Assessment of Antimicrobial Activity of *Carica papaya leaves in Khadi fabric*

Dhanalakshmi.P

(14PTF003)

A Thesis Submitted to the

Avinashilingam Institute For Home Science And Higher Education For Women

Coimbatore -641043.

In Partial Fulfillment of the Requirements for The

Degree of Master of Science in Textiles and Fashion Apparel

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Signature of the Head of the Department

Signature of the Guide

ACKNOWLEDGEMENT

First and foremost, the investigator places her humble salutations at the feet of **GOD ALMIGHTY** who has given sound wisdom, knowledge, strength and the opportunity to do the investigation effectively.

The investigator expresses her immense gratitude and thanks to **THIRU.Dr.T.S.AVINASHILINGAM AYYA**, Founder and First Chancellor of Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, and **HONY.COLONEL PADMASHRI Dr.(Tmt) RAJAMMAL P. DEVADAS**, M.A., M.Sc., Ph.D. (Ohio State), Hon. D.Sc. (Azad Agri. University), (Kanpur), Former Chancellor, Avinashilingam Institute for Home science and Higher Education for Women, Coimbatore, for providing and shaping this temple of learning.

The investigator wishes to express her immense gratitude to **PADMASREE Dr. (Thiru) P.R.KRISHNAKUMAR,** Chancellor and **Dr.(Thiru) MEENAKSHI SUNDARAM,** M.A., M.Phil., Ph.D. (HonorisCaussa),Anna Avl., Former Chancellor, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, for the opportunity to conduct research in this esteemed university.

The investigator owes her deep sense of gratitude and thanks to Dr.(Tmt SHEELA RAMACHANDRAN), M.Sc, P.G.Dip., Ph.D (Avinashilingam), Vice Chancellor and **Dr. (Tmt) PREMAVATHY VIJAYAN**, Vice-Chancellor, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, for providing all the amenities required and for her immense support in the conduct of the study.

The investigator owes her respectful regards and sincere thanks to **Dr (Tmt) A.VENMATHI**, M.Sc., Dip. Ed., M.Phil., Ph.D., Registrar In Charge, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, for her encouragement towards the research.

The investigator records her respectful regards and tribute to **Dr.(Tmt.) N. VASUGI RAAJA**, M.Sc., M.B.A., M.Phil. (Madras), Ph.D. (Avinashilingam), Dean, Faculty of Home Science, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, for her encouragement and valuable help during the progress of her study.

She expresses her respectful regards and sincere thanks to **Dr.(Tmt)S.AMSAMANI**, M.Sc, M.Phil. Ph.D. Professor and Head of the Department of Textiles and Clothing, Avinashilingam Institute for Home Science and higher education for women, Coimbatore for rendering all help neede for the successful completion of the study.

The investigator feels immensely indebted and extremely privileged to have worked under the supervision of her esteemed guide, **Dr. (Tmt)R.Prabha**, M.Sc., M.Phil., Ph.D., Assistant Professor, Department of Textiles and Clothing, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, for her valuable guidance, technical support, timely help and constant encouragement throughout the study.

The investigator expresses her deep sense of gratitude to all the **STAFF MEMBERS** of the Department of Textiles and Clothing, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, for being supportive, suggestive, understanding and their encouragement rendered towards the completion of her study.

The investigator express her special thanks to librarian for the facilities provided.

The investigator owes her sincere thanks and gratitude to her beloved parents, her sister and brother, for their enthusiasm, co-operation, love, care, support, constant encouragement, blessings, prayers and help rendered and moral support for the successful completion of the study.

Last but not the least, the investigator extends her thanks to her friends and their family members for their constant prayers, support and encouragement.

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1. INTRODUCTION

The word textile used in the literal meaning/use of it a person thinks of is the apparel fabric, but basically textile is beyond that. Textiles are formed by weaving, knitting, crocheting, knotting or pressing fibres together by the name of felting(Tripti,2012) .Textiles, defined as felt or spun fibres made into yarn and subsequently netted, looped, knit or woven to make fabrics, appeared in the Middle East during the last stone age. From ancient time to the present day, methods of textiles production have continually evolved and the choices of textiles available have influenced how people carried their possessions, clothed themselves, and decorated their surroundings (Anita, 2011).

The textile industry is one of the nation's oldest and dynamic segments of an entire manufacturing industries (Nadaraj, 2008).Textile industries in India are the backbone of the national economy .It is the largest industry in India ,occupying a vital role in the Indian economy and occupies a unique place in the country. Its accounts for 14 percent of the total exports and is the second largest employment generator after agriculture. In India, the textile industry contributes substantially to the foreign exchange and also second largest producer of raw cotton, cotton yarn, cellulosic fibre and yarn and silk. It is the third largest producer of synthetic fibres and yarn. It has the pride of place as the largest producer of jute (Malik,2008).Due to increasing requirements on the finishing of textile fabrics ,increasing use of technical textiles that have been processed by environmentally sound methods, new innovative production techniques are demanded (Rain et.al,2007) .

Both industrialized and developing countries now have modern installations capable of highly efficient fabric production. At the same time the mechanical improvement also occurs in yarn and fabric manufacture, there have been rapid advances in development of novel fibres and processes to improve textile characteristics. The testing methods allowing greater quality control. The modern textile industry is still closely related to the apparel industry, but production of fabrics for industrial use has gained in importance. The resulting wide range of end uses demands a high degree of specialization (Seema, 2012). The demand for textiles is considerably influenced by numerous factors such as changes in income, growth in population, changing in lifestyle, climatic conditions and fashion cycles. The changes in textile manufacturing segments, by the way of fibre base ,development ,diffusion of technology location and integration trade are primarily a response to shifting consumption patterns, further modulated by local variations in factor endowments(Sasmila et.al,2006).

Khadi is a hand spun and hand woven fabric involving a labor oriented processes. The process is believed to be 5000 years old having its roots from ancient India. Basically this fabric made from cotton which are locally available and harvested by peasants and laborers especially women. It is woven into cloth by men from various specialist weaving castes and worn by peasants and artisans in pre-industrial India. The precise technology involved in the production of khadi and its decoration (dyeing, embroidery, printing, etc.) vary from place to place .Usually khadi fabric light, and soft making it comfortable to wear. Its weave create air pockets which make it cool in summers and warm in winters. The handcrafted self-texture make each khadi cloth unique and expensive. The inherent strength of khadi makes it highly durable. By using khadi fabric associated with many advantages. It provides employment to weavers, financial support to farmers and eco friendly and healthy. Inspite of all the benefits provided by khadi, Its sale is dwindling day by day due to stiff competition from mass-produced fabric in domestic and foreign markets (Ashish kumar, 2016).

In textile manufacturing, finishing refers to the processes that convert the woven or knitted cloth into a usable material and more specially to any process performed after dyeing the yarn of fabric to improve the look performance or Hand of the finished textile or clothing. Textile finishes are important because it help to improve the appearance of fabric and enhance its looks. It produces variety in fabric through dyeing and printing (Shuklaet al., 2008).

Today dyeing is a complex, specialized science. Nearly all dyestuffs are now produced from synthetic compounds. This means that costs have been greatly reduced and certain application and wear characteristics have been greatly enhanced. But many practitioners of the craft of natural dyeing (i. e using naturally occurring sources of dye) maintain that natural dyes have a far superior aesthetic quality which is much more pleasing to the eye. In many of the world’s developing countries, natural dyes can offer not only a rich and varied source of dyestuff, but also the possibility of an income through sustainable harvest and sale of these dye plants. Many dyes are available from tree waste or can be easily grown in market gardens. In areas of synthetic dyes, mordant (fixatives) and other additives are imported and therefore relatively expensive, hence natural dyes can offer an attractive alternative (Tripti, 2012).

Natural dyes have been known and used for thousands of years without any report showing that they are harmful. Presently many research and developments are involved to explore all the possible source of natural dyes. Use of natural dyes in coloration of textile material is just one of the consequences of increased environmental awareness (Pant et, al.1999).Recently, a number of commercial dyers and small textile export houses have started looking at the possibilities of using natural dyes for regular basis dyeing of textiles to overcome environmental pollution caused by the synthetic dyes (Samanta,2009).

Finishing is the final stage of fabric processing. It covers a wide range of processing which make unattractive,' greige' fabric turn into an attractive one. There is chance to apply the finishes during the textile production in different stages (Seema Sekhri, 2011). Finishing is one of the most important aspects that enhance good appearance and feel of the fabric. Eco friendly finished functional textiles are non toxic and free in nature.

Micro organisms are ubiquitous in nature and are present on human body which are termed as natural flora. Rapid and uncontrolled growth of microorganisms hampers hygiene and personal health. Microorganisms cause problems with textile raw materials and processing chemicals, wet process in the mill, roll or bulk goods in storage, finished goods in storage and transport and goods as consumer uses them. Microbial growth on textiles triggers degradation of textile leading to microbial strains and discolouration of textiles. It also generates unpleasant odours, skin infections and allergies. The consumers are now increasingly aware of the hygienic life style and there is a necessity and expectation for a wide range of textile products finished with antimicrobial properties (Manasi, 2014).

The term antimicrobial encompasses agents that can act against specific group of microorganisms. This finishes applied to the textiles protects both textile substrate and user. Antimicrobial finished textiles find application in sport textiles, medical textile bandages, healthcare sector and leisure (Manasi, 2014). The antimicrobial finishing resists the growth of odor causing bacteria arising in the human body use of apparel and home textile .Antimicrobial treatment is need for textile materials, in order to control micro organisms. The humid and warm environment conditions are encourage the growth of micro-organism in the fabric which are in contact with the human body provide and ideal environment for microbial growth. Infestation by microbes can cause cross –infection to the humans and the development of odor when the fabric is worn next to skin (Dinesh et.al, 2011).

Papaya is well known for its food and nutritional value throughout the world. Papaya also known as traditional system of medicine because of its medicinal property in a papaya fruit and other parts of the plant. Carica papaya leaves belongs to the family caricaceae; it's also known as pawpaw, papaya, papayer, pepol, tinti, chich, put, fan, kua, wan shou kuo, kavunagaci, kepaya etc (Kafaru,1994). The carica papaya leaves has been found to be remove the stain which are to be used as soap substitute. Dietary papaya does reduce the urine acidity in humans while the flowers have been used for jaundice (REED, 1978).This plant having the important role of medicinal usages. Based on this many of the countries are used for their different purpose. Based on the many studies, this plant having antimicrobial property .Around the world many of the people are used as therapeutic alternatives because of their antimicrobial properties (Adriana, 2007).

Considering the above facts the investigator selected the research work on the topic**,** **"Assessment of Antimicrobial Activity of C*arica papaya leaves in Khadi fabric*"** with the following Efficacy objectives;

- To select the plants for antimicrobial finish
- To extract the dye from selected *carica papaya leaves*
- To dye the selected fabric with selected plant extract
- To evaluate the dyed khadi fabric
- To study the standard testing method for antimicrobial fnished fabrics

2. REVIEW OF LITERATURE

The review literature pertaining to the study entitled **“Assessment of Antimicrobial Activity of *Carica papaya* leaves in Khadi fabric”** is discussed under the following aspects:

2.1 Khadi

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2.1.2 Khadi Post Independence

2.1.3 Benefits of Khadi

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2.1 Khadi

"Khadi" is a Handspun and Hand woven cloth which is made on a machine used by hand to weave cloth for people living in the villages-"A Handloom" An Indian homespun cotton cloth (Joshi, 2002).

2.1.1 History of Kadhi

Khadi became a symbol of freedom struggle."Livery of Freedom" as Nehru described Khadi and it was referred by Mahatma Ghandi. Khadi was introduced in 1920 as a political weapon for the boycott of foreign goods in general and cloth in particular and thus stimulate in every Indian a desire for independence as well as attitude of self-discipline. Khadi was a vital part of non-cooperation movement. Gandhiji was always alive and conscious about the economic aspects of Khadi. He, therefore, emphasized the economic value of Khadi, as a means of finding work of spinners and weavers, as a means of relief from evil of widespread unemployment. Slowly, a separate Board called the All India Khadi Board was established in December, 1923, but this continued to be an integral part of the congress organization and worked under its direction and supervision (Sekhri, 1992).

Khadi was conceived in 1920's as a symbol of swadeshi movement and self-reliance of the village. Simplictiy , swadeshi spirit and decentralization are embodied in khadi. It was practical attempt to relieve the poverty and uplift of the standards of Indian village people. In 1919, when there was a movement to boycott foreign goods, Gandhiji appealed to his countrymen to adopt Khadi. At the same time of Nagpur session the Indian National Congress decided to encourage Khadi (Sekhri, 1992).

The All India Spinner's Association also known as Akhil Bhartiya Charkha Sangh, was formed in 1925.Though this body was closely associated with the Indian National Congress, it was completely autonomous in its working. Till 1935 the Association concentrated its activities on propagation, production and sale of Khadi. The main objectives of this association was that Khadi could have "a permanent effect only when carried out as a part and parcel of the wider program of non-violence village uplift or village reconstruction" (Nanda, 1935).

The available Khadi was converted into clothing and in few days 108 type of cloth articles were prepared and displayed in Khadi shop. To meet the demand of stitched clothing which was increasing, a stitching section was opened in Khadi Bandhar. Initially only the fabric which could not be sold on the counter and then the fabic converted into clothes, later concept changed. The fabric was produced not only to be sold in yardage but also to be converted into clothes. This led to increase in sales and giving the world readymade clothing in KHADI (Swaroop, 2002-2003).

2.1.2 Khadi Post Independence

Khadi represented a powerful symbolic challenge to british imperialism, but Indians never realized it even after Independence .During the freedom struggle many had worn Khadi more for its political effectiveness than for love of the cloth, just as many had spun their own yarn more out of self-sacrifice and national duty than out of belief in the economic and moral benefits of hand spinning. The history of Khadi's revival in the 20th and 21th centuries reveal the ongoing tension between capitalist development and a Gandhian style modernity based on alternative economic and moral principles .Khadi may not become the popular every day wear that Gandhi hoped it would be, it is likely that it will retain its important symbolic role in providing an alternative vision of modernity and evoking the texture and uniqueness of India's Freedom Struggle (Verma, 2012).

2.1.3 Benefits of Khadi

Khadi is hand woven and hand spun fabric which takes time to be made .One of the most beautiful hand spun and hand woven Indian fabric, Khadi has the added value of allowing more air penetration. The hand woven fabric forms air pockets in the fabric due to the thick and thin places created during hand spinning and is therefore, cooler, softer, more absorbent and breathes better than highly uniform and compact machine made fabrics. The added breathability means the fabric will stay cooler in summer and warmer in winter. Hand woven fabric also has a textural beauty and visible character (Babji, 2009).

Khadi cotton is a very strong fabric even when it is wet, so it holds up very well to repeat laundering. It has a handcrafted self texture making each Khadi cloth unique and expensive.

Certain fine Khadi such as mulmul has a translucent quality .Khadi silk is priced for its richness and sheen .Different Indian states produces different varieties khadi. In cooler Northern state woolen Khadi is produced whereas in Madhya Pradesh special weaves such as Tussar silk are made. Khadi today is dyed in a variety of cooler and decorated by block prints, it is tied and dyed ,block printing to give it beautiful surface (Babji,2009).

2.1.4 Study related to Khadi

Cloudy effect on Khadi fabric using tri functional reactive dyes was developed and compared with tie and dye .It was tested for colorfastness towards sunlight, washing, rubbing, ironing and dry-cleaning. It was found that the cloudy and tie and Dye effect has excellent fastness properties towards washing, dry cleaning, ironing, rubbing and sunlight (Suneet,2007). Wrinkle-recovery treatment to Khadi and handloom fabrics in the form of functional finish for value addition to the product of handloom cotton and hand spun and hand woven Khadi was done to have a real financial upliftment for the artisans by way of higher consumer preference (Balakrishnan, 2007). A study were conducted on Anti crease Finishes on comfort properties of Khadi fabric. Various experiments were done (Sugandhi, 2007).

The designing of Khadi suits were done by combining Embroidery with other embellishment Techniques. The main objective of the study was to provide novelty and variety in designs and promote Khadi giving it a more gracious and Luxurious look to the salwar suit using sequins, mirror, patchwork, printing etc. and evaluate the acceptability of developed designs (Garg, 2007). The study has been done on "Creating fantasies on Khadi belts". The investigations was planned to design Khadi belts. Different shapes, surface enrichment techniques and embellishment material of earlier times were combined with an ethic as well as trendy look (Singh, 2007).

The various studies of design development in Khadi have also been done (Bajpai, 2007). Carried out a study on Effect of different de-sizing methods on the comfort and physical properties of Khadi. Value addition on Khadi suits (Mittal, 2007).Adaption of Mughal carpet motifs for designing for Khadi suits was done by (Kumari, 2007). (Rawat, 2006-2007) Worked on designing of Khadi Trousers and Capri's. In case of all the above studies the acceptance of the developed product was very good.

