

**Antimicrobial Effect of Cactus Plant Extracts  
on Cotton Fabric**

By

**Sharmila Devi, S  
(13PBX005)**

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

**Bio-Textiles**

**March, 2015**

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Certified as Bonafide Research Work



Signature of the  
Head of the Department



Signature of the  
Guide

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# 1. INTRODUCTION

The term 'Textile' is a Latin word originated from the word 'texere' which means to weave (Harper, 2012). Textile refers to a flexible material comprising of a network of natural or artificial fibers, known as yarn. Textile materials are formed by weaving, knitting, crocheting, knotting and pressing fibers together (Dharmistha, 2012). The history of textile is almost as old as that of human civilization and as time moves on the history of textile has further enriched itself (Ashwani kumar, 2009). Indian textile enjoys a rich heritage and the origin of textiles in India traces back to the Indus valley civilization where people used home spun cotton for weaving their clothes. Rigveda, the earliest of all the Vedas contains the literary information about textiles and it refers to weaving. Ramayana and Mahabharata, the eminent Indian epics depict the existence of wide variety of fabrics in ancient India. These epics refer both to rich and stylized garment worn by the aristocrats and ordinary simple clothes worn by the common people. The contemporary Indian textile not only reflects the splendid past but also cater to the requirements of the modern times (Kavitha, 2010).

In textile manufacturing, finishing refers to the processes that convert the woven or knitted cloth into a usable material and more specifically to any process performed after dyeing the yarn or fabric to improve the look, performance, or "Hand" (feel) of the finished textile or clothing. Textile finishes are important because it helps to improve the appearance of fabric and enhance its looks. It produces variety in fabrics through dyeing and printing. It also improve the feel or touch of the fabric (Hein, 2013).

Special finishes or functional finishes are the treatments that are applied to the fabric to make them suited for specific uses. It enhances fabric performance in a specific area by improving shape, appearance, retention, comfort, biological control and also safety. Textiles always play a central role in the evolution of human culture by being at the forefront of both technological and artistic development. The protective aspects of textile have provided the most textiles found for innovative developments. Hygiene has acquired

importance in recent years. Unpleasant odor can arise from the acquisition of a variety of compounds produced in bodily fluids such as perspiration. “Consumers are looking for solutions to odor and microbial problem and the unique benefits provided by antimicrobial finish” (Gopalakrishnan, 2003).

Microorganism growth is another factor that has resulted in development of antimicrobial finish. Microbial infestation poses danger to both living and non-living matters. Microorganisms cause problems with textile raw materials and processing chemicals, wet processes in the mills, roll or bulk goods in storage, finished goods in storage and transport, and goods as the consumer uses them. Obnoxious smell from the inner garments, fungal staining and degradation of textiles are some of the detrimental effects of bad microbes (Rajendran, 2003).

Antimicrobial finish causes a fabric to inhibit the growth of microbes. The humid and warm environment found in textile fibers encourages the growth of the microbes. The fabrics which are in contact with the human body provide an ideal environment for the microbial growth. Infestation by microbes can cause cross-infection to humans and the development of odor when the fabric is worn next to skin (Mucha, 2002). In addition, stains and loss of fiber quality of textile substrates can also take place. With an aim to protect the skin of the wearer and the textile substrate itself, an anti-microbial finish is applied to textile materials. The antimicrobial property of fabrics is considered to be more important and inevitable finish for garments, which is in direct contact with human body (Swerev, 2002).

Antimicrobial finish provides various benefits like controlling the infestation by microbes, protects textile material from staining, discoloration, and quality deterioration and prevents the odor formation. The application of the finish is now extended to textiles used for outdoor, healthcare sector, sports and leisurewear (Triplett, 2003).

Control of microbes in sensitive health care settings cannot be maintained without effective disinfection methods. Recently, increasing microbial resistance to common chemical agents, including antibiotics, has

required the implementation of new approaches to disinfection where such sanitary practices are critical. Pharmaceutical manufacturers and many interrelated industries also have a need for effective disinfection and sanitation strategies. As a result, a standard practice that direct and maintain effective microbial controls are established. These practices exploit a thorough understanding of biological process and manipulate them to preserve the quality and safety of a valuable product.

Most biological processes are delicately balanced with their surroundings, or environment. When changes are made to the environment during disinfection, damaged microbes may respond by repairing the immediate damage or by adapting their biological processes through developing a resistance. Unless sound disinfection procedures are consistently applied, new strains of environmental microbes that can utilize multiple resistance markers may be artificially selected. Examples of related drug resistance are currently being studied and managed in many large hospitals, but non-chemical methods are also subject to similar concerns (Chakraborty, 2013).

Cotton is the backbone of the world's textile trade. Many of our every day textile fabrics are made from cotton; fabrics that are hard wearing and capable of infinite variety of weave and colour. Cotton is one of the most commonly abundant natural fiber having many advantages textile related properties. In a tropical country like Indian, cotton is most desirable for making apparels because of its easy availability, comfort, excellent heat conductivity and hydroscopic nature (Samanta *et al.*, 2003). It conducts moisture away from the body and permits the cooler temperature outside to reach the body. So it is cool for summer (Rastogi, 2009).

Cotton is exclusively used in apparel fabrics for men and women wears and household fabrics like bed sheets, towels, rugs and carpets. Cotton is blended with other man made fabrics like polyester, viscose, acrylic etc., to be used for variety of purposes (Jindal, 2007). Cotton is the most widely used in textile fiber due to its availability, comfort during wear and excellent washing

property. Cotton had many characteristics that make it an ideal for cloth. It is durable, soft and absorb large amount of moisture in cotton fabrics.

Cactus belongs to the Cactaceae family that can grow up to two meters in height and produce lemon yellow flowers in the spring and summer, followed by purplish-red fruits (Hassan, 2011). Its habitats are rocky slopes, river banks and urban areas and is drought resistant because of its succulent nature, lack of leaves and thick, tough skins (Jana, 2012). The plants that use the majority of its internal tissues for water storage and its outer parts to reduce water loss and damage by grazing and browsing animals. It can remain vigorous in hot, dry conditions that cause most other plants to lose vigor or even die (Lopez, 2009).

The cactus fruit is spiny and pear-shaped. Plants are normally leafless succulent shrubs. Stems are divided into segments pads or joints that are flat and often incorrectly called leaves. The high sugar and acid content in cactus fruit a sweet acidic taste. It is also put to different traditional and industrial uses (Saenz, 2000). The use of medicinal plants is as old as human life. Cactus has been used in traditional folk medicine because of its role in treating a number of diseases and conditions, including anti-inflammatory effects of antioxidant actions and also used for treating burns and asthma (Kim *et al.*, 2006).

The word “bandage is often used for dressing, which is used for directly on a wound a bandage is technically used to support a wound dressing bandage. A bandage is a piece of material used either to support a medical device such as a dressing or splint, or on its own to provide support to the body; it can also be used to restrict a part of the body. The most common type of bandage is the woven strip of material to a absorbent barrier to preventing adhering to wounds, a bandage can come in number of widths and lengths, can be used for almost any bandage in type of wound bandages. A Bandages are available in a wide range of types, from generic cloth strips to specialized shaped bandages designed for a specific limb or part of the body, although bandages can often be improvised as the situation demands, using clothing, blankets or other material.

Keeping all the above facts in mind the researcher took up **“Antimicrobial Effects of Cactus Plant Extracts on Cotton Fabric”** with the following objectives.

- to extract the herbal solution from cactus plant
- to optimize various parameters for application of cactus plant extract on cotton fabric
- to evaluate the antimicrobial activity on herbal extract finished cotton fabric
- to develop a bandage using the herbal finished cotton fabric

## **2. REVIEW OF LITERATURE**

The review of literature pertaining to the study entitled “**Antimicrobial Effect of Cactus Plant Extracts on Cotton fabric**” is discussed under the following headings.

### **2.1 Cotton**

### **2.2 Finishes**

### **2.3 Herbal plants**

### **2.4 Bandages**

### **2.5 Cactus Fruit**

### **2.6 Cactus Leaf**

### **2.7 Antimicrobial Property**

#### **2.1 Cotton**

Cotton fiber is defined by technologist as “a very fine much elongated, single cell seed hair, which grows on the outside of a cotton seed” (Smurphy, 2000). Cotton is the backbone of the world’s textile trade. It is also known as “King of fibers”. Cotton is a soft, staple fiber that grows in a form known as a ball around the seeds of the cotton plant (*Gossypium*) (Prayag, 2009) a shrub native to tropical and subtropical regions around the world, including the America, India and Africa (Rastogi, 2009). Cotton is grown in more than sixty countries of the world, but United states, India, Russia, Brazil, Egypt and China are some of the largest producers. Cotton cultivation practices vary from country to country (Shenai, 2000). Cotton is a fiber produced the highest quantity to textiles. Hence, processing of cotton occupies an important place in the textile sector (Srivastava, 2009). Cotton occupies a very prominent place in the Indian economy being an important commercial crop, providing livelihood to million of people as well as serving the basic raw material for the huge domestic textile industry (Vishwanath, 2004). The quality of cotton, is determined by its color, length, strength, fitness and most of all the contamination, significantly affects it’s price. Cotton fiber is increasingly facing

competition from artificial fibers, notably polyester, cotton being a natural product, varies widely its fiber characteristics, both physical and chemical which is based on its genetic, environmental, harvesting and ginning factors (Satish and Khanna, 2013).

Cotton has been cultivated for more than 5000 yrs. Archeological findings indicated that cotton was grown and used for textile purposes in the Indus valley well before 2100 B.C., Mexico by 3500 B.C., in Peru by 2500 B.C and in the south western United States by 500 B.C., Cotton fabrics have been so well known and so extensively used throughout the world for hundreds of years that the spinning of cotton fiber into yarns, the weaving of cotton yarn into fabric and many of the finishing processes used for cotton goods come first to mind naturally serve as foremost examples in a study of fiber and fabric (Sharma and Goel, 2011). Composition of cotton fiber is obtained as cellulose hairy material which covers the seed product by various species of the cotton plant. Cellulose 88-96%, Fat and Waxes 0.3-1%, Pectin 0.7-1.2 %, Mineral matter 0.7-1.6 %, Protein 1.1-1.9 %.

### **2.1.1 Properties of Cotton**

Cotton is a universal textile fiber offering excellent comfort, aesthetic and substrate properties. The fabric made out of cotton yarns lose considerable tensile and tear strengths and abrasion characteristics (Ramachandran *et al.*, 2013). It's a good conductor of heat and very absorbent but does not dry quickly. They lack appreciable resilience, (Ola and Pant, 2000) but offers maximum comfort under extreme heat and humidity. Cotton fiber is relatively strong due to the intrinsic structures of layers crisscrossed, minute. Spiraled fibrils that compose the fiber cell. They possess very little natural elasticity (Singh, 2008). Cotton is widely available and it's the cheapest natural fibers used for clothing (Jacob and Sundaram, 1992). It is weak, dimensionally unstable, easily wrinkled and difficult to care (Swahney *et al.*, 1991). The reason for its absorbency, wet strength, softness, durability and other characteristics lies in the fibre itself. The fibre is a short and fine, usually about one inch long cotton is called a dead fibre because it has little luster wrinkle resistance and elasticity. It is a flat, ribbon like fibre with 150 to 300 turns of

natural twist per inch, one of its greatest advantages for use in textiles. The tenacity of cotton 0.19-0.45 N/tex. Which is based on the thickness of fibre wall and cellulose degradation. Strongest of mature fibres. The average extension in cotton fibre is 5-7 % and its affected by moisture content. Initial modulus of cotton, ranges from 4-73 N/tex. It varies cotton with the shape, conditions of growth and the wall thickness of fibres and maturity.

Raw cotton has a deposit of natural wax, calcium and magnesium pectates and other substances on the primary wall that make it water repellents. They contain a moisture regain of 8%, it depends on temperature and relative humidity. Moisture content affects the strength and extension of cotton fibre positively (Chavrn, 1991). It absorbs moisture, which makes it feel, cool against the skin in hot humid weather for this reason cotton has traditionally been a summer fabric. Cotton fabrics range from the light and sheer to the heavy and thick strong and sturdy. It is used in innerwears, outerwears, accessories, decorative material. Even though man-made fibers have encroached on the markets that were once dominated by 100% cotton fabrics, look is still maintained (Hollen *et al.*, 1988). Cotton is a strong and reasonably low in price. All these qualities can be greatly improved by special fabric constructions and finishes. Cotton has a long history being the world's major textile fibre. They are washable and durable holding up well after launderings.

## **2.2 Finishes**

A finish is anything that is done to fiber, yarn or fabric either before or after fabrication to change the appearance in hand or the performance. All finishing adds to the cost of the end product and the time it takes to produce the item (Stephens, 2002). Finishing is done to a fabric after weaving or knitting. Finishes also help to introduce variety and improve its serviceability and durability. Finishes basically are processes applied to fabrics to improve its properties and its uses. Finishing may be done in the mills where the fabric is manufactured or sent to special centers called "converters" or "Finishing houses".

The processes of finishing are many. Their suitability for a particular type of fabric is determined by the nature of the fiber, the type of yarns and weaves

(Yadav, 2007). Finishing is not only what catches the eye, but the feel and touch that the treated material imparts. Buyers always expect a high degree of wearing comfort and finishing plays an important role in achieving that goal (Sivakumar *et al.*, 2008).

Finishes are classified in several ways. It is classified as physical, mechanical and chemical finishes on the basis of techniques used. Permanent finish, durable finish, semi-durable finish, temporary finish on the basis of degree of performance. Generally it is classified as basic finishes and special or functional finishes (Mullik, 2006 and Kadolph, 2007). Textile finishes are persons concerned with end products like designers, merchandisers and sales personnel usually categorize finishes as aesthetic and functional finishes. The former modifies the appearance or feel of fabrics, while the later improves the performance a fabric under specific end use conditions. In textile manufacturing, finishing refers to the processes that convert the woven cloth into a usable material and more specifically to any process performed after dyeing to a fabric to improve the look, performance, or hand the finished textile or clothing (Collier, 2010). Some finishing techniques such as bleaching and dyeing are applied to yarn before it is woven. While others are applied to the grey cloth directly after it is woven or knitted. Some finishing techniques, such as filling, have been in use with hand- weaving for centuries; others, such as mercerization, are in industrial revolution. Functional finishes for textile reviews are the most important fabric finishes in the textile industry. It discusses finishes designed to improve the comfort and other properties of fabrics, as well as finishes which protect the fabric or the wearer.

## **2.3 Herbal plants**

### **2.3.1 History of medicinal plants**

From prehistoric days, plants are used for food, shelter and medicine. The use of plants for medicinal purposes is as old as our civilization. The first known written record of curative plants was of Sumerian herbal of 2200 BC. In the 5<sup>th</sup> century BC, the greek doctor Hippocrates listed out some 400 herbs in common use. Discords, a roman physician, pharmacologist and botanist of

greek origin, in the 1<sup>st</sup> century AD, wrote a book on herbals which consist of 600 plants that ultimately became the base for many later works. Herbs have been used for numerous time for various purposes like healing the sick and weakness. Most of the people still continue to avail the benefits of herbs for their proper body functioning. People thought that herbs keep the body in tune with nature, as nature intend to maintain proper balance. Many scientific studies are still continuing with modern research following the lead of old folklore and herbal uses to help finding new western medicine. Man has also been aware of the effects of Herbs on the body, mind and emotion. For example – Flowers were utilized to attract love, food and protection. Fragrant plants were worn to heal the body and give a sense of well being.

Herbs are generally defined as non-woody plants, which die after blooming. This definition can be expanded to particular part or whole plant that could be used in medicinal treatments, culinary preparations as seasonings, nutritional supplementation, coloring agents and cosmetic agents. Fresh herbals and medicinal plants can be acquired by gathering them in wild conditions or growing them in your own personal garden, or buying them from other gardeners and health food stores (Firenzuoli *et al.*, 2007).

From the germ theory of disease and the advent of antibiotics to combat various infections, it appeared that infectious diseases were by gone. With the realization that chemical medicines are not always “magic bullets” and may carry serious side effects, herbalism and ancient medicines are making a comeback. Our challenge for now is to ensure that valued botanicals should remain abundant for future generations (Kelsy Willcox, 2013).

