# Development and Evaluation of Ayurvedic Socks for Treatment of *Tinea pedis*

*By*

**Sudharsana Devi. R**

**(13PTF015)**

A Thesis submitted to the

**Avinashilingam Institute for Home Science and Higher Education for Women**

**Coimbatore - 641 043**

In Partial Fulfillment of the Requirements for the

**Degree of Master of Science**

**in**

**Textiles and Fashion Apparel**

**March, 2015**

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Certified as Bonafide Research Work

27/3/15

Signature of the

Head of the Department

Signature of the

Guide

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# CONTENTS

# LIST OF FIGURES

# LIST OF PLATES

# LIST OF APPENDICES

# 1. INTRODUCTION

Clothing is one of the basic needs of human being. The clothing has been made from a very wide variety of materials. Materials have ranged from leather and furs to woven materials, to elaborate and exotic natural and synthetic fabrics. Not all body coverings are regarded as clothing. Articles carried rather than worn (such as purses), worn on a single part of the body and easily removed (scarves), worn purely for adornment (jersey) or those that serve a function other than clothing are, foot wears and hats.

A primary function of clothing is to improve the comfort of the wearer by providing protection against the elements. The distinction between clothing and protective equipment is not always clear-cut since clothes designed to be a fashionable often have protective value and clothes designed for function often consider fashion in their design (Raghav, 2011)

Globally, as many countries have been enforcing a ban on textiles that have been coloured using chemical dyes, at the same time, textile dyed using natural vegetable dyes, especially medicinal plants, have been commanding a huge market due to their obvious advantages. Nowadays much of the stress in textile industry is given to herbal dyes that use only natural plant and minerals for all steps of the production process.

'Ayur- be everything with it' Ayurveda Sanskrit etymology, 'the science of life', the ancient and proven natural and holistic healing system of medicine, practiced in India for more than 5000 years, is now a globally accepted science because it is the world's most eco-friendly system of medicine, since it does not use any material unfriendly to the ecosystem (Joshi *et al,* 2010)

Ayurveda creates safe and effective management of chronic and lifestyle disorders. They follow unique methods of medical management with equal emphasis on internal cleaning and preventive care. In India up to 83% of people use some form of traditional medicine, a category which includes Ayurveda, the holistic science (www.ayurveda2z.com)

In the present day world, hygiene is headline news and consumers are very conscious of textiles that are hygienic. Health care is a serious business which is not only influenced by practicing medical professionals. Good hygiene is an aid to health, comfort and social interactions. It directly aids in disease prevention or disease isolation (Rajkumar, 2010)

Ayurvastra is a branch of Ayurveda medical science in clothing. Ayurvastra cloth is completely free of synthetic chemicals, toxic irritants and thus avoids global warming. Cloth infused with herbs of traditional Indian medicine is becoming increasingly popular as the country's stressed urban workers see cures for conditions such as insomnia and eczema (Velapure, 2010)

The most effective time to use herbal clothing is when the body is at rest such as during sleep or meditation because this is when the body is naturally healing and re-establishing balance (Miller, 2006). Skin is recognized as being the body's largest organ. The skin can act as a barrier but also as a conduit for outside substances to enter the body. Many environmental toxins and chemicals in conventional clothing are assimilated into the body through the skin.

Anything which can improve the skin's natural ability to block and resist harmful chemicals and toxins from entering the body will be beneficial to health (Rajeev, 2008) Keeping this in mind, herbal textile is often used in making bed coverings, undergarments, towels, meditation clothes, sleepwear and other such garments that stay close to human skin so that all its benefits could be absorbed through the skin. The technology for making herbal clothing is also being utilized for making coir mats, mattresses, door mats and carpets. For coir mats, the fibers are first soaked in herbal dyes and then woven into coir mats (Reena, 2007)

Ayurvastra believes in restoring the balance within the body's system and strengthen the immune system. The various herbs used have well proven antimicrobial and other medicinal properties. Various emerging natural extract impregnated wellness garments are hoping to tackle various diseases like hypertension, heart ailments, arthritis , asthma and diabetes with the herbal dyed bed linens, mattresses, healing herbal blankets, sun towels, comforting apparels, aprons, night wears and so on. As the waste generated during the process also

can be efficiently used as fertilizers, wellness fabric is purely a green technology that definitely soothes our souls. Brands like, ayurvastra, Ayurganic are developing herbal textiles can resist and fight against diseases (Arun, 2009)

Worldwide textile producers face various challenges. About one half of the worlds waste water problems are linked to production of textile goods, and many of the chemicals used to dye and finish fabrics are known to harm human health. Therefore, product design should begin with the selection of healthful ingredients. Customers of 21st century are also safety and health conscious. Thus it is well accepted that they will not mind to pay extra for this health and safety. It is definitely a value addition that protects the interest of a consumer (Sharma, 2008)

Rising interest of the consumers around the globe in sustainable development, environment friendly products and natural healing is creating an increased demand for safe and healthy organic clothes. Encouraged by naturalists and allergy-sufferers in its infancy, the organic textile market is expanding as consumers demand products that are not only earth-friendly but human-friendly as well. Because the process to manufacture textiles requires treatments that can leave chemical residue on the finished product, just using organic fibres is not enough. The entire production process must be considered (Jain, 2010)

According to (Hay, 2006) disease is an abnormal condition of the body or mind that causes discomfort, disinfectant from injuries, in so far as the latter is usually instantaneously acquired. Tinea Pedis (athlete's foot) is a very common skin condition that affects the sole and the foot of the skin between toes. Athlete's foot is one of the most common fungal infections. Unlike body and scalp ringworm, this order is generally an ailment of adult life. Fungi love sweaty feet, and they thrive on moist shower floors.

A fungal infection of the feet is characterized by itching, redness and scaling. Severe cases may be accompanied by blisters. The condition most commonly occurs between the toes and may spread to the soles (Holt, 2010) the treatment of athlete's foot can be divided into two parts. The first and most important part is to make the infected area less suitable for the athlete's foot fungus to grow. This means keeping the area clean and dry. Occlusive shoe

materials, such as vinyl, cause the feet to remain moist, providing an excellent area for the fungus to breed. Likewise, absorbent socks like cotton that wick water away from your feet may help. Cotton socks helps to absorb more sweat and draw it to the areas where air can evaporate the perspiration (Tomshinsky, 2011)

Considering these facts, the problem is taken as a major study and the use of selected herbs is believed to reduce the irritations caused by tinea pedis. Along with that the selected herbs, is also taken as a source for anti fungal activity reducing the attack of fungus and thereby reducing the problems faced by Tinea Pedis. These selected herbs not only used for treatment of Tinea Pedis but also reduces blood pressure, cures wounds and enhance skin on use of regular basis. It gives out natural colours with their property of healing.

Dyeing of textiles with medicinal plants is a promising area which needs to be explored scientifically and systematically for producing diversified value products. Hence the investigator has selected the topic on 'Development and Evaluation of Ayurvedic socks for Treatment of Tinea Pedis (Athlete's foot) with following objectives,

- To select and extract dye from medicinal herbs for tinea pedis.
- To optimize the dye extraction
- To develop cotton socks and apply the medicated extraction on it.
- To evaluate the medicated socks.

# 2. REVIEW OF LITERATURE

## 2.1 AYURVEDA

### 2.1.1 Introduction

Ayurveda is an ancient medical treatise, summarizing art of healing and prolonging life. In Sanskrit ‘Ayur’ means life and ‘veda’ means knowledge, considering it as the knowledge of life, to live a vigorous and disease free-life. Ayurveda treats man as a whole which is a combination of body, mind and soul (Chadha, 2007)

In Ayurveda, health is defined as Sarira (body), Manas (mind) and Atman (self) that must be nurtured if individual is to have good health. Ayurveda works by balancing Tridosha, Vata (air), Pitta (bile), and Kapha (phlegm) were three essential humours, which governs the internal and external health of the body. Also these humours cause disease if they become imbalanced, and by promoting or depleting them which are causative, that relieves from root cause of the disease (Agarwal and Tiwani, 2008)

### 2.1.2 History

Ayurveda is the oldest healing science which is practised over 5000 years ago in India. The science is practised from generation to generation in India, where it begins from kuzhuvila family in Kerala. Ayurveda was considered as a gift of god to mankind that is communicated to saints and sages of India through deep meditation (Krishnan, 2007)

Ayurveda is a holistic system of medical science, which evolved in Himalayas from the spirituality enlightened by rishis (saints or sages). In the beginning, veda vyasa, one of the greatest sage of India, with all the medical knowledge and wisdom of healing, put into writing Vedas for the first time, which then forms Rig, Sama, Yajur and Atharva veda, where Ayurveda falls under the subsection of Atharva veda, meaning science of life (Sachdev, 2011)

The earliest recorded knowledge about Ayurveda is found in Rig and Atharva Veda. Athreya samhita is perhaps the oldest medical book is the world. It survives from Takashila University. The Atharva Veda lists eight divisions of Ayurveda, which leads to two concepts of treatment. Susruta Samhita which

describes highly developed surgery and Charak Samhita which is a vast work on internal medicine (Sharma, 1997)

### 2.1.3 Principles of Ayurveda

As per principles of Ayurveda, there is a remarkable theory to effect that every human being is a miniature form of the universe a micro cosm, everything in this universe is connected, that material content of man and universe are constituted of Panjaboothas (five elements of nature) Prithvi (solid), Apas (liquid), Tejas (radiant energy), Vayu (air), Akasa (orifices) (Nayar, 1999)

According to philosophical concept on which Ayurveda is based, all bodies, material, living, conscious and unconscious are all evolved out of Prakrti by the subtle influence of Purusa (human). It is believed that every component of the human organism is created out of the Tattvas (fundamental compounds) as evolved out of prakrti. When all Indriyas, Tridosha, Agni, Malas, Kriyas, Seven Dhatus are in normal state and in equilibrium then the health is in an ideal state. The main aim of Ayurveda includes maintenance of this equilibrium, and its repair in case of any imbalance and derangement. Ayurveda attempts this process by application of all spiritual and material resources available to man (Moosath, 2006)

### 2.1.4 Role of Ayurveda

Ayurveda is completely ‘natural therapy’ hence it has no side effects; it is blessed to give healthy attitude towards life. It is a holistic approach, when after the treatment a person find an improvement in their physical, mental and psychological conditions (warrier, 1993) Ayurvedic therapies can relieve stress and rejuvenate the body. It emphasizes more on prevention of diseases rather than its cure. It takes care of the metaphysical and even spiritual needs of man.

Ayurveda is traditional system that does not pollute the environment through contamination of water resources in areas close to processing units (Sharma, 2010). According to (Tyler and Premila, 2012) Ayurveda, not only helps in treating diseases but also in preventing the occurrence of diseases. It is preventive as well as curative. Ayurveda is highly popular and mainly followed in India. It is an alternative treatment, which helps to cure certain chronic diseases

that cannot be totally cured using allopathic medicines. Ayurveda is primarily a spiritual and traditional way of curing a disease. Ayurvedic medicines deal with permanently healing the person and effectively treating the disease. Moreover, it is also suggests a suitable lifestyle for improving our overall health. On the other hand, the objective of allopathic treatment is to provide instant relief by destroying the germs, bacteria, virus etc; that caused the sickness. However, it cannot ensure that the disease will be cured permanently. Since Ayurvedic medicines use organic products, they are environment friendly; and hence they help to save the forest and atmosphere from the dangerous chemical pollution.

### 2.1.5 Fungal Infection

Fungal infections are contagious and tend to spread easily from one part of the body to another and from one person to another. The commonest sites for fungal infections are between the toes 'Athlete's Foot', in the groin *Tinea Cruris*, waist and underarm. Ringworms and candidaris are also a type of fungal infection. Fungal infections generally crop up in damp and moist areas of skin. Ayurveda offers relief from fungal infections (Richardson *et al,* 2012)

According to Ayurveda fungal infection is referred as 'Dadru' imbalance in three doshas of body, particularly the pitta or the fire humour and kapha Dosha or phlegm humour is what causes them. Athlete's foot is a very common skin condition that affects the sole of the foot and the skin between the toes. It is usually a scaly, red, itchy eruption and occasionally may be weepy and oozing. It affects the feet of athletes and non athletes alike. Although it is frequently caused by a fungal infection, other causes may be indistinguishable without proper testing (Tolugan *et al,* 2011)

The medical name for athlete's foot caused by a fungus is *Tinea Pedis*. There are a variety of fungi that cause athlete's foot, and these can be contracted in many locations, including gyms, locker rooms, swimming pools, nail salons and from contaminated socks and clothing. According to (Freed berg *et al*, 1999) the fungi that are found on human body can also spread directly from person to person by contact. Most people acquire fungus on the feet from walking barefoot in areas where someone else with athlete's foot has walked. Some people are

simply more prone to this condition while others seem relatively resistant to it. Another colourful name for this condition is ‘jungle rot’, often used by members of the armed services serving in tropical climates.

Without the proper environment (warmth and moisture), the fungus may not easily infect the skin. Seventy percent of the population may develop athlete’s foot at some time. An infection by athlete’s foot fungi does not confer any resistance to subsequent infections (www.skinsheen.com) As suggested by Habif, 2001; the fungus that causes athlete’s foot can be found on floors and clothing, and these organisms require a warm, dark and humid environment to grow. The infection spreads by direct contact with contaminated surfaces or objects. As the infection spreads, it may affect the soles of the feet or the toenail. There are three common types of fungal athlete’s foot:

- Soles of the feet, also called ‘moccasin’ type;
- Between the toes, also called ‘interdigital’ type; and
- Inflammatory type or blistering.

