Extraction of Natural Dye from *Persea americana* pit and its Application on Cotton Fabric

By

Pavithra, A.P

(14PTF008)

A Thesis submitted to the

Avinashilingam Institute for Home Science and Higher Education for Women

Coimbatore – 641 043

In partial fulfillment of the Requirement for the

Degree of Master of Science

In

Textiles and Fashion Apparel

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Certified as Bonafide Research Work

Signature of the

Head of the Department

Signature of the Guide

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1. INTRODUCTION

Textile industry is the oldest and most important sector in the Indian economy. It is the second largest employment provider in the country, next to agriculture. Textiles industries are facing a tough condition in the field of quality and productivity, due to the globalization of the world marker (Nataraj *et al*.,2005) Cotton the "White Gold" is the most precious gift of nature to the mankind and the backbone of the World's textile trade. It is the oldest textile fiber which has great economic importance as a raw material for textile cloth and is one of the most widely produced textile fabric (Deshwal and khambra 2006).

Cotton grown and used to make fabrics in ancient China, Egypt, India Peru and Mexico and today is one of the most important and widely used fibers Worldwide. It grows in any part of the world with cold temperature to hot climate, long growing seasons and adequate rain (Stauffer, 2004). One of the main advantage of cotton is its resistance to alkali solution and the mild alkali solution like sodium carbonate have no action on cotton in the absence of air either at low temperature. However, in the presence of oxygen or air, cellulose is formed with graduated tendering of cotton (Mishra *et al.,* 2000). The most commonly encounter and natural fiber in cotton, but the wide spread use of cotton fibers also have various characteristics microscopic features, and appear flat and spiraled or twisted under the microscopic. Their fiber can be dyed with a range of dyes and because of their convoluted structure, transfer easily during contact (Clark *et al,* 2006).

Cotton is a wonderfully versatile and globally important fiber that is used for a vast variety of fiber and food products it is popular because of its comfortaness throughout the year. It is the most widely used textile fiber. Because of its inherent properties it has been able to have an important position in spite of the advent of the regenerated synthetic man-made fibers (Bhattacharya and Patel, 2004). Cotton is the "King of Fiber" and "Miracle Fiber" respectively (Mahalingam,2006).

The world has become aware of environmental problems through discussion about the ozone layer depletion, water pollution and water disposal. Scientist have recently found that the number of dyestuff and textile auxiliaries being used by the industry either for emphasis aesthetic appeal or imparting some desirable characteristics contain certain harmful and toxic substance which cause irreparable damage to ecology and mankind. The popular perception is that industrial practices and in particular the chemical industry has somehow or the other altered the natural balance in the universe. There is a view that chemistry is somehow ‘fiddling with nature’ (Glover and pierce, 1993)

Nowadays cotton dyeing the highest point. Every management is bothered how to solve the present day problems goes to arise in cotton dyeing. (Gokum consultants, 2006) cotton is currently the leading plant fiber crop worldwide and is grown commercially in the temperature and tropical regions of more than 50 countries, with a total coverage of 34 million. The cotton seed coat extends into tubular fiber and is spun into yarn. Specific areas of production include countries such as USA, India, China and the Middle East and Australia (Zehr, 2010). Among all the cotton growing countries, India has the highest acreage under cotton, which almost doubled since independence (Chandra and Sreenivasan, 2011).

The eco-friendly products becoming a top priority in recent years, the dye industry turned its attention to newer products which carter to the fashion trends as well to the environmental specification. With the present national and international awareness of environment, ecology and pollution control, natural dyeing derived from flora and fauna are believed to be safe because of their non-toxic, non-carcinogenic, bio-degradable natural and can be handled very easily and safely (Bhuvan & Saikia,2004)

Natural dyes, which were pushed during the last sixty years into the background by synthetic dyes, are recently again becoming object of consumer interests. This is due to the awareness of possible risks during production of synthetic dyes which involve use of petrochemical based raw materials and the violent chemical reactions for their synthesis. The manufacture of such dyes is energy intensive with adverse impact on environment adding to its pollution. Many of these dyes, especially the azo- based ones, are found to be carcinogenic (Prabhu 2012)

Conventional wisdom leads to the belief that natural dyes are more friendly to the environment than synthetic dyes. Today in the world of environment ecology conservancy, natural colorants have attracted the attention of the whole world, because of its non-hazardous nature. The protection of environment has become a challenge for the chemical industry worldwide and the water pollution caused by synthetic dyes in particular and also the control of effluent continues to be a problem (Grover and Patni, 2011).

Natural dyes have been existiny in plants, tress, insects, minerals, sea-animals etc., since the ages. Natural dyes are in no way harmless to man and the environment particularly as they are least toxic, fairly non –polluting waste effluents and less health hazardous. They are considered as very good for their colour experimentation quality, excellent for the soft lustrous colouring and it retain great beauty and charm (Chengaiah *et al.,*2010).

Natural dyes in the present day are sought and used for their many intrinsic values. Natural dyeing gives glow of rich colour , aromatic smell , soft light and shadow effect soothing to human eyes are considered to very good sources for various effects on characteristic of colour values on natural fibers (Rahman *et al*., 2014).

Natural dye materials can be sourced directly from your kitchen, garden, or even urban neighborhood. A perfect example of a natural dye that applies gorgeous color and transforms waste into wonder is the avocado pit.A mordant is a metal or plant-based fixative used to extend light, color, and wash-fastness for natural dyes. Some mordants can alter or change the plant color entirely. In the case of avocado pits, the tannin in the seed acts as a mordant that binds well to cotton fiber. Avocado pits produce light- to deep-pink shades and russet reds with no mordant added. When an iron solution is added, the color will transform into inky blues, purples, and blacks. Applying an iron after-bath to your pink and russet red dyed fiber can also allow you to resist-pattern and dip-dye your fabrics for overwhelming effects (Sasha Duerr,2014).

Hence, the objective of the present study was undertaken to "**Extraction of Natural Dye from *Persea americana* pit and its Application on cotton Fabric*"*** is to,

- Selection of fabric and natural dye source.
- Optimize the dyeing concentration, time, temperature and pH.
- Dye the selected fabric with selected natural dye solution.
- Evaluate the properties of the dyed fabric.

2. REVIEW OF LITERATURE

The review of literature pertaining to the study entitled **"Extraction of Natural Dye from *Persea americana* pit and its Application on Cotton Fabric"** reviewed under the following headings.

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2.1. Introduction of cotton

Cotton fiber that has been processed to remove seeds(ginning) and traces of honeydew (a secretion from aphids), protein, vegetable matter, and other impurities, consist of nearly pure cellulose, a natural polymer. cotton production is very efficient, in the sense that only ten per cent or less of the weight is lost in following processing to convert the raw cotton balls(seed coat) into pure fiber. The cellulose is set in a way that gives cotton fibers a high degree of strength, durability and absorbency. each fiber is made up of twenty to thirty layers of cellulose coiled in a neat series of natural of natural spring. when the cotton ball is opened, the fibers dry into flat, twisted, ribbon-like shapes and become kinked together and interlocked. This interlocked form is ideal for spinning into a fine yarn (Naresh and Deepak,2005)

India is known world over for its ancient and rich textiles trade and industry. Its origin gas to least 5 millions years ago when during Harappan's excavation piece of cotton stuck to a silver vase and some spindles were discovered, revealing the existence of spinning and weaving of cotton during that period or before, reveals (Iyer and Saxena,1999).

2.1.1 History of cotton

Cotton was cultivated by the inhabitants of the Indus valley civilization by the 5^{th} millennium BCE- 4^{th} millennium BEC. Cotton has been spun, woven and dyed since prehistoric times. Hundreds of years before the Christian era cotton textiles were woven in India with matchless skill and their use spread to the Mediterranean countries (cotton, Columbia encyclopedia, 2007)

India's cotton processing sector gradually declined during British expansion in India and the establishment of colonial rule during late 18^{th} and early 19^{th} centuries. This was largely due to the east India company's de-industrialization of India, which forced the closing of cotton processing and manufacturing workshop in India to ensure that India market supplied only raw materials and were obliged to purchase manufactured textiles from Britain, as pointed out by Sharma et al. (2003)

2.1.2. Properties of cotton

Unlike synthetic fibers, cotton is a natural product and contains no chemical. Cotton becomes stronger when wet. This has high absorbency rate and holds up to27 times its own weight in water. Cotton is very versatile, it can be blended, coated, finished, is dry cleanable, machine washable and easy to print on (www.cottoaustralia.com)

Cotton fiber has extensive applications in apparel, as well as in related industrial sector and technical textiles, owing to its outstanding properties, such as excellent properties of air permeability, biodegradable, no static electricity, etc. (Guesmi et al,2013).

2.1.3 Physical properties of cotton

The length and width of cotton is the shortest natural fiber used in commercially in textile industry ranging from 0.5-2.5 inches in length. The width of typical cotton fiber may vary between 12 to 20 microns. Shape of cotton fiber looks like a flattened tube and the cross section are oval or kidney shape. It is a moderately strong fiber. Tenacity of fiber is 26.5-44 CN/Tex and extension at break is about 8-10% (Sathyanarayana and Rameshchandra, 2013).

The elasticity of cotton is relatively less elastic fiber. At 2% extension it has an elastic recovery of 74% at 5% extension the elastic recover is only 45%. The fiber is somewhat porous and consequently it absorbs moisture readily (Sharma and Grover, 2011). The moisture regains of 8.5%. At 100% humidity, and has a absorbency of 25-27%. And the colour of cotton is creamy white. And it is naturally very soft and comfortable that is why it is particularly favored for garments is that get close to the skin. The fiber have a natural luster which is due to the natural polish on the surface and it is nearly circular cross sectional shape (Prabaharan and Rao,2003).

2.1.4 Chemical properties of cotton

Cotton swells in high humidity environment, in water and concentrated solution of certain acids, salts and bases. The swelling effect is usually attributed to the sorption of highly hydrated ions. The moisture regain for cotton about 7.1-8.5% and the moisture absorption is 7-8% (Murugajothi and Moses,2008). It is attacked by hot dilute or cold concentrated acid solutions. Acid hydrolysis of cellulose produces hydro- celluloses. Cold weak acids do not affect it. The fibers show excellent resistance to alkalis. There are few other solvents that will dissolve cotton completely. One of them is a copper complex of cupramaniumhydroxidde and cupriethylene diamine (Schweitzer's reagent). Cotton degradation is usually attributed to oxidation, hydrolysis or both. Oxidation of cellulose can lead to two types of so-called oxy-cellulose, depending on the environment, in which the oxidation takes place. (Natarajan,2004).

2.1.5 Advantage of cotton

There are many benefits of cotton clothing, but some of the most commonly cited are the material's hypoallergenic nature, weather proof and its moisture- wicking properties. Fabrics made of cotton are naturally resistant to dust and dust mites, and are also non-irritating even in people who are prone to skin problems like rashes or eczema. The fabric can tolerate very hot water so it's easy to sterilize, and it can be used for almost any sort of clothing (www.wisegeek.com).

2.1.6 Uses of cotton

Cotton today is the most used textile fiber in the world. It can be used in all types of garment and household fabrics, being used in boots and shoes, carpets and curtains, and clothing and hats (Davulcu et al,2014)

It is cultivated and procedure in over 30 countries across the world and is a major source of export income for several countries (Singh,2010)

2.1.7 Pretreatment of cotton

The basis of even dyeing produced lies in the efficient preparatory process. According to Pardeshi(2006), the impurities have to be removed thoroughly and uniformly from the fabric, the witness must be leveled, independent of the location within the fabric, for improving the efficiency of the dyeing process. As stated by Shukla (2005) the three categories of wet processing namely pretreatment, coloration and finishing are adopted for better and pleasing result in textile. The fabric need to be prepared before dyeing, printing and finishing, describe Giridev *et al* (2005). The process of preparing the fabric for further finishing is called pretreatment preparatory process (Prabhu and Bharathimohan,2003). To prepare a finished product the various processing are done. They are desizing, scouring, bleaching, mercerizing, dyeing, printing, softening and stabilization (Nataraj *et al*,2005)

Desizing is a process employed to remove the sizing material present in the greige cloth to make it suitable for further processing, state National Institute of Industrial Research(2000). The objectives of desizing is to remove the sizing material which may hinder during subsequent wet processing treatments and completely as possible. Efficient and uniform size removal are the two important requirements of any desizing process (Nayak,2006).

