A STUDY ON DYEING OF ECO -FRIENDLY FABRICS WITH TEMPLE WASTE FLOWER – TAGETES ERECTA

DISSERTATION

Submitted in Partial Fulfillment of the Requirement for
The Award of the Degree of

MASTER'S PROGRAMME IN FASHION DESIGNING

BY

SHERIN TREASA
(Register Number: SM16MFD004)

DEPARTMENT OF FASHION DESIGNING
ST. TERESA'S COLLEGE (AUTONOMOUS)
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Signature of the External Examiner

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CERTIFIED AS A BONAFIDE RESEARCH WORK

Signature of the Head of the Department | **Signature of the Guide**

CERTIFICATE

I hereby certify that the dissertation entitled '**a study on dyeing of eco - friendly fabrics with temple waste flower – Tagetes erecta'**submitted in partial fulfillment of the requirement for the award of the Degree of **Master's Programme in Fashion Designing** is a record of original research work done by Ms. Sherin Treasa during the period of her study under my guidance and supervision.

Signature of the HOD

Signature of the Guide

Smt. Vinitha Paulose
Assistant Professor,
Department of Fashion Designing,
Women's Study Centre,
St. Teresa's College [Autonomous]

DECLARATION

I hereby declare that the matter in this dissertation entitled '**a study on dyeing of eco -friendly fabrics with temple waste flower – Tagetes erecta**' submitted in partial fulfillment of the requirement for the award of the Degree of **Master's Programme in Fashion Designing** is a record of original research work done by me under the supervision and guidance of, **Smt. Vinitha Paulose**, Assistant Professor, Department of Fashion Designing, Women's Study Centre, St. Teresa's college [Autonomous], Ernakulam and that the thesis has not previously formed on the basis for the award of any degree work has not been submitted in part or full or any other degree/diploma/associate ship/fellowship or the similar title to any candidate of any other university.

Place: **SHERIN TREASA**

Date:

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Sherin Treasa

ABSTRACT

Eco friendly textiles play a vital role in the human history. Eco textiles have reduced carbon, energy, and pollution impact when compared to the standard methods of producing textiles. There are many fibres which can be considered as eco-friendly in nature. Eco friendly fabrics when dyed with natural dyes are known as natural dyed textiles. Natural dyes are those which are extracted from the roots, stems, leaves, flowers, fruits of various plants. In India, temple offerings mainly consists of flowers, fruits, clothes etc. which goes into garbage more often. The temple waste has a unique share of flower waste in the total waste disposed. The present study deals with the natural dyeing of eco-friendly fabrics using temple waste flower- Tagetes Erecta which is commonly called as African Marigold. Natural dyed fabrics are environmental friendly and is the best option to keep our place, society, and world clean and a safe place to live.

Key words : Eco friendly fabrics, natural dyes, temple waste flower.

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INTRODUCTION

1. INTRODUCTION

Clothing is one among the most important three basic needs in every human life. It protects our body from various climates and gives us a good appearance. Clothes have no longer been used to hide sexual difference in its strong biological sense, at the same time to pointing up and signalling it through assumptions concerning gender in clothing codes. The clothing and textile sector is a significant part of the world's economy.

The word textile is derived from the Latin term "textere" for woven fabrics. Textiles serve the everyday needs of people, but they may also serve to distinguish individuals and groups of individuals in terms of social class, gender, occupation and status with the group.

Fibers are the fundamental units used in making of textile yarns and later on into fabric. The common fibers that are used for fabrics are obtained from different sources. There are few fibers which are naturally available. Still some fibers are synthetized by using chemicals and are known as synthetic fibres like for example nylon, polyester and acrylic fibers. Some fibres are manufactured by using raw materials from nature and they are termed as man-made fibres like rayon, polynosic, azlon etc. Synthetic fibres eventually become waste and let off harmful toxins when they degrade. Many people are allergic or dislike wearing synthetic textiles.

Natural fibres that occur in nature are classified as vegetable fibres, animal fibres and mineral fibres. Vegetable fibres found in the vegetative matter are basically cellulosic in composition. Many of the natural fibres are used as reinforcing materials in composites. As compared to the conventional reinforcing fibres like Glass, Carbon, and Kevlar, natural fibres have the advantage of being environmentally friendly, nontoxic, easy to handle, light weight/low density, good insulation against heat and noise renewable, low cost, free from hazards, good thermal properties and ease of separation.

Eco and organic fabrics once considered an alternative are now entering into the mainstream. Eco-friendly fabrics are made from fibres that do not require the use of any pesticides or chemicals to grow. They are naturally resistant to mould and mildew and are disease free. Hemp, linen, bamboo, ramie, etc are some of the eco-friendly fibres. Organic and eco fibres grow without any pesticides or chemical fertilizers. They are also biodegrading naturally over the time.

The organic and eco-fibres are natural and do not contain irritating chemicals. Many of them are also considered hypoallergenic and naturally anti-bacterial. Eco fabrics have all the properties of the new synthetic breathable fibres with added softness and drape. They feel better against the skin. Organic goods have been around for a while and it is a natural evolution that organic and eco-friendly fabrics will also gain popularity.

In textile processing, dyeing is an integral part of which textile coloration is done to make the fabric lively. Dyeing is an ancient art which predates written records and it was practiced since bronze age. Consumers are becoming increasingly very much conscious to environmental friendly consumer goods and are much concerned about green processing. The tendency of eco-friendliness in textiles is important as it comes in contact with the skin for a prolonged period of time.

Natural dyes were the main source of colorants for textiles until the end of 19^{th} century. However, after the discovery of synthetic dyes, natural dyes were completely replaced by them. Synthetic dyes are produced from cheap petroleum sources. Researches has shown that synthetic dyes are suspected to release harmful chemicals that are allergic, carcinogenic and detrimental to our environment and human body. Natural dyes have better biodegradability with the environment. They are non-toxic, non-allergic to skin, non-carcinogenic, easily available and renewable.

Natural dyes are dyes or colorants derived from plants, invertebrates, or minerals. Various parts of plants like roots, stems, barks, leaves, fruits and seeds may contain colouring matter which can be exploited. Normally natural dyes are extracted from the roots, stems, leaves, flowers, fruits of various plants, dried bodies of certain insects and minerals. Some plants may have more than one colour depending upon which part of the plant one uses. The shade of the colour a plant produces will vary according to time of the year the plant is picked, how it was grown, soil conditions, etc. The minerals in the water used in a dye bath can also alter the colour. Some natural dyes contain natural mordants.

Natural dyes are also obtained from renewable sources that can be harnessed without imposing harm to the environment. Natural dyes are eco-friendlier than the synthetic dyes, as the synthetic dyeing procedure can produce pollutants and certain diazo dyes are carcinogenic. Natural dyes are also free from carcinogenic components and most of natural dyes are known as antioxidants. Natural dyes are biodegradable and disposing them do not cause any pollution to the environment.

Clothes dyed with natural dyes could be sold at higher prices. Depending on the mordants used with one dye can give variety of colours which also depends on the source of the dye. Because they come from natural sources, natural dyes are not harmful to the environment, which makes it so appealing for consumers.

In India, worshiping is the way of living and people offer various offerings to the deities which mainly consist of flowers, leaves, fruits, coconuts, clothes etc. out of which floral offerings are found in huge quantity. Thus, temple waste has a unique share of flower waste in the total waste. After fulfilling their purpose, flowers along with other waste, find their way into the garbage or they are discarded either into some water bodies or left up on the open places as a waste, causing various environmental problems. The majorly offered flowers in temples are rose, jasmine, marigold, chrysanthemum, hyacinth, hibiscus, etc. This floral waste can be utilized in different ways to produce valuable products and can thus help to save environment from pollution caused due to improper disposal of flower waste.

Some of the methods which can be used for the reuse of these waste products are techniques like vermicomposting, composting, dye extraction, extraction of essential oils, making of holi colours and bio-gas generation etc. Moreover, this flower waste can also be used for making incense sticks besides using them for some art and craft techniques. Petals of different flowers can also be utilized for handmade papermaking by extracting the pulp or by converting them into the readymade pulp. Based on the above observations, the study was planned with the following objectives in mind.