Occasionally, it may appear as small or large blisters of the feet called Bullous *Tinea pedis*, thick patches of dry, red skin or calluses with redness. Sometimes, it may look like just mild dry skin without any redness or inflammation (Marshel Cavendish Corporation, 2007)

Fungal athlete’s foot may present as a rash on one or both feet and even involve the hand. A ‘two feet and one hand’ presentation is a very common presentation of athlete’s foot, especially in men. Hand fungal infections are called *Tinea Manuum*. Fungal athlete’s foot may also be seen along with ringworm of the groin, especially in men or hand. It is helpful to examine the feet whenever there is a fungal groin rash called *Tinea Cruris*. It is important to treat all areas of fungal infection at one time to avoid reinfection. Simply treating the soles and ignoring the concurrent fungal infection of toenails may result in recurrences of athlete’s foot (Schlossberg, 2008)

The treatment of athlete’s foot can be divided into two parts. The first, and most important part, is to make the infected area less suitable for the athlete’s foot fungus to grow. This means keeping the area clean and dry (Dietz, 2012)

Occlusive shoe materials, such as vinyl, cause the feet to remain moist, providing an excellent area for the fungus to breed. Likewise, absorbent socks like cotton that wick water away from. If the fungal infection has spread to the toenails, the nails must also be treated to avoid reinfection of the feet (Elston, 2009)

## 2.2 MEDICINAL PLANTS

### 2.2.1 Introduction

According to the world health organisation that has estimated at least 80% of world's population relies on traditional system of medicine, for their primary health needs. Medicinal plants have curative properties due to the presence of various complex chemical substances of different compositions, which are found as secondary plant metabolites in one or more parts of these plants (Gupta and Choudhry, 2006) Medicinal plants are world's oldest known health care products which plays a key role in traditional medicine. But these plants are not only used for health care but many widely used pharmaceuticals are derived from plants and other natural sources (www.herb-med.com)

The traditional medicine is used in the world over but is particularly relied on in developing countries. In the south, 80% of people endeavour to protect, to restore health using methods that have been handed down from generation to generation (Trivedi, 2006) Since the earliest time that in the pre-historic period before man developed agriculture and became fully civilized, plants were the only refugee for him in various ways. It was even considered to souls in many civilizations. The variety and sheer number of plants with therapeutic properties are quite astonishing. It is estimated that around 70,000 plant species from lichens to towering trees have been used one at time or another for medicinal purposes (Jain, 2010)

In, Ayurveda, about 2000 plant species are considered to have medicinal values. In India medicinal plants have made a good contribution to the development of ancient Indian material medica, one of the earliest treatises on Indian medicine, the charak samhita in 1000 B.C records the use of over 340 drugs of vegetable origin (Jaggi, 2000).

### 2.2.2 Role of Medicinal Plants

Medicinal plants play a key role in the development and advancement of modern studies on biological activities of substances. Traditional health care systems using medicinal plants can be recognized and used as a starting point for the development of novelties in drugs. The use of plant substances for medication is believed to be less toxic compared to that of the synthetic chemical compounds, while there is general concern about the negative side effects of synthetic compounds, the medicinal plant substances are considered to be less dangerous (Boon *et al*, 2008)

Herbal medicines industry in the last five years has shown relatively a good growth. Its product range includes herbal medicines, food supplements, cosmetics and perfumery. However, scientific documentation on the efficacy and safety of medicinal plants to cure major health problems in India, however, are still very limited (Daniel, 2006)

### 2.2.3 Herbal Sources

#### 2.2.3.1 Aloe Barbadensis (Aloe Vera)

Aloe Vera is a semi tropical plant. There are over 250 species of aloe grown around the world. It contains more than two hundred tonic ingredients including essential amino acids, minerals, vitamins, enzymes and steroids. Also contains the most essential components required by the human body. It is grown wild in hedge-rows in dry soil conditions and almost all parts of India. It can be grown even under constant drought conditions (Panda, 2003)

Aloe Vera has been used for thousands of years to treat burns, heal wound, treat ulcer and relieve haemorrhoids. The use of aloe is thought to have begun in Egypt or the Middle East (Bacroft, 2003) According to (Gage, 1996) the aloe Vera plant has developed many special characteristics to survive in extremely dry climates and endure weeks, even years, without moisture. The gel inside the leaves of an aloe Vera plant is its life blood, rich in nutrition and moisture.

Aloe Vera contains a mucopolysachharide called acemannan, which is highly effective in cure of infections, and burns. Aloe gel contains polyethylene oxide that is very much effective in healing wounds like stomach ulcers when taken internally. Even some more serious skin problems can be solved by aloe Vera (Elkins *et al*, 1997)The anti-fungal and anti-microbial properties of the aloe Vera extract are an excellent tonic for athlete's foot infections and other types of skin irritation. More importantly, this has anti-inflammatory components which help in curing wounds and scrapes. Topical use of the aloe Vera extract is also recommended for scars because it gently smoothens the skin (Alosi, 2011)

#### 2.2.3.2 Azadirachta Indica (Margosa/ Neem)

Neem an evergreen tree of India belongs to the plant family Meliceae (mahogany). It has been recognized as one of the most promising sources of compounds with insect control, antimicrobial and medicinal properties. In India, neem has been in use since ancient times as a traditional medicine against various human ailments and about seven hundred herbal preparations based on neem are found in Ayurveda, Siddha, Unani, Amchi and other local health prescriptions. Neem has also received a lot of attention worldwide for its potential use as an herbal pesticide and other healthcare formulations in countries such as china, USA, France, Germany, and Italy etc (Norten, 1999)

The uses of neem are very well known in India and are documented in the earliest Sanskrit medical writings. For centuries the tree has been held in esteem for its medicinal and pesticide properties (NIIR Board, 2004) Neem leaves poses excellent antiseptic and antifungal characters. Leaf extracts also demonstrate a surprising effect on the fungus Aspergillus Flavus, which quickly spreads on our food stuffs. The extracts keep it from producing the highly toxic Aflatoxin and thereby render the fungus harmless. Aflatoxin is considered one of the most dangerous carcinogens. In spite of their fungicidal effects, the leaves and the seeds can also fall prey to this fungus if they are not carefully dried and stored (Puri, 2003)

#### 2.2.3.3 Calendula Officinalis (Marigold)

Calendula Officinalis commonly called Marigold is a flower plant that are native to the Mediterranean regions. Calendula has been used medicinally since

the 16th century. The ancient Egyptians valued calendula as a rejuvenating herb. In northern countries it is used in drinks medicinal teas, foods, conserves and ointments (Nelson *et al,* 2013)

The parts of the herbs used are the whole flower heads or just the petals for medicinal use. The petals of the calendula plant have the highest concentrate of active ingredients, they contain essential oil that has an antibiotic and antimicrobial effect and lends the flower its scent. The Saponins, Mucins and Flavonoids give the flower its wound healing properties (Braun *et al,* 2010)

The calendula flower has a lot of golden yellow to orange petals that are about 2 to 3 inches across and are sometimes fluted that spring out around the head. The flower will continue to bloom so long as they are deadhead May through November. The seed is beige and about ¼ of an inch along, shaped like a curved apostrophe with a knobby backbone and a prickly surface. The calendula leaves are 2 to 6 inches long, mid-green with a hairy base and are paddle shaped (Balch, 2002)

Calendula is well tolerated by people with allergies but always use precautions. The calendula flowers have very strong antiseptic properties topically and internally. According to (Arrowsmith,2009) The components in calendula promotes blood cell growth in rejuvenating skin tissue, speeding the healing process and helping to minimize the formation of scars. Applied externally the plants antibiotic action helps promote the painless healing of minor wounds, lactations, and acne and skin ulcers by reducing inflammation, puss information and also improves blood circulation and promotes the information of new blood cells. Calendula is very useful to burns, bruises and for reducing scaring.

#### 2.2.3.4 Commiphora Mol Mol (Myrrh)

Myrrh is a gum-resin exuding from the stem of a small tree or shrub which is a native of the hot and dry countries around the southern extremity of the red sea. The myrrh trees appear to be of low stature and minute flowers and small, oral, dry berries. The exuded protective gummy substance is anti inflammatory and contains antifungal properties (Wells, 2010)

Myrrh is native to northeast Africa and Arabia. The shrub can grow to 30 ft tall. Myrrh exudes from natural cracks or manmade incisions in the bark. It leaves the tree as a pale yellowish liquid, which hardens into yellowish-red or reddish brown substance which is collected for use. This resin or gum has been used for thousands of years for its healing properties (Shealy, 2012) the gum-resin consists of Polysaccharides, Triterpene acids. It is predominantly used as an antiseptic and anti-inflammatory agent for topical treatment of mouth and throat infections (Castleman, 2001)

Myrrh is an effective antimicrobial agent that has been shown to work in two complementary ways. Its primary action is to stimulate the production of white blood corpuscles, which have anti pathogenic actions. Secondarily, it has a direct antimicrobial effect. Myrrh may be used in wide range of conditions appropriate for treatment with an antimicrobial agent. It finds specific use in the treatment of infections of the mouth, such as mouth ulcers, gingivitis, and pyorrhoea, as well as catarrhal problems, such as pharyngitis and sinusitis. Myrrh is often employed as part of an approach to the treatment of the common cold, and may be of benefit for laryngitis and respiratory complaints. Systematically it is useful in the treatment of boils and similar conditions, glandular fever, and brucellosis. Applied externally, it is healing and antiseptic for wounds and abrasions (Hoffmann, 2003)

#### 2.2.3.5 Copaifera Officinalis (Copaiba Balsam)

Copaiba is an oversized legume native to the humid or tropical climatic regions of South America. This giant tree bearing edible seeds is found in abundance in Columbia, Brazil and Venezuela. The resins of this tree that collects in the cracks on the trunk are used for remedial purposes. The copaiba tree is basically tapped in the same manner as the rubber tree. When the resin from the tree is amassed, the liquid is refined to garner the essential oils from it. The thick, transparent exudates vary in colour from light gold to dark brown, depending on the ratio of resin to essential oil (Opdyke, 2013)

The copaiba trees bear numerous white, petite flowers that appear on extended panicles and small fruit pods each enclosing two to four seeds. In all, there are as many as 35 species of Copaifera species that are mostly found in

different parts of the South American rain forests, especially in Argentina, Brazil, Colombia, Guyana, Peru, Bolivia and Venezuela. A number of different species of Copaifera are used in traditional herbal medications reciprocally (Balazsy *et al*, 2012) says that, Oleoresin is the part of the tree that is generally used for medicinal purposes. The oleoresin gathers in the cavities in the trunk of the trees. The resin is collected by tapping or making holes into the timber of the trunk, while the resin that drips from the tree is collected in the same way as maple syrup is harvested.

Copaiba balsam consists of almost 15 percent of volatile oils; while the remaining constituents include resins and acids (Crellin *et al*, 1996) the herb is useful for treating conditions like arthritis, gonorrhoea, eczema, herpes, psoriasis and the sexually transmitted disease syphilis. Copaiba balsam is a volatile oil that possesses antimicrobial properties and puts off secondary contagions in conditions, such as herpes, eczema and psoriasis.

(Balch, 2002) tells that, the Copaiba balsam is used as herbs for different treatments as such as; it is applied externally to heal wounds, stop bleeding and sure skin sores and psoriasis. The resin is also used to calm irritation or inflammation. Traditionally this copaiba resin is used as herbal medicine for the treatment of stomach ulcers throat infections cancers. It is an anti- inflammatory medicine to cure all kind of skin conditions.

#### 2.2.3.6 Tinospora Cordifolia (Giloe)

Tinospora cordifolia is a woody climber found on trees and shrubs throughout the tropical and sub-tropical parts of India. It grows readily in different soils, the stem attaining a thickness of 6cm diameter. The bark is gray or creamy white, deeply cleft spirally and longitudinally, with large rosette-like lenticels. The wood is white, soft and porous, and porous and when freshly cut, quickly assumes a yellow tint. The branches bear smooth, heart-shaped leaves, unisexual greenish flowers in summer, and red berries in winter. Long thread-like aerial roots arise from the branches. The viscose sap is light yellow, with an odour and a nauseating bitter taste (Patwardhan, 2007)

Cordifolia is an Indian medicinal plant that has been used in Ayurvedic preparations for the treatment of various ailments for centuries. Europeans in India became interested in the tonic and a diuretic property of Tinospora Cordifolia (Coon et al, 1998) the prepared tincture has received official recognition in the Indian pharmacopoeia. It has been used to treat general weakness, fever, dyspepsia, dysentery, viral hepatitis, skin diseases and anaemia. In compound formulations, it is used clinically to treat jaundice, rheumatoid arthritis, and diabetes.

Tinospora cordifolia mature stem powder, the aqueous extract, the starch obtained from the stem by repeated washing of crushed stem with water are used in Ayurveda for debility, hepatitis, dyspepsia, jaundice and other liver disorders. It is an official drug in the Indian herbal pharmacopoeia, for its analgeric and antipyretic activity (Premila, 2006)

## 2.3 DYEING

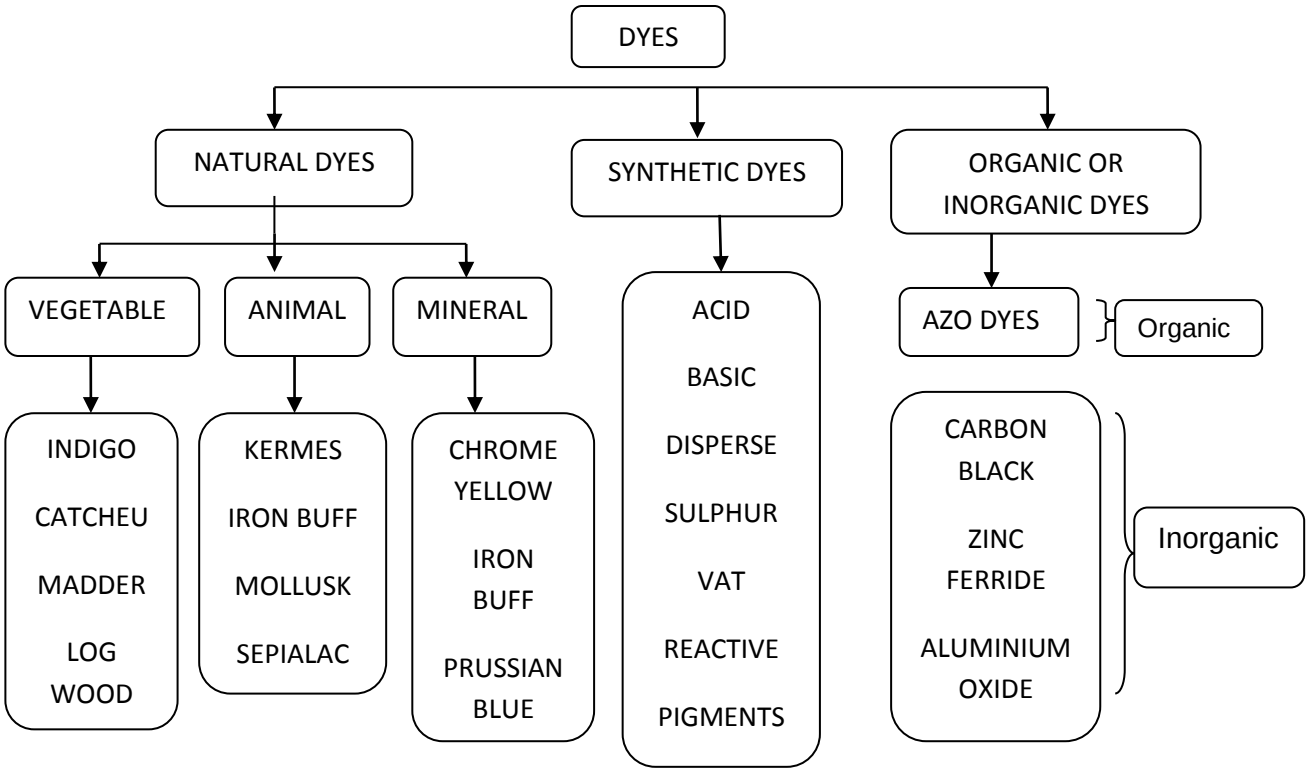
### 2.3.1 Introduction

Dyeing is a method which imparts beauty to the textile by applying various colours and their shades to a fabric. Dyes are coloured organic compounds used to colour fabrics, leather, furs, papers, plastic, cured rubber, wood and other materials (Chauhan, 2003)