Desizing is the first step which enables the garment to properly receive subsequent chemical and mechanical treatments by removing the previously applied warp sizes and finishes, express Jinenez and Estape (2004). Desizing is the process of removing of the sizing material from the fabric (Murphy,2000).

2.2 Natural dyes

Coloring matters derived from natural sources are called natural dyes, states jayalakshmi (2008). Till later half of the dyes were derived from animal and vegetable sources (Paul *et al*,2006).

Natural dyes are associated with our ancient culture and heritage. The traditional kalamkari and Rajasthan prints, Bhandhani are all arts which used natural dyes (Sharma *et al,* 2007).

The main natural dye substances used in india have been extracted from the roots, barks, flowers and fruits of various dye producing plants. These were used extensively during the Harappan and Vedic civilization, during medieval times and even during early days of British rule in India (mondal *et al.,*2004).

Natural dye gives subtle, rich, warm colours that are unique. The beauty of natural dyes resets in their colours and ability for those colours blends and mix in a way uniform and visually pleasing. They have mystery and life that fascinate and satisfies (javali *et al*,2009).

2.2.1 History of natural dyes

In every civilization from remote ages to the present, the art of dyeing has play an important role in adding beauty to the world. natural dyes makes an important contribution of fabric decoration by producing various beautiful colours and colour harmonies, obtained by a combination of various dyeing methods (Agarwal and Gupta, 2003).

The history of natural dyes is very interesting. Egyptian mummies have been found wrapped in clothes dyed with dyes from the madder plant. Alexander, the great was supposed to have deceived the Persians into thinking that his army was wounded, by sprinkling on his soldiers with a red dye, probably madder plant juice, which contain the dye alizarin (sidhu *et al* 2005). Since early ages, natural dyestuffs were used for dying the fabric and almost 19th century all the dyes were natural in origin. But as the science and the technology progressed, synthetic dyes were invented and the world quickly adopted them because of certain advantages as compared to natural dyes (Mahajan *et al,* 2007).

Dyes are organic compounds that can be fixed in a substances with more or less performance in the form of a colour (patel and karolia 2005). Dyes are fluids or substances, which permanently fix the colour on fabric. Dye stuff is the name givento material, solution or matters that colour textiles (Rawat et al 2006).

2.2.2 Advantage and disadvantage of natural dyes

Natural dyes have several advantages over synthetic dyes from the point of view of health, safety and ecology. There is increased awareness and demand for this type of product. Much work has been done on their application on natural fibers. And with synthetic fibers like polyester having become a part and parcel of our lives, dyeing them with natural dyes can immensely help in their value addition (Korkmoz *et al*.,2007).

In the recent years concern for the environment has attracted the attention of the world towards natural dyes. This is further enhanced when toxicological effects of dyes during production and harmful effects on skin during wearing are being more and more known. While natural dyes do not create any pollution problems and in some cases like harda, indigo, etc. The "waste" in process becomes an ideal fertilizer for use in agricultural fields (Vankar et al 2008).

Compared to synthetic colour the colour obtained from natural sources are more soothing to human eyes. No synthetic dyes to dates have been made that match the subtle tones created by the natural dyes. Thus, efforts should be made to explore different dye sources hidden in the beauty of nature (Kale *et al* 2007). The application of the new synthetic dyes drove the art and craft of the natural into oblivion. The unbridled use of synthetic dyes and the non-treat of effluents contained in the waste water of the dyeing process had led to hazardous results, as pointed out (Phukan and Phukan,2004).

The market for the natural dyestuff is very small. Natural dyed material is not widely available to the average consumer. The technology to utilize natural dyes in the modern clothing industry is relatively new and still being improved upon.many textile manufacturers are not using these days regularly because these dyes are more expensive than synthetic dyes (Indi and Chinta 2007).

2.2.3 Classification of Natural Dyes

Natural dyes can be classified in various ways. The earliest classification was according to alphabetical order, later it was based on chemical structure, where grouping of each structure was carried out according to the use, there would be at least 30 different types. There are therefore, categorized into fewer groups based upon the method of application used and the type fibers that each dye will colour (Ansari and Thakur,2000). Natural dyes have also been classified based on botanical and common names.Natural dyes are broadly classified as natural organic dye stuff of vegetable or animal origin and mineral dye stuff or inorganic pigment (Kiran and Kapoor,2004)

Vegetable origin

Colouring matter derived from nature through herbs and plants, flowers, seeds, barks and root are vegetable origin yes. It is believed that there are at least 3000 plants from which colouring matter can be extracted. The main common vegetable dyes are indigo, alizarin, madder, henna, catechu, saffron, fustic, sumac, legwood, etc (Buhchanan, 1987).

Animal origin

Lac, cochineal and kermes has been the principle dye yielding insects. The other animal dyes are squid septa and tyrian purple obtained from species of fish and small insects (Sujata saxena and Raja,2014)

Mineral origin

Mineral dyes comprise all those inorganic metal salts and metal oxides.

Natural dyes can be divided into two classes:

a) Substantive dyes, which have a direct affinity for the fiber and
b) Adjective dyes, which require a mordant to fix the colour upon the cloth by (Kate Wells, 2000).

Substantive dyes

These dyes can be used without any additional chemicals, but they may not produce as strong or as fast a colour as they might if a mordant is employed during the process.

The amount of dyestuff required is calculated on the weight of the dry fabric. It is then weighed out into a suitable dye container and boiled in water for 30 minutes to extract the dye. The wetted out fabric is then sunken in the dye liquor and boiled for a further 45-60 minutes before being removed from the dye, rinsed well and dried (Muthu, 2014).

Adjective or mordent dyes

These dyestuffs require a mordant to fix the colour onto the fibers of the fabric. A mordant can be applied to the fabric before or during dyeing, or afterwards a modifier. Different mordant will, of course, produced different colours and shades with the same dye separate mordanting techniques are required for dyeing. Natural dyes can be categorized as either substantive or adjective. Substantive dyes (also known as direct)dyes such as indigo, lichens or walnut hulls affix to the fiber without the aid of another chemical or additives. Adjective (also known as mordant dyes) requires a fixative, usually a metal salt, to prevent the colour from washing or bleaching out. Most adjective dyes are also considered reactive because they form a chemical bond with the fiber and do not easily wear off (Javali *et al*,2009).

2.3 Mordant

The word ‘mordent’ is derived from Latin mordere ‘to bite’ because mordents were believed to eat away the surface or open up the pores in a fiber and thus facilitate dye absorption (Ratnapandian, 2013). Mordant are metal salts which produce affinity between the fabric and the dye. Alum, chrome, stannous chloride, copper sulphate and ferrussulphate are the commonly used mordants (Singh and Purohit, 2014).

Due to the environment hazard caused by metallic mordant while dyeing of textile fabric, manufacturers have to find out safe nature mordant for application of natural dyes (Teli et al, 2013). Mordant prevents the colour from either fading with exposure to light to washing out. These compounds bind the natural dyes to the fabric.

2.3.1 Types of mordant

- **Metallic mordants :** metal salts of aluminium, chromium, iron, copper and tin are used.
- **Tannins :** myrobalan and sumach are commonly used in textile industry.
- **Oil mordants :** these are mainly used in dyeing turkey red colour from madder. The main function of the oil mordants is to from complex with alum
- used as the main mordant (Shan, 2009).

2.3.2 Mordanting Technique

It could be suggested that mordanting method directly affects the kind and stability of complex formed by the mordanting agent and strength of the bond between dye and fiber, resulting in light absorption, reflectance and fastness properties of dyed material (Ismal and Yildirim, 2012). Mordanting techniques employed play a significant role in the colour strength and fastness properties during the subsequent dyeing operations onto cotton (Mahangade et al,2009).

- Pre-mordanting, where the mordent is applied first, followed by dyeing.
- Post-mordanting, where the dyeing is done first and then mordanting is carried out
- Simultaneous mordanting, where mordant and dye are mixed together and applied.(Singh, 2010).

2.4 Selection of Natural Dye *Persea americana* pit

Natural dye materials can be sourced directly from your kitchen, garden, or even urban neighborhood. A perfect example of a natural dye that applies gorgeous color and transforms waste into wonder is the avocado pit.

Avocado pits produce light- to deep-pink shades and russet reds with no mordant added. When an iron solution is added, the color will transform into inky blues, purples, and blacks. Applying an iron after-bath to your pink and russet red dyed fiber can also allow you to resist-pattern and dip-dye your fabrics for awe-inspiring effects (Gomez Lopez, 1998).

2.4.1 Uses of *Persea americana* pit

Make dye

Use both the skins and the pit to create a natural pink-hued dye for fabric. You'd think it would turn out green, but no, it turns out pink. Artist Ruth Singer offers her step-by-step technique and shows off her lovely results. The shade of pink depends on the fabric you use.

Whip up a facemask

Dry the pits, grind them up, and put them in a homemade facemask as an exfoliant. Blend a seed with your choice of ingredients: olive oil and a banana, avocado and lemon juice, or any ready-made facial scrub. The avocado seed helps the mask slough off dead skin, says Simply Jayy.

Grow an avocado plant

Start with three toothpicks, a glass of water, some sunlight and one avocado pit, says sustainable America. You should see the roots and stem start to sprout in just a few weeks.

Be creative

A chef who goes by the name of Triclaw says, he goes through so many avocados in his restaurant that he felt bad tossing the seeds. He started carving them and said they were like dry clay. He's made faces, snails and all sorts of interesting shapes. Or carve the pits and make them into jewellery.

Wash your hair

Get clean with some homemade avocado shampoo. This easy recipe from Bread with Honey uses three dried and grated avocado pits, six cups of water and just a few ounces of your regular shampoo. The shampoo supposedly thickens and softens hair (McLeod,2008)

2.4.2 Medical Properties

- It is an antioxidant: it prevents cell aging
- Helps raise defenses and fight diseases caused by microbes, fungus, and parasites
- Joint and muscle pain relaxer when used topically
- Prevents epilepsy
- Quickly eliminates the appearance of blemishes and boils when applied topically because it dries them up
- It has a rejuvenating effect on the skin, because it boosts collagen formation
- It is a good supplement for naturally treating asthma (Morton and dowling, 1987).

2.4.3 Application of *Persea americana* pit

- Crush them and mix with alcohol and let the mixture soak for at least a week. Use this alcohol for massages and rubs, in the case of joint and muscle pains for example. In the case of migraines, massage your temples and neck gently.
- With the seed's powder, you can make a cream to apply to blemishes and boils, thus making them dry quicker. Mix the powder with a little bit of hot water to make a paste, which you will put between two layers of grease to apply to the skin for 5 to 10 minutes until you notice that it is dry. You can repeat every day until it improves.
- For shiny hair and to fight dandruff: Grate the seed but make sure it is raw and not toasted. Mix it with castor oil and let soak for a day. Then rub it on your scalp. Cover your head with a towel or film and let sit for an hour and wash your hair well. We don't recommend this treatment for very oily hair.
- You can also use the seed's powder to exfoliate and tone your skin.
- For your information, ground avocado seeds mixed with cheese and flour are used for mouse poison (Leite *et al,* 2009)

2.5 Extraction methods

Natural dyes are generally prepared by boiling the crushed powder with water and sometimes it is left to steep in cold water. Technology for production of natural dyes could vary from simple aqueous to complicated solvent system to sophisticated super critical fluid extraction techniques depending on the product and clarity required (Kashkar and Mansour,2013). The different method for extraction of colouring material are:

2.5.1 Aqueous extraction

Steeping, boiling and fermentation in water of plant material forms the most common dye extraction technique. The extract is purified by simple filtration, settling and evaporation to obtain the final dye in paste, cake, granule or powder form. This process diminish transportation cost of raw materials and also helps to standardize the final product (Ratnapandian, 2013).

2.5.2 Solvent extraction

Natural colouring matter depending upon their nature can also be extracted by using organic solvent such as acetone, petroleum ether, chloroform, ethanol, methanol, or a mixture of ethanol and methanol, mixture of water with alcohol and soon. The water/alcohol extraction method is able to extract both water-soluble and water-insoluble substances from the plant property. The extraction yield is thus higher as compared to the aqueous method as a larger number of chemical and colouring material can be extracted.

2.5.3 Acid and alkali extraction

As many dyes are in the form of glycosides, these can be extracted under dilute acidic or alkaline condition. The addition of acid or alkali facilitates the hydrolysis of glycosides ensuing in better extraction and higher yield of colouring materials(Muthu,2014).