1.1 OBJECTIVES OF THE STUDY

1. To study about eco-friendly fibres.
2. To get an awareness on the plants that can be used as natural dyes.
3. To study the process of extraction of Tagetes Erecta/Marigold –the temple waste flower for natural dyeing.
4. To dye the selected eco-friendly fabrics with Tagetes Erecta extracts.
5. To test the properties of naturaly dyed eco- friendly fabrics.

REVIEW OF LITERATURE

2. REVIEW OF LITERATURE

2.1. Clothing

Human beings, like all mammals, are born into the world without clothing. Clothing is both a basic necessity and an expression of the human spirit views Michele Saracino*et.al.* (2012). Clothing, which is also known as clothes and attire is a collective term for garments, items worn on the body. Clothing can be made of textiles, animal skin, or other thin sheets of materials put together. The amount and type of clothing worn depend on body type, social, and geographic considerations. Some clothing can be gender-specific. Physically, clothing serves many purposes. It can serve as protection from the elements and can enhance safety during hazardous activities such as hiking and cooking.

Clothing helps to protect the wearer's body from rough surfaces, rash-causing plants, insect bites, splinters, thorns and prickles by providing a barrier between the skin and the environment. Clothes can insulate against cold or hot conditions. They provide a hygienic barrier, by keeping infectious and toxic materials away from the body. Clothing provides protection from ultraviolet radiation. Wearing clothes is also a social norm, as being deprived of clothing in front of others may be embarrassing. Though we may not accept the mantra that "clothes make the person," our dress often does reveal much about ourselves states Michele Saracino et.al.(2012).

2.2. Natural fibres

Natural fibers are emerging as low cost, lightweight and apparently environmentally superior alternatives to man-made fibers. They are environmentally superior because natural fiber production has lower environmental impacts compared to man-made fibres, they have high fiber content for equivalent performance, reduces polluting base polymer content, the light-weight natural fiber composites improve fuel efficiency and reduce emissions in the use phase of the component, especially in auto applications, and end of life incineration of natural fibers results in recovered energy and carbon credits.

2.3. Eco friendly fibres

Eco friendly fabrics once considered as an alternative are now entering into the mainstream. Eco-friendly fabrics are made from fibers that do not require the use of any pesticides or chemicals to grow. They are naturally resistant to mould and mildew and are disease free. Hemp, linen, bamboo and ramie are eco-friendly fibers. Chemicals and pesticides invade drinking water and groundwater, polluting its fish and even reaching human consumption. Hence eco well – disposed fibers are favored in hot and muggy atmosphere since they keep the body cool suggests, Subramanian Senthilkannan Muthu *et.al.* (2018).

They also bio-degrade naturally over the time. Organic and eco-fibers are natural and do not contain irritating chemicals. Many of them are also considered hypoallergenic and naturally anti-bacterial. Eco fabrics have all the properties of the new synthetic breathable fibers with added softness and drape. Also, most of them are antibacterial, skin amicable and have certain recuperating properties. They feel better against the skin Subramanian Senthilkannan Muthu *et.al.* (2018). Organic goods have been around for a while and it is a natural evolution that organic and eco-friendly fabrics will also gain popularity. Some of eco-friendly fabrics are as follows.

2.3.1. COTTON

The word "cotton" is originated from the Arabic term 'al qutn', which became 'algodon' in Spanish and 'cotton' in English. The wide scale introduction of genetically modified (GM) cotton varieties by both commercial and developing farmers has contributed significantly to improving the yield and profitability of cotton. Cotton was originally grown in several different colours including rust, brown and light purple, states Jared *et.al.*, (2016).

Cotton also known as ‘vegetable wool’ is a major source of apparel fibres. Celebrated for its excellent absorbency, durability and intrinsic softness, cotton accounts for over 50% of all clothing produced worldwide. This makes cotton the most widely used clothing fiber. Organic cotton is grown without the use of any genetically modification to the crops, without the use of any fertilizers, pesticides, and other synthetic agro-chemicals harmful to the lands.

Cotton is the leading fibre in textile industry. Apart from its fairly good strength, it is considered to provide comfort due to good moisture, absorption and wicking properties. It is estimated that approximately 20 million tons of cotton is processed worldwide yearly. Unlike manmade cellulosic fibers such as rayon and lyocell, cotton must be properly prepared for dyeing, printing and finishing suggests Menezes and Choudhari, (2011).

Like all organic products, organic cotton was harvested without the use of pesticides, insecticides or other chemicals that could harm the environment. Cotton plays a complementary role with other ecological fibres. Organic cotton is number 5 on the list. Although it offers an alternative to conventional cotton, all types of cotton culture are extremely demanding on the environment because of the necessary water and soil depletion. It is stated that the organic cotton is grown without using pesticides and insecticides in a more sustainable conditions that enhance the quality of soil views Neeti Sirohi *et.al.,* (2016).

Plate 1: cotton

2.3.2. LINEN

Linen is a natural fibre, made from the stalk of a flax plant. It is regarded in Europe as the best quality fabric. Europeans have long favoured linen for their sheeting because of its amazing properties. It softens more it is used and washed, is extremely durable and lasts decades when cared for correctly. It is not uncommon that European families will pass linen sheets on to the younger generation as an heirloom. Vintage linen is very desirable, it is soft and the feeling is very hard to replicate by any mechanical process.

Linen is one of the most biodegradable and stylish fabrics in fashion history. It is strong naturally moth resistant and made from flax plant fibers; when untreated it is fully biodegradable. Linen can withstand high temperature. It absorbs moisture without holding bacteria. In fact, it is actually stronger when wet than dry and become softer and more pliable the more it is washed. Linen is a very durable fibre and has many benefits over cotton. Linen is 30% stronger than cotton, has a high moisture absorbency, hypo-allergenic, highly breathable, structurally sound fibre so products keep their shape, and structure in prolonged use.

Plate 2: Linen Plant

2.3.3. BAMBOO

Bamboo fiber resembles cotton in unspun form which is a puffball of light, airy fibers. Preparation of bamboo fibers can be done by both mechanical and chemical processing. Regenerated bamboo can also be manufactured by viscose route.

Bamboo has a wider application due to its comfort, soft, lustre and absorbency. Examples are nonwovens, baby wears, home textiles, decorative series, etc. Bamboo apparel is crowned as “Air Conditioning

Dress". Bamboo fiber is praised as "the natural, green and eco-friendly new type textile material of 21st century".

Plate 3: Bamboo plants

2.3.4 BANANA

Banana fibres are extracted from the barks of the banana tree and are biodegradable. These fibres are bonded by natural gums and made of thick walled cell tissues. Normally two to three outer sheaths are removed, and the intermediate layers are used. The outer layer of the plant gives coarse fibres that are very brittle and the innermost sheaths are also rejected as they contain pulpy matter. It can be easily blended with cotton or other synthetic fibers. It is popularly known as Manila hemp since decades in Philippines. Bamboo fibers have an intrinsic worth such as high tensile strength, light weight, lustre, drape and good moisture absorption. High water absorbing property of this fabric makes this clothing cool to wear.

Plate 4: Banana plant

2.3.5. JUTE

Jute is a cheapest fibre obtained from skin or bast of plant's stem, an integral part of Bengal, in entire southwest of Bangladesh. So it is called GOLDEN FIBRE OF BANGLADESH. Due to its texture initially it was processed by hand. It is the second most important vegetable fibre after cotton, in terms of usage, global consumption, production and availability. Today jute can be defined as an eco- friendly natural fibre with versatile application prospects ranging from low value to high value example: carpet, apparel, composites, upholstery furnishings, decorative colour boards. Non-woven jute fabrics carry applications in meditech, agrotech, protech, geo- textiles and many.

Plate 5: Jute Plant

2.3.6. CORN

Corn fibers are bio-degradable. It possess good dye ability in comparison to some natural fibers such as cotton and milkweed fibers, and good fastness with all classes of dyes. The energy required for production of corn fibers was low. Corn-based polylactic acid (PLA) is used for wide range of applications similar to polyethylene terephthalate (PET) based on renewable resources. Corn is a clean product; i.e., on reaching the end of its lifetime, it is completely biodegradable, compostable, burnable (without producing dangerous fumes) and recyclable. Corn fiber has already threaded its way into some winning outfits produced by designers from across the globe. Corn fiber manufacturers have claimed that these fibers can be used for sportswear, jacket, outer coat, apparels.