2.2 Medicinal Plant

Medicinal plants have been used from ancient time for their medicinal values as well as to impart flavor to the food. Nowadays, the crude extracts and dry powder samples from medicinal and aromatic plants and their species have been showing interest in the development and preparation of alternative traditional medicine and food additives (Karadogan, 2004). Medicinal plants are reservoirs of various metabolites provide unlimited sources of important chemicals which is having the biological presents and also represents a rich sources from which antimicrobial agents can be obtained (Timothy et al., 2011).

Plants are the most naturally effective and cheapest sources of drugs (Pretorious et al.,2001,Prince et al.,2011 & Mathur et al.,2011).The use of local plant as primary health remedies ,due to their pharmacological properties, is fairly common in Asia, Latin, America, USA, China ,Japan, and Africa (Bibitha et al.,2002). The plant kingdom synthesizes diverse active compounds which are valuable in the treatment and control of many disease .These compounds are principally secondary metabolites. Some of the active compounds do occur singly or in combination with other inactive substances which inhibit greatly the life processes of microbes, especially the pathogenic microbes. Medicinal plants are cheap and renewable source of pharmacologically active substance (Basile et al.,1999)

Infectious diseases are given to the more threat to human health around world. Due to this is disease almost 50,00 deaths are happen in everyday(Ahmad et al.,2001).Antibiotics are currently used because there is a emergence of resistance strains of pathogenic microorganism has continued to pose a major health concern the effectiveness of several drugs(Timothy et al.,2011).The usage of antibiotics which is resistant to pathogenic microorganisms ,there is increasing rate will be developed ,it has led to make search for newer ,more effective, affordable and readily available sources, especially, which are easily available from local medicinal plant(herbs) (Adekunle et al.,2009).

2.2.1 *Carica papaya*

Carica papaya leaves belongs to the family caricaceae; its also known as pawpaw, papaya, papayer, pepol, tinti, chich,put, fan, kua, wan shou kuo, kavunagaci, kepaya etc. The whole plant having the bioactive compound which include the leaf, fruit, seed, latex, root, etc.

The plant is describes as a fast growing erect; usually this plant grows 7-8m tall with copious late trunk of about 20 cm in diameter usually un branched tree shrub. The plant act as analgesic, amebicide, cardiotonic, cholagogue, digestive, emenagogue, febrifuge, hypotensive , laxative, pectoral, stomachic and vermifuge, antibacterial, which refer to these plant described as a form of documented property. This documented property forms are distributed throughout Asia, Nigeria, etc (Afolayan,2003). This plant was preferred for the therapeutic purpose because of it having the highest amount of concentration of these component (Karafu,1994).Each part of the plant having the active component may be vary from structure to structure .During the last few decades the significant development has been achieved regarding the therapeutic property of papaya (Udoh et al.,2005).

2.2.2 Bioactive compounds occurs in *Carica papaya*

Carica papaya having a two important bioactive compounds which includes the chymenopapain and papain . The papin is a bioactive compound which is used for treatment of arthritis. The papin,the proteolytic enzyme has a wealth of industrial uses and it is used also used in medicine compacting dyspepsia and other digestive order because of its wide pH range .It also has milk clotting (rennet) and protein digestive properties (James, 1983)The papaya leaf extracts having phenolic compound such as protocatechuic acid, p-coumaric acid,5,7-dimethoxycoumarin,caffeic acid, kaempferol, quercetin and chlorogenic acid (Romasi et al.,2011;Peter et al.,2014). The chemical compound of karpain, has been found in the leaves of papaya plant which compounds are to kill the microorganisms often interfere with digestive function. Papaya leaves are to be used as a treatment of malaria. The activity of antimalarial and antiplasmodial has been noted in the preparation of the plant (udoh,et.al.,2005).

Papain is also used in a preparatory process like degumming of natural silk. The bioactive compound of papain is mostly imported to US and it is used for the preparation of chewing gums and to tenderize the meat. Also used to extract the oil from tuna liver cosmetically. It is used in some dentifrice, shampoos and face lifting preparations .Use to cleat silks and wools before dyeing and to remove hair from hides during tanning (James,1983).

2.2.3 Application of *Carica papaya*

This plan having the important role medicinal usages. Based on this many of the countries are used for their different purpose (Morton, 1977). In Nigeria this plant is used for the treatment of smooth upper respiratory tract ailment and tumour (uterus). In Honduras and Turkey, it is used for liver ailments, constipation and laxative .In Philippines, India, Malagasy and Malaya, it is used for treating arthritis and rheumatism. In Java, Panama, Srilanka and Turkey, it is used for treating abortifacient. In Honduras, Japan, Panama and West Africa, it is used for the treatment of diarrhea and dysentery (satrija, 1994). The carica papaya leaves has been found to be remove the stain which are to be used as soap substitute. Dietary papaya does reduce the urine acidity in humans while the flowers have been used for jaundice. The young leaves and to lesser degree other parts contain carpain an active bitter alkaloid which has a depressing action on heart. The plant is strong amoebicide (REED, 1976). There are many reports available which demonstrate the wound healing property of the papaya leaves. In addition, papaya leaves possess antibacterial activity which might prevent the multiplication of wound-infection- causing bacteria. With this in mind, the present investigation was undertaken to predict the antibacterial properties of papaya leaves against some wound-infection causing pathogens and to justify plant-based compounds could replace synthetic ones (Aruljothi,2014). Based on the many studies, this plant having antimicrobial property .Around the world many of the people are used as therapeutic alternatives because of their antimicrobial properties (Adriana et al.,2007).

2.3 Natural Dyeing

2.3.1 Natural dyes in textile

Today, natural colourants that are safer and eco friendly in nature are emerging globally, leaving synthetic colourants behind in race. These have been used for textiles for a long time. Natural dyes exhibit better for a long time. Natural dyes exhibit better biodegradability and are generally more compatible with the environment (kumar et al.,2004 & chan et al., 2002). Natural dyes have a wide range of shades, can be obtained from various parts of plant including roots, bark, leaves, flowers, and fruit (Kumar,2004).

Natural dyes produce very uncommon, soothing and soft shades as compared to synthetic dyes. On the other hand, synthetic dyes are widely available at an economic price and produce a wide variety of colours; these dye are produce skin allergy, toxic wastes and other harmfulness to human body.

In response to the "green" movement and ecological campaigns, some dye manufactures might be re-considering the feasibility of adopting natural dye in lieu of synthetic dye in dying process (kumar et al., 2004 & chan et al., 2002) .Worldwide the use of natural dyes for the colouration of textiles has mainly been confined to craftsman, small scale exporters and producers dealing with high value eco-friendly textile production and sales (Deo et al.,1999 &vankar,2000).Recently, there has been revival of the growing interest on the application of natural dyes on natural fibres due to worldwide environmental consciousness (Deo et al.,1999).

2.3.2 Reasons for using natural dyes on textiles

In spite of better performance of synthetic dyes but recently, the using of natural dyes having more attraction to consumers and making more interesting on research studies regarding this natural dyes. some of the important reasons are following:

- Wide availability of natural dyes and their huge potential.
- Availability of experimental evidence for allergic and toxic effects of some dyes, and non-toxic and non allergic effects of natural dyes.
- Availability of scientific information on chemical characterizations of different natural colourants, including their purification and extraction.
- Availability of knowledge base and data base on application of natural dyes on different textiles.
- To protect the ancient and traditional dyeing technology generating livelihood of poor artisan/dyers, with potential employment generation facility.

- To generate sustainable employment and income for weaker section of population in rural and sub-urban areas of both of dyeing as well as for non-food crop farming to produce plants for such natural dyes.
- Specialty colours and effect of natural dyes produced by craftsman and artisans for their exclusive technique and specialty work (Samanta et.al,2001 &Gotmare et.al,2001).

2.3.3 Application of natural dye in textiles

2.3.3. a. Antibacterial and Deodorizing properties of natural dyes

A number of studies have indicated that plants synthesize aromatic substances such as alkaloids, terpenoids, and phenolic compounds as their secondary metabolites (Singn et al., 2005).These compounds are antimicrobial and are produced by the plants in response to an attack by a pathogen; therefore their function is that defense mechanism for plants against microorganisms. These compounds are great importance as the substances have been successful in protecting plants from bacterial attack since time immermorial , without causing the bacteria to develop resistance to them (Sarkar et al., 2009). The use of natural product and natural dyes for antimicrobial finishing of textile material has been widely reported (Hang et al., 2005).

2.3.3. b. Textile printing of natural dyes

There are four reports on the printing of textile materials with different natural dyes. The printing of natural fabrics with natural dyes from alkanet and rhubarb by using pigment-printing techniques(Rekaby et al.,2009). From this study showed that the highest K/S value was obtained by using Meypro gum as a thickener. The K/S increases rapidly as the concentration of the natural dye powder in the printing paste increases from 10 to 40g/kg printing paste. Moreover, results show that the printed goods, which were fixed via steaming, have relatively higher colour strength than their corresponding samples fixed via thermodynamics. The best results were obtained by using metal mordants at a concentration of 20 g/kg printing paste. The colour fastness results were ranging between very good and excellent (Hakeim et al.,2005).

2.4 Mordants

Natural dyes require chemical in the form of metal salts to produce an affinity between the fibre and pigment, and these chemicals are known as “mordants” (Sengupta, 2001). Mordants help binding of dyes to fabric by forming a chemical from dye to fibre, thus improving the staining ability of a dye along with increasing its fast properties (Vankar, 2000).

A mordant is often a polyvalent metal ion used to cause fibres to open up and receive colouration by absorbing the dye acids present in the plants. The resulting coordination complex of dye and ion is colloidal and can be either acidic or alkaline. A mordant does not serve as a colour source of its own (Samanta et al.,2009 & Blisset et al.,1993) .

2.4.1Types of Mordants

Different types of mordants yield different colours even for same natural dye. The choice of mordant depends upon the fabric. An alkali mordant, such as soda ash, works well with cotton, and acid mordant such as vinegar works well with wool. Mordants can be classified as follows (kumbasar,2011).

A) Metallic mordants

Metallic mordants are generally metal salts of aluminium, chromium, iron, copper and tin. They can be again classified into following into two categories:

a) Brightening mordants (e,g.)Alum, chrome (potassium dichromate), and Tin (stannous chloride).

b) Dulling mordants (e.g.)Copper (cupric sulphate), and Iron (ferrous sulphate)

(Kumbasar, 2011).

B) Tannins

Tannins are polyphenolic compounds having capacity of gelling under certain conditions. Among the tannins, myrobalan (herda) and galls/sumach are most important (Kumbasar, 2011).

C) Oil type mordants

These types of mordants are vegetable oil or turkey red oil (TRO). TRO is mainly used in the dyeing of deep red colour from madder. Oil mordanted samples show better fastness and hue.

2.4.2Common mordants for natural colour dyeing

Commonly used mordants for natural colour dyeing include tannic acid, alum, urine, chrome, alum, sodium chloride, and certain salts of aluminium, chromium, copper, iron, iodine, potassium, sodium, and tin. Containers , other than glass or stainless steel may also be used, and the metals from which they are made may be employed to exert an influence on the ultimate color of the dye the form of a mordant.

Historically, stale urine was used a lot as a mordant. It is strongly alkali and also affects the final colour of several day. It is still a good one t use but not many people like working with these days (Clarke, 2013).

2.4.2. a. Cream of Tartar

It is used to soften wool, brighten shades, and point the color of some dyes .Cream of tartar works best with animal or protein fibres and is seldom used with plant or cellulose fibres (Vankar et.al,2008).

2.4.2. b. Myrobalan

This dyestuff consists of ground nuts of the Terminalia chebula tree. It may be classed as both a mordant and a dye, giving a light buttery yellow when applied. The color works well for over dyeing. Myrobalan is also the perfect color to lay down under a single indigo dip for teal (Vankar et. al,2008).

2.4.2. c. Alum (Aluminium Potassium Sulfate)

This is the most widely used mordant. It usually produces pale version of the prevailing dye color in the plant. It is usually considered a neutral mordant, in that it does not result in a color that is appreciably different than that of the dye bath. It is considered to have good color fast properties, though other mordants result in even more color fast shades .

2.4.2. d. Copper (Copper Sulfate/Bluestone)

This mordant is used to bring out the greens in dyes. It will also darken the dye colors, similar to using tin, but is less harsh. Copper is used to "sadden" color, as it tends to turn them blue-green. It can be used as both an after-bath to adjust an alum-mordanted color, or it can be used as a pre-mordant on its own. The colors dyed with copper are generally more colorfast than those dyed with alum.

2.4.2. e. Chrome (Potassium Dichromate)

Chrome brightens the dye colors and is more commonly used with wool and mohair than with any other fibre. Chrome is a mordant that tends to add a golden hue to dyes, and is considered to be quite color fast .Chrome has played an important historical role in dyeing very dark and colorfast blacks in conjunction with logwood .It is not used often now ,due to health hazards .

2.4.2. f. Tin (Stannous Chloride)

Tin will give extra bright colors to red, oranges and yellows on protein fibres. Tin is considered to be a generally neutral mordant, yet it brightens colors causes them to pop a bit. Tin can be used as a pre-mordant in a separate step, like alum , through care must be taken to preserve the hand of the fibre .

2.4.2. g. Iron (Ferrous Sulfate/Copperas/Green Vitiol)

It dulls and darken the dye colors. Iron can be used as a mordant on its own, but it's generally used an afterbath, to modify color dyed on fibre that was initially mordanted with alum. Its "saddens" color, making it more greenish - brown. Protein fibres like wool are very sensitive to iron, and too much time can damage the fibre and or make it have a harsh feel .

2.4.3 Methods of applying mordants

There are three methods by which mordanting can be done:

- Pre-mordating (on chrome): The Substrate is treated with the mordant and then dyed.
- Meta-mordanting(metachrome): The mordant is added in the dye bath itself.
- Post –mordanting(afterchrome): The dyed material is treated with a mordant.

This type of mordant used changes the shade obtained after dyeing and also affects the fastness property of the dye.

The study were done on the effect of pre-mordanting and post –mordanting with aluminum sulfate, ferrous sulfate under different and reported that pre-mordanting and post-mordanting with ferrous sulfate, there was huge change in hue and a great deal of decrease in the chroma or purity of color .Also, alum and iron did not result in any appreciable increase in fastness properties (Ali et al, 2009). The methods of dyeing silk with some natural colourants derived from arjun bark, babul bark and pomegranate rind and also mordanted with various mordants viz. tannic acid, copper sulfate, stannous chloride, ferrous sulfate and aluminum sulfate by using different mordanting techniques (pre, post and meta mordanting). It was found that dyed samples were compared to the unmordanted dyed samples which indicate that mordant improves color strength, brightness as well as fastness properties of the dyed silk fabric (Bhattacharya et al, 2009).

The effect of nylon fabric was dyed with three natural dyes derived from onion(Allium cepa,) lac (Laccifer Lacca) and turmeric (curcuma longa)using various mordants by two different techniques.(viz. open bath and high temperature high pressure(HTHP) dyeing methods).HTHP dyeing has been found to give better results as compared to the open bath dyeing. Good wash fastness was obtained with all three natural dyes (Lokhande et al., 1999).

2.5Anti microbial Finishing

The antimicrobial finishes are also referred to as bacteriostatic or antiseptic finishes. As the term suggest , these suppress growth of microbes, including disease and rot causing bacteria as well as mildew producing fungi. Such fabrics serve very important purpose in everyday life and also in special situations. By using some natural dyes too have inherent antimicrobial properties, making fabrics dyed with resistant to germs (Seema, 2011).Antimicrobial finishes, particularly important for industrial fabrics that are exposed to cold weather conditions .Fabrics used for wings, windscreens, tents, tarpaulins, ropes, frost protection from rotting and mildew. Home furnishing textiles such as carpets, shower, curtains, bath mats,floor mats, mattress ticking and upholstery also require antimicrobial finishes. Fabrics and clothing used in place where there might be danger of infection from pathogens can benefit from antimicrobial finishing (Kumar, 2013).

2.5.1History of Antimicrobial

The history of Antimicrobial begins with the observations of pesticide Joubert, who discovered that one type of bacterial could prevent the growth of another. Microorganisms especially bacteria, are becoming resistant more quickly than new drugs, are being made available. Thus future research in antimicrobial therapy may focus on finding how to over come resistance to antimicrobial or how to treat infections with alternative means, such as pieces (Ramakrishnan et al., 2007). The consumers are now increasingly aware of the hygienic life style and there is a necessity and expectation for a wide range of textile products finished with antimicrobial properties (Manasi , 2014).