2.5.4 Microwave assisted extraction

Started in the late 1970s, the use of microwave energy as a heating source in analytical laboratories was applied. Indeed, a novel process such as microwave-assisted extraction (MAE) has been over conventional extraction methods. MAE possesses the advantages of considerable reduction in time (Ahmad *et al*,2014).

2.5.5 Enzymatic extraction

Enzymes degrades the cell wall tissue and exposes the interval vesicles for more efficient process, i.e., it disintegrates the plant tissue to improve the yield in pigment extraction. Enzymatic extraction process is clean and environment friendly and a substitute to conventional solvent based extraction process (Mishra *et al*,2009).

2.5.6 Soxhlet extraction

Soxhlet extraction is a general ad well-established technique that procedure higher yields than other conventional extraction techniques. It is therefore an exhaustive method. It has been used for a long time for extraction of products from plants. Soxhlet is used as a reference extraction method for evaluating the performance of new solid-liquid extraction approaches, even for the most advanced extraction methods due to its simplicity, low cost per sample, and the inexpensive and robust extraction apparatus(Mauricio *et al*,2013).

3. EXPERIMENTAL PROCEDURE

The experimental procedure pertaining to the study entitled **"Extraction of Natural Dye from *Persea americana* pit and its Application on Cotton Fabric"** is carried out under the following headings.

3.1 Selection of fabric

3.1.1 Pre treatment of fabric

3.2 Selection of natural dyes sources

3.3 Pilot study

3.3.1 Extraction of natural dye

3.3.2 Processing of Natural Dye

3.4 Selection of mordants

3.4.1 Selection of mordanting Technique

3.5 Optimization Parameter for Extraction of Natural Dye

3.5.3.1 Solvent

3.5.3.2 Dye concentration

3.5.3.3 Time

3.5.3.4 Temperature

3.5.3.5 pH

3.6 Dyeing

3.6.1 Dyeing Parameters

3.6.2 Dyeing Method

3.7 Evaluation of the Dyed fabric

3.7.1 Objective Evaluation

3.7.1.1 Physical and Mechanical Evaluation

3.7.1.1.1 Fabric Thickness

3.7.1.1.2 Tensile Strength and Elongation

3.7.1.1.3 Fabric weight

3.7.1.1.4 Drapability Test

3.7.1.1.5 Fabric Stiffness

3.7.1.2 Wettability and Absorbency Evaluation

3.7.1.2.1 Drop Test

3.7.1.2.2 Sinking Test

3.7.1.2.3 Vertical wicking Test

3.7.1.3 Colour Fastness Evaluation

3.7.1.3.1 Fastness to Sunlight

3.7.1.3.2 Fastness to Wet and Dry Pressing

3.7.1.3.3 Fastness to crocking

3.7.1.3.4 Fastness to Washing

3.8 Nomenclature

3.1 Selection of fabric

Cotton is a soft, comfortable and most widely used cellulosic material for apparel purpose. Cotton possesses many excellent qualities such as coolness, durability, good absorbency, high tensile strength, good abrasion resistance and low cost. Cotton enjoys an extremely positive image due to its naturalness and gentleness to the human skin. The cotton material was bought from the local khadi shop, Coimbatore.

3.1.1 Pre treatment of fabric

The aim of the preparatory process is to improving the quality, by removing impurities and foreign matters thoroughly and uniformly from the fabric and make the fabric suitable for follow up processes (Anthappan *et al*.,2006). All fabrics need to be free from impurities before dyeing, says (shenai 2004). Desizing process was employed to remove the sizing material present in the fabric to make it suitable for further processing, as suggested by NIIR. The selected cotton material was desized with the following receipe:

Cotton material : 2 meter

Detergent powder : 2%

Wetting agent : 0.5%

Temperature : 80^0- 100^0 C

M L R : 1 : 20

Time : 1 hour

3.2 Selection of natural dyes sources

Natural dye can be defined as those colored substances that have the affinity to the substrate to which it is being applied and derived from natural sources such as plants, animals and minerals (Mishra et al.,2009). The dyes are obtained from renewable sources having no health hazards and no disposable problems (Bansal and Sood, 2002).

Persea Americana pit with its eco – friendly natural possess medicinal benefit property. Hence the seed was selected for the present study (Plate-I).

3.3 Pilot study

A pilot study was carried out in order to select natural dye sources, mordants, mordanting techniques and dyeing procedure.

3.3.1 Extraction of natural dye

The pi of *Persea Americana* pit is collected and washed. The pits are then cut and dried in shade (Plate-II). The dried pit is grounded and made into a fine powder. The extraction was carried out with 8 grams of powder (Plate-III) is boiled in 100ml of water at 100^{0}C for 150 minutes in water bath.

Then the solution was filtered using filter paper. Thus, the filtered extract serves as the dyeing solution (Plate-IV).

3.3.2 Processing of Natural Dye

The flow chart for extraction of dye components from plant sources as follows:

Figure 1

Processing of natural dye

Plate I
Persea americana pit

Plate II
Fresh pit- cut and dried

Plate III
Persea americana Powder

Plate IV
The Dye Extract

Plate V
Orange Peel and Powder
(Mordant)

3.4 Selection of mordants

Dye and mordant is the essential two dependent factors responsible for the development of natural colours applied to the textiles (wanyama et al.,2010). A large number of natural dyes have low affinity and required the use of a mordant to fix the dye to the textiles and hence are known as mordant or adjective dyes (Rathnapandian.,2013).

Orange peel (Plate-V) as a new natural dyestuff with strong ultraviolet absorbance. It is an abundant, cheap and readily available agricultural byproduct. Orange peel are a rich source for carotenoids.it contain flavonoids, phenolic acid, pectin and waxes. The compound in orange peel extracts are by some researches tested on their UV-protective properties (Wang *et al,* 2008). Natural mordant, orange peel was selected for the study because it showed good dye affinity (Shah.,2009).

3.4.1 Selection of Mordanting Technique

The techniques selected are given below:

1. Without mordanting
2. Mordanting
    - Pre mordanting
    - Post mordanting
    - Simultaneous mordanting

The study was conducted among pre mordanting, post mordanting and simultaneous mordanting. Out of this simultaneous mordanting technique was followed for the present study (Singh, 2010)

3.5.3 Optimization Parameter for Extraction of Natural Dye

3.5.3.1 Solvent

To determine the suitable solvent for extraction 5 grms crushed powder of *Persea americana* seeds was tested with different solvents such as water, ethanol, methanol and NaoH individually and placed in water bath for 1 hour at 90^0c. the resulting dye extract was filtered and colour intensity was measured at 273 nm using spectrophotometer. The solvent which showed higher absorbency was selected as the suitable solvent and used for further study.

3.5.3.2 Dye concentration

To determine the optimum concentration of the dye source, *Persea americana* seed at various concentration such as (1,2,3,4,5,6,7,8,9,10%), was taken individually and placed in water bath for one hour at 90^0c. the optical density of the dye solution was analyzed with spectrophotometer at 273 nm. The concentration at which the colour intensity was higher was fixed as optimum dye concentration and used for the subsequent study.

3.5.3.3 Time

To determine the optimum extraction time, the dye extraction was carried out at different time intervals such as 30-150 min. the dye solution was analyzed with spectrophotometer at 273 nm. The time at which the absorbance was maximum was selected as optimum time.

3.5.3.4 Temperature

To determine the optimum temperature, the dye extraction was carried out at different temperature such as 30 - 110^0c. the optical density of the dye solution was analyzed with spectrophotometer at 273 nm. The temperature at which the absorbance was maximum was selected as the optimum temperature for the dye extraction.

3.5.3.5 pH

To determine the optimum pH for extraction, the pH of the solvent was adjusted to 1,3,5,7,8,9,10 using 1 N HCL and 1 N NaoH. Optical density of the dye solution was determined.

3.6 Dyeing

3.6.1 DyeingParameters

Dyeing parameters namely dye concentration, dyeing time, temperature, and method of mordanting were optimized. To determine the optimum dye concentration different percentage of dye extract such as 20, 40, 60, 80 and 100percentage was used for dyeing. The optimum dye concentration was selected based on the shade produced on the fabric. To evaluate the optimum dyeing time, dyeing was carried out at different time (30,60,90,120,150 minutes) Dyeing temperature was determined by dyeing the selected fabric at different temperatures such as (30,60,90,100,110^{o} C). The optimized parameters for dyeing the selected cotton fabrics are as follows.

Table I

Dyeing parameters

PARAMETERS	DYEING
Material Liquor ratio	1:20
Dye concentration (%)	8
Dyeing time(min)	150
Dyeing temperature(^{o}C)	100

The selected cotton fabric was dyed under optimized condition by extraction method.

3.6.2 Dyeing Method

The selected cotton fabric was dyed using dip and dry method. The cotton fabric was immersed in dye at 100^{0}C for 150min. The dyed fabric was taken out from the bath and dried in shade (Jothi,2009).

3.7 Evaluation of the Dyed fabric

3.7.1 Objective Evaluation

Textile testing is the process of inspecting , measuring , evaluating characteristics and properties of textile materials. The desized originals and the samples dyed with biomordants were tested by using the sample pieces, from the same relative portions of the material for their respective laboratory tests.

3.7.1.1 Physical and Mechanical Evaluation

3.7.1.1.1 Fabric Thickness

The thickness of a textile material is the distance between two plane parallel plates as the pressure foot and the other as the anvil , says Jewel (2005).Thickness is measured to an accuracy of at least 0.01 mm under the prescribed pressure ranging from 0.005 psi , depending on the type of fabric under (stocker *et al*, 2005).

The Hungarian Thickness Tester (Plate – VIII)was used to determine the thickness of the original and the dyed materials. The thickness tester is a hand operated instrument which had a broad anvil, upon which a pressure foot is pressed by spring. The dial indicated the thickness of the material in thousands of an inch between the anvil and the pressure foot.

Each division on the dial read 0.01mm the sample was placed on the anvil without tension or crease and the presser foot was lowered on to the sample by releasing the rising level very slowly and allowed it to rest upon the sample for two seconds at 2 kgs pressure. The dial reading was recorded. The readings were taken from different places of the same material and the mean value was calculated. Similarly , mean value often readings from the original and dyed materials were calculated and thus recorded the fabric thickness of each material separately.

3.7.1.1.2 Tensile Strength and Elongation

Breaking strength is the force required to break a fabric when it is under tension (Vaishnav and Joshi, 2000). It is the resistance of the fabric to a tensile load or stress in either the wrap or filling directions (Osayuanda, 1990). Elongation is the extent to which the fabric under tension extends, till it cut off (Nakamura, 2000). The percent strength loss and percent change in elongation at break were determined by the tensile testing method using tensile strength tester, according to standard procedures (Prabaharan and Rao, 2003).

Eureka Brand Pendulum Tensile Strength Tester (plate – VII) was used to determine the breaking strength and elongation of the desized and dyed samples without and with mordants. The capacity of the machine and the rate of transverse were 90 kg and 40 cm per minute respectively. The gauge length or the distance between the jaws was set at 20 cm. the sample was cut to a width of 2 inch and length 12 inches. The yarns reveled from both the edges until the width measured to one inch.

Under the optimum conditions, the sample was mounted centrally, gripped along the full width to prevent slippage of the sample. The pendulum of the tester was ser vertically and the pointer at zero on the scale. When the load was applied to the sample it ruptured the sample, mechanism was stopped and the dial reading is recorded in kilograms for breaking strength and elongation in cms were noted. Ten readings for original and dyed samples both wrap and weft direction were recorded.

3.7.1.1.3 Fabric weight

Fabric weight is the mass per unit area of a length of material that also plays a role in determining the density of a material. The fiber content, yarn size, and fabric count impact the weight of the material (Bubonia,2014)

A sample of 10 * 25 cm was cut using gsm cutter (Plate-X). It has sharp blades which penetrate onto the fabric when pressure is imparted with slight twist. The weight of the cut sample was found using electronic weighting balance. The inference found was calculated using the following formula:

$$\text{Grams per square meter (GSM)} = \frac{\text{Weight of the fabric * square meter}}{\text{Area of square}}$$

The same was followed to find out the fabric weight of original and dyed fabric and was carefully recorded and the mean value was calculated.

3.7.1.1.4 Drapability Test

Drape is the ability of a fabric to hang in soft folds and to fit around a figure, particularly in movement, without creating distorted creases (Aldrich, 2012).

