extract dye from *Ixora singaporensis*.

SPECIFIC OBJECTIVES

1. To standardise the extraction of dye from *Ixora* flowers
2. To standardise dyeing procedure for cotton and wool yarns
3. To assess colour fastness properties.
4. To estimate the cost.
5. To assess the consumer acceptability.

1.7 LIMITATIONS

Only two mordants were used and combination of mordants was not used due to paucity of time.

Review of Literature

REVIEW OF LITERATURE

Colour in ancient times was considered a spiritual necessity of equal importance to the physical needs of food. So in every civilisation from remote ages to the present day, the art of dyeing has played an important part in adding beauty to the world. Dyeing makes an important contribution to fabric decoration by producing many beautiful colours. This topic is divided under the following headings:

2.1 Origin of natural dyes

2.2 Classification of natural dyes

2.2.1 Classification based on chemical nature

2.2.2 Classification of natural dyes on the basis of colour

2.2.3 Mineral colourants of natural dyes

2.3 Techniques of dye application

2.4 Studies on vegetable dyes

2.4.1 Studies on vegetable dyes on cotton

2.4.2 Studies on vegetable dyes on wool

2.5 Ixora varieties

2.1 ORIGIN OF NATURAL DYES

Dyeing is one of the processes of decorating textiles with different dyestuffs like natural or synthetics. India was once known as a leading source of the earliest natural dyes. These dyes are classified as vegetable, mineral or animal origin, which were abundantly used by primitive people.

Vegetable Origin: The inorganic dyestuffs are obtained from roots, stems, leaves, berries and flowers of various plants.

Ex :- Indigo, Safflower, Cutch, etc.,

Animal Origin:- These pigments are spread out in nature from micro-organisms to mammals. Colour is manifested in organisms through two different means, one chemically by natural pigments called Biochromes and secondly by colourless submicroscopic structures called Chromochromes. It is the biochromes, that are the potential sources of natural dyes.

Ex :- Kermes, Cochineal, Tyrian Purple, Lac, etc.,

Mineral Origin:- They include various inorganic metal salts and metal oxides.
Ex- Mineral Khaki, Red Lead, etc.

2.2 CLASSIFICATION OF NATURAL DYES

Natural dyes can be classified in various ways. The earliest classification was according to alphabetical order. Later classification was based on chemical structure, where grouping within each structure class according to hue was carried out. Besides these methods of classification, the natural dyes have been listed on the basis of their botanical names and common names. In the colour index, the dyes are classified according to chemical constitution as well as major application classes. Within application class, the dyes are arranged according to hue. Natural dyes form a separate section. In this section, the dyes are arranged hue-wise. Some dyes produce more than one hue. (Paul et.al 1996).

2.2.1. CLASSIFICATION BASED ON CHEMICAL NATURE

The natural organic dues and pigments cover a wide range of chemical classes viz. Polymethine, Ketone, Imine, Quinones, Anthraquinonoids, Napthoquinones, Flavones, Flavonols, Flavanones, Indigoids and Chlorophyll.

2.2.1.1 Indigoid Dyes

Two very important natural dyes have indigoid structure namely indigo and tyrian purple. Indigo is perhaps the oldest natural dye used by man. It occurs as the glucoside indican in the plant *Indigofera tinctoria* and has been known in India for about 400 years. Another blue dye woad (*Isatis tinctoria*) also possess indigo as the main dyeing component.

2.2.1.2 Anthraquinonoids

Some of the most important red dyes are based on the anthraquinone structure. They are obtained both from plants as well as insects or animals. These dyes are characterised by good fastness to light. They form complexes with metal salts and the resultant metal complex dyes have good wash fastness. Madder, Lac, Kermes, Cochineal are some of the examples possessing this type of structure.

2.2.1.3 **Alpha Napthoquinones**

The most prominent member of this class of dyes is Lawsone or Henna. It is obtained from the leaves of *Lawsonia inermis*, cultivated mainly in India and Egypt. Lawsone has been identified as 2-hydroxy-1-4-napthoquinone. Another similar dye is Juglone, 5-hydroxy-1-4-napthoquinone obtained from the shells of unripe walnuts.

2.2.1.4 **Flavones**

Flavone is a colourless organic compound. Most of the natural yellows are derivatives of hydroxy and methoxy substituted flavones or isoflavones. The most important European yellow dye weld (*Roeseda luteola*) contains the pigment luteolin, which is a flavone.

2.2.1.5 **Dihydropyrans**

Closely related in chemical structure to the flavones are substituted dihydropyrans viz. haematin and its leuco form haematoxylin. These are the principal colouring bodies of logwood and are historically the most important natural dyes for dark shades on silk, wool and cotton. Brazilwood is closely related in chemical structure to logwood.

2.2.1.6 **Anthocyanidins**

The naturally occurring member of this class include, Carajurin obtained from the leaves of bignonia chica and awobanin, which is blue in colour, extracted from the flower *Tsuyukusa cammelia communis.* It dyes silk in blue shade.

2.2.1.7 **Carotenoids**

The class name carotene is derived from the orange pigment found in carrots. In these, the colour is due to the presence of long, conjugated double bonds. The prominent natural dyes based on carotenoid structure are annatto (*Bixa orellana*) and saffron (*Crocus sativus*).

2.2.2 CLASSIFICATION OF NATURAL DYES ON THE BASIS OF COLOUR

Normally, natural dyes are extracted from the roots, stems, leaves, flowers and fruits of various plants and dried bodies of certain insects and minerals. It is very useful to divide different sources of natural dyes on the basis of the colour which they impart on fibre substrate. (Paul et.al. 1996). Natural dyes are divided according to the colour such as red, yellow, blue, black, brown, green and orange colours.

2.2.3. MINERAL COLOURANTS

These colourants derive their name from the natural source which was at one time used to produce these colourants. Later, the so called mineral colours were produced from purified inorganic compounds. These colourants, with the exception of mineral khaki, are now only of historical importance. Some of the important mineral colourants are chrome yellow, iron buff, namkin yellow, prussian blue and manganese brown (Gulrajini 1995)

2.3 TECHNIQUES OF DYE APPLICATION

The process of dyeing yarn or fabric involves several steps:-

i. Dye Extraction
ii. Mordanting
iii. Dyeing
iv. Washing

2.3.1. EXTRACTION OF DYE

Dye can be extracted in various ways from the raw material and development of standard methods of extraction can reduce the time required for dyeing. There are four ways of extraction

i) **Aqueous** :- The material is boiled in water and the liquid obtained is filtered through fine fabric to obtain the dye.

ii) **Alkaline** :- The raw material is boiled in alkaline medium. The solution is made alkaline with the addition of one per cent sodium carbonate per litre of water.

iii) **Acidic** :- Acid is the medium for dye extraction. The raw material is boiled in acidic medium. The solution is made acidic with addition of one per cent HCl per litre of water.

iv) **Alcoholic** :- The raw material is boiled in a solution containing equal proportions of water and alcohol.

2.3.2 **MORDANTING**

All natural dyes are called as mordant myes because they require a mordant to fix the colour. There are three methods of mordanting the fabric :-

i) Pre mordanting
ii) Simultaneous mordanting
iii) Post mordanting

i) **Pre mordanting** :- This method of dye application has two stages. In the first stage of mordanting, the mordant is applied to the textile material. In the second stage, the mordanted textile material is put in the dye liquor. The mordant is applied to the textile from an aqueous medium containing the mordant. Ex:- Sodium or Potassium dichromate and an acid such as acetic acid. Mordanting involves boiling the textile material in the aqueous solution containing the mordant for about 30 to 45 minutes. The mordanted textile is then transferred to the aqueous solution containing the mordant dye.

ii) **Simultaneous Mordanting** :- This is a one stage process in which the dye and the mordant are applied to the fibre simultaneously. This method can only be used with dyes which do not form the dye mordant complex immediately on coming together, that is the mordant and the dye union do not form the complex, until they have entered the polymer system of the fibre.

ii) **Post mordanting** :- This method involves a two stage process which is the reverse of the pre mordanting method. This method involves the use of certain mordant dyes which are actually of acid dyes which can be mordanted. The dyes are applied to the textile material from an aqueous solution, which contains the dye and sodium sulphate. The textile material is first dyed and then it is mordanted.

2.3.3. **DYEING** :- It is the process where dye molecules attach themselves to mordant molecules present in the fibre structure. The fabric is then boiled in extracted dye bath and the temperature and time help in making the dye fast.

2.3.4 **WASHING** :- After dyeing, the fabric is washed in plain water to remove excess of dye.

2.4 STUDIES ON VEGETABLE DYES

They are many studies extensively done by different research workers on extraction and application of natural dyes.

2.4.1 STUDIES OF VEGETABLE DYES ON COTTON

Padhye and Rathi (1990) studied effect of mordants on dyeing of cotton with vegetable dyes. Madder and Saualikodi were taken as dyes. Cotton fabric was treated with myrobolan first and then the myrobolan treated fabric was treated each with different mordants namely, alum, aluminium sulphate, stannous chloride, potassium dichromate, copper sulphate and ferrous sulphate. The treatment was carried out at various concentration of myrobolan, mordant and dyes. Depending upon the nature of mordants and the concentration of mordants and dye used, shades obtained varied from pinkish red, crimson to dull red, reddish brown, reddish orange, deep violet to dark grey. Among all the mordants, potassium dichromate gave best results for all fastness properties. Wash fastness was found to be moderate to poor.

Udayini and Jacob (1988) developed new vegetable dyes for Kalamkari printing on cotton fabric. Colours such as orange, garnet, lavender and blue were obtained from annato seeds, sappan wood and indigo respectively. Results showed that blue colour exhibited fair resistances to washing, sunlight, crocking, perspiration and pressing. Orange had poor fastness to sunlight. Garnet and Lavender colours had almost similar colour fastness characteristics with exception of pressing in which lavender had changed its hue. Garnet and lavender colours showed poor resistances to perspiration.

Prabhu and Senthil Kumar (1998) dyed cotton and silk with the natural dye extracted from *Rosa indica*. Cotton fabric was treated with tannic acid and myrobolan extract separately. These were subjected with six metal salts each namely, copper sulphate, potassium dichromate, ferrous sulphate, stannous chloride and tartar emetic. Silk sample was mordanted with copper sulphate, aluminium sulphate, stannous chloride, ferrous sulphate separately. It was found that *Rosa indica* gave dull yellow colour on cotton and yellow colour on silk. Fastness properties were good.

Katyayini and Jacob (1998) standardised the dyeing of cotton with natural dye, extracted from Mesta calyx. Cotton samples were pretreated with myrobolan solution. Each mordant namely alum, copper sulphate, acetic acid and stannous chloride was tried with mesta calyx extract. Results showed that unwashed samples having colours of pink, pinkish brown and violet exhibited fair to good fastness to rubbing and fair fastness to sunlight. The washed samples with colours of grey, greyish green and violet exhibited fair to good fastness to rubbing, fair resistances to washing and poor resistances to sunlight.

Vineet and Bharati (1998) dyed cotton with the dye extracted from eucalyptus hybrid bark. Cotton fabric was scoured with non-ionic surfactant at boil for one hour. Results showed that colour obtained with ferrous sulphate as mordant were black in shade and the colour obtained by using stannous chloride were yellowish brown except incase of simultaneous mordanting and dyeing. It was also observed that aqueous extract of eucalyptus hybrid bark yielded bright brown dye with medium wash and light fastness on cotton.

Kalyani and Jacob (1998) dyed cotton with extract from red gulmohar flowers. Cotton fabric was treated with myrobolan solution. The myrobolan treated fabric was premordanted each with mordants namely copper sulphate, potassium dichromate, ferrous sulphate and cobalt sulphate. Colours obtained were olive green, green, brownish black and biscuit. Colour fastness test showed fair to excellent fastness for dry rubbing and wet rubbing showed poor to fair fastness. Wash fastness was found to be poor to good and it showed poor to excellent fastness for perspiration. Sunlight test showed good to excellent fastness after 8 hours and poor to fair fastness after 40 hours of exposure.

Dedhia (1998) dyed cotton, viscose rayon, cotswool, wool and silk with the dye extracted from henna. Each fabric was treated with potassium dichromate, chrome, alum, copper sulphate, ferrous sulphate and nickel chloride which were used as mordants. Results showed that pure wool showed best dye uptake, potassium dichromate was found to be the best mordant and nickel chloride resulted in poor dye uptake.

Radhika and Jacob (1999) extracted and developed dye from Jatropha seeds on cotton fabric. The fabric was pre-treated with myrobolan. The myrobolan treated fabric was premordanted each with copper sulphate, ferrous sulphate, cobaltous sulphate and a combination of the two mordants, potassium dichromate and lead acetate. It was found from the study that, the colours obtained were dark khaki, biscuit colour and greenish yellowish khaki. Results showed good to excellent fastness for perspiration. Black and dark khaki had poor rub fastness and biscuit colour had the best fastness. Biscuit colour showed poor wash fastness and black had the best fastness to sunlight test.

2.4.2 STUDIES OF VEGETABLE DYES ON WOOL

Verma and Gupta (1994) dyed woollen knitting yarns with natural dye obtained from Eucalyptus bark. Each type of yarn was mordanted with alum, chrome, ferrous sulphate, stannous chloride, acetic acid and sulphuric acid. The dyed samples were subjected to light fastness and wash fastness tests and also compared the tensile strength of dyed samples with synthetic dyed samples. It was found that the loss in tensile strength of samples dyed with eucalyptus bark was less than that of samples dyed with synthetic dyes. The samples exhibited fairly fast to light and good fastness to washing.

Verma and Gupta (1995) dyed wool fabric with wattle bark. All the three method of mordanting i.e. pre mordanting, simultaneous mordanting and post mordanting were adopted. Each fabric was treated with alum, chrome and copper sulphate. Results showed that copper sulphate gave higher light fastness, when compared to the other mordanting agents. Iron, chrome and alum mordanted at 6.5 P^{H} also gave superior light fastness. The samples showed good wash fastness.

Garg et al (1991) studied the effect of mordants on colour of natural dye extracted from tessue flowers. Each sample was mordanted with potassium dichromate, alum, ferrous sulphate and stannous chloride. Combination of mordants i.e. chrome and alum, chrome and stannous chloride, chrome and ferrous sulphate and stannous chloride and ferrous sulphate were also tried out. Variety of colours including rust golden yellow, Ochre yellow, orange, dull vermilion and buff yellow were obtained by combination of mordants. The samples showed fair to good colour fastness to light. Samples mordanted with chrome and chrome in combination with other mordants exhibited fair to excellent fastness to washing and staining.

Agarwal and Goel (1992) optimised dyeing process for wool with natural dye obtained from turmeric. The dye extracted from turmeric yielded colours ranging from yellow mustard, bright yellow, yellow brown, dull yellow, greenish light yellow. Each samples were tried with combination of mordants i.e. chrome and stannous chloride, chrome and ferrous sulphate, chrome and alum, stannous chloride and alum, ferrous sulphate and alum. Wash fastness of the samples mordanted with alum, ferrous sulphate and stannous chloride was fair to good and these mordanted with chrome also exhibited good wash fastness. Wash fastness of the samples mordanted with combination was fair to good. The samples mordanted with alum and stannous chloride showed fairly good fastness, while with combination of mordants, the light fastness ranged from fair to fairly good.

Gulrajani et al(1992) dyed wool with natural yellow dyes obtained from flavonoids of Kamala, Onion skin and Tesu. Colours obtained from Kamala ranged from bright golden yellow, dull mustard yellow to olive green. The dye yielded was fairly fast to washing and has good fastness to light. Wool dyed with onion (*Allium cepa*) exhibited colours ranging from clay to olive brown and sepia brown. It showed average light fastness and fair to good wash fastness. Tesue (*Butea monosperma*) dyed wool yielded rich warm colours ranging from bright golden yellow, yellow browns, yellow orange and deep rust. Light fastness was found to be fair and wash fastness to be good.

Gulrajani *et al* (1992) dyed wool with Myrobolan (*Terminalia chebula*). Colours obtained with myrobolan were yellow ochre with alum, olive green with copper and chrome, brown with ferrous sulphate, beige with stannous chloride and pale yellow without any mordant. It was observed that wool when mordanted with ferrous sulphate, copper and chrome salts exhibited better light fastness than samples mordanted with alum and stannous chloride. Wash fastness was found to be good.

Gulrajani et al (1992) extracted dye from harshingar, safflower and barberry. Harshingar yielded deepest yellow shades. The dyed samples exhibited moderate fastness to light and good fastness to washing. Safflower dyed wool gave bright yellow colour without the use of mordants, golden yellow with alum and stannous, green with copper and yellow ochre in combination with ferrous and chrome. Light fastness was fair to good and wash fastness was found to be good. The roots and stems of barberry yielded golden yellow without the use of mordants, greenish yellow with alum and copper, yellowish green with ferrous and mustard yellow with chrome and stannous. Light and wash fastness was found to be poor.

Gulrajani et al (1992) dyed wool with extract from Majith or Madder, Patangwood and red wood. It was found that madder or majith yielded a red dye. It exhibited very good light fastness and good wash fastness. Patangwood yielded wide range of colours on applications of different mordanting methods, beige, brownish grey, purple and brown. On mordanting, it showed improved fastness to light and washing. Red wood yielded colours ranging from beige to brown only. Pinkish brown shade was developed on wool. Light fastness was fair to good and wash fastness was good.

Rama et al (1991) dyed wool from the extract of balsam flowers. The study was carried out to optimise the concentration of dye, time for extraction of dye, dyeing time, concentration of mordants and the best method of mordanting. It was found that balsam flowers gave best results with optimum concentration of 5 gms flowers in 100 ml of water, dye extracted in 60 minutes and dyeing time 120 minutes was found to be optimum. It yielded a wide range of colours with optimum concentration of 25 per cent alum, 2 per cent copper sulphate, 2 per cent chrome, 4 per cent stannous chloride and 2 per cent ferrous sulphate for 100 gms of wool. Simultaneous mordanting method was followed for alum, copper sulphate, stannous chloride and ferrous sulphate while pre mordanting method was followed for chrome. The colours obtained were orangish brown, blackish brown, orange fawn, mustard yellow and greenish yellow. Colour fastness was good to light and washing.

Rama et al (1991) dyed woollens with Parijataka flowers (*Nycthanthes arbortristis*). The range of shades obtained from the flowers were yellow, yellow orange, yellow green and yellow ochre. Each sample was mordanted with alum, chrome, ferrous sulphate, copper sulphate and stannous chloride respectively. The best results were obtained by using post mordanting method for all the mordants except stannous chloride, which gave the best colour with simultaneous mordanting and dyeing method. Results showed that it had poor fastness to light and excellent fastness to washing. It was also observed that it showed no staining on wool.

Agarwal and Gargh (1992) developed dyeing process for wool with henna. A wide range of colours including yellowish brown, beige, yellow ochre, dull yellow brown, bright ochre, dark brown grey, beige brown, mustard and dull yellow were obtained after mordanting with optimum concentration of mordants such as alum, chrome, ferrous sulphate and stannous chloride respectively. The best results were obtained using post mordanting method with alum and chrome, while simultaneous mordanting and dyeing gave best results with ferrous sulphate and stannous chloride. It was found that samples dyed with henna and mordanted with alum, chrome and ferrous sulphate, showed fair to good wash fastness, while those mordanted with stannous chloride exhibited good to excellent wash fastness.