Plate 6: corn

2.3.7. ALOE VERA

To create a textile with the technologies developed that are soothing to the skin. The fabric can now be infused with aloe Vera capsules. These capsules are microscopic, airtight and waterproof. They open to release the gel only when the fabric is touched or rubbed. Essentially, every time an infused garment is worn, the content is applied to the skin. In addition to the skin benefits, aloe also adds a few interesting features to the fabric itself; it is naturally anti-bacterial, and so not only does it keep clothing cleaner, it also combats body odour. It is proving to be an exciting and beneficiary fiber for the wearer, describes Benitta and Kavitha (2014).

Plate 7: Aloe Vera

2.4. Dyeing

Dyeing is an ancient art practiced worldwide with the use of natural dyes but with the advent of synthetic dyes having superior fastness properties the use of natural dyes has declined. But in the present time there has been growing interest and research studies are exploring new natural dyes on natural fabrics as consumer environmental conscious is on rapid increase. In textile processing, dyeing is an integral part of which textile coloration is done to make the fabric lively. Dyeing is an ancient art which predates written records and it was practiced since bronze age. Consumers are becoming increasingly very much conscious to environmental friendly consumer goods and much concerned about green processing. The tendency of eco-friendliness in textiles is important as it comes in contact with the skin for a prolonged period of time.

2.5. Natural dyeing

Natural dyes are dyes or colorants derived from plants, invertebrates, or minerals. The majority of natural dyes are vegetable dyes from plant sources—roots, berries, bark, leaves, and wood—and other biological sources such as fungi and lichens.

2.5.1. Source of natural dyes

Animal-derived dyes

- Cochineal insect (red)
- Cow urine (Indian yellow)
- Lac insect (red, violet)
- Murex snail (purple)
- Octopus/Cuttlefish (sepia brown)

Plant-derived dyes

- Catechu or Cutch tree (brown)
- Gamboge tree resin (dark mustard yellow)
- Himalayan rhubarb root (yellow)
- Indigofera plant (blue)
- Kamala tree (red)
- Larkspur[5] plant (yellow)
- Madder root (red, pink, orange)

- o Myrabolan fruit (yellow, green, black)
- o Pomegranate peel (yellow)
- o Weld herb (yellow)(*Wikipedia, the free encyclopaedia)*

2.5.2. Mineral dyes

Mineral dyes are derived from coloured clays and earth oxide, few examples are Chrome green-from a compound of chromium and oxygen, Chrome red -from a compound of chromium and lead, Chrom yellow-from a compound of chromic acid and lead and Prussian blue-from a compound of iron and cyanide says Tassew Alemayehu, Zenebesh Teklemariam *et.al.,* (2014).

In natural dyeing process the colours are extracted from the nature. Some of the examples of plants that give natural dyes are:

- red colour is extracted from sandal wood bark.
- Orange colour is taken from madder root and red sandalwood.
- Yellow colour is extracted from safflower dried petals,
- turmeric rhizome, harda fruit,
- beriberi's root and mulberry leaves.
- Blue colour is taken from indigo leaves.
- Green colour is taken by mixing indigo and beriberi's leaves roots, also by mixing indigo and peppermint leaves.

- Violet colour is derived from red sandalwood bark, alkanet root and jamun fruit pulp.
- Brown-green is taken from the leaves of the eucalyptus plant, basil leaves, onion peel dried, spinach (unboiled) leaves, henna leaves, hibiscus petals suggests Gupta.G et.al (2017).

2.5.3. Floral dyes

Natural Floral Dye can be used as dyeing material for dyeing the textile fibres as well as making colourful powders. Floral dyes and Pigments are widely used in the coloration of live and dried flowers such as carnations, potpourri, and raffia, rose tansy, Solidago, Chrysanthemum blossoms, Sunflower heads, marigold, etc.

Plate 8: Red rose

Plate 9: Tansy

Plate 10: Solidago

Plate 11: Chrysanthemum blossoms

Plate 12: Sunflower

2.6. Tagetes erecta

Tagetes is a genus of annual or perennial, mostly herbaceous plants in the sunflower family (Asteraceae). Tagetes erecta, the Mexican marigold or Aztec Marigold, is a species of the genus Tagetes native to Mexico. Despite its being native to the Americas, it is often called African marigold. In Mexico, this plant is found in the wild in the states of México, Puebla, and Veracruz. This plant has been used for medicinal purposes.

Tagetes erecta a major source of carotenoids and Lutin, is grown as a cut flower and a garden flower, in addition to being grown for its medicinal values. Tagetes which are yellow to orange red in colour, are a rich source of lutein, a carotenoid pigment. This pigment has acquired greater significance because of its excellent colour value.

2.6.1. Significance of Marigold in Indian Culture

Marigold flower has a very important and prominent place on any occasion of celebration, either it's the welcome of some important person, the marriage ceremony, a festival celebration, a Pooja of a deity or any function. It's being elegantly, prominently colourful, it's presence makes an occasion not only beautiful, but vibrant and energetic too.

Marigolds were originally flowers of the Calendula family, also brightly coloured in shades of orange and yellow, but with simpler petals. From Dussehra to Diwali, marigolds are everywhere. Garlands of glowing orange blooms are hung for auspicious reasons and flowers are offered in rituals. Marigolds are so deeply part of these Indian festivals (The Economic Times (Oct 20,2017)

The genus name for marigold (Tagetes) gets its name from the Etruscan god 'Tages' - the god of wisdom. It's common popular name 'marigold' comes from "Mary's gold" after Mother Mary. The common name used for it in many parts of India is 'Genda' **.** The word Genda possibly comes from the 'Gonda', the tribe in Chhattisgarh where the flower is cultivated in abundance.

In both Christianity and Hinduism, the marigold has a lot of spiritual significance. The flower is offered to Mother Mary on the Feast of the Annunciation (March 25th of every year). This is the day when the angel Gabriel came to Mother Mary to tell her of Jesus Christ's coming. On this day, in some traditions, marigold seeds are sown in pots as a symbol for auspiciousness and patience to await the divine.

In Hinduism too, the flower symbolizes auspiciousness. The saffron/orange colour signifies renunciation and hence is offered to God as a symbol of surrender. While offering the flower one should also remember that marigold is a very hardy flower and has a stout, erect stalk (hence the scientific name of 'erecta') - in fact, the Sanskrit name for marigold is Sthulapushpa which signifies this. It symbolizes a trust in the divine and a will to overcome obstacles. This is also why the flower assumes such importance on Vijayadashami - the day Lord Rama prevailed over Ravana - a victory of good over evil. Mishra D.D (2016)

Although marigold flower extract has been used in veterinary feeds, the potential use of marigold as a natural textile colorant has not been exploited to its full extent. This is due to the lack of information on its safety, stability, and compatibility in textile coloration.

Plate 13: French marigold yellow and African marigold orange

2.7. Mordants

A mordant is a chemical binding agent that adheres well to both the fibres and to the dye. The word comes from the Latin *mordere*, which means to bite.

Mordants are used to improve the bond between the dye and the fabric, as well as extending the range of hues that can be obtained from the dyestuffs. The main mordants are alum, tin, iron, chrome, and copper: mordants can be obtained from plants, such as oxalic acid which is found in rhubarb leaves, alum which comes from clubmoss, and tannin from oak galls and sumac leaves.

Mordants are used to set the colour when using natural dyes. Different mordants will give different results. Alum (Aluminium Potassium Sulphate): This is the most widely used mordant. The compound is the hydrated aluminium potassium sulphate with the formula $KAl(SO4)2.12H2O$. Chrome (Potassium Dichromate, $K2Cr2O7$): Chrome brightens dye colours and is more commonly used with wool than with any other fiber. Extremely toxic material, therefore chrome should not be inhaled and gloves should be worn while working with chrome. Left over mordant water should be disposed of at a chemical waste disposal site and treated as hazardous waste suggests Shishir M.H. (2014).

2.7.1. TYPES OF MORDANTING

The three common types of mordanting are:

1. Pre-mordanting - the mordant is applied first, followed by dyeing.
2. Post-mordanting - the dyeing is done first and then mordanting is carried out.
3. Simultaneous mordanting – the mordant and dye are mixed together and then applied.