There are several ways to prepare herbal extracts for consumption and use in medicinal remedies. When herbs are prepared by steeping in boiling water it is drunk as a tea and are known as an infusion. If these dried herbs get simmered in hot water, they are called as decoction. If it gets incorporated with other ingredients and made into cream, they are viewed as a herbal ointment. Sometimes used a Herbal compress where piece of cloth is soaked in an infusion or decoction which is wrapped and applied externally. If herbs are used

to cleanse and heal externally, they are called herbal wash. Herbal infusions and decoctions can also be used as herbal bath for relaxation and healing. Herbalists today, believe to help build their good health with the help of natural sources. Herbs are considered to be food rather than medicine because they're complete, all-natural and pure, as nature intended. When herbs are taken, the body starts to get cleansed. It gets purified itself. Unlike chemically synthesized highly concentrated drugs that may produce many side effects, herbs can effectively realign the body's defenses. Herbs do not produce instant cures, but rather offer a way to put the body in proper tune with nature (Ashok Vaidya, 2007). Plants are in cooking for flavoring foods and perfumes, disinfectants, to protect us against germs, as medicines to heal when we are sick.

Medical plants are assumed safe because they are 'natural' - 'a plant or a food'. Potential drug interactions exist and patient age health can compromise metabolism. Use and adverse effects are under-reported; forty-one percent (41%) of patients do not disclose herbal supplementation to their health providers. Dosing of herbs can be difficult. Lack of knowledge of health care professionals as they don't know where to look for information. Lack of Quality Control (QC) – contamination and adulteration.

## **2.4 Bandages**

Medical textiles is one of the most important growing field in technical textiles. Medical textiles represent structures designed and accomplished for a medical application. The textile materials and products, that have been particular needs, are suitable for any medical and surgical application for combination of strength, flexibility, moisture and air permeability. Recently, application of textiles has started going beyond the usual wound care, incontinence pads, plasters etc., (Anand, 2000). The constituent element of medical textile products and applications such as fibers, yarns, woven fabrics include healthcare and Hygiene products, Extracorporeal devices, Implantable materials, Non-implantable materials (Dattilo *et al.*, 2002).

## 2.5 Cactus fruit

Cacti are classic examples of plants that have evolved, apparently from tropical environments the swollen stems which contain water storage tissues, it is a thick water proof epidermis, to help prevent water loss. Plant of this type are termed stem succulents. In place of leaves, cacti have special organs called areoles. These are like buds and they are arranged regularly along the ribs of the stem or on the tips of tubercles. They produce spines which help to protect the stems from being eaten by herbivores. In some cacti the spines are so dense that they almost completely obscure the underlying stems, shielding the stems from intense sunlight and preventing the plant from overheating.

The cactus pear fruit derived from *cactaceae* is one of the most morphologically distinct and impressive plant families. This fruit is abundantly found in Mexico and the United states, but is also grown in Africa, Madagascar and India. The fairly high sugar and acid content gives it a sweet acidic taste. Cactus fruits are usually consumed fresh, but are also put to different traditional and industrial uses. Due to the tasty acidic flavor, succulent texture and long lasting permanence on the plant. It is regarded as a valuable food that is consumed as fresh fruit it is main ingredient in desserts, an appetizer, in alcoholic beverages (Barbera *et al.*, 1992). It is also processed on a small scale in the food industries as a jelly and jam, as whole fruit in syrup or brine to be used in food products. Moreover cactus pear fruit contains betalain pigments it has good potential for use as natural food colorants. Cactus pear is very particular for the presence of betalain, a widely used natural colorant in the food industry. Betalains are nitrogenous chromoalcaloids and their presence excludes that of anthoetanins.

## 2.6 Cactus leaf

Nopales are thick, oval, flat, modified stems of cactus plant, eaten as a vegetable. Its young tender pads known as *Nopalitos* are one of the chief components of Mexican cuisine. since centuries and today, health benefiting properties. The cactus species is to have originated in the deserts of Mexico. Over two hundred *Cactaceae* cultivars grow in their natural habitat, particularly

in semi-arid and dry lands of northern Mexico (Galati *et al.*, 2006). Edible cactus paddles are usually gathered from *Opuntia ficus-indica* species. Cactus is a modified evergreen plant that grows easily under semi-arid and desert climates plant may grow up to 10-12 feet in height, in farms their growth is about 4-5 feet. The paddle surface is covered with sharp spines. Nopales are one of very low calorie vegetable 100 g of fresh leaves provides just 16 calories. Nonetheless, its modified leaves (paddles) have many vital phytochemicals, fiber, anti-oxidants, vitamins, and minerals that can immensely benefit health (Phytother, 2005).

The succulent paddles are rich sources of dietary fiber, especially non-carbohydrate polysaccharides, such as pectin, mucilage and hemi-cellulose. In addition, the juice extracted from these nopales has been suggested to have immune-booster, and anti-inflammatory properties (Saleem *et al.*, 2011). Cactus pads feature moderate amounts of vitamin A with 100 g fresh pads provide about vitamin A, and 250 µg of β-carotene convert into vitamin-A inside the body. In addition, nopal pads contain small levels of B-complex group of vitamins such as thiamin, riboflavin, niacin, vitamin B-6 and pantothenic acid. These vitamins are essential for optimum cellular enzymatic and metabolic functions inside the human body. They contain small amounts of minerals, especially calcium, potassium, magnesium and iron (Kemp, 2010).

## **2.7 Antimicrobial property**

Microbes are the tiniest creatures not seen by naked eyes. They include a variety of microorganisms like bacteria, fungi, algae and viruses (Gopalakrishnan, 2004). The inherent properties of the textile fibres provide room for the growth of microorganisms. Besides, the structure of the substances and the chemical processes may induce the growth of microbes (Sinha, 2011). An antimicrobial is a substance that kills or inhibits the growth of microorganisms. It occupies every habitat on earth and play both beneficial and harmful roles. Some of the beneficial roles include production of oxygen via photosynthesis, nitrogen fixation, circulation of carbon by decomposition of dead organic matter. Harmful effects are caused by virulence of pathogenic

microorganisms, that is infection causing bacteria such as staphylococcus aureus, E.coli etc., (Ranganath, 2011).

On the basis of mode of action, antimicrobials are classified into two broad categories such as microbial, that kill microbes without leaving any option for their survival and microbistatic that crease all the metabolic activities of microbes that are important for their survival. So they are called as growth inhibitors of microbes. The history of antimicrobials begins with the observation by discovered that one type of microbe could prevent the growth of other microbes by secreting a compound called antibiotic. The discovery of antimicrobials like Penicillin and Tetracycline paved way for better health of people in the world by curing diseases like Gonorrhoea, Strepthroat and Pneumonia.

Textile products, while are made of natural, synthetic or blended fibres are sensitive to contamination by and growth of pathogenic microorganisms. The increasing consumer demand for hygienic products has dramatically increased antimicrobial substance use on textiles. Antimicrobial textile products vary in their effectiveness and durability depending on the type of fabric, the agent finishing method used. The microorganisms is generally referred to as antimicrobial to negative effect on the vitality (Shanmugasundaram, 2006). Antimicrobials are used to control bacteria, fungi, mould, mildew and algae. Their control reduces or eliminates the problems of deterioration, staining, odors and the health concerns that they cause (Joshi, 2010).

Many antimicrobial agents used in the textile industry are also known in the foodstuff and cosmetics sectors. These substances are incorporated with textile substrates, comparatively at lower concentrations. It must be ensured that these substances are not only permanently effective but also compatible with skin and the environment. Materials with active finishes contain specific active antimicrobial substances, which act upon microorganisms either on the cell, during the metabolism or within the genome. However, due to the specific nature of their effect, it is important to make a clear distinction between

antibiotics and other active substances, which have a broad range of uses. (Tanveer Malik, 2012).

The antimicrobial agents can be applied to the textile substrates by exhaust, pad-dry-cure, coating, spray and foam techniques. The substances can also be applied by directly adding into the fibre spinning dope. It is claimed that the commercial agents can be applied during the dyeing and finishing operations. The use of antimicrobial finishes and treatments within textiles can help to avoid or control cross infection, and by stopping microbial growth, can extend the lifetime of the product (Krishnaveni and Amsamani., 2010). The antimicrobial textiles can be classified into two categories, namely passive and active based on their activity against microorganisms. Passive materials do not contain any active substances but their surface structure (lotus effect) produces negative effect on the living conditions of micro organisms. Materials containing active antimicrobial substances act upon either in or the cell (Ljiljana *et al.*, 2010).

Antimicrobial finish inhibits action to kill the microorganisms. Antimicrobial finishes can be divided into two types (Asimkumar, 2008) as impervious finishes, in which skin of resin provides an impervious barrier to the fungus or bacterium. Active finishes, which are effectively bactericidal or fungicidal. They can be subdivided into further two types: (a) Rot proofing agents for industrial uses requiring a cheap leach-resistant material, which may or may not be coloured (b) Sanitized type of finish used for apparel, where a much more efficient, non-toxic, durable but costly finishing chemical is used.

Antimicrobial agents are of two types. They are leaching and non-leaching types. Leaching type antimicrobials are diffused from the contact with microbes. Products migrate off the substrates, forming a sphere of activity, and any microbes coming into the sphere are destroyed. Leachable antimicrobial agents are not chemically bonded with the fabric can be removed by contact with moisture. Non-leaching type antimicrobials are bound to the product, allowing control of the microbes. Products do not migrate off the substrates and destroy the bacterial coming in contact with the treated fabric surface. The

microbes are not consuming the anti-microbial as they act on the cell membrane by mechanically destroying them. The finishing will be permanent and will remain functional throughout the life of the treated (Sampath, 2003).

### **2.7.1 Properties of antimicrobial finish**

Antimicrobial finish maintains hygiene, freshness and stops bad odour from the surface of the fabric. Controls or eliminates microbial staining and improves life of the articles wherever it is applied. Improves hand most of the fabric, eliminates the chances of diseases transmission and is effective on any substrate like cellulose, synthetics as well as their blends and any surface other than textiles (Ganesan *et al.*, 2008). Antimicrobial finishes add value to textiles and protect the wearer or user of a textile against bacteria, yeast, dermatophytic fungi and other related microorganisms for aesthetic, hygienic or medical purposes. It protect the textile against bio-deterioration caused by mould, mildew and rot producing fungi and protect the textile from insects and other pests for preservation of the fibre and protection of persons wearing clothing from insects and pests.

The antimicrobial finishing of textiles should be effective against a broad spectrum of bacterial and fungal species, but at the same time exhibit low toxicity to consumers. The finishing should be durable to laundering, dry cleaning and hot pressing. The finishing should not negatively effect the quality or appearance of the textiles (Geo *et al.*, 2008). Finishing should preferably be compatible with textile chemical processes such as dyeing, be cost effective and not produce harmful substances to the manufacturer and the environment. It should not kill the resident flora of non pathogenic bacteria on skin of the wearer.

Finishing should have acceptable moisture transport properties and should be easy to apply (Gaurav, 2005). Finish should be resistant to body fluids and to disinfections / sterilization ([www. fiber 2 fashion.com](http://www.fiber2fashion.com)). Finish should be effective in acid as well as alkaline media, have speedy action, have high penetrating power and be stable. It should not cause local irritation or sensitization and not interfere with healing [Bernard, 2008]. Antimicrobial

treatment for textile materials to fulfill the following objectives such as to control microorganisms, to reduce odors from perspiration, stains and other soil on textile material, to reduce the risk of cross infection being carried by feet from ward to ward in hospital, to control spread of disease and danger of infection following injury, to control the deterioration of textiles particularly fabrics made from natural fibre caused by mildew (Gopalakrishnan, 2006).

### **2.7.2 Benefits of antimicrobial finish**

Antimicrobial is an agent that works against microbes. It can either inhibit their growth and reduce the undesired by products or kill them altogether (Rahul, 2003). The use of antimicrobial finish improves the durability of the fabric by controlling growth of microbes, grants freshness to the fabrics and prevents skin diseases (Avernita, 2010).

The hospital related infections are urgent health care issues. Medical textiles such as doctor's and nurse's uniforms, patient gowns, bedding sheets, wipers and covering materials have been shown to be the carriers of drug resistant microorganisms and are potential vehicles for diseases transmission in hospitals (Shroff, 2001). Antimicrobial materials which can prevent growth of microorganisms are important not only for medical textiles, but for use in hotels, for the transport industry and in biological research institutions. The use of antimicrobial finish in garments helps in preventing skin related diseases and track infection. As the internal intake of antibiotic for the infant is not desirable, the protective action should be given the clothing (Ruma, 2003).

### **3. EXPERIMENTAL PROCEDURE**

The experiment pertaining to the research entitled “**Antimicrobial Effect of Cactus Plant Extracts on Cotton Fabric**” is discussed under the following headings.

- 3.1 Selection of the fabric**
- 3.2 Pretreatment of fabrics**
- 3.3 Selection of plant source**
- 3.4 Selection of Solvent**
- 3.5 Selection of Extraction Method**
- 3.6 Selection of Source and Extraction Method**
- 3.7 Pilot Study**
- 3.8 Optimization**
- 3.9 Assessing its Antimicrobial Activity**
- 3.10 Actual Finishing Process**
- 3.11 Evaluation of the Antimicrobial Activity**
- 3.12 Preparation Bandage**
- 3.13 Evaluation of the Samples**
- 3.14 Statistical Analysis**

#### **3.1. Selection of the fabric**

##### **3.1.1 Cotton**

Cotton fabric is made from 100% seed. It is characterized by its good hydroscopicity, excellent permeability, soft feel, straighten, dye absorption and splendid color effect of pigmentation (Subrata, 2006). Cotton is used to make a number of textile products, it is less expensive and more durable (Greg, 2008). The cotton plant is highly water absorbent. The textile resembles the plant in this aspect. Cotton has excellent wicking properties. It can uptake three times

of its weight. The textile retains this ability to some extent, pulling the moisture away from the skin so that it can evaporate. Cotton fabric has some insulating properties. This means that the fabric will help the wearer to stay cooler in summer (Bill and Susan, 2008). Cotton fiber has natural property anti- bacteria, bacteriostasis and deodorisation excellent function of natural antibacterial function differs greatly from that of chemical antimicrobial (Manoharan, 2005). Hence the investigator selected 100 percent cotton fabric for the study (Appendix - I).

### **3.2.1 Pretreatment of Fabrics**

#### **3.2.1 Desizing**

Desizing is the process of removing the size material from the warp yarns in woven fabrics (Michal Vik, 2002). The desizing parameters as followed are, Fabric - 1000gms, Liquid Detergent - 200ml, Soap oil - 200ml, Hydrochloric acid - few drops, Water - 2000ml, Temperature - 60<sup>0</sup> c, Time - one hour. The process of desizing was immersing the fabric in the water bath with the mixture of detergent, soap oil and hydrochloric acid, it was boiled at 60<sup>0</sup>c temperature for one hour. After which the fabric was washed thoroughly and dried. This desized fabric was used for the further study (Appendix - I).

### **3.3 Selection of Plant Source**

Herbs are available in nature abundantly; they play a dominant role in the primary health care of about 80% of the world's population (Usha and Jawale, 2006). Herbal source are eco-friendly and are less expensive. Herbs play an important role in retaining the quality of environmental conditions with which it is grown. Cactus is a common road side plant seen in tropical countries. Cactus plant's leaf aqueous extract has antibacterial property with more activity index for air borne disease causing bacteria (gram positive as well as gram negative) and skin infectious bacteria, it is useful in developing drugs for diseases like dermatitis, acne, skin rashes and also can be developed as antiseptic (Dasgupta, 2010). It has been a traditional part of Indian's Ayurveda medicine practice. It also has antimicrobial and antibacterial properties and even contains some phytochemicals that may have antioxidant abilities. The

cactus antifungal, antimicrobial, and antibacterial abilities are significant factors for which it is used as an effective herbal treatment for many conditions (Varshney, 2010). Cactus plant is very important economic plant. Considering all these properties the investigator selected cactus plant for the study.