Dyes are in substrates by physical adsorption, salt or metal complex formation solution, mechanical retention or by the formation of covalent chemical bonds. The stability of dye depends on many factors, including chemical structure, the type of bond with the substrate, and the nature of the substrate (Mukundan, 2009)

### 2.3.2 Classification of Dyes

The Dyes are mainly classified into




(Panda,2013)

#### 2.3.2.1 Natural Dyeing

##### 2.3.2.1.1 Introduction

Natural dyes have been a part of human life since time immemorial. Natural dyeing is one step ahead of organic lifestyle. It supports the core concept of organic to eliminate the impact of harmful chemicals and pesticides. It avoids many ailments that are common with conventional clothing (Sharma, 2014)

Natural dyes can be broken down into two categories, substantive and adjective. Substantive or direct dyes become chemically fixed to the fiber without any other chemicals or additives, such as indigo or certain lichens. Adjective dyes or mordant dyes require some sort of substance, to prevent the colour from washing or light-bleaching out. Most natural dyes are adjective dyes, and do require the application of a mordant solution to the fibres at some point in the dyeing process (Krishnan, 2014)

Natural dyes are non-allergic, non toxic and exhibit better biodegradability and generally have a higher compatibility with the environment than their synthetic counter parts. The harmonious and wonderful colours obtained from natural dyes are safe, very exciting and have soothing effect (Ibrahim, 2010) Natural dyes are known for their soft, lustrous colours and endurance. Even after a long period they retain a great beauty and charm. As they are originating from natural sources, they do not create any pollution problem and in some cases, the 'waste' obtained in the process becomes an ideal fertilizer (Gulrajani, 2007)

#### 2.3.2.1.2 History and Development

Dyeing, the ancient art which predates written records the use of Natural or Herbal dyes was found in china around 2600BC (quilthistory.com). They have been used since ancient times for colouring and printing fabrics. Until the middle of last century, most of the dyes were derived from plants or animal sources by long and elaborate processes. Among these, well known ancient dyes include, colours like blue derived from indigo, obtained from leaves of Indigofera Tinctoria. The highly priced colour was Tyranian purple, which was achieved from crushing thousands of shells of Mollusk, found in east coast of Mediterranean. Crimson from kermes, are insect found in oak trees. The first formed colour is madder, which is red dye from the roots of Rubia Tinticorum. Alizarin, Cochineal and logwood dyes too deserve special mention among natural dyes (Donatelli, 2011)

The development of natural dyes took place at the same time after the technique of weaving had been discovered in about 5000BC. In India, the use of natural dyes for dyeing, painting and printing goes to the pre-historic periods, These paintings are the evidence of the use of colourful garments worn by men and women of that era (Joshi, 2013)

Natural dyes can be categorized under vegetative or animal origin. Until the latter half of the nineteenth century, all dyes with the exception of few mineral colours, the colouring matter was extracted from the roots, stems, leaves, flowers, barks and fruits of plants and from certain insects and shellfish by an elaborate series of extraction processes (Patil, 2012)

Environmentalists have espoused the advantages of these types of dyes which include renewability, absence of health hazards and absence of disposal problems. Almost all vegetables can be used as sources for the dyes. However, only a few of these sources yield colorants which can be extracted and worked out to be commercially viable (Gulrajani, 1999)

#### 2.3.2.1.3 Advantages of Natural Dyes

Herbal dyes cause no disposal problem as they are biodegradable. They are obtained from renewable sources and the shades obtained are soft lustrous and soothing to human eye (Park and Shore, 2000) Natural or Herbal dyes cover the area of green chemistry. They are non-carcinogenic and above all it is environmental safer method of dyeing textiles (Sarkar and Deo, 2012) practically no or mild reactions are involved in their preparation. They have pharmacological effects and possible health benefits (Mishra, 2012) It is possible to obtain full range of colours using various mordant.

### 2.3.3 Herbal Extraction Techniques

All the substances in the universe, including plants, are composed of chemical compounds. To study herbal medicine, the major bioactive chemical components should be first known. Only after the biological compounds in herbs are correctly extracted, isolated and identified can be biochemical, biological or pharmacological studies that are performed scientifically. Chemical studies of herbal medicines provide fundamental substances for further studies of biological and pharmacological activity. During the earlier decades of the 1800s, chemical studies in plants could only be performed on active compounds that were highly concentrated and isolated into a relatively pure form by techniques such as distillation or extraction with water, acid, base or alcohol. Their structures were mainly determined by chemical degradation and proven by synthesis in an unambiguous manner. Scientists were unable to determine the stereochemistry of compounds (Braun, 2010)

Although conventional medicine is the mainstream medicine in western countries, application of traditional medicine, including herbal medicines, is

growing worldwide for many reasons, in particular, the side effects or inefficacy of modern drugs. To a large extent, the depth and progress of research on herbal medicines depend on the development of related technology and equipment, as well as the in-depth understanding of the human body and diseases. Mechanism study and functional evaluation of herbal medicine involve the fields of chemistry, biochemistry, biology, pharmacology, toxicology and clinical study. Thus, organized and consistent teamwork is absolutely vital (Pizzorno *et al*, 2012)

#### 2.3.3.1 Decoctions

Decoctions are usually the method of choice when working with tougher and more fibrous plants, barks and roots. Instead of just steeping it in hot water, the plant material is boiled for a longer period of time to soften the harder woody material and release its active constituents (Phillips, 2005)

#### 2.3.3.2 Infusions

Infusions are typically used for delicate herbs, leaves and fresh tender plants. Preparing an infusion is much like making a cup of tea. Water is brought just to a boil and then poured over an herb; it is covered and allowed to sit or steep for 10 to 15 minutes or so subjected by (Zevin, 1997) If an infusion is prepared in the heating pan or pot, it is best to use a ceramic pot with a lid. Stirring it a few times while steeping is helpful. Keeping the infusion covered while steeping is generally recommended as well. The ratio of herb to water can vary depending on the remedy, the plant and whether cut herb or powdered herb is used (Taylor, 2004)

#### 2.3.3.3 Poultices and Compresses

Many herbal remedies are applied directly, to the skin as poultices – usually on rashes and wounds and as topical pain- relieving remedies. They are done in different ways; one of the methods is to mashing up fresh leaves or roots by hand or with mortar and pestle. Sometimes just enough hot water is poured over dried or fresh plant material to soften them. Then the wet herbs are placed directly on the skin or between two pieces of cloth and laid on the skin (Hoffmann, 2003)

Compresses are simply soaking a cloth in decoction or infusion and laying the cloth on to the affected part of the body or skin (Duke, 2000)

#### 2.3.3.4 Maceration

This method of preparation is certainly the easiest. The fresh or dried plant material is simply covered in cool water and soaked overnight. The herb is strained out and the liquid is taken. Normally this is used for very tender plants, or those with delicate chemicals that might be harmed by heating (Wichtl, 2004)

### 2.3.4 Herbal Mordanting Techniques

The mordant are used for fixation of the dyestuff, increasing the fastness properties or variation in the colour appearance. To make the colours bright and fast, natural mordant such as Myrobolan, Rhubarb leaves, Oils, Minerals, Alum, and Iron so and so are used (Flint, 2008)

When using dyes for fibers and textiles, it is very essential to consider using mordant- fixatives- to help set colour so that it won't fade or bleed. Mordant also help the colour adhere to the yarn or fabric, and they may affect the hue. A few plant dyes don't require a mordant; and allows a greater range of potential shades. Mordant are usually applied before dyeing by simmering the yarn in water combined with the mordant (Balick, 2014)

Basically three different types of mordanting are followed in herbal mordanting; pre, after and Meta mordanting. The process varies in the time of mordant addition. While pre- and- post mordanting require an additional treatment step in a separate bath, the simple addition of a concentrated salt solution directly to the dye bath is used in the so called meta-mordanting process (Lighthouse *et al,* 2013)

Pre-and-post mordanting is very similar besides the time of mordant addition states (Robert, 2013) Both require, two fillings, which double the water input. However, a repeated cycle of mordanting, dyeing and re-use of the dyeing solution and the mordant bath is possible if the solutions can be stabilized and contamination is avoided. On the contrary meta-mordanting procedures, where the mordant is added after some minutes, show an advantage in handling

because only one dye bath exists and the water consumption is minimized. Although this option seems to be favourable, one disadvantage is the hindrance of repeated dyeing cycles because the dyeing liquor is contaminated with mordant and re-use is therefore not possible for a second dyeing (Rayburn, 2007)

Generally small variations are found in the colour depth are found in the three mordanting types are compared. In most cases pre-mordanting leads to darker shades compound to meta-mordanting. The pomegranate rind or skin is rich in tannin, which improves the colour fastness. Alum, copper and ferrous mordant have been used as antibacterial agents for treatment of cotton fabrics (Bechtold *et al,* 2009)

## 2.4 AYURVASTRA

### 2.4.1 Introduction

Ayurvastra is a branch of Ayurveda, 'Ayur' in Sanskrit means health, 'veda' means wisdom, and 'vastra' is clothing. Ayurvedic clothing is made from organic fabric that has been permeated with special herbs and oils (Velapure, 2012)

The herbal textile is completely free of synthetic chemicals, toxic irritants and thus avoids global warming. The herbs are selected according to Ayurveda, with the infused cloth known as ayurvastra (Gotipamul, 2012)

### 2.4.2 History

The clothing as means to protect and heal goes back to the Rig-Veda an ancient and sacred Hindu text composed in about 1500 BC, as well as Ayurvedic scriptures like Charak samhita and Susruta samhita (Jain, 2010). According to Kumar (2010), the ancient physician Charaka sued this method where by an environment is created around the patient with clothing, bedding, wall covering etc. All treated with medicinal Ayurvedic herbs / plants specific to the health condition.

Ayurvastra is based on the Ayurvedic principle of direct touch with body pores. Regular contact with a cloth made from the yarns infused with organic herbs and medicinal plant extracts will receive metabolic disorders and threads a new line of healthy living by coming in contact with Ayurvastra, the body looses toxin and its metabolism is enhanced (Evaristo, 2008)

Herbal textile is finished entirely with herbal extractions, without using any sort of chemicals. These herbs are applied directly to the fabric with the help of natural ingredients, so that the medicinal value of the herbs can be kept intact. No chemical process is adopted while finishing process. Herbal treated cloth has the ability to protect us from various skin diseases, provides relief from viral infected disease and mental depression, since the herbal finished clothes or garments come in prolonged contact with the human body. The medical properties of herbs are known to cause no damage to the human body (Jayalakshmi and Manjusha, 2010)

### 2.4.3 Advantages of Ayurvastra

- Herbal textiles do not contain any sort of chemicals.
- It balances ecology cycle thus only 6% surface water used globally (Vidyathi and Gupta, 2011)
- The textiles are dyed with herbs will have highly therapeutic value (www.dermatology.com)
- Herbal textiles can fight diseases like hypertension, diabetes, heart ailments, skin infections (Arun, 2009)
- Herbal textiles are not only eco friendly but also they give away certain residues that can be further used for making other environmental products (www.holistic.com)
- The solid as well as liquid wastes from herbal dyeing process can be recycled to be used as manure in fields (Krishnaveni, 2010)

### 2.4.4 Application on Garments

Herbal dyeing is applied to textile articles like: Raw fiber, Woven fabric, Knitted fabric, Nonwoven fabric and Stitched garments. Since all cotton material are cellulose based; wood, paper should be regarded as textile article. Textile article could be a blend of Plant fiber and Animal fiber. The raw materials for such textile articles include cotton, silk and wool. (Holt, 2010) Preparing herbal cloths such as nightwear, fashion wear, Bandages, mask, sportswear, sheeting, undergarments, shirts, helps in curing a number of diseases and shield the human skin by adding medicinal value of herbs to cloths. Some of the apparels products

available in market are robe, apron, eye mask, fitted sheet, hand mitt, bath mitt, shower towel, hand towel and face towel (Fisher, 2010) Also considering the detrimental effects associated with pathogenic bacteria and fungi. The herbal textiles find extensive use in innerwear, yoga wear, sleep wear and surgical textiles and clinical wear (Chakraborty *et al.,* 2013)

## 2.5 COTTON

### 2.5.1 Introduction

Cotton fiber is one of the oldest natural fibers which is much familiar to human beings and widely used for numerous purposes. Cotton has number of distinguishable characteristics and is graded as fiber which is preferred mostly. Cotton has distinction among fibers due to numerous seasons. Particularly its softness, absorbency, luster, strength and weave comfort have contributed a lot to make it most liked and used fibers since ancient times (Hsieh, 2007) Cotton is preferred for its comfort, good heat and electrical conductivity, launderability, absorbency, ease of finishing and dyeing, strength and cost. It is a preferred fabric for children and for anyone who has a sensitive skin and allergic to other fibers, since cotton is non-allergic in nature (Gautam *et al.,* 2013)

Humans realised very early that the soft, fluffy cotton fibres can be used to make comfortable. Cotton is one of the greatest of all industrial crops. It is the principal fiber plant as well as one of the oldest and most economical. It was known since ancient times and well before written records. There are references to cotton by the ancient Greeks and Romans. Literature provides many evidences about the use of cotton and to some extent it was agreed around in 3000BC (Militky, 2009)

Cotton has been spun, woven, and dyed sine prehistoric times. It clothed the people of ancient India, Egypt and China. Cotton was introduced to Europe by the Arabs who called the plant ‘qutn’ which means a land found in a conquered land (Collier and Tortora, 2001) Neil valley, India and Peru are some of the areas, where people were cultivating pattern of the world. The cotton is originated in India for it is mentioned in Rig-Veda written nearly 3,500 years ago.

### 2.5.2 Properties of Cotton

#### 2.5.2.1 Physical Properties

The physical appearance of cotton include colour of fibre that depends on its type, environment, soil and chemical conditions under which it is grown. There are five recognized groups of colour white, grey, spotted, tinged and yellow stained, as the colour of cotton deteriorates, the proccessability of the fibre decreases (www.swicofil.com, 2011) the length of an individual cotton fiber is usually from 1,000 to 3,000 times its diameter. The diameter may range from 16 to 20 microns. In cross section, the fiber has a U or kidney bean shape with a central canal known as the lumen. During growth, this channel carries nutrients to the developing fiber (Sundaram, Iyer and Srinivasan, 2008) the natural twist of cotton results in uneven surface that breaks up and scatters light rays reflected from the fiber surface.