2.8. Benefits of natural dyed clothes

Natural dyes have been used as colorants in food, leather as well as textile. These dyes are obtained from vegetable and animal matter with no or very little chemical processing. In 1856, cheaper and easily available synthetic dyes were introduced, which resulted in a drastic decline in the usage of natural dyes. However, natural dyes are non-polluting, non-carcinogenic and eco-friendly nature. Natural dyes are biodegradable and do not cause any health hazards and hence they can be easily used without much environment concerns. Recently, many commercial dyers have started using natural dyes to overcome the environmental damage caused by synthetic dyes. Also, synthetic dyes such as azo dyes are reported to be carcinogenic and can cause allergic reactions (Arora, J. Agarwal, P and Gupta, G *et.al.,* 2017).

Natural dyes exhibit several important properties that provide them a significant edge over synthetic dyes. Natural dyes are biodegradable, non-toxic and non-allergic. Natural dyes are environment friendly and aesthetically appealing. Natural dyes helps in employment generation and utilization of wasteland. Help in easy extraction of colours by boiling the plants, berries, leaves, bark or flower heads in water. Synthetic dyes such as azo dyes are carcinogenic and can produce toxic and allergic reactions. It is said that fabric dyed with natural dyes exhibits higher UV absorption that can result in reduced incidence of melanoma Arora, J. and Agarwal, P. (2017).

Many natural dyes have antibacterial properties. Natural dyes are mostly renewable as most of them are plant based whereas synthetic dyes are petroleum-based that is a non-renewable source of energy. Thus, application of natural dyes instead of fossil fuel (petroleum) based synthetic dyes has the potential of earning carbon credits (Arora, J. Agarwal, P. and Gupta, G *et.al.*, 2017).

The waste generated can be used as bio-fertilizers in some cases such as dyeing with indigo, and as a result there is no waste disposal problem. A wide spectrum of colours by mix and match system can be produced. A small variation in the mordant used or extraction medium or dyeing technique can bring about a drastic change in the colour (Arora, J. Agarwal, P. and Gupta, G et.al., 2017). Natural dyes bleed but do not stain other fabrics except turmeric. Natural dyes are moth proof and can replace synthetic dyes in kids garment and food stuff for safety.

METHODOLOGY

3.METHODOLOGY

The methodology pertaining to the present study "A study on dyeing of eco - friendly fabrics with temple waste flower – Tagetes Erecta" are discussed under the following headings:

3.1. SELECTION OF FABRIC

3.2. SELECTION OF THE DYE

3.3. EXTRACTION OF THE DYE

3.4. SELECTION OF MORDANT

3.5. DYEING OF THE ECOFRIENDLY FABRICS

3.6. EVALUATION AND TEST METHODS

3.1. Selection of fabric:

Hundred percent pure cotton and linen fabrics of plain weave structure were selected for the study. Cotton and linen fabric were washed repeatedly to remove the dirt and impurities. The fabrics were then dried in shade and kept ready for dyeing.

3.2. Selection of the dye

Tagetes is a genus of 56 species of annual and perennial herbaceous plants in the sunflower family. The common name is English Marigold. Huge amounts of the Tagetes plant were offered in temples creating a large amount of waste to the environment. The flower gives vibrant orange and yellow colours for dyeing textile fabrics. For the study, two varieties of Tagetes Erecta, African Marigold Orange and French Marigold Yellow were selected for the study.

The flowers collected from the temple premises were sorted, cleaned and impurities were removed. The petals of each flowers were plucked and kept separately in sealed covers.

3.3. Extraction of the dye

The collected orange and yellow flower petals were carefully cleaned and dried under the shade separately for 4-5 days. The dried petals were then finely grinded and powdered.

The finely powdered of marigold flowers of orange and yellow were mixed with required amount of water and boiled for 30 minutes at room temperature in two different containers. The extracted dye solution is filtered twice to get a clear solution. The solution was kept aside for further process.

Plate 14: Collection of petals yellow and orange

3.4. Selection of mordant

A mordant is necessary to fix the dye to the fabric. Mordant is a mineral salt used to increase the affinity of the material. For the study, Potassium Alum was used as a mordant to fix the dye to the material.

Plate 15: Potassium Alum

3.5. Dyeing of the eco-friendly fabrics

3.5.1. Desizing

Desizing plays a major role in achieving a perfect fabric feel. It is the process of removing the sizing material from warp yarn in woven fabric. A stainless steel vessel was taken with 10 litres of soft water and non-ionic detergent was added. Then cotton and linen fabrics were rinsed well separately and introduced into the water bath for 1 hour at 80°C to remove starch or any other impurities present in the fabric.

3.5.2. Dyeing procedure

Recipe for dyeing

- Material: Liquor ratio- 1: 20
- Mordant - 1: 0: 0.5
- Temperature - 75°C
- Time - 45 minutes

For dyeing the fabric, simultaneous mordanting and dyeing method was adopted. The cotton fabric was immersed in the diluted orange flower extract solution directly and gently boiled for 45 minutes by maintaining the temperature at 75 degree celsius on a hot plate. The requires amount of mordant were added into the dye solution.

Initially the surface of the fiber is dyed when dye contact with the fiber, then the dye slowly enters into the core of fiber. The sample was kept immersed in the dye solution overnight, and the next day it was dried in shade. The same process was then repeated with diluted yellow flower extract solution in cotton fabric.

Dyeing of linen fabrics were also done the in the same manner. Thus the four floral dyed cotton and linen samples were obtained for the study:

Plate 16: Dyeing process

3.7. Nomenclature

The nomenclature of the dyed samples is given in table No: I

TABLE I: NOMENCLATURE OF DYED FABRIC SAMPLES

Sl.No.	Nomenclature	Fabric Sample
1	CY	Cotton fabric dyed with yellow colour
2	CO	Cotton fabric dyed with orange colour
3	LY	Linen fabric dyed with yellow colour
4	LO	Linen fabric dyed with orange colour

3.6. Selection of evaluation and test methods

3.6.1. Visual evaluation

3.6.2. Selection of test methods

The following tests methods were done to evaluate the dyed cotton and linen fabrics

1.Determination of yarn count

2.Determination of tensile strength

3.Determination of crease recovery

4.Abrassion resistance

5.Determination Colour Fastness

- Determination of colour fastness to Rubbing
- Determination of colour fastness to Washing
- Determination of colour fastness to Sunlight
- Determination of colour fastness to pressing.

3.6.1. VISUAL EVALUATION

Visual Evaluation of the four dyed fabric samples, CO, CY, LO, LY were done to find out general appearance, evenness in dyeing, colour, texture, lustre. A group of 50 panel members evaluated the dyed fabrics and the results are given in Table No:2 in Results and Discussion.

1.Determination of yarn count

Beasley's balance is worked on the principle of fixed weight and fixed length system. It is used for assorting the count of warp and weft yarns from the small sample of yarns or from the fabric. The Beasley's balance consists of a pillar which carries a cross beam at a knife edge as point G. At one end of the cross beam is a hook that is point B on which the yarns are to be placed. The other end of the beam is imbalanced. The pointer will coin side with the determine of the arrow mark on the beam. The pillar is mounted on the base the whole instrument is levelled by a levelled screen. The cross has a small notch at the point D to take the counter weight or rider.

The dyed fabrics were cut using the template. The pointer is set directly opposite to the datum line, with no material and counter weight in their proper places, by adjusting the levelling screw. The counter weight for the particular length which is supplied with the instrument is chosen and suspended at the notch D. The yarn is withdrawn from sample and placed sample on the hook until the pointer comes in level with the datum line. At that stage the threads are taken out and counted which gives directly the count of yarn taken for testing. The results of the tests are given in the Table No: III-VI in Results and Discussion.

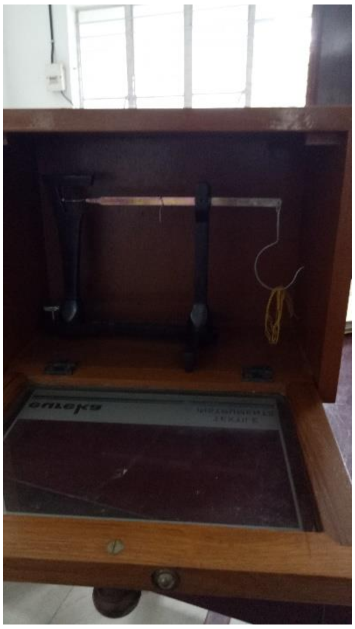


Plate 17: Beasley's balance

2. Determination of tensile strength

The tensile strength of the fabric sample was tested in the Tensile Strength Tester. The width of the sample is 2 inch and test length is 8 inch. The test specimens are cut for exact width and 12-inch length wise. This method is used for coated and heavily sized fabrics, where ravelling of thread would be difficult. The samples are prepared and clamped on the top and bottom jaw of the fabric strength tester care should be taken while fixing the sample. To ensure that force is acting tangential to the width of the sample. The equipment is operated till the fabric gets ruptured. At the same time of rupturing the load applied for the sample to treat and the rate of elongation is noted. The results of the tests are given in the Table No: XX and XXI in Results and Discussion.