Drapability of the fabric was determined using eureka drape tester (Plate-XI). A circular piece of fabric was cut by placing a circular disc and same was cut in a pattern sheet. A hole was made to the specimen through which it was fitted and the fabric was allowed to hang on its own weight. A small disc was placed on the top of it and the instrument was closed. A light was switched on. A pattern sheet was placed and drape of the fabric was drawn by following the shadow of the draped fabric.

Drape co-efficient was determined by considering the following,

The drape co-efficient is given by,

$$F = \frac{A - A_d}{AD - A_s} \times 100$$

AD – the area of the specimen

A_d – the area of the supporting disc

A_s - the actual projected area of the specimen

Ten Readings were taken from the original sample and dyed sample and their mean values were calculated and tabulated.

3.7.1.1.5 Fabric Stiffness

Fabric stiffness is the ability of a material to resist deformation, says Grover (1969). Fabric stiffness can also be determined by finding the bending length. Talukdar *et al* (1998) indicates that the bending properties of textile provide a measure of fabric properties like stiffness, drape, handle and crease recovery. The bending length increases with the increase in fabric weight and fabric stiffness as shown by the way in which a fabric bends under its own weight.

Fabric stiffness is defined as the resistance of a fabric to bending under its own weight(Plate-IX). The Shirley fabric stiffness tester was used to measure the stiffness of the sample. The samples were cut to the size of the template. Sample were taken in both warp and weft direction of the sample. Four ends in two side with two ends in each side were marked as A,B,C and D. the readings were recorded for all four sides. Ten samples in each direction were taken. The tester was set on the table so that the horizontal platform and the index lines are at eye level.

The specimen was placed on the platform with the template on top of it, so that the leading edges coincide. The specimen and the template were slowly pushed forwarded until the leading edges of the specimen touch the index line. The bending length was measured. This was carried out for all the fabric samples and the mean value was calculated (Mehta and Bhardwaj, 2000).

Plate VI
Electronic weighing Balance

Plate VII
Fabric Tensile Strength Tester

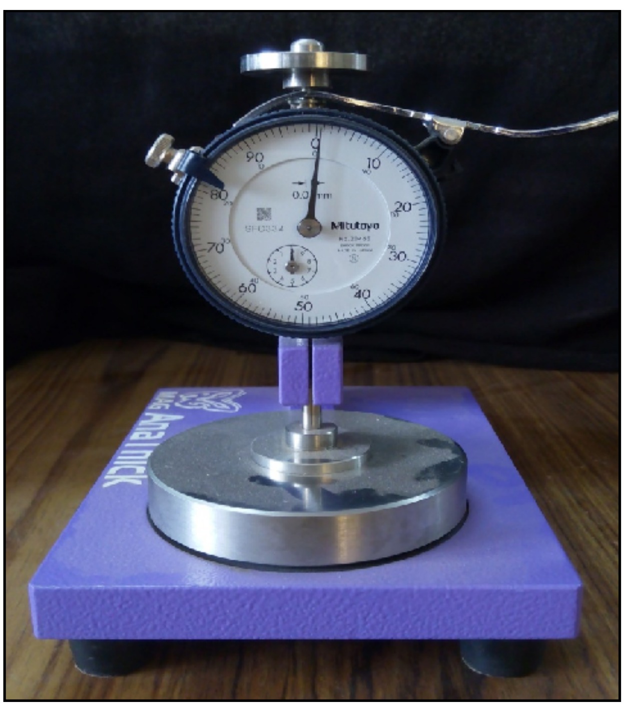


Plate VIII
Fabric Thickness Tester

Plate IX
Fabric Stiffness Tester

Plate X
GSM Cutter

Plate XI
Drape Meter

3.7.1.2 Wettability and Absorbency Evaluation

British cotton industry research association has developed a test, in that test, a dropof water (or sugar solution) is placed on the specimen fabric which is mounted horizontally. The time taken for the contact angle to drop to 45 degrees is noted. The reciprocal of thr time taken is called “wetting velocity” or simple “wettability”.

3.7.1.2.1 Drop Test

The drop test is a count of number of drops required to penetrate through to the underside of the fabric when all the drops fall on the same spot, described Jewel (2005). The ability of the fiber to take up moisture is determined as absorbency. Wettability is a time taken in seconds for a drop of water to sink into the fabric. If any fabrics takes more than 200 seconds to absorb water are considered as unwettable. This is known as “drop test”.

In this experiment, a burette filled with distilled water was clamped in a stand. The same was mounted in an embroidery frame and was placed at the base of the stand. The weight between the sample and burette nozzle was kept constant. The nozzle of the burette was opened to allow a drop of water to fall on to the sample. The stop watch was started simultaneously and it was stopped when the drop of water fully sank into the material. The time taken for this was noted. The same procedures was repeated for ten samples of the same material and the mean value of ten samples, from the desized original and the dyed material was calculated and thus, the wettability of each material was recorded separately (Jewel, 2009).

3.7.1.2.2 Sinking Test

Sinking test is a simple test of wettability of fabric. In this test, as ten small square specimens about 5 x 5 cm were cut from the each of desized original and the dye materials and drop it to the surface of water in a beaker contain 1000ml of distilled water and few drops of wetting agent was added into the distilled water. The stop watch was started when the fabric struck the surface of water and stopped when the last corner sank below the water surface and the time required for the sample to sink was noted. The same procedure was repeated for ten samples. Then the mean value was calculated for the above samples. Similarly, the mean value of the desized original and the dyed materials were calculated and the sinking time of each material was recorded separately (Booth, 2000).

3.7.1.2.3 Vertical wicking Test

Wicking test is the test that helps to measure the rapidity of absorption,. The samples were prepared with the dimension of 15 cm length and 2.5 cm width. A mark was made of 1 cm from one end of the sample. The other end of the sample strip was hoisted with the glass rod which was placed across the beaker. The sample was left to dip in the water such that the surface of the water in line with the 1 cm mark made on the fabric. The rise of water level on the sample was noted after 30 minutes keeping the time constant. The measurement was made starting from the 1 cm mark to the extend up to which the sample was wet. The readings were recorded and the mean value was calculated. A total of ten samples were tested, recorded and expressed in centimeters (paul, 2005).

3.7.1.3 Colour Fastness Evaluation

In natural dyeing colour fastness of the natural dyes requires considerable attention and careful selection of materials and processes. The color fastness quantifies the color change on a dyed material under specific conditions and also the transfer of dyestuff to uncoloured adjacent material (bleeding) (Bechtold and Mussak, 2009). Color fastness test such as colorfastness to sunlight, crocking, pressing and fastness to washing were determined.

3.7.1.3.1 Fastness to Sunlight

Fastness to light is one of the most important properties of a dyed fabrics needs in order to fulfill its utilization purpose over a period of time (Paul *et al*, 2003).

A dyed sample of 6cm length and 1cm width size were taken from each of the dyed materials. The entire samples were divided into eight parts by marking distance of two inches in the larger side marked up to eight. Each sample was covered to prevent the samples from direct sunlight. For the successive seven days the other portions were exposed accordingly along with the first portion. The first portion got seven days exposure to sunlight. The changes in color of dyed samples were compared with the original and the specimen were rated using grey scale.

3.7.1.3.2 Fastness to Wet and Dry Pressing

The National Bureau of Standards suggested a test to determined color fastness to dry and wet pressing. A hot iron was used to ascertain the fastness of dyed textile to wet and dry pressing. Test sample were cut into 5X10cm. they were kept between the desized material both in dry and wet condition and were pressed with a heavy iron for five seconds at a temperature at 420^0F and 10 seconds at 350^0F respectively.

3.7.1.3.3 Fastness to crocking

Crocking is defined as the colour transfer from one colour textile to another by rubbing method (Wingate and Mobler, 1970).

Sasmira crock meter was used to determined the fastness of the dyed textile to wet and dry crocking. It has metal blocks. The base block was stationary, while the upper block had an arrangement to move to and fro from the base by means of a rotating handles. There was a finger knob attached to the upper block to hold the cotton material with ring. The samples were cut into pieces with the size of 20 X 10 cm, the sample was fixed on the base block with longer side in the direction of rubbing the white desized original material (5X5cm) was fixed on the finger knob of upper movable block with a ring. The number of rubs given was standardized and fixed as ten rubs. Each sample was given ten strokes and the colour change and staining on the white cloth were graded.

3.7.1.3.4 Fastness to Washing

Major loss of colour from the fabric is due to washing and results in staining over the adjacent fabric. Test sample of the dyed fabric measuring 5x10 cm size were cut. Each of them was sandwiched between the undyed white cloth which was desized well. Specimen was completely soaked in the soap solution about 5g/1 for 30 minutes at 40^0C,after that the sample was removed rinsed in cold water, squeezed well and dried. Evaluation on staining on the white adjacent fabric was found using grey scale. The same procedure was carried out for other dyed sample.

3.8 Nomenclature

The details of nomenclature used in the chapter – 4 are presented in the Table II.

Table II

Nomenclature

S.No	Sample Details	Nomenclature
1	Original cotton	OC
2	Desized cotton	DC
3	Desized dyed cotton	DdC

4. RESULT AND DISCUSSION

The result and discussion pertaining to the study entitled **"Extraction of Natural Dye from *Persea americana* pit and their Application on Cotton Fabric"** is discussed under the following headings.

4.1 Selected parameters for Extraction of Natural Dye

4.1.1 Dye concentration

4.1.2 Time

4.1.3 Temperature

4.1.4 pH

4.2 Optimized condition for the extraction of dye from *Persea Americana* pit

4.3 Evaluation of Dyed Fabric

4.3.1 Objective Evaluation

4.3.1.1 Physical and Mechanical Evaluation

4.3.1.1.1 Fabric Weight

4.3.1.1.2 Fabric Thickness

4.3.1.1.3 Fabric Tensile Strength (Warp)

4.3.1.1.4 Fabric Tensile Strength (Weft)

4.3.1.1.5 Fabric Elongation (Warp)

4.3.1.1.6 Fabric Elongation (Weft)

4.3.1.1.7 Fabric Stiffness (Warp)

4.3.1.1.8 Fabric Stiffness (Weft)

4.3.1.1.9 Drapability Test

4.3.1.2 Wettability and Absorbency Evaluation

4.3.1.2.1 Drop Test

4.3.1.2.2 Sinking Test

4.3.1.2.3 Vertical Wicking Test

4.4 Evaluation of Colour Fastness

4.1 Selected parameters for Extraction of Natural Dye

The extraction efficiency of colorant component present in natural plant, animal, mineral, sources depend on the media type like aqueous, organic solvent, acid, alkali, pH of the media and condition of extraction, such as temperature, time and material to liquor ratio particle size of the substrate (Alemayehu *et al*,2014).

4.1.1 Dye concentration

The effect of various concentration of *Persea americana* pit was studied and the result are presented in Table III.

Table III

Dye Concentration

Concentration of *persea Americana* pit (%)	**Optical density at 273nm Extraction method**
1	0.519
2	1.097
3	1.445
4	1.803
5	1.259
6	1.622
7	1.505
8	**1.835**
9	1.386
10	1.209

Table III and figure 2, clearly indicates that dye the concentration of 8% in extraction method show maximum increase in absorbency. Hence *Persea americana* pit 8% concentration was used for extraction method.

4.1.2 Optimization of time

To determine the optimum time for effective extraction of natural dye, extraction was done at different time from 30-150 min and result are shown in the Table IV.

Table IV

Optimization of Time

Time (min)	**Optical density at 273nm Extraction method**
30	1.510
60	1.873
90	1.924
120	1.746
150	**2.294**

From the Table IV, it is clear that the colour intensity of the dye extract increases with increase in time and reaches maximum at 150 min in extraction technique and further increase in time has gradually decreased the colour intensity of the dye. Hence, the optimum time for extraction of dye was selected as 150 min respectively.

