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Natural Dyes for Cotton Fibre

M. Gopalakrishnan[1*], S. Anubama[2], E. Prasanth[3], M. Srinithi[4]
[1]*Assistant Professor, Department of Textile Technology, Bannari Amman Institute of Technology, Erode, India*
[2,3,4]*Student, Department of Textile Technology, Bannari Amman Institute of Technology, Erode, India*

***Abstract*: Textile Industry sector is considered to be one of the most polluting sector. In Recent times, the Textile industry is moving towards the Sustainable products and processes. The enlightened awareness of Ecology, Environment and Pollution control encourages the application of Natural resources. This initiates the use of Natural dyes. This paper explains the Dyeing of Cotton Fabric using Natural stuff from various natural materials. There are several process involved in dyeing of fabric. First, the dye extraction from the natural material. Since it is natural dye, Mordanting should be done. The Mordant used are Copper Sulphate, Aluminum Sulphate and Potassium Dichromate. Mordant will enhance the Fastness properties of naturally dyed materials.**

***Keywords*: Natural Dye, Coconut Root, Mordant, Fastness Properties.**

1. Introduction

Dye is a substance which gives colour to the fabric and fiber which we use in our daily life. Basically dyes are classified into 2 categories, Natural and Man-made. The Synthetic dye was found in 1878. The Fastness properties of Synthetic dye are excellent comparatively others. The synthetic dyes are By-products of the crude oil they are highly toxicated and causes inhibition of bentic photosynthethsis and also a carcinogenic agent [1-3].

The Natural dyes are Anti-Allergic, Non-Toxic and easy to biodegradable and also inherit deodorising properties. As Natural dyes are Bio compatible, they do not affect the environment. They are green approach and eco-friendly in nature. Natural dyes are in use since the Bronze Age. Now they are extended their usages to antimicrobial finishing of textile, UV protection clothing, food colourings and pharmaceuticals etc. Since Natural dyes does not require strong acid and alkali for their application and production their demand is continuously increasing. Natural dyes includes all the dyes extracted from natural resources like Plants, Minerals and Animals. But the dye content and colour yield of natural dye is lower compared to synthetic dyes. Major problems with the Natural are colour fastness, reproducibility results so dyeing procedures are difficult and different. Natural dyes don't interact directly with fabric, they need a medium called Mordant. This Mordant makes their affinity to textile material and to produce different dye shades with various level of colour fastness [4]. Mordants are metallic or mineral salts when added to dye bath either it intensifies the dye or changes the colour. Mordants plays the role in making the resultant shade to have prominent light and wash fastness. A Mordant is an element which aids the chemical reaction that takes place between the dye and fabric, so that dye is absorbed. The containers used for dyeing should be non-reactive, materials like stainless steel, enamel etc can be used. Brass, iron materials should not be used as they do their own mordenting [5].

Natural dyes are obtained from animal, vegetable, root and leaves. Because natural dyes are less toxic and allergenic that synthetic dyes and bio-degradable. Nowadays, contribution of synthetic dyes more than Natural dyes. Using natural dyes to products becoming important for avoiding the skin related problems. Textile chemical processing industry is one of the most environmental pollutants. If process a one ton of textile product, one might have use as much as 230-270 tons of water. There are two types to control the environmental pollution of textile processing.one is two build a sufficiently and high effective effluent treatment plants. Natural dyes have range of different shades that can be obtained from roots, flowers, fruits, leaf. Instead of using, synthetic dyes and also reduce the pollution apart from these advantages natural dyes have also some drawbacks like availability of dye source, natural dyestuff source might be found for a particular season. Most natural dyes are unable to form strong bonds with fabric without any usage of mordant materials. The reason for mordant using to increase the binding nature and dye affinity to fabric and create a stronger bond in comparison to using any dye. Modrants are also improving the fastness properties. Mordant are classified into two main group, basic and acidic mordant. Metal Salt of Iron used as basic mordant and Acid mordant like Alum. We planned to produce the fully natural and eco-friendly fabric. It is cost effective as compare to chemical mordant and eco-friendly product [6-8].