Plate 18: Tensile strength tester

3. Determination of crease recovery

Shirley’s Crease Recovery Tester was used to find out the crease recovery of the yarns of all fabric samples. The amount of recovery is impressed as the angle between the limits of the fold which is called the crease recovery angle. Three warp and weft of 2-inch x 1-inch size were cut with the help of a template. The sample was folded in half and placed in between and load of 1kg weight was applied for 1 minutes to get crease. The sample was removed after one minute and transferred to the fabric clamp of the instrument. They are then allowed to require from the crease for 5 minutes. After one minute the dial of the instrument rotated to keep the free edge of the specimen in the line with the knife edge. Crease recovery angle was measured from the engraved protractor. Warp and weft crease recovery angle were measured separately and the mean of each reading were reported.10 readings were taken for each sample and results are given in Table No: XXII - XXVII in Results and Discussion.

Plate 19: Shirley crease recovery tester

4. Abrassion Resistance

The abrassion resistance of the fabric samples were done using a Rotary Abrassion Tester. A fabric sample was rubbed against an abraded (emery paper) by multi-directional motion. Assessment of abrasion is done by compression between original cloth and abraded sample. An emery paper was cut in 15 x 15 cm size and fixed in the lower part of the machine to form the abrasion surface. Cut the fabric samples of 38 mm (15 inches) diameter with the help of a template. Place the circular sample inside the abrasion head and fastened it to the machine. The dial was per -set for 10 movements and start the machine. Results are observed after each batch of 10 movements until the end point was reached for a woven fabric, end point is when 2 or more yarns have broken. The process was repeated for all the four dyed samples and results are shown in Table No: XIV - XIX in Results and Discussion.

Plate 20: Rotary abrassion tester

5. Determination Colour Fastness

Colour fastness is a term used for the degree to which dye holds fast to the fibre or fabrics. A good or high fastness means that they do not bleed or rush in washings, crock or rub off in wear. The colour fastness of the textile material is of considerable importance in judging its quality

5. a. Determination of colour fastness to Rubbing

To determine the rub fastness of the dyed textile material a crock meter is used. This method is designed to determine the amount of colour transferred from the surface of coloured textile materials to other surface by rubbing. The crock meter helps to find out both the dry rubbing and wet rubbing fastness.

The hand driven crock meter is constructed entirely from metal components. The hand crocking direction is anti-clockwise. It has a finger normally 16mm diameter and rests on the specimen with a force of 9N. The finger moves to and fro in a straight line along a 10cm track on the specimen. The equipment is provided with a resettable counter to record the no of strokes.

All the 4 dyed fabric samples were cut in size of the sample of 30cm x 12.5cm were cut. The first fabric sample was mounted over the instrument platform in such a way that in the long direction of the sample follows the rubbing track of the device. The sample was fastened with the aid of the sample holder. On the rubbing finger the white fabric piece was fixed. The counter is set to zero. Then the handle is rotated in the clockwise direction with the rubbing finger over the fabric sample in a to and fro movement 10 times in 10 seconds with a downward force. The rest of the samples were also tested in the same way.

The same procedure was repeated for wet rubbing except that the white fabric piece was wetted before placing on the rubbing finger. The degree of staining was evaluated by means of a grey scale and the ratings were assigned. The same procedure was repeated for all samples. The results are shown in Table No: VI - XI in Results and Discussion.

Plate 21: Crock meter

5.b. Determination of Colour Fastness to Washing

Colour fastness to washing test was designed to determine the effect of washing on the colour fastness of the textiles. The colour fastness to washing was done in a launder meter. This method determines the effect of washing on colour fastness of the textile material irrespective of the composition and form of the material. The sample specimen in contact with the given fabric piece is mechanically agitated in soap solution at 50°C for 45 minutes rinsed and dried. The change in the colour of the specimen and the staining of the adjacent fabric are assessed with the help of the standard grey scale for staining.

The dyed cotton and linen fabric specimen is cut to 10 x 4 cm avoiding the selvedge. The first piece was sandwiched between two white fabric pieces of the same dimension where one piece is made of the same kind of fibres as that of the textile sample to be tested and the second piece is made of the fibre an indicated in the standard (viscose). The pieces of the fabric samples were sewn by running stitches on all four side. This composite specimen was placed in a steel jar of the launder meter with the required amount of soap solution. The jar was closed securely with its lid and placed in the launder meter. The temperature was adjusted and the treatment is carried for 45 minutes. After the specified time the specimen was removed and rinsed in cold water. The stitches were opened out from the two long and one short side and left to dry at room temperature. The change in colour of the dyed fabric specimen and the degree of staining on the white fabric were evaluated with the grey scale and rated accordingly. Results are given in Table No: XIII in Results and Discussion.

5.c. Determination of Colour fastness to sunlight

The dyed samples of 3 x 6 cm were fixed on a black cardboard in such a way that all samples were half exposed and half covered. This frame was placed inside the fade meter with mercury bulb tungsten lamp. The specimens were brought out after 10 hours and colour fading was assessed against the blue wool standards.

5.d. Determination of Colour Fastness to pressing

Pressing fastness test of dyed materials is performed to determine resistance of the textile materials to ironing and to processing on a cylinder. The dyed fabric sample were taken and placed between two undyed dried test cloth (cotton). A hot iron was rolled over the test sample for 15 seconds. The change in the colour and staining of the treated cloth was evaluated. Similarly, the test was conducted for rest of the dyed samples. Consecutive samples were prepared in each and subjected to testing. Results were recorded in the Table No: 12 in results and discussion.

RESULTS AND DISCUSSION

4.RESULTS AND DISCUSSION

The Results and Discussion pertaining to the present study "A study on dyeing of eco -friendly fabrics with temple waste flower – Tagetes Erecta" are discussed under the following headings:

4.1. Visual Evaluation

4.2. Evaluation of the samples by Test Methods.

4.1 Visual Evaluation

The visual evaluation of the dyed samples was done by a panel of 50 members. The samples were judged for their general appearance, colour, evenness in dyeing, texture and lustre. The results are shown in Table No:II

TABLE II – Table of Visual Inspection

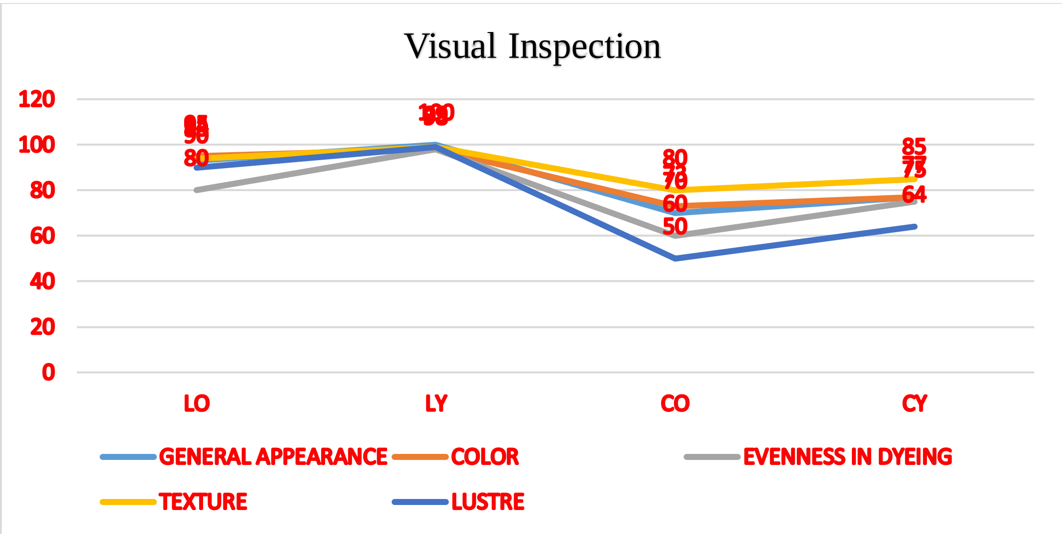
SAMPLE	GENERAL APPEARANCE	COLOR	EVENNESS IN DYEING	TEXTURE	LUSTRE
LO	93%	95%	80%	94%	90%
LY	100%	98%	98%	99%	99%
CO	70%	73%	60%	80%	50%
CY	80%	77%	75%	85%	64%

Form the above table it was noted that sample LO was rated as excellent by 93% in general appearance, 95% good in brilliancy of colour, 80% evenness in dyeing, 94% soft texture and 90% high in lustre.