2.5 IXORA VARIETIES

There are many varieties of *Ixora*. It flowers throughout the year but is at its best during the rainy season.

i) ***Ixora coccinea*** :- It is also known as Scarlet *Ixora* or flame tree of the woods. The word *coccinea* means "Scarlet". This is one of the smaller varieties and reaches little more than 5 feet in height.

ii) ***Ixora rosea*** :- Meaning "The Pink *Ixora*" is an untidy, straggling bush, rarely reaching 4 feet, but it bears large, round heads of flowers which contrast attractively with the darkgreen leaves. The pink is inclined to darken as the flower ages.

iii) ***Ixora parviflora***:- Means "the small-flowered *Ixora*" and it is known as the torch tree. It is a small tree with many branches and fragrant whitish flowers but is not particularly attractive.

iv) ***Ixora barbata***:- It is called the "bearded *Ixora*" because of the woolly appearance of the month of the flower. It is a large shrub with many branches, starting almost from the ground. The flower stalks are dull purple and the long tubed white flowers bear spreading, yellow-anthered stamens.

v) ***Ixora griffithsii*** :- It is considered to be the best of *Ixora*. It grows to about 4 or 5 feet and bear huge orange trusses. It is frequently grown in tubs.

vi) ***Ixora chinensis*** :- It is orange flowered.

vii) ***Ixora undulata*** :- The wavey leafed *Ixora*.

viii) ***Ixora fulgens*** :- It is a very ornamental shrub with large long-tubed, scarlet flowers.

ix) ***Ixora lutea*** :- It is another attractive shrub, rather like *Ixora coccinea* but with yellow colour flowers.

X) ***Ixora bracheata*** :- The commonest and abundant *Ixora* around Mumbai is a small rather ugly tree growing upto 20 feet.

Ixoras are usually grown from layers and to keep their compact and rounded shape the garden hybrids should be pruned fairly closely after flowering.

Materials and Methods

MATERIALS AND METHODS

This chapter deals with the selection of materials, preparation and implementation of experimental procedures. Cotton and wool yarns were selected and experiments were carried out using mordants. Series of trials have been carried out to select suitable method for dye extraction, appropriate mordants, method of mordanting and dyeing. The dyed samples were tested for their colour fastness properties.

3.1 SELECTION OF MATERIALS

3.1.1 COLLECTION OF IXORA FLOWERS

Ixora is one of the finest shrubs, endowed with most of the desirable characters one can look for in a plant of this type. These are commonly seen everywhere. The flowers are attractive, gaily coloured and arranged in large clusters. All colours and shades are found except in blues and purples. As the flowers remain fresh for a long time after plucking, they are well suited for indoor decoration. The rural folk find many medicinal uses for the various parts of the plant. The roots are made into a medicine to alleviate stomach troubles and cure dysentery. *Ixora singaporensis* has very large and showy heads of flowers of a rich terra-cotta colour. The flowers were collected and the dye extracted from the flowers was used for the study. The available literature indicates that, there are no studies on extraction of dye from *Ixora* and hence, the study was selected.

3.1.2 SELECTION OF YARN

Cotton and wool yarns were selected for the study. Scoured and bleached white cotton and pure white scoured wool yarns were selected.

3.1.3 SELECTION OF MORDANTS

Selection of mordants was done after conducting many experimental trials with different mordants. Myrobolan was selected as a mordant because it gave darker shades and alum was selected for lighter shades (Plate 3).

3.2 SELECTION OF METHODS

3.2.1 SELECTION OF RESEARCH DESIGN

The experimental research design was used as the study involves experiments and laboratory tests. Methods of dye extraction, dyeing and mordanting were taken from the earlier published research articles of Katyayini and Jacob(1998) and Kalyani and Jacob(1999).

3.2.2 SELECTION OF DYE EXTRACTION METHOD

Selection of dye extraction method was done after a series of extraction trials with dried *Ixora* flowers (Plate 2). Different methods of dye extraction such as aqueous, alkaline, acidic and alcholoic methods were tried and extracts obtained were applied on both cotton and wool samples. Alkaline method of dye extraction was selected for cotton and acidic method of dye extraction was selected for wool.

3.2.2.1 DYE EXTRACTION METHOD FOR COTTON

Extracts obtained from four methods of dye extraction were tried. Cotton produced good shade with alkaline method of dye extract. Aqueous, acidic and alcoholic extracts produced uneven and patchy shades, hence they were not selected and alkaline method of extraction was selected.

Plate 2

DRIED IXORA FLOWERS

Plate 3 MORDANTS

ALUM MYROBOLAN

3.2.2.2 **DYE EXTRACTION METHOD FOR WOOL**

Wool yarn samples produced good colours, only with acidic dye extract. Aqueous, alkaline and alcoholic dye extracts had negligible effect on wool yarn, hence they were not selected and only acidic dye extraction method was selected for wool.

3.2.3 **SELECTION OF METHOD OF MORDANTING**

Cotton and wool yarns were subjected separately to different methods of mordanting viz., pre mordanting followed by dyeing, simultaneous mordanting, dyeing and post mordanting.

3.2.3.1 **MORDANTING METHODS FOR COTTON AND WOOL**

Pre mordanting method showed best results on cotton and wool and produced brighter shades. Simultaneous and post mordanting methods produced dull colours with unevenness, hence pre mordanting method was selected.

3.3 **STANDARDISATION OF DYE EXTRACTION AND DYEING PROCEDURE**

Standardisation of dye extraction and dyeing procedure were carried out after conducting many preliminary tests.

3.3.1 **DYE EXTRACTION AND DYEING PROCEDURE FOR COTTON**

3.3.1.1 **PRETREATMENT**

Cotton yarn was subjected to pretreatment process for scouring and bleaching according to the procedure given by Prayag (1990).

a) **Scouring** : The grey yarn was boiled in open vats under atmospheric pressure using 2 per cent caustic soda, 1 per cent soap and 1 per cent sodium silicate (on the weight of the material) using material liquor ratio of 1:20 for 4-6 hours taking care to see that the yarn remains immersed in the liquor throughout. It is left overnight in the liquor and washed thoroughly with water the following day.

b) **Bleaching** : (Hydrogen Peroxide method)

Yarn was treated with 2 vol of 'H_2O_2' per litre and 4gms of sodium silicate, which acted as a stabilizer for full bleach at 80-85°c and P^H 11.5 using material liquor ratio of 1:20. The treatment was continued for half an hour at 85°c and one hour at 90°c. The solution was made alkaline with caustic soda or soda ash.

3.3.1.2 **DYE EXTRACTION**

Alkaline method of dye extraction was followed by taking 3 and 7 gms of dried *Ixora* flowers in 100 ml of water respectively containing one gram of Sodium carbonate. The temperature was raised to 95°c and boiling was carried out for an hour, P^H was maintained at 11(Plate 4).

3.3.1.3 **MORDANTING**

The cotton yarn was pretreated with myrobolan solution for 24 hours at room temperature and then dried under sunlight for 3 hours. The myrobolan to liquor ratio was 1:20. The cotton yarn was also pre mordanted with 15 per cent concentration of alum taking material liquor ratio as 1:30. Mordanting was carried out for 30 minutes at 95°c temperature.

3.3.1.4 **DYEING**

The samples mordanted with myrobolan and alum were dyed with alkaline dye extract taking material liquor ratio as 1:30 and temperature at 95°c, for one hour. The

Plate 4

ALKALINE EXTRACT

Plate 5

ACIDIC EXTRACT

dyed samples were allowed to cool to room temperature, rinsed in water then dried under shade.

3.3.2 DYE EXTRACTION AND DYEING PROCEDURE FOR WOOL

3.3.2.1 DYE EXTRACTION

Acidic method of dye extraction was followed taking 3 and 7 gms of dried *Ixora* flowers in 100ml of water containing one per cent of HCl. The temperature was raised to 95°c and extraction was carried out for one hour(Plate 5).

3.3.2.2 MORDANTING

The wool sample was pretreated with myrobolan solution for 24 hours at room temperature and then dried under sunlight for 3 hours. The myrobolan to liquor ratio was 1:20. Wool sample was also pre mordanted with 15 per cent concentration of alum taking material liquor ratio as 1:50. Mordanting was carried out for 45 minutes at 95°c temperature.

3.3.2.3 DYEING

The wool sample was dyed with the acidic extract of *Ixora* flowers taking the material liquor ratio as 1:50. P^H was maintained at 4.5 and temperature was kept at 95°c. The dyeing was carried out for one hour.

3.4. PREPARATION OF SHADE CARD

A shade card was prepared with 3 and 7 per cent shade for cotton and wool with two different mordants. (Appendix II)

3.5 EXPERIMENTAL PROCEDURE

3.5.1 OPTIMISATION OF DYEING VARIABLES

3.5.1.1 OPTIMUM CONCENTRATION OF DYE MATERIAL

The concentration of dye material was optimised by taking five dye solutions which were prepared by taking 1,3,5,7 and 10 gms of dried *Ixora* flowers respectively each in 100 ml of water . Boiling was carried out at 95°c for one hour. The extract was then filtered. Five yarn samples each weighing one gram was taken and added to each of the dye solution. Dyeing was carried out for an hour raising the temperature to 95°c. The dyed samples were allowed to cool to room temperature and then rinsed in water and dried under shade.

3.5.1.2 OPTIMUM TIME FOR DYE EXTRACTION

To optimise the time for extraction of dye, 3gms of dried *Ixora* flowers was taken in each of 3 beakers containing 100 ml of water. The temperature for boiling was raised to 95°c. The beakers were removed from water bath after 30,45 and 60minutes of boiling respectively. The extract was then filtered and one gram of the sample was placed in each of the 3 beakers and then boiled upto one hour. After dyeing, the samples were allowed to cool to room temperature and then rinsed in water and dried under shade.

3.5.1.3 OPTIMUM P^{H} FOR EXTRACTION OF DYE

To optimise the P^{H} for dye extraction in alkaline medium, three different P^{H} were tried. 3gms of dried *Ixora* flowers was taken in each of 3 beakers containing 100ml of water. The P^{H} in the 3 beakers was maintained at 9,10 and 11 by adding sodium carbonate. Extraction was carried out for one hour raising the temperature to 95°c. The extract was then filtered and one gram of sample was added to each of the 3 beakers and dyeing was carried out for one hour maintaining the temperature at 95°c. The samples were allowed to cool to room temperature, rinsed and dried under shade.

To optimise the P^H for dye extraction in acidic medium, five different P^H were tried. 3 gms of dried *Ixora* flowers was taken in each of 5 beakers containing 100ml of water. The P^H in the five beakers was maintained at 2,3,4,4.5 and 5 by adding HCl. Extraction was carried out for one hour raising the temperature to 95°c. The extract was then filtered and one gram of samples was added to each of the 5 beakers and dyeing was carried out for one hour maintaining the temperature at 95°c. The samples were allowed to cool to room temperature, rinsed and dried under shade.

3.5.1.4 OPTIMUM TIME FOR DYEING

To optimise the time for dyeing, one gram of each sample was placed in 3 beakers containing 50 ml of filtered dye solution. The temperature for boiling was raised upto 95°c.The beakers were removed from water bath after 30,45 and 60 minutes respectively. The dyed samples were allowed to cool to room temperature, then rinsed in water and dried under shade.

3.5.1.5 OPTIMUM TIME FOR MORDANTING

To optimise the time for mordanting, 5 per cent concentration of alum solution was taken in 5 beakers. One gram of sample was place in each of the 5 beakers containing 30 ml of water for cotton and 50 ml of water for wool and 5 per cent concentration of alum. The temperature was raised to 95°c. The beakers were removed from water bath after 30,45,60, 75 and 90 minutes of time respectively. The samples were allowed to cool to room temperature, rinsed and then dried under shade.

3.5.1.6 OPTIMUM CONCENTRATION OF MORDANTS

To optimise the suitable concentration of the mordants, three concentrations of alum was tried on the samples. Three mordanting liquors were prepared with 5,10 and 15 per cent concentration of alum. One gram of sample was placed in each of the 3 beakers containing 30 ml of water for cotton and 50 ml of water for wool with different mordant concentration. The temperature was raised to 95°c and mordanting was carried out for 30 minutes. The samples were cooled to room temperature, rinsed and dried under shade.

3.5.2 WASHING

The samples were rinsed with soap solution and then rinsed with tap water to remove the unfixed dye on the yarn.

3.5.3 EVALUATION OF COLOUR FASTNESS TESTS

Colour fastness from the point of view of consumer is of considerable importance. Four colour fastness tests were carried out on both cotton and wool yarns separately to evaluate the colours obtained from dried *Ixora* flowers.

i) colour fastness to washing

ii) colour fastness to sunlight

iii) colour fastness to rubbing

iv) colour fastness to perspiration

The above tests were done on 5 samples each and rated according to BIS standard tests procedures IS 768-1956 for colour change and IS 769-1956 for staining using grey scale. The ratings was done by judges comprising the staff and post graduate students of Textiles and Clothing Department of College of Home Science

3.5.3.1 ATMOSPHERIC CONDITIONS FOR TESTING

Prior to testing, the samples were conditioned as per the BIS standard IS 1359-1971. The test specimens were kept in standard atmosphere at 65±2 per cent relative humidity and 27 ± 2°c for 24 hours before testing.

3.5.3.2 COLOUR FASTNESS TO WASHING

Colour fastness test for washing was done as per BIS standard test procedure IS 687-1979. A composite specimen of 10cm x 4cm was prepared as per the standard procedure. The test soloution was prepared by dissolving 5 gms of soap in one litre of distilled water. The composite specimens were placed in jars of launder-o-meter containing the test solution. The test solution was pre heated to 40°c. The tank of the launder-o-meter was filled with water upto the needed level and the temperature was controlled. The jars containing the specimens were clamped in the rotars with the help of holders and the rotar was worked for 45 minutes. Then, the samples were removed from the jars. The samples were rinsed in water for 10 minutes and dried at temperature below 60°c. The samples were evaluated for colour change and for degree of staining on two adjacent fabrics using geometric grey scale following BIS test procedure IS 768-1956 for colour change and IS 769-1956 for colour staining.

3.5.3.3 COLOUR FASTNESS TO SUNLIGHT

The test for colour fastness to sunlight was conducted as per BIS test IS 686-1956, for testing the fastness of material to the action of sunlight under glass, based on the amount of exposure. Five samples of each 1cm x 6 cm were mounted on a cardboard and covered by an opaque cover. Exposure to sunlight was done between 9:00 A.M to 3:00 PM in sunlight cabinet which was placed facing south and at an angle of 14°. One square centimeter of each specimen was exposed to sunlight for 8,16,24,32 and 40 hours. They were evaluated for colour fastness to sunlight by comparing the unexposed portion of the test specimens with the exposed portions of the test specimen by observing the change in colour using geometric grey scale for colour change following BIS test procedure IS 768-1956.

3.3.3.4 **COLOUR FASTNESS TO RUBBING**

The test was carried out as per BIS test procedure IS 768-1956 on SASMIRA crock-o-meter. The specimens were tested for both wet and dry rubbing. The testing was done using white undyed piece of cloth of size 5cm x 5 cm, which is fitted onto the knob and rubs the specimen fixed on a flat rectangular steel platform.

3.5.3.4.1 COLOUR FASTNESS TO DRY RUBBING

Test specimen of size 14 cm x 5 cm was fixed on flat rectangular steel platform. The undyed sample of size 5cm x 5 cm was placed at the end of the finger of the rubbing device. The dyed sample was rubbed to and fro in a straight line along the 10 cms length on dry sample for 10 times, with a downward force of 900 gms on the finger.

3.5.3.4.2 COLOUR FASTNESS TO WET RUBBING

Test specimen of size 14cm x 5 cm was fixed on flat rectangular steel platform. Undyed cloth of size 5cm x 5 cm was soaked in distilled water and squeezed to remove excess water. This wet, undyed cloth was placed over the end of the finger of the rubbing device. The test piece was rubbed to and fro in straight line along the 10 cm length for 10 times with a downward force of 900 gms on the finger and the pieces were dried at room temperature.

The evaluation for both dry and wet rubbing was done using geometric grey scale for staining according to BIS test procedure of IS 769-1956.

3.5.3.5 COLOUR FASTNESSS TO PERSPIRATION :

The fastness of dyed samples to both acidic and alkaline perspiration was conducted by following BIS test procedure IS 971-1956.

3.5.3.5.1 ACIDIC TEST SOLUTION

The test solution was prepared by dissolving 2.65 gms of sodium chloride and 0.75 gms of urea per litre of water. The P^H was adjusted to 5.6 by addition of acetic acid.

3.5.3.5.2 ALKALINE TEST SOLUTION

The test solution was prepared by dissolving 3 gms of sodium chloride per litre of water and P^H was adjusted to 7.2 with the addition of sodium bicarbonate.

Composite specimen of size 5 cm x 4 cm was prepared by placing the test specimen between two undyed samples of size 5 cm x 5 cm and stitched together along the common 5 cm side. The composite specimen was steeped in test solutions with the material liquor ratio of 1 :50 (gms : ml) and kept at room temperature for 30 minutes. Then the specimen was placed between acrylic separators and at a pressure of 4.5 kilograms for 10 minutes in the oven for 4 hours at 37 ± 2 ^oc. At the end of 4 hours, the specimen was removed and dried at temperature of not more than 60^oc.

The samples were evaluated for colour change and colour staining using the geometric grey scale according to BIS test procedure IS 768-1956, IS 769-1956 respectively.

3.6 SUBJECTIVE EVALUATION

Subjective evaluation was done by 20 judges comprising of staff and postgraduate students of Textiles and Clothing Department, College of Home Science using evaluation sheet. (Appendix I)

3.7 STATISTICAL ANALYSIS

Result of colour fastness tests were analysed statistically using arithmetic means.

3.8 ESTIMATION OF COST OF DYEING

The cost of raw material used in dyeing was calculated without the cost of yarn. The average cost of dyeing for 10 gms of fibre was calculated to assess the economic feasibility of dyeing process.

Results and Discussion

RESULTS AND DISCUSSION

The results obtained after conducting a series of experimental trials are presented and discussed based on four aspects viz.,

a) Optimisation of dyeing variables.
b) Evaluation of colour fastness tests.
c) Estimation of cost of dyeing process.
d) Evaluation of consumer acceptability.

4.1 OPTIMISATION OF DYEING VARIABLES:

The optimum or the best concentrations of the dye material, method, time for extraction, suitable mordants, method of mordanting and concentration of mordants were standardised after a series of experimental trials.

4.1.1 OPTIMISATION OF DYEING VARIABLE FOR COTTON:

Dye extraction was found to be maximum by alkaline method of extraction than the other methods. So, alkaline method was found to be the best method of extraction. It was also found that premordanting was best suited than post mordanting and simultaneous mordanting. The best concentration of dye material and mordants were selected by a panel of judges comprising of staff and postgraduate students of Textiles and Clothing Department. Time for dye extraction, dyeing and mordanting were standardised after conducting a series of experimental trials.