### **3.3.1 Cactus Leaf**

Cactus leaf are variable in so many varieties it is ovary and surrounded by material receptable tissue. Cactus are flattened in species. The structure of the leaves varies some what between these groups, with it has visible photosynthetic leaves it have very small spiny and thin leaves, less than 0.5 mm long and species studied less than 1.5 mm (James, 2007). The function of leaves role is production of plant hormones. Leaves help to prevent water loss by reducing air flow close to the cactus and providing some shade. Cactus are produced from specialized structures called areoles (Durate, 2006). They have swollen stems which contain water-storage tissues, and the stems have a thick water proof epidermis, covered with a waxy cuticle to help prevent water loss. Plants has termed stem succulents. The cactus plant extensive root systems, spreading the soil surface during light showers of rain. The main exceptions are the cactus leaves have cylindrically and fleshy, adapted to withstand to some water loss to drought conditions (Plate – I).

### **3.3.2 Cactus Fruit**

Cactus fruit genus which belongs to cactaceae family in full fruit development from to physiological maturity, the stage development of full-full mature. The cactus fruit, cladodes infusions have been traditionally used as folk medicine to treat ailments such as fatigue and rheumatism and as a diuretic agent. The pathogenic organisms to commonly use in anti-microbial properties . A cactus plant is conspicuous for its fleshy green stem, which performs the functions of leaves and for the spines of various colors, shapes, and arrangements. Cactus flowers are notably delicate in appearance although usually large and they are commonly yellow, white, or shades of red and purple. Cactus fruits are berries and are usually edible (Plate – II). Considering the above facts cactus leaf and fruit were selected as herbal sources.

### **3.4 Selection of Solvent**

Ethanol was found to penetrate easily into the cellular membrane to extract the intracellular ingredients from the plant material. The concentration of ethanol effect the efficiency of antimicrobial activity of the plant extracts. Hence considering the above facts full concentration of ethanol was selected for extraction (Cowan, 1999). Thus the pure ethanol of 99% absolute ethanol was bought from the chemical shop Ponmani & Co, Coimbatore for the extraction of cactus leaf and fruit.

### **3.5 Selection of Extraction Method**

#### **3.5.1 Shaker**

Ethanolic extraction was done in an orbitek shaker. An orbitek shaker has a table board that shakes in a circular motion. The solutions to be stirred and extracted were taken in conical flasks. The board has holders to hold conical flasks. A protective ring is provided that has to be put around the holder and the flask together to secure it. The number of rotations per minute was set as 230 rpm and the temperature as 30°C for a period of 24 hours (Behera *et al.*, 2014). After the extraction process was over, the solutions were filtered using filter paper to remove the residues in the extract. The filtered extract was collected in a sterilized beaker and stored in a refrigerator. The collected extracts were evaporated to remove the solvent

#### **3.5.2 Soxhlet Apparatus**

The soxhlet apparatus ground crude is placed in a porous bag or “thimble” made of strong filter paper, which is placed in chamber of Soxhlet apparatus. The extracting solvent in flask is heated, and its vapors condense in condenser. The condensed extraction drips into the thimble containing the crude drug, and extracts it by contact. When the level of liquid in chamber rises to the top of siphon tube , the liquid contents of chamber siphon into flask. This process is continuous and is carried out until a drop of solvent from the siphon tube does not leave residue when evaporated (Chitra Wendakoon, 2011). The advantage of this method, compared to previously described methods, is that large amounts of drug can be extracted with a much smaller quantity of solvent.

This effects tremendous economy in terms of time, energy and consequently financial inputs. At small scale, it is employed as a batch process only, but it becomes much more economical and viable when converted into a continuous extraction procedure on medium or large scale (Egwaikhide, 2007).

The 30gram of source 350ml of ethanol to extract the source and taken the one liter solvent. The evaporation process was done using a Soxhlet apparatus (Plate – III). The extracts was mounting to 350 ml was taken in the round flask and the temperature was set as 35°C. Thus the solvent was collected in the upper tubular flask and stored in a refrigerator. This process was continued until all of the solvent was evaporated.

### **3.6 Selection of Source and Extraction Method**

For the selection of source and extraction method, the leaf and fruit extracts got from shaker and soxhlet apparatus was tested for antimicrobial in agar diffusion method (3.11). The results showed a higher zone of inhibition for fruit extract obtained by soxhlet method. Therefore fruit extract got by soxhlet extraction method was further used for the research work.

### **3.7 Pilot study**

A pilot study was conducted to check the antimicrobial activity of ethanol extracts qualitatively by using the test method AATCC 147 (Agar plate test). It is a rapid qualitative method for determining antibacterial activity of treated textile materials against gram-positive and gram negative bacteria. The untreated (control fabric) and treated fabric samples were placed in nutrient agar that is streaked with test bacteria. *Staphylococcus aureus* for gram positive and *E-coli* for gram negative. Then they were incubated at 37°C for 24 hrs to enable the bacteria growth as explained ( kumar *et al.*, 2009). After 24 hours, the bacterial growth was visually determined. For antifungal test AATCC method 30 was adopted. The untreated (control fabric) and treated fabric samples were exposed to *Candida albicans* in an agar plate streaked with the fungi. The petri plates were left to rest in room temperature for 3 days. The zone of inhibition for both bacteria and fungi were measured using a metric scale. Ten readings were taken for each and the average was calculated. The

average value was taken as the zone of inhibition. Then the zone of inhibitions formed for the ethanolic extract. The extract with the larger zone of inhibition was chosen for further study. After the zones were measured, the decontamination process was carried out (Saravanel, 2009).

### **3.8 Optimization**

The concentration of the extract was optimized based upon the antimicrobial activity. *Cactus Fruit* was extracted using ethanol in five concentrations namely 2 percent (4g in 200 ml), 4 percent (8g in 200 ml), 6 percent (12g in 200 ml), 8 percent (16g in 200 ml) and 10 percent (20g in 200 ml). The qualitative test for antimicrobial activity of the solutions was carried out. The AATCC agar diffusion method was adopted. The zone of inhibitions was recorded for each solution. The concentration that corresponds to the largest zone was decided as the optimized concentration.

#### **3.8.1 Optimization of concentration**

The extract was diluted using water in a beaker for three different concentrations 20, 30, 40 percent. The fabric sample was impregnated with extract of varied concentrations and it was subjected to antimicrobial tests. It was seen that 30 percent extracted solution showed good antimicrobial activity in the pilot study. Hence 30 percent concentration was chosen for further study.

#### **3.8.2 Optimization of temperature**

Three different temperatures 30, 45 and 60<sup>0</sup>c were chosen for optimization keeping time and concentration as constant. The extracts were applied on fabrics in these three temperatures. These fabrics were evaluated for antimicrobial test as done for varied concentration. The fabric kept at 45<sup>0</sup>c was found to have excellent antimicrobial activity in the pilot study and hence 45<sup>0</sup>c have been used for further study.

#### **3.8.3 Optimization of time**

The temperature and concentration were kept constant for different timings such as 15, 30 and 45 mins. The fabric samples were treated with the extract for these three different time durations. Later the fabrics were tested for

antimicrobial activity as mentioned above. It was seen that the fabric treated with the extract for 45 minutes showed good antimicrobial activity. Hence 45 minutes was considered as an optimum time for the study.

### 3.8.4 Optimization of parameters

**Table – I**  
**Optimized of Parameters**

S.No	Criteria	Pilot study	Selected Parameters
1	Herbal solution	20, 30 and 40 percent	30 percent
2	Temperature	30, 45 and 60 <sup>0</sup> c	45 <sup>0</sup> c
3	Time	15, 30 and 45 minutes	45 minutes

From the above table it was clear that herbal extraction solution is mixed with water in the optimized concentration and the temperature was maintained at 45<sup>0</sup>c for 15 minutes.

### 3.9 Assessing the Antimicrobial Activity

Antimicrobial finish can be applied to a fabric either by using chemicals or by using natural agents. Herbal antimicrobial finishes given to fabrics are gaining popularity and are proved to be effective and useful. Considering this fact, herbal source was selected for imparting antimicrobial property to the Cotton material. The concentration have taken from various parameters.

### 3.10 Actual Finishing Process

The application of the finish on the fabric was carried out using the Pad-dry-method.

Pad – dry – cure method was executed using a padding mangle. The objective of this process is to mechanically impregnate the fabric with the extract. The M:L ratio for the process was taken as 1:5 (Karolia and Mendapara, 2007). A padding mangle offers continuous processing of the

fabric in the concerned liquor. During padding mangle, the fabric was made free from creases and the selvages were opened out before feeding the fabric into the guide rollers (Plate – IV). The padding mangle was made to run at a speed of 15 min. After padding, the fabric was then cured for 3 minutes at 140°C (Yadav *et al.*, 2006). The cotton fabric was cut to 15” width and 36” length. The extracted fruit were taken. One end of the wetted fabric was immersed into the solvent and then passed the fabric was made through the rollers in between the two rollers. The excess source was removed and the process was continued for 3 to 5 times for good and even penetration of the extracts. Then the fabric was taken out and allowed for drying in shade.

### **3.11 Evaluation of the antimicrobial activity**

#### **3.11.1 Evaluation of microbial action**

The cactus plant extract finished samples were subjected to antimicrobial assessment by agar diffusion method.

#### **3.11.2 Selection of bacterial Species**

*Staphylococcus aureus*, gram positive and *Escherichia coli*, gram negative bacteria's were selected to identify the bacterial activity in the treated fabric. When compared with Gram-positive bacteria, Gram-negative bacteria are more resistant against antibodies because of their impenetrable cell wall. These bacteria have a wide variety of applications ranging from medical treatment to industrial use and Swiss cheese production, hence they were selected for the study.

#### **3.11.3 Agar Diffusion Method (SN 195920)**

Agar diffusion is an easy and direct way of achieving the result. A small volume of the culture was swabbed in the Petri plate evenly. The dispersed cells develop into isolated colonies (Chabra *et al.*, 2007) reveal that the treated samples were tested for their antimicrobial activity. Qualitative assessment was done by the zone of inhibition. The incubated plates were examined for interrupted growth or clear zone of inhibition on either side of the wall (Prescott *et al.*, 2005). The fabric were treated with 20, 30, 40 percent for its antibacterial

activity using agar diffusion method shown in (plates – XVIII, XIX, XX, XXI, XXII).

### 3.11.4 Procedure for antibacterial test

Nutrient agar was prepared and sterilized. It was poured in the petri plate which was allowed to solidify. The test organism was evenly swabbed on sterile plates with the culture taken from the mixture. The original, treated and treated samples were placed at the centre of the Petri plate and is incubated for 24 hours at 37<sup>0</sup>c. The zone of inhibition that forms around the fabric samples reveals the antibacterial activity of the samples.

### 3.11.5 Nomenclature of the samples

**Table – II**  
**Nomenclature**

S.No	Samples	Code
1	Original fabric	OF
2	Original desized fabric	ODF
3	Treated Cactus fruit	TCF

### 3.12 Preparation Bandage

In order to prepare the cactus fruit extract the bandages are commercially available on strip type of bandages were purchased. The treated fabrics were cut in suitable sizes. The cut fabrics were kept in the laminar air flow and placed in between the stripped bandages to sterilized. The prepared bandages it was kept in uv chamber for 10 to 15 minutes. After sterilization the bandages were taken out and immediately packed in ziplock covers for further use (Appendix -II).

### 3.13 Evaluation of the samples

#### 3.13.1 Subjective evaluation

##### 3.13.1.1 Visual inspection of the antimicrobial finished fabric

The finished samples were visually evaluated by the 25 students mastering Textiles and Clothing, Avinashilingam University, Coimbatore using a rating scale of general appearance, evenness of finishing and brightness of shade. This is given in (Appendix – III). This results were collected and consolidated for further discussion and are presented in results and discussions.

### **3.13.2 Objective evaluation**

Textile testing is the process of inspecting, measuring and evaluating the characteristics and properties of textile materials. The samples applied with the extract were tested for their respective laboratory tests namely fabric weight, fabric thickness, crease recovery, breaking strength and elongation of the fabric, wet ability and absorbency.

#### **3.13.2.1 Physical property test**

The fabric was tested for its physical properties such as fabric weight, fabric thickness and fabric count.

##### **3.13.2.1.1 Fabric weight**

Fabric weight is an important component when comparing two similar fabric constructions, it refers to the relative weight of the fabric, it refers weight of the fabric, it may be expressed as the weight of the fabric at a standard size such as gram per square meter or ounce per square yard (Jewel, 2005). A sample was cut using GSM cutter and it was weighed in the electronic weighing balance. The same procedure was repeated for original and treated fabrics and the mean weight was calculated (Plate a – V) & (Plate b- VI).

##### **3.13.2.1.2 Fabric thickness**

Fabric thickness is defined as the distance between upper and lower surface of the material as measured under standard pressure. The difference in thickness of the samples was found by using thickness gauge. The fabric was placed between the pressure foot and anvil, the reading was noted from the dial. The readings were taken for original and treated samples. The mean value was then calculated (Plate – VII).

### **3.13.2.1.3 Fabric count**

Fabric count is the number of picks and ends per unit area which can be obtained by counting the number of picks and ends per unit length. The counting glass is a small magnifying glass (Plate – VIII & IX) in a stand over a square exactly one inch away. The fabric was held without tension and was free from folds and wrinkles. The number of threads in the field directly gives the number of threads per inch. Then the average number of picks and ends were calculated for the original and treated samples.

### **3.13.3.1 Mechanical properties**

The fabric was tested for its mechanical properties such as tensile strength, elongation, abrasion resistance and pilling property.

#### **3.13.3.1.1 Tensile strength and elongation**

Tensile strength is the force required to break the fabric when it is under tension (Vaishnav, 2000). Elongation is the extent to which the fabric under tension extends, till it gets cut off. Tensile strength and elongation of the fabric was tested using Eureka Model Tensile Strength Tester (Plate – X & XI). The rate of transverse and capacity of the machine was 45cm per minute. The gauge length was kept as 25 cm and the dial of the machine was calibrated in pounds and kilograms.

The test sample was cut from each of the treated material with length of 33 cm and width of 7cm in warp and weft directions separately. Each sample was mounted between two jaws, care was taken to see that the sample was perpendicular to the load. The load was applied until the sample was torn. The dial reading in lbs for tensile strength and elongation in centimeters from scale was noted. The samples were tested for ten readings from each samples OC, OD and TCF were tested for its tensile strength and elongation their mean value was recorded. The tensile strength and elongation of each material was calculated separately for both warp and weft directions in the fabric. (Plate – XII & XIII).

### **3.13.3.1.2 Abrasion resistance**

Abrasion is rubbing away of the component fibers and yarns of the fabrics. Abrasion causes deformation or disturbance to the yarns and their constituent fibers leading to change in appearance and loss of mechanical properties (Shim and Poudeyhimi, 2006). Samples were cut based on the given template and fixed on the circular specimen holders, under desired load on the brass plate. When the sample holders are subjected to multi directional motion, the fabric samples mounted on its rubs uniformly against the abrading surface. The weight of the fabric before and after abrasion was noted in electronic weighing balance and the difference was calculated (Plate – XIV).

$$\text{Abrasion resistance} = \frac{\text{Initial weight-final weight}}{\text{Initial weight}}$$

In the manner ten readings were noted for the original, desized and the mean values was calculated.

### **3.13.4.1 Absorbency test**

#### **3.13.4.1.1 Drop test**

The ability of a fabric to take up moisture is determined as absorbency. Wettability is the time taken in seconds for a drop of water to be absorbed into the fabric. If it takes more than 200 seconds to absorb the water through fabric, it is considered as unwettable. A burette filled with distilled water was clamped in a stand. The sample was mounted in an embroidery frame and it was placed at the base of the stand. The distance between the sample and nozzles of burette was kept constant. The nozzle of the burette was opened just to allow a drop of water to fall on the sample. The stop watch was started simultaneously and it was stopped when the drop of the water gets fully absorbed into the material. The same procedure was repeated for all the samples and the mean values were calculated (Plate – XV).

#### **3.13.4.1.2 Sinking test**

Sinking test is a simple test to find the wettability of fabric. The time taken for the material to sink completely is observed. The shorter the time,

greater is the wettability. For the sinking test the samples were cut with the size of 5cm x 5cm square. A 1000 ml beaker was filled with distilled water and the sample was dropped on surface of the water from a standard height. The stop watch was started when the fabric struck the surface of water and stopped when the last corner sank below the water surface and the time required for the sample to sink was noted. The same procedure was repeated for all the samples. The mean values were calculated from the readings (Plate – XVI).