2. Coconut

- Common name: Coconut
- Botanical name: Cocos nucifera
- Family: Arecaceae (Palm family)

Coconut Tree is one of the useful tree in the world .It is also known as “Tree of Life”. It is used as Food, fuel, cosmetics, and building materials ect. Its origin region is Southwest Asia and Melanesia .It is highly sustainable in the sandy and salinity place. It can grow up to 30 meter. The Leave can grow up to 4-

*Corresponding author: gokin_m@yahoo.co.in

6 m. It can yield 75 fruits per year. The Top producers of Coconut tree was Indonesia, Philippines and India. The coir from coconut tree is used for making ropes, mats, doormats, brushes etc. Leaves of coconut tree are used for making baskets, roofing thatch, mats, decorative climbing etc. Roots from coconut tree are used as mouth washed skin curer. Coconut tree has Fibrous root system. Nearly 2000-4000 roots may grow. The Decayed roots are replaced with newly grown roots. Fewer roots only penetrate into soil for the stability and the remaining root grows outward on the surface [9-11]. These natural dyes are extracted from different parts of the plants including the flower, fruit, leaves, stem and roots. The fruits from which dyes can be extracted are avocado, cherries, blue berries, orange peel, pomegranate peel etc. The leaves that are used as sources for natural dyes are red cabbage, henna, Indigo, mulberry, mango, spinach and so on. Hibiscus, Roses, Jasmine, marigold and saffron are some of the flowers from which we can extract natural dyes. The barks of oak, sandalwood and ivy can produce natural dyes of different colours. And lastly the roots of some plants includes beetroot, Carrot, turmeric, madder etc. Other than this the coconut husk can also use to extract dye and in our project we have taken the roots of coconut tree to extract the natural dye [12-15].

Fig. 1. Coconut tree

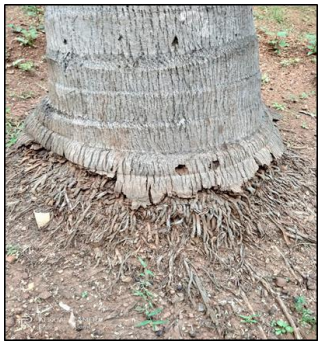

Fig. 2. Coconut root

3. Coconut Husk

This paper explains the Dyeing of the Cotton fabric using Natural Dye stuff extracted from the coconut husk. There are several processes involved in the dyeing of Fabric using Natural Dye. First, the Dye extraction from coconut husk using Aqueous Extraction method. The Mordants used were Alum and Vinegar. Dyeing with Mordants was carried out with Pre Mordanting and Post Mordanting. Study of Fastness of Dyed fabrics are undergone. The fabric chosen was 100%cotton fabric. Its specifications are like plain weave with 1x1. The ends per inch (EPI) is about 60 and Picks per Inch (PPI) is about 50.The equipment used in these experiment are weighting balance, Crock meter, Laundero meter and Xenon tester. dyeing is carried out under 2 shade ,2%and 4%.Mordanting were done with the concentration of 2%,4%,6%,8% maintained for 45 mins in the dye bath .Extraction of dye is taken place by aqueous solution method. In the process of dyeing the temperature of different shades are varied with the process temperature like 4^0C, 6^0C, 8^0C, 10^0C. The resultant samples are dried and taken for further procedure. To analyze the fastness properties testing are done. The test like rubbing fastness, wash fastness and light fastness are done. Fastness test of coconut fiber dyed sample are satisfactory. In this paper they finally conclude that coconut fiber can also give good dye ability of cotton fabric [16-20].