#### 2.5.2.2 Mechanical Properties

The mechanical property of cotton could be classified into strength and recovery where the strength of the cotton is considered quite well with medium degree of scales. Cotton cellulose has a higher degree of polymerization and crystallinity that are associated with higher fiber strength, whereas the strength of cotton is greatly affected by moisture which imparts on its functional properties (Kiron, 2011) Cotton does not stress easily and the Recovery from deformation of cotton fibres is very low that the cotton of low density deformed than that of the higher density(Riello, 2013) Cotton is fairly flexible. According to fineness of fibre, the bending resistance is high (Sekhri, 2011)

#### 2.5.2.3 Chemical Properties

When property of cotton fibre is tested, the chemical property and fibre reaction towards acids are also noted. Cotton fibre has high absorbency power and this is why the fiber can be dyed properly and without any harassment. Its good absorbency makes cotton comfortable in hot weather and suitable for material where absorbency is important (Aggarwal, 2007) Cotton has an excellent resistance to degradation by heat. It has moderately high heat conductivity which makes the fabric comfortable in hot weather. It conducts electricity and thus does

not build up static electrical charges (Saville, 2008) The cellulosic materials are reactive to chemicals, cotton swells in a high humidity environment in water and in concentrated solutions of certain acids, salts and bases.

#### 2.5.2.4 Environmental Properties

Towards the end of 20$^{th}$ century farmers started experimenting with organic cotton, grown without chemicals or pesticides. People are aware of environmental issues on textile pollution and thus this era jumped into eco-friendly textile products. Cotton is attacked by fungi and bacteria. Mildew will feed on cotton fabric, rotting and weakening the materials. Mildews and bacteria will flourish on cotton under hot and humid conditions. They can be protected by impregnation within certain types of chemicals (Murphy, 2011) Cotton shows better resistance to sunlight than do many fibers. It also degrade the polymer system of fiber as it is attacked by Ultraviolet rays of sunlight (Subrata, 2011)

### 2.5.3 Advantages of Cotton

- Cotton is hypo allergenic and does not irritate skin.
- Cotton fabric has very good breathable characteristics, also have good durability and utility (Retnam, 2006)
- Cotton has high water-absorbing capacity. In humid atmosphere cotton fabric can absorb 27% of water without getting damp (Raul, 2005)
- Cotton has a high tensile strength, making it strong, durable and less likely to tear.
- Cotton is a chemically stable material, it stays undamaged even under the continuous exposure of weak acids and alkalis (Mundoor and Laga, 2012)
- Cotton fibers have the ability to conduct heat energy, minimizing any destructive heat accumulation (NAM S&T Non-Aligned Movement Centre Of Science And Technology, 2009)
- Since cotton is non-allergic in nature, it is highly used in medical science (Sayed and Jawale, 2006)

## 2.6 KNITTING

### 2.6.1 Introduction

Knitting is a process whereby fabrics are formed by the interlacing of neighbouring yarn loops. The fabric manufactured by knitting has distinctly different properties than those of the woven structures. The properties of more than one type of fibre may be incorporated into a fabric as the result of blending the fibres during spinning or by knitting two or more types of yarn (Guagliumi, 2014)

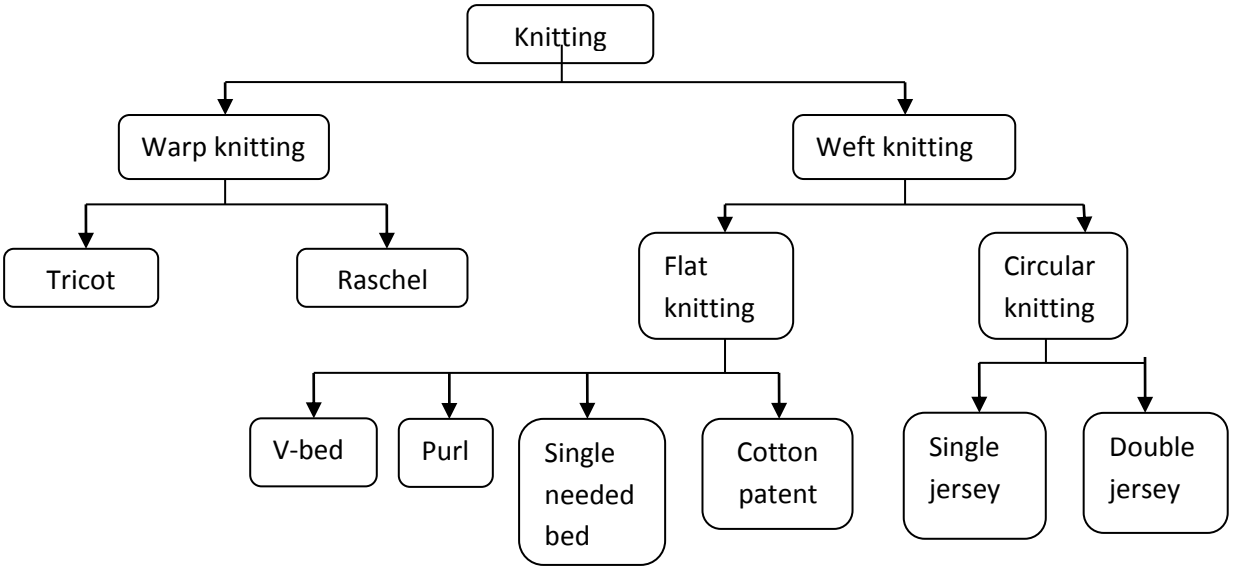
Knitting requires a relatively fine, smooth, strong yarn with good elastic recovery properties; the worsted system has proved particularly suitable for spinning yarns used for knitwear, outerwear, socks and the combed cotton system for underwear, sportswear and socks (Spencer, 2014)

### 2.6.2 History

The term knitting has evolved from the Saxon word ‘Cynttan’ which in turn was derived from the ancient Sanskrit word ‘Nahyati’. Knitting is one of the oldest and most popular needle craft arts. Histories are varied and most histories place knitting’s origin in the Middle East and spread to Mediterranean trade routes, Europe and then to America with European colonization (Hubert, 2010)

People were knitting as far back as the middle ages, although at that time knitting was primarily considered ‘busy work’ for upper class women and girls. But it was also practiced for economic reasons. Economics played a role even later, whenever times got tough. In today’s fast-paced world, knitting has taken on a whole new function (Klopper, 2005)

### 2.6.3 Classification of knitting




(Spencer, 2014)

### 2.6.4 Single Jersey Knit

Jersey fabric is a type of knit textile made from cotton or cotton-synthetic blend. Some common uses for jersey fabric include t-shirts, winter bedding, medical dressings and sportswear. The fabric is warm, flexible, stretchy and very insulating, making it a popular choice for the layer worn closest to the body. Jersey also tends to be soft, making it very comfortable. Like many other knit fabrics, jersey fabric has a right side and a wrong side. The right side of the material is marked by a series of very small lines which run vertically, and the wrong side has a horizontal grain (Stauffer, 2004)

One of the reasons many people like to wear jersey fabric is the stretch factor. The fabric can stretch 25% percent along its grain. Garments made from the material gives ease to the wearers, and also tend to cling to the body, since the fabric contracts as well as expanding. Knit dresses are usually made from jersey fabric, exploiting the clingy characteristic of the fabric. Jersey fabric is also available in a large assortment of colours and patterns to suit all tastes (textile learner. Blogspot.com, 2012) All knits tend to shrink when they are washed, and washing beforehand eliminates shrinkage issues. It is also important to use a attern specifically designed for knit fabrics, as the pattern will account for the

stretch factor of the material. Most seamstress fabrics also use a double layer of stitching or an over lock stitch on jersey fabric, to prevent unravelling (Banerjee, 2015) plain is the simplest and most economic weft knitted structure to produce and has maximum covering power. It normally has a potential recovery of 40 percent in width after stretching (textile helpline.blogspot.in, 2014)

### 2.6.5 Advantages of Knitted Fabrics

Knitted fabrics are much more elastic, which accounts for their historical use of stockings and other clothing that requires changes in shape. There is no single straight line of yarn anywhere in the pattern; a knitted piece can stretch in all directions. This elasticity is unavailable from woven fabrics, which only stretch along the bias (Rastogi, 2009) Garments made from knitted fabrics can be more form-fitting than counterparts made from a woven fabric. Knitted fabrics can stretch from 0 to 500%, depending on their material and knitting pattern. The elasticity of knitted fabrics gives them an excellent drape (Anbumani, 2007)

Knitted fabrics are generally warmer and more comfortable than woven fabrics, which is why they are worn closer to the body. Mostly preferred for close fitted garments and medical dressings like socks and wound coverings. They are highly stretchable. These are considered to be an excellent fabric for draped garments, such as t-shirts and gowns (Au, 2011)

## 2.7 SOCKS

A sock is an item of clothing worn on the feet. The foot is among the heaviest producers of sweat in the body, as it can produce over 0.25 US pints (0.121) of perspiration per day. Socks help to absorb this sweat and draw it to areas where air can evaporate the perspiration. In cold environments, socks decrease the risk of frostbite (Sen., 2007)

Socks can be created from a wide variety of materials. Some of these materials are cotton, wool, nylon, acrylic, polyester, olefins or spandex. To get an increased level of softness other materials that might be used during the process can be silk, bamboo, linen, cashmere or mohair. Sock ‘colouring’ can come in a wide range of colours. Sometimes art is also put onto socks to increase their

appearance. Colored socks may be a key part of the uniforms for sports, allowing players teams to be distinguished when only their legs are clearly visible (Sullivan, 2013)

Cotton soaks up perspiration like a towel and holds it. Cotton fiber retains three times the moisture of acrylic and fourteen times the moisture of CoolMax®. When exposed to ambient air, socks composed of cotton retain moisture ten times longer than acrylic. Natural fibers (cotton-wool) when laden with moisture, compress more easily than synthetic fibers like acrylic and CoolMax®.

Cotton and wool socks have a higher resistance to sweat transport by wicking. When wet, acrylic fibers swell less than 5% while cotton swells 45% and wool swells 35%. Swollen fibers that are compressed reduce air spaces and thus reduce moisture transport. It's no wonder that cotton socks exhibit a 2.4 times higher resistance to moisture transport than acrylic (Werd *et al,* 2010) Cotton also tends to stretch and flatten out under the weight exerted by the body. Cotton loses all resilience when it becomes wet, ceases to cushion the foot and can become the foot and can become the source of blisters where it forms creases within the shoe or wherever there is any friction in a wet environment (Balch, 2010)

# 3. EXPERIMENTAL PROCEDURE

## 3.1 SELECTION OF FABRIC

The cotton fabric have been commonly used for herbal textile as it absorbs perspiration quickly, thus allowing the material to be fine and dry (Sekri, 2011)

The knitted fabric has distinctly different properties than those of woven structures. Mostly knitting is carried out in a circular knitting machine (Anbumani, 2007) Cotton fabric can control and cure various diseases without causing any side effects when combined with herbal extract and close contact with skin (Mary, 2008) thus the investigator selected 100% plain single jersey knitted fabric for the study.

## 3.2 WET PROCESSING OF FABRIC

### 3.2.1 Desizing

**TABLE I**

**DESIZING RECIPE**

| Desizing Variables | Proportions |
|---|---|
| Sea Salt | 100g |
| M:L Ratio | 1.15 |
| Desizing Time | 13 hours |

The gray cloth was boiled for 1 hour in solution of sea salt. Cloth was dipped in the sea salt solution for 12 hours. Then washed in running water and kept for drying in sunlight. Gray cloth was passed through this process for removing the sizing gums, oils and impurities on it, which makes the cloth more absorbent for the herbals. Detergent is not involved in this process. The detergent contains hazardous chemicals (Sabat and Magum, 2012)

### 3.2.2 Bleaching

**TABLE II**

**BLEACHING RECIPE**

| Bleaching Variables | Proportions |
|---|---|
| Cow Urine | 1 Ltr. |
| Milk | 500ml |
| Honey | 500ml |
| M:L Ratio | 1:15 |
| Bleaching Time | 12 hours |

The selected gray cloth was first bleached using a solution which contains cow urine, milk and honey. This preparation is used for cleansing or purifying rituals. Sunlight is the best source of natural bleaching. So, if possible, the fabric was spread on grass and also exposed to direct sunlight as the part of the process. Reaction between sun and grass makes the cloth bleach to a great extent (Patel *et al*, 2006)

### 3.2.3 Gumming

**TABLE III**

**GUMMING RECIPE**

| Gumming Variables | Proportions |
|---|---|
| Aloe Vera | 50g |
| Camphor | 5g |
| M:L Ratio | 1:5 |
| Time | 12 hours |

To make the colour and property fast, preparatory gumming process was carried out before dyeing which includes Aloe Vera and Camphor that is applied on the fabric for 12 hours. This in turn will help the Kashaya hold the colour (Ravi, 2010)

## 3.3 SELECTION OF HERBS FOR CONCOCTION

According to (Stubberfield, 2006) wearing natural cotton, wool or silk which has been dyed naturally is going to obviously help the skin. The herbs selected for the study are Calendula Officinalis (Marigold), Copaiba Balsam, Tinospora Cordifolia (giloe), Commiphora Mol mol (Myrrh), Azadirachta Indica (Neem) and Aloe Barbadensis. These are specifically blended leaves, barks, roots and seeds. The herb sources in raw and powdered form and concoction were shown in plate I- IX.

## 3.4 PILOT STUDY

The concoction made from the extraction of leaves, barks, roots and seeds were selected based on the medicinal property, availability and appealing colours. The above mentioned herbs were selected for the study. The herbs were powdered and used for dyeing.

Fungi generally grow slowly and often in multi cellular forms, they are more difficult to quantify than bacteria. Despite these limitations, numerous advances have been made in developing new antifungal agents and in understanding the existing ones. Herbs that contain Flavonoids, Saponins and Antifungal properties are selected; dried and powered that is applied on fabric for medication of Athlete's Foot.

## 3.5 DEVELOPMENT OF SOCKS

**Socks construction details**

Yarn count - 30's

Knit structure – flat knit (single jersey)

Size – 9 to 11

Cylinder – double cylinder

Diameter – 4

Needles – 168

Weight (socks) – 0.015gms

Yarn – 100% cotton yarn

The jersey stitch is one of the most common machine knitting. Jersey has different appearance on the face and reverse, sometimes called plain knitting, the jersey side is referred to as the technical face in commercial technology, which means the side is usually the outside. The knit side is smoother, and the stitches form a sort of V. Reverse jersey is called the technical back. Jersey and reverse jersey are the front and back of the same loop.