2.5.2 Types of Anti microbial

Anti microorganism having the two important types are

A) Leaching type

This type of antimicrobials diffuse from the textile substrate into medium, such that growth of the microorganisms coming in contact with the leached products get inhibited. This type of antimicrobial compound can be incorporated into fibres and control the release rate to extend shelf life of the antimicrobial agent or even add them to chemical binders. Also these type of compounds are directly incorporated into fabric, such fabrics are termed as bioactive fabric.

B) Non-Leaching type

This antimicrobial being bound to the garment do not migrate off but destroy the bacteria coming in contact with the surface of the garment .The chemical gets attached to the substrate either by chemical bounding or by polymerizing, forming a layer on the surface of the treated fabric .Hence, the finishing will be permanent and will remain effective for a substantial length of time. The finish may withstand for more than 40 laundry washes (Manasi ,2014).

2.5.3 Requirement of antimicrobial finish

- Wash durability, dry cleaning and hot pressing
- It should not produce harmful effects to the manufacturer, user and the environment
- It should compile with the statutory requirements of regulating agencies
- Compatibility with the chemical processes
- Easy method of application
- No deterioration of fabric quality
- Resistant to the body fluids
- Resistant to disinfectant/sterilization
- Quick acting and effective in killing or inhibiting the growth of a broad spectrum of microbes
- Non-selective and non-mutable to pathogens
- Fast to repeated laundering,
- dry cleaning and exposure to light
- Minimal environment impact (Sunny, 2013).

2.5.4 Mechanism of antimicrobial activity

A variety of chemical finishes have been used to produce textile with demonstrate antimicrobial properties. These products can be divided into two types based on the mode of attack on microbes. One type consists of chemical that can be considered to operate by a controlled release mechanism. The antimicrobial is slowly released from a reservoir either on the fabric surface or in the interior of the fiber (Peter, 2004).

2.5.5 Techniques for applying antimicrobial finish

1. Exhaust and pad-dry-cure processes can be used for antimicrobial finishing on natural as well as synthetic fibers for the application of biocides such as triclosan etc
2. Padding, spraying and foam finishing have been for the silicon –based quaternary agents (gang sun,1994).
3. An emerging method for antimicrobial finishing is to used the sol-gel process which allows the fabrication of materials with a large variety of properties-ultra fine powders, monolithic ceramic fibers, inorganic membranes thin film (Cransto, 2008).
4. Microencapsulation of a chemical agent with the fiber in a matrix (Choudhury, 2008).

2.5.6 Microbes used in textiles

A variety of antimicrobial finishes have been developed for application to textiles .All the active chemicals are designed to kill microbes and pests but the issue or otherwise to the humans continue to be area of concern (Deepti, 2001). Biodegradable non-allergic and non-toxic, chitin and chitosan have binding properties that work as excellent flocculants to clarify liquids; helps wound quickly, from strong, permeable films and function effectively as drug-delivery gels for tropical application of a variety of treatments (Raymond,2002). Microorganisms have been affected the industry through the development of more efficient and more environmentally friendly manufacturing processes, as well as through the design of improved textile material. Some of their key roles have involved the implementation, production of novel and biodegradable fibres from biomass feedstock (Soni,2007).Textiles incorporating antimicrobial agents might not be prevent the penetration or direct contact with viable ring use requires pathogenic microbes during use, as the effectiveness of antimicrobial agents requires direct contact with the microbes for a specific period under defined conditions (Maheswari,2010).Textiles designed for biological protection have two functions: first protection of the wearer from being attacked by bacteria, yeast, dermatophytic fungi, and other related microorganisms which cause aesthetic, hygiene or medical problems: secondly, production the textile itself from deterioration caused by mold, mildew, rot-producing fungi and digested by insect and other pests (Craighead,2011).

2.5.7 Introduction: Fungi

Antifungal textiles have been mainly developed for the production of textile itself and a better preservation of the characteristics of the fiber. Dampness favors the development of microscopic fungi which can damage the textile and cause permanent coloring (Singh, 2006).Fungi are thallophytic that have no green plant pigment .Spores generally reproduce fungi. The fungi derive organic substances from the bodies of other organisms, living or dead. The fungal body, which is generally called “thallus”, is either a single cell or thread structure. That is called hyphae. In the most fungi, spore-producing cells, from a part of special structure made up of hyphal tissue and called the fruit body. The simplest part of the fungi possess a unicellular, filamentous, branching thallus, whose cytoplasm contains, a great member of partitions to divide them (Mishra, 2005).

2.5.8 Introduction: Bacteria

E.coli can carry genes that allow the bacteria to colonize the small intestine, where bacterial numbers are usually very low. This allows the bacteria to have earlier access to the nutrients passing down the gastrointestinal tract removing the need to complete with the bacteria of the large intestine (Amyes, 2013).Bacteria produce many enzymes that digest or change complex food materials into simpler compounds into larger compound .Certain bacteria are able to synthesize all compounds necessary for growth from sugars and essential elements. Other must obtain certain growth factor, vitamins, and or/amino acids from the environment. Bacteria occur everywhere in soil, water, air, food, dust, the oceans and are found on and in plants and animals.

2.5.9 Benefits of antimicrobial

The user of the textile products can expect them to be safe in use and not to pose a health risk. For instance, an employer demands that specific work wear is worn or actually provides such work wear, he must ensure that this is safe as part of his duty of care towards his employee (Isner, 2006).A wide range of textile products is now available for the benefit for the consumer. Initially, the primary objective of the finish was to product textiles and technical textiles such as geo-textiles have therefore all been finished using antimicrobial agents. Later, the home textiles such as curtain coverings, bath mats came with antimicrobial finish. The application of the finish is now extended to textiles used for outdoor, healthcare sector, sports and leisure (Maheswari, 2010).

3. EXPERIMENTAL PROCEDURE

The methodology of the present study entitled **"Assessment of Antimicrobial Activity of *Carica papaya leaves in Khadi fabric*"** is discussed under the following two phases

3.1. Selection of Fabric

3.2 Preparatory process

3.2.1Desizing

3.3 Collection of Source

3.4 Preparation of source extraction

3.5 Optimization of various parameters for Dye Extraction (UV-Visible spectroscopy)

3.6 Dyeing parameters

3.7 Selection of Mordant

3.8 Selection of mordanting technique

3.9 Evaluation of finished fabric

3.9.1Physical Property

3.9.1.a. Fabric Thickness

3.9.1. b. Fabric Weight

3.10Mechanical property

3.10.a. Fabric Tensile Strength and Elongation

3.11Comfort Property

3.11.a. Fabric Stiffness

3.11.b. Fabric drapeability

3.12 Absorbency test

3.12.a. Drop test

3.12.b. Sinking test

3.12.c. Wicking test

3.13 Colour fastness

3.13.a. Colour fastness to sunlight

3.13. b. Colour fastness to washing

3.13.c. Colour fastness to dry and wet pressing

3.13.d. Colour fastness to dry and wet crocking

3.14 Antimicrobial test

3.14. a. Parallel streak method Bacteria _(AATCC 147)

3.14. b. Agar Diffusion method Fungai – (AATCC 30)

3.14. c. SEM test

3.15 Statistical Analysis

3.16 Nomenclature

3.1 Selection of the fabric

The hand spun and hand woven process gives khadi an extra ordinary texture and finish that can't be found in any machine made fabrics.The loom used in weaving of khadi interlaces the threads in a manner that allows maximum air permeable and sooths the body better than any other fabrics does. It is warm in winter, cool in summer, very light, soft feel texture and versatile fabric. This fabric has coarse texture and gets easily crumpled, therefore in order to keep it firm and stiff, starch is to be added. This fabric on washing is more enhanced thus the more wash it gives the better look. They are to the body and do not cause any allergies or irritations to the body like other synthetic fabrics do. Khadi is an alternative lifestyle in tune with the rhythm of nature.The production and all marketing process of khadi are done by Khadi & village Industries Commission(KVIC) which are set up by government of India in 1956(Elangoran and Mohan,2006).Hence the investigator purchase khadi cotton fabric fom the khadi shop, Coimbatore.

3.2 Preparatory process

The aim of the pretreatment operations for khadi to remove the natural and added impurities to the maximum possible extent with minimum loss in strength of the fabric (chaven,2013)

3.2.1 Desizing

Desizing is the process in which the sizing material applied to the warp yarn before weaving is removed to facilitate the penetration of dyes and chemicals in the subsequent wet processing operations. Desizing process is done in three methods:

1. Rot steeping

2. Acid desizing

3. Enzymatic desizing (karmakar,2011)

Although it is the most important operation but in many mills it is neglected.The main ingredients of sizing mixture are starch, wax and tallow; they remain on the warp yarn after weaving.An emulsifying agent is also added to sizing mixture, which facilitates the subsequent removal of size ingredients (kara,2011). Desizing of khadi fabric is the most important step necessary to make fabric suitable for further processes.Desizing is most commonly two categories:

1 .Oxidative

2. Acid desizing (khana,2013)

Five percent of detergent powder was mixed thoroughly in 1:20 ratio of water and heated upto 100^0c.The sample was stirred gently for 1 hour. After that it was taken out, squeezed and then rinsed using soft water until it was free from traces of detergent. Later the fabric was dried in shade. (plate I)

TABLE-I

Recipe for desizing

S.NO	PARTICULARS	PARAMETERS
1	Material (gms)	Kg
2	Detergents (gms)	5%
3	Water (ml)	1:20
4	Temperature (^{0}C)	100^0
5	Time (hr)	1

Desizing of khadi fabric(plate I)

Carica papaya leaves (plate II)

Carica papaya leaves powder (plateIII)

Extraction solution (plate IV)

3.3 Collection of source

The *carica papaya* plant is fast growing an erect, usually this plant grows unbranched shrub/tree (Afolayan, 2003). The plant act as analgesic, amebicide, cardiotonic, cholagogue, digestive ,emenagogue, febrifuge, hypotensive , laxative, pectoral, stomachic and vermifuge, antibacterial, which refer to these plant described as a form of documented property. During the last few decades the significant development has been achieved regarding the therapeutic property of papaya. The chemical compound of karpain, has been found in the leaves of papaya plant which compounds are to kill the microorganisms often interfere with digestive function. Papaya leaves are to be used as a treatment of malaria. The activity of antimalarial and antiplasmodial has been noted in the preparation of the plant (udoh, et. at 2005).Due to these activities the investigator selected carica papaya leaves for this study.The leaves were collected from the rural area of Coimbatore and around the campus.The collected leaves were shadow dried for four to seven days and then it was powered stored in an air tight container (plate II, III).

3.4 Preparation of source extraction

The source carica papaya leaves were collected from rural areas in Coimbatore and around the campus, washed and shade dried for four to seven days. The source was prepared in a powder form, further aqueous extraction was carried in water bath. Boil known amount of dyestuff at one hour. Then, the solution was filtered using filter paper to remove the residues, after extraction was over the dyestuff was record the optical density (plate IV).

3.5 Optimization of various Parameters for Dye Extraction(UV-Visible spectroscopy)

UV-Visible spectroscopy is a mature technique capable of both quantitative and qualitative analysis of liquid, solid and gaseous samples. The technology can be applied to instrumentation capable of measuring micro-volume liquid samples less than 1µL up to solid sample surface larger than the instrument performing the instrument performing the measurement. The wide range of sample provides the flexibility of automating liquid handling measurement of large batches of samples.

With a wide range of reflectance and fibre optics accessories the technique can be applied to virtually any solid sample surface from matte to mirror like in nature. Measurement environments range from ambient air to oxygen and moisture free atmospheres and from low temperature to high temperature conditions (www.thermofisher.co.nz).

Colours of extract are used to measure using UV-Visible spectrophotometer. Therefore numbers of pilot studies were carried out to measure the exhaustion and fixation of the dyestuff. Degree of exhaustion is the amount of dyestuff, which is diffused in the fibre from the dye bath at the time of dyeing. The absorbance of the extracted *Carica papaya* dye is also analyzed by UV-Visible spectroscopy instrument. The maximum colour absorbency was obtained at 296 nm wavelength which was kept constant for optimization of dye concentration, time, temperature and ph for the extraction (rahman et al., 2013).The dyes from Carica papaya were extracted by the following methods using UV-Visible spectrophotometer.

3.5.1 Optimization of dye concentration

To determine the optimum concentration of the dye source, was carried out at various concentration such as(1,2,3,4,5,6,7,8,9&10%), were taken individually and placed in water bath for one hour at 100^{o}c.The optical density of the dye solution was analysed spectrophotometrically at 296nm.

TABLE-II

Concentration of dye (%)	Optical density at 296nm
1	0.296
2	0.378
3	0.566
4	0.779
5	0.966
6	**1.511**
7	1.504
8	1.507
9	1.510
10	1.510

From the above table, it is clear that the absorbance of the dye extract increased with increase concentration of selected powder. Maximum colour intensity was noticed at 6% concentration.

Optimization of dye concentration

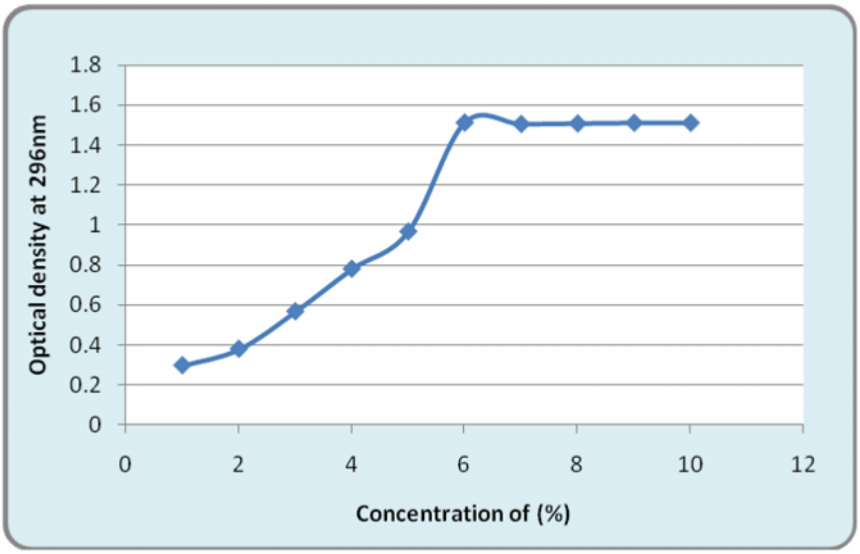


Figure I

3.5.2 c dye extraction time

To determine the optimum extraction time, the dye extraction was carried out at different time intervals such as 30-120 min. The optical density of the dye solution was analysed spectrophotometerically at 296nm.

TABLE-III

Optimization of time

Time(min)	Optical density at 296 nm
30	1.217
60	0.742
90	**1.319**
120	0.325
150	0.317

From the above Table it was clear that the colour intensity of the dye extract ,increase in time and reaches maximum at 90 min. Hence, the optimum time for extraction of dye was selected as 90 min.

Optimization for dye extraction time

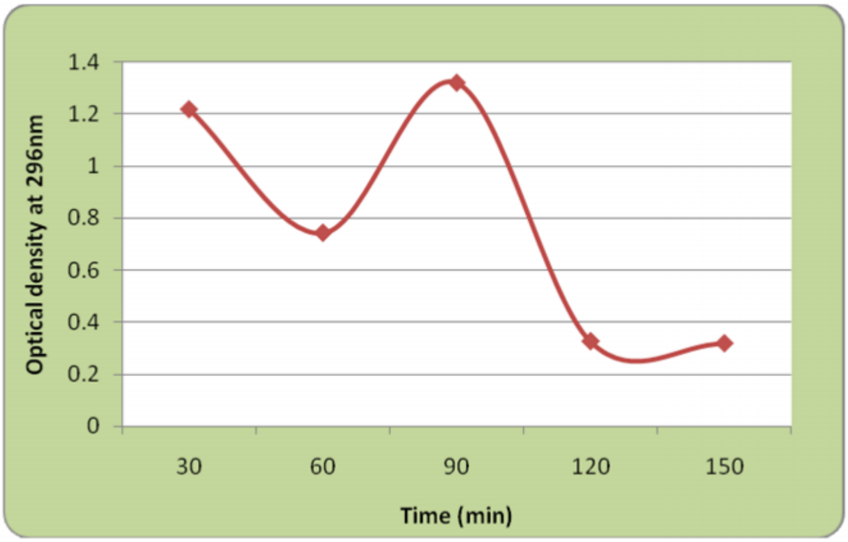


Figure II

3.5.3 Optimization for temperature during extraction

To determine the optimum temperature for dye extraction was carried out at different temperature such as 30-110^{o}c.The optical density of the dye solution was analysed spectrophotometrically at 296nm.