#### **3.13.4.1.3 Wicking test**

Capillary rise test method is used to measure the rapidity of absorption. Samples were cut into size of 15 cm length and 2.5 cm width from all the fabric samples. One end of the sample strip was placed with a glass rod and in the other end two gram weight was attached to keep the sample straight. The sample placed in glass rod was placed on heavy wooden block. The sample was allowed to immerse in a tray of distilled water. The rise of the water level in the strip was measured, the same procedure was repeating for all the samples and the readings were recorded for the mean values (Plate – XVII).

#### **3.13.5.1 Comfort properties**

##### **3.13.5.1.1 Fabric drapability**

Drape is one of the subjective performance characteristics of fabrics that contribute to aesthetic appeal. It is a complex property involving bending and shearing deformations. Drape is the ability of the fabric in which it hanged down in folds. Samples and brown papers were cut into circular from using the template and sandwiched between the two horizontal discs of smaller diameter and the unsupported annual ring of fabric was allowed to hang down under the action of gravity (Basu, 2006). The outer glass cover was closed and brown paper was placed on the glass lid. A planar projection of the counter of draped specimen was recorded on the brown paper and the outside was measured using pencil. It was trimmed accordingly and weighted(Plate – XVIII). The readings were recorded and mean values were calculated. The drape coefficient was calculated using the formula.

$$\text{Drape coefficient} = \frac{A_s \times A_d}{A_D - A_d} \times 100$$

$A_s$  – Mass of shaded area

$A_D$  – Mass of total paper ring

$A_d$  – Mass of Supporting area

### 3.13.5.1.2 Fabric stiffness

Stiffness is the resistance of the fabric to bending. Bending length is the length of the fabric that bends under its own weight to a definite extent. This parameter is one of the factors that determine the manner in which fabric drapes i.e., the cloth having high bending path tends to drape stiffly (Sunita *et al.*, 2010). The stiffness of the sample is determined by Shirley Stiffness Tester. The specimens from treated fabric were cut using template provided with the tester. Each rectangular strip was mounted over a horizontal plate form until the edges of the fabric coincide with the index line, the reading was noted in centimeters pointed in the template. Ten readings were taken from each slide up, first at one end than the other. The mean value of the five readings was calculated as single readings (Plate – XIX & XX).

### 3.13.6.1 Bandage Testing

The prepared Bandage was further examined for its efficiency based on the results from the antimicrobial activity. The test categories include determination of water soluble matters, ether soluble matters, pH of aqueous extract and ph of water used.

The water soluble matter test determines the water soluble content present in the fabric as these water soluble matter if present beyond certain limits in the textile material will adversely affect its quality (WWW. techno.com) The sample size of the specimen includes a weighing 10g, the cut fabric had been subjected to conditioning for 24hrs to moisture equilibrium at  $65 \pm 2\%$  standard atmosphere. The conditioned test specimen is put in a flask and sufficient amount of water with liquor to material ratio as 20:1 is added into the flask, the liquor is connected to boil for 60 minutes and then later cool to room

temperature to filter the extract and wash the residue with small amount of water. The water soluble matter as a percentage of the conditioned weight of the specimen was calculated using this following formula.

$$P = W_2 / W_1 \times 100$$

Where,

P = Percentage of water soluble matter

W<sub>2</sub> = Weight in g of the residue

W<sub>1</sub> = Weight in g of the conditioned test specimen

Similar procedure is carried out ether soluble matters using ether as a solvent. The test is carried out based on ASTM – D7674,14a standard test method. In order to identify the ph of the specimen, the fabric was subjected aqueous and water extract testing. The ph of aqueous extract was determined using ISO3071:2005 ([www.resource.org](http://www.resource.org)). This test was carried out in SITRA, Coimbatore.

### **3.14 Statistical analysis**

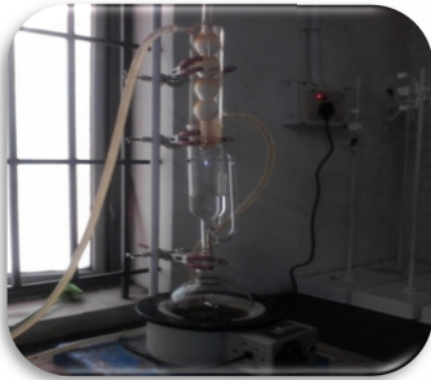
Consolidation and analysis are important steps in problem solving and these producers are required in any kind of research to arrive at meaningful conclusions. Hence the collected data was consolidated and symmetrically analyzed results of these treatments are presented and discussed under result and discussion. The results of the laboratory tests were analyzed statistically selecting appropriate test. The difference between the various samples were analyzed using F test and ANOVA, to learn whether the difference was significant or not.



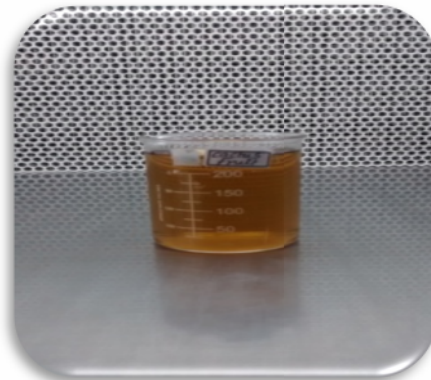
**Plate I**  
**Cactus Leaf**



**Plate II**  
**Cactus Fruit**



**Plate III**  
**Soxhlet apparatus**



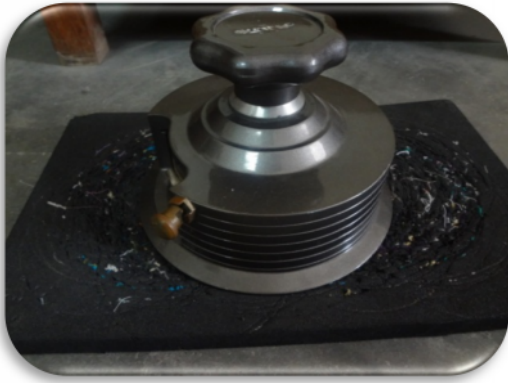
**Plate IV**  
**Solutions**



**Plate V**  
**Padding mangle**



**Plate VI**  
**Sterilization**



**Plate VII**  
**GSM Cutter**



**Plate VIII**  
**Weight**



**Plate IX**  
**Thickness**



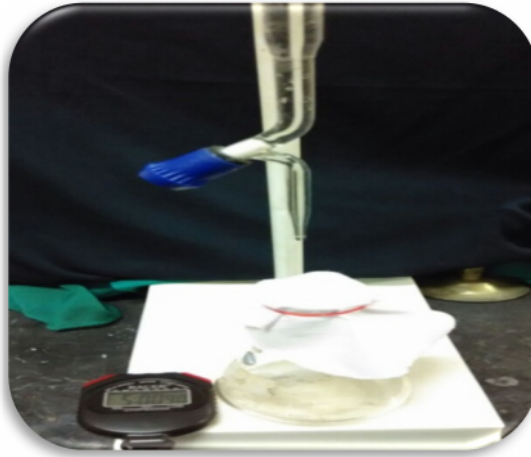
**Plate X**  
**Pickglass**



**Plate XI**  
**Tensile strength**



**Plate XII**  
**Abrasion**



**Plate XIII**

**Drop test**

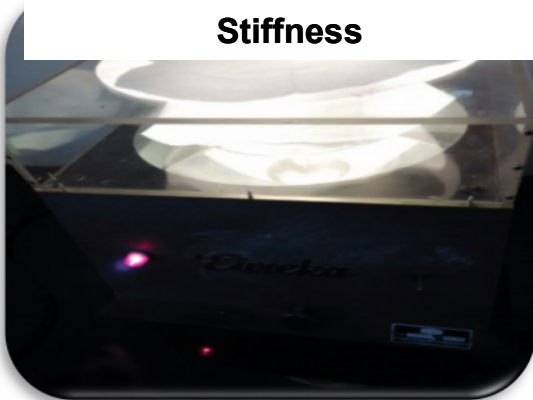


**Plate XV**

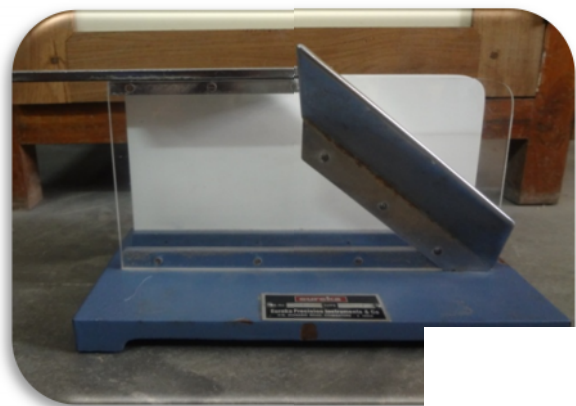
**Wicking**

**Plate XVII**

**Stiffness**



**Plate XVI**  
**Drapability**



**Plate XIV**

**Sinking**

## 4. RESULTS AND DISCUSSIONS

The findings of the study “Antimicrobial Effect of Cactus Plant Extracts on Cotton Fabric” are discussed under the following headings.

### 4.1 Subjective Evaluation

### 4.2 Objective Evaluation

### 4.3 Assessment of Antimicrobial Activity

### 4.4 Assessment of Prepared Bandage

#### 4.1 Subjective Evaluation

The results of the subjective evaluation are presented in the Table – III

TABLE –III

#### VISUAL INSPECTION

S. No	Sample	General appearance		Texture			Luster		Evenness of finishing		color	
		Good	Bad	Smooth	Moderate	Rough	High	Medium	Even	Uneven	Bright	Dull
1	OF	-	-	-	-	-	-	-	-	-	-	-
2	TCF	90	10	95	5	-	35	65	60	40	20	80

The Table –III, reveals that when comparing the original and treated fabric for the visual inspection, general appearance was rated as good by 90 percent of the judges. Whereas texture was rated as smooth by 95 percent of the judges with reference to luster, evenness in finishing and colour 65, 60 and 80 percent of the judges rated the treated fabric as medium, even and dull

respectively. Hence it could be concluded that the treated fabric was good in general appearance, texture, luster and evenness.

## 4.2 Objective Evaluation

### 4.2.1 Physical Properties

The results of the fabrics tested for its physical properties are presented below.

#### 4.2.1.1 Fabric Weight

The fabric weight of the original fabric, desized fabric and treated fabric samples of cotton fabric are given in the below Table-IV and Figure –1.

**Table -IV**  
**Fabric Weight**

S.No	Sample	Mean value In (GM)	Gain (or) loss over original weight	% of gain or loss over original weight	'F' value
1	OC	1.169	-	-	1.4354
2	ODF	1.257	-0.088	7.52	
3	TCF	1.258	-0.089	7.61	

Ns- Not significant

The Table –IV and Figure – 1 show an increase in the fabric weight for the desized and treated fabric with the percent of 7.52 and 7.61 respectively. From the count values it is clear that there is closeness in the weaves which could be the reason for increases in fabric weight. This increase is due to the consolidation of fibre. The F value for the data is not significant. Thus it could be concluded that the treated fabric has an increase in the weight when compared to the original one.

#### 4.2.1.2 Fabric Thickness

The results of fabric thickness for the original fabric, desized fabric and treated samples of cotton are given in the Table – V and Figure – 2.

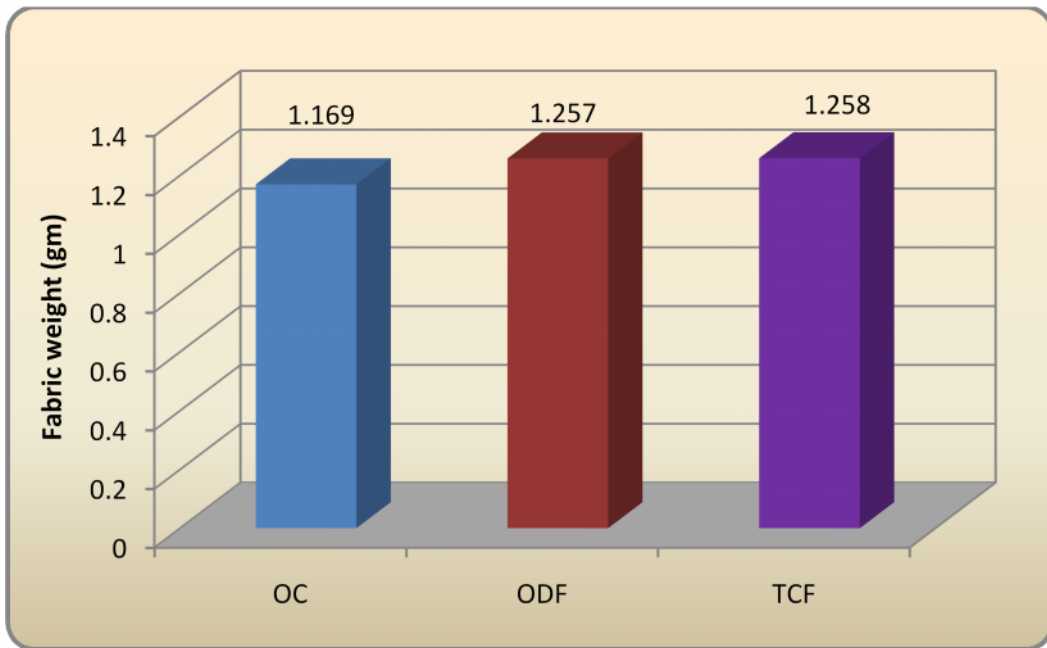
**Table –V**  
**Fabric Thickness**

S.No	Sample	Mean value In (MM)	Gain (or) loss over original weight	% of gain or loss over original weight	'F' value
1	OC	0.26	-	-	1.5366
2	ODF	0.27	-0.01	3.84	
3	TCF	0.31	-0.05	19.23	

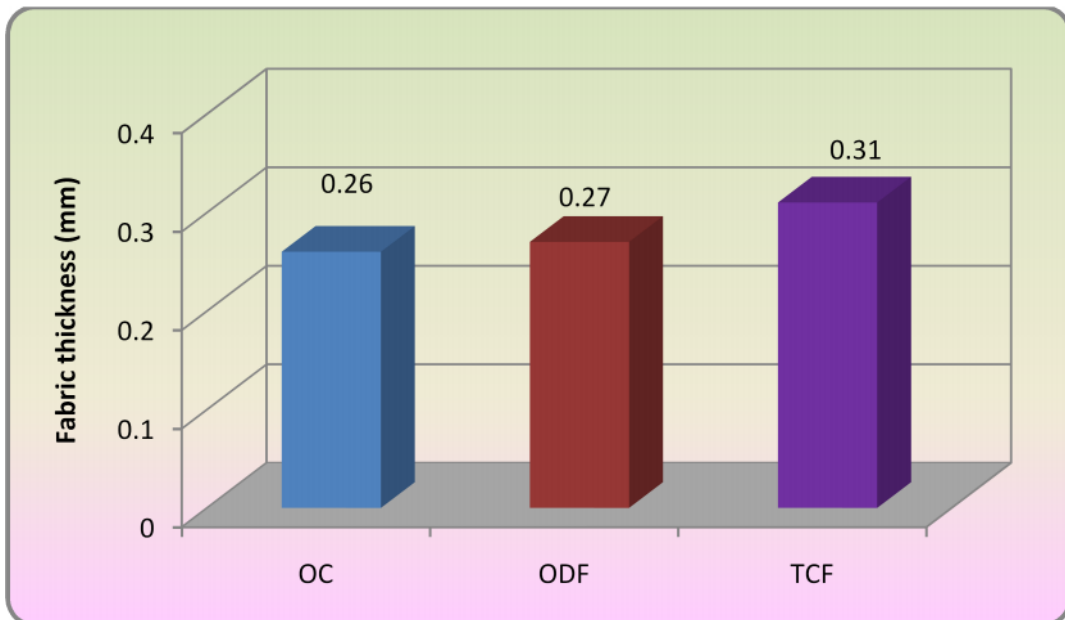
Ns – Not significant

The Table – V and Figure – 2 it is noticed that the fabric thickness for the desized fabric and treated fabric with was 3.84 and 19.23 percent, which has increased when compared to the original in treated fabric respectively. This increase is due to the compact placement of yarn. The F value 1.5366 for the data is not significant level. Thus it could be concluded that the treated fabric has an increase in fabric thickness when comparison made between the original and treated sample.