TABLE 4.1: **OPTIMUM PROPORTIONS FOR DYEING COTTON WITH IXORA FLOWERS IN ALKALINE MEDIUM:**

S.No	Variables	Trail proportions	Selected proportions
1.	Dye material	1,3,5 and 7 gms	3 and 7gms
2.	Time of extraction	30, 45 and 60 minutes	60 minutes
3.	P^H for extraction	9, 10 11	11
4.	Time of dyeing	30, 45 and 60 minutes	60 minutes
5.	Mordanting time	30, 45, 60, 75 and 90 minutes	30 minutes
6.	Concentration of alum mordant	5, 10 and 15 per cent	15 per cent
7.	Concentration of myrobolan(1:40), (M:L)	20 gms per litre of water	20 gms per litre of water

As given in data in table 4.1, for 1 gram of cotton 3 and 7 grams of dried Ixora flowers respectively were taken in 100 ml of water, P^H being maintained at 11. To prepare the shade card 3 and 7 per cent of shades were selected so as to obtain a light and a dark shade. It was found that 60 minutes of time was optimum for dye extraction since 30 and 45 minutes of extraction produced lighter shade. It was also observed that P^H of 11 was ideal for dye extraction as P^H 9 and P^H 10 produced very light shade. Optimum time for dyeing was found to be 60 minutes as 30 and 45 minutes dyed samples gave dull and light colours. From the table 4.1, the best time for mordanting was 30 minutes as it was found to be good for premordanting. Among the three different concentrations of alum ie., 5, 10 and 15 per cent. 15 per cent was selected as it produced a better shade and there was not much difference in 10 and 15 per cent shade. It was also found that 20 grams of myrobolan per litre of water was best suited for mordanting cotton sample.

4.1.2 OPTIMISATION OF DYEING VARIABLES FOR WOOL

Acidic method of dye extraction was found to be the best when compared to the other three methods ie., aqueous, alkaline and solvent method of extraction. It was found that pre mordanting gave best results than simultaneous and post mordanting. The best concentration of dye material and mordants were selected by a panel of judges comprising of staff and postgraduate students of the Textiles and Clothing department. Time for dye extraction, dyeing and mordanting were arrived after conduction a series of experimental trials.

TABLE 4.2: **OPTIMUM PROPORTIONS FOR DYEING WOOL WITH IXORA FLOWERS IN ACIDIC MEDIUM.**

S.No	Variable	Trail proportions	Selected proportions
1.	Dye material	1, 3, 5and 7gms	3 and 7gms
2.	Time of extraction	30, 45 and 60 minutes	60 minutes
3.	P^H for extraction	2, 3, 4, 4.5 and 5	4.5
4.	Time of dyeing	30, 45 and 60 minutes	60 minutes
5.	Mordanting time	30, 45,60,75 and 90 minutes	30 minutes
6.	Concentration of alum mordant	5, 10 and 15 per cent	15 per cent
7.	Concentration of myrobolan	20 gms per litre of water	20 gms per litre of water

From the data in table 4.2, it is clear that for 1 gram of wool best result was obtained with 3 and 7 grams of dried Ixora flowers in 100 ml of water respectively, P^H being maintained at 4.5. To prepare the shade card 3 and 7 per cent of shades was selected so as to get a light and a dark shade. It was found that 60 minutes of time was optimum for dye extraction. Extract obtained after 30 and 45 minutes produced lighter shades. It was found that a P^H of 4.5 was found to be ideal for dye extraction. Optimum time for dyeing was found to be 60 minutes as samples dyed for 30 and 45 minutes produced paler shades. Among 30, 45, 60, 75 and 90 minutes of mordanting, 30 minutes was found to be best. It was found that 15 percent of alum concentrations was best suited as it improved the colour.

4.2 EVALUATION OF COLOUR FASTNESS TESTS

The samples dyed with Ixora flower dye extract were subjected to laboratory tests to assess their colour fastness on cotton and wool yarn. The dyed samples were subjected to the following colour fastness tests:

a. Colour fastness to washing

b. Colour fastness to sunlight

c. Colour fastness to rubbing

d. Colour fastness to perspiration

4.2.1 COLOUR FASTNESS TO WASHING

4.2.1.1 COLOUR FASTNESS TO WASHING ON COTTON

Table 4.3: - COLOUR FASTNESS TO WASHING ON COTTON SAMPLES

(Values in mean rating)

S.No	Shade	Colour change	Staining
1.	Unmordanted 3%	4	4.5
2.	Unmordanted 7%	4	4.5
3.	Alum 3%	4	4.5
4.	Alum 7%	4	4.5
5.	Myrobolan 3%	4	4.5
6.	Myrobolan 7%	3	4.5

From the data in table 4.3 and fig 1(A), it can be seen that, cotton samples after washing showed mean rating of 4 which indicates that all the samples except 7 per cent myrobolan mordanted samples showed very good fastness to washing and 7 per cent myrobolan mordanted samples showed good fastness with mean rating of 3. The colour staining on composite specimens of all the test samples was negligible with mean rating of 4.5.

It is clear from the findings that all the samples had good to very good fastness to washing. It can be seen from fig 1(B) that staining on composite specimen was negligible with a mean rating of 4.5. These findings corroborated with the study of

Fig 1A: Colour Change to Washing on Cotton

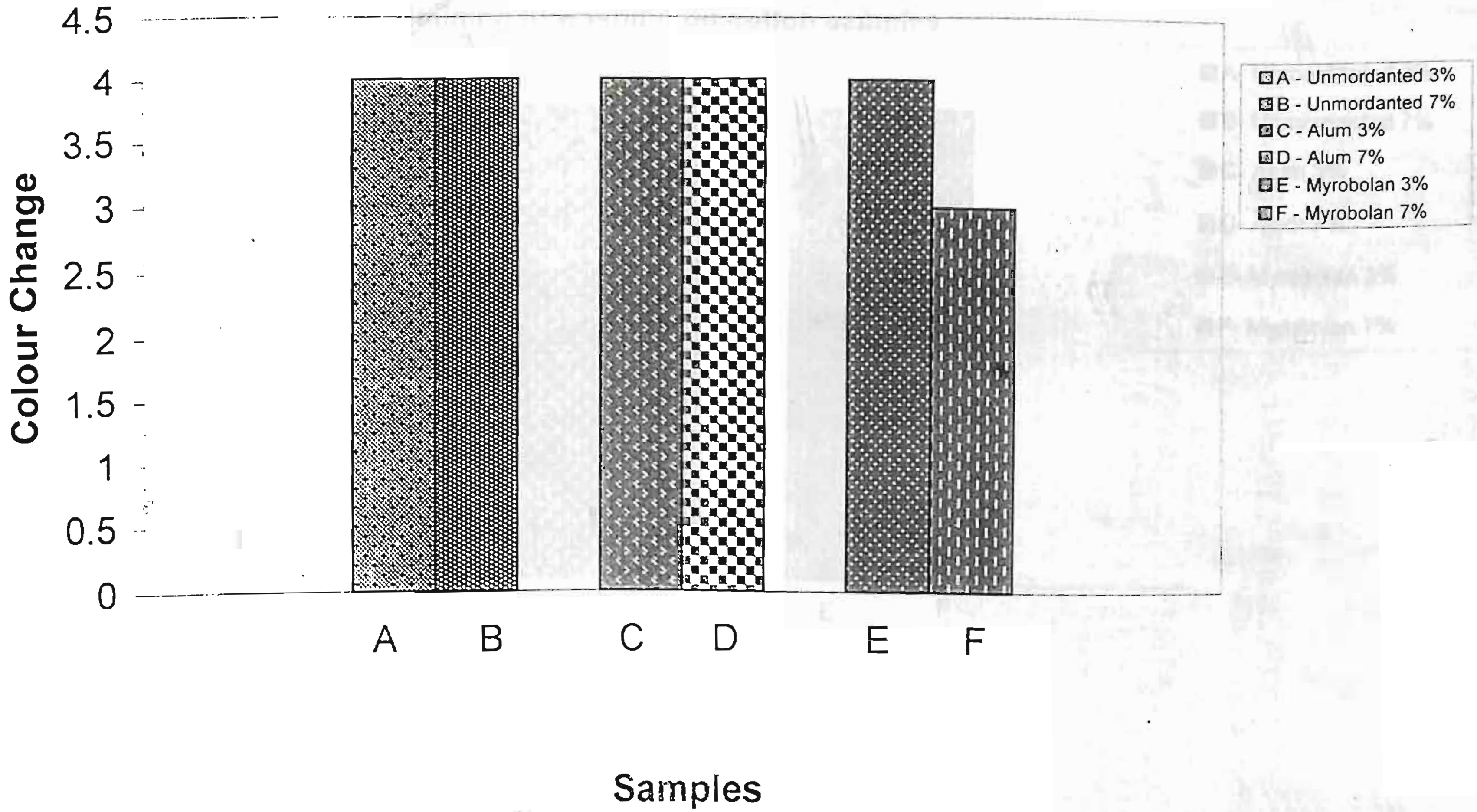
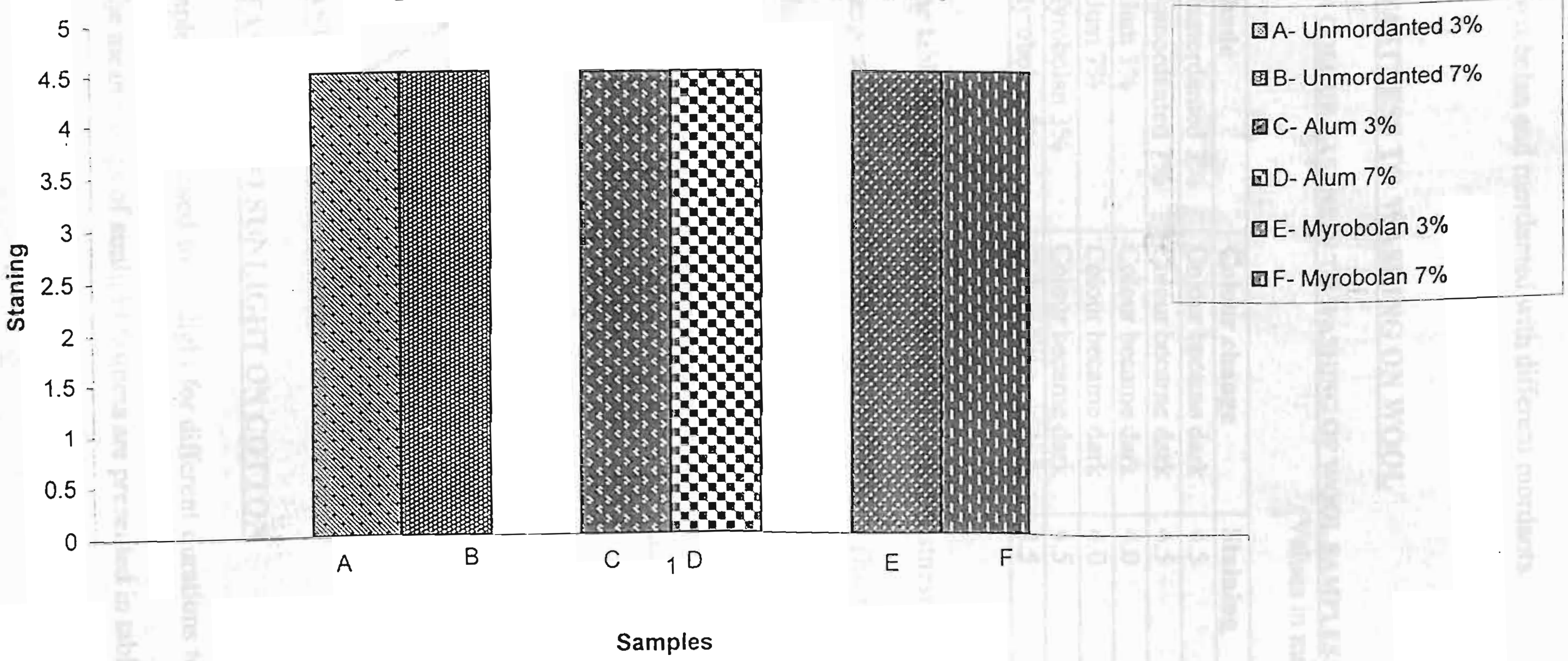


Fig 1B Staining to washing on cotton samples



Prabhu and Senthil Kumar (1998) were wash fastness was found to be good for cotton fabric treated with myrobolan and mordanted with different mordants.

4.2.1.2 COLOUR FASTNESS TO WASHING ON WOOL

Table 4.4 COLOUR FASTNESS TO WASHING OF WOOL SAMPLES

(Values in mean ratings)

S.No	Shade	Colour change	Staining
1.	Unmordanted 3%	Colour became dark	4.5
2.	Unmordanted 7%	Colour became dark	4.5
3.	Alum 3%	Colour became dark	4.0
4.	Alum 7%	Colour became dark	4.0
5.	Myrobolan 3%	Colour became dark	4.5
6.	Myrobolan 7%	Colour became dark	4.5

Data from the table 4.4 present mean ratings of colour fastness to washing with regard to colour change and staining for all the wool samples. The findings from the table reveal that, after washing the colour of all the wool samples became dark with a very slight change in shade. Regarding the staining onto the composite specimens, all the samples except samples mordanted with alum showed a mean rating of 4.5, while alum mordanted samples showed a mean rating of 4.

Thus, from the data in table 4.4 and fig 2 it can be concluded that wool samples showed good to very good fastness to washing.

4.2.2 COLOUR FASTNESS TO SUNLIGHT

4.2.2.1 COLOUR FASTNESS TO SUNLIGHT ON COTTON

The test samples were exposed to sunlight for different durations to analyse the change in colour. The mean ratings of sunlight fastness are presented in table 4.5.

Fig 2 Staining to washing on wool samples

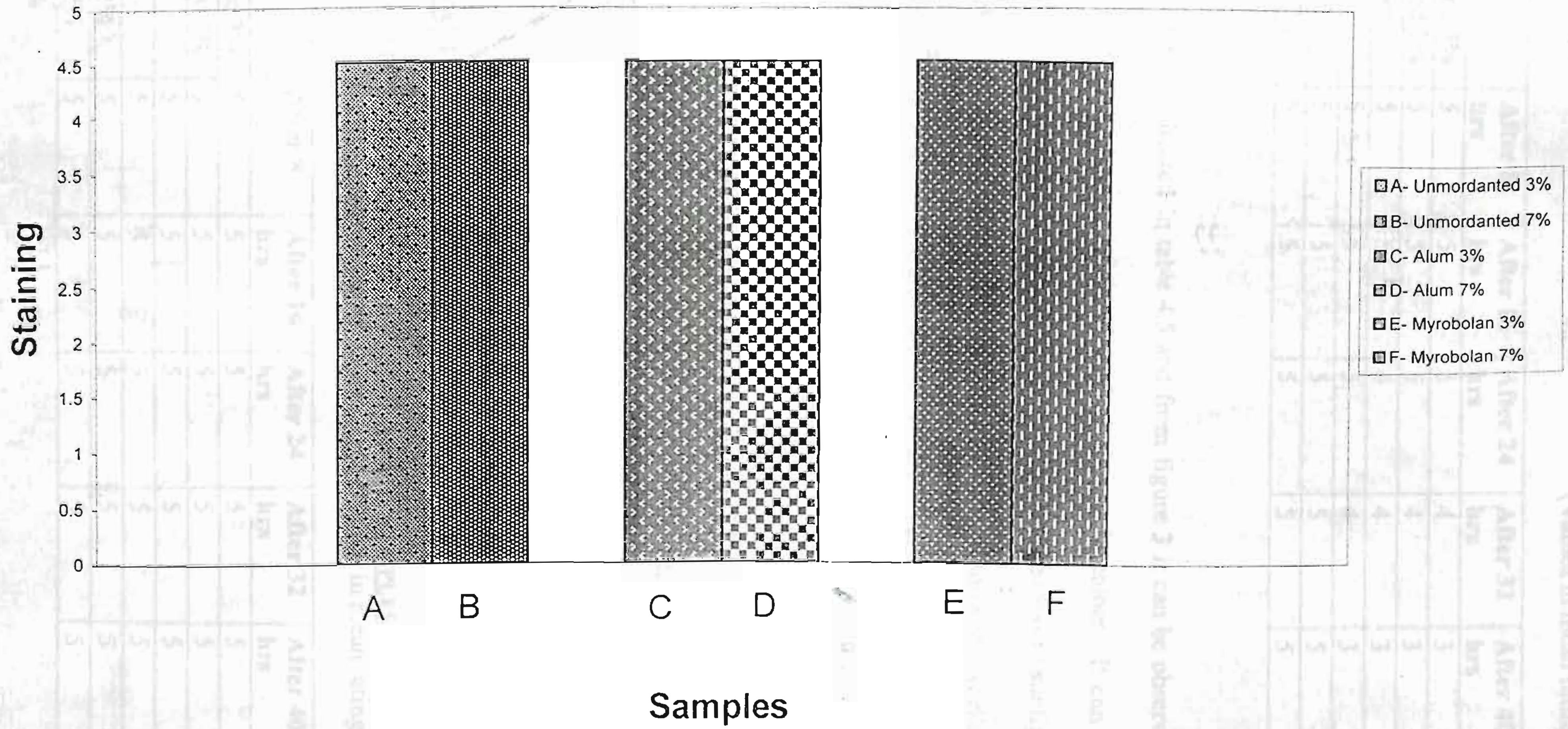


Table 4.5 COLOUR FASTNESS TO SUNLIGHT ON COTTON SAMPLES

(Values in mean rating)

S.No	Shade	After 8 hrs	After 16 hrs	After 24 hrs	After 32 hrs	After 40 hrs
1.	Unmordanted 3%	5	5	5	4	3
2.	Unmordanted 7%	5	5	5	4	3
3.	Alum 3%	5	5	4	4	3
4.	Alum 7%	5	5	5	4	3
5.	Myrobolan 3%	5	5	5	5	5
6.	Myrobolan 7%	5	5	5	5	5

The mean rating as indicated in table 4.5 and from figure 3 it can be observed that samples subjected to sunlight test exhibited gradual change in colour. It can be seen that till 24 hours of exposure, all the samples showed excellent fastness to sunlight with mean rating of 5. The samples mordanted with myrobolan showed excellent fastness to sunlight till 40 hours of exposure. Colour change was observed after 24 hours for unmordanted and alum treated samples with a mean rating of 4 and 3 for 32 hours and 40 hours of exposure respectively.

Thus, it can be concluded that all the samples exposed for 24 hours duration and myrobolan samples exposed for 40 hours duration exhibited excellent fastness, whereas unmordanted and alum mordanted samples showed good to fair fastness after 32 and 40 hours of exposure respectively.