Today, many of the shoes and boots we buy are made of synthetics that do not breathe. It means even if we are wearing the socks made of materials that wick the moisture away from the skin, there is usually only one way to vent that moisture. It must migrate up the sock and out the top of shoe or boot. Using flat knitting method 25 set of cotton socks were developed. The socks were given no finish or no chemical bleaching. The gray socks were then used for further finishes (Werd *et al*, 2010)

### 3.6 DYEING OF FABRIC

#### 3.6.1 Preparation of Concoction

Each herb was taken separately dried in shade and powdered. Then the medicated dye was extracted by soaking herbs in water in the ratio of 1:15 m: l and boiled at 100 $^{0}$c for 2 hours to get a thick viscous herbal solution. Then the solution was strained through cloth and kept overnight. The strained solution was used for dyeing (Tuncay, 2014)

#### 3.6.2 Dyeing Recipe

**TABLE IV**

**DYEING RECIPE**

| Dyeing Variables | Proportions |
|---|---|
| Aloe Vera | 150g |
| Copaiba Balsam | 100g |
| Giloe | 100g |

| | |
|---|---|
| Marigold | 100g |
| Myrrh | 100g |
| Neem | 100g |

### 3.6.3 Application of Concoction on Fabric

The pre treated cotton material was soaked in the concoction and boiled for 2 hours at 60 $^{0}$c. Constant stirring was done from time to time it have good absorbency and also to have even dyeing with herbal solution. Then the dyed cloth was allowed to cool and repeatedly washed to remove the loose particles in running water and dried in shade. Pomegranate rind powder was added in the dyeing solution for fixation of dye (Varghese, 2006)

### 3.6.4 Washing

The herbal textiles should be washed in running water with soap nut and lime (Kumar, 2011). Hence the dyed fabric was washed with soap nut. Then the fabric were rinsed thoroughly in the water to remove loose particles and dried in shade.

## 3.7 EVALUATION

### 3.7.1 Subjective Evaluation

#### 3.7.1.1 Wear Study

Fungal infections are common in places where there is warmth and moisture. The infection like Athlete's foot can be seen most commonly in between toes and can spread to other areas too. Problems can get aggravated by sweat and body heat, especially in individuals who have high phlegm. Ayurveda treatments focus on reducing the body heat and sweat as well as reducing the infection. The developed socks were given to persons (20-50 years) who were suffering from foot fungus disease and they were asked to wear from time being10.00am to 6.00pm. After each wear the socks were washed and given for next wear. The subjects were asked to wear for a period of one week. The dyed socks were compared with the original and gummed fabric. The samples given for wear study is shown in plate XI.

### 3.7.2 Objective Evaluation

Evaluation is defined as the making of judgement about the value for some purpose, ideas, works, solutions and materials. The properties of the socks were believed to reduce the fungal infection. Hence it is necessary to evaluate socks for an effective end use (Pradip *et al*, 1998)

#### 3.7.2.1 Physical Property Test

##### 3.7.2.1.1 Fabric Weight

Fabric weight is the relative weight of the fabric and its weight of a particular size of piece grams per square meter or ounces per square yard. And sometimes in weight of fabric is measured in pounds.

Fabric was cut using a GSM cutter and Electronic Weighing Balance to find out the weight of the sample. The inference obtained is calculated using the formula:

$$\textit{Grams per square meter (GSM)} = \frac{\textit{Weight of the Fabric x Square Meter}}{\textit{Area of Square}}$$

Weight of the fabric = Xg

Square of the fabric = 100cm x 100cm = 10000 $cm^2$

Area of square = length x breadth square unit

The same procedure was followed to find out the fabric weight of original and dyed fabrics were carefully recorded and the mean value was calculated (Hu, 2004)

##### 3.7.2.1.2 Fabric Thickness

Determination of thickness of fabric samples in laboratory is usually carried out with the help of a precision thickness gauge. In this equipment, the fabric whose thickness is to be determined is kept on a flat anvil and a circular pressure

foot is pressed on to it from the top under a standard fixed load. The dial indicator directly gives the thickness in mm.

The principle of measurement of fabric thickness is based on ‘’ the precise measurement of the distance between two plane parallel plates separated by the cloth when a known pressure is applied and maintained on the plates’’ (Wei, 2009)

#### 3.7.2.1.3 Absorbency Drop Test

According to **AATCC Test Method 79**, Absorbency of Textiles, This test method is designed to measure the water absorbency of textiles by measuring the time it takes a drop of water placed on the fabric surface to be completely absorbed into the fabric.

- The Sample is placed over the top of a beaker so that the center is unsupported
- A measured drop of water is placed on the fabric 1cm from the surface.
- Time is recorded until the water drop absorbs completely (Russell, 2006)

#### 3.7.2.1.4 Sinking Test

The samples of the size 2inches square swatches are cut. Each sample is kept on the surface of water taken in 500ml glass beaker. Time taken by the piece to sink just beneath the water surface is measured. A sinking time of about 5sec is generally considered satisfactory for well prepared cellulosic materials (Choudhury, 2006)

#### 3.7.2.1.5 Capillary Rise Test

A 5cm wide strip is cut across the filling direction. The strip is then cut into 5cm long sections. The numbered specimens are then immersed 1mm deep in 500ml of water in a glass beaker for the time duration of 30 minutes. After that the fabric is immediately placed on a wire screen. The capillary rise of the dye solution is measured. The uniformity in absorbency across the width can thus be tested (Pohl, 2010)

### 3.7.2.2 Mechanical Property Test

#### 3.7.2.2.1 Abrasion Resistance

According to ASTM standard (2005) abrasion is rubbing away of the component fibres, yarn of the fabric. Martindale abrasion resistance tester was used to determine the abrasion resistance of the fabrics. Five specimens each 38mm in diameter were cut using the appropriate cutter. They were then mounted in the specimen holders with a circle of standard foam behind the fabric being tested. It is important that the mounting of the sample is carried out with the specimens placed flat against the mounting block.

The test specimen holders were mounted on the machine with the fabric under next to the abrading. A spindle was inserted through the top plate and the current weight was placed on top of this. The specimen was examined at suitable intervals without removing it from its holder to see whether two threads are broken. The abrading was continued until two threads were broken. All specimens were judged individually (Fung *et al*, 2001)

#### 3.7.2.2.2 Air Permeability

The Air Permeability of a fabric is a measure of how well it allows the passage of air through it. Air permeability is the volume of air in millimetres which is passed in one second through 100 S/mm$^2$ of the fabric at a pressure difference of 10mm head of water (jewel, 2005).

In the British Standard test the air flow through a given area of fabric was measured at a constant pressure drop across the fabric of 10mm head of water. The specimen was clamped over the air inlet of the apparatus with the use of rubber gaskets and air was sucked through it by means of a pump. The air value is adjusted to give a pressure drop across the fabric of 10mm head of water and the air flow was then measured using a flow meter (Li *et al*, 2006)

#### 3.7.2.2.3 Bursting Strength

Bursting strength is a method of measuring strength in which the material is stressed in all the direction at the same time and is therefore more suitable for materials such as knitted fabrics, lace or non –woven.

Bursting strength testing is the application of a perpendicular force to a fabric until it ruptures. The force is normally applied using either a ball or a hydraulically expanded diaphragm. The fabric is clamped in place around the device that applies the force by a circular ring. The material is stressed in all directions at the same time regardless of the fabric construction. Ball burst testing is used as an alternative to tensile testing for materials that are not easily prepared for tensile testing or have poor reproducibility when tensile tested (Sung *et al*, 2013)

#### 3.7.2.2.4 Drapability

Drape is a term used to describe the way a fabric hangs under its own weight. Fabric drapability is an important factor from an aesthetic point of view. Draping qualities are related to fabric bending stiffness and sheer properties. Factors such as fibre content, yarn structure, fabric structure and type of finish after the drape behaviour. Drape test systems currently used worldwide include the Peirce's cantilever method, the Rotrakote - CUSICK drape tester, the Fabric Research Liberating method (FRL drape meter) (Japan), and the 3D body scanner.

The cantilever method measures fabric bending characteristics and then converts them into a measure of fabric drape. The FRL drape meter also works on a similar principle. The cantilever method and FRL drape meter only reflect a fabric's two-dimensional characters, and as fabric drape is actually a three-dimensional phenomenon, they are now less widely used (Fairhurst, 2008)

The CUSICK drape tester is a simple but apt instrument which uses a parallel beam of light to cast a shadow form a circular piece of fabric, supported by a smaller circular disc. The area of shadow ($A_S$) is measured and compared with

the area of the sample ($A_D$) and that of the supporting platform ($A_d$). The drape coefficient F is defined as

$$F = \frac{A_s - A_d}{A_D - A_d} \times 100\ \%$$

$A_s$ - Area of Shadow

$A_d$ - Supporting Platform

$A_D$ - Area of the Sample

F - Drape Coefficient

In the actual test, the light beam casts a shadow of the draped fabric onto a ring of highly uniform translucent paper supported on a glass screen. The surface drape pattern area on the paper ring is directly proportional to the mass of that area. So the drape coefficient (F) can be calculated in a simple way:

$$F = \frac{\text{mass of shaded area}}{\text{Total mass of paper ring}} \times 100\%$$

There are three standard diameters of specimen that can be used for different types of fabrics:

- 24 cm for limp fabrics (drape coefficient below 30% with the 30 cm sample)
- 30 cm for medium fabrics
- 36 cm for stiff fabrics (drape coefficient above 85% with the 30 cm sample) (Hu, 2008)

**3.7.2.2.5 Pilling**

Pills are small knots or balls of mixture of large number of small fibres accumulated at the surface of the fabric and entangled by the mild frictional action during processing or wearing. These are tested through the 1.e.1 pill box tester. Pills are soft, firmly held on the surface of the material. A piece of fabric measuring 127 x 127mm is stitched so as to be a firm fit when placed round a rubber tube of 152mm long, 32mm outside diameter and 3mm thick. The cut ends of the fabric are covered by cellophane tape. Four such tubes encircled by the fabrics are placed in the pillbox tester (229 x 229 x 229mm), which has inner lining with cork.

The box is then rotated at 60 rpm for 5 hours. The extent of pilling is assessed visually by comparison with the arbitrary standards, which are given in the table (Saville, 1999)

### 3.7.2.2.6 Antifungal Activity Test

AATCC 30-1993: antifungal activity. Assessment of antifungal finishes on textile material – measures the degree of anti- fungal activity – agar diffusion test.

The plate agar diffusion method was employed to assess the antifungal activity of the prepares extracts. 20ml of the rosebengal agar were distributed into sterile petri dishes and the agar was left to set. The samples where then placed on the agar plates after parallel streaking of microorganisms. the plates were then incubated at 37 $^{0}$C for 18 hours. The diameter of the growth inhibition zones were measured at 24 hours of incubation and the mean values were tabulated (Kumar *et al* , 2007) the antifungal activity is shown in plate X.

## 3.8 Statistical Analysis

The term statistical analysis refers to the computation of certain measures along with searching for patterns of relationship that exist among data groups (Kothari, 2005). Thus statistical analysis has been done for the parameters and the findings are presented in Results and Discussion chapter.

## 3.9 Nomenclature

| **Sample** | **Abbreviation** |
|---|---|
| GC | Gray Cotton |
| BC | Bleached Cotton |
| DC | Dyed Cotton |

**PLATE I**

**ALOE VERA**

**PLATE II**

**NEEM**

**PLATE III**

**MARIGOLD**

**PLATE IV**

**MYRRH**

**PLATE V**

**COPAIBA BALSAM**

**PLATE VI**

**GILOE**

**PLATE VII**

**POMEGRANATE RIND**

**PLATE VIII**

**MYROBOLAN**

**PLATE I**

**ALOE VERA**

**PLATE II**

**NEEM**

**PLATE III**

**MARIGOLD**

**PLATE IV**

**MYRRH**

**PLATE V**

**COPAIBA BALSAM**

**PLATE VI**

**GILOE**

**PLATE VII**

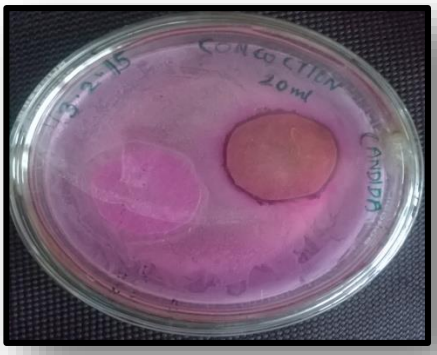
**POMEGRANATE RIND**

**PLATE VIII**

**MYROBOLAN**

**PLATE IX**

**CONCOCTION**



**ANTIFUNGAL ACTIVITY TEST**

**WASH TEST - 1**

**WASH TEST - 2**

**PLATE X**

**BEFORE TREATMENT**

**MEDICATED SOCKS DAY 1**

**DAY - 4**

**DAY- 7**

**DAY- 8**

**AFTER TREATMENT**

**PLATE XI**

**WEAR STUDY**

# 4.RESULTS AND DISCUSSION

## 4.1 SUBJECTIVE EVALUATION

### 4.1.1 Wear Study

The result of the wear study is presented in Table V.The dyed socks were given to the persons who suffer from foot fungal disease. The subjects were asked to wear the socks from 10.00am to 6.00pm for one week. The wear study report is shown in Table V.

**Table V**

**Wear Study**

| S.no | Sample | General appearance | | | Comfort | | | Irritation | | Healing effect | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Excellent | Good | Fair | Excellent | Good | Fair | Yes | No | Excellent | Good | Fair |
| 1. | GC | 36 | 56 | 8 | 32 | 68 | - | 24 | 76 | 16 | 48 | 36 |
| 2. | BC | - | 56 | 8 | 36 | 56 | 44 | 12 | 88 | - | 32 | 68 |
| 3. | DC | 4 | 76 | 20 | 16 | 76 | 8 | - | 100 | 36 | 52 | 12 |

**Wear Study Report**

The wear study report given in Table V show that the sample DC has been rated good by 76% of judges indicating to be maximum when compared to GC and BC that had been rated by 56% of judges. Though 36% of judges rated GC sample to be excellent, it is lower when compared to DC sample rated as good by 76% of judges. Regarding comfort, property, the maximum preference given by 76% of judges refers to sample DC, followed by sample GC and BC 100% of judges referred the sample DC to show no irritation during wear.

It is considered that healing effect is an important criteria for the study and based on the results, the efficiency of the product is estimated. Though 68% of judges rated sample BC to be fair, its efficiency is lower when compared to 36% and 52% determining excellent and good in sample DC. Hence, it could be

concluded that the sample DC show good properties and is liked by the judges during wear trial.

## 4.2 OBJECTIVE EVALUATION

### 4.2.1 Physical Property Test

#### 4.2.1.1 Fabric Weight

The fabric weight and analysis of variance of Gray, Bleached and Dyed cotton samples are shown in Table VI and Figure I.