**Figure - 1**  
**Fabric Weight**



**Figure - 2**  
**Fabric Thickness**



#### 4.2.1.3.1 Fabric Count in Warp Direction

The results of fabric count in warp direction for the original fabric, desized fabric and treated samples of cotton are discussed below.

**Table –VI**

**Fabric Count In Warp Direction**

S.No	Sample	Mean value In (inch)	Gain (or) loss over original weight	% of gain or loss over original weight	'F' value
1	OC	113	-	-	31.714**
2	ODF	121	-8	7.07	
3	TCF	127	-10	8.84	

\*\* Significant at 1% level

The Table – VI and Figure -3 show an increase in the fabric count in warp for the desized and treated fabric which is higher than the original fabric by 8.84% respectively. The reason may be due to shrinkage of fabric. The F value for the above data is significant. Hence it could be concluded that the original fabric and treated fabric has an increase on fabric count in the warp direction. It was evident ANOVA test in 1% level.

#### 4.2.1.3.2 Fabric count in Weft Direction

The results of fabric count in weft and analysis for the originals fabric, desized fabric and treated samples is presented in the Table-VII and Figure - 4 .

**Table –VII**  
**Fabric Count In Weft Direction**

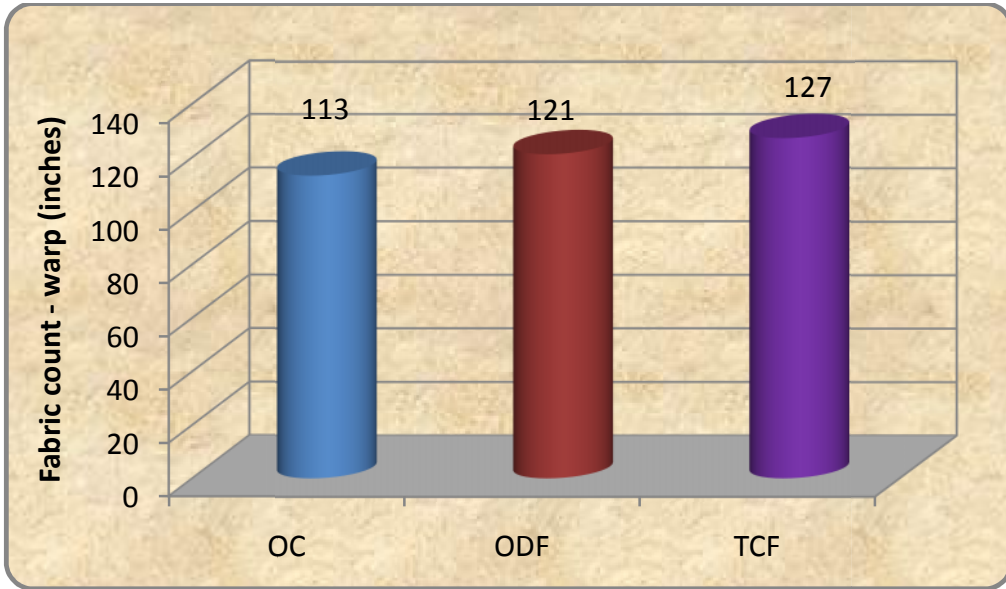
S.No	Sample	Mean value In (inches)	Gain (or) loss over original weight	% of gain or loss over original weight	'F' value
1	OC	86	-	-	22.071**
2	ODF	91	-5	5.81	
3	TCF	92	-6	6.97	

\*\* Significant at 1% level

The Table –VII and Figure - 4, show an increase in the fabric count in weft for the desized fabric as 5.81% and treated fabric as 6.97% respectively. The F value for the data is significant. Thus it could be concluded that the treated fabric has an increase in fabric count in weft direction after treatment with the cactus fruit extract.

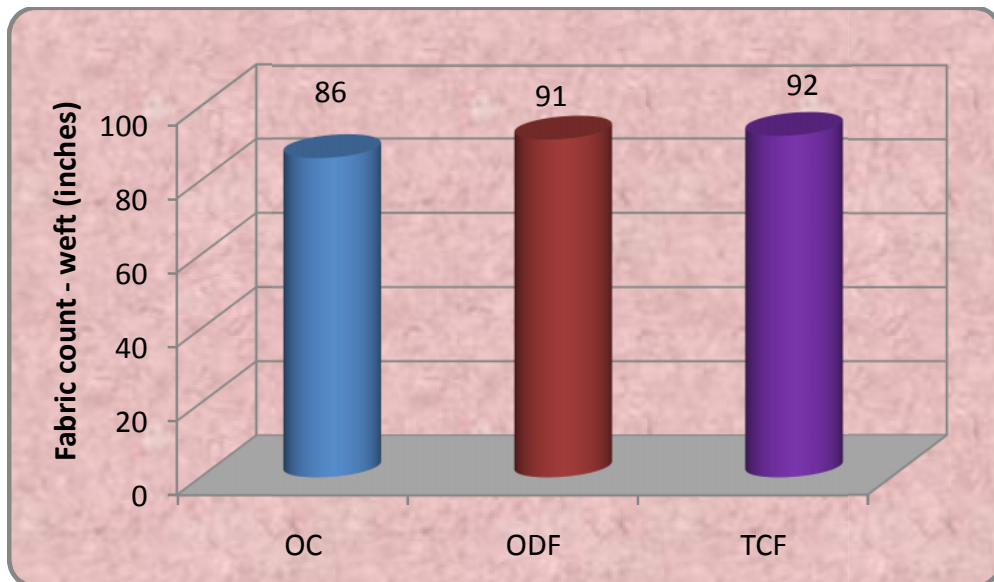
**Figure - 3**

**Fabric Count In Warp Direction**



**Figure - 4**

**Fabric Count In Weft Direction**



## 4.2.2 Mechanical Properties

The results of the mechanical properties of the fabric are presented below

### 4.2.2.1.1 Fabric Tensile Strength in Warp Direction

The result of fabric tensile strength analysis in warp direction for the original fabric, desized fabric and treated samples is presented in Table-VIII and Figure - 5.

**Table – VIII**  
**Fabric Tensile Strength In Warp**

S.No	Sample	Mean value In (kg)	Gain (or) loss over original weight	% of gain or loss over original weight	'F' value
1	OC	46.8	-	-	105.571**
2	ODF	51.4	-4.6	9.82	
3	TCF	59.4	-12.6	26.72	

\*\* Significant at 1% level

The Table -VIII and Figure - 5 show that the tensile strength of the sample OC was 46.8 kg and the desized fabric and treated fabric increased by 9.82 and 26.72 kg % respectively. This may be due to presence of starch in binding. The F value for the data is significant at one percent level. Therefore, it is clear that, the strength of the samples (ODF and TCF) has increased when compared to original sample (OC). This may be due to application of the cactus fruit extract, which has penetrate into the fabric.

### 4.2.2.1.2 Fabric Tensile Strength in Weft Direction

The results of tensile strength in weft direction for the original fabric, desized fabric and treated samples are given in Table - IX and Figure – 6.

**Table – IX**

**Fabric Tensile Strength In Weft Direction**

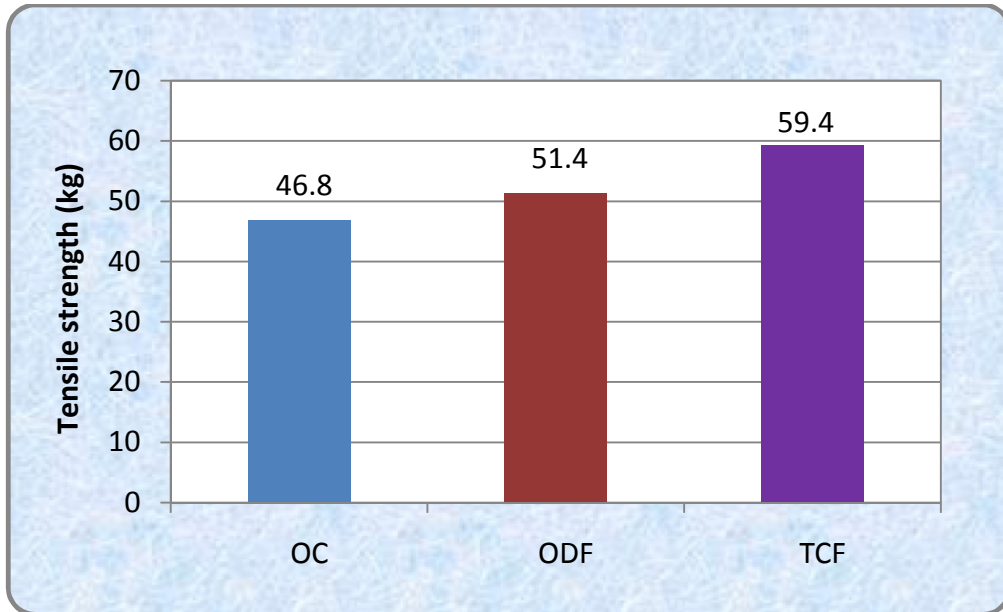
S.No	Sample	Mean value In (kg)	Gain (or) loss over original weight	% of gain or loss over original weight	'F' value
1	OC	29.0	-	-	248.107**
2	ODF	35.2	-6.2	21.37	
3	TCF	37.2	-8.2	28.27	

\*\*Significant at 1% level

The Table – IX and Figure – 6 represent a deduction in tensile strength of the weft direction for the desized fabric and treated fabric by 21.37 and 28.27 percent respectively. The F value for the data is 248.107 which is significant at one percent. Therefore, it is clear that strength of the sample (ODF and TCF) has increased when compared with (OC) this may be due to the presence of starch in the original fabric.

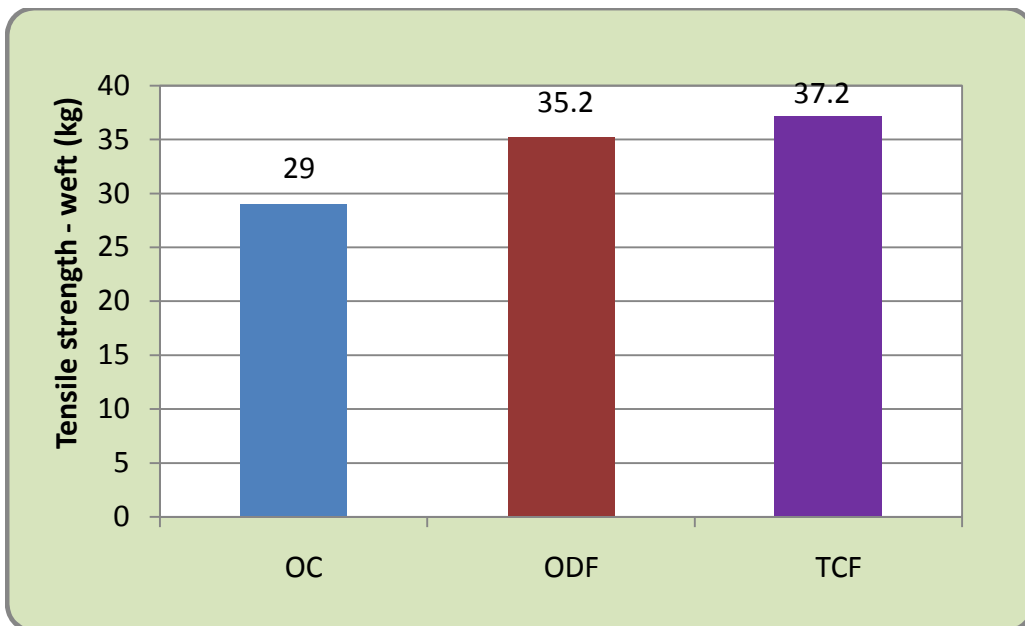
**Figure - 5**

**Fabric Tensile Strength In Warp**



**Figure - 6**

**Fabric Tensile Strength In Weft Direction**



#### 4.2.2.2.1 Fabric Elongation In Warp Direction

The results of fabric elongation for the original fabric, desized fabric and treated samples are given in Table – X and Figure – 7.

**Table – X**

**Fabric Elongation In Warp Direction**

S.No	Sample	Mean value In (inch)	Gain (or) loss over original weight	% of gain or loss over original weight	'F' value
1	OC	0.80	-	-	12.926**
2	ODF	0.82	-0.02	2.5	
3	TCF	1.16	-0.36	45.0	

\*\*Significant at 1% level

The Table – X and Figure –7 show that the fabric elongation in warp of the sample OC, ODF and TCF was 0.80, 0.82 and 1.16 inch, thereby showing an increase in the desized and treated fabric by 2.5 and 45.0 percent respectively. Therefore, it is clear that elongation of the sample (OC) has compared to original sample this may be due to strength of the fabric. The F value for the data is 12.926 and it is significant at one percent level. Thus it could be concluded that the warp direction show an elongation with desizing and treatment.

#### 4.2.2.2.2 Fabric Elongation in Weft Direction

The fabric elongation and analysis of variance of the samples in original fabric, desized fabric and treated samples are given Table- XI and Figure - 8.

**Table – XI**

**Fabric Elongation In Weft Direction**

<b>S.No</b>	<b>Sample</b>	<b>Mean value In (inch)</b>	<b>Gain (or) loss over original weight</b>	<b>% of gain or loss over original weight</b>	<b>'F' value</b>
1	OC	1.74	-	-	0.3636
2	ODF	1.80	-0.06	3.44	
3	TCF	1.82	-0.08	4.59	

Ns – Not significant

The Table – XI and Figure - 8 and show the fabric elongation of the samples OC, ODF and TCF as 1.74, 1.80 and 1.82 inch, thereby showing an increase in the desized and treated samples by 3.44 and 4.59 per cent respectively. Therefore, it is clear that elongation of the samples when compared to original samples (OC) has increased, this may be due to application of cactus fruit extraction of the fabric. Hence it could be concluded that the desized and treated fabrics elongation in weft direction is higher. From the value it is evident that the data is not significant.

**4.2.2.3 Abrasion resistance**

The abrasion resistance results of the original fabric, desized and treated finished samples are described in Table- XII and Figure – 9.