4.2.2.2 COLOUR FASTNESS TO SUNLIGHT ON WOOL

Table 4.6 COLOUR FASTNESS TO SUNLIGHT ON WOOL SAMPLES

(Values in mean ratings)

S.No	Shade	After 8 hrs	After 16 hrs	After 24 hrs	After 32 hrs	After 40 hrs
1.	Unmordanted 3%	5	5	5	5	5
2.	Unmordanted 7%	5	5	5	5	5
3.	Alum 3%	5	5	5	5	5
4.	Alum 7%	5	5	5	5	5
5.	Myrobolan 3%	5	5	5	5	5
6.	Myrobolan 7%	5	5	5	5	5

Fig 3 Colour Fastness to Sunlight on cotton samples

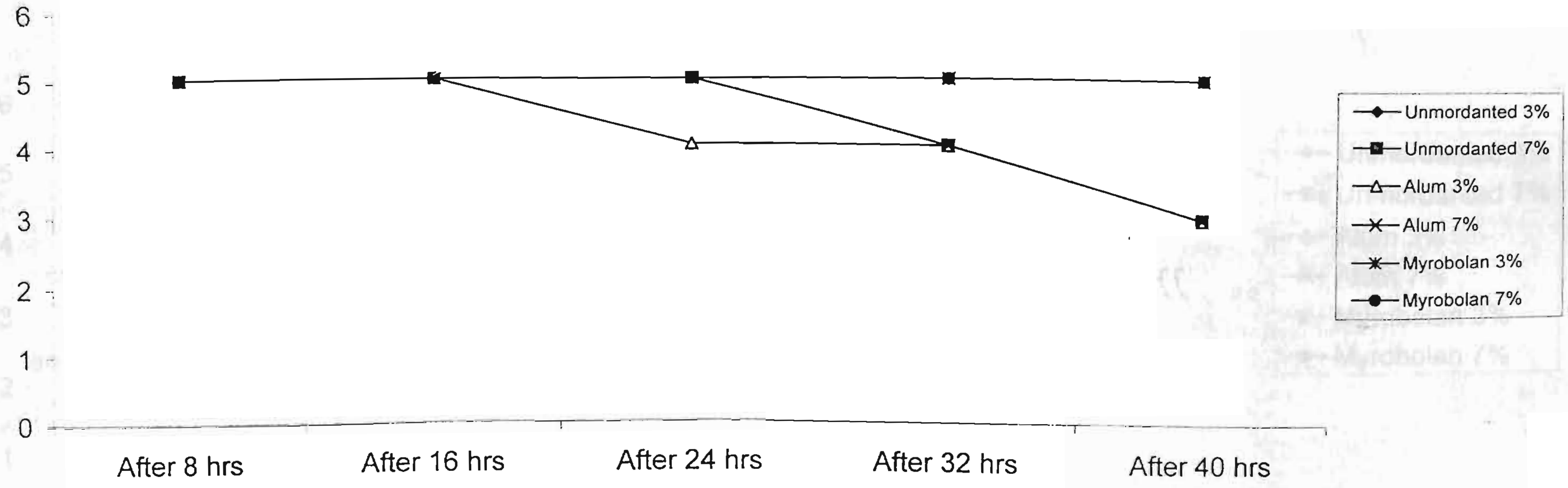
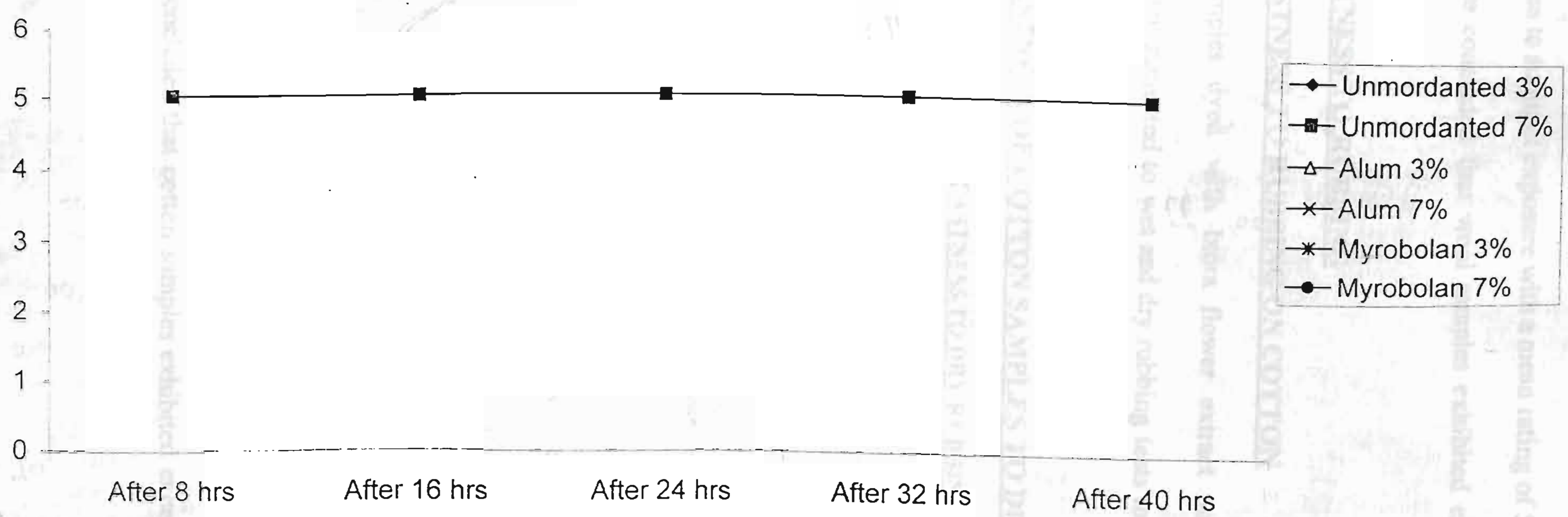


Fig 4 Colour Fastness to Sunlight on wool samples



From the data in table 4.6 and fig 4, it can be concluded that, wool samples had excellent colour fastness to sunlight exposure with a mean rating of 5.

Thus, it can be concluded that wool samples exhibited excellent fastness to sunlight.

4.2.3 COLOUR FASTNESS TO RUBBING

4.2.3.1 COLOUR FASTNESS TO RUBBING ON COTTON

The cotton samples dyed with Ixora flower extract and mordanted with myrobolan and alum were subjected to wet and dry rubbing tests to find out the colour fastness to rubbing.

4.2.3.1.1 COLOUR FASTNESS OF COTTON SAMPLES TO DRY RUBBING

TABLE 4.7 COLOUR FASTNESS TO DRY RUBBING

(Values in mean rating)

S.No	Shade	Colour change	Staining
1.	Unmordanted 3%	5	5
2.	Unmordanted 7%	5	4
3.	Alum 3%	5	4.5
4.	Alum 7%	5	4.5
5.	Myrobolan 3%	5	4
6.	Myrobolan 7%	5	4

From the above table 4.7 and fig 5(A), it can be seen that all the samples exhibited excellent fastness to dry rubbing with a mean rating of 5. Staining had negligible effect on samples mordanted with alum with a mean rating of 4.5. Samples mordanted with myrobolan and unmordanted sample of 7 per cent shade showed very good fastness to dry rubbing, whereas 3 per cent unmordanted sample exhibited excellent fastness to dry rubbing as seen in fig 5(B)

Thus, it can be concluded that cotton samples exhibited excellent to very good fastness to dry rubbing.

Fig 5A Colour change to dry rubbing on cotton

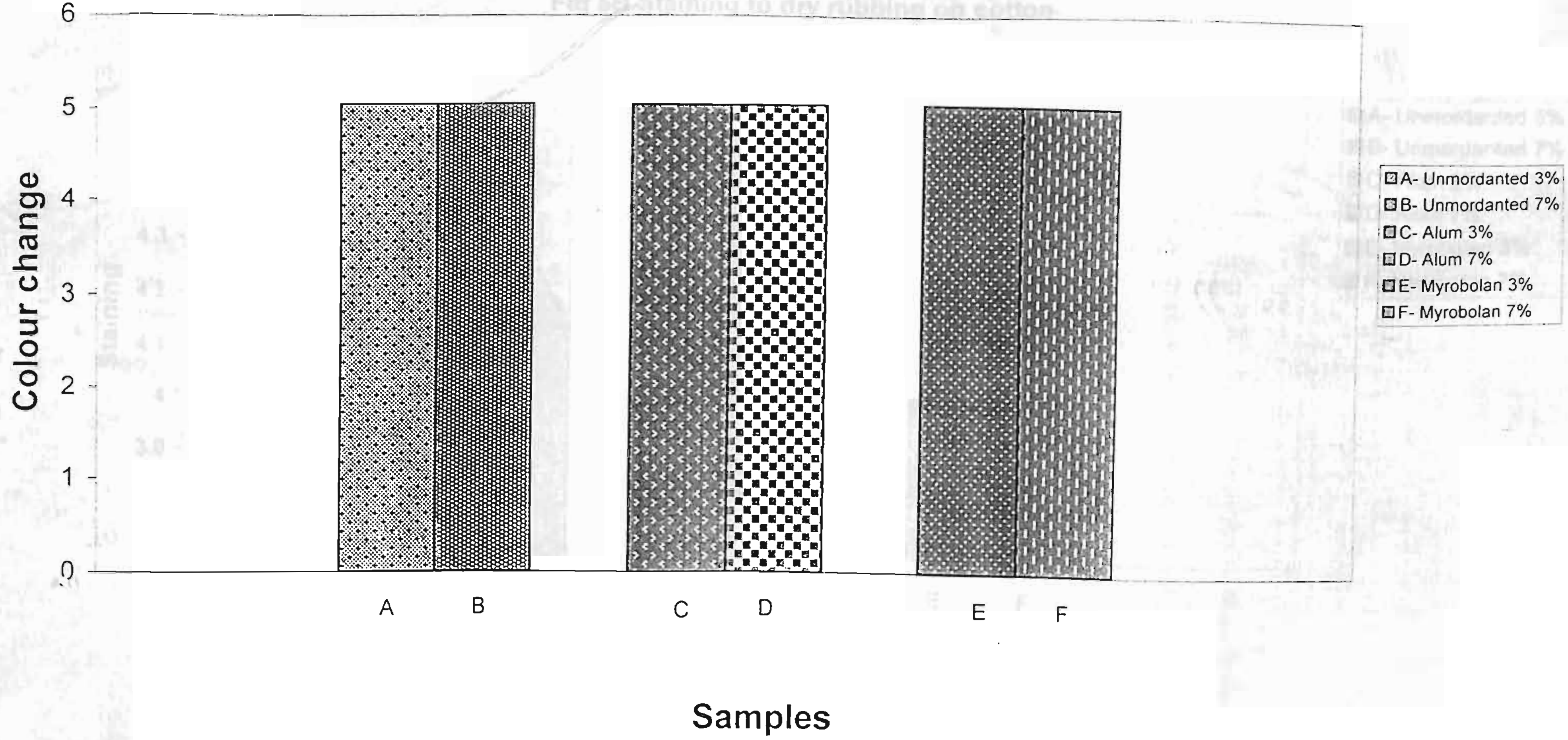


Fig 5B Staining to dry rubbing on cotton

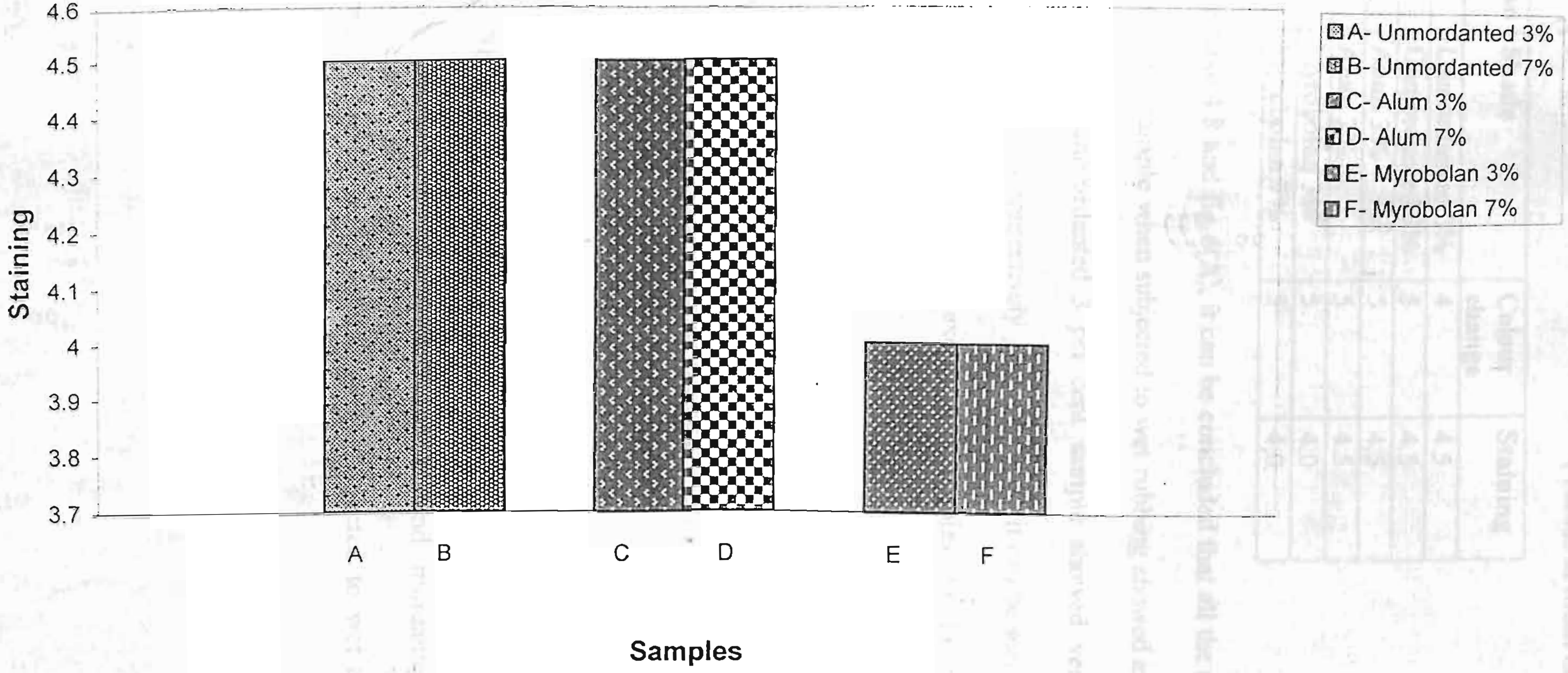


Table 4.8 COLOUR FASTNESS TO WET RUBBING

(Values in mean rating)

S.No	Shade	Colour change	Staining
1.	Unmordanted 3%	4	4.5
2.	Unmordanted 7%	5	4.5
3.	Alum 3%	5	4.5
4.	Alum 7%	5	4.5
5.	Myrobolan 3%	5	4.0
6.	Myrobolan 7%	5	4,0

From the data in table 4.8 and fig 6(A), it can be concluded that all the samples except 3 per cent unmordanted sample when subjected to wet rubbing showed excellent fastness to colour change and unmordanted 3 per cent sample showed very good fastness with a mean rating of 5 and 4 respectively. From fig 6(B), it can be seen that all samples exhibited minimum staining of 4.5 except the samples mordanted with myrobolan, which had a mean rating of 4.

These findings corroborated with that of Katyayini and Jacob (1998) where washed cotton samples treated with myrobolan and mordanted with mordants namely copper sulphate,acetic acid and stannous chloride showed fair to good fastness to rubbing.

4.2.3.2 COLOUR FASTNESS TO RUBBING ON WOOL

The wool samples dyed with Ixora flower extract and mordanted with myrobolan and alum and the unmordanted samples were subjected to wet and dry rubbing tests.

Fig 6A Colour change to wet rubbing on cotton

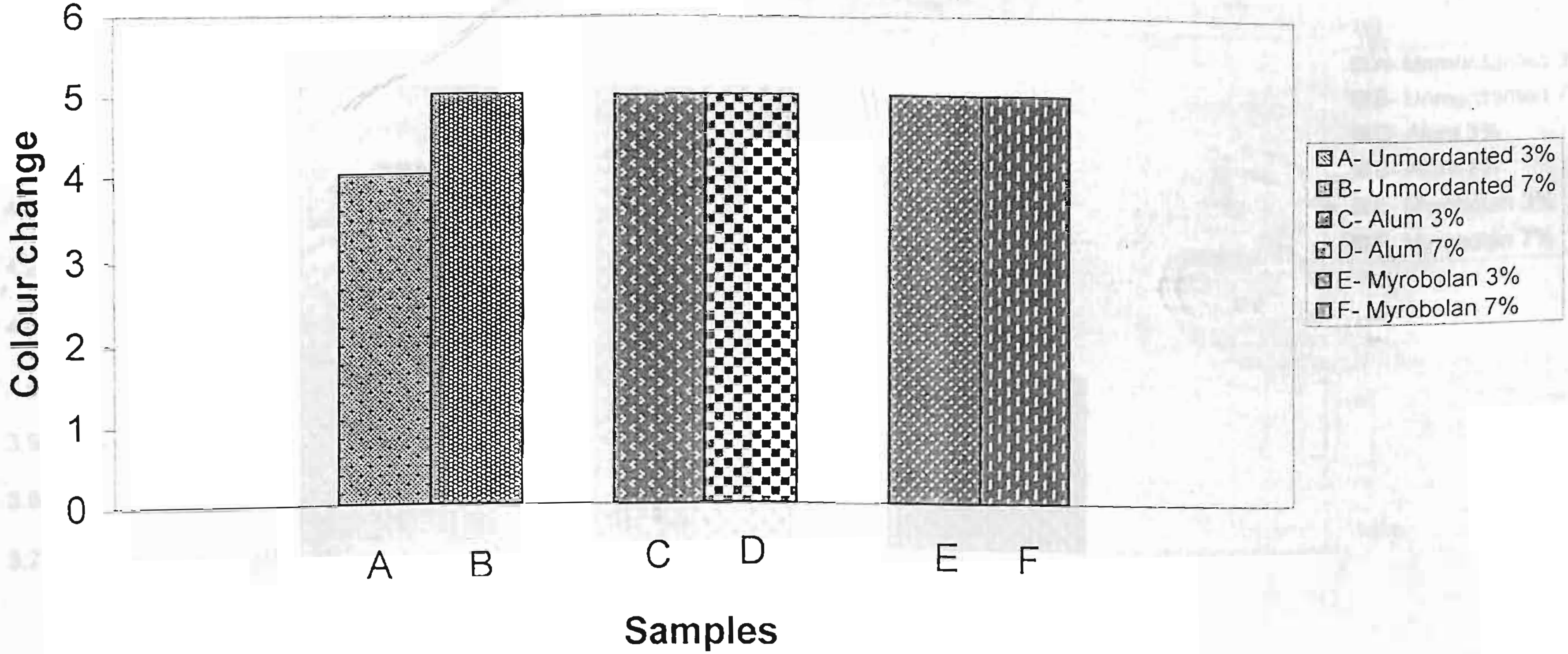
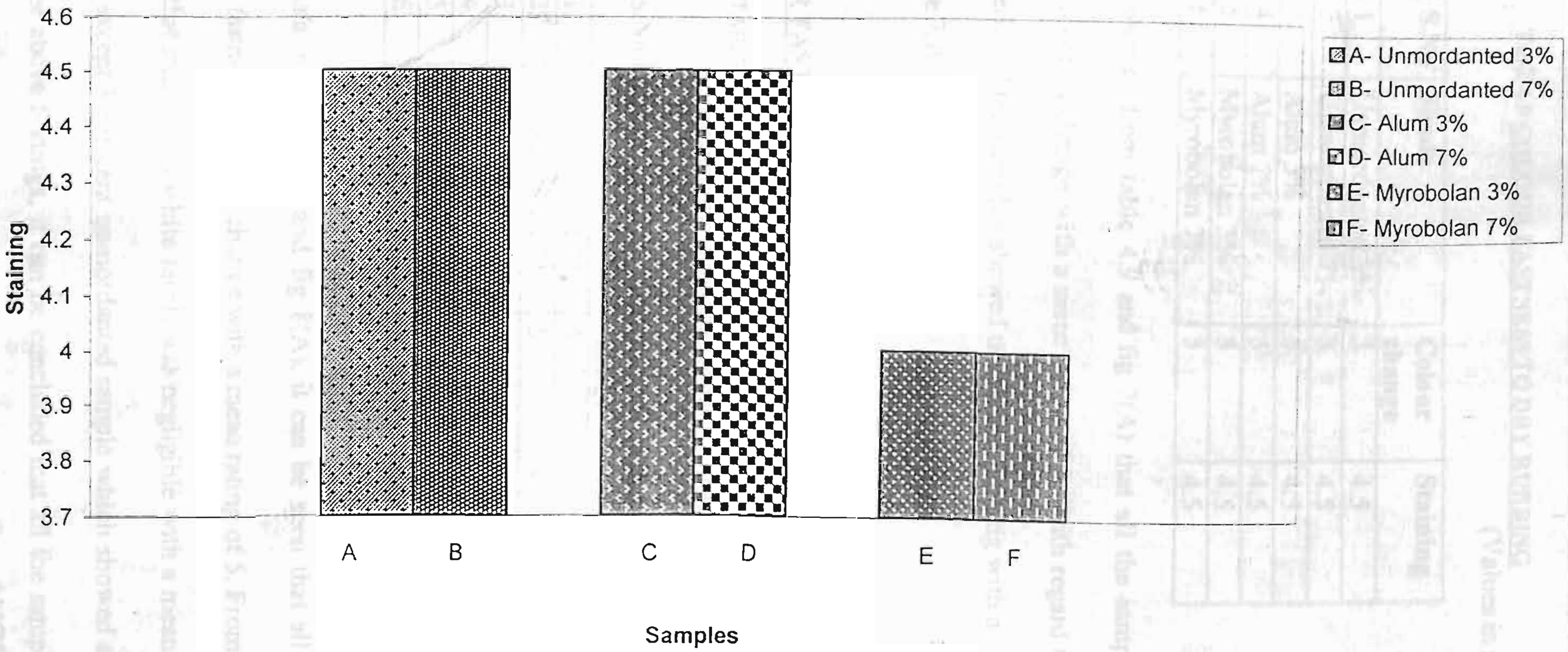


Fig 6B Staining to wet rubbing on cotton



4.2.3.2.1 COLOUR FASTNESS OF WOOL SAMPLES TO DRY RUBBING

Table 4.9 COLOUR FASTNESS TO DRY RUBBING

(Values in mean rating)

S.No	Shade	Colour change	Staining
1.	Unmordanted 3%	5	4.5
2.	Unmordanted 7%	5	4.5
3.	Alum 3%	5	4.5
4.	Alum 7%	5	4.5
5.	Myrobolan 3%	5	4.5
6.	Myrobolan 7%	5	4.5

It can be observed from table 4.9 and fig 7(A) that all the samples exhibited excellent fastness to colour change with a mean rating of 5. With regard to staining on the composite material all the samples showed negligible staining with a mean rating of 4.5 as seen in figure 7(B).