4. Beetroot

Beetroot Beta Vulgaris is an edible vegetable obtained from the taproots of the beet plant, other than edible purpose this vegetable can also be used to extract natural dye. The dye extracted from beetroot is purplish pink in colour. In the journal "Extraction of natural dye and preparation of herbal gulal from beetroot (Beta vulgaris)" by SK Tiwari, they have used three different techniques to observe the yield from beetroot and they also use completely organic solvents and followed an eco-friendly and cost effective process during their experiment. The three different techniques they followed were the aqueous technique, acidic technique and alkaline technique. In the alkaline technique they used 4 different concentrations of NaOH. They also prepared herbal gulal (name of coloured powder in Bengali) from wheat flour and rice flour and observed the colour of gulal after drying them in sunlight for about 24 hours and grinding them. It is observed that the colour of gulal obtained from mixing with wheat flour gives brown colour and rice flour gives pink colour. The yield from different techniques differ in percentages. They get a maximum yield of about 54% and a minimum yield of about 50% in their observation. The wavelength of the beetroot extract is 580 nm with different absorbance values according to the type of technique and the solvent used. They claims that the dye they got from this process is completely not harmful to human skin and human health while other synthetic colour powders may cause any harm to the skin when used. Further the process they carried out is a green synthesis and environmental-friendly. The cost of the process is also very low that it is affordable for most of the people and the process flow is also very simple and easy [21-23].

5. Madder

Madder Rubia tinctoria is an old Turkish plant belonging to the family Rubiaceae which is used to extract dye from the ancient times. The roots of this plant gives a bright red colour dye which were used for ages. This plant is likely to grow in the central parts of Europe and western Asia. The roots contain an

acid called ruberthyrin which is responsible for the red colour. This dye is used on cotton, wool, and silk and also on leather fabrics. The shade of the dye ranges from Orange red to fiery red. The shade variation is achieved by using different types of mordants. The dye is prepared by making the madder paste by adding the madder root powder and a small amount of hot water. The process of dyeing involves adding this paste in a vessel full of water and boiling it at 80° C for about an hour with the pre-mordanted fabric and leaving it in the dye bath overnight. If the temperature is kept below 80°C the madder paste can produce a bright red shade and if the temperature is increased above 80°C it may produce brown-red shade on the fabric. The most preferred mordant for madder dyeing is Alum. During the dyeing process a small amount of chalk powder (Calcium carbonate) is added to enhance the shade of the dye. Apart from dyeing the madder roots also have a lot of medicinal values. They were also used in dissolving kidney stones, in treating disorders associated with the menstrual cycle, urinary tract and blood. It may also use to an extent in controlling jaundice, paralysis and bruises [24-27].

6. Turmeric

Turmeric Curcuma Longa is a flowering perennial plant belonging to the family Zingiberaceae, which is known from ancient times and is majorly used in cooking for both antibacterial property and as a food colouring. It has many medicinal uses and it is very effective against rheumatoid arthritis, conjunctivitis, small pox, chicken pox, skin cancer and wound healing. In the journal "Optimization of extraction and dyeing conditions for traditional turmeric dye" by Kiran Sachan and VP Kapoor, they extracted a yellow colour dye which is water soluble from the turmeric rhizomes. They collected fresh turmeric rhizomes from various sources namely, from Lucknow, Shillong and from local market and powdered them. They carried out the dye extraction process in three different methods namely, aqueous, solvent and spray drying. Out of the three different samples the samples obtained from Shillong gives a very good yield. They got a maximum yield of about 27.6% in the Shillong samples through solvent extraction method using Ethanol. The extracted dye colour has a wavelength of about 426 nm. The extracted dye is used to dye cotton, wool and silk fabrics. They used sox different mordants includes, aluminum sulphate, copper sulphate, ferrous sulphate, stannous chloride, acetic acid and Lactic acid. They dyed in two timing periods, one is for 30 minutes and other for 60 minutes. After dyeing the samples dyed for about 30 minutes is washed in two variants of water, one is normal wash and other is hot water wash. During this process they observed a variety of colour shades bright yellow, golden yellow, Ivory, light khaki, olive green, smoke-brown etc. The turmeric dye is an eco-friendly and also a well-known dye, but the limitation is it has poor light fastness properties which is not sufficient for long term applications [28-32].

7. Lemon and Orange Peel

The natural dyes are non-toxic and non-allergic has gained significant importance due to ever increasing awareness and concerns regarding environmental pollution in synthetic dyes. It was observed from higher with 50 ml ethanol extraction and peel have given better yield compare to other. M: L is 1:30 pre mordanting the cotton fabrics dyed with extracts from Orange and lemon peel has better fastness to rubbing in dry and wet state. The utilization Orange and lemon waste from food processing industry as value addition of natural dyes improves dye stuffs performance characteristics. Ethanol cold extraction method was used for higher concentration of dye extract. Two organic solvent alum and sodium carbonate are used for three different ratios, namely 10%, 20%, 30%. The higher solvent have mordanted for higher dye uptake [33-34].