Figure 2

Dye Concentration

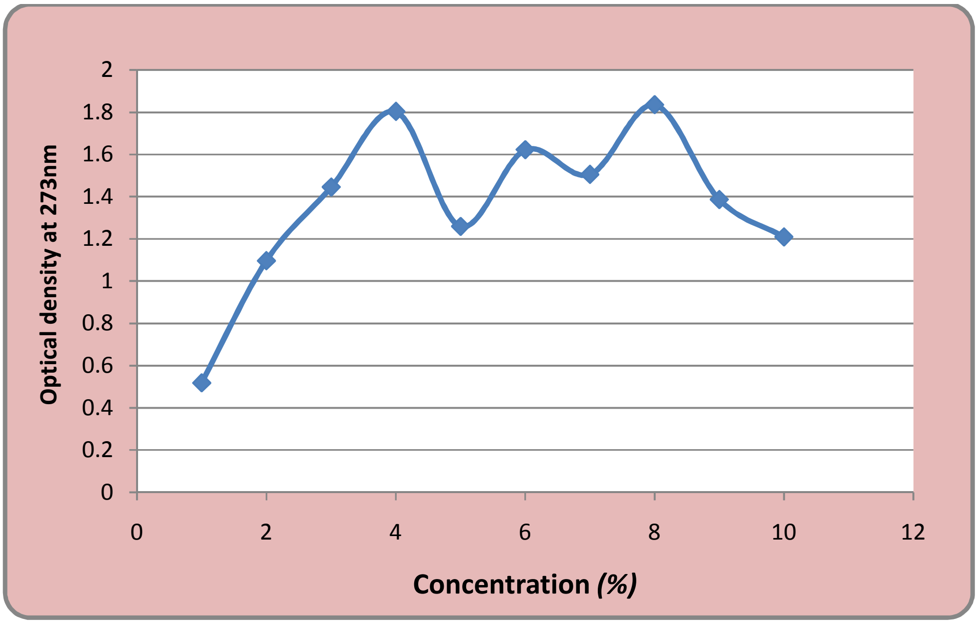
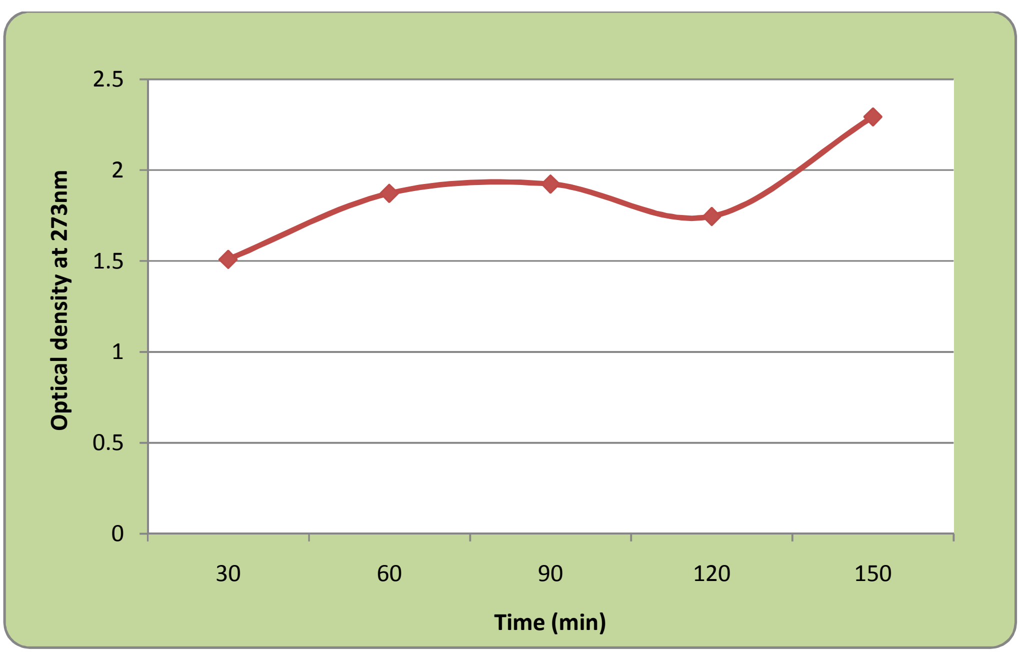


Figure 3

Optimization of Time



4.1.3 Optimization of temperature

To determine the optimum temperature for the effective extraction of natural dye, extraction was done at different temperature from 30-110^{0}C and result are shown in Table V.

Table V

Optimization of Temperature

Temperature (C^0)	Optical density at 273nm Extraction method
30	0.682
60	1.108
90	1.170
100	**1.195**
110	1.089

From the Table V, it can be seen that colour strength increases with increasing dyeing temperature in extraction method, dye extraction has reached maximum at 100^{0}C in extraction method. Hence 100^{0}C was a optimum temperature for the extraction method.

4.1.4 Optimization of pH

To determine the optimum pH for the effective extraction of natural dye, the extraction was carried out at different pH (1-10) and the result shown in Table VI.

Table VI

Optimization of pH

pH	**Optical density at 273nm Extraction method**
1	0.223
3	0.592
5	1.866
7	**2.185**
8	2.014
9	1.858
10	1.794

The effect of pH on the colour value of the dye was determined by recording the visible spectra of the dye solution at different pH ranging from 1to 10.

From the Table VI, it is clear that increase in pH increases dye extraction up to pH 7, and further increase in pH decreases the colour intensity. Hence pH 7 was selected optimum pH for extraction of dye.

Figure 4

Optimization of Temperature

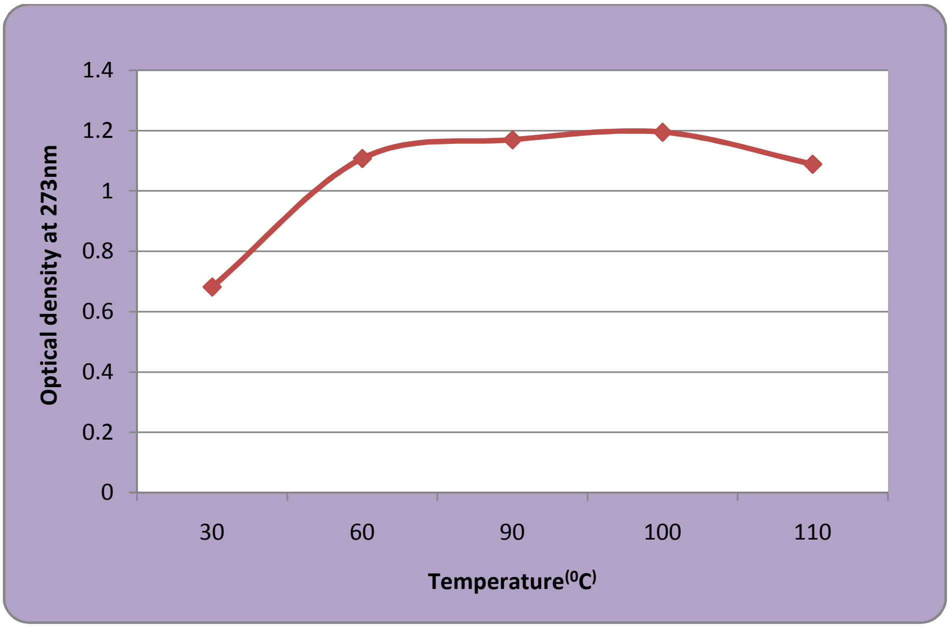
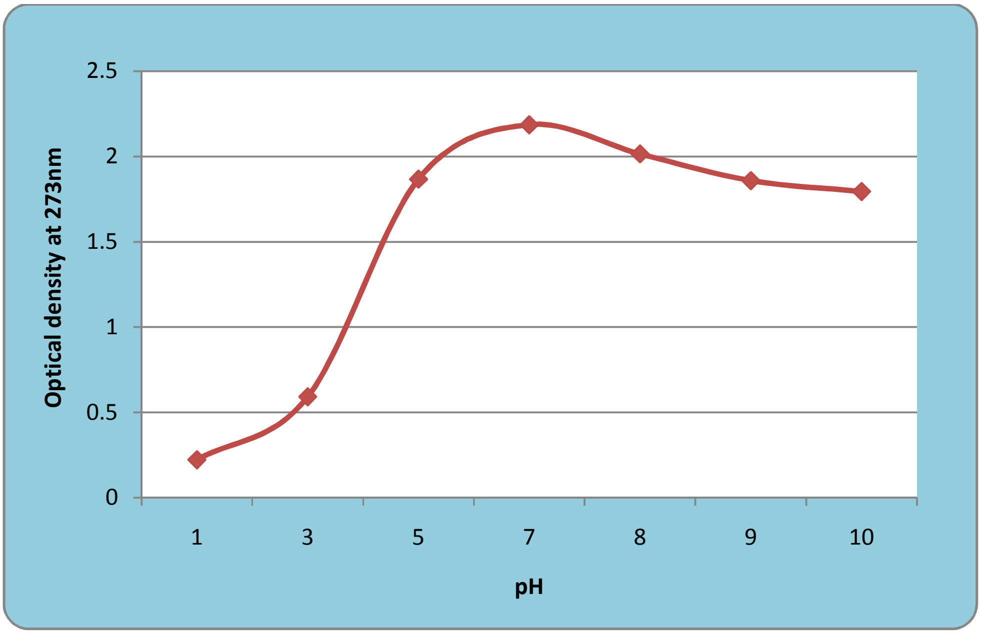


Figure 5

Optimization of pH



4.2 Optimized condition for the extraction of dye from *Persea americana* pit

Optimized conditionfor the extractionof dye from *Persea americana* pit are presented in Table VII.

Table VII

Optimized condition for the Extraction of Dye from *Persea americana* pit

Parameters	Optimized condition
Solvent	Water
Time	150 min
Temperature	100^0
Concentration	8%
Mass : Liquor ratio	1:20
pH	7

The dye was extracted under optimized conditions. The natural dye was extracted from *Persea americana* pit using water as a solvent at 100^0C for 150 min and filtered. The filtrate was used as the dye source.

4.3 Evaluation of dyed fabric

4.3.1 Objective Evaluation

4.3.1.1 Physical and Mechanical Test

4.3.1.1.1 Fabric Weight

The fabric weight and analysis of variance of the sample OC, DC, DdC are shown in Table VIII and Figure 2.

Table VIII

Fabric Weight

Sl.No.	Sample	Mean Value (GSM) g	Gain of Loss Over Original	% of gain or loss over original	"F" Value
1.	OC	1.56			5.682**
2.	DC	1.58	0.02	1.282	
3.	DdC	1.60	0.04	2.564	

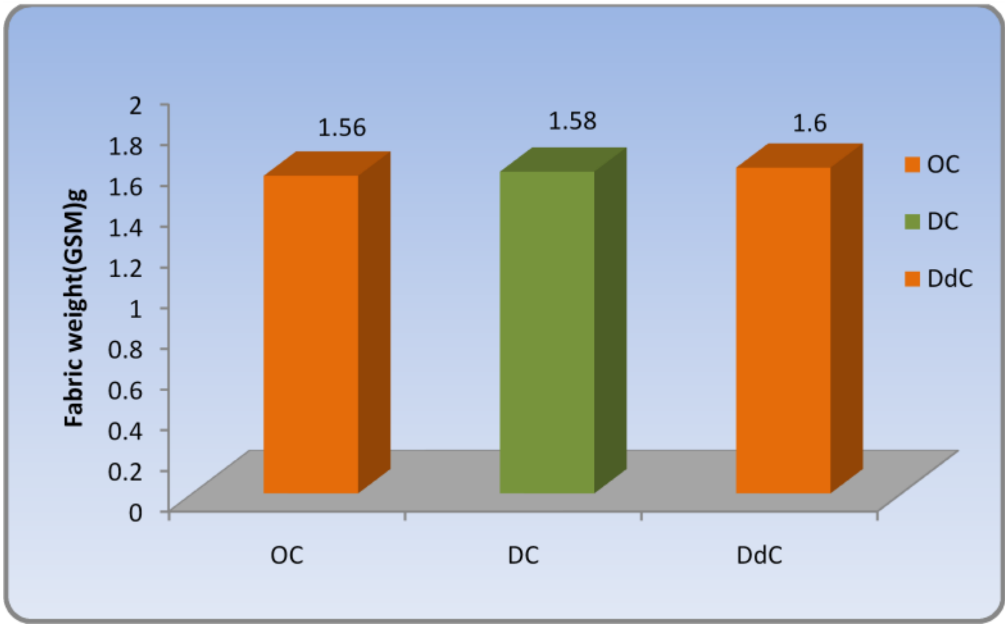
Values are mean of 5 samples

** - Significant at 1% level

From the above Table VIII and Figure 2, it is clear that, the fabric weight of sample DC and DdC has increase by 0.02% and 0.04% respectively when compared to the original sample. Thus, the weight of the sample DdC was increased because the dye applied on the sample. The weight of the sample DC, DdC when subjected to statistical analysis found to be significant at 1 percent level.

Figure 6

Fabric weight



4.3.1.1.2 Fabric Thickness

The fabric thickness and analysis of variance of the sample OC, DC, DdC are shown in Table IX and Figure 3.