Figure - 7

Fabric Elongation In Warp Direction

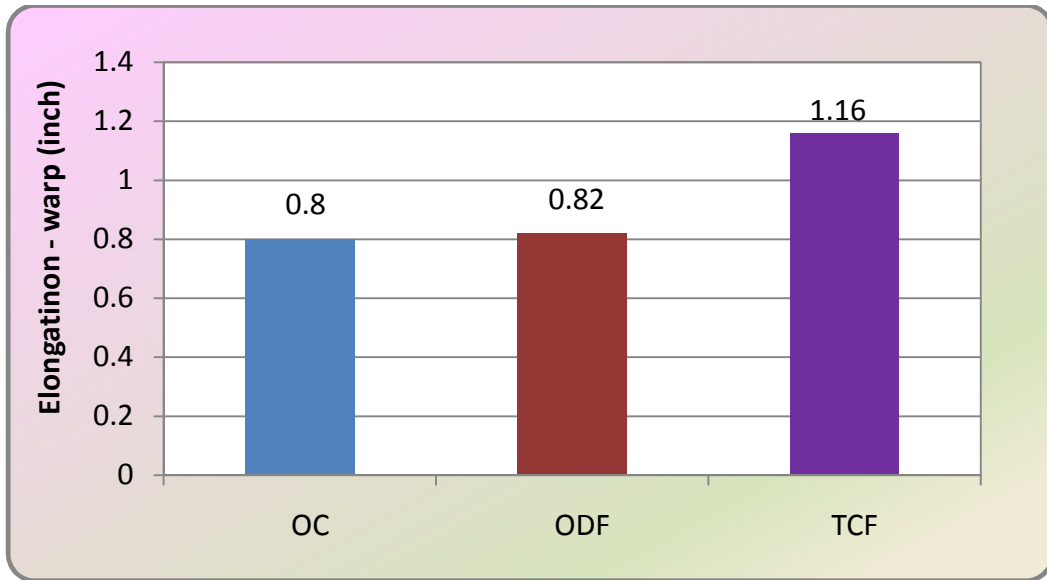
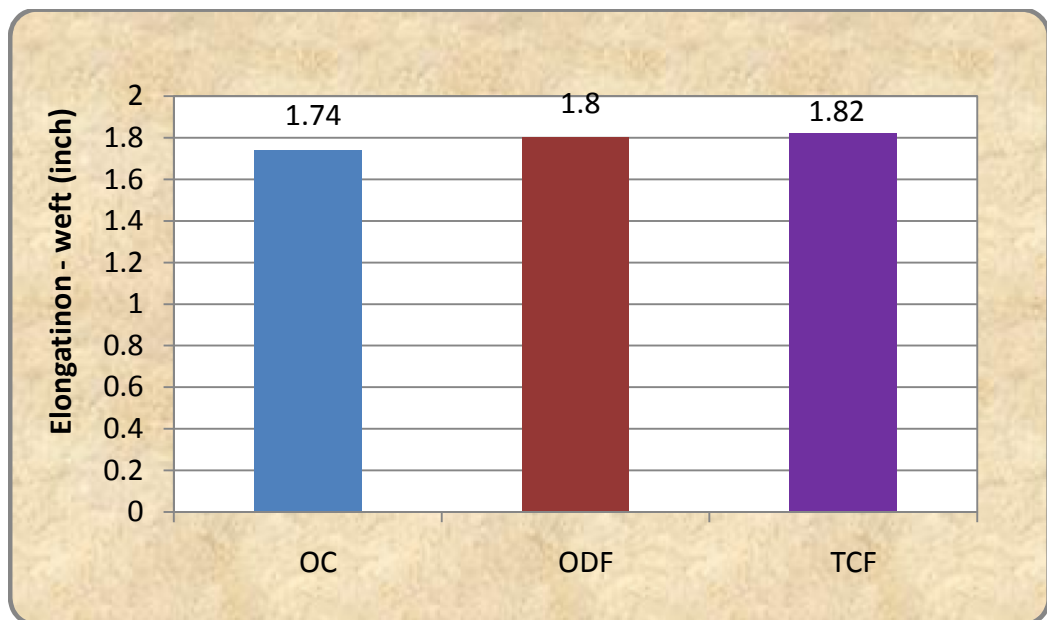


Figure - 8

Fabric Elongation In Weft Direction



**Table – XII**

**Abrasion Resistance**

<b>S.No</b>	<b>Sample</b>	<b>Mean value In (inch)</b>	<b>Gain (or) loss over original weight</b>	<b>% of gain or loss over original weight</b>	<b>'F' value</b>
1	OC	0.172	-	-	12.451 **
2	ODF	0.192	-0.02	11.62	
3	TCF	0.195	-0.023	13.37	

\*\*Significant at 1% level

The Table – XII and Figure – 9 show an increase in the fabric resistance after desizing and treatment by 11.62 and 13.37 percent respectively. From the abrasion value it is clear that there is an increase in abrasion resistance. The F value for the data is significant at 1% level. Hence it could be concluded the treated fabric has an increase abrasion resistance.

**4.2.3 Absorbency Test**

The results of the samples tested for its absorbance property are represented below and discussed

**4.2.3.1 Drop Test**

The absorbency results of the original fabric, desized and treated finished samples are described in Table – XIII and Figure - 10

**Table– XIII**

**Drop Test**

<b>S.No</b>	<b>Sample</b>	<b>Mean absorbency (seconds)</b>	<b>Gain (or) loss over original weight</b>	<b>% of gain or loss over original weight</b>	<b>'F' value</b>
1	OC	27.34	-	-	400.299 **
2	ODF	18.67	8.67	31.71	
3	TCF	13.12	14.22	52.01	

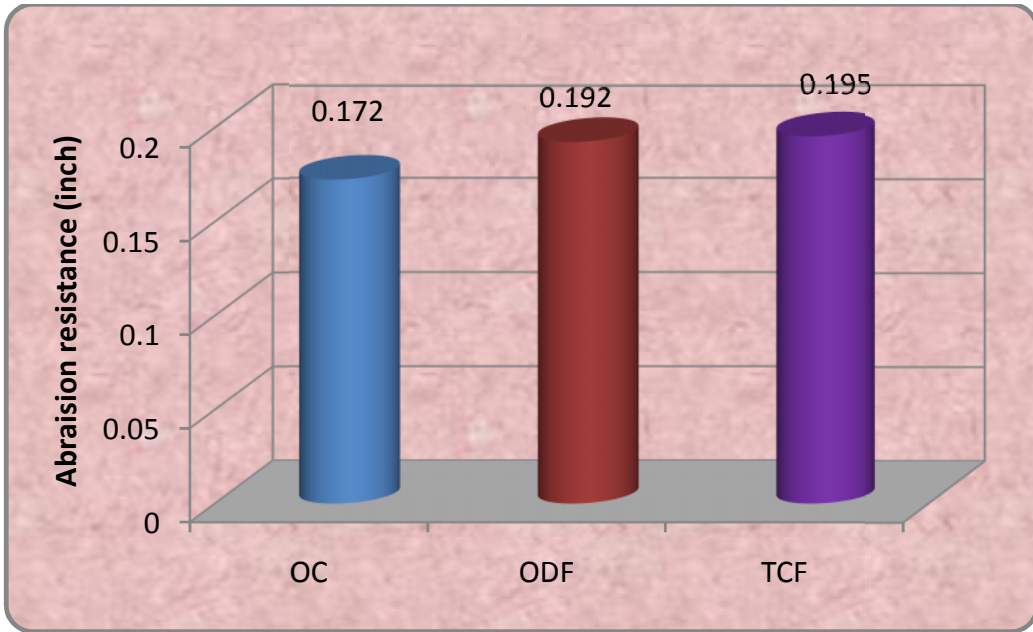
\*\*Significant at 1% level

From the Table – XIII and Figure - 10, it is obvious that the absorbency of the samples OD, ODF and TCF was 27.34, 18.67 and 13.12 sec respectively. The Table represents an increase in value when compared to original, it could actually be implied that the absorbency rate is proportional to time. Therefore the sample ODF and TCF show an increase of absorbency as 31.71 and 52.01 per cent respectively. Thereby concluding that the absorbency is good for the treated sample. The F value at 400.299 is significant of 1% level.

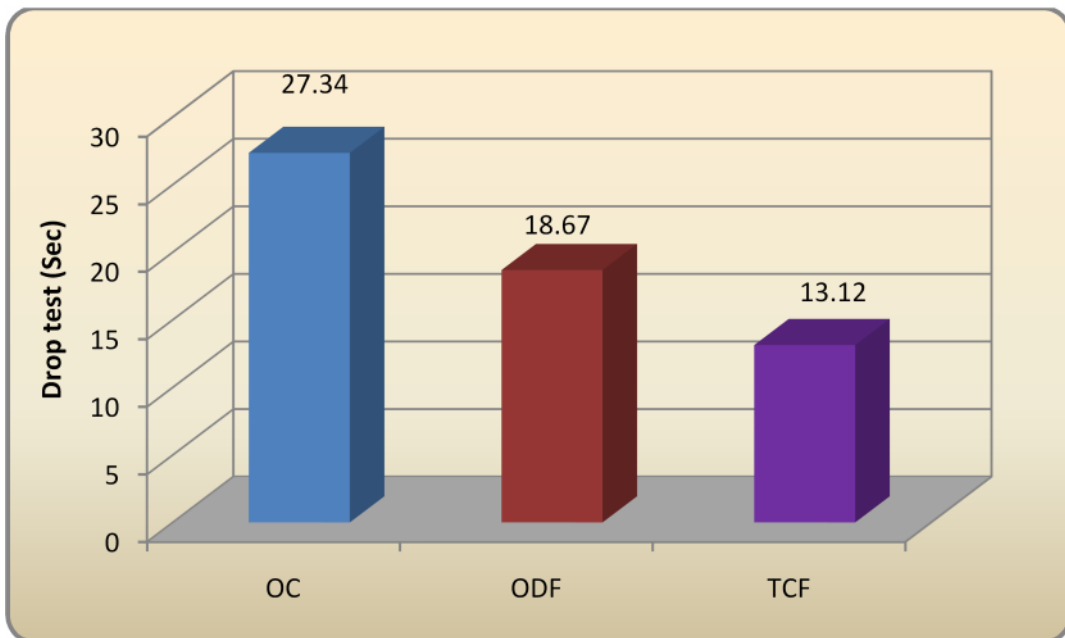
**4.2.3.2 Sinking Test**

The absorbency of the original fabric, desized and treated extract samples by sinking test method is depicted in Table – XIV and Figure - 11

**Figure - 9**  
**Abrasion Resistance**



**Figure - 10**  
**Drop Test**



**Table – XIV**

**Sinking Test**

<b>S.No</b>	<b>Sample</b>	<b>Mean absorbency (seconds)</b>	<b>Gain (or) loss over original weight</b>	<b>% of gain or loss over original weight</b>	<b>'F' value</b>
1	OC	23.74	-	-	743.087 **
2	ODF	7.9	15.84	66.72	
3	TCF	4.8	18.94	79.78	

\*\*Significant at 1% level

From the Table – XIV and Figure – 11 it is obvious that the solution penetration level of samples OF, ODF and TCF was 23.74, 7.9 and 4.8 sec respectively. The Table represents a decrease in value when compared to original. It could actually be implied that the penetration rate is inversely proportional to time. Therefore the samples ODF and TCF show an increase in absorbency, when compared to the original sample (OC). The F value of the above data is significant at 1% level. Hence it could be concluded that the ODF sample has an increase in absorbency and the TCF sample has decrease in absorbency as it took long time for sinking.

**4.2.3.3 WICKING TEST**

The absorbency for the original fabric, desized and treated finished sample by wicking test is presented in Table – XV and Figure – 12.

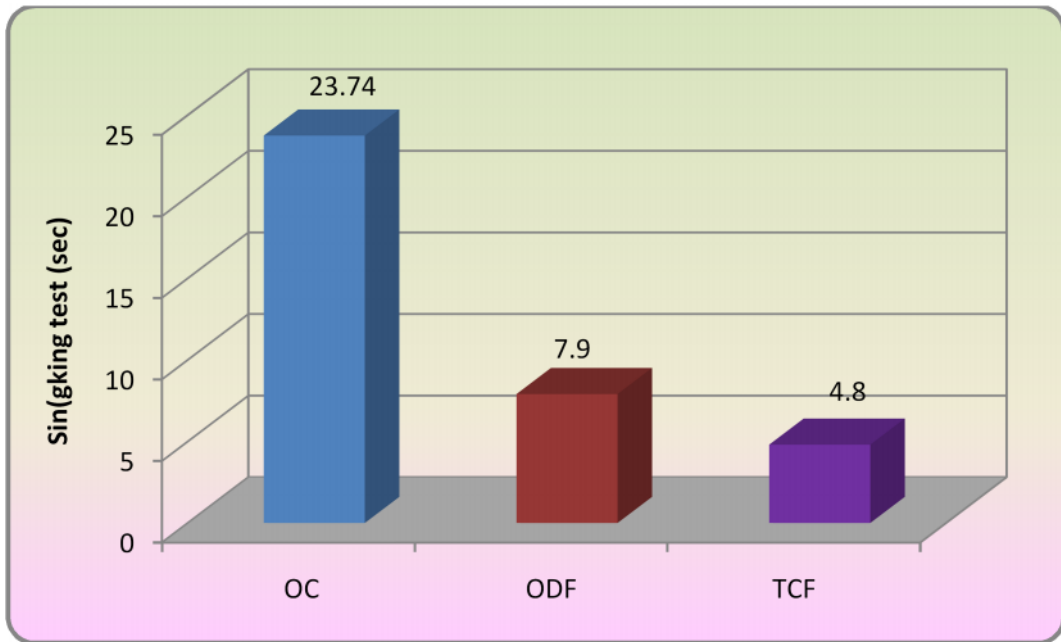
**Table – XV**  
**Wicking Test**

S.No	Sample	Mean absorbency (seconds)	Gain (or) loss over original weight	% of gain or loss over original weight	'F' value
1	OC	4.1	-	-	35.88**
2	ODF	5.28	-1.18	28.78	
3	TCF	5.5	-1.4	34.14	

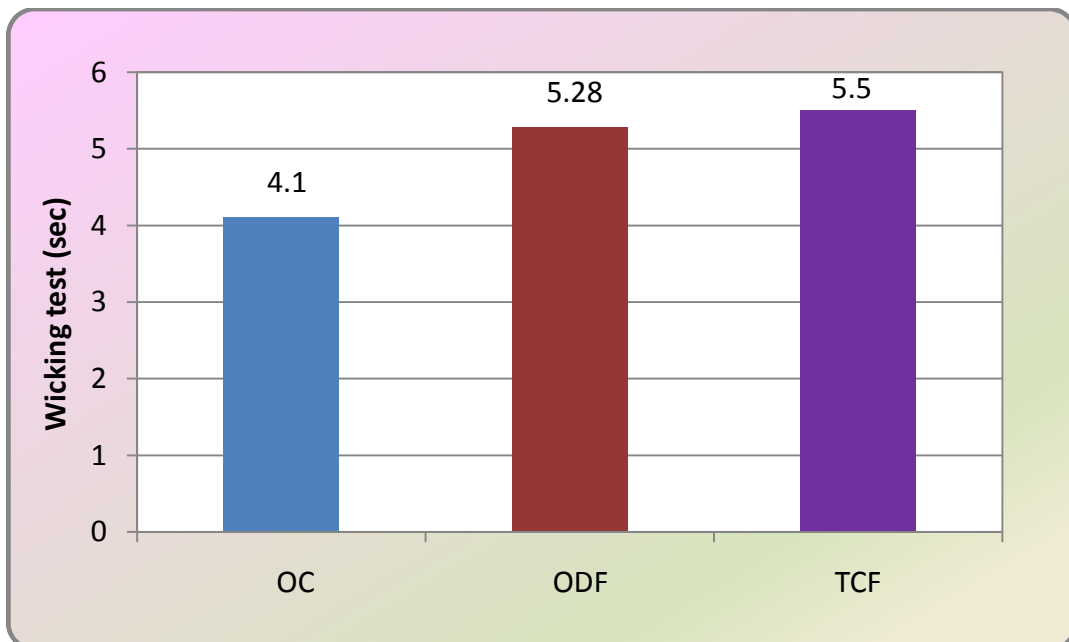
\*\*Significant at 1% level

From the Table - XV and Figure -12, it is that the absorbency of the samples OC from wicking test was 4.1cm whereas the absorbency has increased in the desized sample by 5.28cm and the maximum rise of 34.14 is observed in cactus fruit extract treated sample. It is also clear that the absorbency of the samples has increased when compared to the original sample (OC). The F value of data is significant at 1% level. Hence it could be concluded to the desized and treated samples have better in absorbency.

**Figure - 11**  
**Sinking Test**



**Figure - 12**  
**Wicking Test**



#### 4.2.4 Comfort Properties

##### 4.2.4.1 Fabric Drapability Test

The Table - XVI and Figure - 13 show that the values of drapability of the original fabric, desized and treated finished extract finished sample

**Table – XVI**

##### **Fabric Drapability**

S.No	Sample	Mean value in (%)	Gain (or) loss over original weight	% of gain or loss over original weight	'F' value
1	OC	64.28	-	-	49.139**
2	ODF	68.6	4.32	6.72	
3	TCF	68.92	4.64	7.21	

\*\*Significant at 1% level

From the Table – XVI and Figure – 13 it is perceptible that the drapability of the sample OC was 64.28. This has increased in the desized and treated samples by 6.72 and 7.21% respectively. It is clear that drapability of the samples has increased when compared to original sample (OC). The F value for the data is 49.139 which is significant at one percent level.

##### 4.2.4.2 Fabric stiffness warp

The fabric stiffness of the original fabric, desized and finished treated sample of cotton fabric in warp direction are given in Table – XVII and Figure – 14.