TABLE-IV

Temperature ^{o}c	Optical density at 296nm
30^{o}c	2.193
60^{o}c	1.572
90^{o}c	2.060
100^{o}c	1.261
110^{o}c	**2.297**

From the table, it was clearly portraits that rise in temperature increase dye extraction and reaches maximum absorbency at 110^{o}c.Hence, 110^{o}c was fixed as optimum temperature for the extraction of dye.

Optimization of temperature

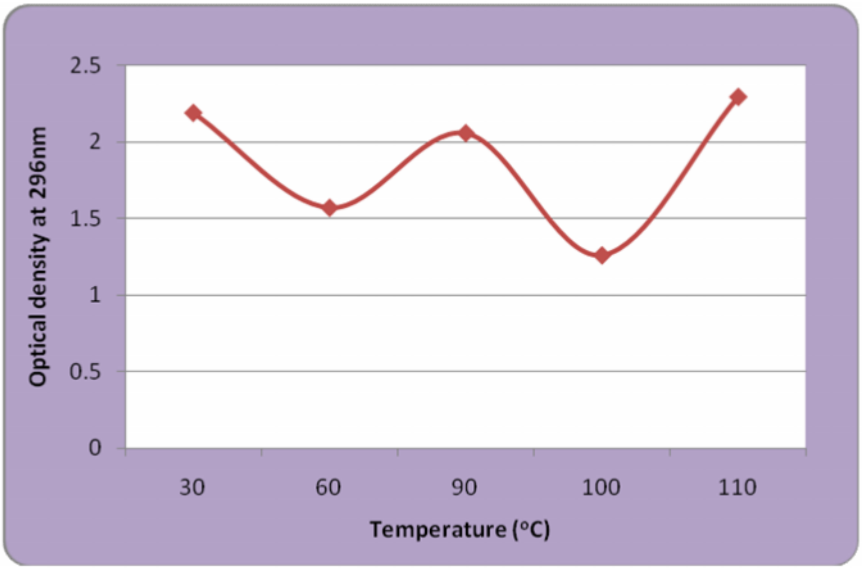


Figure III

3.5.4 Optimization of pH

To determine the optimum pH for extraction, the pH of the solvent was adjusted to 3,5,7,9,11 and 1 using 1NH HCL or 1 N NaOH. Optical density of the dye solution was analysed spectrophotometrically at 296nm.

TABLE-V

pH	Optical density at 296nm
3	0.95
5	0.37
7	1.06
8	**1.94**
11	0.42

OPTIMIZATION OF pH

The above table clearly reveals that increase in Ph increase dye extraction up to 8,and further increase in pH decreases the colour intensity .In the acid medium the selected source was not possible to dye the fabrics. Hence pH was selected as optimum pH for extraction of dye from from selected source.

Optimization of pH

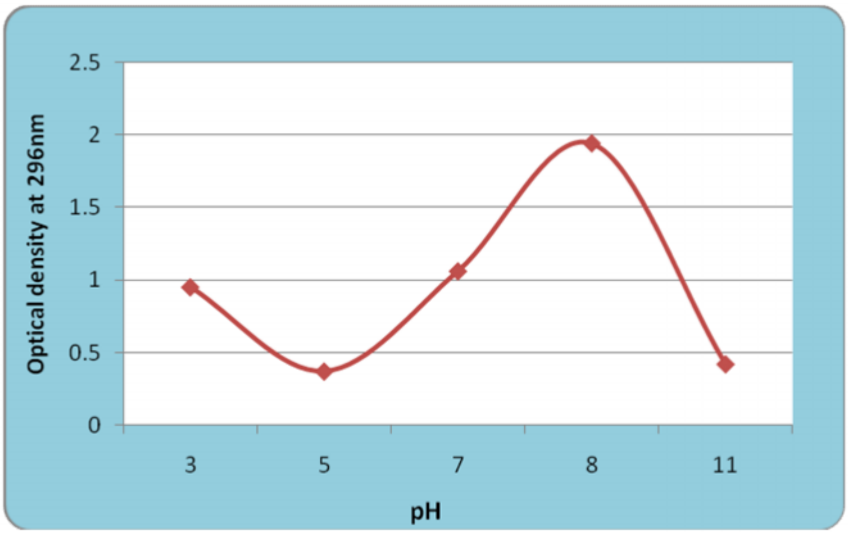


Figure IV

3.5.5 Extraction of dye under optimized conditions

Dye was extracted using suitable solvent under optimized conditions of pH, time, concentration and temperature.

TABLE-VI

Optimized parameter for dyeing

Parameters	Optimized conditions
Solvent	Water
Time	90 min
Temperature	110^{o}c
Concentration	6%
pH	8

3.6 Dyeing Parameters

3.6.1 Optimization of dyeing temperature

When a cellulosic fabric is dyed with natural colourant, the amount of dye absorbed on the fabric depends upon its temperature. At low temperature dye molecules are not activated to absorb on to fabric while at high temperature either colourant may be degraded or clusters of dye molecules gather on surface may start desorbing and give poor shades. To determine the dyeing temperature was carried out at different temperature 30^{o}c, 60^{o}c, 90^{o}c, 100^{o}c and110^{o}c.Based on visual inspection colour obtain from 110^{o}c was excellent.Hence,110^{o}c is the optimum temperature.

3.6 .2 Optimization of dyeing time

In dyeing time process is very important parameter because long and short – time dyeing gives the same effects as the variation of dyeing temperature. Dyeing for low time causes absorption of less amount of colourant onto fabric, while dyeing for long time may shift the equilibrium from fabric to dye bath (Batool et al., 2013). For this reason the optimum time dyeing was carried out at different time intervals 30, 60, 90, 110 and 120min.Based on visual evaluation colour obtain from 80 min time interval was excellent.Hence,110 min is the optimum dyeing temperature.

3.6 .3 Optimization of material liquor ratio

Too low amount of dye cause unevenness due to presence of insoluble materials while too high concentration may cause gathering or cluster of dye molecules onto fabric resulting in unevenness. For this reason the optimization for material liquor ratio was carried out at different ratio of 1:10,1:20,1:30 and 1:40 of M:L.The optimum dye concentration was selected based on the shade produced on the fabric (Hasan et al.,2014). The optimized parameters for dyeing the selected khadi fabric are as follows.

Material: liquor ration	: 1:10
Time	: 110 min
Dyeing temperature	: 90^{0}c

3.7 Selection of mordant

The importance of mordant comes in when dye has no affinity to the fibre. Most of the natural colourants are in nature; they require an intermediate to fix in to the fibre, which is called (Ammayappan et al.,2013). The importance of mordants is attributable to the fact that they are employed to fix the colouring matter of the dye stuff in the fibres of the organic bodie and to give them brilliancy and permanency. They are many different mordants used to help natural dyestuff bindings to a textile substrate whereas others can also influence or change the colour impression and saturation of the dyed textile, depending on the nature and concentration of the mordant(Cardon,2007). Some of the commonly used natural mordant is myrobalan, pomegranate peel, alum, onion peel, goa leaf ash, sodium chloride and orange peel.

Alum (aluminum potassium sulphate) is a white mineral deposit that is a component of many types of rocks. Alum usually refers to a hydrated double sulfate of potassium hydrogen sulphate, which confers evenness and brightness on dyed fabrics. Potassium aluminum sulfate is the mordant most frequently used by dyers for protein (animal) and cellulose fibres and fabrics. It improves light and wash fastness of all natural dyes and keeps the colours clear. It is expensive and safe to use (http://www.maiwa.com/pdf/natural-dyeing.pdf).

Punica granatum is from the family Punicacea. Pomegranate is used both as a tannin rich mordant and also as a dye. The rind of pomegranate contains a considerable amount of tannin, about 19 percent with pelletierine .It will provide a greater colour range with more successful results in most vegetable fibres. The main colouring agent in the pomegranate peel is granatonine which is present in alkaloid form N-methyl granatonine it helps for dye fixation to the textile material (Kulkarni et al., 2011)

From the above listed mordants, the best was selected based on optimization of the mordants by a mordanting technique.Each mordant was subjected to premordanting at 110^{o}c for 90 min.Among these mordants the investigator had planned to choose alum as the suitable mordant.

3.8 Selection of mordanting techniques

Three process of mordanting were used; they are pre mordanting, simultaneous mordanting and post mordanting (Suitcharit et al.,2010) Pre mordanting is a technique in which the fabric is first soaked in mordant and then boiled in the dyestuff. Simultaneous mordanting is a technique in which mordants as well as the dye is mixed together and then fabric is soaked and boiled. Post mordanting technique in which the fabric is first boiled in the dyestuff and then soaked in the mordant (Gularajani et al., 1992).

For pre mordanting one percent of alum was mixed with 100ml of water ,and then one gram fabric were first soaked in mordant for 90 min at 110^{o}C,whereas the same fabric was then boiled in the dye for 90 min. For simultaneous mordanting 50 ml of alum and 50 ml of dye solution was taken in beaker and then one gram of fabric was soaked in the solution for 90 min at 110 ^{o} C. Post mordanting one gram of sample was bolied in the dye solution for 90 min and then boiled in 100 ml of mordant solution for 90 min at 110^{o}C.

All the three types of mordanting were carried out among and these three mordanting techniques, the pre-mordanting technique was found to give better shade. Hence pre-mordanting technique was followed for the present study.

3.9 Evaluation of Finished Fabrics

To evaluate the impact of the finish given on the antimicrobial treated fabric samples and untreated samples.The samples were evaluated objectively.

3.9.1 Physical Property

Physical properties include those that characterize the physical structure of the fabric and test that measure these properties are sometimes called characterization tests. Physical properties include fabric thickness, and number of fabric weight.

3.9.1.a. Fabric Thickness

Fabric thickness is an important property that adds to the insulating effect. Two thin layers of fabric are more effect. Two thin layers of fabric are more effective than one thick layer because there is extra dead air space between the two layers. Fine fibres fill up spaces in fabric layers and increase its insulating effect. Thickness gague is the instrument used for measuring fabric thickness (Arrora, 2011).In order to determine the thickness of a compressible material such as textile fabric, the precise measurement of the distance between two parallel plates should be measured with the cloth separates them. A known arbitrary pressure between the plats should be applied and maintained. It is useful to measure fabric thickness is also useful to measure fabric thickness in order to check the material against the specification. Fabric thickness is also useful in studying fabric properties such as thermal insulation, resilience, dimensional stability, fabric stiffness, abrasion and total handle value (Kothari, 2012).

The Hungarian thickness tester was used. It has two parts, the anvil and the presser foot, which work under a lever spring action. On the top, dial indicated the thickness of the sample in the thousand of an inch. Each division on the dial read is 0.01mm.The sample was placed on the anvil plate, the lever of the presser foot presser foot released very slowly, and the presser foot pressed the sample. The dial indicated the thickness of the sample. Ten readings were taken from different places of the fabric samples and the mean was calculated (plate VII).

3.9.1. b. Fabric Weight

Fabric weight is determined by weighting the complete piece roll,cut, or bolt, or by selecting and weighting the a full with sample,1/4 yard in length there from the weight per square yard,weight per linear yard,per pound may be calculated as follows yard.

$$\text{Fabric weight} = \frac{\text{fabric weight in lbx6x36}}{\text{Fabric length in yards}} \text{ X width in inches}$$

The O was cut with GSM (Grams per Square Meter) die cutter which is 100 cm2.The sample was weighed in an electronic balance. The weight of the sample was measured in grams and multiplied with 100 to get GSM value. Five samples were tested and the average was calculated. The same procedure was followed for all OS, PS, DS samples (plate V).

GSM cutter (plate V)

Electronic weighting balance (plate VI)

Fabric thickness tester

(plate VII)

Fabric Tensile Strength Tester **Fabric stiffness**

(Plate VIII) **(Plate IX)**

Drape meter (plate X)

3.10 Mechanical property

3.10. a. Fabric Tensile Strength and Elongation

Tensile strength is the most important property of a fabric. In almost every fabric development and manufacturing, tensile properties are reported. Modules, breaking strength and elongation at break are widely used for quality control. This method of tensile testing was commonly used in textile industries such as cotton, wool and flax, but is increasingly being replaced by the single and strength test method .Another important quality of practical interest is the breaking length of the yarn, expressed in kilometers.The breaking length of specimen breaking under its own tensile strength (Hall, 2004).

Each O sample was clamped between the jaws. It is necessary to see whether the sample was perpendicular to the load. The load was applied and the readings were noted in kilograms and the elongation in inches as well as centimeters was noted as soon as the sample was broken. Five readings were taken and the mean strength and elongation was fund out to the strength loss or gain in the fabric before and after finishing .Similarly OS, PS, DS also tested using same procedure (plate VIII).

3.11 Comfort Property

3.11. a. Fabric Stiffness

The main purpose of the stiffness function is to provide a means to automate the calculation of the stiffness matrix of arbitrary finite elements and thereby increasing the flexibility of the meshing process. The facility with which the material stiffness matrix can be calculated is not only important in terms of under spinning mesh refinement and adaptive meshing, but more importantly, to conduct a more correct and precise, i. e material adaptive stress analysis(Weissenbach,2004).

A5x1 rectangular strip of fabric is mounted on a horizontal platform in such a way that it overhangs,like a cantilever and bends downwards.From the length and angle, a number of values are determined.Each specimen is tested four times, at each end and again with strip turned over.Mean value for the bending length in warp and weft direction can be calculated and if required,values for flexural rigidity and bending modulus can be included(plate IX).

3.11 b) Drape Test

Drape test systems currently used worldwide include the pierces cantilever method, the fabric research liberating method (FRC drape meter) the cantilever method measures fabric bending characteristics and then converts them into a measures of fabric drape. In the actual test, the light beam casts a shadow of the draped fabric on to a ring of uniform translucent paper supported on a glass screen.The surface pattern area on the paper ring is directly proportiponal to the mass of that area.So the drape coefficient can be calculated in a simple way (Hu,2008).

$$F = \frac{\text{Mass of shaded area}}{\text{Total mass of paper ring}}$$

Drapability, coupled with lightness, therefore explains, largely, the success of fibres for clothing and these are often the reasons why fibres find use in technical applications. However, this means that the structure made from fibres is different from other structural material (Bunsell, 2009).

Two small circular plates held a circular piece of fabric, so that its free edges drape down under their own weight.For ordinary textile fabrics, a satisfactory spread of difference in drape behavior is obtained, when diameter of fabric specimen is 30 cm and the diameter of the disc in 18cm.

A value known as drape co-efficient F1 is determined by considering the following,

A_D-the area of the specimen

A_d-the area of the supporting disc

A_s- the actual projected area of the specimen

To drape co-efficient is given by

$F=A_S-A_d/A_D-A_dX100$

Thus the readings were taken from original and all finished samples.Then their mean value was calculated and tabulated (plate X).

3.12 Absorbency Property

3.12. a. Drop Test

It was noted earlier that in the initial stages of wetting the drops of wetter pearl off the fabrics but in time pearling ceases, the fabric become wet. The drop test is a count number of drops required to penetrate through to the underside of the fabric when all the drops fall on the same spot (Raul,2005).

A burette filled water was clamped in a stand. The stand was mounted in an embroidery frame and was placed at the base of the stand. The distance between the sample and the burette nozzle was kept constant. The nozzle of the burette was opened just to allow a drop of water to fall on the sample. The stopwatch was simultaneously and it was stopped when the drop of water fully sink into the material. The time taken for this was noted. The same procedure was carried out for the untreated and treated sample and the mean value was calculated and recorded (plate XI).

3.12. b. Sinking Test

Sinking time test can also be carried out on the fabric cutting it in to a specific small size and dropping the same on the surface of water loosely without putting any thurst (chudhry, 2006). Fibres of known density are placed in the column and allowed to reach their stable positions in the liquid i.e. where the density of the fibre matches that of the liquid. The test fiber is introduced into the system and the point at which the sample stop sinking is taken as the point of equivalent density (Houck, 2009).

Five samples were cut into te size of 5 cmx5 cm square from the untreated and treated samples.A 1000ml beaker was filled with distilled water.The sample was dropped into the surface of the water from a standard height.The stopwatch was started when the fabric struck the surface of the fabric 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 five samples. The mean value was calculated for the above samples.Similarly, the mean value of the untreated and treated samples were calculated and the sinking time of each material was record separated (plate XII).

3.12. c. Wicking Test

Wetting and wicking in textile fabrics are complex processes. The liquid comes into direct contact with ,fibres, forming a solid-liquid(wetting) and is then transported in the capillaries between the fibres must first wetted, so wetting is an essential procure or to wicking characteristics of fabric depend on the chemical nature of both the liquid and the fibre and on the fabric structure itself(ward man et al., 2011). This test method measures the distance water will wick up a cut edge of fabric. Sample is conditioned in atmosphere conditions for textiles; 1 cm of the sample is submerged in ionized water has moved along a cut edge of fabric is measured (wasif, 2013).