**Table VI**

**Fabric weight**

| S.no | Sample | Mean weight of the fabric (g) | Weight loss or gain over original (g) | Weight loss or gain percentage over original (%) | 'F' test |
|---|---|---|---|---|---|
| 1. | GC | 1.4 | - | - | 11820.983* |
| 2. | BC | 1.4 | 0 | - | |
| 3. | DC | 1.5 | -0.1 | 7.1 | |

*- significant at 1% level.

The results pertaining to fabric weight demonstrated in Table VI and figure I determines an increase in weight by the sample DC by 7% when compared to its bleached and gray sample. The mean value of sample DC was identified to be 1.5g whereas sample BC does not show any change in weight and is found similar to the gray fabric as 1.4g. The reason for increase in weight of DC sample may be due to the presence of dye compounds absorbed by the fabric.

The statistical analysis shows the F value which is 11820.983 significant at 1% level with respect to the samples. Hence, it could be concluded that dyed fabric shows a consistent increase in weight as seen in sample DC due to concoction treatment.

### 4.2.1.2 Fabric Thickness

Table VII and Figure II determines the fabric thickness and ANOVA of gray, bleached and dyed cotton samples.

**Table VII**

**Fabric thickness**

| S.No | Sample | Mean value (mm) | Loss or gain over original (mm) | Percentage of loss or gain over original (%) | 'F' Test |
|---|---|---|---|---|---|
| 1. | GC | 0.43 | - | - | 14.880* |
| 2. | BC | 0.43 | 0 | - | |
| 3. | DC | 0.44 | -0.01 | 2 | |

*- significant at 1% level.

From Table VII and Figure II it is clear that the thickness of sample DC has increased by 2% with its mean value as 0.44 whereas sample BC does not show any difference in thickness when compared to its original gray cotton maintaining it to be the same with 0.43mm. The 'F' test result which is 14.880 found to show significant difference.

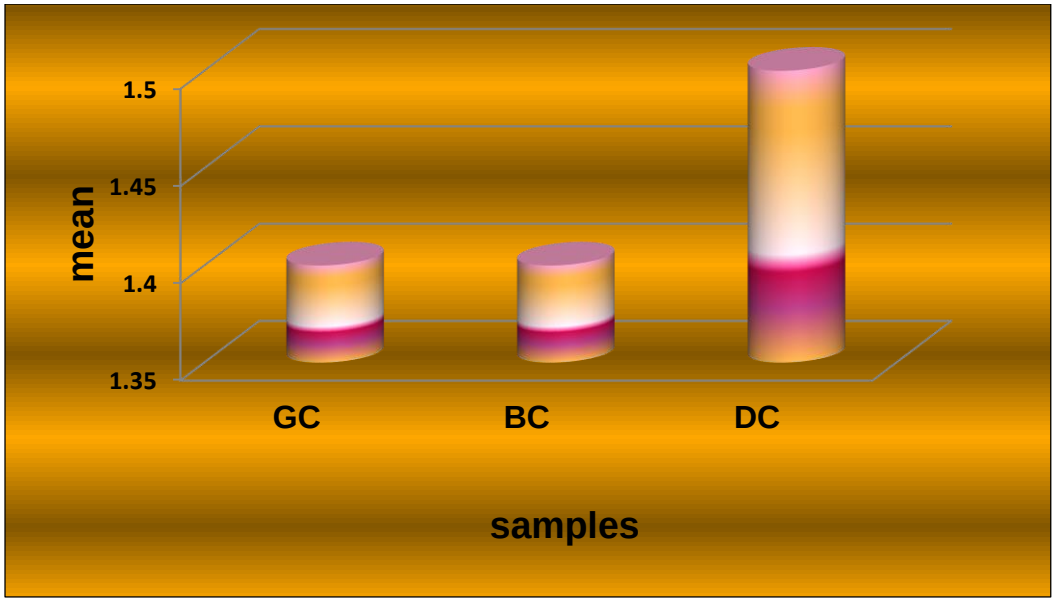



**Figure I**

**Fabric Weight**

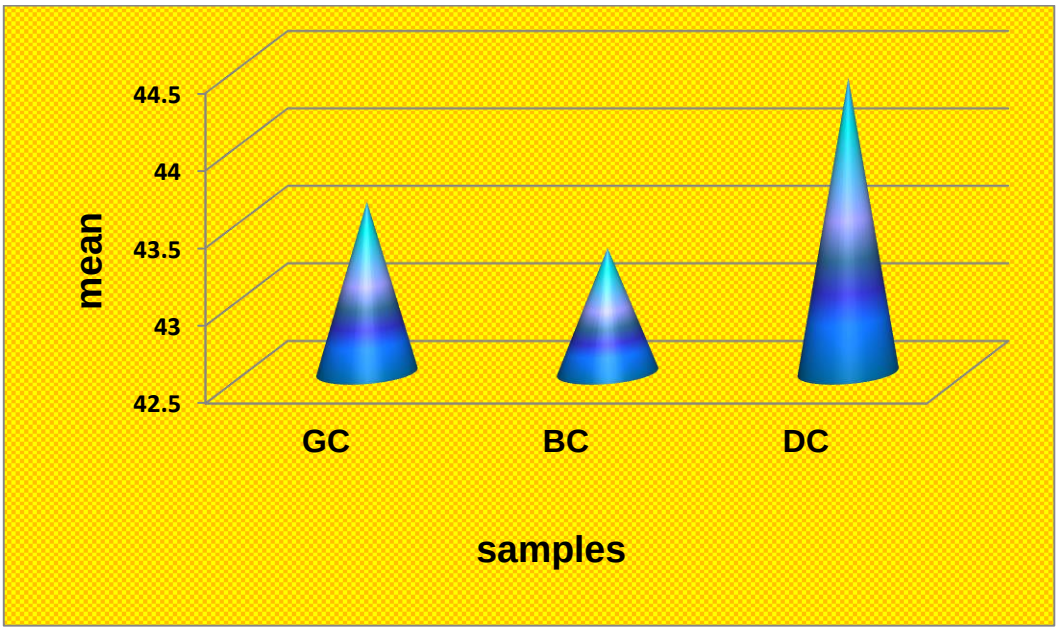



**Figure II**

**Fabric Thickness**

### 4.2.1.3 Absorbency

The fabric absorbency and analysis of variance of gray, bleached and dyed cotton samples are shown in Table VIII and Figure III.

**Table VIII**

**Absorbency drop test**

| S.no | Sample | Mean value (sec) | Loss or gain over original (sec) | Percentage of loss or gain over original (%) | 'F' Test |
|---|---|---|---|---|---|
| 1. | GC | 10.6 | - | - | 36.367* |
| 2. | BC | 16.9 | -6.3 | 59.4 | |
| 3. | DC | 9.2 | 1.4 | 13.2 | |

*-significant at 1% level.

From the Table VIII and Figure III, it is evident that the dyed cotton sample has shown good absorbency by 13% with respect to GC and BC sample. Decrease in value with respect to time determines greater absorbency level of the sample. Hence, the sample DC which shows absorbency in 9.2 seconds is considered to be the best regarding absorbency level when compared to sample BC and GC with its absorbency time in 16.9 sec and 10.6 sec respectively.

With respect to the current study, sweat accumulation is considered to be major criteria for the severenity of athlete's foot. So, absorption property needs to be considered important. Therefore, the sample DC could be suggested as good for athlete's foot due to its higher absorbency and medicinal properties. Statistically, it could be confirmed that the 'F' value which is 36.367 is significant at 1% level.

#### 4.2.1.4 Sinking

The fabric absorbency through sinking and analysis of variance of gray, bleached and dyed cotton samples are shown in Table IX and Figure IV.

**Table IX**

**Sinking test**

| S.no | Smaple | Mean value (sec) | Loss or gain over original (sec) | Percentage of loss or gain over original (%) | 'F' Test |
|---|---|---|---|---|---|
| 1. | GC | 2.9 | - | - | 19.245* |
| 2. | BC | 2.4 | 0.5 | 84.6 | |
| 3. | DC | 1.3 | 1.6 | 20.8 | |

*-significant at 1% level.

From the Table IX and Figure IV, it is evident that the dyed cotton sample has shown good results in sinking by 20.8% with respect to GC and BC sample. Decrease in value with respect to time determines greater absorbency level in sinking. Hence, the sample DC which shows sink level in (1.3 seconds) is considered to be the best regarding sinking level when compared to sample BC and GC with its sinking time 2.4 and 2.9 seconds respectively. Statistically, it could be confirmed that the 'F' value which is 19.245 is significant at 1% level.

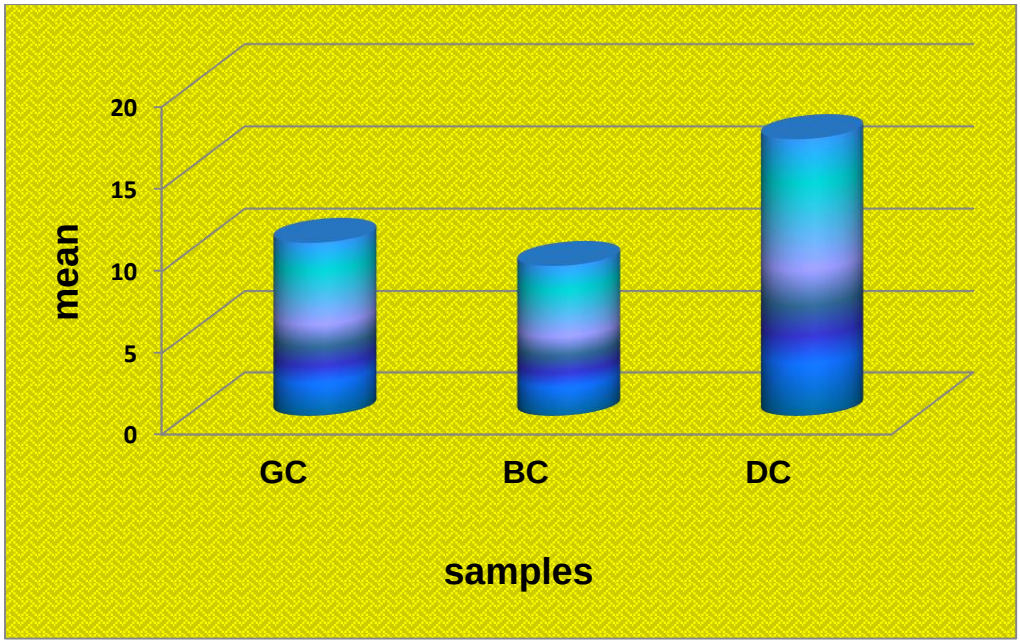



**Figure IV**

**Absorbency**

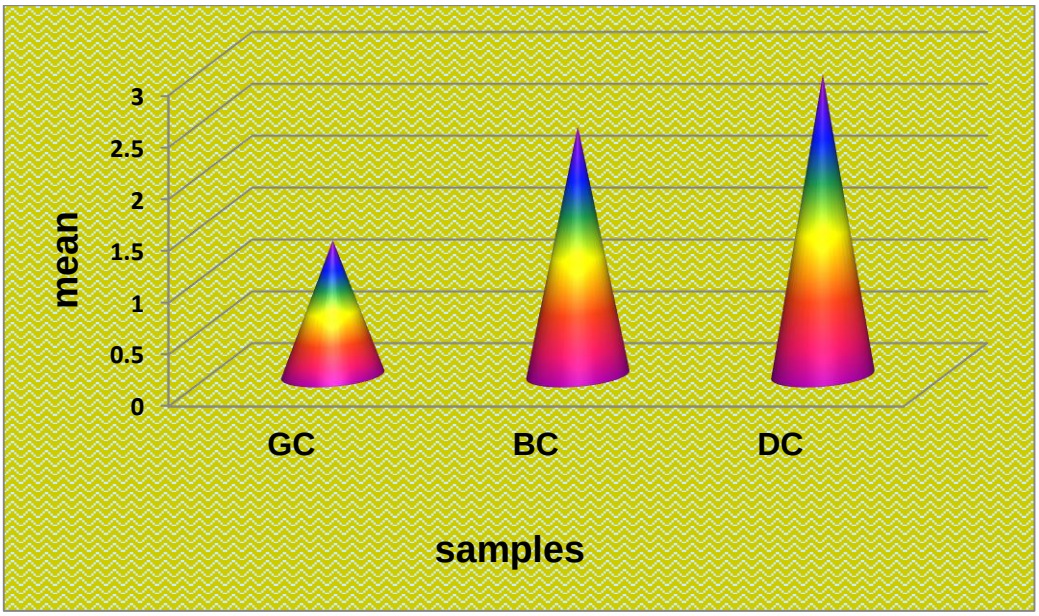



**Figure V**

**Sinking**

### 4.2.1.5 Capillary Rise Test

Table X and Figure V present the results of capillarity test with respect to gray, bleached and dyed cotton samples.

**Table X**

**Capillary rise test**

| S.no | Sample | Mean value (min) | Loss or gain over bleached (min) | Percentage of loss or gain over original (%) | 'F' Test |
|---|---|---|---|---|---|
| 1. | GC | 89.5 | - | - | 10158.934* |
| 2. | BC | 17.4 | 72.1 | 80.5 | |
| 3. | DC | 18.6 | 70.9 | 79.2 | |

*- significant at 1% level.

From Table X and Figure V, it is evident that the treated samples BC and DC show an increase in capillarity. The sample GC shows a capillary rise in 89.5 minutes whereas sample BC and DC shows capillary rise in 17.4minutes and 18.6 minutes respectively. It is clearly understood from the results that as the time increases, the speed of absorbency is reduced. Absorbance level is said to be good for results showing minimum time when compared to original. In correlation to this statement, it could be determined that the sample BC and DC showed minimum time with respect to GC pertaining to good capillarity. In comparison between BC and DC samples, maximum absorbance is seen in sample BC.

Though sample BC has increased in capillarity by 80% and DC by 79% with respect to GC both the treated samples is observed to show good absorbance than the gray cotton. The 'F' value of the samples is 10158.934 which are significant at 1% level. Therefore, it could be concluded that the bleached cotton and dyed cotton fabric show good absorbency without any disturbances even after Ayurvedic dyeing treatment.

### 4.2.2 Mechanical Property Test

#### 4.2.2.1 Abrasion Resistance

Table XI and Figure VI display the abrasion resistance analysis of variance of gray, bleached and dyed cotton sample.

**Table XI**

**Abrasion resistance**

| S.no | Sample | Mean value (g) | Loss or gain over bleached (g) | Percentage of loss or gain over original (%) | 'F' Test |
|---|---|---|---|---|---|
| 1. | GC | 1.09 | - | - | 165.336* |
| 2. | BC | 0.67 | 0.42 | 38.53 | |
| 3. | DC | 0.13 | 0.96 | 88.07 | |

*- significant at 1% level.