4.2.3.2.2COLOUR FASTNESS OF WOOL SAMPLES TO WET RUBBING

TABLE 4.10 COLOUR FASTNESS TO WET RUBBING

(Values in mean rating)

S.No	Shade	Colour change	Staining
1.	Unmordanted 3%	5	5
2.	Unmordanted 7%	5	4.5
3.	Alum 3%	5	4.5
4.	Alum 7%	5	4.5
5.	Myrobolan 3%	5	4.5
6.	Myrobolan 7%	5	4.5

From the data in table 4.10 and fig 8(A), it can be seen that all the samples exhibited excellent fastness to colour change with a mean rating of 5. From the fig 8(B), it can be observed that staining on white fabric was negligible with a mean rating of 4.5 for all the samples except 3 per cent unmordanted sample which showed a mean rating of 5. Thus, from the above findings, it can be concluded that all the samples exhibited very good to excellent fastness to dry as well as wet rubbing.

Fig 7A Colour change to dry rubbing on wool

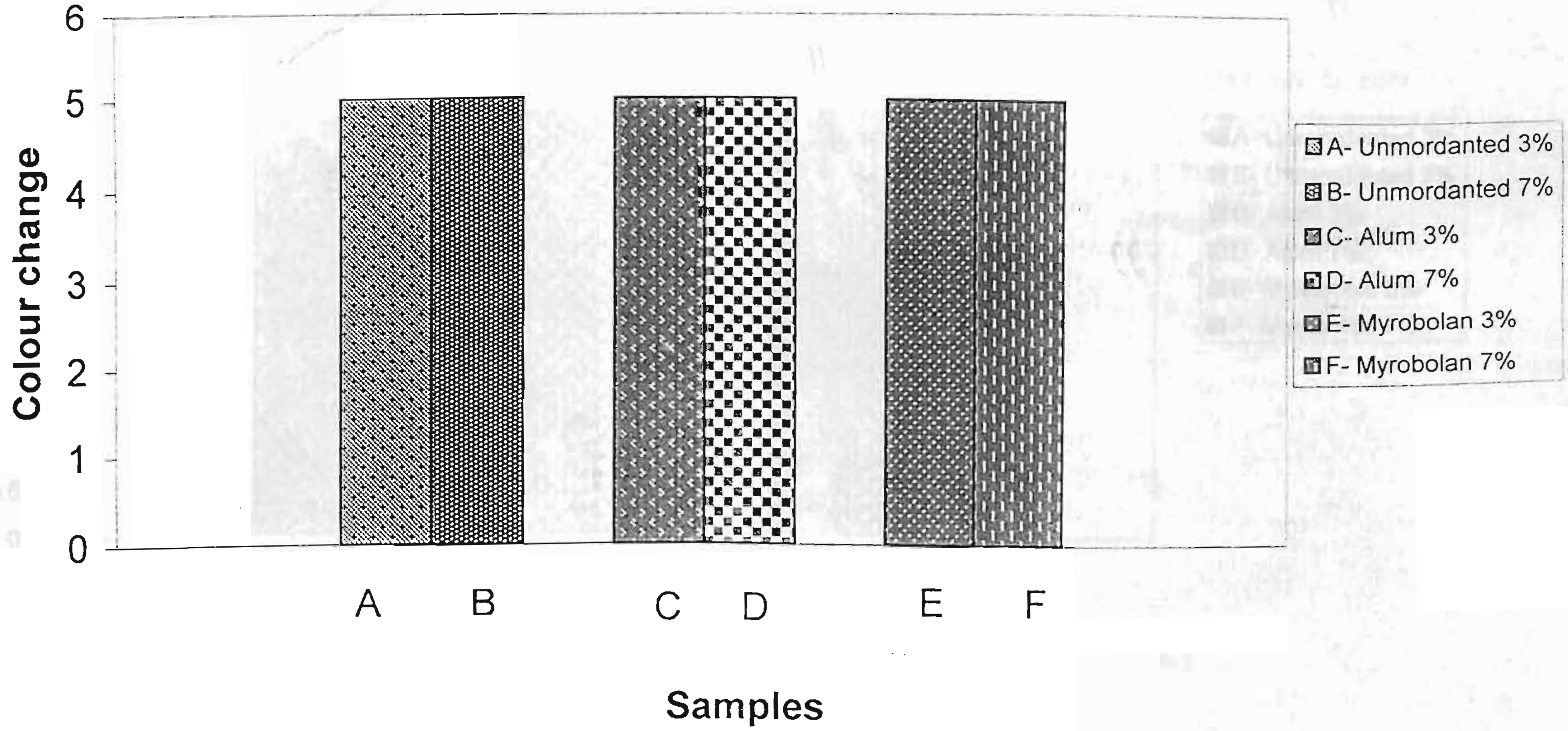


Fig 7B Staining to dry rubbing on wool

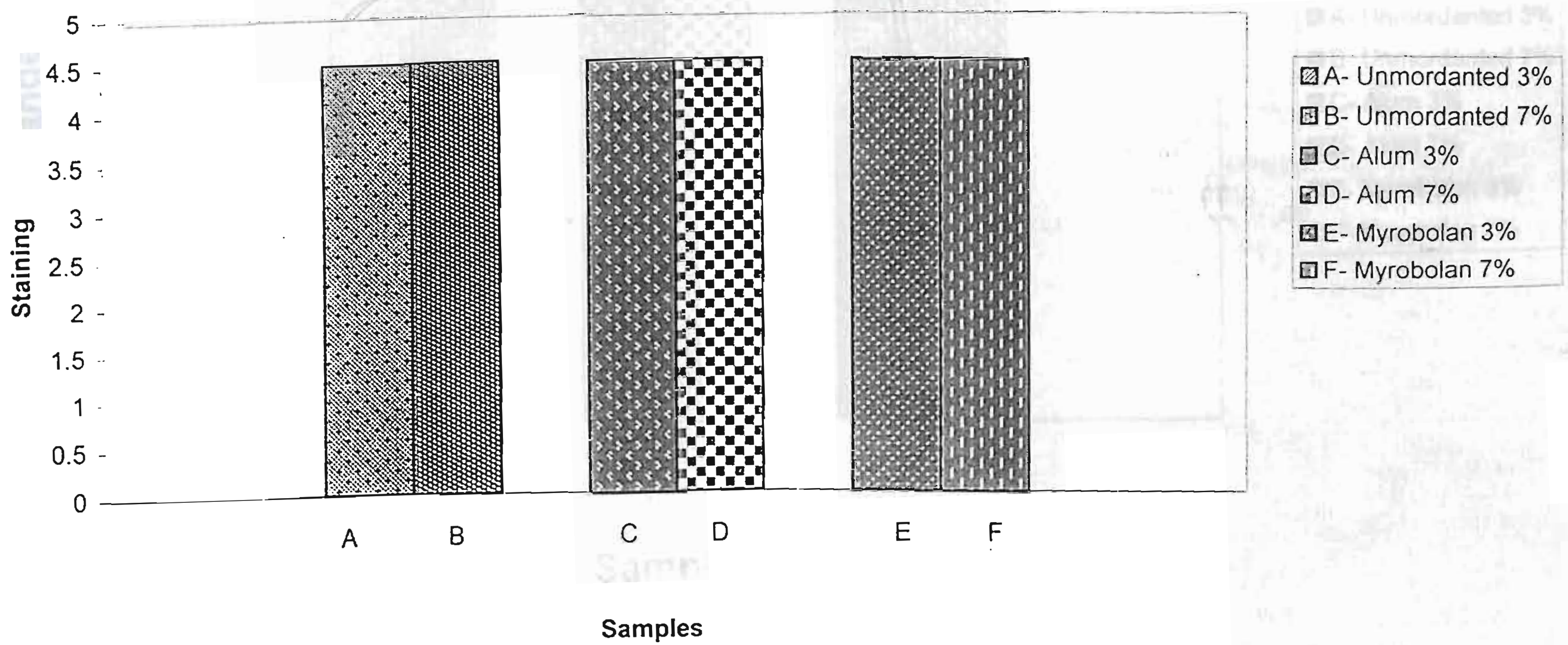


Fig 8A Colour change to wet rubbing on wool

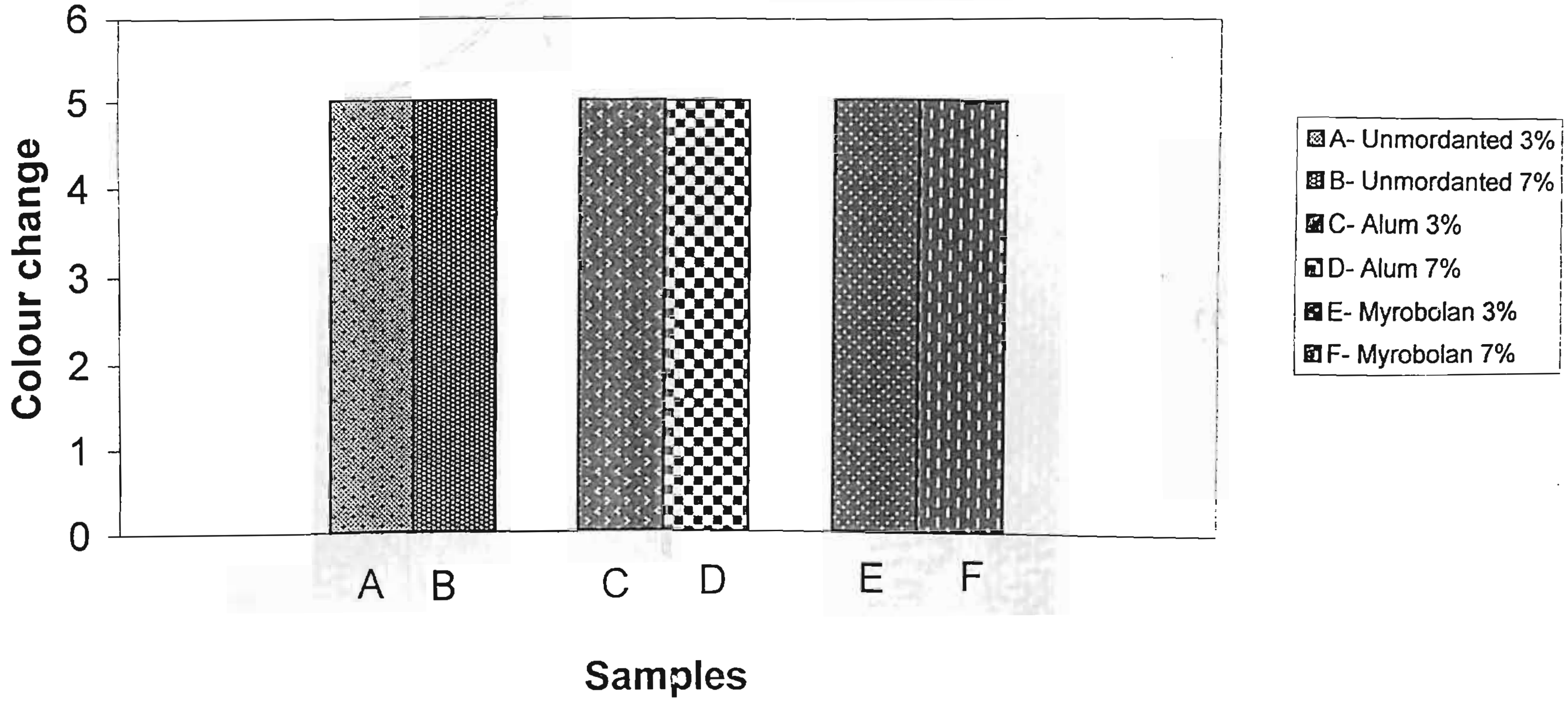
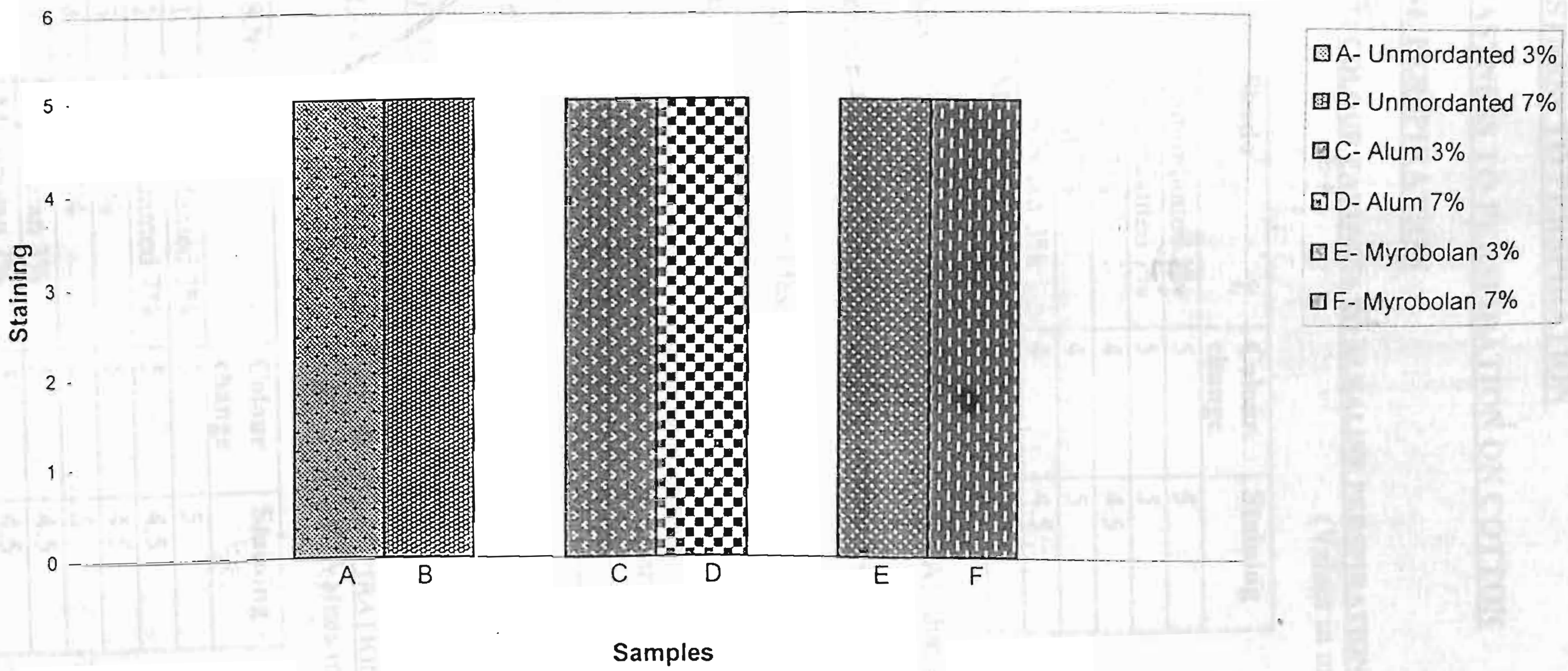


Fig 8B Staining to wet rubbing on wool



4.2.4 COLOUR FASTNESS TO PERSPIRATION

4.2.4.1 COLOUR FASTNESS TO PERSPIRATION ON COTTON

4.2.4.1.1 ALKALINE PERSPIRATION

Table 4.11 COLOUR FASTNESS TO ALKALINE PERSPIRATION

(Values in mean rating)

S.No	Shade	Colour change	Staining
1.	Unmordanted 3%	5	5
2.	Unmordanted 7%	5	5
3.	Alum 3%	4	4.5
4.	Alum 7%	4	5
5.	Myrobolan 3%	4	4.5
6.	Myrobolan 7%	4	4.5

It can be observed from the data in table 4.11 and fig 9(A), that all the samples exhibited excellent colour fastness with a mean rating of 5 except myrobolan and alum treated samples which showed very good fastness with a mean rating of 4.

From fig 9(B), it can be concluded that samples mordanted with myrobolan and 3 per cent alum sample showed very good fastness and the samples mordanted with 7 per cent alum and unmordanted samples exhibited excellent fastness to staining.