A strip of fabric was suspended vertically with its lower edge in reservoir of distilled water. The rate of rise of the leading edge of water was then noted. To detect the position of water line a dye was added to the water after 30 minutes and the rise in the water line was noted. The measured height of rise in 30 minutes was taken as a direct indication of the test fabric and recorded in centimeters (plate XIII).

3.13 Colour fastness

Clolour fastness is the resistance of the coloured materials to colour change or loss as the result of exposure to different agencies. These agencies that will affect the coloured materials include the light, water, washing, bleaching agents, dry cleaning solvents and abrasion etc. The coloured materials are normally exposed to these agencies during the manufacturing process and in daily subsequent use.Therefore, the fastness test methods must stimulate the end use and performance expected by different customers for the materials (Nassauk, 1997).

There are many national standards including the British Standards (BS), International Standard (ISO) and the European Standards (EN). The major types of colour fastness test are colour fastness to washing, colour fastness to washing to rubbing (Horrocks &S.C., 2000).

Drop test(plate XI)

Sinking test(plate XII)

Wicking Test (plate XIII)

3.13. a. Colour Fastness to Sunlight

The colour fastness to light is the most important properties of dyed and printed fabric needed to fulfil its utilization purpose over a period of time. It's referring to the ability of the fabric to withstand colour change when exposed to sunlight (Prabhavathi et al.,2014).A sample piece of 2x2 cm was cut from the material .It was divided into eight divisions of 2 cm and exposes, consecutively, II – division was cut on the second day and so on. Finally, the first division, after exposing for seven days was evaluated with the help of grey scale for the natural dyed and printed samples.

3.13. b. Colour Fastness to Washing

The loss of colour during laundering is referred to as lack of wash fastness or bleeding. During wet treatment such as washing and dry cleaning, adjacent analysed material may take up colour due to the transfer of dye from the original dyed material as staining in wet treatments.

The test samples of 7 x 7 size were cut from the coloured materials. Each sample was sandwiched between the undyed cloth which was desized (Ingameils, 1993). For wash test, soap solution of about 5gm/100 ml was prepared and test samples were removed. Later the samples were rinsed in cold water thoroughly, squeezed well and dried. The colour change and staining of the specimen were assessed using grey scale.

3.13. c. Colour Fastness to dry and wet pressing

This method was intended for the determination of colour fastness of textile material of all kinds and in all forms to ironing and to processing on hot cyclinders. A piece of coloured fabric was placed between two pieces of white cloth. The fabric were placed under heat for 30 seconds, at a particular temperature. The specimen was removed from the heat and compared for the colour change and staining with the gray scale. The same procedure was adopted adding moisture to the white material for wet processing (AATCC, 1994).

3.13 d) Colour Fastness to dry and wet crocking

Crocking test is designed for determining the degree of colour which may be transferred from the surface of coloured textile material to other surface by rubbing. The sasmira crock meter consists of a platform over which the fabrics to be tested is fixed using fabric holder. The centre of the fabric holder has a rectangular slot through which the crank arm rubs the standard white fabric of size 2 inch x 1 inch was cut against the fabric to be tested. A load was applied on the crank such that rubbing takes places at a particular load. The instrument had automatic counter which can be set for predetermine to and fro strokes for the crocks. After completion of test cycle the rubbed area and the grey area are completed with ASTM grey scale.Grades are classified as 1, 2,3,4 and 5 were grade 1 indicates poor rubbing fastness and grade five indicates good rubbing fastness. To determine the rubbing colour fastness test in wet condition the white fabrics was wetted and test procedure was the same (Booth, 1996).In this manner, the crocking fastness both in wet and dry condition for dyed fabrics were noted. The results were tabulated for both dry and wet crocking separately.

3.14 Anti microbial test

The effect of the extracts on the test organisms were studied by following methods for bacteria and fungu namely:parallel streak method and agar diffusion method.

3.14 a) Parallel streak method-bacteria (AATCC test method 147-1988)

Principle

The Parallel Streak Method has filled a need for a relatively quick and easily executed qualitative method to determine antibacterial activity of diffusible antimicrobial agents on treated textile materials. The objective of this test was to detect bacteriostatic activity on textile materials. The Parallel Streak Method has proven effective over a number of years of use in providing evidence of antibacterial activity against both Gram positive and Gram negative bacteria.

Specimens of the test material including corresponding untreated controls of the same material were placed in intimate contact with AATCC bacteriostasis agar, which has been previously streaked with an inoculum of a test bacterium. After incubation, a clear area of interrupted growth underneath and along the sides of the test material indicated antibacterial activity of the specimen. A standard strain of bacteria was used, which was specific to the requirements of the materials under test.

Culture medium used

AATCC bacteriostasis agar medium was used as growth medium for valuation. (composition is as mentioned earlier).

Test specimens

Test specimens (non sterile) were taken, and they were cut in to pieces of 25mm x 50mm size. A 50mm length permitted the specimen to lay across 5 parallel inoculums streaks each of diminishing width from both 8mm to 4mm wide.

Test cultures used

Escherichia coli, and *Staphylococcus aureus* were the standard Gram positive and Gram negative cultures for the assessment of antibacterial activity of textile substrates as per the recommendation of AATCC.

Procedure

Sterile AATCC bacteriostasis agar was dispensed in sterile petridishes. 24 hrs broth cultures of test organisms were used as an inoculum. Using sterile 4mm inoculating loop, a loop full of culture was loaded and transferred to the surface of the agar plate by making five parallel inoculum streaks approximately 60mm in length and spaced 10mm covering the central area of the petridish without refilling the loop. The test specimen was gently pressed transversely, across the five inoculums of streaks to ensure intimate contact with agar surface. The plates were incubated at 37^{o}C for 18 to 24 hours.

Evaluation

The inoculated plates were examined for the interruption of growth along the streaks of inoculum beneath the fabric and for a clear zone of inhibition beyond the fabric edge. The average width of the zone of inhibition around the test specimen was calculated in mm using the formula (2).

Zone of inhibition (mm) = (T-I)/2 ……. (2)

where **T** referred to width of zone of inhibition and **I** referred to width of specimen.

3.14. b. Agar diffusion method-fungi (AATCC 30)

The purpose of this test method was to determine the susceptibility of textile materials to mildew and rot, and to evaluate the efficacy of fungicides on textile materials. Certain fungi can grow on textile products without causing measurable breaking strength loss within a laboratory experimental time frame. This procedure was used to evaluate textile specimens where growth of these fungi was important.

Test specimens

Fabric samples were cut into 3.8 ± 0.8 cm in diameter in duplicate and used.

Test Organism: *Aspergillusniger* and *Candida albicans*

Culture medium

The stock culture of *Aspergillusniger* and *Candida albicans* was maintained on potato dextrose agar slants.

Potato dextrose agar

Dextrose	– 20 g
Infusion from potatoes	– 500 ml
Agar	– 20 g
Distilled water	– 500 ml
pH	– 3.5

Fresh potato (200 g) were cut into small slices and boiled in 500 ml of distilled water and squeezed through cheesecloth to get as much pulp as possible. Then dextrose (20 g) and agar agar (20 g) were added to potato extract and the final volume was made up to 1litre with distilled water. A quantity of 10.0 ± 0.5 ml was dispensed in conventional culture tubes (125 x 17 mm), sterilized and the slants were prepared.

Inoculum

The scrapings from a ripe (7-14 days) fruiting culture of the fungus were added to sterile Erlenmeyer flasks containing 50 ± 1 ml of sterile water and a few glass beads. The flask was thoroughly shaken to bring the spores into suspension. This suspension was used as the inoculum.

Procedure

Potato dextrose agar medium was prepared and dispensed in petridish and the spores of the fungi were inoculated into 50±2 ml of sterile distilled water containing few glass beads and shaken vigorously to bring the spores into suspension. About 1.0±0.1 ml of inoculum was distributed evenly over the surface of the agar. The test specimens were placed in contact with hardened agar medium over which 0.2±0.001 ml of the inoculums was evenly distributed by means of a sterile pipette. The plates were incubated at 27^0C for 5 days.

Evaluation method

At the end of the incubation period the antifungal activity was reported by measuring the zone of mycostasis underneath and alongside of the fabric.

3.14 c) Surface Morphological Studies Using Scanning Electron Microscopy (SEM)- EBSD

The scanning electron microscope (SEM) uses a focused beam of high-energy electrons to generate a variety of signals at the surface of solid specimens. The signals that derive from electron-sample interactions reveal information about the sample including external morphology (texture), chemical composition, crystalline structure and orientation of materials making up the sample. In most applications, data are collected over a selected area of the surface of the sample, and a 2-dimensional image is generated that displays spatial variations in these properties. Areas ranging from approximately 1 cm to 5 microns in width can be imaged in a scanning mode using conventional SEM techniques (magnification ranging from 20X to approximately 30,000X, spatial resolution of 50 to 100 nm). The SEM is also capable of performing analyses of selected point locations on the sample; this approach is especially useful in qualitatively or semi-quantitatively determining chemical compositions (using EDS), crystalline structure, and crystal orientations (using EBSD).

3.15 Statistical Analysis

Statistics is used for presenting facts in a definite form, statistics simplifies mass of figures facilitates comparison and also help in prediction and in formulating hypothesis (www.bcps.org). ANOVA is commonly used to test difference among the mean of several independent groups.Thus statistical analysis has been done for the parameters and the findings are presented in results and discussion paper.

3.16 Nomenclatures

The nomenclature of samples is given below:

TABLE-VII

Nomenclature of the samples

S.NO	Nomenclature	Abbreviation
1	Original Khadi Cotton	OKC
2	Pretreated Khadi Cotton	PKC
3	Dyed Khadi Cotton	DKC

4. Results and Discussion

The results of the study "**Assessment of Antimicrobial Activity of *Carica papaya leaves in Khadi fabric*"** are discussed under following headings

4.1 OBJECTIVE EVALUATION

4.2 Objective Evaluation

4.2.1 Fabric Weight

The fabric weight and analysis of variance of original khadi cotton fabric, desized, natural dyed fabric is shown in the Table VIII and Figure V .

Table VIII

Fabric weight

S.No	Sample	Mean value(g)	Gain/Loss	% Gain/Loss	F Value
1	OKC	1.10	-	-	157.625**
2	PKC	1.08	-0.02	1.44	
3	DKC	1.23	-0.15	13.38	

Original Khadi Cotton(OKC), pretreated Khadi Cotton(PKD),Dyed Khadi Cotton sample(DKC)

** - Significant at 1% level

From the table-VIII and figure V it is clear that the weight of the OKC sample was 1.10 grams and the fabric DKC has shown a consistent increase in weight by 1.23 grams and PKC has decreased in weight by 1.44 percent respectively. The reason for increasing the weight of natural dyed sample may be due to presence of dye compound absorbed by the fabric. From the results, it is evident that ANOVA value of 157.625 is significant at one percent level.

Fabric weight

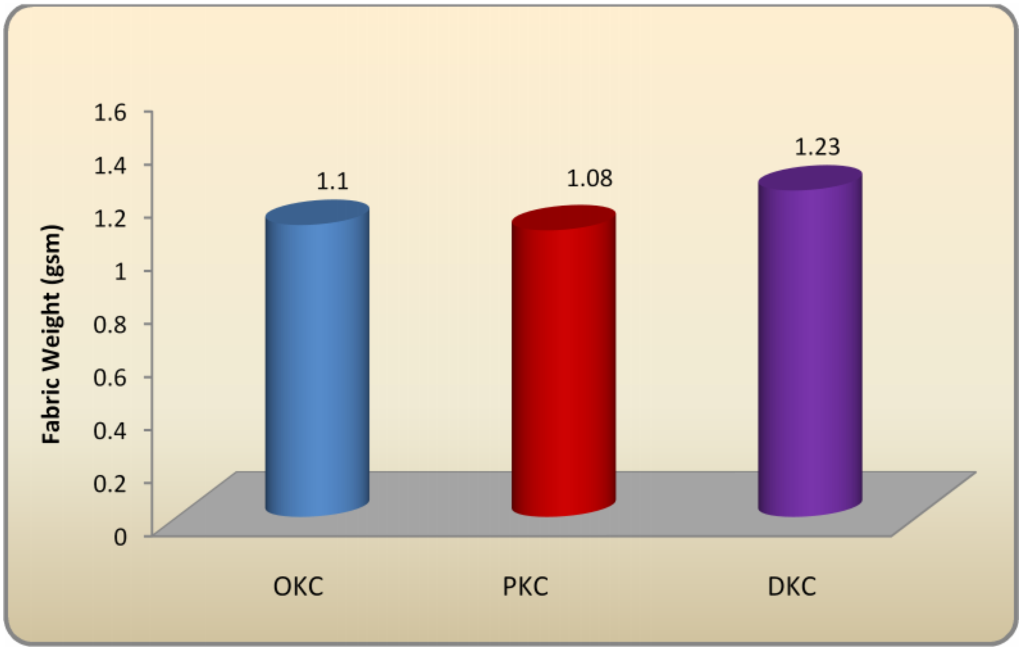


Figure V

4.2.2Fabric thickness

The fabric thickness and analysis of variance of original khadi cotton fabric, desized khadi cotton and dyed khadi cotton fabric is depicted in the table IX and figure V.

Table IX

Fabric Thickness

S.No	Sample	Mean value	Gain/Loss	% Gain/Loss	F Value
1	OKC	0.42	-	-	4.758*
2	PKC	0.39	-0.03	6.67	
3	DKC	0.41	-0.02	5.77	

Original Khadi Cotton(OKC), pretreated Khadi Cotton(PKD),Dyed Khadi Cotton sample(DKC)

* - Significant at 5% level

From table IX and figure VI, it is noticed that among natural dyed samples, the fabric thickness has increased when compared to the original fabric by 5.77 percent . Reduction was found in PKC of 0.39 grams. The reason for increase in thickness of dyed samples may be due to presence of dye compounds which are absorbed by the fabric and the compact placement of yarn. From the value it is clear that there is pretreatment process reduce the thickness of pretreated fabric. From the results, it is evident that ANOVA value of 4.758 is significant at five percent level.

Hence it could be concluded that natural dyeing with *carica papaya* leaves increases fabric thickness.

Fabric thickness

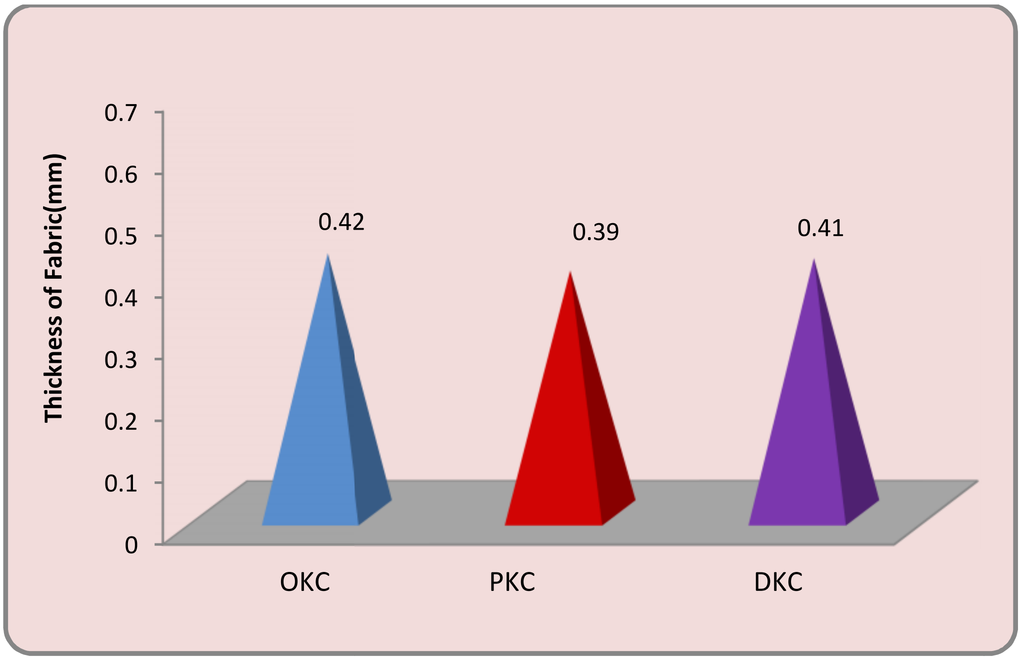


Figure VI

4.3 Assessment of mechanical property

The salient mechanical properties of the original, pretreated and dyed samples were analyzed.