**Table – XVII**

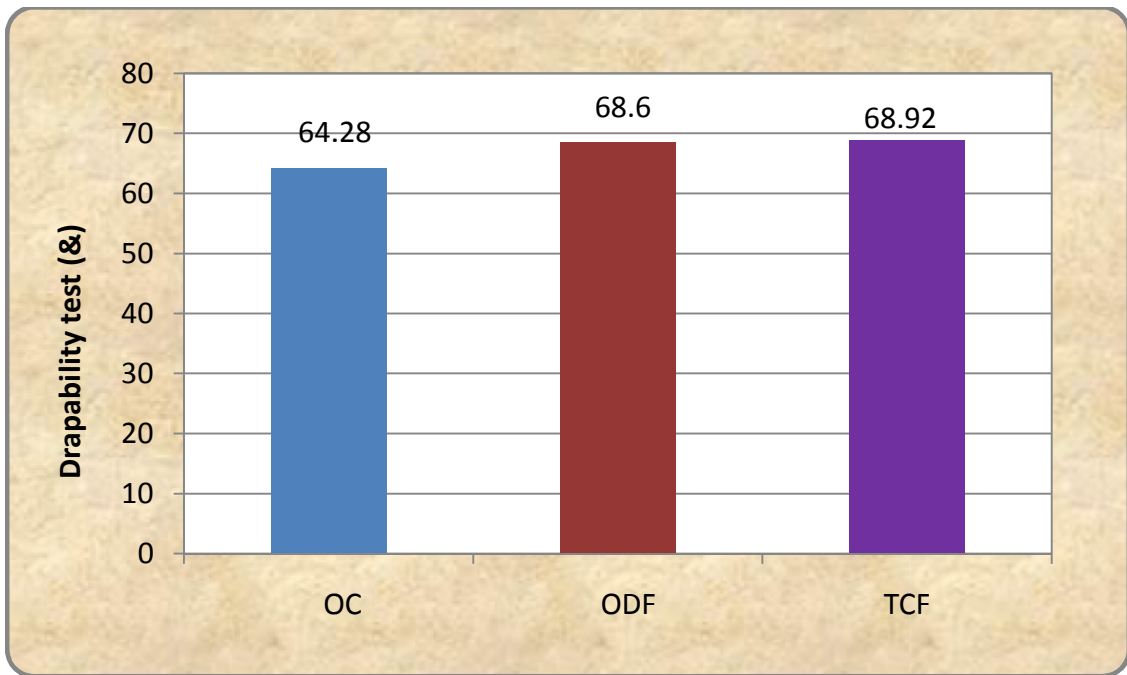
**Fabric Stiffness Warp Direction**

<b>S.No</b>	<b>Sample</b>	<b>Mean in (cms)</b>	<b>Gain (or) loss over original weight</b>	<b>% of gain or loss over original weight</b>	<b>'F' value</b>
1	OC	2.92	-	-	3.0215
2	ODF	2.64	0.28	9.58	
3	TCF	2.62	0.30	10.27	

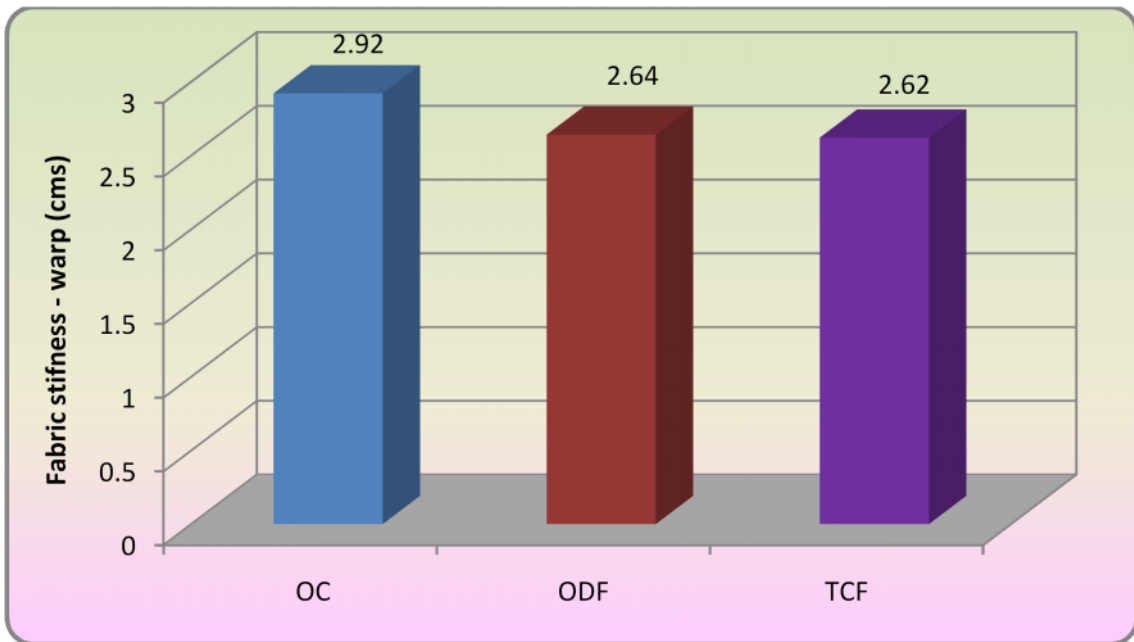
NS – Not significant

From the Table –XVII and Figure – 14 the fabric stiffness of desized and treated fabric samples show a decreased by 2.64 and 2.62 cm when compared to sample OC which was 2.92cm. The percentage loss of the samples over original was calculated to be 9.58 and 10.27 per cent respectively. This decrease in fabric stiffness may be due to the removal of starch in the original that hasn't undergone any pretreatments. Hence it could be concluded that desized and treated sample has decrease fabric stiffness in warp direction. The F value for the data is not significant.

**Figure - 13**  
**Fabric Drapability**



**Figure - 14**  
**Fabric Stiffness Warp Direction**



#### 4.2.4.3 Fabric stiffness weft

The fabric stiffness of the original fabric, desized and treated sample of cotton fabric in weft direction are given below.

**Table – XVIII**

**Fabric Stiffness Weft Direction**

S.No	Sample	Mean in (cms)	Gain (or) loss over original weight	% of gain or loss over original weight	'F' value
1	OC	1.9	-	-	2.2941
2	ODF	1.6	0.3	15.78	
3	TCF	1.5	0.4	21.05	

Ns – Not significant

From the Table – XVIII and Figure – 15 the fabric stiffness is desized and treated samples has decrease by 1.6 and 1.5cm when compared to sample OC which was 1.9cm. The percentage loss of the samples (ODF and TCF) over original was calculated to be 15.78 and 21.05 percent respectively. This decrease in fabric stiffness may be due to the removal of starch in the original. From the F value it is evident that the data is not significant.

#### 4.3 Assessment of Antibacterial Activity

The Table –IX and Figure - 16 show the values of antibacterial activity of the original and treated extract samples.

Table – IX

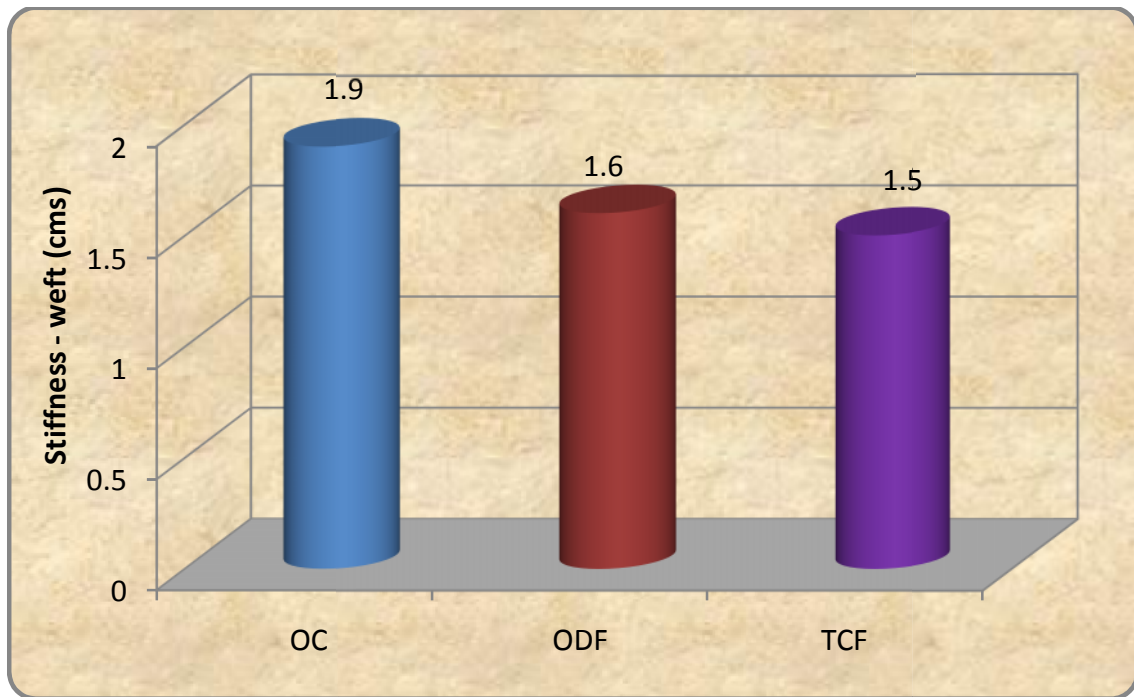
**Antibacterial Activity Of Extract Treated Fabrics**

S.No	Antimicrobial activity	Zone of inhibition		
		Test organisms		
	Fabric samples	<i>Escherichia. coli</i>	<i>Staphylococcus . aureus</i>	<i>Candida albicans</i>
1	OF	-	-	-
2	TCF	9.75	9.5	7

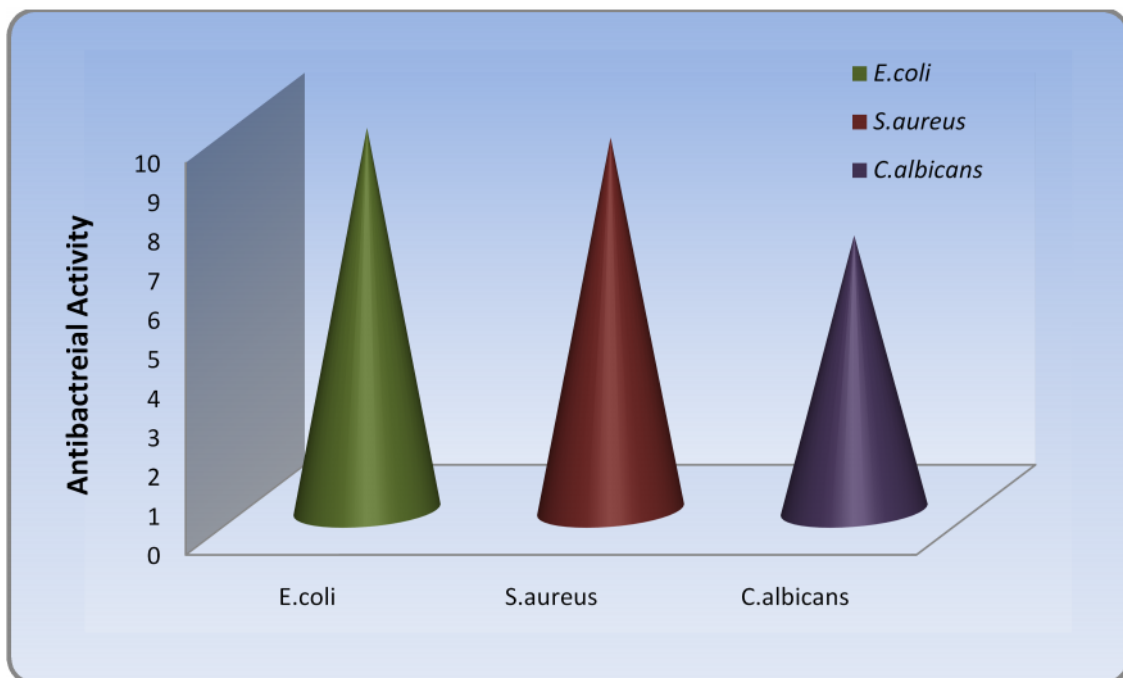
From the above Table –IX and Figure – 16 show the antibacterial activity of treated extract finished fabric. The zone of inhibition of 9.75 mm *Escherichia coli* and 9.5 mm for *staphylococcus aureus* and 7 mm *candida albicans* is seen in the treated sample. This is higher than the TCF sample.

Hence it could be concluded that the fabric exposed to cactus fruit extract has the maximum has inhibition and antimicrobial activity.

**Figure - 15**  
**Fabric stiffness weft Direction**



**Figure - 16**  
**Antibacterial Activity of Extract Treated Fabrics**



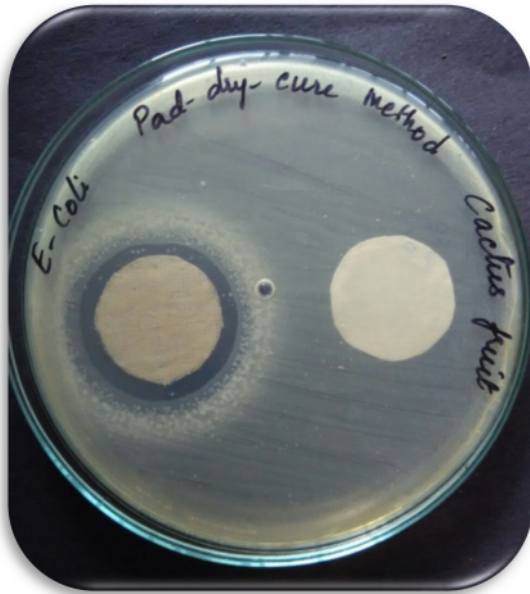
#### 4.4 Assessment of Bandage Test

The prepared bandage was tested for water and ether soluble matters and present in Table below.

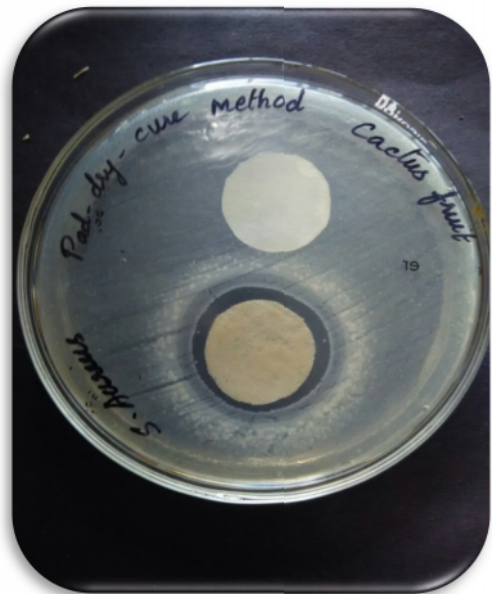
**Table - XX**

<b>S.No</b>	<b>Samples</b>	<b>Cotton Woven Cloth</b>
1	Water Soluble Matters	2.96
2	Ether Soluble Matters	0.28
3	pH of Aqueous Extract	6.38
4	pH of Water used	6.85
5	Present of Surfactants	present

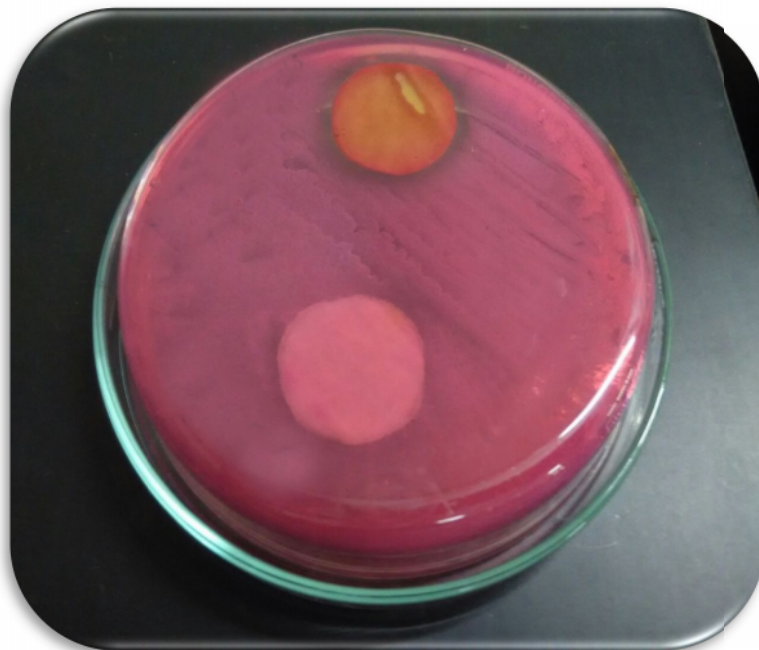
From the above table it is clear that the bandage had high water soluble matters (2.96%) when compared to there soluble matters (0.28%). The pH of the bandage in Aqueous Extraction and water used was similar as 6.38 and 6.85, which is close to netural. Therefore it is clear that bandage will not cause irritation to wound and it will be above to absorbs water soluble matters.