8. Rose

Rose flower is very common flower seen in our environment. It is very attractive and mostly used for the ornament purposes. A journal named “Extraction of Natural dye from rose flower for Dyeing Cotton fabrics” by D. B. Patil, explains the dye extraction from the rose petals by four techniques. They are Aqueous Extraction method, Alkaline Extraction method, Acidic Extraction method and Alcoholic Extraction method. The objective of the experiment is to identify which method yield is good. The substrate used in this experiment is 100% cotton fabric. The pretreatment process for the fabric is done. In Aqueous extraction method rose petals are boiled in distilled water at 100Cfor 30 mins and then filtered and used for further purpose. In Alkaline extraction method, the rose petals are boiled in NaOH for 30 mins and then filtered for next process. In Acidic extraction method, the rose petals are boiled in acid solution at 100C for 30 mins and filtered. In alcoholic extraction method, Rose petals are boiled in 50% alcohol solution at 100c for 30 mins. Since it is Natural dye extraction method, Mordants are used. The The chemicals used in this experiment are Ferrous Sulphate($FeSO_4$), Stannus Chloride($SnCl_2$),Copper Sulphate($CuSO_4$)and 95% Ethanol is used. After the dyeing process fastness test are carried out. The Resultant of the experiment is there is good yield in all the 4 dye extraction technique [35].

9. Jungle Geranium

Jungle geranium (lxora coccinea) is a cluster of little flowers commonly seen in our locality.it also has been used in the antioxidant, antimicrobial, anti-inflammatory activities. The journal with the topic “Extraction of Natural dye from lxora coccinea (Linn) flowers for cotton fabric colouration” by Monali U.Ghurde explains the dye extraction from jungle geranium and to tired out to found the functional group in the extracted powder. The subtract used in this experiment is 100% cotton fabric. They collected grey fabric so pretreatment process like Desizing, Scouring and Bleaching is carried out. The pretreatment process is done to improve the dye affinity towards fabric and functional properties. The Mordants used in these experiment are Alum 5%, Copper Sulphate 2%, Ferrous Sulphate 2%and Stannous Chloride 2%.The flower petals are crushed and added to the water and methanol at 10^0C

maintained at 80C for 2 hrs. And then filter and use for further purpose. The extracted solution is in dark red colour. In the process of mordanting the temperature is maintained about 80c for 30 mins and cooled it another 30 mins. In the process of dyeing, M: L ratio 1:40 was used and followed the standard procedure. Then the sample is dried and taken for testing .Light fastness, Wash fastness testing was done. To identify the functional group UV-Visible Spectroscopic study was done .The peaks are found at anthocyanin, cyanidin, betalin and chloa. The Resultant sample has excellent wash fastness property Methanolic extract has high yield compared to aqueous extraction method. Finally they concluded that three is a good scope for Jungle geranium [36].

10. Marigold Flower

The Journal topic "Extraction of natural dyes from African Marigold flower (Tagetes Ereectal) for Textile Colouration" by D. Jothi experimented this found out marigold extract is able to dye the cotton and silk fabric and analysed its fastness properties too. Here Dark yellow color marigold flowers are chosen. The substrate used in this project is Cotton and Silk .The pretreatment process for cotton is like Desizing, Scouring and Bleaching .The Pretreatment process is done to improve the Properties of fabric. The Mordanting used in this experiment are Alum, Copper Sulphate, Stannous Chloride and Ferrous Sulphate. The marigold flowers are dried and crushed as powder. The Powerded flower is added to the distilled water which boils at 100℃ about 2 hours. The solution is then filtered and used for the future purpose. The Mordanting was done in 2 % concentration of all mordants. The Mordanted sample is next taken to Dyeing .The Dyeing process is carried out in 1:40 M: L ratio. Buffer solution is added to maintain pH of the Dyeing bath solution. Then the sample is taken out and proceeded to testing. The Hydroxyl group present in the structure of marigold flower gives good fastness properties. The Light reflectance measurement using computer colour matching software colour yield was evaluated. The Kubelka- Munk equation is used evaluate the colour strength of the dyed sample. The Ferrous sulphate mordanted sample has good light fastness .The Marigold dyed sample has excellent wash fastness property [37].