4.3.1 Tensile strength and elongation

The evaluation of tensile strength and elongation of the fabrics both warp and weft direction are discussed under the following headings

4.3.2 Fabric Strength (Warp)

Fabric strength and analysis of variance of original khadi cotton fabric, desized khadi cotton and dyed khadi cotton is presented in the Table X and Figure VII

Table X

Fabric Strength (Warp)

S.No	Sample	Mean value (lb)	Gain/Loss	% Gain/Loss	F Value
1	OKC	87.20	-	-	9.674**
2	PKC	85.60	1.60	-1.83	
3	DKC	80.80	6.40	-7.48	

Original Khadi Cotton(OKC), pretreated Khadi Cotton(PKD),Dyed Khadi Cotton sample(DKC)

** - Significant at 1% level

The table X and figureVII ,show that the tensile strength of the sample OKC was 87.20 lb and desized and dyed khadi cotton sample were 85.60 and 80.80 lb resulting to a decrease in strength by -1.83 and -7.48 percent respectively. Therefore, it is clear that, the strength of the samples (PKC and DKC) has decreased when compared to OKC sample this may be due to the presence of starch in the original fabric which gives a strong binding. The statistical analysis shows that there is a one percent significant level with ANOVA value of 9.674 in comparison made between the original and treated sample.Hence it could be concluded that natural dyeing with carica papaya leaves decreased he fabric strength in warp direction.

Fabric Strength (warp)

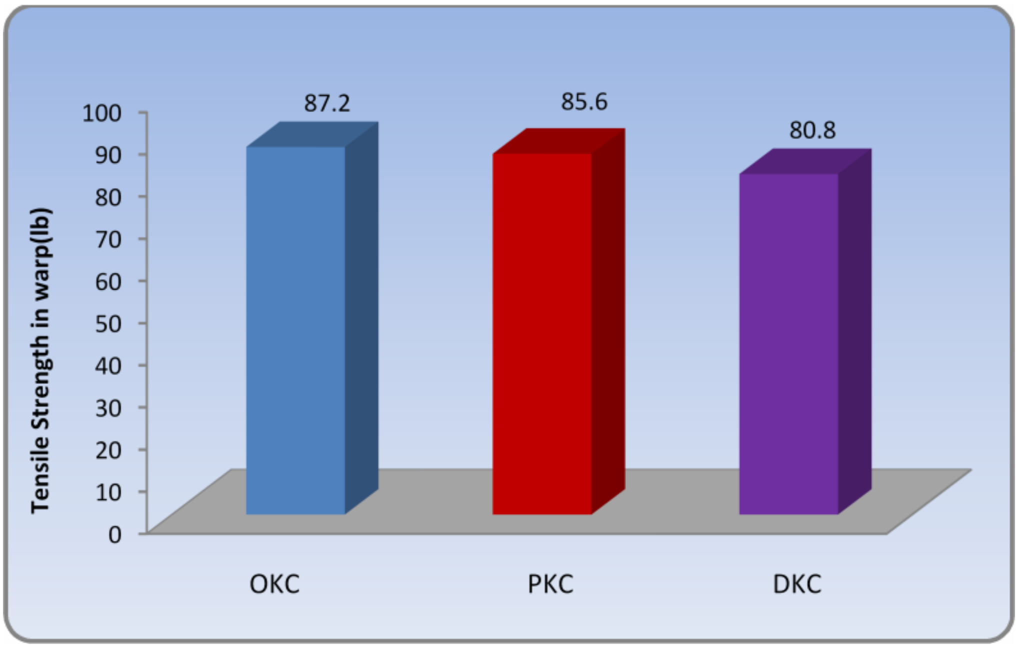


Figure VII

4.3.3 Fabric Strength (Weft)

Fabric strength and analysis of variance of original khadi cotton fabric, desized khadi cotton and dyed khadi cotton is portrayed in the Table XI and Figure VIII

Table XI

Fabric Strength (Weft)

S.No	Sample	Mean value(lb)	Gain/Loss	% Gain/Loss	F Value
1	OKC	83.20	-	-	13.64**
2	PKC	79.60	-3.60	-4.33	
3	DKC	64.0	-2.40	-24.12	

Original Khadi Cotton(OKC), pretreated Khadi Cotton(PKD),Dyed Khadi Cotton sample(DKC)

** - Significant at 1% level

The table XI and figure VIII, represent a deduction in tensile strength of the PKC and DKC samples by -4.33 and -24.12 percentage respectively. Therefore it is clear that the strength of the samples (PKC and DKC) has decreased when compared to the OKC sample this may be due to the presence of starch in the original fabric. From the results, it is evident that ANOVA value of 13.64 at one percent level. Hence the weft direction shows a decrease in strength when naturally dyed with *carica papaya* leaves.

Fabric strength (weft)

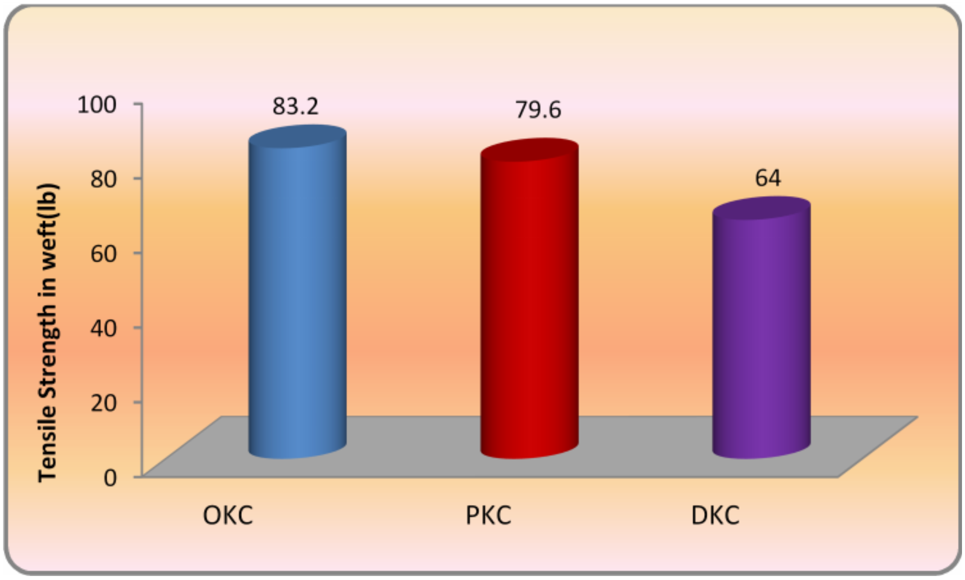


Figure VIII

4.3.4 Fabric Elongation (Warp)

Fabric elongation and analysis of variance of original khadi cotton fabric, desized khadi cotton and dyed khadi fabric is portrayed in the Table XII and Figure IX

Table XII

Fabric Elongation (Warp)

S.No	Sample	Mean value(inches)	Gain/Loss	% Gain/Loss	F Value
1	OKC	28.40	-	-	21.650**
2	PKC	26.20	2.20	-7.75	
3	DKC	31.00	-2.60	9.92	

Original Khadi Cotton(OKC), Pretreated Khadi Cotton(PKD),Dyed Khadi Cotton (DKC)

**- Significant at 1% level

From the table XII and figureIX it is perceptible that the fabric elongation (warp) of the sample OKC ,PKC and DKC was 28.40,26.20 and 31 inches thereby showing an decreased in the pretreated khadi cotton samples by -7.75 percent and increased by dyed khadi cotton sample 9.92 percent respectively. Therefore it is clear that elongation of the sample DKC and PKC has increased and decreased when compared to original khadi cotton sample. . Increase of elongation of fabric due to the pretreatment process involved in the finished fabric.

The statistical analysis shows that there is a one percent significant level with ANOVA value of 21.650 in the comparison made between the original and treated sample. Hence the warp direction shows a increase in elongation when naturally dyed with *carica papaya* leaves

Fabric elongation(warp)

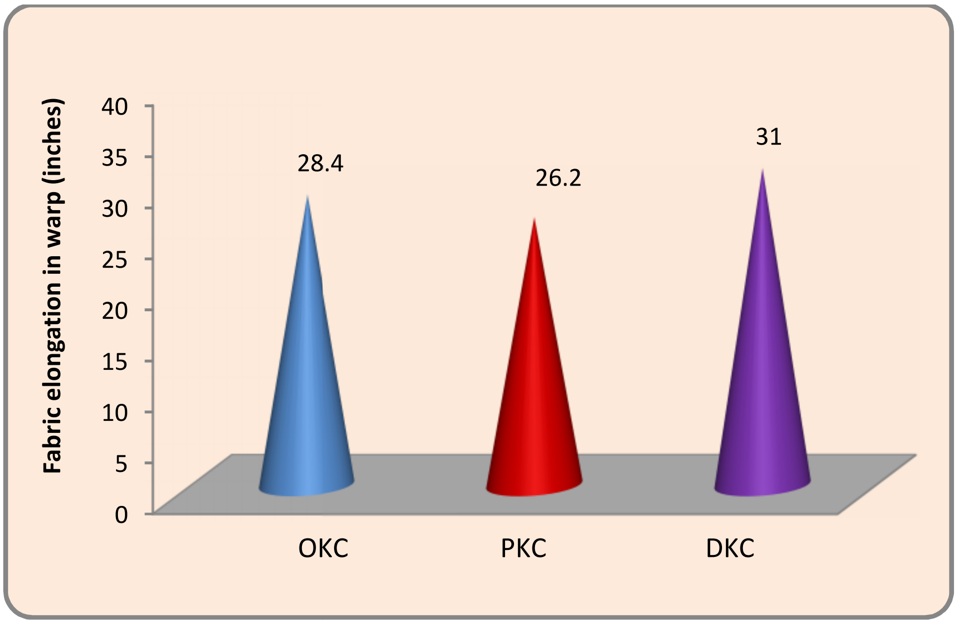


Figure IX

4.2.6 Fabric Elongation (Weft)

Fabric elongation and analysis of variance of original khadi cotton , desized khadi cotton and dyed khadi cotton fabric is represented in the Table XIII and Figure X

Table XIII

Fabric Elongation (Weft)

S.No	Sample	Mean value (inches)	Gain/Loss	% Gain/Loss	F Value
1	OKC	23.60	-	-	8.946**
2	PKC	21.60	2.00	-8.47	
3	DKC	19.40	4.20	-19.44	

Original Khadi Cotton(OKC), pretreated Khadi Cotton(PKD),Dyed Khadi Cotton sample(DKC)

** - Significant at 1% level

As per the table XIII and figure X it is clear that the fabric elongation (weft) of the sample OKC,PKC and DKC was 23.60 ,21.60 and 19.40 inches thereby showing an decreased in dyed khadi cotton and pretreated khadi cotton samples -19.44 and -8.47 percent respectively. Therefore, it is clear that elongation of the samples has decreased when compared OKC sample. The statistical analysis shows that there is a one percent significant level with ANOVA value of 8.946 and the comparison made between the original and treated sample.Hence it could be concluded that natural dyeing is reduction was found in natural dyed with *carica papaya* leaves fabric elongation in the weft direction.

Fabric elongation(weft)

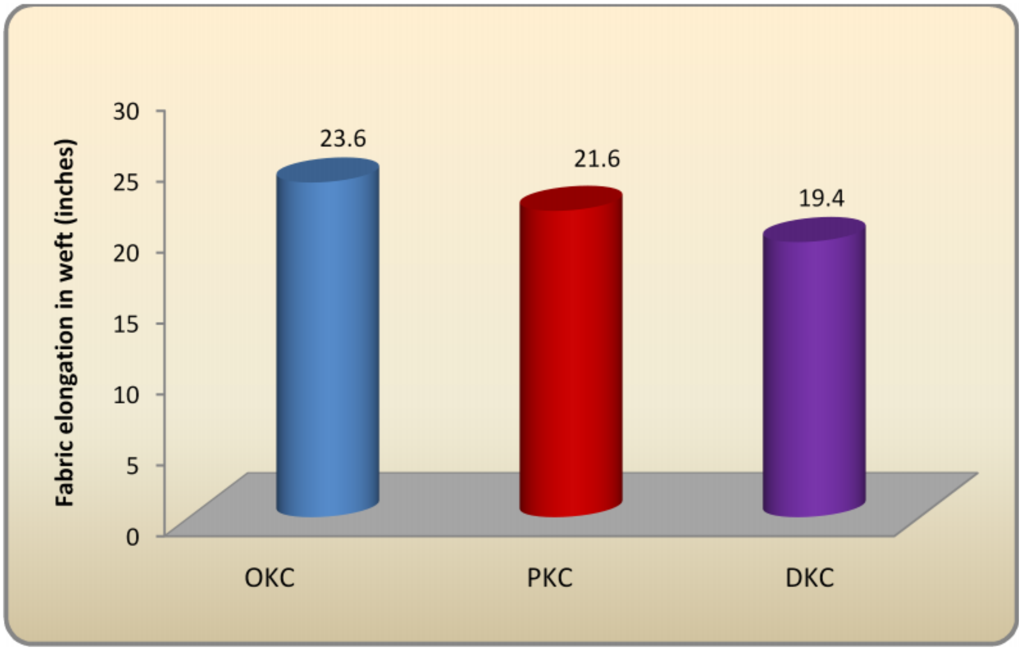


Figure X

4.4 Assessment of comfort property

4.4.1 Stiffness of fabric

The fabric stiffness evaluated in warp and weft direction were presented under the following table and figure.

4.4.1 .a. Fabric Stiffness (Warp)

Fabric stiffness and analysis of variance of original khadi cotton fabric, desized khadi cotton and dyed ckhadi cotton fabric is represented in the Table XIV and Figure XI

TABLE XIV

Fabric Stiffness (Warp)

S.No	Sample	Mean value (cm)	Gain/Loss	% Gain/Loss	F Value
1	OKC	2.86	-	-	60.581**
2	PKC	2.60	0.26	-9.09	
3	DKC	2.16	0.70	-26.92	

Original Khadi Cotton(OKC), pretreated Khadi Cotton(PKD),Dyed Khadi Cotton sample(DKC)

**- Significant at 1% level

It is obvious from the table XIV and figure XI that the fabric stiffness of PKC and DKC samples had decrease by 2.60 cm and 2.16 cm when compared to sample OKC which was 2.86 cm. The percentage loss of samples (PKC and DKC) over OKC was calculated to be -9.09 and -26.92 percent respectively.The maximum reduction in the fabric stiffness is seen in the DKC sample.This decreased in fabric stiffness may be due to removal of starch in the original that hasn't undergone any pretreatments.The statistical analysis showed that there was the significant one percent difference with ANOVA value of60.581 in the comparison made between the original and trested sample.

Hence it could be concluded that natural dyeing with carica papaya leaves decreased fabric stiffness in the warp direction.

Fabric Stiffness (Warp)

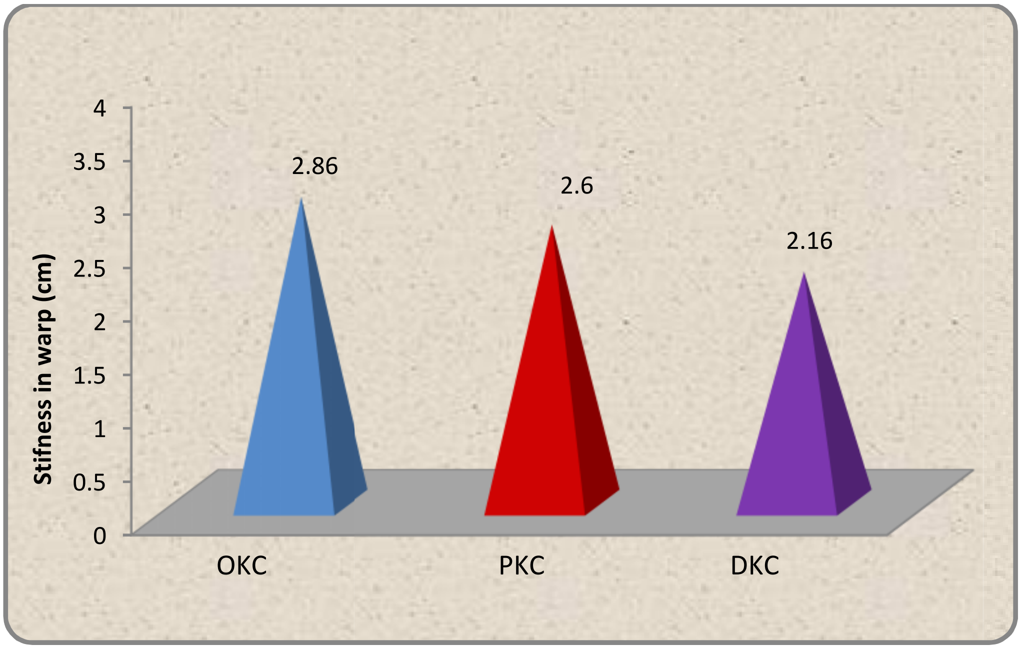


Figure XI

4.4.1.b Fabric Stiffness (Weft)

Fabric stiffness and analysis of variance of original khadi cotton fabric, pretreated khadi cotton and dyed khadi cotton fabric is presented in the Table XV and Figure XII

Table XV

Fabric Stiffness (Weft)

S.No	Sample	Mean value (cm)	Gain/Loss	% Gain/Loss	F Value
1	OKC	2.44	-	-	27.892**
2	PKC	2.12	0.32	-13.11	
3	DKC	1.92	0.52	-24.53	

Original Khadi Cotton(OKC), pretreated Khadi Cotton(PKD),Dyed Khadi Cotton sample(DKC)

**- Significant at 1% level

It is obvious from the table XV and figure XII that the fabric stiffness of pretreated khadi cotton and dyed khadi cotton sample has decreased by 2.12 and 1.92 cm when compared to sample OKC which was 2.44cm.The percentage loss of the samples (PKC, and DKC) over original was calculated to be -13.11 and -24.53 cm respectively. This decreased in fabric stiffness may be due to removal of starch in the original that hasn't undergone any pretreatments. The statistical analysis showed that there was the significant one percent difference with ANOVA value of 27.892 in the comparison made between the original and treated sample.