4.2.4.1.2 ACIDIC PERSPIRATION

TABLE 4.12 COLOUR FASTNESS TO ACIDIC PERSPIRATION

(Values in mean rating)

S.No	Shade	Colour change	Staining
1.	Unmordanted 3%	5	5
2.	Unmordanted 7%	5	4.5
3.	Alum 3%	5	4.5
4.	Alum 7%	5	5
5.	Myrobolan 3%	5	4.5
6.	Myrobolan 7%	5	4.5

Data from the table 4.12 and fig 10(A) it can be seen that all the samples exhibited excellent fastness to colour change with a mean rating of 5. It can be observed

Fig 9A Colour change to alkaline perspiration

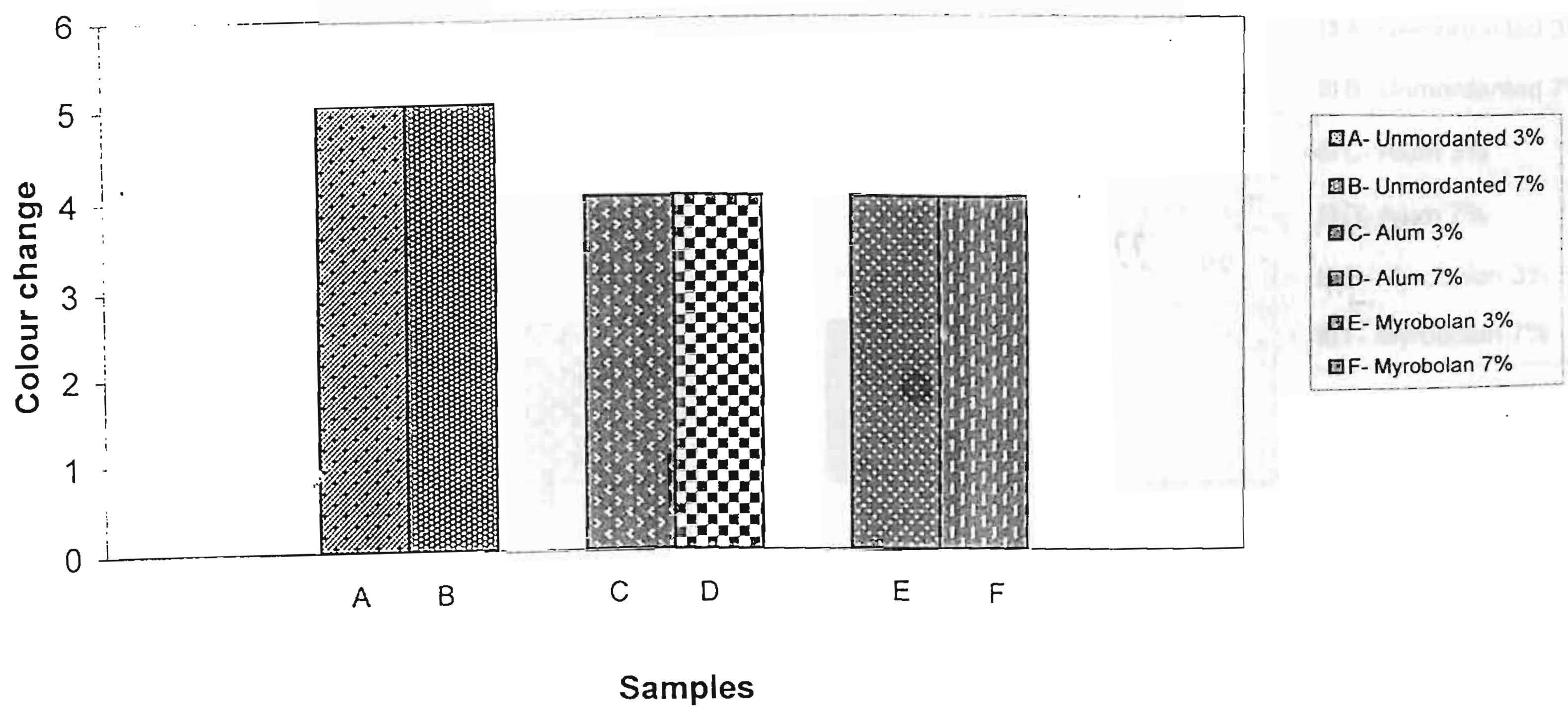


Fig 9B Staining to alkaline perspiration on cotton

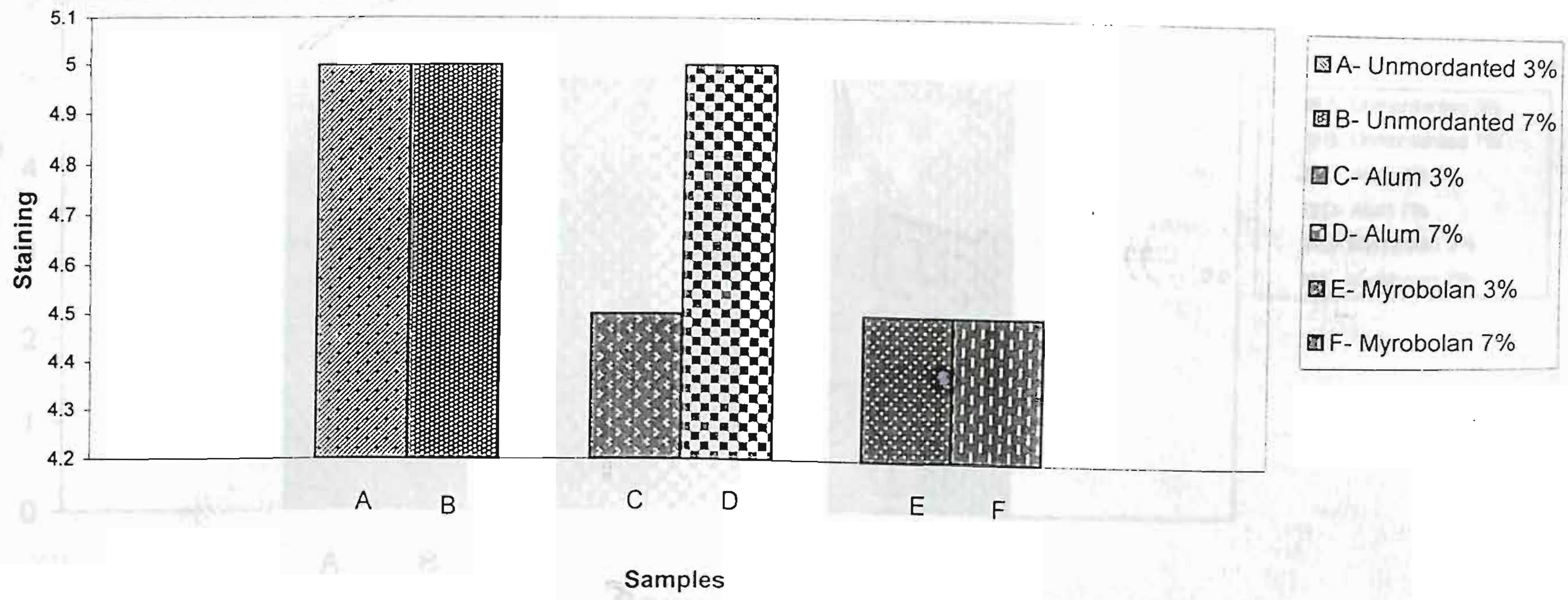


Fig 10A Colour change to acidic perspiration on cotton

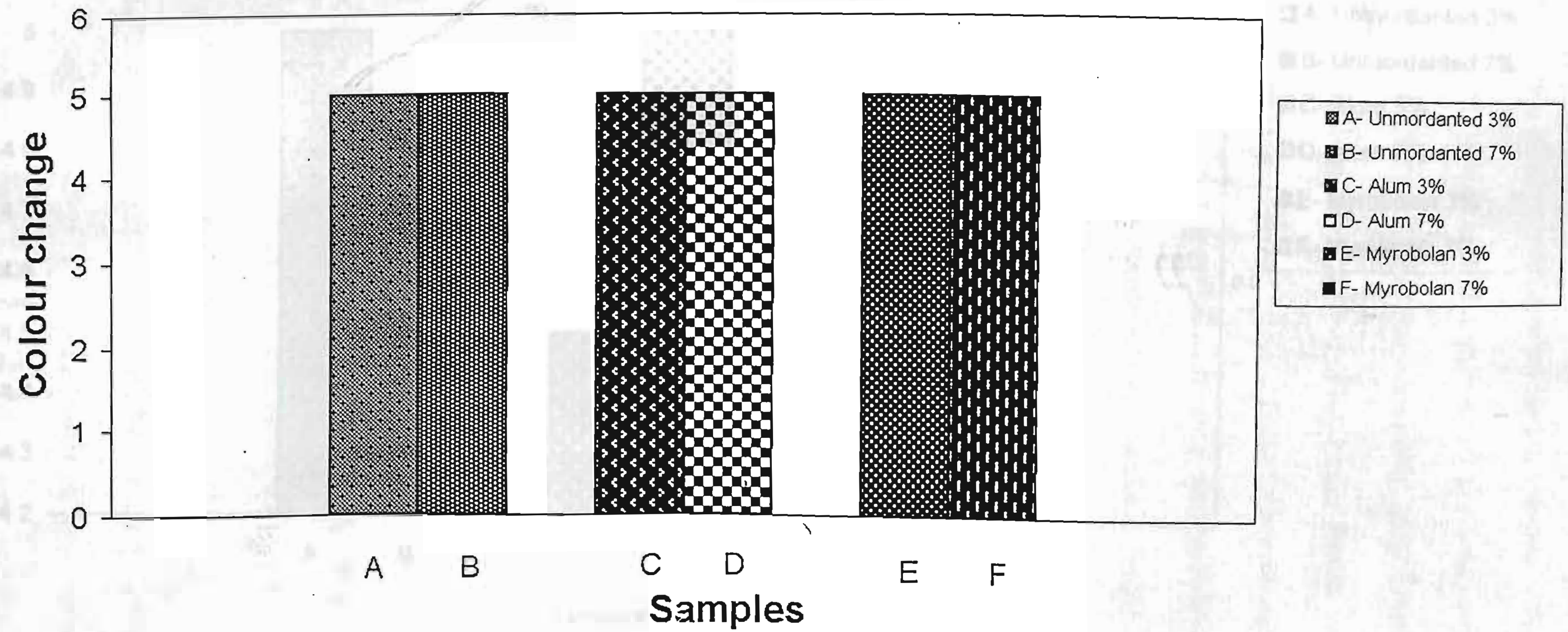
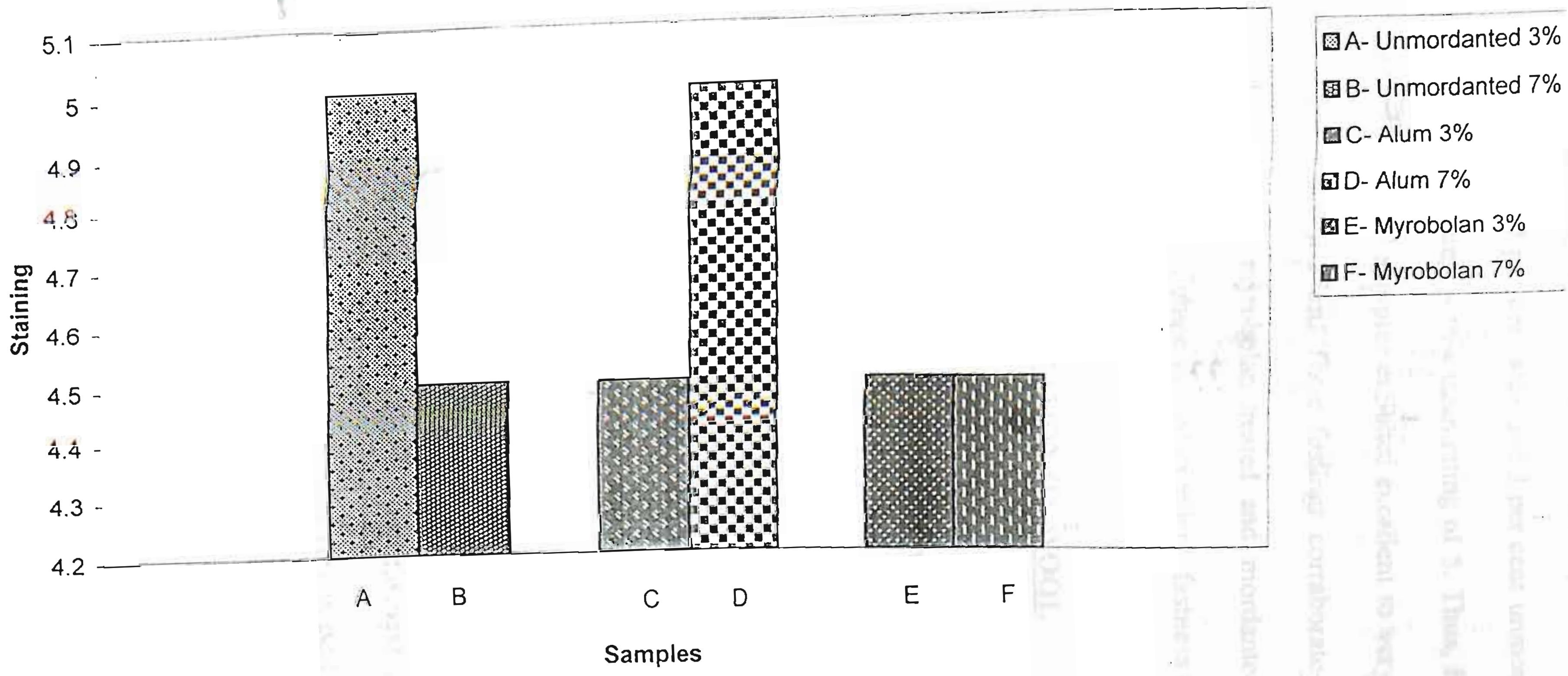


Fig 10B Staining to acidic perspiration on cotton



from fig 10(B) that 7 per cent unmordanted and samples mordanted with myrobolan and 3 per cent alum showed very good to excellent fastness to staining with a mean rating of 4.5. The samples mordanted with 7 per cent alum and 3 per cent unmordated samples exhibited excellent fastness to staining with a mean rating of 5. Thus, from the above findings it can be concluded that all samples exhibited excellent to very good fastness for both acidic and alkaline perspiration. These findings corraborate with those of Radhika and Jacob (1999) where myrobolan treated and mordanted with copper sulphate, ferrous sulphate, cobaltous sulphate showed excellent fastness to perspiration.

4.2.4.2 COLOUR FASTNESS TO PERSPIRATION ON WOOL

4.2.4.2.1 ALKALINE PERSPIRATION

TABLE 4.13 COLOUR FASTNESS TO ALKALINE PERSPIRATION

(Values in mean rating)

S.No	Shade	Colour change	Staining
1.	Unmordanted 3%	5	4.5
2.	Unmordanted 7%	5	4.5
3.	Alum 3%	5	4.5
4.	Alum 7%	5	4.5
5.	Myrobolan 3%	5	4.5
6.	Myrobolan 7%	5	4.5

From the above table 4.13 and fig 11(A), it can be seen that all the samples except 7 per cent alum mordanted sample showed excellent fastness to colour change whereas sample mordanted with 7 per cent alum exhibited very good fastness to colour change with a mean rating of 5 and 4 respectively.

From fig 11(B), it can be observed that all the samples exhibited excellent to very good fastness to staining on to the composite specimen with a mean rating of 4.5. These results corroborate with those of Dedhia (1998) where wool samples dyed with red sandalwood and mordanted with alum showed good to excellent fastness to alkaline perspiration.

Fig 11A Colour change to alkaline perspiration on wool

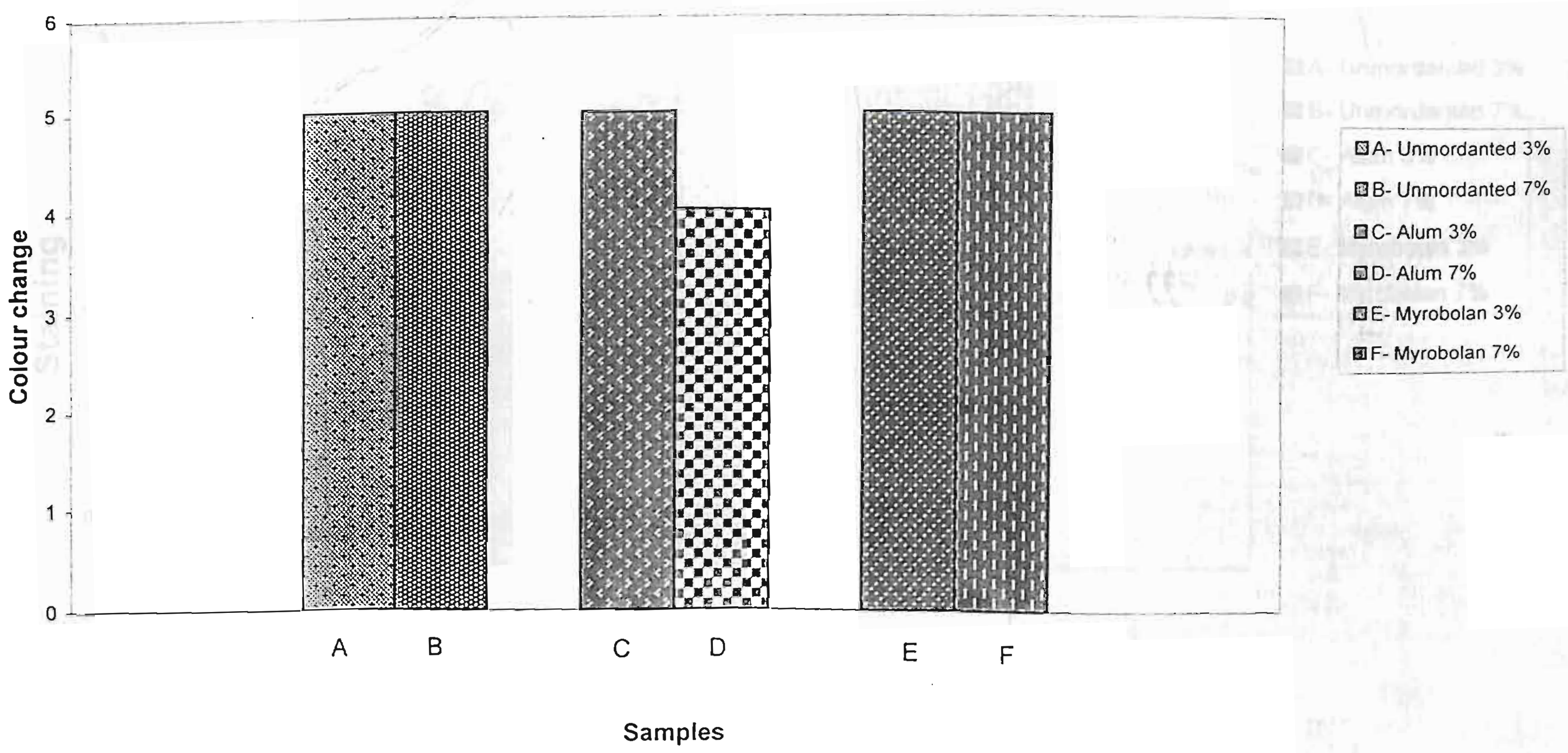
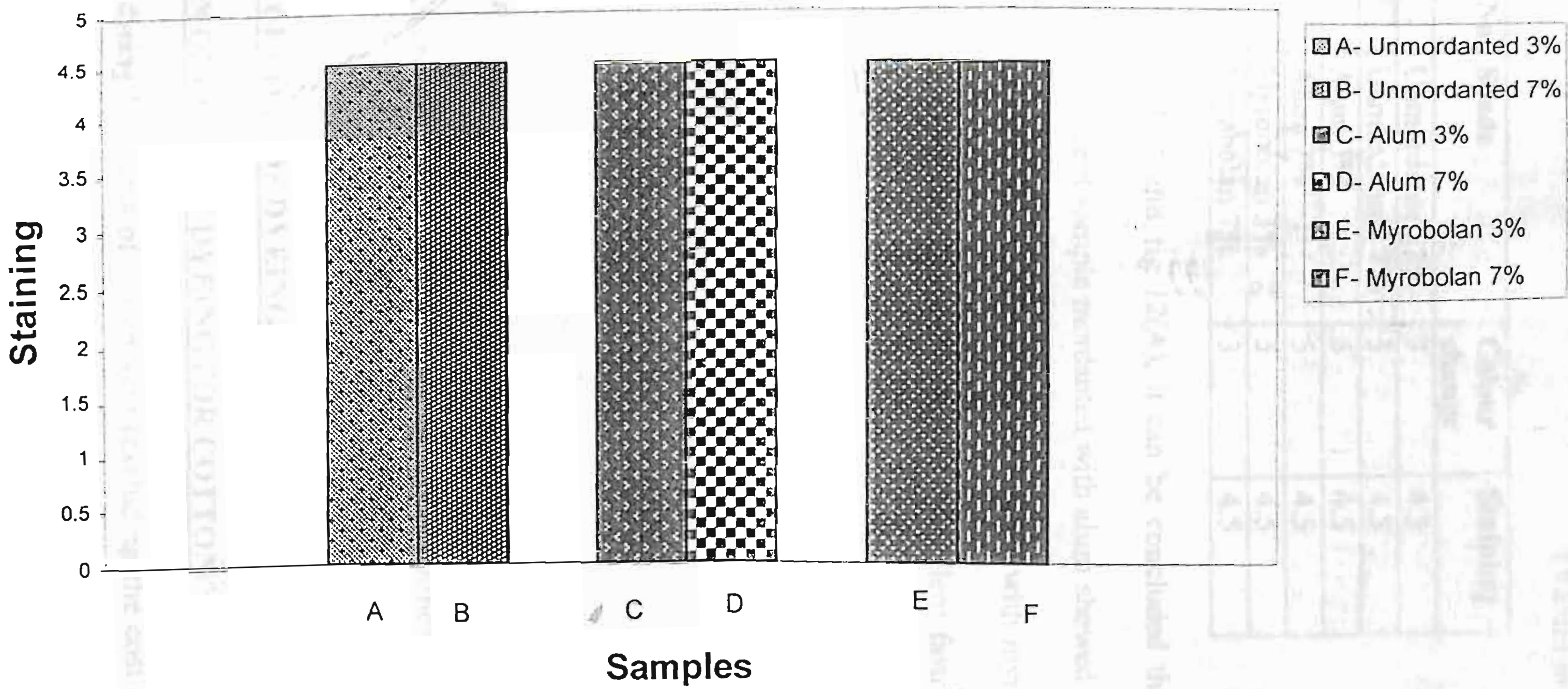