11. Red Cabbage

Red cabbage Brassica Oleracea is a variety of cabbage plant which is purplish in colour. The change in colour of the plant is due to the change in the pH of the soil. If the soil nature is acidic the leaves are reddish purple in colour, if it's a neutral soil the leaves are purple and in the alkaline soil the leaves are greenish yellow. Red cabbage is a leafy vegetable which is preferably used in cooking, it is also nutritious and delicious to eat. Other than edible purpose we can also manufacture natural fabric dyes from these red cabbages. In the research paper "Red cabbage - A natural dye for silk" by Chhavi Singh and Ekta Grover, they dyed both silk and cotton fabrics by using the natural dye extracted from red cabbage. Before dyeing they degummed the silk fabric which helps in better penetration of the dye in the fabric. They used three mordanting methods. They are pre-mordanting, simultaneous mordanting and post mordanting. The mordants used by them are Alum 10% , Copper sulphate 2% and ferrous sulphate 3%. They conducted four types of fastness tests such as the Light fastness, wash fastness, Rubbing fastness and Perspiration. Their results showed that the simultaneous mordanting process exhibits good fastness properties compared to the other two pre-mordanting and post mordanting. They observed different shades of pink when treated with different mordants. Out of all the three mordants Copper sulphate produced excellent results follwed by Alum and Ferrous sulphate [38].

12. Mango

"A Study on Application of Ecofriendly Natural Dye Extracted from Mango Leaves on Silk Fabric with Metallic and Natural Mordants" by Mr Riaj Hossen .In this Paper the silk fabric is dyed with metallic and natural mordants and to analyse the color yield, colour coordinate and colour fastness of the sample. Alkaline aqueous extraction method is used for extraction of dye from mango leaves.The substrate used is raw silk fabric with plain weave construction. Since it is raw silk Degumming and bleaching process takes place to improve its functional properties. The mangoes leaves are washed and cleaned .The Cleaned mango leaves are dried in sunlight and powdered .The Powder leaves are added to hot water at 100C for 60 mins and the solution is filtered used for further process. The Natural mordants used in the process are Aloe vera, lemon and Myrobalan. The Metallic mordants blends are used Alum-Ferrous sulphate, Alum-Tin, Ferrous Sulphate-Copper sulphate. The Aloe vera Mordant is prepared by collecting a white pulp from the plant and mixed with distilled. The Lemon is prepared by collecting the juice inside the fruit and mixing it with water. The Myrobalan extracted solution is prepared by drying it thoroughly and grinding into fine powder. The powdered Myrobalan is added to the water and filtered for future purpose. The Mordanting process is carried out at 1:30 M: L ratio. The temperature maintained at 100C for about 60 mins for Aloe vera and for lemon mordant temperature is about 100C for about 30 mins. For Myrobalan the temperature is about 80C for about 60 mins. After the mordanting process, Dyeing process is proceed with the 80C for about 60 mins with M:L 1:30 .after dyeing the samples are taken out and squeezed .The Post mordanting process was done the sample after the dyeing process. Colour strength is measured by Kubelak munk equation and colour co-ordinate are measured. The samples are undergone fastness test .In metallic mordant, ferrous sulphate mordant has high colour yield compare to others. In Natural Mordant. Aloe vera has high colour yield. For the all the fastness test of all the sample the results are good to excellent. Overall, even without metallic mordant, the natural mordant with the mango leaves dyed fabric fastness are acceptable [39].