The result of abrasion resistance shown in Table XI and Figure VI determines that the sample BC and DC show good abrasion resistance when compared to the GC sample. The mean value of GC is 1.09g which is higher when compared to sample BC and DC showing 0.67 and 0.13g respectively. A higher value in weight as seen in sample GC is due to less resistance to abrasion. The final weight increases only when there is a considerable change in the abraded and before abrasion sample.

Hence, it could be determined that the bleached and dyed cotton samples show good abrasion over the original by 38 and 88% respectively with the maximum resistance seen in sample DC. The F-value of GC, BC and DC samples is165.336 which is significant at 1% level. Therefore, it could be concluded that the sample DC shows good abrasion resistance.

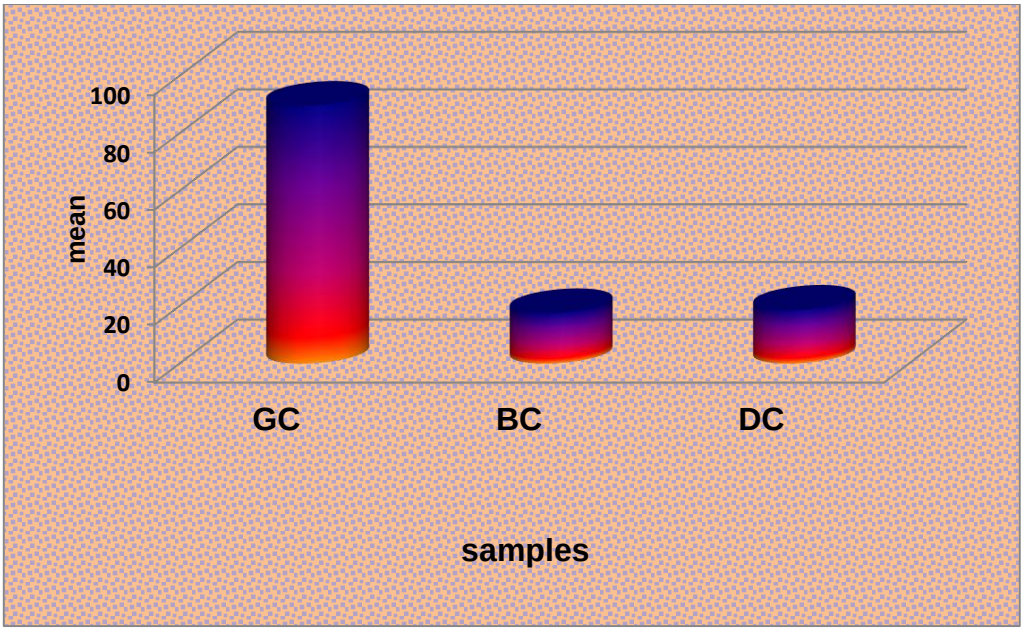



**Figure V**

**Capillarity**

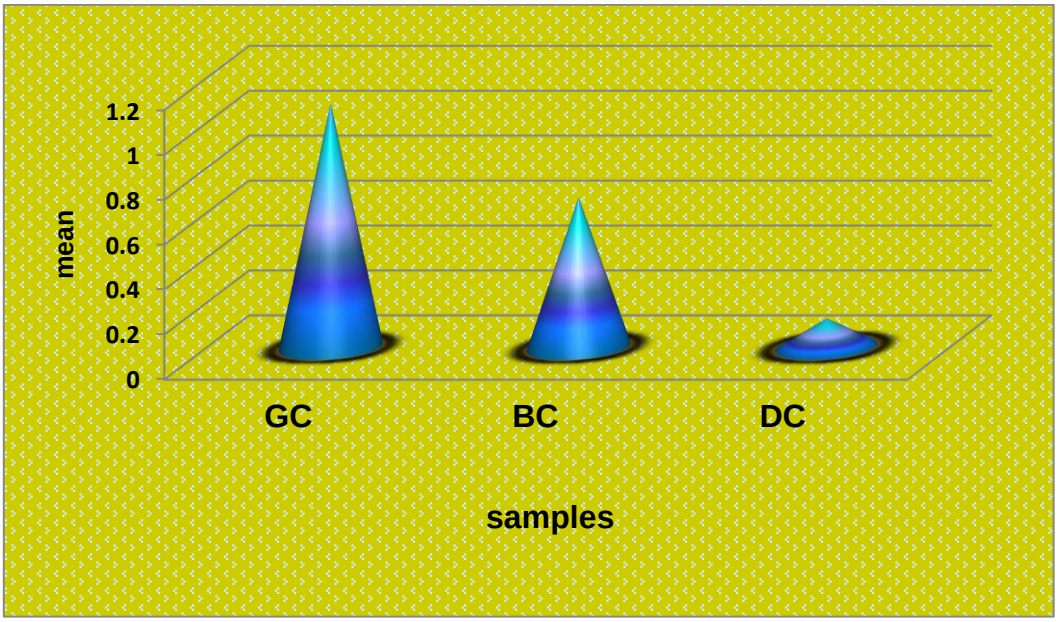



**Figure VI**

**Abrasion Resistance**

### 4.2.2.2 Air Permeability

The air permeability level along with its F value is presented in Table XII and Figure VII.

**Table XII**

**Air permeability**

| S.no | Sample | Mean value (sec) | Loss or gain over bleached | Percentage of loss or gain over original | 'F' Test |
|---|---|---|---|---|---|
| 1. | GC | 293.76 | - | - | 4.369* |
| 2. | BC | 293.19 | 0.57 | 0.2 | |
| 3. | DC | 292.94 | 0.82 | 0.3 | |

*- significant at 1% level.

The Table XII and Figure VII determines that the air permeability level has been maximum in sample DC followed by sample BC. The sample Dc showed its air permeability level through fabric in 292.24 seconds and sample BC in 293.19 seconds, whereas sample GC lets air pass through the fabric only in 293.76 seconds. The reason for better air permeability in sample DC may be because of dyeing treatment that had made the fabric porous and the fibres to swell leading to more vaccum spaces.

Thus the treated samples showed an improvement in air permeability level over original by 0.2% and 0.3% in BC and DC samples respectively. The 'F' value of the untreated and treated samples presented in the table is 4.369 which is significant at 1% level. Hence, the results shows that the sample DC has the maximum air permeability.

### 4.2.2.3 Bursting Strength

The fabric bursting strength and analysis of variance of gray, bleached and dyed cotton samples are shown in Table XIII and Figure VIII.

**Table XIII**

**Bursting strength**

| S.no | Sample | Mean value Pounds/in$^2$ | Loss or gain over original (pounds/in$^2$) | Percentage of loss or gain over original (%) | 'F' Test |
|---|---|---|---|---|---|
| 1. | GC | 102 | - | - | 357.538* |
| 2. | BC | 107 | -5 | 4.9 | |
| 3. | DC | 127 | -25.7 | 25.19 | |

*-significant at 1% level.

From the bursting strength results given in Table XIII and Figure VIII , it is clear that the samples BC and DC showed high bursting strength when compared to GC. The maximum bursting strength was seen in sample DC with 127 pounds/in$^2$ pertaining to 25% increase in strength when compared to GC which is 102 pounds/in$^2$, whereas sample BC showed 107 pounds/in$^2$ pertains to only 4% increase in strength.

Hence, it could be concluded that the sample DC treated with herbal extracts using Ayurvedic treatment showed good bursting strength than BC and GC samples. The F-value which is 357.538 was found to be significant at 1% level.

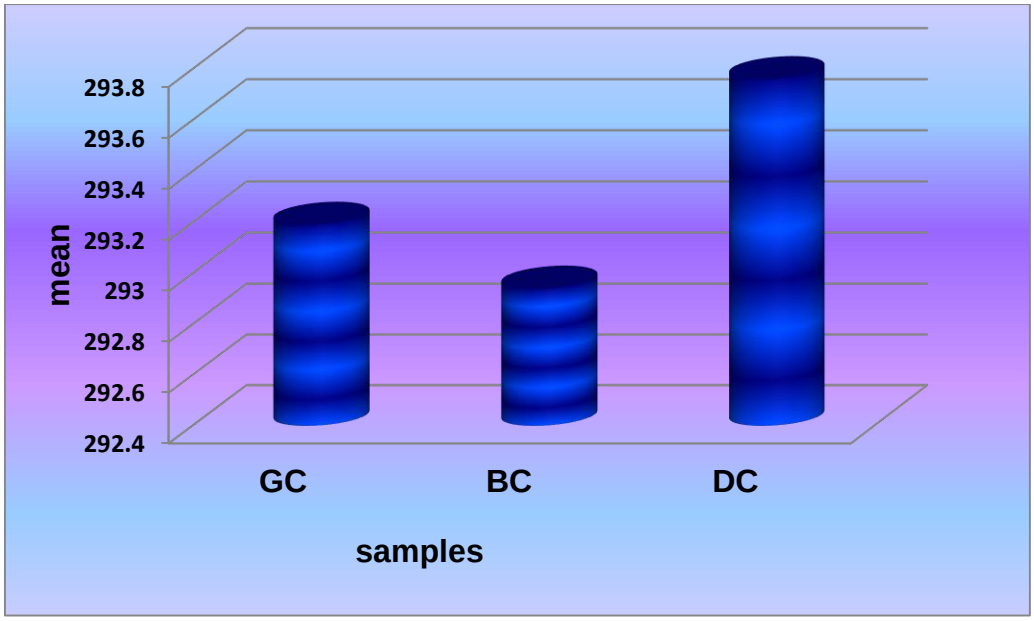



**Figure VII**

**Air Permeability**

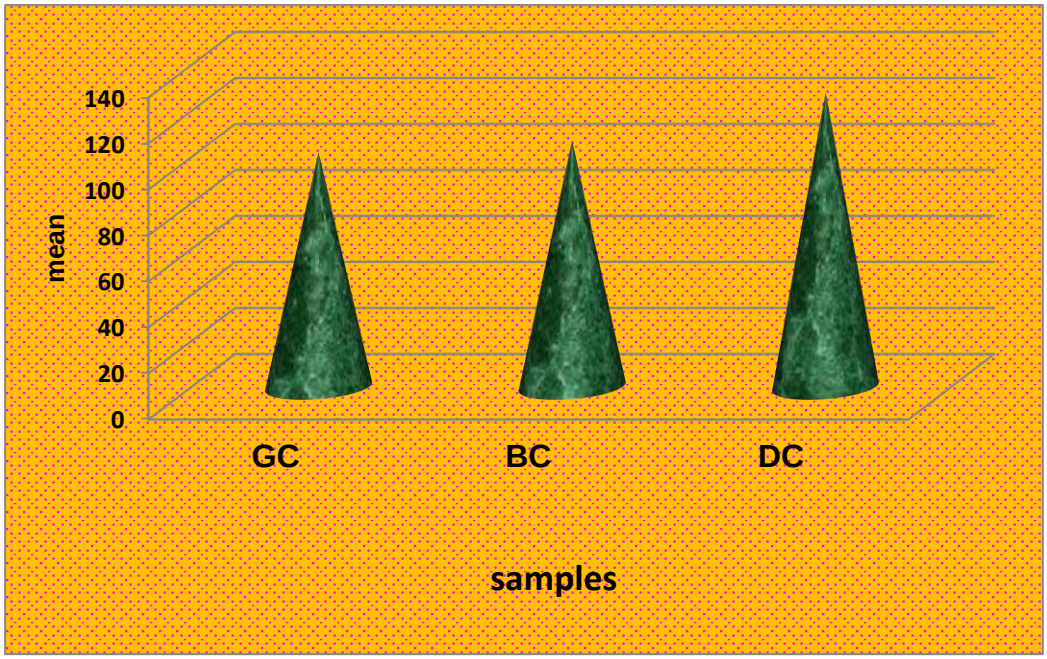



**Figure VIII**

**Bursting Strength**

### 4.2.2.4 Drapability

Table XIV and Figure IX show the drapability values of GC, BC and DC samples.

**Table XIV**

**Drapability**

| S.no | Sample | Mean value | Loss or gain over bleached | Percentage of loss or gain over bleached (%) | 'F' Test |
|---|---|---|---|---|---|
| 1. | GC | 45.8 | - | - | 6.656* |
| 2. | BC | 44.6 | 1.2 | 3 | |
| 3. | DC | 36.4 | 9.4 | 21 | |

*- significant at 1% level.

From Table XIV and Figure IX, it is evident that the sample GC shows 45.8 as its mean drape coefficient value, whereas samples BC and DC show 44.6 and 36.4 as its drape value. From the result it is observed that the sample DC shows the maximum drape when compared to GC sample, followed by sample BC. The drape coefficient is inversely proportional to the weight of fabric, thereby denoting that a decrease in weight would let to good drape whereas increase in weight would substantially led to poor drape.

Hence, from the calculated values, it is clear that the maximum percentage difference as observed in the sample DC by 21% refers to good drape than sample BC pertaining to 4 % difference. The statistical analysis of the fabric drapability determines the F-value which is 6.656 to be significant at 1% level. Therefore, it is concluded that the sample GC denotes good drapability after finishing treatment.

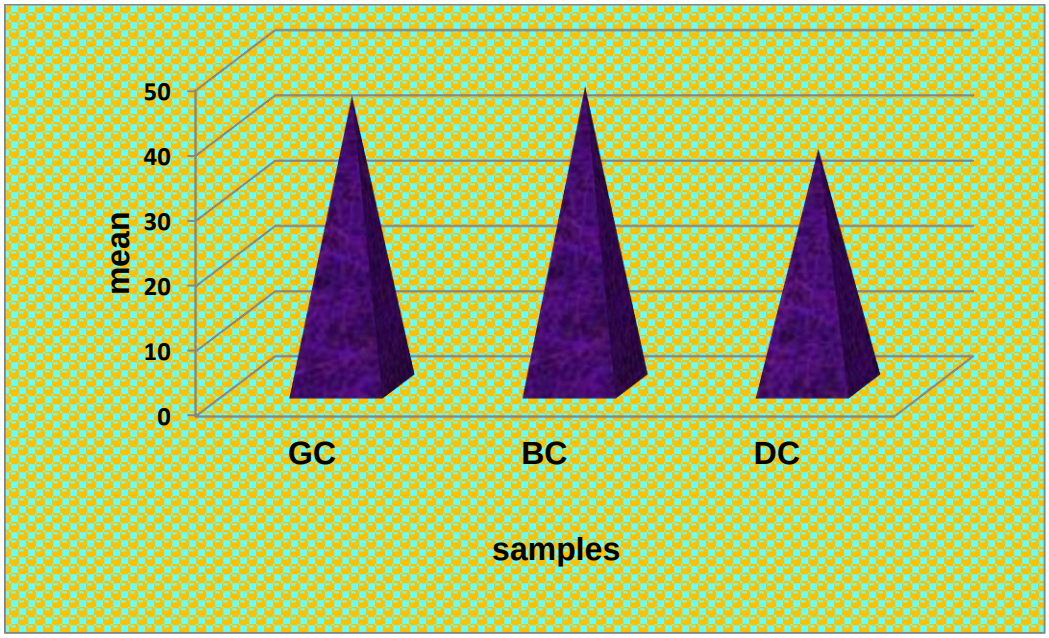



**Figure IX**

**Drapability**

### 4.2.2.5 Pilling

The fabric piling level and analysis of its variance of gray, bleached and dyed cotton samples are shown in Table XV and Figure XI.