Sample LY was rated as excellent by 100% in general appearance, 98% good in brilliancy of colour, 98% evenness in dyeing, 99% soft texture and 99% high in lustre.

Sample CO was rated as excellent by 70% in general appearance 73% good in brilliancy of colour, 60% evenness in dyeing, 80% soft texture and 50% high in lustre.

Graph I: visual inspection



Sample CY was rated as excellent by 80% in general appearance, 77% good in brilliancy of colour, 75% evenness in dyeing, 85% soft in texture and 64% high in lustre. The graph representing the visual inspection of the fabric samples are represented in graph No:

4.2. Evaluation of samples by Test methods

The properties of the dyed fabrics were evaluated by the following test methods:

4.2.1. Determination of Yarn count

4.2.2. Determination of tensile strength

4.2.3. Determination of crease recovery

4.2.4. Abrassion Resistance

4.2.5. Determination of colour fastness test

- Colour fastness to rubbing
- Colour fastness to washing
- Colour fastness to sunlight
- Colour fastness to pressing

The results of the tests are described as follows:

4.2.1. Determination of Yarn count

Yarn count of all the treated fabrics were tested and the results are shown in Tables below:

TABLE NO III: Yarn count of CO

Sl.No	No. of warp yarns	No. of weft yarns
1	7	6
2	7	6
3	7	6
Average	7	6

TABLE NO IV: Yarn count of CY

Sl.No	No. of warp yarns	No. of weft yarns
1	7	5
2	7	5
3	7	5
Average	7	5

TABLE NO V: Yarn count of LO

Sl.No	No. of warp yarns	No. of weft yarns
1	20	17
2	20	17
3	20	17
Average	20	17

TABLE NO VI: Yarn count of LY

Sl.No	No. of warp yarns	No. of weft yarns
1	17	15
2	17	15
3	17	15
Average	17	15

From the tables it was noted that cotton dyed with orange colour fabric (CO) has a warp count of 7 and a weft count of 6. For the cotton fabric dyed with yellow colour (CY)has a warp count of 7 and a weft count of 5.

For the linen fabric dyed with orange colour(LO) has a warp count of 20 and weft count of 17and for the linen fabric dyed with yellow (LY)has a warp count of 17 and a weft count of 15.

4.2.2. Determination of Tensile Strength:

The tensile strength of all the samples in the warp and weft direction was taken. The test results are shown below:

TABLE NO VII: Tensile strength in warp direction

Sample	Elongation Load in mm	Average in mm	Breaking load in kg's	Average in kg's
C	1) 5.3 2) 3.5 3) 7.9 4) 7.2 5) 7.1	6.2	37.650 34.650 22.700 26.950 30.700	30.53
CO	1) 6.9 2) 5.4 3) 5.5 4) 5.1 5) 6.8	5.94	28.400 27.700 26.800 35.100 25.650	28.73
CY	1) 6.5 2) 4.2 3) 6.1 4) 4.1 5) 3.0	4.78	37.050 31.200 24.750 31.350 33.850	31.69
L	1) 8.1 2) 10.3 3) 7.5 4) 7.9 5) 9.3	8.62	46.550 42.500 48.250 39.400 40.350	43.41
LY	1) 3.4 2) 3.3 3) 2.3 4) 1.9 5) 2.7	2.72	36.250 41.950 41.350 38.350 46.300	40.84

LO	1) 9.1 2) 5.9 3) 6.2 4) 7.5 5) 4.4	6.62	34.050 40.900 38.400 39.000 28.100	36.09

TABLE NO VIII: Tensile strength in weft direction

Sample	**Elongation Load in mm**	**Average in mm**	**Breaking load in kg's**	**Average in kg's**
C	1) 6.2 2) 7.3 3) 5.7 4) 7.3 5) 6.4	6.58	31.750 32.200 37.150 31.500 31.295	32.77
CO	1) 5.8 2) 5.7 3) 6.8 4) 6.3 5) 5.9	6.1	32.450 35.300 26.350 29.050 24.250	29.48
CY	1) 5.8 2) 5.4 3) 5.5 4) 4.9 5) 6.2	5.56	29.050 26.800 36.050 32.100 32.150	31. 23
L	1) 6.2 2) 6.3 3) 8.7 4) 9.5 5) 9.3	8.0	52.450 40.450 46.350 40.600 50.400	46.05

LO	1) 6.1 2) 5.3 3) 4.9 4) 5.3 5) 4.6	5.24	65.300 70.900 51.750 43.250 44.050	55.05
LY	1) 4.7 2) 5.7 3) 7.1 4) 5.2 5) 5.4	5.62	65.100 49.250 52.600 67.950 42.350	55.45

TABLE NO IX: Average in tensile strength of warp and weft yarns of the test samples

Sample	**Warp average**	**Weft average**
C	30.53	32.77
CY	31.69	31.23
CO	28.73	29.48
L	43.41	46.05
LY	40.84	55.45
LO	36.09	55.05

From the above table it was noted that the Linen and linen dyed samples have more tensile strength when compared to cotton and cotton dyed fabrics.

4.2.3. Crease recovery:

The crease recovery of the samples was taken in the warp and weft direction. The test results are shown in the below tables:

TABLE NO X: Crease recovery for sample C

Serial no:	Sample	Duration in minutes	Warp	Mean	Weft	Mean
1	1	1 min	85 ^{o}	87.2 ^{o}	70 ^{o}	70.4 ^{o}
2	2	1min	87 ^{o}		69 ^{o}	
3	3	1min	88 ^{o}		68 ^{o}	
4	4	1min	90 ^{o}		72 ^{o}	
5	5	1min	86 ^{o}		73 ^{o}	

TABLE NO XI: Crease recovery for sample L

Serial no:	Sample	Duration in minutes	Warp	Mean	Weft	Mean
1	1	1 min	71 ^{o}	56.6 ^{o}	27 ^{o}	31.4 ^{o}
2	2	1min	43 ^{o}		31 ^{o}	
3	3	1min	61 ^{o}		37 ^{o}	
4	4	1min	48 ^{o}		29 ^{o}	
5	5	1min	59 ^{o}		33 ^{o}	

TABLE NO XII: Crease recovery for sample CO

Serial no:	**Sample**	**Duration in minutes**	**Warp**	**Mean**	**Weft**	**Mean**
1	1	1 min	94 º	91.8 º	79 º	87.2 º
2	2	1min	81 º		92º	
3	3	1min	99 º		89 º	
4	4	1min	93 º		89 º	
5	5	1min	92 º		87 º	

TABLE NO XIII: Crease recovery for sample CY

Serial no:	**Sample**	**Duration in** minutes	**Warp**	**Mean**	**Weft**	**Mean**
1	1	1 min	91 º	94.8 º	69 º	79 º
2	2	1min	99 º		100º	
3	3	1min	94 º		90 º	
4	4	1min	96 º		64 º	
5	5	1min	94 º		72 º	

TABLE NO XIV: Crease recovery for sample LY

Serial no:	**Sample**	**Duration in minutes**	**Warp**	**Mean**	**Weft**	**Mean**
1	1	1 min	30 º	28.8 º	60 º	60.2 º
2	2	1min	31 º		55 º	
3	3	1min	29 º		66 º	
4	4	1min	26 º		61 º	
5	5	1min	28 º		59 º	

TABLE NO XV: Crease recovery for sample LO

Serial no:	Sample	Duration in minutes	Warp	Mean	Weft	Mean
1	1	1 min	38 ^{o}	61.2 ^{o}	35 ^{o}	29.8 ^{o}
2	2	1min	61 ^{o}		34^{o}	
3	3	1min	73 ^{o}		24 ^{o}	
4	4	1min	62 ^{o}		32 ^{o}	
5	5	1min	72 ^{o}		24 ^{o}	