Fig 11B Staining to alkaline perspiration on wool



4.2.4.2.2 ACIDIC PERSPIRATON

TABLE 4.14 COLOUR FASTNESS TO ACIDIC PERSPIRATION

(Values in mean rating)

S.No	Shade	Colour change	Staining
1.	Unmordanted 3%	3	4.5
2.	Unmordanted 7%	5	4.5
3.	Alum 3%	5	4.5
4.	Alum 7%	5	4.5
5.	Myrobolan 3%	5	4.5
6.	Myrobolan 7%	3	4.5

Data from the table 4.14 and fig 12(A), it can be concluded that 3 per cent unmordanted sample and 7 per cent sample mordanted with alum showed good fastness to colour change with a mean rating of 3. Samples mordanted with myrobolan, 3 per cent alum and 7 per cent unmordanted samples exhibited excellent fastness to colour change with a mean rating of 5.

From fig 12(B), it can be seen that, all samples exhibited excellent to very good fastness to staining on to the composite specimen with a mean rating of 4.5. Thus, from the above findings it can be concluded that all samples exhibited excellent to very good fastness to both acidic and alkaline perspiration. These findings corroborate with those of Radhika and Jacob (1999) where myrobolan treated and mordanted with copper sulphate, ferrous sulphate, cobaltous sulphate showed excellent fastness to perspiration.

4.3 ESTIMATION OF COST OF DYEING

4.3.1 ESTIMATION OF COST OF DYEING FOR COTTON

The cost of dyeing 10 grams of cotton yarn (excluding the cost of yarn) using different mordants is presented in table 4.15.

Fig 12A Colour change to acidic perspiration on wool

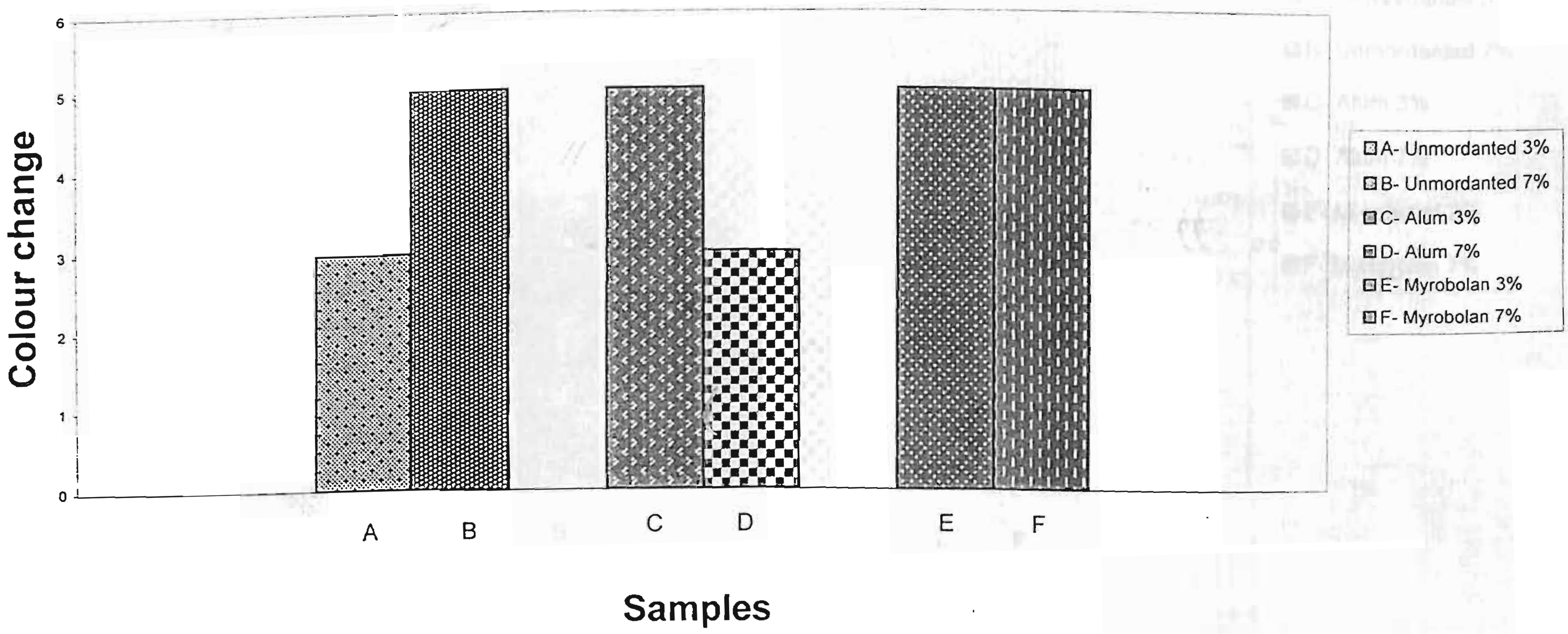


Fig 12B Staining to acidic perspiration on wool

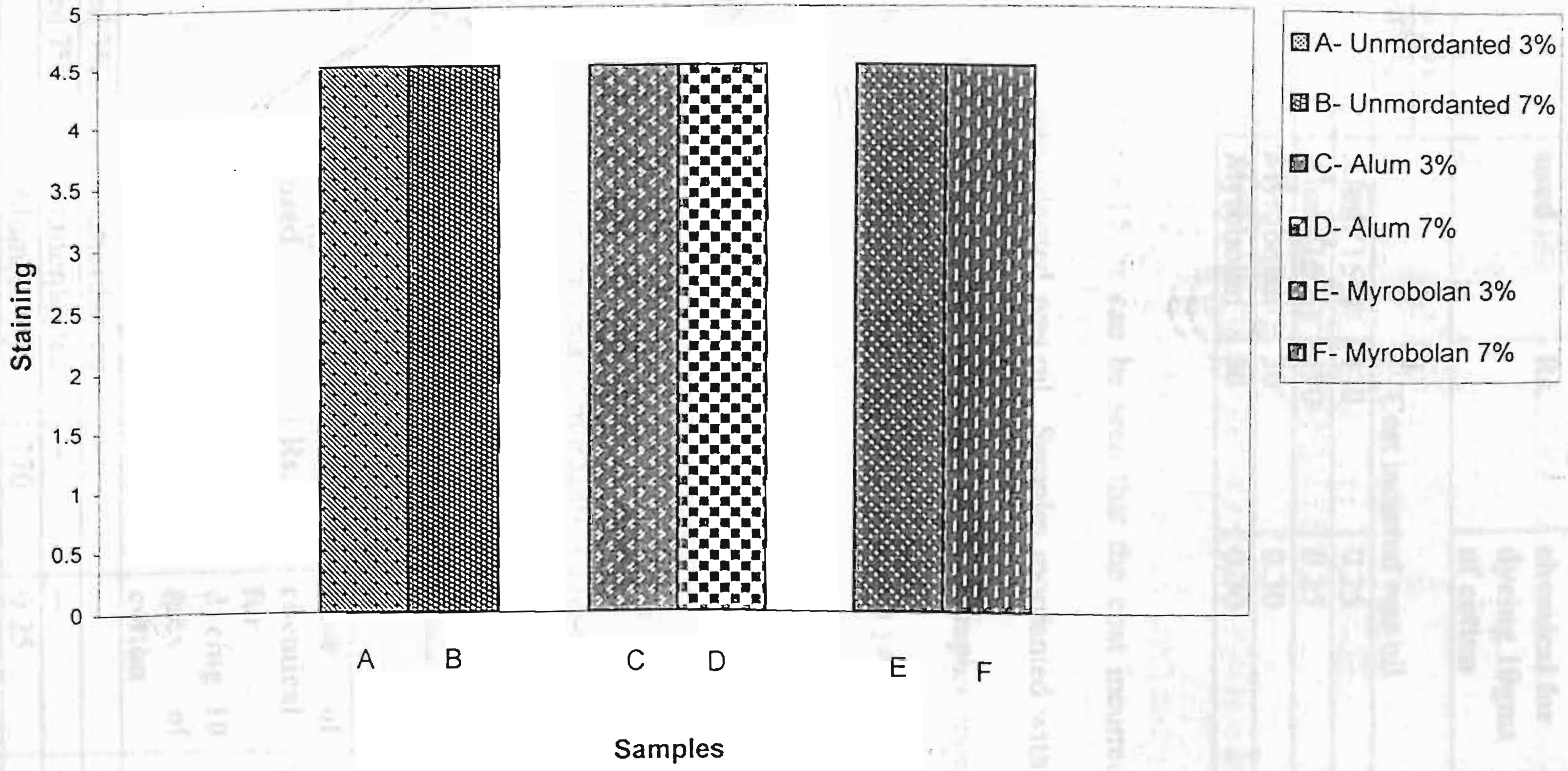


TABLE 4.15 COST ESTIMATION OF DYEING COTTON

S.No	Shade	Chemicals used	Cost/Kg Rs.	Cost of chemical for dyeing 10gms of cotton	Total cost in Rs.
1.	Unmordanted 3%	Cost incurred was nil			
2.	Unmordanted 7%				
3.	Alum 3%	Alum(15%)	170	0.25	0.25
4.	Alum 7%	Alum(15%)	170	0.25	0.25
5.	Myrobolan 3%	Myrobolan	30	0.30	0.30
6.	Myrobolan 7%	Myrobolan	30	0.30	0.30

From the data in table 4.15, it can be seen that the cost incurred for dyeing cotton samples which are unmordanted was nil. Samples mordanted with 15 per cent alum amounted to Rs.0.25 per 10 grams of cotton yarn. Samples mordanted with myrobolan incurred higher cost of Rs.0.30 per 10 grams of cotton yarn.

4.3.2 ESTIMATION OF COST OF DYEING FOR WOOL

The cost of dyeing 10 grams of wool yarn (excluding the cost of yarn) in different shades using different concentrations of mordants is presented in table 4.16.

Table 4.16 COST ESTIMATION OF DYEING WOOL

S.No	Shade	Chemicals used	Cost/Kg Rs.	Cost of chemical for dyeing 10 gms of cotton	Total cost in Rs.
1.	Unmordanted 3%	Unmordanted	--	--	--
2.	Unmordanted 7%	Unmordanted	--	--	--
3.	Alum 3%	Alum(15%)	170	0.25	0.25
4.	Alum 7%	Alum(15%)	170	0.25	0.25
5.	Myrobolan 3%	Myrobolan	30	0.30	0.30
6.	Myrobolan 7%	Myrobolan	30	0.30	0.30

It can be seen from the data in table 4.16, that the cost for dyeing unmordanted samples was nil as no chemicals were used, whereas samples mordanted with alum incurred Rs.0.25 per 10 grams of yarn. Samples mordanted with myrobolan incurred cost of RS. 0.30 per 10 grams of yarn.

4.4 EVALUATION OF CONSUMER ACCEPTABILITY

To assess the consumer acceptability, subjective evaluation was conducted. The subjective evaluation was done by judges drawn from the staff and postgraduate students of College of Home Science, Hyderabad. The rankings given by the judges were taken as frequencies, which were converted into percentages.

4.4.1 SUITABILITY OF IXORA FLOWERS AS DYE

TABLE 4.17 SUITABILITY OF DYE

(Values in mean rating)
N=20

Suitability of dye	Cotton	Wool
Suitable	17(85)	15(75)
Fairly suitable	3(15)	5(25)
Not suitable	--	--

(Figures in Parenthesis indicate percentages)

From table 4.17 and fig 13(A) and fig 13(B), it can be seen that 85 per cent and 75 per cent of the respondents found that the dye was suitable for dyeing cotton and wool respectively.15 per cent and 25 per cent of the respondent found that the dye was fairly suitable for dyeing cotton and wool. Most of the respondents are aware of the importance of natural dyes, its impact on environment and its eco-friendly nature. As natural dyes are the trend of the present scenario, most of the respondents opined that the dye was suitable and fairly suitable.

Fig 13A Suitability of dye for cotton

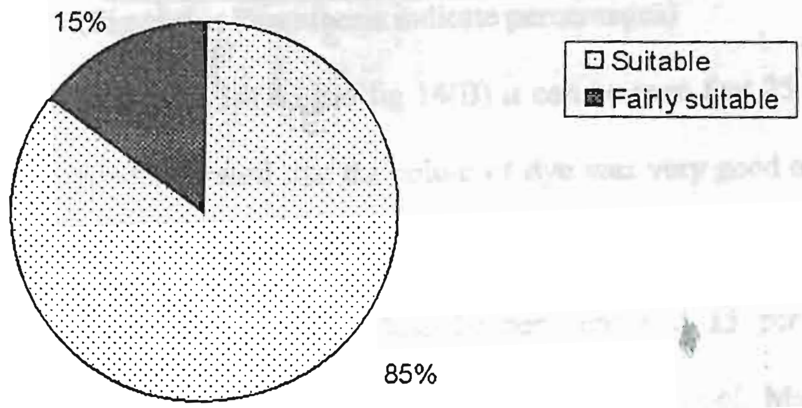
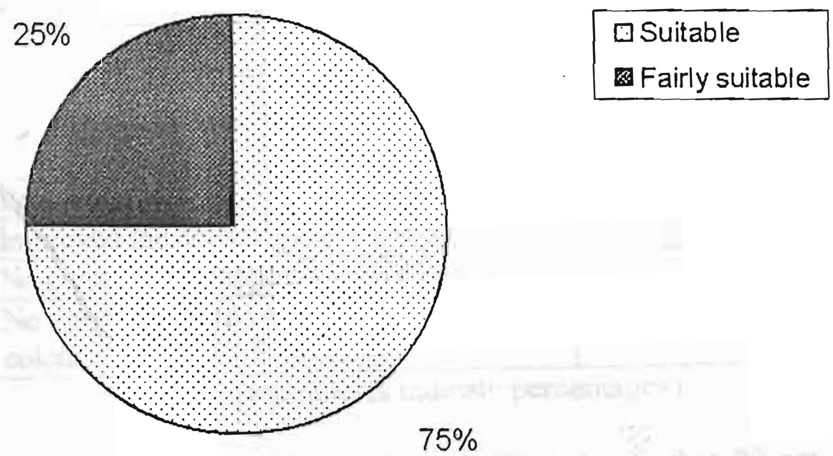


Fig 13B Suitability of dye for wool



4.4.2 COLOUR OF THE DYE

Table 4.18 COLOUR OF THE DYE

(Values in mean rating)
N=20

Colour	Cotton	Wool
Very good	5(25)	3(15)
Good	13(65)	14(70)
Fair	2(10)	3(15)
Poor	--	--

(Figures in Parenthesis indicate percentages)

From table 4.18 and fig 14(A) and fig 14(B) it can be seen that 25 per cent and 15 per cent of the respondents rated that the colour of dye was very good on cotton and wool respectively. 65 per cent and 70 per cent of the respondents felt that the colour was good for cotton and wool respectively while 10 per cent and 15 per cent of the respondents expressed that the colour was fair for cotton and wool. Majority of the respondents opined that the colour was good. As colour is a visual sensation and is mainly responsible for the acceptance or rejection of any material.

4.4.3 PRETREATMENT WITH ALUM

TABLE 4.19 PRETREATMENT WITH ALUM

(Values in mean rating)
N=20

Pretratment	Cotton	Wool
Improved the colour	16(80)	16(80)
No considerable change	4(20)	4(20)
No improvement of the colour	--	--

(Figures in praenthesis indicate percentages)

Data in table 4.19 and fig 15(A)and fig 15(B) indicate that 80 per cent of the respondents opined that the pretreatment with alum has improved the colour for both cotton and wool, while 20 per cent of the respondents expressed that pretreatment with alum had no considerable change on both cotton and wool. As mordanting is done to get a variation in shade and to improve the colour fastness properties, most of the respondents found that pretreatment with alum has improved the colour.