Table IX

Fabric Thickness

Sl.No.	Sample	Mean Value Mm	Gain of Loss Over Original	% of gain or loss over original	"F" Value
1.	OC	0.033			17.34**.
2.	DC	0.034	0.001	3.030	
3.	DdC	0.035	0.002	6.060	

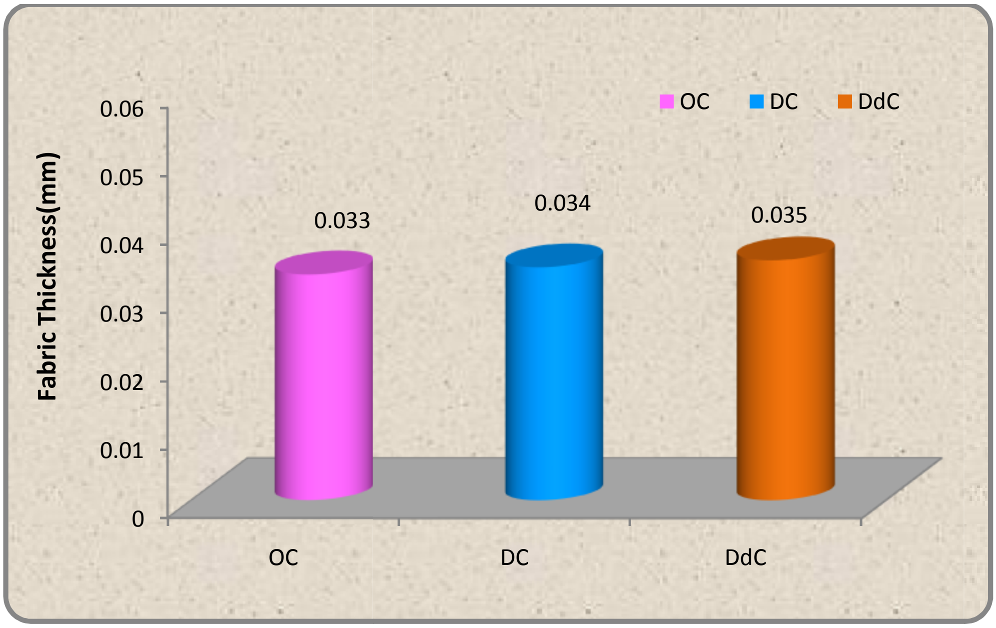
Values are mean of 5 samples

** - Significant at 1% level

From the above Table IX and Figure 3, it is clear that, the thickness of sample DC and DdC has increase by 0.001%and 0.002% respectively when compared to the original sample. Thus, the thickness of the sample DdC was increased because the dye applied on the sample. The thickness of the sample DC, DdC when subjected to statistical analysis found to be significant at 1 percent level.

Figure 7

Fabric Thickness



4.3.1.1.3 Fabric Tensile Strength (Warp)

The fabric tensile strength (warp) and analysis of variance of the sample OC, DC, DdC are shown in Table X and Figure 4.

Table x

Fabric Tensile Strength (Warp)

Sl.No.	Sample	Mean Value (lbs)	Gain of Loss Over Original	% of gain or loss over original	"F" Value
1.	OC	26.30			21.65**
2.	DC	30.78	4.48	17.03	
3.	DdC	27.74	1.44	5.47	

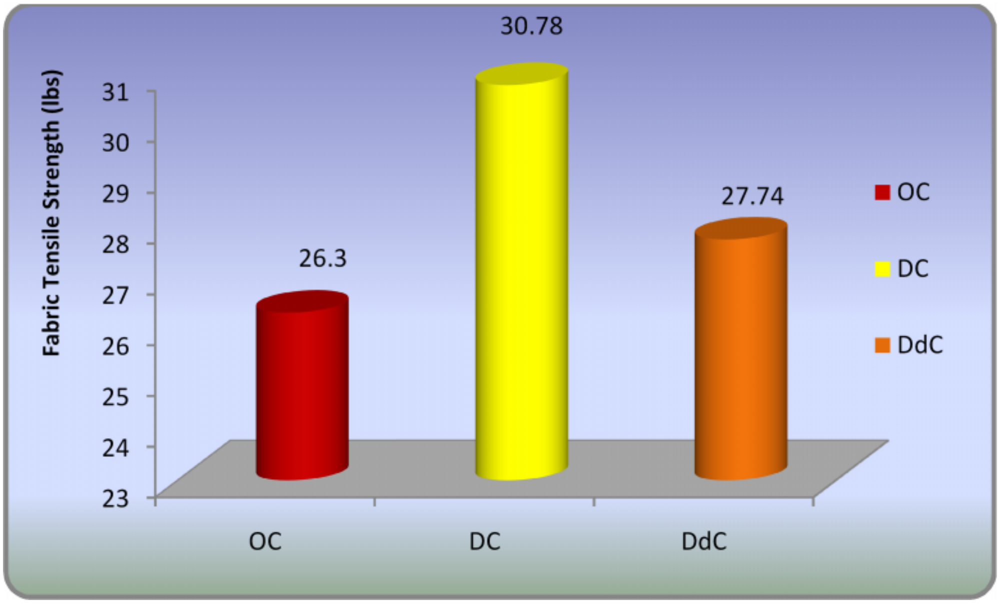
Values are mean of 5 samples

** - Significant at 1% level

From the above Table X and Figure 4, it is clear that, the fabric tensile strength of sample DC and DdC has increase when compared to the original sample. The increase in fabric strength was maximum in dC at 4.48%. The strength of the sample DC, DdC when subjected to statistical analysis found to be significant at 1 percent level.

Figure 8

Fabric Tensile Strength (Warp)



4.3.1.1.4 Fabric Tensile Strength (Weft)

The fabric tensile strength (weft) and analysis of variance of the sample OC, DC, DdC are shown in Table XI and Figure 5.

Table XI

Fabric Tensile Strength (Weft)

Sl.No.	Sample	Mean Value (lbs)	Gain of Loss Over Original	% of gain or loss over original	"F" Value
1.	OC	23.60			19.82**
2.	DC	26.20	2.6	11.01	
3.	DdC	28.40	4.8	20.33	

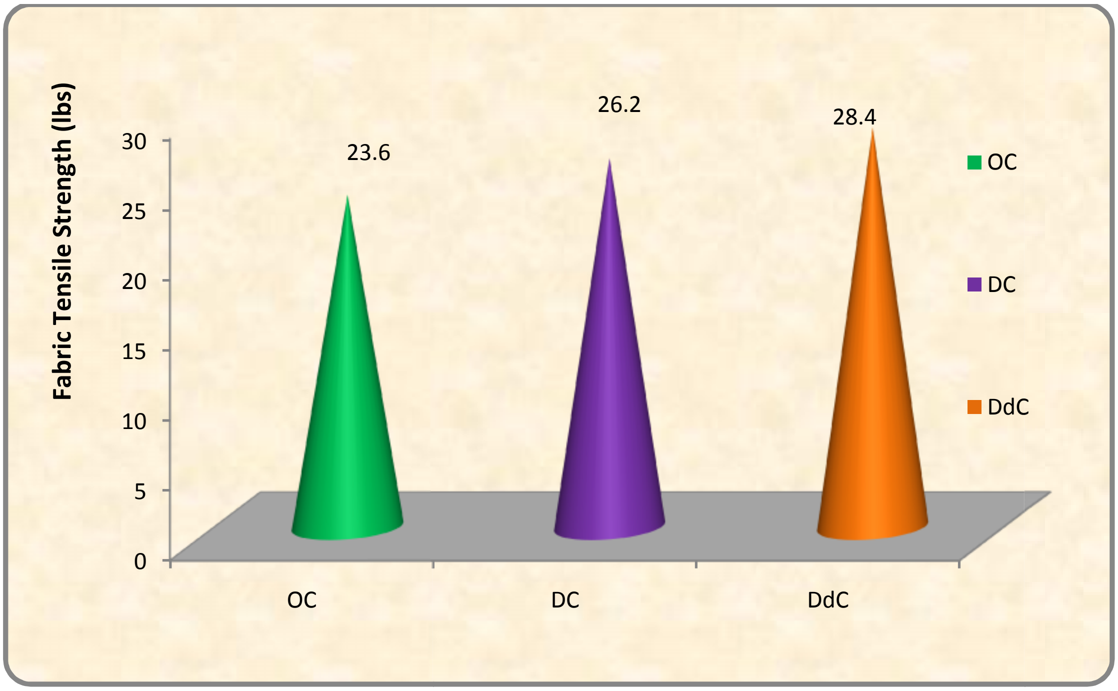
Values are mean of 5 samples

** - Significant at 1% level

From the above Table XI and Figure 5, it is clear that, the fabric tensile strength of sample DC and DdC has increase when compared to the original sample. The increase in fabric strength was maximum in DdC at 4.8%. The strength of the sample DC, DdC when subjected to statistical analysis found to be significant at 1 percent level.

Figure 9

Fabric Tensile Strength (Weft)



4.3.1.1.5 Fabric Elongation (Warp)

The fabric elongation (warp) and analysis of variance of the sample OC, DC, DdC are shown in Table XII and Figure 6.

Table XII

Fabric Elongation (Warp)

Sl.No.	Sample	Mean Value (Inches)	Gain of Loss Over Original	% of gain or loss over original	"F" Value
1.	OC	1.230			3.62*
2.	DC	1.310	0.08	6.50	
3.	DdC	1.320	0.09	7.31	

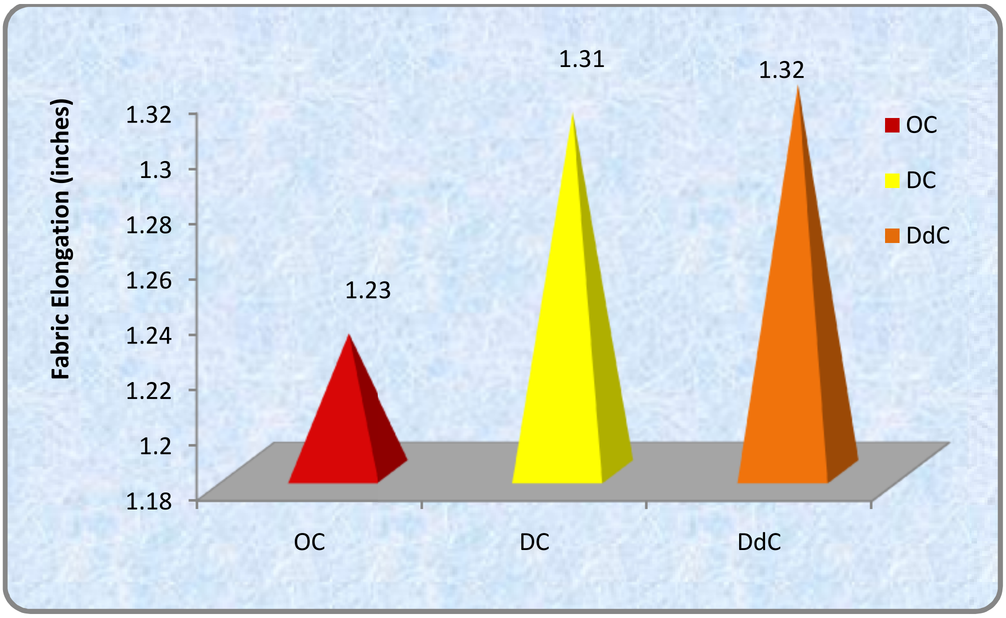
Values are mean of 5 samples

* - Significant at 5% level

From the above Table XII and Figure 6, it is clear that, the elongation of sample DC and DdC has increase when compared to the original sample. The increase in fabric elongation was maximum in DdC at 0.09%. The elongation of the sample DC, DdC when subjected to statistical analysis found to be significant at 5 percent level.

Figure 10

Fabric Elongation (Warp)



4.3.1.1.6 Fabric Elongation (Weft)

The fabric elongation (Weft) and analysis of variance of the sample OC, DC, DdC are shown in Table XIII and Figure 7.