Hence it could be concluded that natural dyeing with *carica papaya* leaves decreases fabric stiffness in the weft direction.

Fabric Stiffness (Weft)

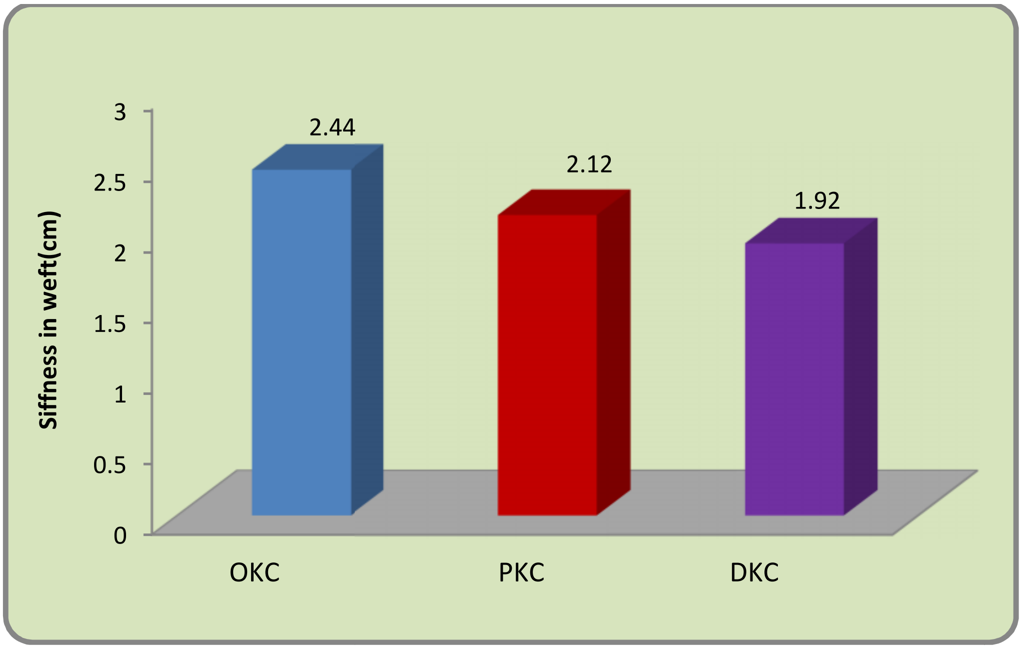


Figure XII

4.4.1.c FABRIC DRAPE

The results of the drape coefficient of fabric is original khadi cotton ,pretreated khadi cotton and dyed khadi cotton samples presented under the following table X VIand figureXIII.

TABLE-XVI

Fabric drapebility (%)

S.No	Sample	Mean value(Mg)	Gain/Loss	% Gain/Loss	F Value
1	OKC	0.74	-	-	13.27**
2	PKC	0.58	-0.16	27.58	
3	DKC	0.62	-0.12	-16.21	

Original Khadi Cotton(OKC), pretreated Khadi Cotton(PKD),Dyed Khadi Cotton sample(DKC)

** - Significant at 1% level

From the table XVI and figure XIII it is perceptible that the drapability of the sample OKC was 0.74.This has decreased in the pretreated khadi cotton and dyed khadi cotton sample by 0.58 and 0.62mg when compared to the original khadi cotton sample was 0.74mg.The percentage loss of samples(PKC and DKC) over OKC was calculated to be -0.16 and -0.12 percent respectively. The maximum reduction in fabric drapability is seen in the PKC sample. The statistical analysis showed that there was the significant one percent difference with ANOVA value of 13.27 in the comparison made between the original and treated sample.

Fabric drapebility

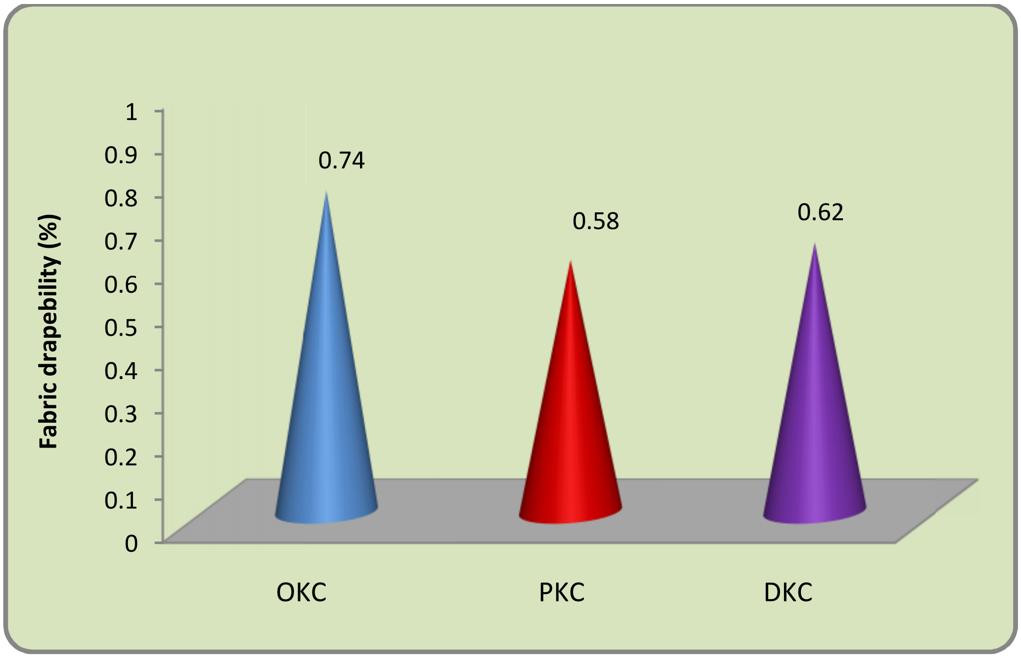


Figure XIII

4.5 Absorbency tests

The result of the absorbency tests carried out for the original khadi cotton, pretreated khadi cotton and dyed khadi cotton sample in both warp and weft directions are expressed.

4.5.1 Wicking test

The result of wicking of fabric is original khadi cotton ,pretreated khadi cotton and dyed khadi cotton samples are presented under the following table XVII and figure XIV

Table XVII

Wicking in warp and weft directions

S.No	Sample	Mean value(60 seconds in mm)	Gain/Loss	% Gain/Loss	F Value
1	OKC	58	-	-	34.28**
2	PKC	62	4.0	6.89	
3	DKC	66	8.0	13.79	

Original Khadi Cotton(OKC), pretreated Khadi Cotton(PKD),Dyed Khadi Cotton sample(DKC)

** - Significant at 1% level

From the table XVII and figure XIV it is obvious that the absorbency of the sample OKC from wicking test was 58mm whereas the absorbency has increased in the PKC and DKC samples. From among the samples (PKC and DKC) sample DKC showed the maximum rise of 13.79 percentage. Therefore it is clear that the absorbency of the samples (PKC and DKC) has increased when compared to the OKC sample. The statistical analysis showed that there was a significant one percent difference with ANOVA value of 34.28 in the comparison made between the original and treated sample.

Hence it could be concluded that the PKC and DKC sample show in increase in absorbency rate.

Wicking test

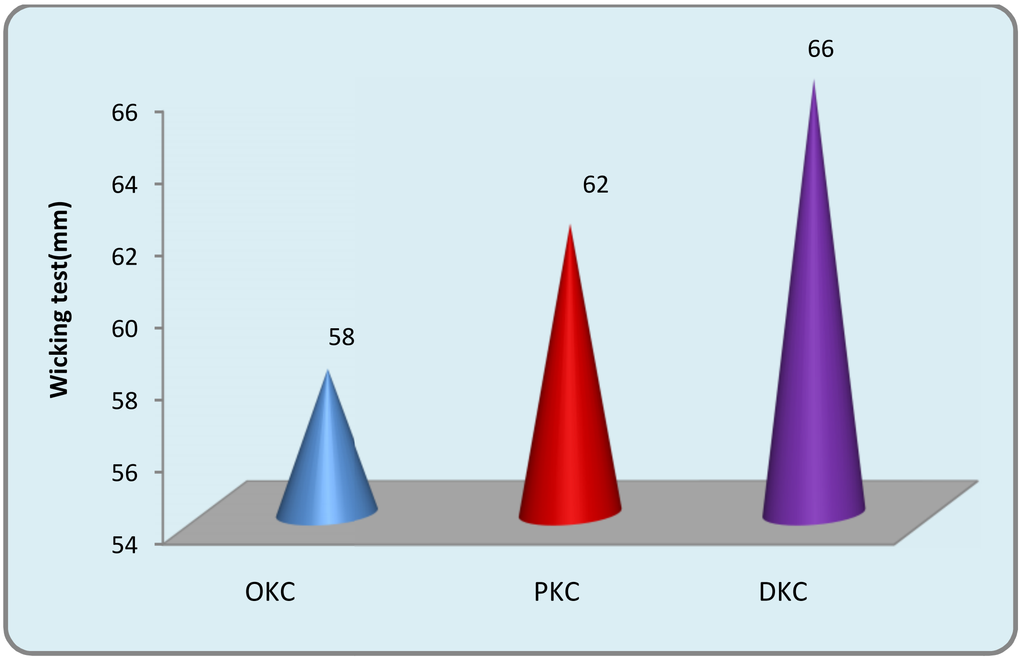


Figure XIV

4.5.2 Sinking test

The result of sinking test of original khadi cotton, pretreated khadi cotton and dyed khadi cotton samples are presented under the table XVIII and figure XV

Table XVIII

Sinking test (Seconds)

S.No	Sample	Mean value	Gain/Loss	% Gain/Loss	F Value
1	OKC	42	-	-	13.52**
2	PKC	36	-8.0	-14.28	
3	DKC	38	-4.0	-9.52	

Original Khadi Cotton(OKC), pretreated Khadi Cotton(PKD),Dyed Khadi Cotton sample(DKC)

** - Significant at 1% level

From the table XVIII and figure XV it is obvious that the liquid penetration level of the samples was OKC, PKC and DKC was 42,36and 38 sec. The represents a decrease in value when compared to OKC sample, it could actually be implied that the penetration rate is inversely proportional to time. Therefore, the sample PKC and DKC shows an increase in absorbency by -8.0 and -4.0 percent respectively. Thereby concluding that the absorbency of treated sample has decrease compared to OKC sample. The statistical analysis showed that there was the significant one percent difference with ANOVA value of 13.52 in the comparison made between the original and treated sample.

Hence it could be concluded that the pretreated khadi cotton sample exhibited an increase in absorbency and dyed khadi cotton sample exhibit decrease in absorbency as it look time for sinking.

Sinking test

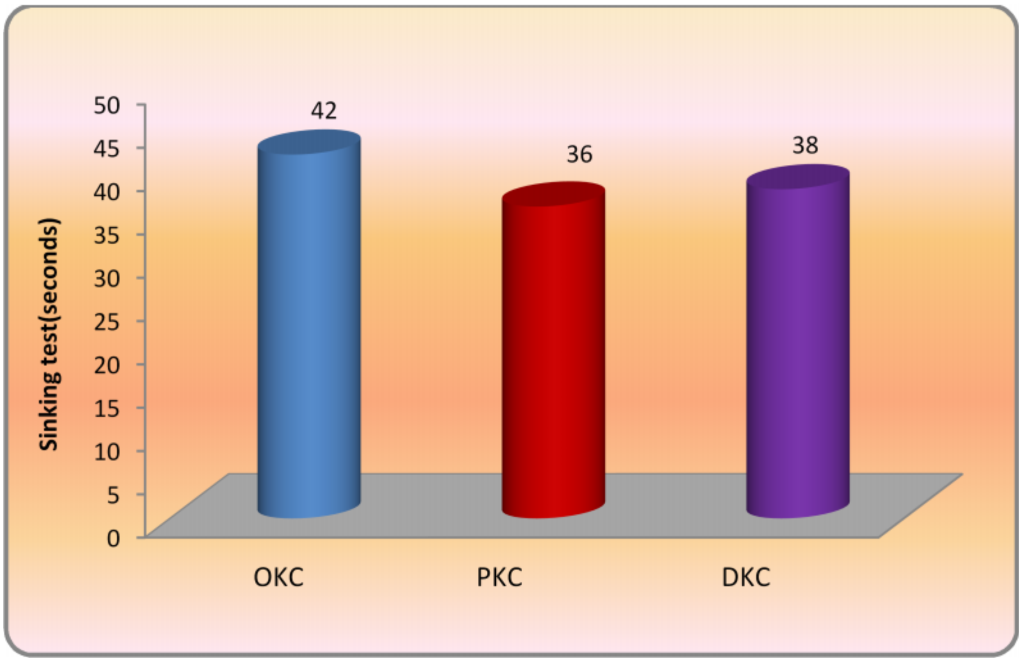


Figure XV

4.5. 3 DROP TEST

The result of drop test of original khadi cotton , pretreated khadi cotton and dyed khadi cotton samples are presented under following table XIX and figure XVI.

TABLE-XIX

Drop test (seconds)

S.No	Sample	Mean value	Gain/Loss	% Gain/Loss	F Value
1	OKC	37	-	-	46.16
2	PKC	22	-15	-40.54	
3	DKC	25	-12	-32.0	

Original Khadi Cotton(OKC), pretreated Khadi Cotton(PKD),Dyed Khadi Cotton sample(DKC)

** - Significant at 1% level

From the table XIX and figure XVI it is obvious that the absorbency of the samples OKC, PKC and DKC was 37,22 and 25 sec. Through the table represents a decreased in value when compared to OKC sample, it could actually be implied that the absorbency rate is inversely proportional to time. Therefore the sample PKC and DKC show decrease in absorbency by -40.54 and -32 percent respectively .Thereby concluding that the absorbency of the treated samples has increased compared to OKC sample.From the results, it is evident that ANOVA value of 46.16 is significant at one percent level.