**Table XV**

**Pilling**

| S.no | Sample | Pilling | Grade |
|---|---|---|---|
| 1. | GC | moderate pilling | 4 |
| 2. | BC | Slight pilling | 4 |
| 3. | DC | Slight pilling | 5 |

Grade 5 – no change grade 4 – slight pilling grade 3 – moderate pilling grade 2 – distinct pilling grade 1 – severe pilling

Form the Table XV and Figure XI; it is evident that the pilling of dyed cotton and bleached cotton is seemed to be very good as they showed only slight pilling than the gray cotton. The dyed cotton and bleached cotton was rated as good since moderate pilling was noticed.

### 4.2.3 Antifungal Activity Test

AATCC 30-1993: Antifungal activity, Assessment of textile material: Efficacy of Antifungal Activity of Textile Material – Agar Diffusion Test. And the antifungal activity of the finished samples was evaluated for fastness to washing after different wash cycles.

**Table XVI**

**Antifungal Activity**

| **sample** | **Zone of inhibition against fungi *Candida* in (mm)** |
|---|---|
| Untreated | - |
| Concoction sample | 22 mm |
| Wash 1 | 21 mm |
| Wash 2 | 21 mm |
| Wash 3 | 21 mm |

The Table XVI and Figure X show the Antifungal Activity of untreated, concoction and washed samples. It is evident from the results that all the treated samples showed activity against *candida*. The maximum inhibition growth was seen in the concoction sample by 22 mm, whereas all the washed samples showed similar inhibition level as 21 mm. Hence it is evident from the results that the samples showed maximum Antifungal Activity due to herbal finishing using Aloe Vera, Neem, Copaiba balsam, Myrrh, Giloe and Marigold.

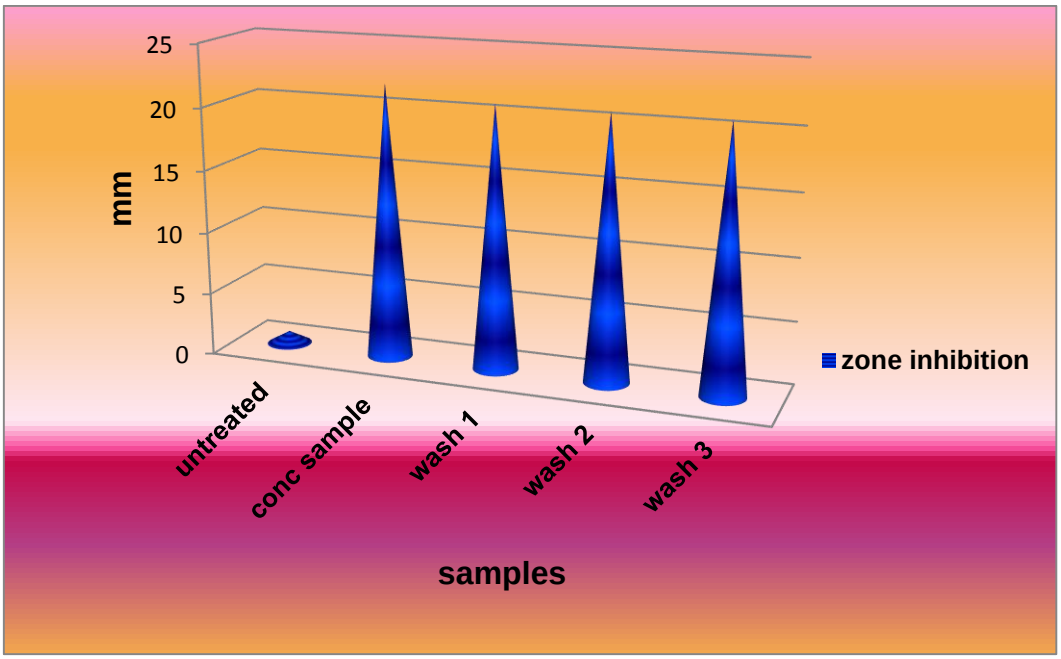



**Figure X**

**Antifungal Activity**

# 5. SUMMARY AND CONCLUSION

The world cotton production uses more chemicals per unit area than any other crop and accounts to a total of around 25% of the world's pesticides. The chemicals used in the processing of cotton also pollute the air and surface waters, which can be decreased by organic production. Eco- friendly processing of cotton gives importance to worker's health and reduces the uses of water (Krishnaraj, 2011)

Worldwide textile producers face various challenges. About one half of the worlds waste water problems are linked to production of textile goods, and many of the chemicals used to dye and finish fabrics are known to harm human health. Therefore, product design should begin with the selection of healthful ingredients. Customers of 21$^{st}$ century are also safety and health conscious. Thus it is well accepted that they will not mind to pay extra for this health safety. It is definitely a value addition that protects the interest of a consumer.

Now Ayurvastra is climbing the popularity graph as it reaches beyond the geographical boundaries. With people becoming increasingly health conscious, the Ayurvastra fabric that is dyed using various Ayurvedic herbs is honored as the royal medicinal dress. Thus Ayurvedic clothing is the new way to live a natural and healthy life. The Ayurvedic textile products were hand loomed, the production is slower at that same time economically it is time and manpower consuming process. Thus for the present era, modern world and with faster technologies, Ayurvedic knitted textile products are becoming popular. A wide variety of products including socks and such can be produced (Virginia *et al*, 2014)

Disease is an abnormal condition of the body or mind that causes discomfort, disinfectant from injuries, in so far as the latter is usually instantaneously acquired. Athlete's Foot (*Tinea pedis*) is one of the most common fungal infections. Unlike body and scalp ringworm, this disorder is generally an ailment of adult life. Fungi love sweaty feet, and they thrive on moist shower floors. A fungal infection of the feet is characterized by itching, redness, and scaling. Severe cases may be accompanied by blisters. The condition most commonly occurs between the toes and may spread to the soles.

Considering these facts, the investigator has taken this problem as a major study and the use of selected herbs is believed to reduce the irritations caused by *Tinea pedis.* The selected herbs, acts as a source for anti fungal agent reducing the attack of fungus and thereby reducing the problems faced by *Tinea pedis*. These selected herbs not only for treatment of Tinea pedis that also reduce blood pressure, cures wounds and enhances skin on use of regular basis. It gives out natural colours with their property of healing.

The treatment of athlete's foot is to make the infected area less suitable for the athlete's foot fungus to grow. This means keeping the area clean and dry. Occlusive shoe material, such as vinyl, cause the feet to remain moist, providing an excellent area for the fungus to breed. Likewise, absorbent socks like cotton that wick water away from your feet may help. Cotton socks help to absorb more sweat and draw it to the areas where air can evaporate the perspiration.

The Ayurvedic herbs have various medicinal properties and when they are dyed with the fabric, it gives a cooling and efficient effect. They are good for various skin disorders, asthma, rheumatic, body ache, diabetes, blood pressure, skin infections and allergies. In contact with clothing, the skin absorbs medicinal qualities of herbs. The trans-dermal process of fiber with skin contact, through which the herbs and plants which are diffused into the pores of skin to restore vitality with balance for healing.

Dyeing of textiles with medicinal plants is a promising area which needs to be explored scientifically and systematically for producing diversified value products. Hence the investigator has selected the topic on 'Development and Evaluation of Ayurvedic Socks for Treatment of *Tinea pedis* with following objectives,

- To select and extract dye from medicinal herbs for *Tinea pedis*
- To optimize the dye extraction
- To develop cotton socks and apply the medicated extraction on it
- To evaluate the medicated socks

**Experimental Procedure**

Among the natural fibers pure cotton is selected which has excellent moisture absorbency, soft texture, lustre and affinity to dyes. Fibres were developed into single jersey knitted socks. The socks were desized with salt to remove the sizing material. The fabrics were bleached with milk, honey and cow urine, a process called gumming also done with Aloe Vera and camphor. Then the Herbs that contain antifungal properties were selected, dried in shade and were powered by using mortar, this powder was used to prepare concoction for further dyeing process. The optimizations for various parameters namely dyeing temperature, time and material liquor ratio were done. Simultaneous mordanting method was done with pomegranate rind to fix the dye without losing its property. Dyeing was carried out at $65^0$C for 2 hours in open air in double boiling method. Finally, the samples were taken out from the dye bath, washed and dried in shade.

The dyed samples were evaluated subjectively and objectively. In subjective evaluation, wear study and performance study analysis was carried out. Ayurvedic dyed socks were given to subject's and in objective evaluation fabric weight, fabric thickness, drape, abrasion resistance, bursting strength, air permeability, absorbency drop test, sinking, capillary rise test and pilling were evaluated. The results were analysed by ANOVA.

**Findings of the Study**

**Wear Study:** The wear study report showed that the sample DC has been rated good by 76% of judges indicating to be maximum when compared to GC and BC. The samples DC exhibited good appearance, comfort, healing effect and no irritation.

**Fabric Weight:** The weight of the sample DC has increased when compared to the GC and BC. The increase in weight of sample DC is due to the concoction treatment.

**Fabric Thickness:** The thickness of the fabric has increased in DC by 2% when compared to GC and BC.

**Absorbency Drop Test:** The drop test results the best regarding absorbency level in sample DC when compared to sample GC and BC.

**Sinking Test:** The absorbency of the DC increased when compared to the GC and BC sample. The DC showed maximum absorbency than the GC and BC sample.

**Capillary Rise Test:** The absorbency of the fabric has increased in DC when compared to GC. Both the sample BC and DC showed good absorbance than GC.

**Abrasion Resistance:** The abrasion resistance of the fabrics showed an increase in value for DC when compared to GC and BC. Out of which maximum value is DC sample that show good abrasion resistance.

**Air Permeability:** The air permeability level has been maximum in sample DC followed by sample BC. It may be due to the dyeing treatment that made fabric porous and the fiber to swell leading to more vacuum spaces.

**Bursting Strength:** The bursting strength of fabrics was studied and it was found to show an increase in value for DC by 25% when compared to GC and BC. The Ayurvedic dyed sample showed good bursting strength.

**Drapability:** The drapability of the sample increased in DC when compared to GC and BC. The sample DC showed maximum percentage difference by 21% that refers to good drape.

**Pilling:** The pilling test depicted a slight pilling in BC and DC samples. Therefore, it could be concluded that the durability of samples is found to be high.

**Antifungal Activity:** all the treated samples showed good antifungal activity against *candida.* The sample DC showed maximum antifungal activity due to herbal finishing.

## Conclusion

The present work showed that, herbal dyeing is applicable to knitted cotton and serves its medicinal power through its purpose. The whole process of extraction and dyeing is 100% natural and ecologically safe. The obtained results

have shown the medicinal power of selected herbs *Aloe barbadensis, Azadirachta indica, Calendula officinalis, Commiphora mol mol, Copaiba balsam* and *Tinospora cordifolia* which is prepared as concoction and dyed for socks. The developed socks by herbal dyeing when comes in direct touch with human skin, protect human skin from fungal infection by transmitting medicinal value of the herbs to skin and into body by transpiration. There is need for proper knowledge, documentation and assessment of a lot of scope to use herbs to cure disease through Ayurvedic dyeing, applied in garments that come in contact with skin.

Hence dyeing the textile article with herbs, the medicinal value of herbs in cloths will remain intact because dyeing is done without chemicals. The waste of dyeing process containing an herbal dye dispatched in the environment does not cause any type of pollution in environment, but on the contrary it may be useful as fertilizer and enhance the value of non fertile land. It is having antiallergic, antiseptic and antimicrobial functioned. Herbal wear is advisable to all age of people, children, handicapped and pregnant woman. Therefore the research has laid a strong foundation to enhance Ayurvedic dyeing , which cast an eye on global market, that people will not mind to pay extra for this health safety products, also medicinal herbs have been commanding huge demand in market.

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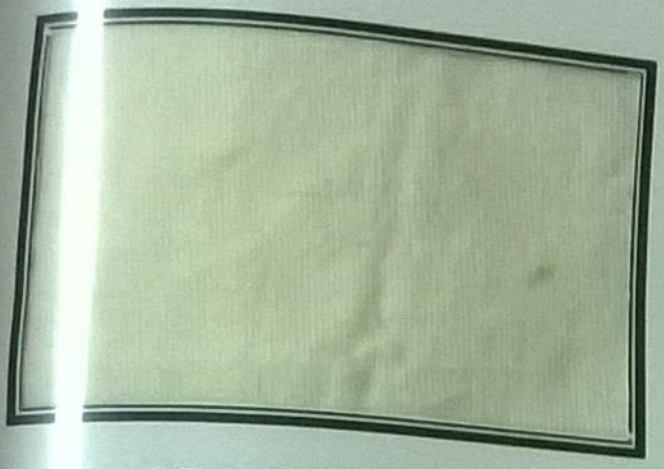
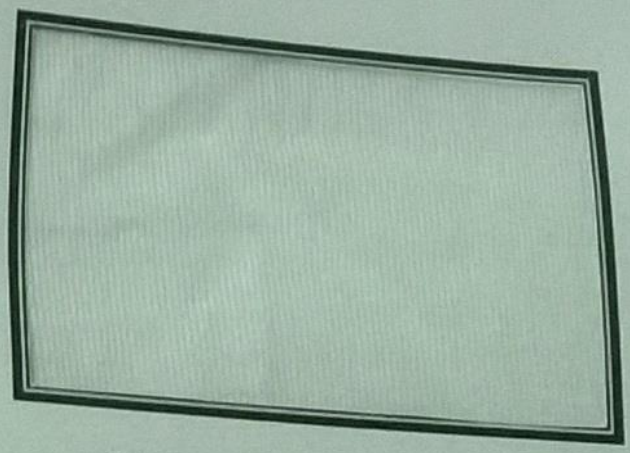
# APPENDIX – I

## DETAILS OF THE FABRIC SAMPLES



GRAY COTTON



BLEACHED COTTON

DYED COTTON

## APPENDIX – II

### PERFORMANCE STUDY

| | TREATED SAMPLE AFTER USE | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| S.No | GENERAL APPEARANCE | | | COMFORT | | | EFFECTIVITY | | | IRRITATION | |
| | EXCELLENT | GOOD | BAD | EXCELLENT | GOOD | BAD | HIGH | MEDIUM | LOW | YES | NO |
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