TABLE NO XVI: Crease recovery average of warp and weft

Sample	Warp average	Weft average
C	87.2	70.4
CY	94.8	79.0
CO	91.8	87.2
L	56.6	31.4
LY	28.8	60.2
LO	61.2	29.8

From the above table it was noted that cotton and cotton dyed fabrics were having greater crease recovery than linen fabrics

4.2.4. Abrassion test:

Abrassion test for all the fabric samples were done in Rotary Abrasion Tester and the results are given in the below tables**:**

TABLE NO XVII: Abrassion test for C

Serial No.	Sample details	Weight applied(gm)	Weight of fabric before Abrassion	Weight of fabric after Abrassion	Number of Revolution	Degree of shading
1	C	400	0.31	0.30	5	3
2	C	400	0.30	0.29	5	3
3	C	200	0.30	0.30	5	4
4	C	200	0.30	0.29	5	4

TABLE NO XVIII: Abrassion test for sample CY

Serial No.	Sample details	Weight applied(gm)	Weight of fabric before Abrassion	Weight of fabric after Abrassion	Number of Revolution	Degree of shading
1	CY	400	0.31	0.29	5	5
2	CY	200	0.32	0.30	5	4/5
3	CY	400	0.32	0.31	5	4/5
4	CY	200	0.32	0.29	5	4

TABLE NO XIX: Abrassion test for sample CO

Serial No.	Sample details	Weight applied(gm)	Weight of fabric before Abrassion	Weight of fabric after Abrassion	Number of Revolution	Degree of shading
1	CO	200	0.32	0.30	5	5
2	CO	400	0.31	0.29	5	4/5
3	CO	400	0.31	0.30	5	4/5
4	CO	200	0.31	0.30	5	4

TABLE NO XX: Abrassion test for linen sample L

Serial No.	Sample details	Weight applied(gm)	Weight of fabric before Abrassion	Weight of fabric after Abrassion	Number of Revolution	Degree of shading
1	L	400	0.32	0.31	5	4/5
2	L	200	0.31	0.30	5	4
3	L	400	0.32	0.31	5	4/5
4	L	200	0.32	0.31	5	5

TABLE NO XXI: Abrassion test of sample LY

Serial No.	Sample details	Weight applied(gm)	Weight of fabric before Abrassion	Weight of fabric after Abrassion	Number of Revolution	Degree of shading
1	LY	200	0.27	0.26	5	5
2	LY	200	0.27	0.24	5	4/5
3	LY	400	0.27	0.26	5	4/5
4	LY	400	0.26	0.26	5	4/5

TABLE NO XXII: Abrassion test of sample LO

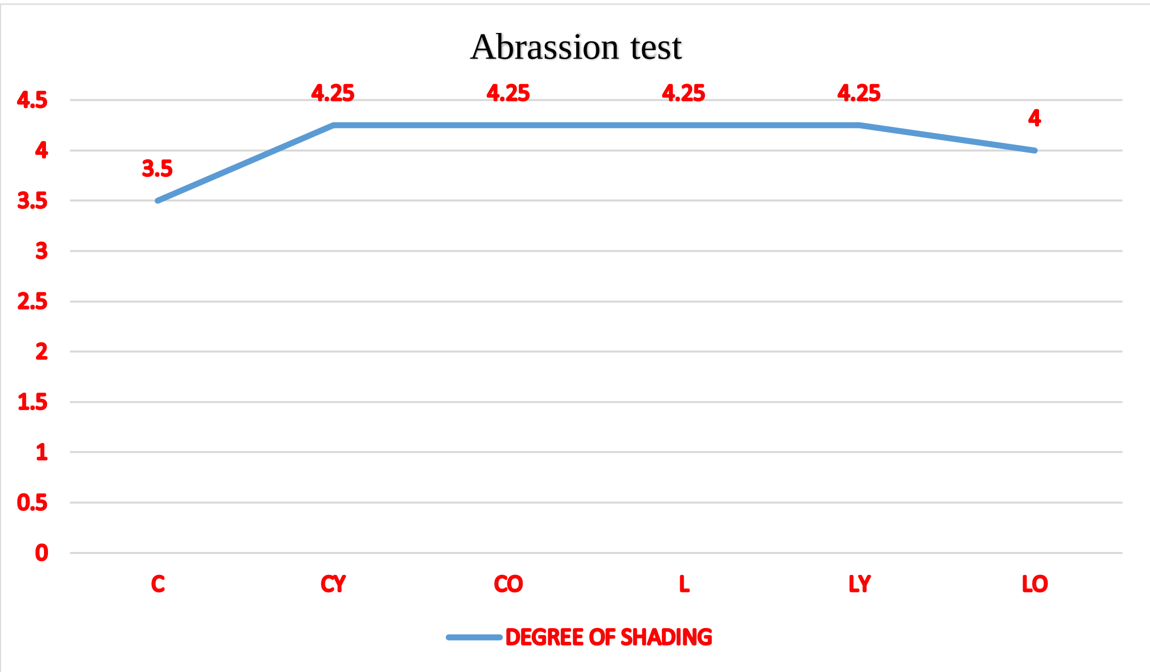
Serial No.	Sample details	Weight applied(gm)	Weight of fabric before Abrassion	Weight of fabric after Abrassion	Number of Revolution	Degree of shading
1	LO	400	0.29	0.29	5	3
2	LO	200	0.29	0.25	5	3
3	LO	400	0.26	0.25	5	1
4	LO	200	0.26	0.26	5	3

TABLE NO: XXIII: Consolidated table of abrassion test of fabric samples

Sl No	Sample	Degree of shading
1.	C	3.5
2.	CY	4.25
3.	CO	4.25
4.	L	4.25
5.	LY	4.25
6.	LO	4

From the consolidated table it was notes that cotton and linen dyed samples have good abrasion resistance. The graph representing the abrasion resistance of the fabric samples are shown in Graph No: II

Graph II: Abrassion test of Fabric Samples



Determination of Colour Fastness Tests

The following colour fastness test were done in all the samples and the results are given as tables below. The fabric samples were evaluated for the colour fastness using the grey scale given in Table No: XXIV

TABLE XXIV: Grey scale for staining and colour change:

Degree of change and staining	Rating	Grade	Remark
No stain	5	A	excellent
slightly stained	4	B	good
Noticeably stained	3	C	fair
Considerably stained	2	D	poor
Heavily stained	1	E	very poor

4.2.5. Determination of colour fastness to rubbing:

TABLE XXV: Rubbing test for sample CY

Serial no:	Sample colour	Rotation	Dry fabric	Wet fabric
1	CY	50	5	3
2	CY	100	4/5	2/3
3	CY	150	4/5	2

TABLE XXVI: Rubbing test for sample CO

Serial no:	**Sample colour**	**Rotation**	**Dry fabric**	**Wet fabric**
1	CO	50	5	3
2	CO	100	5	4
3	CO	150	4/5	2/3

TABLE XXVII: Rubbing test for sample LY

Serial no:	**Sample colour**	**Rotation**	**Dry fabric**	**Wet fabric**
1	LY	50	4/5	4
2	LY	100	4/5	3
3	LY	150	4/5	3

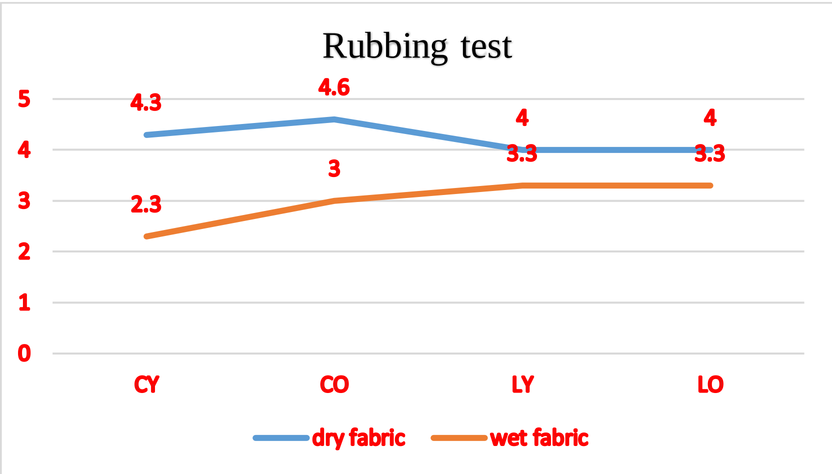
TABLE XXVIII: Rubbing test for sample LO