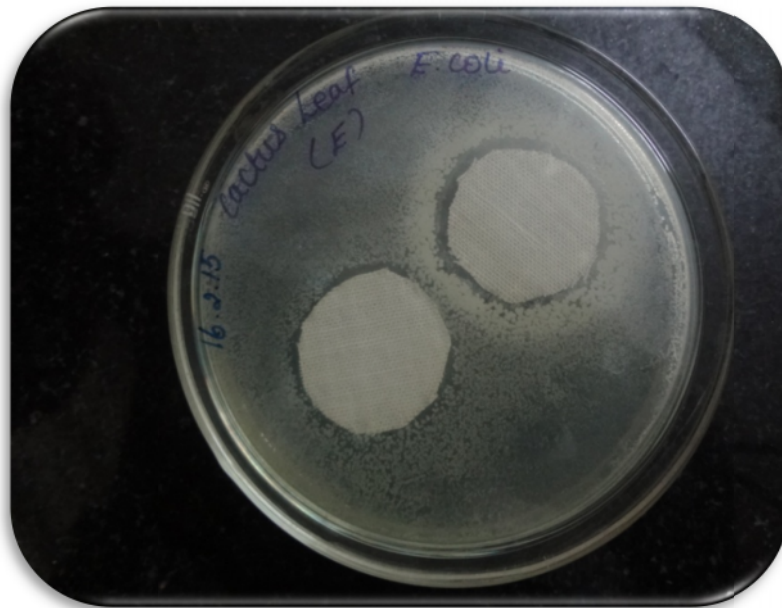
**Plate – XVIII**  
***Cactus Fruit E.coli***



**Plate – XIX**  
***Cactus Fruit S.aureus***

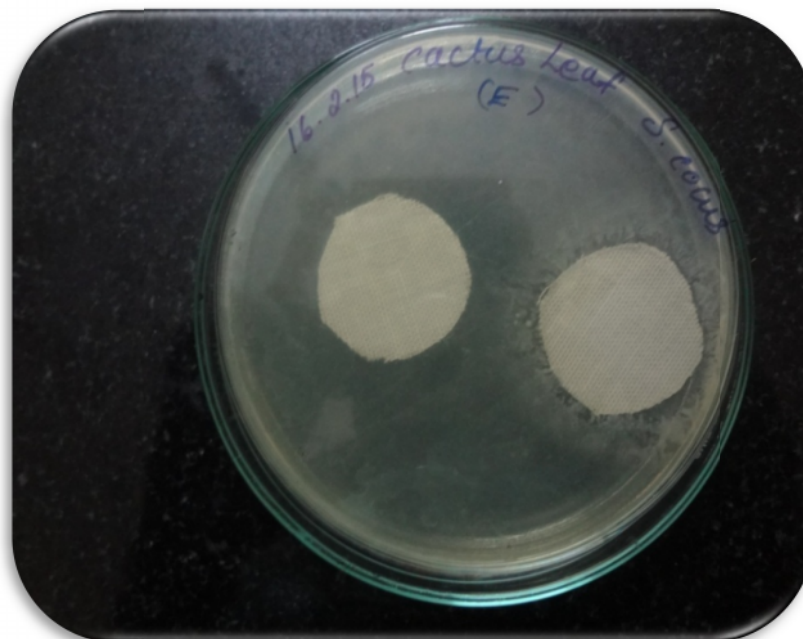


**Plate – XX**  
***Cactus Fruit Candida albicans***



**Plate - XXI**

***Cactus Leaf E.coli***



**Plate - XXII**

***Cactus Leaf S.aureus***

## 5. SUMMARY AND CONCLUSION

Textiles have a long distinguished history in the Indian subcontinent. It is one of the basic necessities of mankind. Textile materials are formed by weaving, knitting, crocheting, knotting and pressing fibers together, the history of textile is almost as old as that of human civilization and as time moves on the history of textile has further enriched itself. Textiles and Clothing should fulfill the functional, comfort, aesthetic, soft and ecological requirements. Textiles have always played a role in the evolution of human culture by bringing at the front of both technological and unpleasant odour can rise from the acquisition of a variety of compounds produced in body fluids. Nature provides numerous health benefits to humans. Many people believe that natural products are always safe and good for them. Herbal medicines are one type of dietary supplement, maintain or improve human health. They are eco-friendly, biodegradable and renewable.

The word “Bandage” is often used for dressing, which is used for directly on a wound bandage is technically used to support a wound dressing bandage. A bandage is a piece of material used either to support a medical device such as dressing or splint, or on its own to provide support to the body; it can also be used to restrict a part of the body. The most common type of bandage is the woven strip of material to a absorbent barrier to preventing adhering to wounds, a bandage can come in number of widths and lengths, can be used for almost any bandage is type of wound range of blanket material.

Microbial infestations posses danger to living and non-living matters. Antimicrobial textiles with improved functionally find a variety of applications such as health and hygiene products, specially the garments worn close to the skin and several medical applications, such as infection control and carrier material. There is a great demand for antimicrobial textiles based on eco-friendly agents which help to reduce effectively the ill effects associated due to microbial growth on textile material. The herbal antimicrobial agents cannot transmit any harmful pollutants and they are free from harmful chemicals.

Cactus plant is also known for its medicinal values. Hence an attempt was made to study its antibacterial effects with cactus leaf and fruit extract. The pilot study was conducted with the samples that were treated with varying like concentration, time, temperature and ph parameters. Then the herbal finishing agent was optimized and applied on cotton fabric using padding mangle technique. Then it was evaluated objectively. The objective test included the physical, mechanical, absorbency, comfort property tests and antibacterial tests.

Hence the present study was carried out to “Antimicrobial Effect of Cactus Plant Extracts on Cotton Fabric” with the following objectives are to

- To extract the herbal solution from Cactus plant
- Optimize various parameters for application cactus extract on cotton fabric
- Evaluate the antimicrobial activity on herbal extract finished cotton fabric
- Development of bandage using cactus fruit extract

## **Methodology**

The methodology of the study was undergone in the following sequence

- Selection of fibers

Cotton fabrics were selected for the study for its advantageous properties such as natural antibacterial activity and high absorbency

- Selection of source

Considering the antimicrobial properties of cactus plant was selected as the source for finishing.

- Pilot study to select the part of the cactus plant with maximum antimicrobial activity was carried out.

Cactus leaf and fruit were collected from rural areas in Coimbatore. The extracts were obtained using the suitable solvents in soxhlet apparatus. Based on the zone of inhibition fruit extract was selected for the study.

- Selection of solvent

Ethanol was found to penetrate easily into the cellular membrane to extract the intracellular ingredients from the plant material.

- Selection of Extraction Technique

The active compounds from herbs were extracted by hot continuous Soxhlet extraction method. This method was selected because this requires only minimum amount of solvents and the solvents.

- Preparation of plant source extract

The source Cactus fruit was collected from the dry rural areas in Coimbatore, washed and shade dried for four days, further extraction was carried in soxhlet apparatus after solvent of source. The solvent source was placed in the thimble.

- Selection of bacterial species

*Staphylococcus aureus*, gram positive and *Escherichia coli*, gram negative bacteria were selected to identify the bacterial activity in the treated fabric.

- Agar Diffusion method

A small volume of the culture was swabbed in the petri plate is an easy and direct way of achieving the result. Qualitative assessment was done by the zone of inhibition.

- Procedure for antimicrobial test

The original and treated samples were placed at the center of the petri plate and incubated for 24 hrs. The zone of inhibition that forms around the fabric samples reveals the antibacterial activity of the samples.

- Nomenclature of the samples

## Nomenclature

S.No	Samples	Code
1	Original fabric	OF
2	Original desized fabric	ODF
3	Treated Cactus fruit	TCF

- Pilot study

A pilot study was conducted to check the antimicrobial activity of ethanol extracts qualitatively by using the AATCC test method.

- Optimization

The concentration of the extract was optimized based upon the antimicrobial activity. The AATCC agar diffusion method was adopted. The zone of inhibitions was recorded for each solution. The concentration that corresponds to the largest zone was decided as the optimized concentration

- Optimization of concentration

The extract was diluted using water in a beaker for three different concentrations 20, 30, 40 percent. The fabric sample was impregnated with extract of varied concentrations and it was subjected to antimicrobial tests.

- Optimization of temperature

Three different temperatures 30, 45 and 60<sup>0</sup>c were chosen for optimization keeping time and concentration as constant. The extracts were applied on fabrics in these three temperatures.

- Optimization of time

The temperature and concentration were kept constant for different timings such as 15, 30 and 45 mins. The fabric samples were treated with the extract for these three different time durations.

- Optimization of parameters

The herbal extraction solution is mixed with water in the optimized concentration and the temperature was maintained at 45<sup>0</sup> c for 15 minutes.

- Selected Parameters for the Study

The parameters selected for the study are concentration of herbal solution 30%, temperature 45<sup>0</sup> c, time 45 mins and M:L ratio 1:6.

- Finishing the selected fabric

The padding mangle was made to run at a speed of 15 min. After padding, the fabric was then cured for 3 minutes at 140°C. The cotton fabric was cut to 15" width and 36" length. The extracted fruit were taken. One end of the wetted fabric was immersed into the solvent and then passed the fabric was made through the rollers in between the two rollers. The excess source was removed and the process was continued for 3 to 5 times for good and even penetration of the extracts. Then the fabric was taken out and allowed for drying in shade.

- Evaluation of antimicrobial effect

Staphylococcus aureus, gram positive and Escherichia coli, gram negative bacteria's were selected to identify the bacterial activity in the treated fabric. Nutrient agar was prepared and sterilized. It was poured in the petri plate which was allowed to solidify. The test organism was evenly swabbed on sterile plates with the culture taken from the mixture. The original, treated samples were placed at the centre of the petri plate and is incubated for 24 hours at 37<sup>0</sup>c. The zone of inhibition that forms around the fabric samples reveals the antibacterial activity of the samples.

- Bandage Preparation

In order to prepare the cactus fruit extract the bandages are commercially available on strip type of bandages were purchased. The treated fabrics were cut in suitable sizes. The cut fabrics were kept in the laminar air flow and placed in between the stripped bandages to sterilized.

### **Finding of the Research work**

- The visual inspection among the fabric samples revealed that the general appearance, evenness of finishing, brightness of shade of the samples were rated as excellent by the evaluators, when compared with original fabric.

### **Assessment of physical properties**

- The fabric weights of the ODF cotton sample had minimum weight of 7.52 percent and maximum weight of 7.61 percent was shown in TCF. The is significant at one % level.
- The fabric thickness of the ODF cotton sample had minimum thickness of 3.84 percent and maximum thickness of 19.23 percent was seen in TCF. F value was not significant.
- The fabric count in warp and weft of ODF cotton sample had minimum count of 7.07 and 5.81 percent and maximum count was in 8.84 and 6.97 percent in TCF respectively. The data was significant at one percent level.

### **Assessment of mechanical properties**

- The fabric tensile strength in warp and weft of ODF cotton sample had minimum strength of 9.82 and 21.37 percent and maximum strength of 26.72 and 28.27 percent was seen in TCF. Statistically the data was a significant at one percent level.
- The fabric elongation in warp and weft of ODF cotton sample had minimum elongation of 2.5 and 3.44 percent and maximum elongation of 4.50 and 4.59 percent was observed in TCF. Elongation in warp has no significant F value, where the weft is significant at one percent level.
- The abrasion resistance of the ODF cotton sample had minimum abrasion of 11.62 percent and maximum of 13.37 percent was present in

TCF. It was statistically proved that there was one percent significant in data values.

### **Assessment of absorbency properties**

- The drop test of the ODF cotton sample had minimum absorbency of 31.71 percent and maximum absorbency of 52.01 percent was seen in TCF. It is also statistically proved to be significant at one percent level.
- The sinking test of the ODF cotton sample had minimum absorbency of 66.72 percent and maximum absorbency of 79.78 percent was present in TCF sample. There was one percent significant as per F value.
- The wicking test of the ODF cotton sample had minimum absorbency of 28.78 percent and maximum absorbency 34.14 percent was observed in TCF. Statistically analysis proved the data to be significant.

### **Assessment of comfort properties**

- The drapability test of the ODF cotton sample had minimum drapability of 6.72 percent and maximum drapability of 7.21 percent was present in TCF sample. It is clear that drapability of the samples has increased when compared with original sample. It is also statistically proved to be significant at one percent level.
- The stiffness test in warp of ODF cotton sample had minimum stiffness of 9.58 percent and maximum stiffness of 10.27 percent was depicted in TCF. It is clear that stiffness of the samples has increased when compared with original sample. Statistically analysis proved the data to be in significant.
- The stiffness test in weft of ODF cotton sample had minimum stiffness of 15.78 percent and maximum stiffness of 21.05 percent was portrayed in TCF. It is clear that stiffness of the samples has increased when compared with original sample. There was no significant difference for the stiffness property.

### **Assessment of anti-bacterial properties**

- The anti-bacterial activity of the treated fabric was found to exhibit maximum zone of inhibition in sample TCF about 9.75 mm in *E.coli*, when compared to OF.
- The anti-bacterial activity of the treated fabric was found to exhibit maximum zone of inhibition in sample TCF about 9.5 mm in *S.aureus*, when compared to OF.
- The anti-fungal activity of the treated fabric was found to exhibit maximum zone of inhibition in sample TCF about 7 mm in *C.albicans*, when compared to OF.

### **Assessment of Bandage**

From the water / ether soluble test and ph values in aqueous water and water used it is clear that the bandage will not cause irritation.

### **Conclusion**

The present research work has focused upon the use of plants for textile functional finishing based upon the plants extract core property. Cactus fruit extract has proven on cotton, to be an effective finish which could used as medical textiles. The results has opened new phases for production of medical textiles.

### **Limitation of the study**

- Due of time constrains the study was stopped with development of bandage and animal ethical tests.

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### **Website**

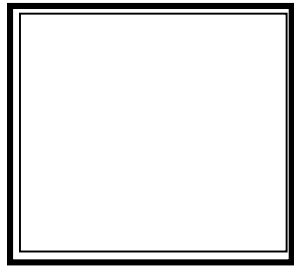
[www.fiber2fashion.com](http://www.fiber2fashion.com)

[www.technotex.gov.in/testing/20 method.pdf](http://www.technotex.gov.in/testing/20%20method.pdf)

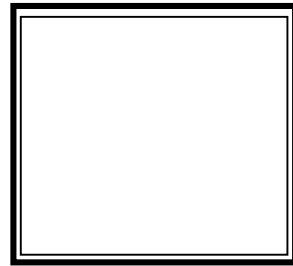
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## APPENDIX – I

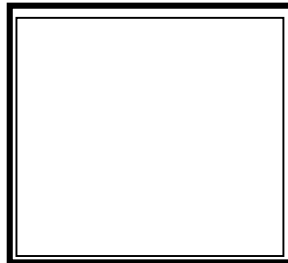
### DETAILS OF THE SELECTED FABRIC



**ORIGINAL COTTON**



**DESIZED COTTON**



**TREATED FABRIC**

**APPENDIX - II**



**UV TREATED BANDAGE**

**APPENDIX – III**  
**VISUAL INSPECTION**

S.No	Sample	General appearance		Texture			Luster		Evenness of finishing		color	
		Good	Bad	Smooth	Moderate	Rough	High	Medium	Even	Uneven	Bright	Dull
1	OF											
2	TCF											



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Tamil Nadu

Customer Reference : dt.12.03.2015  
Date of Receipt of Samples : 13/ 3/ 2015  
Test Report No. : **CHTR-3714**  
Sample Identification : CC7465

Sample No.	CC7465			
Sample Particulars	Cotton			
	Woven Cloth			
Water soluble matters, % by mass	2.96			
Ether soluble matters, % by mass	0.28			
pH of Aqueous Extract	6.38			
pH of Water Used	6.85			
Presence of Surfactants	Present			

Encl : Bill



**IMPORTANT**

*S. Sharmila Devi*  
HOD/Lab Incharge Textile Chemistry

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