Fig 14A Colour of the dye for cotton

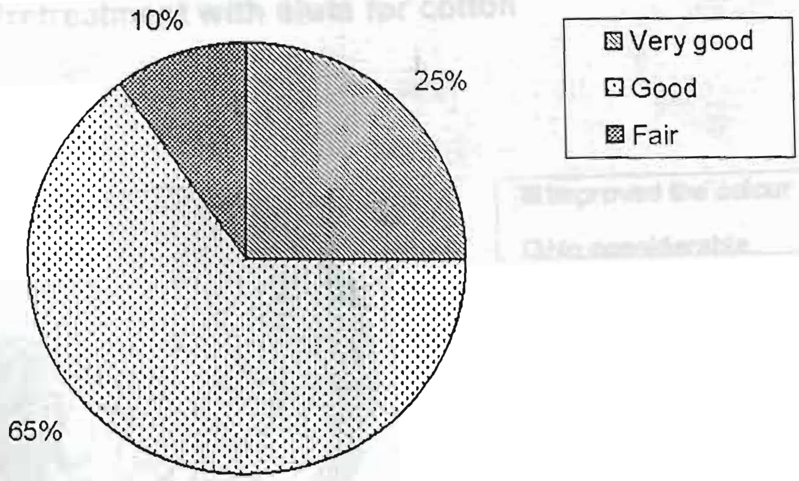


Fig 14B Colour of the dye for wool

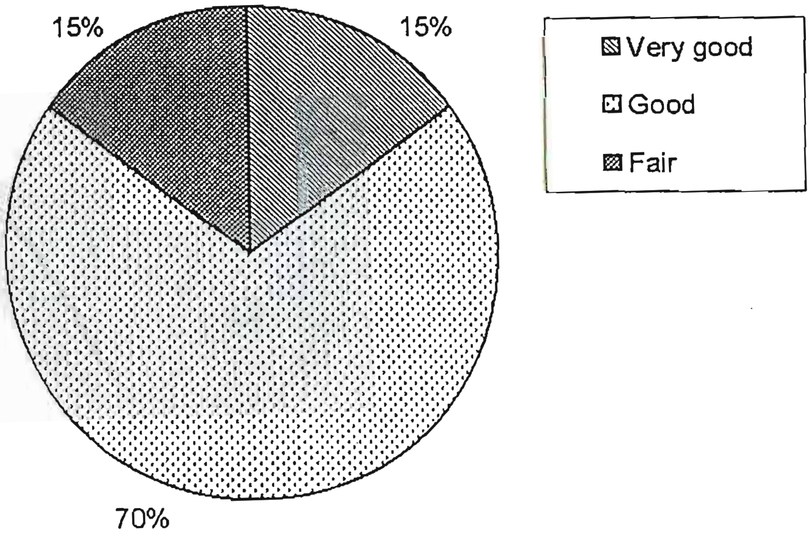


Fig 15A Pretreatment with alum for cotton

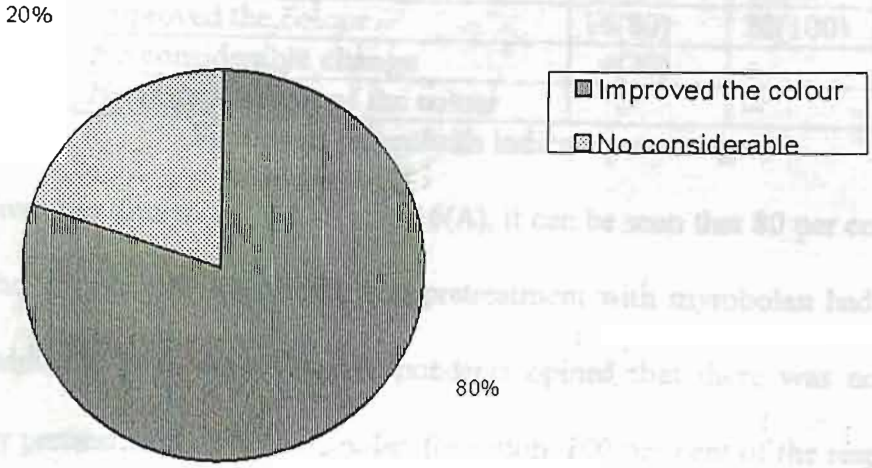
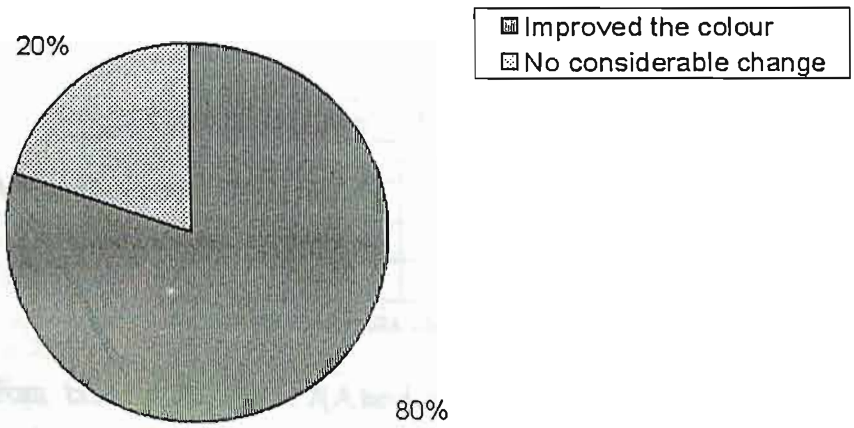


Fig 15B Pretreatment with alum for wool



4.4.4 PRETREATMENT WITH MYROBOLAN

TABLE 4.20 PRETREATMENT WITH MYROBOLAN

(Values in mean rating)
N=20

Pretratment with myrobolan	Cotton	Wool
Improved the colour	16(80)	20(100)
No considerable change	4(20)	--
No improvement of the colour	--	--

(Figures in parenthesis indicate percentages)

From the data in table 4.20, fig 16(A), it can be seen that 80 per cent and 100 per cent of the respondents expressed that pretreatment with myrobolan had improved the colour, while 20 per cent of the respondents opined that there was no considerable change by pretreatment with myrobolan for cotton. 100 per cent of the respondents rated that pretreatment with myrobolan improved the colour of wool.

4.4.5 GENERAL APPEARANCE

TABLE 4.21 GENERAL APPEARANCE OF COTTON AND WOOL

(Values in mean rating)
N=20

General appearance	Cotton	Wool
Very good	6(30)	6(30)
Good	14(70)	11(55)
Fair	--	3(15)
Poor	--	--

(Figures in parenthesis indicate percentages)

Data from table 4.21, fig 17(A)and fig17(B) reveals that 30 percent of the respondents rated the overall appearance of the yarn as very good for both cotton and wool, while 70 per cent and 55 per cent of the respondents opined that the general appearance of the yarn was good for cotton and wool respectively. 15 per cent of respondents expressed that the general appearance of wool was fair. The variations in percentages is dependent on personal choice and taste of the individual.

Fig 16A Pretreatment with myrobolan for cotton

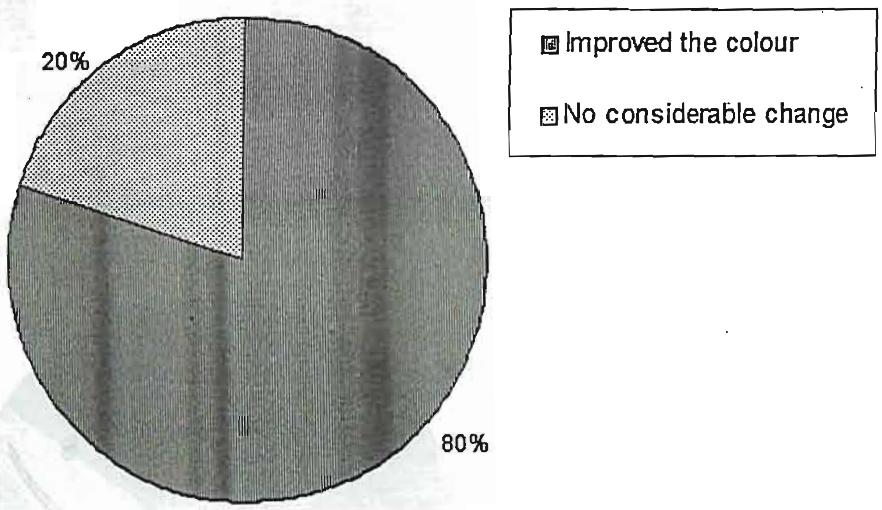


Fig 17A General appearance of cotton

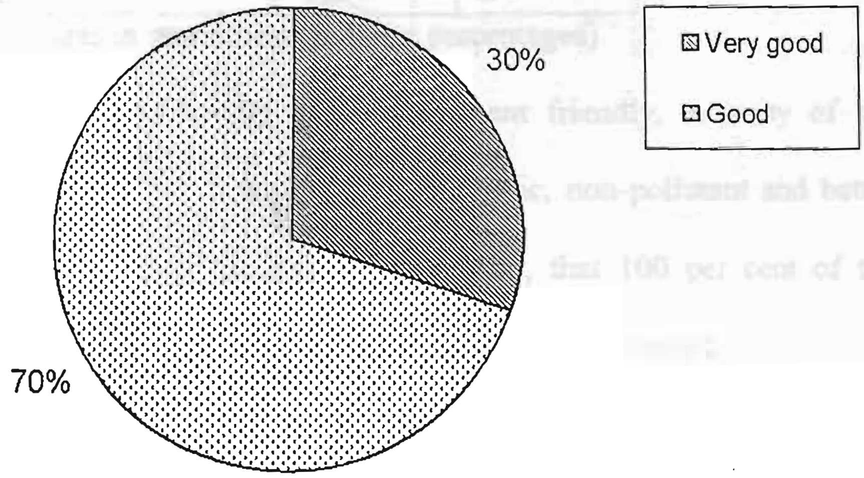
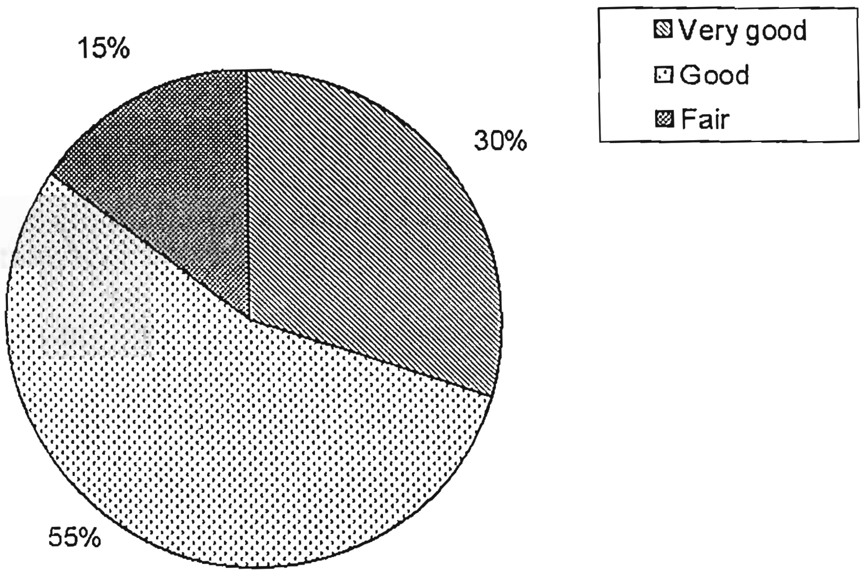


Fig 17B General appearance of wool



4.4.6 POPULARIZATION OF IXORA AS A SOURCE OF DYE

TABLE 4.22 POPULARIZATION OF IXORA AS A SOURCE OF DYE FOR COTTON AND WOOL

(Values in mean rating)
N=20

Popular source of dye	Cotton	Wool
Yes	20(100)	20(100)
No	--	--

(Figures in parenthesis indicate percentages)

As natural dyes are eco friendly and environment friendly, majority of the consumers preferred the natural dye because of its non-toxic, non-pollutant and better biodegradability. It is evident from the data in table 4.22, that 100 per cent of the respondents opined that Ixora as a source of natural dye can be popularized.

4.4.7 SUGGETIONS FOR FURTHER IMPROVEMENT

1.Use of different mordants such as copper sulphate, ferrous sulphate and chrome to obtain a range of colours.

2.Combination of mordants to get varied colours.

3.Use of natural tannin as mordant.

4.Increase in concentration of the mordants to get bright colours.

5.To test dyeability on other fabrics such as man-made and synthetic fabrics.

6. Increase in dye and mordant percentages to get different shades.

Majority of the respondents suggested that by using different mordants, a wide range of colours can be obtained as myrobolan and alum only were used as mordants for the present study. Few of them suggested that the concentration of mordants can be increased to get brighter colours.

Thus, from the above findings, it can be concluded that Ixora dye is a good source of natural dye for dyeing cotton and wool.

Summary and Conclusion

SUMMARY AND CONCLUSION

India has a long tradition of dyeing textiles with dyes obtained from natural sources. After the discovery of first synthetic dye in 1856, there was a gradual decrease in the use of natural dyes. The discovery of many more synthetic dyes followed quickly and flooded the markets. The soft delicacy and harmony of natural colours which formerly characterised Indian fabrics have given place to brilliant tints produced by synthetic dyes. Because of the carcinogenic nature of some synthetic dyes and their intermediates, attempts are being made to revive the old art of natural dyeing. The creative potential, non pollutant nature and soft lustrous colours of natural dyes make them persuasive possibility in our lives today. Natural dyeing can be economically viable for certain textiles. Thus an attempt has been made in this study to extract dye from Ixora flowers which can be added to the already existing list of natural dyes.

OBJECTIVES OF THE STUDY

GENERAL OBJECTIVE

To extract and develop dye from *Ixora singaporensis*

SPECIFIC OBJECTIVES

1. To standardise the extraction of dye from Ixora flowers.
2. To standardise dyeing procedure for cotton and wool.
3. To assess colour fastness properties.
4. To estimate the cost.
5. To assess the consumer acceptability.

The available literature indicates that no study has been done on extraction of dye from Ixora. Hence the study has been taken up, to dye cotton and wool samples with Ixora extract. Alum and myrobolan was selected as mordants. A shade card was prepared with three different shades. The dye extraction and dyeing procedures were adopted and standardised on the basis of the earlier published research articles.

The extracted dye was applied to cotton and wool samples and the colours obtained were subjected to colour fastness tests for washing, sunlight, rubbing and perspiration, The results of colour fastness tests were statistically analysed using arithmetic means. Consumer acceptability for the dyed samples was also assessed by conducting a subjective evaluation. Total cost of dyeing cotton and wool samples were estimated separately to test the viability of the process. The findings of the study are summarized as below:

FINDINGS OF STUDY FOR DYEING COTTON SAMPLES

The preliminary testing carried out to standardise the dye extraction and dyeing procedures for dyeing cotton samples revealed that the extraction of dye was maximum in alkaline method of extraction .It was also found that premordanting method was best suited. The dye concentrations selected for dyeing cotton with Ixora was 3 gms for lighter shade and 7 gms for darker shade. 60 minutes of time was found to be optimum for dye extraction as well as for dyeing. Optimum time for mordanting was found to be 30 minutes and the optimum concentration of the mordants used were 15 per cent alum and myrobolan in the ratio of 1:20.

Scoured and bleached cotton samples were premordanted with alum and myrobolan and then dyed with Ixora extract to produce different shades of brown colours. These samples were later subjected to colour fastness tests. The findings of colour fastness tests on cotton samples are summarized as follows:

- The colour fastness tests to washing showed that all the samples had good to very good fastness.
- The results of colour fastness tests to sunlight revealed that all the samples exposed for 24 hours duration and myrobolan treated samples exposed for 40 hours duration exhibited excellent fastness. Whereas, unmordanted and alum mordanted samples showed good to fair fastness after 32 and 40 hours of exposure.
- The ratings of dry rubbing on cotton showed excellent to very good fastness to dry rubbing.
- The results of wet rubbing on cotton samples revealed that all the samples had excellent to very good fastness to wet rubbing.
- The findings of colour fastness test to acidic and alkaline perspiration showed that all the samples had excellent to very good fastness.
- The results of subjective evaluation revealed that dye from Ixora flowers was suitable for cotton and the colour was found to be good.
- It was also opined that Ixora dye can be popularized as a source of natural dye
- Cost estimation for dyeing showed that cotton fabric mordanted with myrobolan incurred higher cost when compared to alum. Unmordanted samples incurred no cost as no chemicals were used.

FINDINGS OF THE STUDY FOR DYEING OF WOOL SAMPLES

The preliminary tests done to standardise the dye extraction and dyeing procedure for dyeing wool samples revealed that, the extraction of dye was best in acidic method of extraction. It was also observed that premordanting was best suited for mordanting wool samples. The optimum time for dye extraction and dyeing was found to be 60 minutes and 30 minutes was found ideal for mordanting. Optimum concentrations of the mordants used were 15 per cent alum and myrobolan in the ratio of 1:20(liquor myrobolan ratio).

Wool samples were pretreated with myrobolan and alum and dyed with Ixora flower extract. These samples were subjected to colour fastness tests. The findings of colour fastness tests on wool are summarized as follows:

- Colour fastness to washing indicated that wool samples showed good to very good fastness to washing.
- The results of sunlight tests revealed that all wool samples exhibited excellent fastness to sunlight.
- The colour fastness tests on wool samples for dry rubbing and wet rubbing exhibited very good to excellent fastness.
- The colour fastness tests to alkaline and acidic perspiration revealed that all samples exhibited excellent to very good fastness for perspiration.
- From the results of subjective evaluation, it can be concluded that Ixora dye is suitable to dye wool and the colour was also found to be good. It was also found that Ixora dye extract can be popularized as a source of natural dye.
- Cost estimation for dyeing showed that wool fabric mordanted with myrobolan incurred higher cost when compared to samples mordanted with alum. Unmordanted samples incurred no cost as no chemicals were used.

IMPLICATIONS OF STUDY

The study "Extract from Ixora flowers as a source of dye for cotton and wool" is useful for the dyeing industry. This dye can be popularized and used for small scale and as well as cottage industries as there is no toxic substance or huge machinery involved in production of the dye. The cost of dyeing can be reduced further by commercialization. The extracted dye can be used in kalamkari paintings along with some other eco friendly mordants.

SUGGESTIONS FOR FURTHER RESEARCH

- The study can be done on other fabrics as well as blends.
- Mordants other than alum and myrobolan can be used for more range of colours.
- Combinations of mordants can also be tried.
- Combination of Ixora dye with some other natural dyes can be tried and fastness properties can be tested.

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Appendices

APPENDIX I (A)

EVALUATION SHEET

Name of the respondent:

Please critically analyse the suitability of Ixora flowers as a dye for cotton by tick(✓) mark wherever necessary.

1. Suitability of Ixora as dye for Cotton
   a. (3) Suitable
   b. (2) Fairly suitable
   c. (1) Not suitable

2. Colour is
   a. (4) Very good
   b. (3) Good
   c. (2) Fair
   d. (1) Poor

3. Pretreatment with alum has
   a. (3) Improved the colour
   b. (2) No considerable change
   c. (1) No improvement of the colour

4. Pretreatment with myrobolan has
   a. (3) Improved the colour
   b. (2) No considerable change
   c. (1) No improvement of the colour

5. General appearance of the yarn
   a. (4) Very good
   b. (3) Good
   c. (2) Fair
   d. (1) Poor

6. Do you think Ixora flowers can be popularized as a source of dye
   a. (2) Yes
   b. (1) No

7. Please give suggestions for further improvement of colour

APPENDEX I (B)

EVALUATION SHEET

Name of the respondent:

Please critically analyse the suitability of Ixora flowers as a dye for wool by tick(✓) mark wherever necessary.

1. Suitability of Ixora as dye for wool
   a. (3) Suitable
   b. (2) Fairly suitable
   c. (1) Not suitable

2. Colour is
   i. (4) Very good
   ii. (3) Good
   iii. (2) Fair
   iv. (1) Poor

3. Pretreatment with alum has
   i. (3) Improved the colour
   ii. (2) No considerable change
   iii. (1) No improvement of the colour

4. Pretreatment with myrobolan has
   i. (3) Improved the colour
   ii. (2) No considerable change
   iii. (1) No improvement of the colour

5. General appearance of the yarn
   i. (4) Very good
   ii. (3) Good
   iii. (2) Fair
   iv. (1) Poor

6. Do you think Ixora flowers can be popularized as a source of dye
   i. (2) Yes
   ii. (1) No

7. Please give suggestions for further improvement of colour

APPENDIX II (A)

SHADE CARD FOR COTTON

Dye Concentration	Mordant Concentration		
	Unmordanted	Alum	Myrobolan
3%			
7%			

APPENDIX II (B)

SHADE CARD FOR WOOL

Dye Concentration	**Mordant Concentration**		
	Unmordanted	Alum	Myrobolan
3%			
7%			

VITA

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