Serial no:	**Sample colour**	**Rotation**	**Dry fabric**	**Wet fabric**
1	LO	50	4/5	4
2	LO	100	4/5	3
3	LO	150	4/5	3

TABLE XXIX Consolidated table for rubbing test:

SAMPLE	DRY FABRIC	WET FABRIC
CY	4.3	2.3
CO	4.6	3
LY	4	3.3
LO	4	3.3

Graph III: rubbing test



From the above tables it was observed that the fabric samples showed only slight staining while dry rubbing and considerable staining in the wet rubbing for both cotton and linen fabrics. The graph representing rubbing tests of all fabric samples are given in Graph No: III

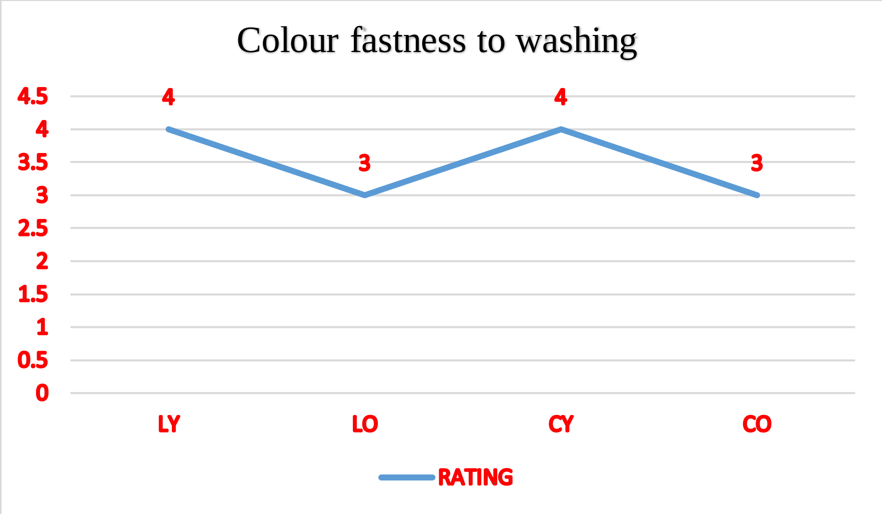
4.2.6. Determination Colour fastness to washing:

TABLE XXX Fastness to washing:

Sl No	Fabric samples	Rating
1	LY	4
2	LO	3
3	CY	4
4	CO	3

Sample LY was rated as good as it showed slightly stained and colour change. LO was rated as fair as it was noticeably stained and visible colour change in colour fastness to washing test. The sample CO and CY was rated as fair as it was noticeably stained and visible colour change was seen during the test. The graph representing colour fastness to washing tests of all samples are given in Graph No: IV

Graph: IV Colour fastness to washing



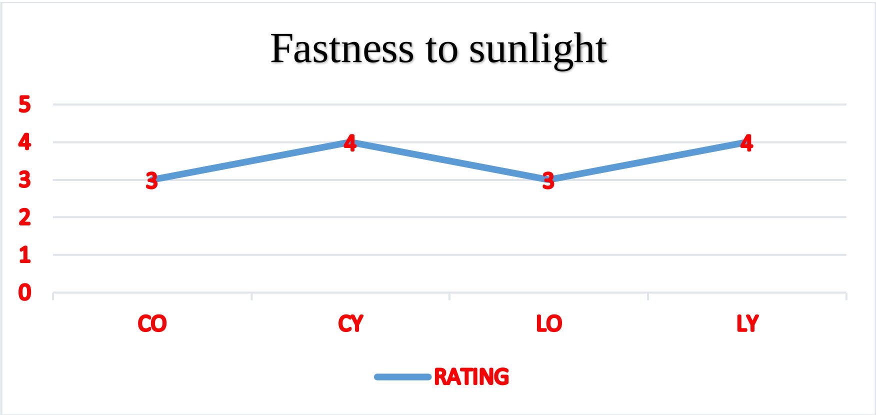
4.2.7. Determination of Colour fastness to sunlight

TABLE XXXI Fastness to sunlight:

Sl. No	Fabric Samples	Rating
1	LY	3
2	LO	4
3	CY	3
4	CO	4

Sample LY was rated as good as it showed slightly stained and colour change. LO was rated as fair as it was noticeably stained and visible colour change in colour fastness to sunlight. The sample CO was rated as fair as it was noticeably stained and visible colour change was seen during the test. And CY was rated as fair as it was noticeably stained and visible colour change in colour fastness to sunlight. The graph representing colour fastness to sunlight of all samples are given in Graph No: V

Graph: V Colour fastness to sunlight



4.2.8. Determination of Colour fastness to pressing:

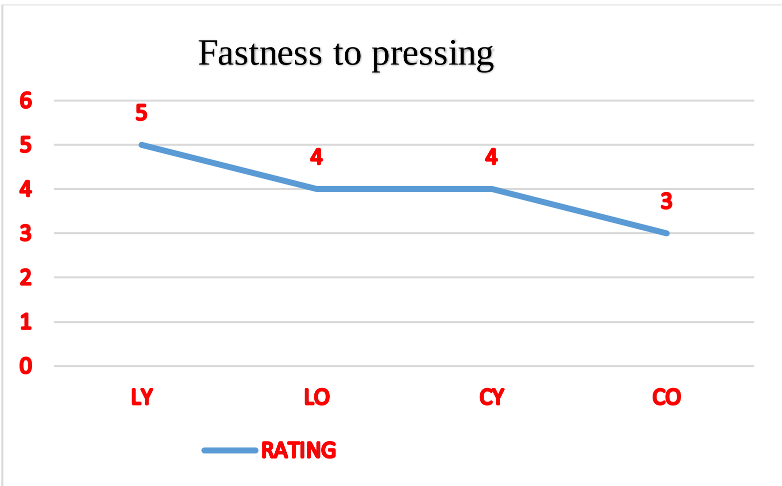
TABLE XXXII: Fastness to pressing

Sl. No	Fabric Samples	Rating

1	LY	5
2	LO	4
3	CY	4
4	CO	3

Sample LY was rated as excellent as it showed no stain or change in colour and LO was rated as good as it showed slightly stained and colour change in colour fastness to pressing. The sample CO was rated as fair, as it was noticeably stained and visible colour change was shown during the test and CY was rated as good as it showed slightly stained and change in colour. The graph representing colour fastness to pressing of all samples are given in Graph No: VI

Graph: VI Colour fastness to pressing



SUMMARY AND CONCLUSION

5. SUMMARY AND CONCLUSION

As green consumerism and environmental friendliness are on an increase, the use of natural dyes are the latest trend. Researchers are exploring natural substances and testing them for their potential as dyes. Eco and Organic fabrics once considered an alternative to manmade synthetic fibres and are now entering into the mainstream. Eco-friendly fabrics are made from fibres that do not require the use of any pesticides or chemicals to grow. They are naturally resistant to mould and mildew and are disease free.

Consumers are becoming increasingly very much conscious to environmental friendly consumer goods and much concerned about green processing. Natural dyes exhibit several important properties that provide them a significant edge over synthetic dyes. Fabrics dyed with natural dyes are also free from carcinogenic compounds. Natural dyes can be obtained from plants, animals and mineral bases.

The present study deals with the natural dyeing of eco-friendly fabrics using temple waste flower Tagetes Erecta of two variants that gives two different colours orange and yellow. Unbleached cotton and linen fabrics were selected for the study. Dyeing was carried out using simultaneous mordanting with alum as mordant.

The dyed samples were also studied for their yarn count, tensile strength, crease recovery, abrasion resistance and colour fastness tests, of which the results were found to be satisfactory. The study revealed that the temple waste flower Tagetes Erecta could be used as a natural dye for dyeing eco-friendly fabrics.

5.1. RECOMMENDATIONS

From the study it is recommended that temple waste flower Tagetes erecta or African marigold can be used for dyeing other eco-friendly fabrics.

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6.BIBLIOGRAPHY

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7.APPENDIX

FABRIC SWATCHES