Table XIII

Fabric Elongation (Weft)

Sl.No.	Sample	Mean Value (inches)	Gain of Loss Over Original	% of gain or loss over original	"F" Value
1.	OC	1.720			2.98*
2.	DC	1.840	0.12	6.976	
3.	DdC	1.860	0.14	8.139	

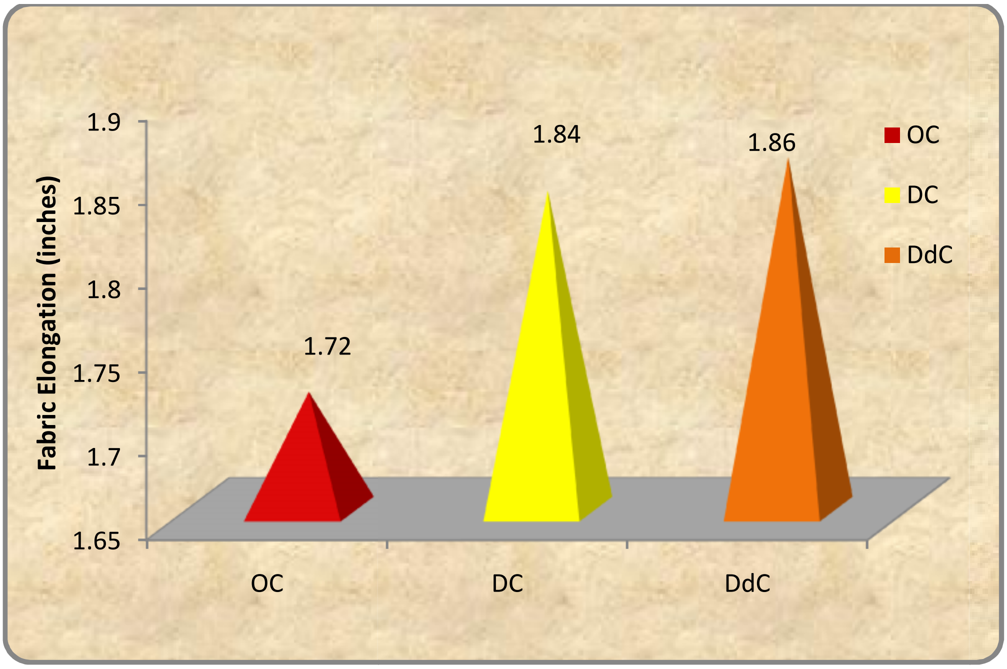
Values are mean of 5 samples

* - Significant at 5% level

From the above Table XIII and Figure 7, it is clear that, the elongation of sample DC and DdC has increase when compared to the original sample. The increase in fabric elongation was maximum in DdC at 0.14%. The elongation of the sample DC, DdC when subjected to statistical analysis found to be significant at 5 percent level.

Figure 11

Fabric Elongation (weft)



4.3.1.1.7 Fabric Stiffness (Warp)

The fabric elongation (Weft) and analysis of variance of the sample OC, DC, DdC are shown in Table XIV and Figure 8.

Table XIV

Fabric stiffness (warp)

Sl.No.	Sample	Mean Value (cm)	Gain of Loss Over Original	% of gain or loss over original	"F" Value
1.	OC	2.210			5.38**
2.	DC	2.410	0.2	9.049	
3.	DdC	2.610	0.4	18.09	

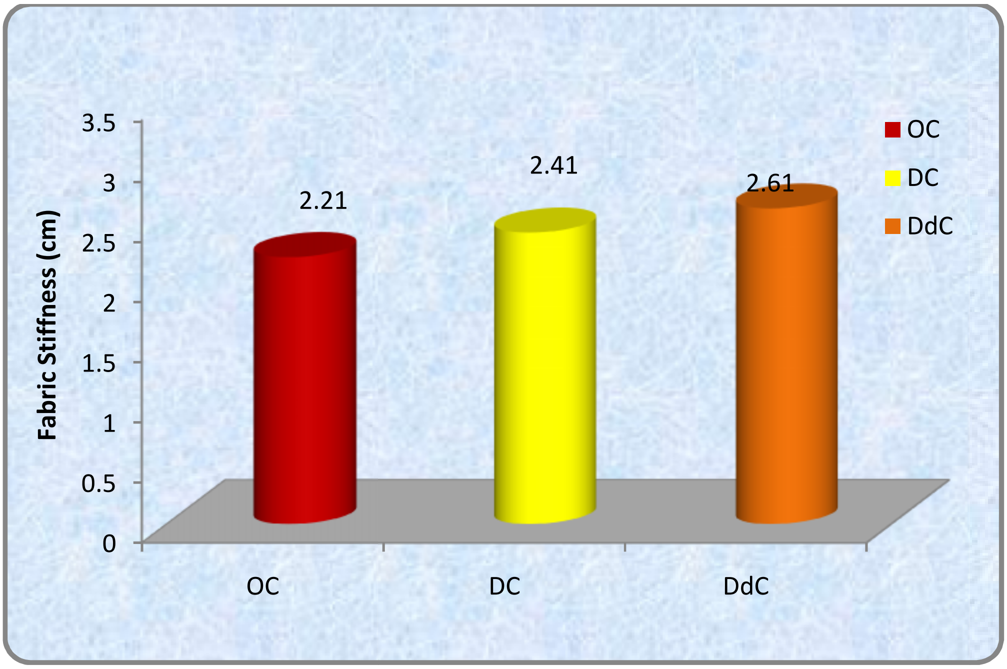
Values are mean of 5 samples

** - Significant at 1% level

From the above Table XIV and Figure 8, it is clear that, the stiffness of sample DC and DdC has increase when compared to the original sample. The increase in fabric stiffness was maximum in DdC at 0.4%. The stiffness of the sample DC, DdC when subjected to statistical analysis found to be significant at 1 percent level.

Figure 12

Fabric Stiffness (Warp)



4.3.1.1.8 Fabric Stiffness (Weft)

The fabric stiffness (Weft) and analysis of variance of the sample OC, DC, DdC are shown in Table XV and Figure 9.

Table XV

Fabric Stiffness(Weft)

Sl.No.	Sample	Mean Value (cm)	Gain of Loss Over Original	% of gain or loss over original	"F" Value
1.	OC	2.160			4.89**
2.	DC	2.320	0.16	7.407	
3.	DdC	2.340	0.18	8.333	

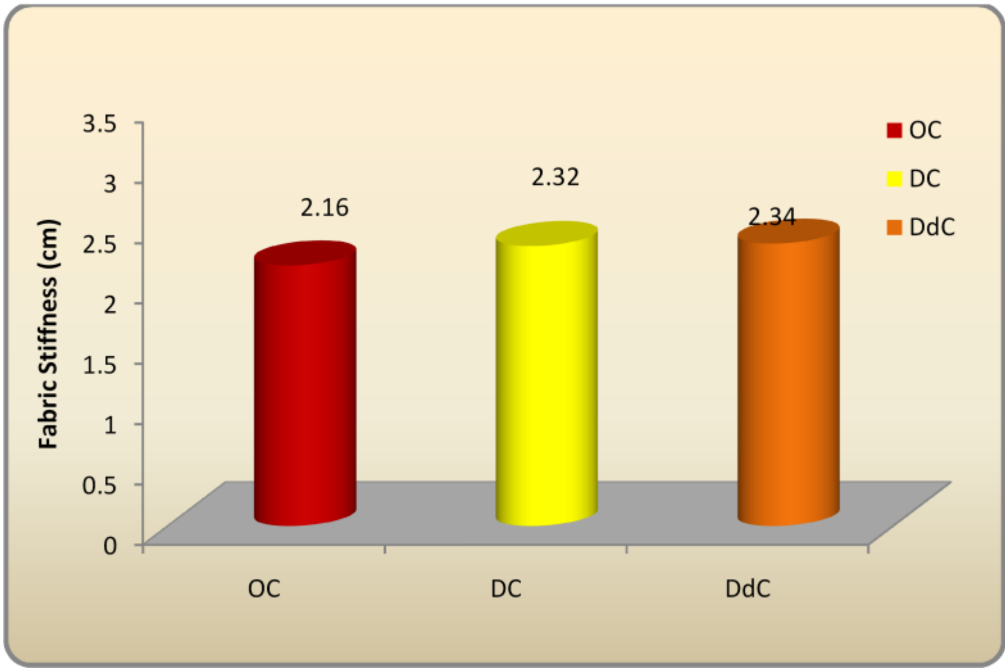
Values are mean of 5 samples

** - Significant at 1% level

From the above Table XV and Figure 9, it is clear that, the stiffness of sample DC and DdC has increase when compared to the original sample. The increase in fabric stiffness was maximum in DdC at 0.18%. The stiffness of the sample DC, DdC when subjected to statistical analysis found to be significant at 1 percent level.

Figure 13

Fabric Stiffness (Weft)



4.3.1.1.9 Drapability Test

The fabric drape and analysis of variance of the sample OC, DC, DdC are shown in Table XVI and Figure 10.

Table XVI

Drapability Test

Sl.No.	Sample	Mean Value (GSM) g	Gain of Loss Over Original	% of gain or loss over original	"F" Value
1.	OC	50.02			26.75**
2.	DC	53.02	3	5.99	
3.	DdC	56.06	6.04	12.07	

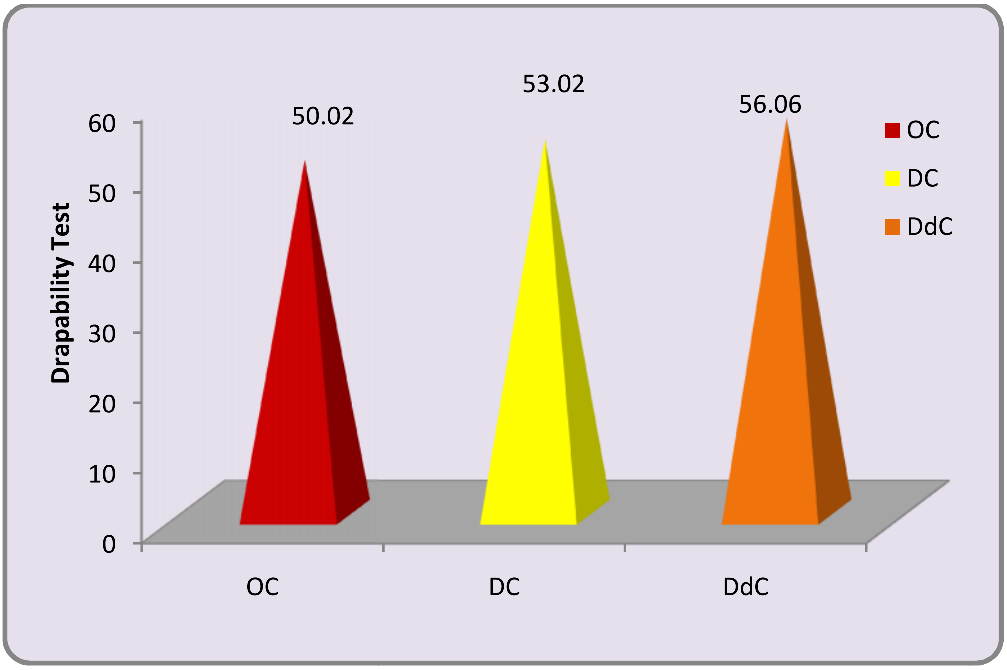
Values are mean of 5 samples

** - Significant at 1% level

From the above Table XVI and Figure 10, it is clear that, the drapability of sample DC and DdC has increase when compared to the original sample. The increase in drapability was maximum in DdC at 6.04%. The drapability of the sample DC, DdC when subjected to statistical analysis found to be significant at 1 percent level.

Figure 14

Drapability Test



4.3.1.2 Wettability and Absorbency Test

4.3.1.2.1 Drop Test

The drop test and analysis of variance of the sample OC, DC, DdC are shown in Table XVII and Figure 11.