13. Banana

"Eco friendly dyeing of cotton fabric with Natural Colorants extracted from Banana leaves" by Salah M Saleh. In this paper,

Banana leaves dyed samples have High Tensile strength, elongation. The Colour parameters and Fastness properties are analysed. The substrate used in this experiment is Eyptian cotton fabric its specifications are plain weave, 36 (Ends per Cm), 30 (Picks per Cm) and Fabric weight is 150g/m2. Since the substrate is grey fabric, scouring, bleaching pretreatment processes are done. This pretreatment process improves the properties of the fabric. The Banana leaf dye solution is extracted by 2 processes, alkaline extraction method and Acetone Extraction method. In Alkaline extraction method, the banana leaves are boiled are in NaOH solution and filtered. In acetone extraction process, the banana leaves added in acetone in soxhlet apparatus and filtered used for further purpose. In the process of dyeing, the temperature used is 80c for 90 mins in the M:L 1:40 ratio. After dyeing process, the sample is allowed to dry. The Sample are tested for tensile strength and elongation under ASTMD412-98a. The colour strength is measured by the equation of Kubelka munk equation. The fastness properties are also tested. Finally, they concluded that even the dyed sample has good tensile strength and elongation. So, Banana leaves dyed fabric has scope to use in Industrial application also [40].

14. Mulberry and Coffee

"Suitability of dyes from Mulberry and Coffee leaves silk fabrics using Eco-friendly Mordants "by Loum Janani. In this paper, the blend of Mulberry & Coffee leave dye dye solution are extracted and its fastness properties are analysed. The Mulberry and Coffee (Robusta) leaves are collected and washed. The Natural dye extract solution is prepared in aqueous extraction method. The Mulberry and coffee leaves are added to distilled water which boils at 60Cfor 60 mins. The substrate used is Raw silk fabric. In this experiment mordants are prepared on their own, not a synthetic one. The Mordants used are Ash water and Iron water. The Ash water is prepared by mixing the wood ash powder with distilled water in a clay pot. This Ash water is used for both degumming and mordanting. The Iron water was prepared by soaking the rusted iron nails about a week and filtered the nails. The lemon juice is mixed with the distilled water The Fresh cow dung is mixed is mixed with cow dung. Since the substrate is raw silk, bleaching is done. In the process of dyeing, the temperature is maintained about 60C for 30 mins. After the dyeing process, the dyed sample is immediately treated with mordants. Then the samples are taken for the evaluation of Wash, Heat and Light fastness. The Iron water mordants give deeper shades, Ash water gives tawny brown and Lemon juice gives light shades. Overall, fastness ranges from good to excellent and also shades gives vibrant [39].

15. Stem

The stem can be used as a natural dyes. The colouring matter was extracted from leaves and stems by boiling water .It was used to dye cotton yarn using different methods for its fastness and other properties. The dyed yarn was immersed in a solution containing 4 % lead acetate for 30 min. The dye yarn was immersed in a solution contains 1% of copper sulphate and potassium dichromate. Each concentration dyed material was immersed in a bath for 30 minutes, rinsed and dried. It can be exploited for extraction of dye can be cheaper and superior to synthetic dyes. The dye has no irrigative and toxic effects on skin [40].

16. Conclusion

Dark shade in Natural dyes is very difficult to achieve it. So almost most of the shade of the natural dye will be the light shade which makes it more suite for formal shirt. In this way, coconut root dye have a lite shade in brown colour. Which is also used in Shirts, scarfs, bags and aesthetic materials. Especially Home textile (curtains) products since it has good light fastness properties. It can be also preferred in the kind's garments because of its Anti-allergy, Non Toxicated properties. The Main targeted persons of this project are consumers who are switching over to the sustainable products over the synthetic one. The Coconut tree root dye was extracted from Coconut tree (Cocos nucifera).The dye from the Coconut root dye was extracted from coconut root by Aqueous extraction method. Since it is a natural dye mordanting is needed. The different mordants were used at different concentrations. The Mordants are Copper Sulphate, Aluminium Sulfate, and Potassium Dichromate. Mordanting was done according to the procedure and parameters. Then the sample is mordanted in the mordant solution about an hour and taken out. The mordant sample is undergone the dyeing process. The Natural dye extracted from the extraction process was further added with salt and required temperature is maintained. Then the fabric is taken out after 24 hours, allowed to cool it down under oven.

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