Drop test

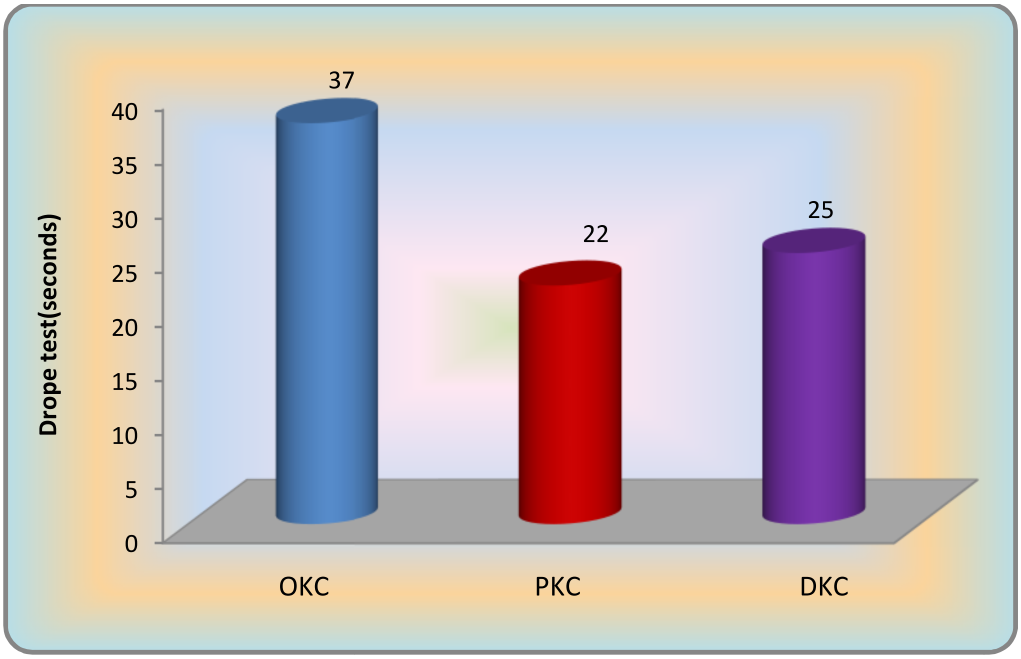


Figure XVI

4.6 Colour Fastness

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

Table-XX

Colour Fastness to crocking , pressing,washing and sunlight

S.No	Sample	Colour fastness to crocking		Colour fastness to Pressing		Colour Fastness to Washing	Colour Fastness to Sunlight
		Dry	Wet	Dry	Wet		
1	DKC	5	4/5	5	4/5	5	5

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

From the table XX ,it is clear that the dyed khadi cotton sample expressed excellent colour fastness to crocking with ratings of 5 in dry condition, whereas it slight decreased in wet condition to 4/5(very good).With regard to pressing in both dry and wet conditions was observed to be 5(excellent) in the dyed khadi cotton sample. As per the colour fastness to washing it was noted to be excellent in the dyed khadi cotton samples. The colour fastness to sunlight was related as 5 in the dyed khadi cotton fabric. Hence it could be concluded that the colour fastness was excellent in the dyed khadi cotton sample.

Hence it could be concluded that the natural dyed khadi cotton samples had good colour fastness crocking, pressing, washing and sunlight.

4.7 ANTIMICROBIAL TEST

4.7.1 Parallel streak method (AATCC test method 147-1988)

Table XXI

Parallel streak method (AATCC test method 147-1988)

S.NO	Samples	Antibacterial activity (Zone of bacteriostasis in mm)	
		Test organisms	
		Escherichia coli	***Staphylococcus aureus***
1	Control	-	-
2	Treated sample	12	18.7

The test indicates the zone of inhibition in the treated samples followed by E.coli and S.aures of 12mm and 18.7 mm respectively (plate XIV,XV).

4.7.2 Agar diffusion method-fungi (AATCC 30)

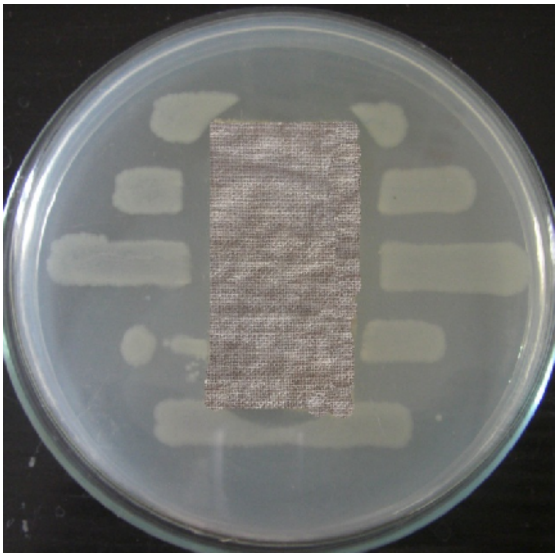
S. No	Samples	Antifungal activity (Zone of inhibition in mm)	
		Test organisms	
		Aspergillus niger	*Candida albicans*
1	Control	-	-
2	Treated sample	6.2	No activity

The test indicates the zone of inhibition of the treated sample is A .niger of 6.2 mm and no activity found in C.albicans (plate XVI, XVII).

4.7.3 Results of Scanning Electron Microscopy

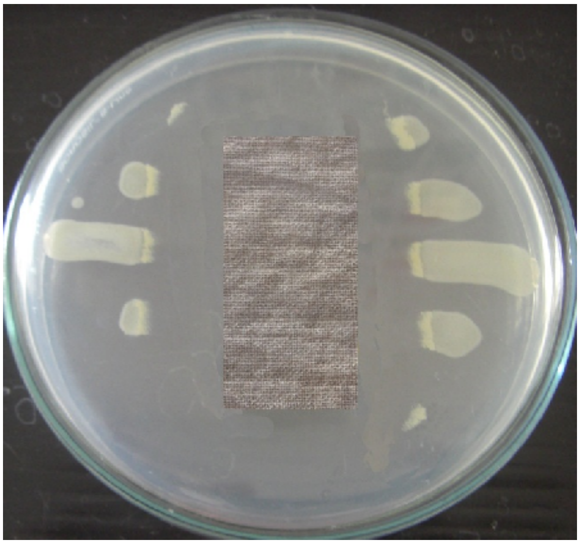
Scanning Electron Microscopic analysis was done to study the surface morphology of the fabrics. The SEM analysis exhibit or showed the adherence of the dye substance on the fabric when compare with the original fabric (plate XVIII).

PLATE XIV



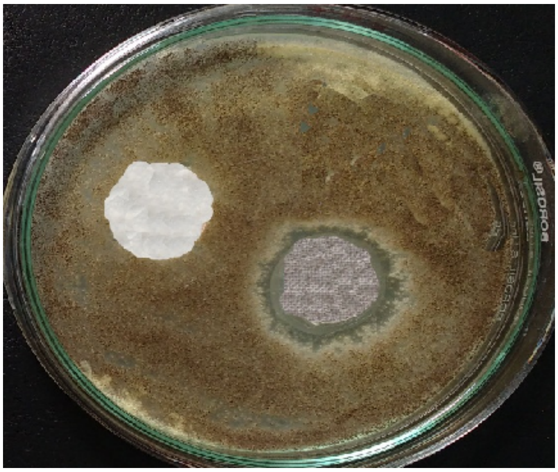
Antibacterial test - Esherichia.coli

PLATE XV



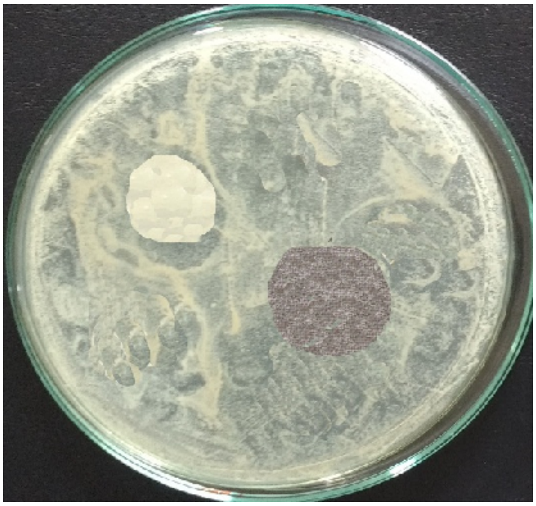
Antibacterial test - Staphylococcus

PLATE XVI



Antifungal test-Aspergillus niger

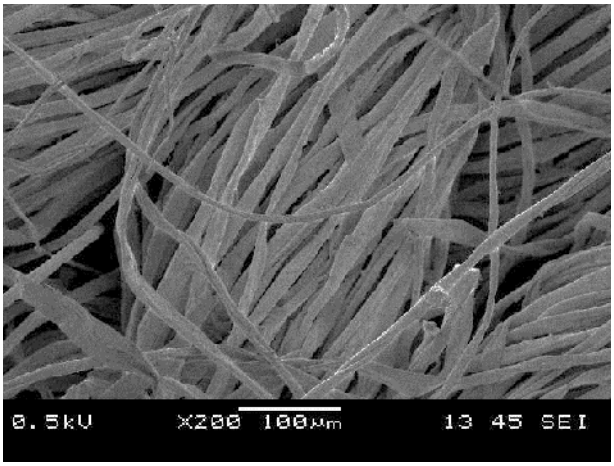
PLATE XVII



Antifungal test-Candida albicans

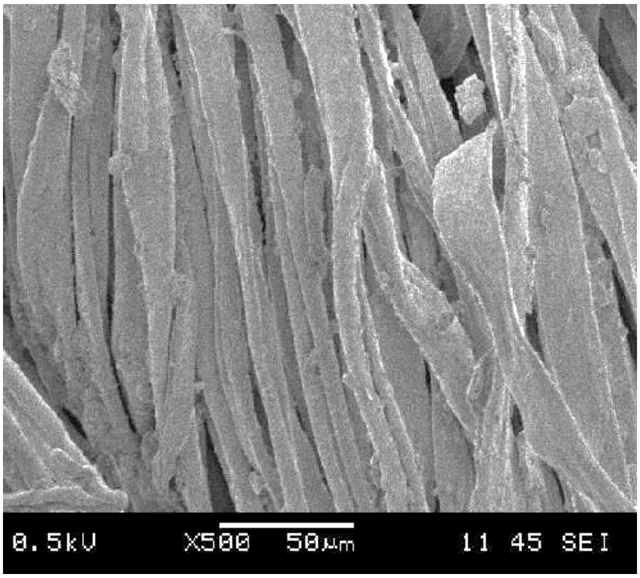
Scanning Electronic Microscopy Analysis (plate XVIII)

Untreated sample



Pretreated sample

Treated sample



5. SUMMARY AND CONCLUSIONS

The word textile used in the literal meaning/use of it a person thinks of is the apparel fabric, but basically textile is beyond that. The need of mankind has increased day by day; also due to growth and development of industries. Textile industries in India are the backbone of the national economy .It is the largest industry in India, occupying a vital role in the Indian economy and occupies a unique place in the country. Due to increasing requirements on the finishing of textile fabrics, increasing use of technical textiles that have been processed by environmentally sound methods, new innovative production techniques are demanded. Both industrialized and developing countries now have modern installations capable of highly efficient fabric production. The Indian textile industry has been undergoing a rapid transformation and is in the process of integrating with the world textile trade and industry.

Finishing is the final stage of fabric processing. It covers a wide range of processing which make unattractive,' greige' fabric turn into an attractive one. Finishing is one of the most important aspects that enhance good appearance and feel of the fabric .Textile finishes are important because it help to improve the appearance of fabric and enhance its looks. It produces variety in fabric through dyeing and printing.

Khadi is a hand spun and hand woven fabric involving a labor oriented processes. Usually khadi fabric light, and soft, making it comfortable to wear. Its weave create air pockets which make it cool in summers and warm in winters. It provides employment to weavers, financial support to farmers and eco friendly and healthy.

Today, natural colourants that are safer and eco friendly in nature are emerging globally, leaving synthetic colourants behind in race. Natural dyes produce very uncommon, soothing and soft shades as compared to synthetic dyes. On the other hand, synthetic dyes are widely available at an economic price and produce a wide variety of colours; these dyes are produce skin allergy, toxic wastes and other harmfulness to human body. Recently, there has been revival of the growing interest on the application of natural dyes on natural fibres due to worldwide environmental consciousness.

Medicinal plants are cheap and renewable source of pharmacologically active substance. The plant kingdom synthesizes diverse active compounds which are valuable in the treatment and control of many disease. Some of the active compounds do occur singly or in combination with other inactive substances which inhibit greatly the life processes of microbes, especially the pathogenic microbes. The usage of antibiotics which is resistant to pathogenic microorganisms, there is increasing rate will be developed ,it has led to make search for newer ,more effective, affordable and readily available sources, especially, which are easily available from local medicinal plant(herbs) .

Antimicrobial textiles are easily finding a place in the global textile market. All the active chemicals are designed to kill microbes and pests but the issue or otherwise to the humans continue to be area of concern. Microorganisms have been affected the industry through the development of more efficient and more environmentally friendly manufacturing processes, as well as through the design of improved textile material. Antifungal textiles have been mainly developed for the production of textile itself and a better preservation of the characteristics of the fiber. Antimicrobial finished textiles find application in sport textiles, medical textile bandages, healthcare sector and leisure. By using some natural dyes too have inherent antimicrobial properties, making fabrics dyed with resistant to germs. The consumers are now increasingly aware of the hygienic life style and there is a necessity and expectation for a wide range of textile products finished with antimicrobial properties.

Considering above facts the investigator selected the research work on the topic, **"Assessment of Antimicrobial Activity of *Carica papaya* leaves in Khadi fabric"** with following objectives.

- To select the plants for antimicrobial finish
- To extract the dye from selected *carica papaya leaves*
- To dye the selected fabric with selected plant extract
- To evaluate the dyed khadi fabric
- To study the standard testing method for antimicrobial activity

Experimental procedure

- **Selection of fabric**

  The khadi fabric was selected for the study.

- **Preparation of fabric**

  The fabric was prepared by desizing treatment to remove the impurities present in the grey khadi fabric absorb more dye than the grey fabric.

- **Preparation of source extract**
    - The leaves were dried and grounding a grinding machine in the laboratory and extracted successively with aqueous extraction method. The solution were boil known amount of dyestuff at one hour. After extraction the dyestuff was recorded the optical density value.
    - Based on the study the fabric was treated with optimized pH of 8, temperature of 110^{o}c, time 90 min and concentration of the dyestuff is 6%.
    - The finished fabric was objectively analyzed for thickness, weight, strength and elongation, stiffness, drape , sinking ,wicking and drop test.

Findings of the study

- In general appearance of the fabric texture improved as soft by using the *carica papaya* leaves.
- The percentage increase in **Thickness** of pretreated sample over OKC sample is 6.67% and the percentage gradually decrease in thickness of dyed sample over original sample is 5.77%.
- Increase in **Fabric weight** was observed on DKC sample over original khadi cotton sample is 13.38% and percentage decreased in fabric weight of the OKC sample.
- The percentage decrease in **Strength of warp direction** of fabric, it lost the strength in DKC sample is 7.48%.The maximum strength was observed in OKC sample.
- Decrease in **Strength of weft direction** of fabric, it lost the strength in PKC sample is 4.33%.
- The percentage of **Elongation in warp direction** increased on DKC sample is 9.92%.
- The percentage of **Elongation in weft direction** decreased on DKC sample is 19.44%.
- Reduction in **Fabric stiffness** was observed on DKC sample in warp and weft direction which may due to the effect of softness that has imparted to the dyed sample, thus making the fabric more pliable. Fabric stiffness in both direction is decreased by 26.92% and 24.53% respectively.

- Reduction of **Drapability** of fabric observed in PKC sample and DKC sample by 27.58% and 16.21% respectively. The maximum drape ability was noticed in OKC sample is 0.74.
- Improvement in **Wicking** both direction was noticed that the DKC sample over the PKC and OKC sample. The utmost wicking in warp and weft direction is 13.79% of dyed sample.
- Decreased in **Sinking** in both direction was observed in PKC sample over the OKC sample is 14.28%.
- Reduction in **Drop test** was noticed in PKC when compared to OKC .The loss percentage observe in this test in PKC is 40.54%.
- Evaluation of antimicrobial activity, it could be concluded that the finished fabric showed the better zone of inhibition was found in E.coli and S.aures by 12mm and 18.7mm and fungal activity of A.niger showed as 6.2mm.
- The statistical analysis also found that there was a significant difference in the tests namely, thickness, weight, strength and elongation, stiffness, drape, sinking, wicking, drop at one percent level.

Conclusion

Natural colourants that are safer and eco friendly in nature and emerging globally, leaving synthetic colourants behind in race. Natural dyes exhibit better bio degradability and are generally more compatible with environment. A variety of antimicrobial finishes have been developed for application of textiles. This finishing of textiles protects both textiles substrate and users. The consumers are now increasingly aware of the hygienic life style. There is a necessity and expectation for a wide range of textile products finished with antimicrobial substances. *Carica papaya* leaves is best for the antimicrobial agent finishes in khadi fabric. This leaves having great potential for antimicrobial finish. When natural antimicrobial finishing is applied to the khadi fabric it was observed that good in microbes resistant which are non-toxic, non-allergenic and also eco-friendly. From this study it was concluded that, the antimicrobial activity greater in *carica papaya* leaves and it was excellent in fabric property. Such as weight, strength, drape, stiffness and absorbency testes.

Recommendations

- The same study could be done on powerloom manufactured cotton fabrics.
- A comparative study can be made with different parts of the *carica papaya* plant i.e stem,seed etc.
- The antimicrobial activity could be suitable with latest techniques, like nano-finishing, microencapsulation plasma treatment.

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Appendix –I

Details of selected material

Original sample

Pretreated sample

Treated sample

Appendix-II

Colour fastness to Crocking, Pressing, Washing and sunlight

S. No	Sample	Colour fastness to crocking		Colour fastness to Pressing		Colour Fastness to Washing	Colour Fastness to Sunlight
		Dry	Wet	Dry	Wet		
1	DKC						

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