Table XVII

Drop Test

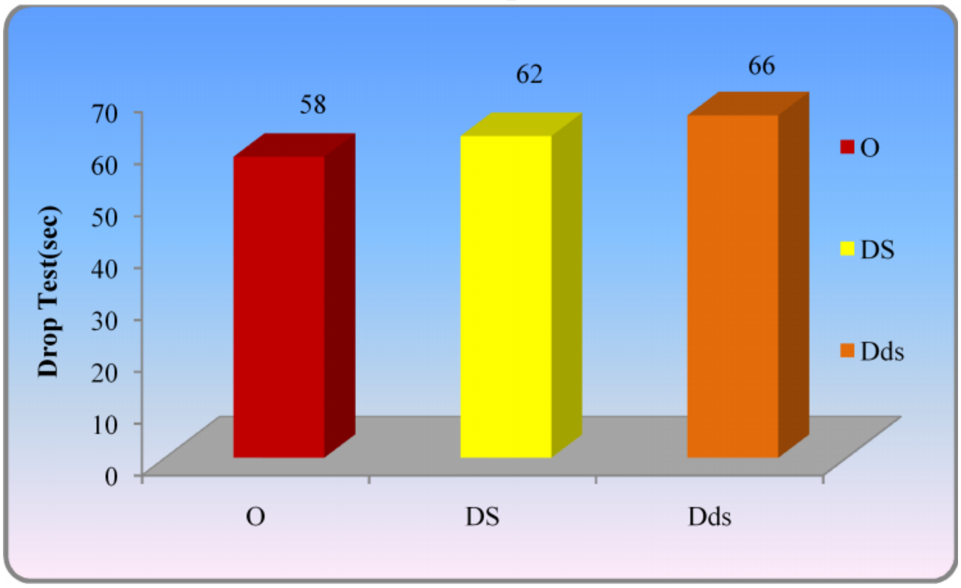
Sl.No.	Sample	Mean Value (sec)	Gain of Loss Over Original	% of gain or loss over original	"F" Value
1.	O	31			29.40**
2.	DS	24	7	22.58	
3.	Dds	27	4	12.90	

Values are mean of 5 samples

** - Significant at 1% level

From the above Table XVII and Figure 11, indicates that the, absorbency of the dyed samples has increased when compared to the original. Maximum absorbency was noted in DdC at 4% sample followed by the DC sample. The sample DC, DdC when subjected to statistical analysis found to be significant at 1 percent level.

Figure 15
Drop Test



4.3.1.2.2 Sinking Test

The sinking ability and analysis of variance of the sample OC, DC, DdC are shown in Table XVIII and Figure 12.

Table XVIII

Sinking Test

Sl.No.	Sample	Mean Value (sec)	Gain of Loss Over Original	% of gain or loss over original	"F" Value
1.	OC	12.000			12.69**
2.	DC	11.000	1	8.33	
3.	DdC	9.600	2.4	20	

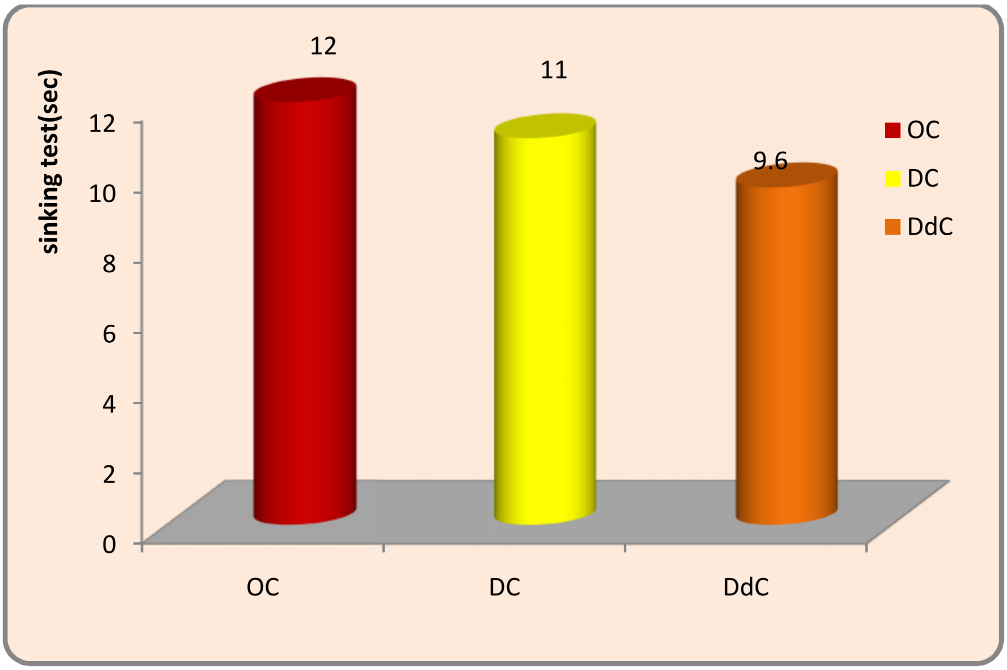
Values are mean of 5 samples

* - Significant at 1% level

From the above Table XVIII and Figure 12, indicates that the, absorbency of the dyed samples has increased when compared to the original. Maximum absorbency was noted in DdC at 2.4% sample followed by the DC sample. The sample DC, DdC when subjected to statistical analysis found to be significant at 1 percent level.

Figure 16

Sinking Test



4.3.1.2.3 Vertical Wicking Test

The wicking ability and analysis of variance of the sample OC, DC, DdC are shown in Table XIX and Figure 13.

Table XIX

Vertical Wicking Test

Sl.No.	Sample	Mean Value (cm)	Gain of Loss Over Original	% of gain or loss over original	"F" Value
1.	OC	4.900			3.60*
2.	DC	5.120	0.22	4.48	
3.	DdC	5.140	0.24	4.89	

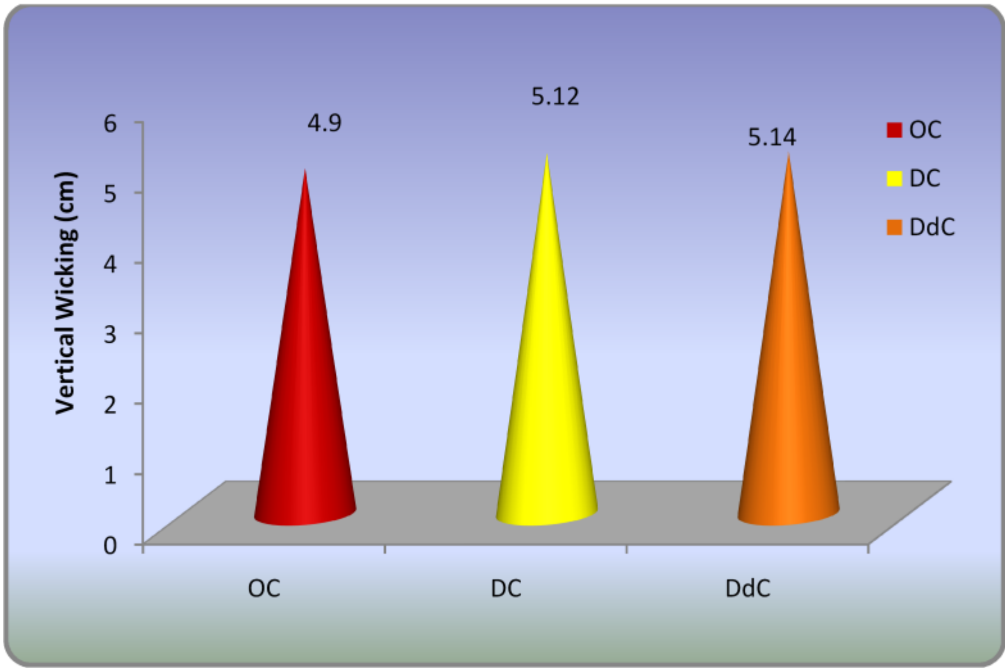
Values are mean of 5 samples

* - Significant at 5% level

From the above Table XIX and Figure 13, indicates that the, absorbency of the dyed samples has increased when compared to the original. Maximum absorbency was noted in DdC at 0.24% sample followed by the DC sample. The sample DC, DdC when subjected to statistical analysis found to be significant at 5 percent level.

Figure 17

Vertical Wicking Test



4.4 Evaluation of Colour Fastness

Colour fastness of the dyed samples to sunlight, crocking and washing were determined and their results are presented in Table XX

Table XX

Colour fastness to sunlight, crocking and Washing

S.No	Sample	Sunlight		Washing		Crocking			
		Colour change	staining	Colour change	staining	Dry		Wet	
						Colour change	staining	Colour change	staining
1.	Ddc	4	4	4	4	5	4	5	4

Rating Scale

5- Excellent, 4- Very Good

From the Table XX, it is evident that all the dyed sample showed good colour fastness to sunlight. With regard to washing and crocking all the sample show good colour fastness.

Colour fastness of any textile product is of considerable importance to the consumer as it directly affects the serviceability of the fabric. Fastness tests establish the fitness for purpose of the fabric and help identify the appropriate care label instructions (Prabhavathi *et al,* 2014.

5. SUMMARY AND CONCLUSION

The summary and conclusion pertaining to the study entitled **"Extraction of Natural Dye from *Persea Americana* pit and its Application on Cotton Fabric"** is discussed under the following headings.

The globalization of market and increasing demand for product has created a deep interest in the use of raw materials from natural resources. Researchers cite immense potential for nayural dye with regard to its biodegradable and eco-friendly nature in the fabric use. The use of natural dyes in fabric production is still under experimentation. From the dawn of civilization to the present day, the art of applying colour through dyeing has played an important role.

Owing to the eco-friendly, eco-conservation, eco-protection and concern over the depleting eco-system and also the global consciousness about the use of eco-friendlydyes due to hazardous and carcinogenic effect among synthetic dyes, natural dyes are preferred over synthetic dyes.

In the present study, colorant extracted from *Persae Americana pit* have been chosen for the for its dye ability. The colored constituents of *persea Americana pit* possess properties which find good application in textile industry. The property of *Persea Americana* includes non-toxicity and medicinal benefits. The cotton fabric dye with *Persae Americana pit* imparts beautiful shades and fastness properties to cotton fabric.

The dye extracted from *Persae americana* pit has many applications. Hence, the the present study "**Extraction of Natural Dye from *Persea americana* pit and its Application on Cotton Fabric"** is to,

- Selection of fabric and natural dye source.
- Optimize the dyeing concentration, time, temperature and pH.
- Dye the selected fabric with selected natural dye solution.
- Evaluate the properties of the dyed fabric.

Methodology adopted

- Natural dye was extracted from *Persae Americana* pit.
- Optimization of dye extraction-various parameters such as solvent, dye concentration, pH, temperature and mass liquor ratio were optimized for extraction of dye.
- Optimization of dyeing- pilot study was carried out to select suitable mordant orange peel was used as for the pilot study.
- Dyeing parameters such as dyed concentration, time, mordanting technique were optimized for effective dyeing of the fabric.
- Dyeing the selected cotton fabric was dye at 100^0C for 150 min, with material liquor ratio 1:20 for extraction.
- The dyed fabric was evaluated objectively.

Findings of the study

- Water was found to be the suitable solvent for dye extraction.
- *Persae americana* at a concentration of 8% was found to be 150 min.
- Dye extraction was found to be maximum at 100^0C.
- The optimum pH for dye extraction was found to be 7.
- The material liquor ratio was found to be 1:20.
- Dyeing time of 150 minutes resulted in maximum dye absorption.
- The result of visual evaluation of dyed fabric revealed that the sample dyed was rated excellent in appearance, brighter in shade and evenly dyed.
- Fabric thickness was found to be increased and maximum % in dyed sample.
- Increase in fabric stiffness was maximum in DC sample in warp direction followed by DdC sample. Stiffness in weft direction was maximum in dyed sample and increase of maximum percentage.
- Fabric strength was found to be maximum in DC sample in warp direction and in weft maximum strength was found in DdC sample with a slight difference.
- Increase in fabric elongation was maximum in dyed sample with equal percentage of increase in DC and DdC sample in warp. And in weft maximum percentage of elongation was noted in DdC sample.
- Increase in weight was recorded in both the sample.
- DdC sample exhibited excellent colour fastness to sunlight, washing and crocking.

Conclusion

Most of the natural dyes are eco safe. Some of the natural colours are not only eco-safe, but also added value for the medicinal effect on skin and are more than skin friendly. The natural dyes for colouring eco friendly textile in variety of soothing, uncommon shaded with eco friendly mordant are the desirable product of the customer of the present and future too.

From the study it could be concluded that *Persea americana* pit produce safe and colourful cotton fabric. The dyed fabric exhibit excellent appearance and good colour fastness properties.

Further Study

- *Persea Americana* pit can be assessed for antimicrobial properties on various fabrics.
- The study can carried out in different types of fabric.
- The selected herbs can be extracted using different solvent and tested for various properties.

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Appendix – I

Desized and Dyed Samples

Desized Sample

Dyed Sample

APPENDIX - II

Colour fastness to Crocking, Washing and sunlight

S.No	Sample	Colour Fastness to Crocking		Colour Fastness to Washing	Colour Fastness to Sunlight
		Dry	Wet		
1	**Ddc**				

5- Excellent; 4/5- Very Good; 4- Good; 3- Fair; 2- Poor; 1- Very Poor.